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ORIGINAL ARTICLE

Can restrictive filling pattern on dobutamine stress echocardiography predict recovery of left ventricular systolic function after valve replacement in patients with low flow-low gradient aortic stenosis?



Ahmed El Zayat ^{a,*}, Ali Refaat ^b, Ehab Sobhy ^b, Amir Farouk ^b

^a Cardiology Department, Zagazig University Hospitals, Egypt

^b Cardiothoracic Surgery Department, Zagazig University Hospitals, Egypt

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KEYWORDS

Low flow/low gradient aortic stenosis;
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Abstract *Background:* Low flow/low gradient severe aortic stenosis continues to be a common medical problem with spontaneous dismal prognosis if left untreated. Relationship between improvement and persistence of restrictive filling pattern (that is present on baseline echocardiography) on DSE (dobutamine stress echocardiography) and recovery of LV systolic function after AVR has not been studied before.

Objective: We sought to clarify the relationship between improvement and persistence of restrictive filling pattern (that is present on baseline echocardiography) on DSE and recovery of LV systolic function after AVR.

Patients and methods: Thirty patients with LF/LG severe AS and restrictive filling pattern on baseline echocardiogram were divided into two groups. Group I included 17 patients with improved diastolic functional class during DSE, and group II included 13 patients with persistent restrictive pattern on DSE study. All patients had a contractile reserve and had AVR afterward.

Results: All patients had restrictive filling pattern. No significant difference was found between both groups regarding AVA, mean transaortic gradient, SV, LVEF, E/A ratio, IVRT, DT, S/D ratio, LV septal thickness or LVEDD ($p > 0.05$). On DSE, group I patients had a significantly more rise in both EF and SV ($49.2 \pm 5.4\%$ in group I compared to $42.5 \pm 6.9\%$ in group II and 66 ± 9 compared to 58 ± 9 ml respectively, $p < 0.05$). In group I, five patients had improve-

Abbreviations: AS, aortic stenosis; AVA, aortic valve area; AVR, aortic valve replacement; DSE, dobutamine stress echocardiography; EF, ejection fraction; IVRT, isovolumic relaxation time; LA, left atrial; LF/LGAS, low flow/low gradient aortic stenosis; LV, left ventricle; LVEF, left ventricular ejection fraction; LVEDD, left ventricular end diastolic diameter; LVEDP, left ventricular end diastolic pressure; LVH, left ventricular hypertrophy; SV, stroke volume; Vp, transmitral flow propagation velocity; CPB, cardiopulmonary bypass.

* Corresponding author. Address: Cardiology Department, Zagazig University Hospitals, Zagazig, Egypt. Mobile: +20 1069849363.

E-mail address: yousefyahia2005@yahoo.com (A. El Zayat).

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ment in the restrictive pattern to impaired relaxation while 12 patients showed a pseudonormal pattern at peak stress ($p < 0.001$). Early post operative LVEF was improved in both groups, although it was statistically significant in group I compared to group II ($53 \pm 7\%$ in group I compared to $45 \pm 6\%$ in group II ($p < 0.05$)). Follow up showed maintained improvement in LVEF ($56 \pm 6\%$ compared to $47 \pm 6\%$ respectively, $p < 0.05$). Only LVEF at peak stress (β coefficient 0.663, $p = 0.009$) and non-restrictive pattern at peak stress (β coefficient 10.084, $p < 0.0001$) were significant independent predictors of post-operative systolic function recovery on stepwise regression analysis.

Conclusion: Persistence of LV restrictive filling pattern during DSE in patients with LF/LG severe AS could be associated with less LV systolic function recovery after AVR.

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1. Introduction

Thousands of aortic valve replacements are performed annually worldwide and this number will continue to increase with the aging population. Over the last two decades, the operative mortality rate has steadily declined from 10% to 4% with improvement in surgical and anesthetic techniques.^{1,2}

Aortic valve replacement (in severe AS), is the only effective corrective treatment that prolongs survival and greatly alleviates symptoms.³

Current ACC/AHA guidelines for valvular heart disease state that dobutamine stress echocardiography is reasonable to evaluate patients with low flow/low gradient AS and LV dysfunction (class IIa).⁴

Patients without contractile reserve ($< 20\%$ increase in stroke volume on DSE) were found to have a very poor prognosis with either medical or surgical therapy.^{5,6}

On the other hand, patients with contractile reserve were found to do well/get benefit from surgery.⁵

Along with age, New York heart association (NYHA) functional class, coexistent coronary artery disease and a low transvalvular gradient, LV systolic function appears to be an important operative and postoperative prognostic factor in patients with severe AS.⁶

Restrictive filling pattern of LV has been studied in patients with LV systolic dysfunction due to a variety of etiologies as ischemic and dilated cardiomyopathy.⁷⁻⁹ It was concluded from these studies that restrictive filling pattern implies a striking rise in left atrial pressure, greatly attenuated LV inotropic response and markedly reduced survival with poor overall prognosis.⁹

The aim of this study was to clarify the relationship between restrictive filling pattern on dobutamine stress echocardiography in patients with low flow low gradient (LF/LG) aortic stenosis who showed viability, and the recovery of LV systolic function after valve replacement (AVR).

2. Patients and methods

This study was carried out in Zagazig University Hospitals on the period from November 2010 to July 2013. This study included 30 patients with LF/LG severe AS, as evidenced by aortic valve area (AVA) $< 1 \text{ cm}^2$. Aortic valve area was obtained using the continuity equation.¹⁰

All patients had LF/LGAS that was defined as low mean gradient across AV of $\leq 30 \text{ mmHg}$.⁴ LV systolic dysfunction was defined as an ejection fraction $< 50\%$. Ejection fraction was

calculated using the biplane Simpson's rule.¹¹ Stroke volume was also calculated by the standard formulae (product of the cross-sectional area of the left ventricular outflow tract and the velocity time integral).¹¹

All patients showed presence of contractile reserve on dobutamine stress echocardiography. Presence of contractile reserve was defined as increase of stroke volume by $\geq 20\%$ from baseline value on DSE.^{6,12-14} All patients had fixed AS, which was defined as an increase in valve area by $< 0.3 \text{ cm}^2$ with a maximal valve area of $\leq 1 \text{ cm}^2$ on DSE.¹²

All patients had aortic valve replacement. Preoperatively, within 30 days of AVR, diastolic function was assessed during peak DSE and the following variables were measured, E wave maximal velocity, A wave maximal velocity, E/A ratio, E deceleration time (DT), Isovolumic relaxation time (IVRT), S/D ratio (where S is the systolic and D is the diastolic wave as recorded by the pulsed Doppler from the pulmonary venous flow) and a mean of 3 beats was calculated.^{15,16} All patients showed restrictive filling pattern of diastolic dysfunction.

According to the working group of the European Association of Echocardiography and the American Society of Echocardiography, LV diastolic function was graded into four classes: normal (E/A > 0.8 , DT $< 200 \text{ ms}$, and E/A > 1 or S/D of 1–1.5 (where S is the systolic and D is the diastolic wave as recorded by the pulsed Doppler from the pulmonary venous flow)), impaired relaxation (E/A < 0.8 , DT $> 200 \text{ ms}$, IVRT $\geq 100 \text{ ms}$ and E'/A' < 1 or S/D > 1.5), pseudo-normalization (E/A = 1–2, DT = 150–200 ms, and E'/A' < 1 or S/D < 1.2), and restrictive pattern (E/A > 2 , DT $< 150 \text{ ms}$ and E'/A' < 1 or S/D < 0.8).¹⁷

Study patients (30 patients) were divided into two groups according to presence or absence of restrictive pattern of diastolic dysfunction at peak DSE before AVR.

Group I (17 patients) with no-restrictive filling pattern at peak DSE before AVR and group II (13 patients) with persistent restrictive filling pattern at peak DSE before AVR. All patients gave an informed consent to participate in the study.

Recovery of LV systolic function was defined as a postoperative increase of LVEF by $> 10\%$.⁸ Echocardiography studies were done using SONOS 5500 machine (Philips technologies, Andover, Massachusetts).

Patients with poor echo-window, history of previous cardiac surgery, previous myocardial infarction, atrial fibrillation, paced rhythm, associated grade 3 or 4 mitral or aortic regurgitation or concomitant operations on other valves were

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