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# Preoperative ejection fraction determines early recovery of left ventricular end-diastolic dimension after aortic valve replacement for chronic severe aortic regurgitation

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ABSTRACT

*Background:* In patients with chronic severe aortic regurgitation (AR), aortic valve replacement (AVR) has been proved to promote left ventricular (LV) remodeling, especially LV end-diastolic dimension (LVEDD) reduction. However, there is little research whether postoperative LVEDD could return to normal parameter after AVR. The objective of this study was to determine predictors for the recovery of dilated LVEDD early after AVR.
*Methods:* The echocardiographic data of 105 patients, who underwent AVR for chronic pure AR between January 2005 and December 2011, were analyzed at the preoperative (3–7 d), early (6–8 mo), and late (2-y) postoperative stages, retrospectively. According to the baseline level, LVEDD >70 mm or LV end-systolic dimension (LVESD) >50 mm or LVESD index >25 mm/m$^2$ were defined as severe LV dilation. Patients were then categorized into two groups (group 1: severe LV dilation; group 2: nonsevere LV dilation).
*Results:* In all patients, four-fifth of the reduction in LV dimension occurred at early (6–8 mo) postoperative stage. The patients in both groups had significant decreases in the LVEDD and LVESD early after AVR, with an additional but insignificant reduction at late postoperative stage. The ejection fraction (EF) in both groups significantly increased at either early or late stage. However, the LVEDD and LVESD in group 1 were larger than those in group 2, and the EF in group 1 was lower than that in group 2 at early postoperative stage. By multivariate analysis, we found that the preoperative EF was a good predictor for the recovery of dilated LVEDD early after AVR ($P = 0.009$). Receiver-operating characteristics analysis showed that EF >52% was the best cut-off value for the recovery of LVEDD.
*Conclusions:* In patients with chronic pure AR, preoperative EF may be a good predictor for successful recovery of dilated LVEDD early after AVR.


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## 1. Introduction

Chronic aortic regurgitation (AR) causes both a volume and a pressure overload condition [1]. Initially, to keep normal left ventricular (LV) systolic function, chamber dilation and hypertrophy compensate for the overload [2]. However, progressive LV dilatation was associated with the increased risks of the development and progression of symptoms, sudden death, postoperative LV dysfunction, and postoperative mortality [3–8].

Although LV dimension and systolic function are regarded as important parameters for the timing of aortic valve replacement (AVR) for patients with chronic AR, the best indicators for describing LV end-diastolic dimension (LVEDD) and the cut-off value to be used as an indication of aortic valve surgery are not unanimously agreed on [3,9,10]. This is why the American College of Cardiology and American Heart Association guidelines and the European Society of Cardiology guidelines are different in this regard [11,12]. So, we raised the question that what impact will be produced by the severe dilation of preoperative LVEDD on the restoration of LV function and LV reconstruction postoperatively in patients with chronic severe AR.

Furthermore, the early reduction in LVEDD after correction of AR has been proved to be related to short-term and long-term improvement in LV systolic function [7,13]. We could speculate that the postoperative early LVEDD should be of great significance for persistent restoration of LV function postoperatively. However, fewer studies have determined the factors that can predict early recovery of LVEDD after AVR [9].

Therefore, the present study aimed to investigate whether the preoperative severity of dilated LVEDD affects the restoration of ejection fraction (EF) and LVEDD postoperatively in patients with chronic severe AR and what factors could be used to accurately predict the recovery of LVEDD early after AVR.

## 2. Methods

A total of 106 patients with chronic pure AR, who underwent AVR in our institution between January 2005 and December 2011, were retrospectively studied. The etiologies of AR were degenerative ($n = 46$), congenital (bicuspid and quadricuspid aortic valve, $n = 18$), chronic rheumatic ($n = 8$), aneurysm and/or aortic annulus ecstatic ($n = 30$), and aortic inflammatory ($n = 4$). Exclusion criteria were as follows: other causes of acute AR (such as trauma and active infective endocarditis) combined with aortic stenosis, significant mitral disease (more than mild disease), aortic dissection, congenital heart disease unrelated to AR, or coronary artery disease; previous cardiac valve surgery.

All patients had preoperative echocardiographic examination (3–7 d before operation). Two-dimensional and color-flow Doppler transthoracic echocardiography examinations were performed using commercially available Hewlett–Packard Sonos 5500 and Sonos 7500 machines (Hewlett–Packard Company, Palo Alto, CA). Echocardiographic images were obtained in standard parasternal and apical views. Left ventricular end-systolic dimension (LVESD), LVEDD, the thicknesses of the interventricular septum, and LV posterior wall thickness were measured using M-mode or two-dimensional technique [14]. The apical 4-chamber and 2-chamber views were used to calculate LVEF with the modified biplane Simpson method [15]. Stroke volume (SV) was calculated using the outflow tract diameter measured at the base of the aortic leaflet in the parasternal long-axis view and the pulsed Doppler velocity integral obtained at the same level in the 5-chamber view [16].

Before the operation, patients with cardiac insufficiency were routinely treated with medical therapy. AVR was performed through a median sternotomy with the use of mild hypothermic cardiopulmonary bypass in all patients. Antegrade cold blood or histidine-tryptophan-ketoglutarate cardioplegia was perfused routinely for the surgical procedure. The operation method included pure AVR ($n = 67$), AVR plus ascending aortic plasty ($n = 13$), Bentall surgery ($n = 24$), and Wheat surgery ($n = 2$). Mechanical prosthesis or biovalve was selected based on ages and wills of patients.

Preoperative clinical characteristics, including patients' symptoms assessed using New York Heart Association functional class, aortic mechanical prosthesis, the presence of hypertension, diabetes, and atrial fibrillation, were evaluated. The valve type of replacement was also assessed. All patients were evaluated again through transthoracic echocardiography early (6–8 mo) and late (2-y) postoperatively.

According to echocardiographic baseline level, LVEDD >70 mm or LVESD >50 mm or LVESD index (LVESD/body surface area) >25 mm/m$^2$ were defined as severe LV dilation. Patients were categorized into two groups (group 1: severe LV dilation; group 2: nonsevere LV dilation). Echocardiographic data (preoperative, early, and late postoperative) and clinical characteristics in both groups were retrospectively compared. The recovery of dilated LVEDD was defined as a LVEDD <55 mm at early postoperative stage. This study was approved by the Ethics Committee of The First Affiliated Hospital of Soochow University.

### 2.1. Statistical analysis

Categorical variables were expressed as numbers and percentages, and continuous variables were expressed as mean ± standard deviation. For continuous variables, Student *t*-test or Mann–Whitney *U*-test was used to compare group 1 and group 2. The paired *t*-test was used for the comparison between preoperative and early postoperative or in that between early and late postoperative echocardiographic parameters. Categorical parameters were compared using Fisher exact test. Binomial logistic regression analysis was used to determine the independent factors associated with the recovery of LVEDD (<55 mm) early after AVR. Variables with a $P$ value of <0.1 in univariate analyses were included in the model. Potential predictors were entered into the stepwise regression model at $P < 0.05$ and retained at $P < 0.1$. Finally, a $P$ value of <0.05 was considered significant. Analysis of the receiver-operating characteristic (ROC) curve was used to assess the ability of preoperative parameters to detect LVEDD <55 mm early after AVR. The optimal cut-off point was