August 30, 2014. Both TEE and TTE were performed with the use of a Vivid 9 imaging platform (GE Healthcare, Waukesha, Wisconsin). Valve sizing was determined by means of multidetector computed tomography. Fluoroscopic guidance was used in all cases. Anesthesia was administered and monitored by a cardiac anesthesiologist. General anesthesia consisted of tracheal intubation facilitated with a paralytic and induction agent. Anesthesia was maintained with inhaled anesthetics and intravenous opioids. MAC was administered with the use of infusions of either dexmedetomidine or propofol in combination with intravenous opioids and local anesthesia (2.0% lidocaine with 0.5% bupivacaine) applied to the femoral access site. Both cohorts were monitored with insertion of a central venous catheter, pulmonary artery catheter, temporary right ventricular pacemaker, and invasive arterial blood pressure catheter. The 2 groups were compared by use of standard statistical methods for continuous and categorical variables, with differences considered statistically significant at $p < 0.05$.

The study population included 111 patients, of whom 64 underwent TAVR with TEE (GA) and 47 underwent TTE (MAC). The Edwards-SAPIEN THV (Edwards Lifesciences, Irvine, California) was placed in 50 of the TEE cohort and in 9 of the TTE cohort. The remainder of the patients received the CoreValve prosthesis. Two patients in the TTE cohort were converted to TEE because of inadequate transthoracic windows. The baseline characteristics are presented in **Table 1**.

Outcome data were statistically similar between the cohorts with regard to procedural success, degree of paravalvular regurgitation, need for additional valve implantation, or complications such as periprocedural stroke or death (**Table 1**). Procedural time was longer in the TEE (GA) cohort ($p < 0.001$) and related to the time needed for weaning off the ventilator. The median length of stay was 6 days in both groups and was not affected by type of valve. The similar length of stay was related to our institutional policy that required monitoring for 48 h in the intensive care unit, irrespective of the type of anesthesia or valve implanted.

Although this is a retrospective study with a modest sample size and relative heterogeneity with respect to type of valve implanted, our data suggest that TAVR can be safely performed with the use of TTE guidance under MAC. These findings require larger, prospective, multicenter studies to more clearly define potential benefits such as shorter procedural times, decreased length of stay, and reduced hospital costs.

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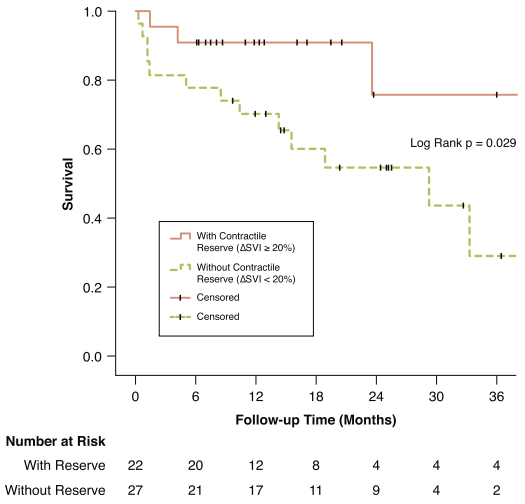
Dobutamine Stress Echocardiography for Risk Stratification of Patients With Low-Gradient Severe Aortic Stenosis Undergoing TAVR

Patients with low-gradient severe aortic stenosis (LGSAS) have dismal outcomes when medically managed and although their long-term outcomes are improved with surgery, their risk of death is significantly higher than that of their counterparts with mean transaortic gradient (ΔP) >40 mm Hg (1). Low-dose dobutamine stress echocardiography (DSE), by determining whether flow reserve (FR) is present with inotropic stimulation, has proven useful in enhancing risk stratification of this high-mortality subgroup undergoing surgical aortic valve replacement (SAVR) (2,3). Whether the lack of FR in patients undergoing transcatheter aortic valve replacement (TAVR) similarly portends poor prognosis is unknown and was explored in this study.

Electronic medical records of patients who underwent TAVR for severe AS at Emory University Hospital from January 2009 to March 2013 were reviewed. Demographics and clinical characteristics including comorbidities, outcomes, and echocardiographic data were retrospectively collected. LGSAS was defined as ΔP <40 mm Hg and an aortic valve area (AVA) ≤1.0 cm^2, with either reduced or normal ejection fraction (EF) on baseline transthoracic echocardiogram. Forty-nine patients with LGSAS who

FIGURE 1 Kaplan-Meier Survival Curves of Patients With Low-Gradient Severe Aortic Stenosis With and Without Flow Reserve



Kaplan-Meier survival curves of patients with low-gradient aortic stenosis who underwent dobutamine stress echocardiography; stratified by flow reserve (FR) (+FR: stroke volume index [SVI] >20%, n = 22; −FR: SVI <20%, n = 27).

underwent DSE before TAVR were identified. DSE was not performed routinely in the evaluation of all patients with LGSAS, and these specific patients had undergone DSE to exclude pseudo-severe AS. The following parameters were collected at baseline and peak dobutamine infusion: EF, AVA, mean and peak aortic transvalvular gradients, left ventricular outflow tract diameter, and velocity-time integral (VTI). In patients with atrial fibrillation, VTI was measured as the mean value of 5 cardiac cycles. FR was defined as a 20% increase in stroke volume index (SVI) from rest to peak dobutamine infusion. All patients completed DSE successfully. All-cause mortality was determined by chart review, phone communication with the patient or next of kin, and searches of the Social Security Death Index. Survival curves were presented as Kaplan-Meier curves, and the log-rank test was used for comparison between groups. Multivariable analysis using Cox proportional hazards model was performed for all-cause mortality. The study was approved by the Emory University Institutional Review Board Committee.

Overall, the cohort consisted of mostly elderly (age 80 ± 8 years), white (88%) men (70%). All patients were treated with a SAPIEN transcatheter heart valve (Edwards Lifesciences, Irvine, California) via either the transfemoral (60%) or transapical approach (40%). The mean EF at baseline was 38 ± 14%, with 77% of patients with EF <50%. Median follow-up time was 14 months (interquartile range: 8 to 24). Twenty-seven patients (55%) did not have FR, with an average increase in SVI of 5 ± 11%, compared with 45 ± 26% for those with FR ($p < 0.001$). Patients without FR had a higher prevalence of chronic obstructive pulmonary disease (COPD) (63% vs. 32%; $p = 0.030$); otherwise, clinical characteristics were similar. At the time of data collection, there had been 16 deaths, of which 13 (81%) were patients without FR. Patients without FR had worse short- and intermediate-term survival compared with those with FR (Figure 1). Two patients without FR (7%) and no patients with FR died during the initial hospitalization. Thirty-day mortality was 21% versus 5%, 1-year mortality 30% versus 9%, and 2-year mortality 46% versus 26% compared with those with FR ($p < 0.001$). Univariable analysis with Cox regression identified COPD (hazard ratio [HR]: 1.77; $p = 0.052$), female sex (HR: 1.83; $p = 0.034$), and SVI <20% (HR: 3.70; $p = 0.041$) as significant predictors of all-cause death. In multivariable analysis including sex and COPD, SVI <20% remained an independent predictor of mortality (HR: 4.47; $p = 0.037$).

This study is the first to describe the use of FR derived by DSE in the risk stratification of patients with LGSAS undergoing TAVR. The subgroup of patients with LGSAS who failed to achieve a 20% increase in SVI with dobutamine infusion had worse short- to intermediate-term mortality compared with those with FR. These findings echo the difference in outcomes in similar subgroups of patients with AS undergoing SAVR (1-3). Thus, despite the avoidance in TAVR of ischemia-reperfusion injury and myocardial stunning induced by cardiopulmonary bypass and cardioplegia during SAVR, patients without FR still have increased mortality. Despite being at higher surgical risk, these patients have post-procedural outcomes similar to those of lower-risk patients who undergo SAVR. Prospective studies comparing outcomes after SAVR and after TAVR in similar surgical risk patients without FR are needed to define a clinically useful role for DSE before TAVR.

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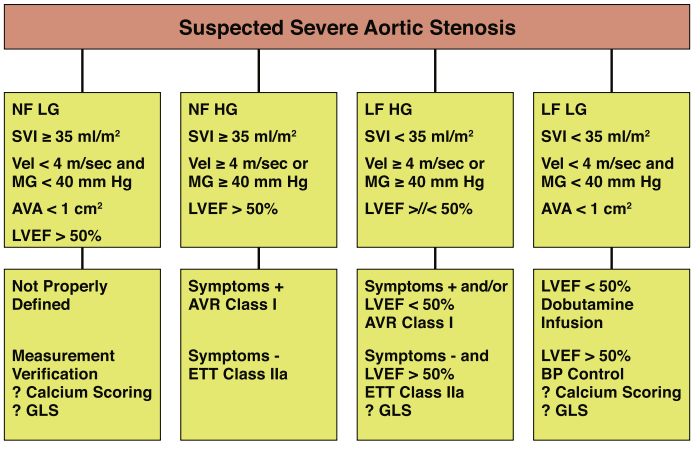
Valvular Disease, Myocardial Mechanics, and Valve Guidelines

The review by Galli et al. (1) provides an important overview of left ventricular mechanics in common valvular diseases. At the same time, for a practicing cardiologist it is important that this information is presented in the context of the current valvular disease guidelines to highlight the areas where clinical decision making can be augmented by this additional information (2). As a relevant example, the algorithm for the management of patients with severe aortic stenosis (Figure 8 in Galli et al. [1]) is confusing. An alternative diagram is presented in **Figure 1** which integrates the current guidelines with evolving knowledge as well as highlights important gaps. The normal flow/low gradient group is not properly defined because the guidelines prioritize the velocity/gradient approach over the aortic area measurement. In these cases careful measurement verification is important, such as obtaining proper outflow tract area and indexing valve area to body surface area. Also, one should bear in mind that in a normal flow state a mean gradient of 40 mm Hg corresponds to an aortic valve area of <0.8 cm^2, so there is inherent discrepancy with the old definition of severe aortic stenosis (valve area of <1 cm^2) (2). In this challenging group, longitudinal strain measurement and calcium scoring may provide valuable information. In the groups of patients with high gradients regardless of flow state, the guidelines are mostly explicit and unequivocal. In the low flow/low gradient group, left ventricular ejection fraction (LVEF) is an important defining factor. Patients in this group who have decreased LVEF should probably undergo dobutamine infusion to identify true severe stenosis and assess contractile reserve. Patients in the low flow/low gradient group with normal LVEF need repeat measurements after adequate blood pressure control and they may also benefit from longitudinal strain measurement and calcium scoring. Unlike the recommendation by Galli et al. (1), dobutamine infusion is not supported by substantial evidence in this subgroup (2).

FIGURE 1 Potential Role of Global Longitudinal Strain in the Management of Patients With Severe Aortic Stenosis According to Flow-Gradient Pattern



AVR = aortic valve replacement; ETT = exercise testing; GLS = global longitudinal strain; LF = low flow; LG = low gradient; LVEF = left ventricular ejection fraction; MG = mean gradient; NF = normal flow; NG = normal gradient; SVI = stroke volume index; Vel = velocity.

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