Impact of Left Ventricular Dysfunction on Outcome in Aortic Stenosis Patients After Aortic Valve Replacement

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Abstract: Surgical treatment for aortic stenosis includes aortic valve replacement, which alleviates symptoms and increases longevity. The purpose of this study was to evaluate the prevalence of left ventricular dysfunction after aortic valve replacement. Left ventricular function was assessed by a retrospective review of preoperative and postoperative ejection fractions (EF) using echocardiography. The prevalence of left ventricular dysfunction after aortic valve replacement was 17.39% with an odds ratio of 4.37 for low preoperative EF. Despite advances in myocardial protection and cardiothoracic surgical care, preoperative EF remains a strong predictor of outcome in patients undergoing aortic valve replacement. Keywords: aortic stenosis, aortic valve replacement, low ejection fraction, aortic valve gradient.

Aortic stenosis (AS) has a high mortality rate when left untreated (1). Primary surgical treatment for AS is aortic valve replacement, which alleviates symptoms and increases longevity. Classic symptoms for aortic stenosis include: exertional angina, congestive heart failure, and syncope (2). Three commonly used rationales are used to determine whether aortic valve replacement is necessary. They are: 1) the preservation left ventricular function, 2) improvement of symptoms or exercise limitation, and 3) the prolongation of life (3). Aortic stenosis can impair left ventricular function. Diagnosing and treating aortic stenosis early can decrease the likelihood of this impairment.

Aortic stenosis creates a pressure overload on the left ventricle, increasing the left ventricle work that is necessary to maintain cardiac output. This pressure overload also produces left ventricular hypertrophy (4). Over time, increased left ventricular workload will produce left ventricular dysfunction. Left ventricular dysfunction is defined as decreased contractility, which causes a decrease in cardiac output, and can be measured as a decrease in ejection fraction (1). Ejection fraction (EF) is the ratio of stroke volume to end-diastolic volume and is the most widely accepted measure of left ventricular function (4).

According to Hwang et al., preoperative ejection fraction is the most powerful predictor of left ventricular dysfunction after aortic valve replacement (3). There are other variables that affect left ventricular recovery after aortic valve surgery. Comorbidities that impede the improvement of left ventricular function after valve replacement include older age, previous myocardial infarction, coronary artery disease, and congestive heart failure (2).

Cardiothoracic surgical advances that include new myocardial protection methods have evolved during the last decade. These advances include routine use of blood cardioplegia, retrograde cardioplegia delivery, “warm-shot” cardioplegia, and aspartate–glutamate-enhanced cardioplegia. Myocardial protection is extremely important in AS patients because of increased left ventricular wall mass. The purpose of this study was to evaluate the prevalence of left ventricular function after aortic valve replacement and to determine whether outcomes have changed since previous publications.

MATERIALS AND METHODS

This study was approved by the Institutional Review Board of the Medical University of South Carolina. A retrospective review was completed on patients with AS who underwent aortic valve replacement. The study was modeled after a previous report by Hwang et al. in 1989 (5) for the Veterans Administration (VA) Cooperative Study on Valvular Heart Disease.

In the present study, the Society of Thoracic Surgeons National Cardiac Surgery Database was used to collect data on aortic valve replacement patients between the years 1994 and 2001. Three hundred twenty-eight patients with AS were retrieved from the database. Complete echocardiographic data were available for 69 of the 328...
patients. Echocardiograms were used to determine preoperative and postoperative EFs and aortic valve gradients. Left ventricular dysfunction was defined by an EF less than or equal to 0.50.

Data collected included age, date of birth, history of myocardial infarction, coronary artery disease, aortic valve gradient, preoperative and postoperative EFs, New York Heart Association classification, and cross clamp time and total cardiopulmonary bypass time.

Stepwise logistic regression and multivariate logistic regression analysis were used for statistical interpretation of indicators for left ventricular dysfunction. A \( p \) value of \(<0.05\) was considered statistically significant. Regression analysis was used to assess the presence or the absence of left ventricular dysfunction postaortic valve replacement. Data are presented as a mean \( \pm \) SD.

RESULTS

Postoperative echocardiograms were performed for this study at a mean of 102.7 \( \pm \) 158.7 days after surgery. The prevalence of left ventricular dysfunction after aortic valve replacement in this study was 12/69, 17.39%. Variables found to be statistically significant from the VA study were the variables used in the present study for the multivariate analysis. Preoperative ejection fraction was found to be statistically significant (\( p = 0.045 \)) for predicting left ventricular dysfunction in both studies. The odds ratio for preoperative EF was 4.37. Therefore, patients with an EF \( \leq 50\% \) were 4.37 times at risk to have postoperative left ventricular dysfunction. Preoperative EF showed a sensitivity of 58\% and a specificity of 77\% in the identification of patients with postoperative left ventricular dysfunction. Myocardial infarction was the only other preoperative factor with an increased odds ratio of 1.6 in predicting left ventricular dysfunction. However, this was not statistically significant (\( p = 0.587 \)).

CONCLUSIONS

Low preoperative EF is still the strongest predictor for left ventricular dysfunction after aortic valve replacement.

Table 1. Logistic regression analyses from the VA study (1989) variables independently predictive of postoperative left ventricular dysfunction.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Odds Ratio</th>
<th>SE</th>
<th>( p ) Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>CAD no/CABG</td>
<td>7.8</td>
<td>1.12</td>
<td>0.059</td>
</tr>
<tr>
<td>MI</td>
<td>6.0</td>
<td>0.7230</td>
<td>0.012</td>
</tr>
<tr>
<td>AV gradient</td>
<td>0.955</td>
<td>0.0193</td>
<td>0.020</td>
</tr>
<tr>
<td>Pre-EF</td>
<td>0.914</td>
<td>0.0262</td>
<td>&lt;0.001</td>
</tr>
</tbody>
</table>

Low EF sensitivity, 72\%; low EF specificity, 82\%. CAGB, coronary artery bypass grafting; CAD, coronary artery disease; MI, myocardial infarction.

Table 2. Logistic regression analyses for the present study (1996–2001) variables independently predictive of postoperative left ventricular dysfunction.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Odds Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre-EF</td>
<td>4.36</td>
</tr>
<tr>
<td>MI</td>
<td>1.62</td>
</tr>
<tr>
<td>AV gradient</td>
<td>0.96</td>
</tr>
<tr>
<td>CAD</td>
<td>0.87</td>
</tr>
</tbody>
</table>

See Table 1 for abbreviations.

The prevalence of left ventricular dysfunction in this study was 17.4\% vs. 26\% (5). The sensitivity and specificity for preoperative EF in the VA study were72\% and 82\%, respectively. Although in the VA study, preoperative myocardial infarction, coronary artery disease, and aortic valve gradient were indicative of left ventricular dysfunction, there was insufficient evidence in this study to support these findings.

Differences in study design may account for some of the findings. The VA study follow-up echocardiogram was performed later, at 180 days postoperatively vs. 102.7 days in this study. Improvement in ventricular function after relief of AS occurs over time and therefore the shorter follow-up time in this study may influence the postoperative EF. Also, postoperative echocardiogram was available in only 21\% of the patients in this retrospective study.

This study is important because it reaffirms the influence of preoperative EF on outcome. Improved myocardial protection techniques may play a role in reducing postoperative left ventricular dysfunction; however, there

Present Study 1996 -2001

328 Aortic Stenosis

| 69 Echo data available |

12(17.4\%) LV Dysfunction

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was insufficient evidence in this study to show a reduction
in the incidence of low EF after aortic valve replacement
compared with previous studies.

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