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# Reversal of Left Ventricular Functions in Chronic Mitral Regurgitation after Mitral Valve Replacement

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## ABSTRACT

**Background:** Mitral valve regurgitation leads to deterioration of left ventricular functions if not treated early. We aimed to study the effect of mitral valve replacement on normalization of ejection fraction, remodeling of left ventricular dimensions, and left atrial reduction in patients with chronic mitral regurgitation.

**Methods:** Between December 2012 and August 2014, 45 patients with chronic mitral regurgitation underwent isolated mitral valve replacement. None of the patients had any other severe valvular or concomitant disease or severe coronary heart disease. The patients were evaluated by echocardiography (preoperative, 1-week, and 1-year postoperative). The results were statistically analyzed by paired t test.

**Results:** Forty-five patients who underwent mitral valve replacement in our hospital were included in the study. The group comprised 20 men and 25 women; the mean age was 31.8 ± 6.76 years. The mean left ventricular ejection fraction was 61.09 ± 7.6 and decreased significantly to 59.04 ± 6.65 and 59.67 ± 6.56, 1-week and 1-year postoperative follow up, respectively. The left atrium showed significant reduction in size (4 ± 0.54 cm) at 1-year postoperative follow up, from (4.51 ± 0.57 cm) one-week postoperative, and from (5.55 ± 0.88 cm) preoperatively. The mean left ventricular end systolic diameter significantly decreased from 4.06 ± 0.65 cm preoperatively to 3.4 ± 0.4 cm, 1-week postoperative ($P = .01$), and also decreased significantly to 3.45 ± 0.51 cm at 1-year follow up postoperatively, but was higher than that at 1-week follow up. Also, the mean left ventricular end diastolic diameter decreased significantly during periods of follow up ($P < .001$).

**Conclusion:** Reversal of left ventricular functions and reduction of left-sided chamber dimensions are possible if early mitral valve replacement is considered in chronic mitral regurgitation before worsening of the condition.

## INTRODUCTION

Significant mitral regurgitation (MR) leads to progressive deterioration in left ventricular (LV) function with time [Starling 1993; Starling 1995], but the extent to which LV function recovers after correction of MR is unclear [Startling 1993]. Furthermore, there is controversy regarding whether ejection fraction (EF) recovers more completely after mitral valve (MV) repair or replacement [Starling 1995; Flemming 2000]. Although several authors have suggested that preoperative EF and LV end-systolic dimension (LVESD) are important predictors of postoperative EF, there is also debate about the timing of operation to optimize long-term EF recovery [Flemming 2000; Enriquez-Sarano 1994; Le Tourneau 2000].

Left atrial (LA) enlargement is commonly witnessed with mitral valve disease. Increased LA size is associated with atrial fibrillation (AF) and the risk of thrombus formation due to stasis of blood [Garcia-Villarreal 2001]. Some surgical groups recommend routine LA reduction with only a modest increase in its size and without any clinical signs of LA enlargement [Badhwar 2006; Scherer 2003]. Some groups even advocate reducing the size of the LA when it is >50 mm [Winlaw 1998]. Surgical reduction of the LA increases cross-clamp and cardiopulmonary bypass times, and is sometimes associated with excessive postoperative bleeding [Kutay 2005]. There are no standard recommendations for this procedure based on the size of the LA. We aimed to study the impact of mitral valve replacement on recovery of left ventricular functions and reduction of left-sided heart chambers in chronic mitral regurgitation patients.

## PATIENTS AND METHODS

This study was a retrospective review of the database records of patients who underwent mitral valve replacement of MV regurgitation resulting from rheumatic or degenerative etiology. The study was approved by Menoufia University Ethics Committee, and a signed written consent was taken from all patients. Between December 2012 and August 2014, 45 patients underwent mitral replacement in the Cardiothoracic Surgery Department, Menoufia University Hospital.

The surgery done in all patients was mitral valve replacement with partial preservation of the chordopapillary apparatus. In these patients the anterior mitral leaflet was completely excised and a partial or complete preservation of the posterior leaflet was performed, as the anterior leaflets had a more frequently redundant or excessive cuspal tissue, subvalvular fusion, extensive scarring, and shortening or calcification of the anterior chordopapillary apparatus. This valve pathology was mainly due to rheumatic valve disease, which was the main pathology of mitral valve in most patients in

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this study. So for the same reason, all patients in the study underwent mitral valve replacement rather than repair. We excluded patients who had previous MV surgery or concomitant cardiac procedures, or had a primary diagnosis of MR caused by congenital or ischemic heart disease. Also excluded were patients with endocarditis causing leaflet defects or subvalvular abscess at the time of the primary MV replacement.

Patients were operated on through a median sternotomy, using cardiopulmonary bypass with aortic and bicaval cannulation. Moderate hypothermia of 32°C was achieved, and tepid blood antegrade cardioplegia was used after ascending aortic cross-clamping. Mitral valve replacement was performed by highly experienced cardiac surgeons through the left atrium, using a bileaflet mechanical prosthesis. A total of 135 follow-up echocardiograms were included in the analysis. They were performed preoperatively, 1-week, and 1-year postoperatively. A GE VIVID S5 Norton Norway equipped with transducer 1.7-4 mHZ echocardiography was used.

The primary outcome of this study was the left ventricular dimensions both systolic and diastolic, left ventricular ejection fraction, and valve morphology, which were assessed by a blinded trained echocardiographer using the transthoracic echocardiography by two-dimensional imaging and Doppler measurements. LA size was measured in parasternal short axis view.

Based on the total number of patients who received MVR and the prevalence rate of changes in left ventricular functions reported in previous studies [Flemming 2000; Suri 2009; Pande 2013], sample size was calculated by Epi Info 7 Program to be 26 patients with 95% confidence interval. Data were represented as mean and standard deviation. Quantitative variables were expressed as mean and standard deviation (SD) while qualitative data were expressed as either number (n), or percentage (%) according to relevance. Statistical significance was tested using an IBM compatible computer and IBM SPSS statistics version 19. Significance of quantitative variables was tested using paired student t test. We considered probability values less than .05 as statistically significant.

## RESULTS

### *Demographic and Clinical Data*

Regarding demographic data (Table 1), male distribution was 20 cases (44.4%), while female distribution was 25 cases (55.6%), age ranged from 22-51 years with mean (31.8 ± 6.76), and 30 cases (66.6%) had atrial fibrillation (AF), while 15 cases (33.3%) were sinus rhythm. The mean NYHA class was 3 ± .0.6.

Table 1. Demographic and Clinical Data of Patients (n = 45)

| | |
|---|---|
| Age, mean ± SD (range) | 31.8 ± 6.76 (22-51) |
| Male, n (%) | 20 (44.4) |
| Female, n (%) | 25 (55.6) |
| NYHA, mean ± SD | 3.1 ± 0.6 |
| AF, n (%) | 30 (66.6) |
| Sinus rhythm, n (%) | 15 (33.3) |

NYHA indicates New York Heart Association; AF, atrial fibrillation.

### *Echocardiography Follow-Up*

Regarding postoperative follow up echocardiography (Tables 2 and 3), after an initial decline in the mean ejection fraction from preoperative to 1-week postoperative time points, EF improved to a certain point (ie, partially recovered) and significantly to the time of the last follow-up echocardiogram, but didn't reach the baseline point. We found the mean preoperative left ventricular ejection fraction was 61.09 ± 7.6 and decreased significantly to 59.04 ± 6.65 1-week postoperative and partially increased to 59.67 ± 6.56 at 1-year postoperative follow up ($P$ = .001 and .01 respectively) (Figure 1).

Table 2. Comparison between Preoperative and 1-week Postoperative Echocardiography Parameters

| | Preoperative (n = 45) | 1-week postoperative (n = 45) | Paired t test | *P* |
|---|---|---|---|---|
| EF, %, mean ± SD (range) | 61.09 ± 7.65 (50-76) | 59.04 ± 6.65 (36-69) | 3.56 | .001 |
| Left atrium, cm, mean ± SD (range) | 5.55 ± 0.88 (4-8.5) | 4.51 ± 0.57 (4-6.3) | 9.12 | <.001 |
| LVESD, cm, mean ± SD (range) | 4.06 ± 0.61 (2.4-5.1) | 3.40 ± 0.40 (3-5) | 2.53 | .01 |
| LVEDD, cm, mean ± SD (range) | 5.63 ± 0.65 (4-7.2) | 5.22 ± 0.37 (4.6-6) | 5.24 | <.001 |

EF indicates ejection fraction; LVESD, left ventricular end systolic diameter; LVEDD, left ventricular end diastolic diameter.

Table 3. Comparison between Preoperative and 1-Year Postoperative Echocardiography Parameters

| | Preoperative (n = 45) | 1-year postoperative (n = 45) | Paired t test | *P* |
|---|---|---|---|---|
| EF, %, mean ± SD (range) | 61.09 ± 7.65 (50-76) | 59.67 ± 6.56 (45-76) | 2.64 | .01 |
| Left atrium, cm, mean ± SD (range) | 5.55 ± 0.88 (4-8.5) | 4 ± 0.54 (3.2-6) | 17.29 | <.001 |
| LVESD, cm, mean ± SD (range) | 4.06 ± 0.61 (2.4-5.1) | 3.45 ± 0.51 (2.8-4.5) | 6.57 | <.001 |
| LVEDD, cm, mean ± SD (range) | 5.63 ± 0.65 (4-7.2) | 4.58 ± 0.51 (3.7-5.3) | 9.34 | <.001 |

EF indicates ejection fraction; LVESD, left ventricular end systolic diameter; LVEDD, left ventricular end diastolic diameter.

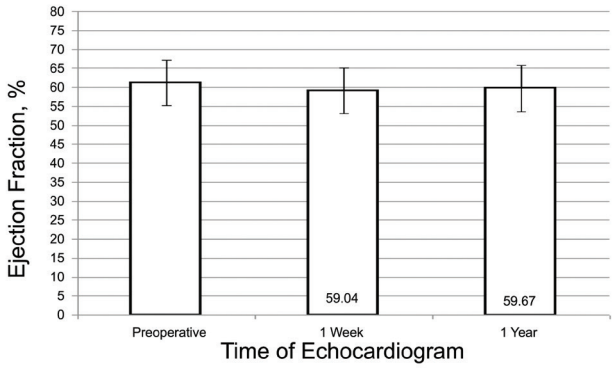


Figure 1. Changes in ejection fraction over periods of follow-up.

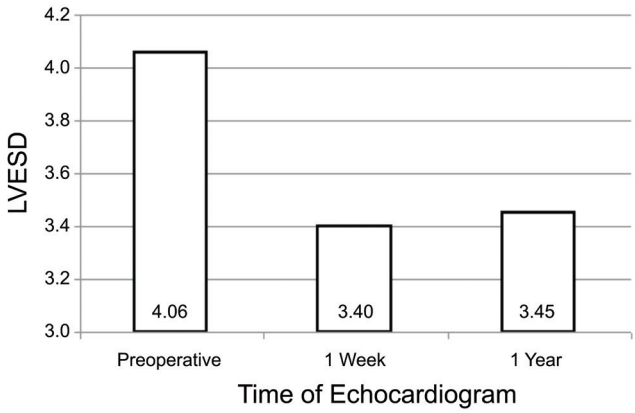


Figure 2. Changes in left ventricular end systolic dimensions over periods of follow-up.

The mean left atrial diameter showed significant reduction in size at 1-year postoperative follow up, from preoperative and 1-week postoperative values ($P$ = <.001) (Tables 2 and 3).

As in Tables 2 and 3, there was a significant regression in systolic dimension between postoperative pre-discharge echocardiograms and those obtained at 1-year follow up ($P$ < .001 ) (Figure 2).

An early decrease in the mean left ventricular end-diastolic dimension (LVEDD) occurred immediately postoperative and continued thereafter. Also, it decreased significantly at 1-year postoperative and reached 4.58 ± 0.51 cm ($P$ < .001) (Figure 3).

## DISCUSSION

Our study represented the outcome of early mitral vale replacement for patients suffering from chronic mitral regurgitation; we focused on echocardiographic follow up of all patients. In our study, we noticed that early surgical interference may lead to more satisfactory postoperative echocardiographic parameters regarding left ventricular functions and diameters. We define early interference here by before the left ventricular functions deteriorate to reach certain points, as described later.

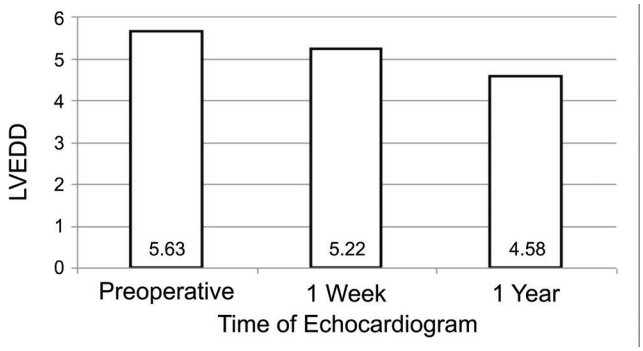


Figure 3. Changes in left ventricular end diastolic dimensions over periods of follow-up.

In regard to the changes in EF during the different points of follow up, we found a statistically significant decrease in immediate postoperative follow up (one week), where the baseline mean EF was 61.09 ± 7.6 and changed to 59.04 ± 6.65 1-week postoperative, and was slightly higher at 59.67 ± 6.65 1-year after surgery. This finding was the same as in the study by Suri et al [Suri 2009], who found that after an initial decline in the early postoperative period (53.4% from 61.8%), the mean EF improved steadily and significantly with time from operation to 1-year follow-up (55.3%). The same authors also found that EF decreased after correction of MR, and to a similar extent, whether patients had valve repair or replacement, they found that the long-term recovery of EF was better after valve repair. Several other authors who have examined LV function in the early perioperative period have arrived at various conclusions about the equivalence of repair versus replacement for preservation of normal EF [Scherer 2003; Bonchek 1984; Corin 1995]. There has also been debate about the importance of chordal preservation during MV replacement [David 1984; Rastelli 1967]. The identification of predictors of recovery of normal EF is important because the prognosis associated with LV dysfunction after surgery is poor [Badhwar 2006]. Pande et al [Pande 2013] reported a decrease in postoperative follow up over 3-5 years, where the preoperative mean EF was 60.45 ± 1.9 and decreased to 59 ± 4.9 over 3-5 years follow up.

In our study, we noted the mean left ventricular end systolic diameter significantly decreased from 4.06 ± 0.65 cm preoperatively to 3.4 ± 0.4 cm 1-week postoperative ($P$ = .01), and also decreased significantly to 3.45 ± 0.51 cm at 1-year follow up postoperatively, but was higher than that at 1-week follow up. This was similar to that reported by Suri et al [Suri 2009], where their mean left ventricular end systolic diameter decreased significantly from 3.71 cm preoperative to 3.6 cm at discharge, and to 3.48 cm at 1-year follow-up echo, and also similar to results from Pande et al [Pande 2013], who reported the decrease in left ventricular end systolic diameter from 3.78 ± 1.05 preoperative to 2.95 ± 0.43 late postoperative.

Suri et al [Suri 2009] determined that the most influential thresholds for recovery of normal EF during long-term follow up were a preoperative EF greater than 65% and LVESD

less than 3.6 cm. Badhwar et al [Badhwar 2006] suggested that greater preoperative EF and smaller LVESD predict improved ventricular function after surgical correction of MR. A report from Enriquez-Sarano et al [Enriquez-Sarano 1994] recommended that operative intervention be performed before EF deterioration to less than 60% or LVESD dilatation to more than 4.5 cm. A more recent study by Matsumura et al [Matsumura 2003] indicated that a preoperative EF less than 55% and an LVESD greater than 4 cm both predicted an increased incidence of postoperative LV dysfunction. We also found the mean left ventricular end diastolic diameter reduced significantly from 5.63 ± 0.65 preoperatively to 5.22 ± 0.37 1-week and 4.58 ± 0.51 1-year postoperative; this was similar to Suri et al, as the mean left ventricular end diastolic diameter was 6.02 cm preoperative and decreased to 5.28 cm at the predischarge point, and 4.14 cm after 1-year follow-up. Also, these were similar to Pande et al [Pande 2013], where it was 5.68 cm preoperatively and decreased to 4.59 cm after 3-5 years postoperative follow-up.

Regarding the changes in left atrial diameter, we recorded a significant reduction from 5.55 ± 0.88 cm preoperative to 4.51 ± 0.57 cm 1-week and to 4 ± 0.54 cm 1-year postoperative follow up, which was in agreement with results reported by Pande et al [Pande 2013], who measured mean preoperative left atrial diameter at 6.7 ± 0.68 cm, which reduced to 4.82 ± 0.88 cm over 5-years follow up. Pande et al [Pande 2013] found a decrease in LA size after 5 years of follow-up, while others have reported a reduction in LA size in the immediate postoperative period, but no further reduction during follow-up [Choo 2004; Hagihara 1995]. Some reports have advocated a reduction in the size of the LA during mitral valve surgery, even in asymptomatic patients, to help regain normal sinus rhythm [Scherer 2006]. Others have found no significant reduction in LA size, regardless of whether or not plication was performed [Di Eusanio 1998]. Apostolakis and Shuhaiber [Apostolakis 2008] reported that there was a significant reduction in LA size after mitral valve replacement. Furthermore, Pande et al [Pande 2013] found that the reduction in LA size was more profound in patients with larger preoperative LA who were in AF and had high grades of mitral regurgitation. This regression in LA size was observed in rheumatic valvular heart disease with asymptomatic LA enlargement. Therefore, the left atrium may not require reduction during mitral valve replacement.

## CONCLUSION

In this retrospective study, comparing postoperative echocardiography parameters to preoperative ones for a group of patients, we can conclude that early mitral valve replacement for chronic mitral regurgitation had positive impact on the improvement of ejection fraction and left ventricular end systolic diameter, which are the two main determinant parameters for normalization of left ventricular functions and dimensions, and before deterioration of left ventricular functions. So reversal of left ventricular functions is possible if surgery is done early.

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