Outcomes of surgical aortic valve replacement for severe aortic stenosis: Incorporation of left ventricular systolic function and stroke volume index

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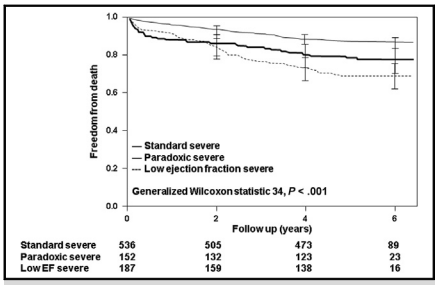
ABSTRACT

Objectives: We sought to assess predictors of mortality in consecutive patients with severe aortic stenosis undergoing aortic valve replacement and to determine whether there are differences in mortality, separated on the basis of different aortic stenosis subtypes and left ventricular stroke volume index.

Methods: We studied 875 patients (aged 69 ± 12 years, 67% were men) with severe aortic stenosis (aortic valve area ≤1 cm^2) who underwent aortic valve replacement between January 2007 and December 2008 (excluding other severe valve disease, balloon aortic valvuloplasty, and transcatheter aortic valve replacement). Clinical and echocardiographic data were recorded. Left ventricular stroke volume index was measured as left ventricular outflow tract velocity time integral × left ventricular outflow tract area/body surface area. Patients were classified into the following subtypes: (1) standard severe (n = 536, left ventricular ejection fraction ≥50% and mean gradient ≥40 mm Hg); (2) paradoxic severe (n = 152, left ventricular ejection fraction ≥50%, mean gradient <40 mm Hg and left ventricular stroke volume index <35 mL/m^2); and (3) low left ventricular ejection fraction severe (n = 187, ejection fraction <50%). Society of Thoracic Surgeons score and all-cause mortality were recorded.

Results: At 4.8 ± 2 years, 153 patients (18%) died (30-day mortality 1.8%). On multivariable Cox analysis, age (hazard ratio [HR], 1.49), New York Heart Association class (HR, 1.52), prior cardiac surgery (HR, 1.41), aortic stenosis subtypes (standard severe reference HR, 1; paradoxic severe HR, 1.48; and low left ventricular ejection fraction severe HR, 2.03), and reduced glomerular filtration rate (HR, 1.17) were associated with higher long-term mortality ($P < .05$).

Conclusions: In patients with severe aortic stenosis undergoing aortic valve replacement, patients with standard severe aortic stenosis had better long-term survival than those with paradoxic severe or low left ventricular ejection fraction severe aortic stenosis. (J Thorac Cardiovasc Surg 2015;149:1558-66)



Kaplan–Meier survival curves of the study population are shown, divided on the basis of AS subtypes (standard severe, paradoxic severe, and low EF severe).

Central Message

In a contemporary study of patients with AS undergoing AVR, we demonstrate that despite low 30-day mortality, approximately 20% patients are dead at the 5-year follow-up. Patients with paradoxic severe and low LVEF severe AS had significantly worse outcomes than those with standard severe AS.

Perspective

In a contemporary study of patients with AS undergoing AVR, despite a low 30-day mortality, approximately 1 in 5 patients are dead at the 5-year follow-up. Along with expected predictors, such as increasing age, low glomerular filtration rate (GFR), and history of cardiac surgery, different AS subtypes and LV flow impairment were independently associated with mortality. Patients with paradoxic severe and low LVEF severe AS had significantly worse outcomes than those with standard severe AS. In patients with severe AS, a thorough clinical and imaging assessment needs to be performed to identify and characterize patients early, before the occurrence of advanced symptoms or LV flow impairment.

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Abbreviations and Acronyms

AS = aortic stenosis
AVA = aortic valve area
AVR = aortic valve replacement
CABG = coronary artery bypass grafting
EF = ejection fraction
EOA = effective orifice area
GFR = glomerular filtration rate
LV = left ventricular
LVOT = left ventricular outflow tract
LV-SVI = left ventricular stroke volume index
NYHA = New York Heart Association
STS = Society of Thoracic Surgeons

Supplemental material is available online.

Over the years, numerous studies have demonstrated that aortic valve replacement (AVR) significantly improves survival in patients with severe aortic stenosis (AS).[1-12] As a result, the current American College of Cardiology/American Heart Association and European Society of Cardiology guidelines designate a class I indication for AVR in patients with severe AS who present with symptoms or who demonstrate signs of cardiac dysfunction, defined as resting left ventricular ejection fraction (LVEF) of 50% or less.[13,14]

However, AS is a complex hemodynamic process, and determination of its true severity is frequently challenging. Although severe AS has been traditionally defined on the basis of echocardiographic aortic valve area (AVA) 1 cm^2 or less and a mean AV gradient of 40 mm Hg or more,[15] it is increasingly recognized that not all patients with severe AS have severely elevated transvalvular gradients. Indeed, recent work has shown that the traditional definition of severe AS can fail to classify up to 15% to 30% of patients with reduced transvalvular flow gradients resulting from decreased LVEF or in those with normal LVEF because of diminished forward stroke volume related to myocardial remodeling, reduced left ventricular (LV) cavity size, or impaired LV compliance.[16-18]

Therefore, cardiologists increasingly are recognizing various subtypes of AS based not only on transvalvular gradient, valve area, and ejection fraction (EF) but also on LV stroke volume index (LV-SVI). Accurate characterization of patients as having standard severe, paradoxic severe, and low LVEF low gradient severe AS, based on AVA, LVEF, transvalvular gradients, and LV-SVI, is likely important, because these groups of patients may have varying outcomes as demonstrated in prior moderately sized studies.[2,3,17,19-24] Many prior studies have confined their attention to patients undergoing isolated AVR. Although this may make analysis of outcomes simpler, it fails to recognize that many of the patients currently undergoing operation for AS have concomitant coronary disease or disease of the aorta that significantly affects their operative and subsequent course and is an inherent part of the disease spectrum of AS in the current era. In the current study, we sought to (1) assess predictors of mortality in a consecutive contemporary group of patients with severe AS undergoing AVR and (2) determine whether there are differences in mortality, separated on the basis of different AS subtypes and preserved versus impaired LV-SVI.

MATERIALS AND METHODS

Study Population

This was an observational cohort study of 875 consecutive patients with severe AS (AVA $\leq$1 cm^2) who had an echocardiogram at our tertiary care center between January 2007 and December 2008 followed by AVR at Cleveland Clinic. We excluded the following patients: those with other valvular disease (ie, mitral/tricuspid valve disease or prosthetic AS) and those who underwent transcatheter AVR or balloon aortic valvuloplasty (because, at the time, these therapies were performed in individuals who were deemed high risk or inoperable).

Clinical Data

Data were assembled by analysis of electronic medical records after appropriate approval by the institutional review board was obtained. Demographics and clinical data were extracted from the electronic health record at the time of the initial visit. The presence of angina, syncope, and New York Heart Association (NYHA) class was extracted from the electronic medical record to assess the symptomatic status of each patient. The decision to operate was made after a careful evaluation by the cardiologist and cardiothoracic surgeon at the time of initial presentation. No patient went directly for AVR without being evaluated by a cardiologist at our center. In patients who were perceived to be asymptomatic at the initial evaluation, the decision to operate was made on the basis of the following potential high-risk factors: LV systolic dysfunction, abnormal blood pressure response, excessive LV hypertrophy, and AVA less than 0.6 cm^2. On the basis of the available preoperative data, Society of Thoracic Surgeons (STS) score was calculated.

Preoperative Echocardiography

All patients underwent a comprehensive echocardiogram with commercially available instruments (Philips Medical Systems, NA, Bothell, Wash; General Electric Medical Systems, Milwaukee, Wis; and Siemens Medical Solutions USA, Inc, Malvern, Pa) as part of a standard clinical diagnostic evaluation. Measurements and recordings were obtained according to current recommendations.[15,25] LV dimensions (end systolic and end diastolic), LV mass, and left atrial dimensions were measured from 2-dimensional images and indexed to body surface area. LVEF was calculated using the Simpson's biplane method. Diastolic function was graded using the current grading recommendations for this assessment.[26] We used a semiquantitative 5-point scale (with grades of none, mild, moderate, moderately severe, and severe) to stratify aortic regurgitation, mitral regurgitation, and tricuspid regurgitation assessed by color 2-dimensional Doppler echocardiography clips obtained in multiple standard views. Right ventricular systolic pressure was estimated in a standard fashion.[27]

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