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Correction of Aortic Valve Stenosis: Is it Effective to Improve Left Ventricular Functions and Reduce Its Mass?

Hamdy D. Elayouty[1,*], Magdy Ibrahim Wahdan[1], Marwan Hassan Elkasas[1], Hany Salman Fiesal[1], Eiman M. Altahawi[2]

[1]Department of Cardiothoracic Surgery, Suez Canal University, Ismailia, Egypt
[2]Department of Cardiology, Ismailia General Hospital, Ismailia, Egypt
*Corresponding author: h.dosoky@yahoo.com

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Abstract **Background:** Aortic valve stenosis causes gradual obstruction to left ventricular outflow tract. It is a common valvular disease that carries many life threatening complications. We hypothesized that the reduction or elimination of the pressure gradient across the aortic valve after correction of the stenotic lesion would lead to regression of left ventricular mass and improve left ventricular functions. Aim of the work is to assess the effectiveness of the correction and factors controlling these changes in left ventricular mass index and functions. **Methods:** preoperative and postoperative Electro-cardiography and echocardiography were performed for all patients. The corrective procedures included aortic valve replacement, balloon aortic valvuloplasty and open valve repair. **Results:** Sixty patients had correction of aortic valve stenosis (44 males, 16 females). ECG score preoperatively ranged between3 and 9 with a mean of 6 ± 1.63. Postoperatively, it ranged between 0 and 6 and mean of 3 ± 0.7. The mean LVED/BSA was reduced from 32.52 preoperatively to 30.41 postoperatively. The mean interventricular septal thickness index was reduced by 1.03. The mean left ventricular posterior wall thickness index was reduced by 0.99. Mean left ventricular mass index was reduced by 31.86 gm. The mean ejection fraction increased by 6.45. Mean trans-aortic peak gradient was reduced by 41.36 mmHg. **Conclusions:** Correction of aortic valve stenosis improves systolic and diastolic left ventricular function and a reduction in left ventricular mass index. Aortic root enlargement procedures can be safely avoided.

Keywords: *aortic stenosis, correction of aortic stenosis, left ventricular mass index, ejection fraction*

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1. Introduction

Aortic valve stenosis causes gradual obstruction to left ventricular outflow left ventricular hypertrophy may result in a large pressure gradient across the stenotic valve. Subsequent elevation of left ventricular end-diastolic pressure is a marker of diminished compliance and diastolic dysfunction of the left ventricle. As the left ventricle becomes less compliant, onset of atrial fibrillation may result in clinical worsening and ventricular decompensation.

We hypothesized that the reduction or elimination of the pressure gradient across the aortic valve after correction of the stenotic lesion would lead to regression of left ventricular mass and improve left ventricular functions. Aim of current study is to assess the effectiveness of the correction and factors controlling these changes in left ventricular mass index and functions.

2. Methods

This prospective randomized study included 60 patients with isolated aortic valve stenosis treated during the last 3 years. The purpose of intervention was to eliminate left ventricular outflow tract obstruction to minimize pressure gradient or eliminate it. This was achieved by aortic valve replacement in 52 cases, balloon aortic valvuloplasty in 4 cases of congenital aortic stenosis and open aortic valve repair in young females with rheumatic valve stenosis. A formal consent was written by each patient after detailed explanation of the procedure. Each patient had electrocardiography and echocardiography preoperatively and three months postoperatively.

2.1. Data Management and Statistical Analysis

The relations between the dependent and independent variables were studied using the Chi-Square test and the T-test. The significant variables were subjected to multiple logistic regression analysis.

3. Results

Sixty patients had correction of aortic valve stenosis (44 males, 16 females). Age ranged between several months and 43 years. The ECG score decreased postoperatively. The mean decrease was 3.3 ± 1.1. this reduction was statistically significant. Pre-and postoperative clinical and echocardiographic parameters were significantly improved. The mean NYHA class was reduced by 1.3 (from 2.6 to 1.3).

The mean index of left ventricular end diastolic pressure reduced by 2.11. the mean inter-ventricular septum thickness index was reduced from 8.01 to 6.98 postoperatively. The mean LV posterior wall thickness index was reduced from 7.63 to 6.64. The mean LV mass index was reduced by 31.86 gram (174.15 to 142.3gram; $p < 0.0001$). The mean ejection fraction was increased by 6.45 from pre to post – operative (54.26 to 60.71, respectively). The mean trans-aortic peak gradient was reduced from 72.12 to 30.8 mmHg.

4. Discussion

Aortic valve replacement (AVR) has become standard therapy for treating diseases of the aortic valve. AVR is now the second most commonly performed cardiac operation and with an increasingly elderly population ,the number of such procedures will inevitably continue to grow [1].

The purpose of aortic valve replacement is to eliminate left ventricular outflow tract obstruction, facilitate regression of left ventricular hypertrophy, and for patients with tight aortic stenosis, to relieve symptoms of heart failure, syncope, angina and sudden death [2]. A regression in left ventricular mass index was documented by many authors [3,4,5].

The postoperative transaortic peak gradient, which is the main cause of concentric hypertrophy and increased left ventricular mass index, decreased dramatically in all patients, with a mean change of 41.36 ± 5.3 mmHg. The more the reduction in transaortic gradient, the more is the improvement in left ventricular functions and mass index.

The electrocardiographic (ECG) score , which reflects cardiac changes from pressure overload, showed a postoperative marked decline in all ECG signs of left ventricular hypertrophy and strain, with a mean decrease of 3 + 0.93 (as in Table 1). This corresponds to results reported by Dare et al., 1993 [6].

Table 1. Mean ECG scores pre and postoperatively

	All patients	Valve size 27	Valve size 25	Valve size 23	Valve size 21	Valve size 19	Valvulo-plasty
Preop.	6 ± 1.6	6 ± 1.3	6 ± 1.4	6 ± .6	6 ± .3	6 ± 1.6	6 ± .1
Postop.	3 ± .7	2 ± .2	2.5 ± .3	2.6 ± .4	3.3 ± .1	2.7 ± .5	2.2 ± .1
Mean reduction	3 ± .9	3.7 ± .5	3.5 ± 1.1	3.4 ± .4	3.3 ± .7	3.3 ± 1.1	3 ± .3

Echocardiography, remains the first choice investigation to evaluate effects of correction of aortic stenosis [7]. However many recent studies showed the superiority of cardiovascular magnetic resonance in certain circumstances [8]. Current study showed improvement in left ventricular systolic and diastolic dimensions and left ventricular mass index. After correction of aortic stenosis, the left ventricular mass index was decreased by > 40 gram which constitutes a reduction of 24% (as shown in Table 2). These data correspond to those reported by De Cario et al., 2003.

Table 2. Mean difference between preoperative and postoperative echo. Data

Variables	Preoperative	Postoperative	Mean difference
NYHA class	2.5 ± .6	1.4 ± .7	1.1 ± .12*
LVED index	32.5 ± 3.6	30.4 ± 3.8	2.1 ± .17*
LVSD index	19.5 ± 2.7	18.2 ± 3.03	1.23 ± .31*
IV septal thickness	8.01 ± .8	6.9 ± .8	1.03 ± .02*
LV posterior wall thickness index	7.6 ± .7	6.6 ± .8	1 ± .14*
LV Mass index	174.2 ± 22.6	142.3 ± 27.7	31.9 ± 5.1*
Ejection Fraction	54.3 ± 7.4	60.7 ± 6.8	6.45 ± .62*
Transaortic peak gradient	72.2 ± 10.8	30.8 ± 16.13	42 ± 5.3*

*= significant difference

Knez and others found that the regression in left ventricular hypertrophy after aortic valve replacement was an impact of the improvement in valve orifice area. They also, found that prosthesis-patient mismatch may occur with small-sized valves, although it is uncommon. when it happens, the outcome of surgery will not be satisfactory both in hemodynamics and left ventricular mass regression [9]. The procedure was selected and the prosthesis or the bioprosthesis was selected to keep prosthesis- patient matching as much as possible. Aortic root enlargement procedures were not essential in any of our cases.

When LV mass index was considered as the dependent variable and the other variables were taken as the independent variables, there were significant correlation between that index and the age, New York Heart Association (NYHA) class, valve size, LVED index and LVSD index, jnterventricular septum-thickness, LV posterior wall thickness index, ejection fraction and trans-aortic peak gradient. This means that the patients with

higher LV mass index will have higher left ventricular end-diastolic index and LV systoic diamwter index, interventricular septum thickness index, LV posterior wall thickness index, ejection fraction and trans-aortic peak gradient ($p < 0.0001$).

The mean ejection fraction was increased by 6.45. The effects of correction of aortic valve stenosis were most pronounced among those with a severely reduced ejection fraction before the procedure.

5. Conclusions

Correction of aortic valve stenosis had an improvement in functional status ; systolic and diastolic left ventricular function with a variable degree of regression of left ventricular mass index.

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Competing interests

The authors declare that they have no competing interests.

Authors' Contributions

H.D.E. did the protocol. took part in surgical operations and follow up, and participated in writing the article. M.E.W. took part in writing the article. M.H.E. took part in surgical operations and follow up, and participated in writing the article, E. E. did the echocardiography and medical follow up.

Abbreviations

LV	left ventricule
NEHA class	New York Heart Association class.
Preop.	preoperative
Postop.	postoperative
LVED index	left ventricular end-diastolic index.
LVSD index	left ventricular systolic diameter index

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