Association of Abnormal Postoperative Left Ventricular Global Longitudinal Strain With Outcomes in Severe Aortic Stenosis Following Aortic Valve Replacement

Owing to improved survival, aortic valve replacement is a class I indication in patients with severe aortic stenosis and associated symptoms or cardiac dysfunction.1-3 However, a recent study has demonstrated that despite excellent early postoperative survival, almost 20% of patients who received aortic valve replacement for severe aortic stenosis were dead at 5 years.4 Because most patients with aortic stenosis have preserved left ventricular ejection fraction (LVEF), we hypothesized that preoperative and postoperative left ventricular global longitudinal strain (LV-GLS) may be a more sensitive way to detect subclinical left ventricular dysfunction and provide incremental prognostic value. We sought to study the effect of aortic valve replacement on postoperative LV-GLS in patients with severe aortic stenosis and preserved LVEF and to associate the change from preoperative to postoperative LV-GLS with outcomes after aortic valve replacement.

Methods | This was a retrospective observational study, approved by the Cleveland Clinic Institutional Review Board, conducted from January 1, 2003, to December 31, 2007, of 208 patients with severe symptomatic aortic stenosis (aortic valve area
Abnormal strain. A composite end point of death or admission for congestive heart failure (excluding admissions owing to rapid atrial fibrillation) was recorded. Statistical analysis was performed from October 1 to November 30, 2015, using SPSS, version 11.5 (SPSS Inc). *P* < .05 was considered significant.

**Results** | The median time between aortic valve replacement and follow-up echocardiography was 14 months (interquartile range, 12-16). Correlation between baseline LVEF and LV-GLS was weak but significant (β, 0.23; *P* = .001). One hundred ninety-six patients (94.2%) had a bioprosthesis and 58 (27.9%) had obstructive coronary artery disease requiring concomitant bypass grafting (Table). Left ventricular ejection fraction was preserved with no postoperative deterioration (mean [SD]; preoperative, 59% [4%] vs postoperative, 59% [5%]; *P* = .60) (Figure, A), while left ventricular mass index regressed significantly (mean [SD]; preoperative, 118 [39] vs postoperative, 101 [29] g/m²; *P* < .01). However, despite a significant improvement in overall LV-GLS from baseline (mean [SD]; preoperative, -14.8% [4%] vs postoperative, -17.2% [3%]; *P* < .001) (Figure, B), 38 patients (18.3%) had abnormal LV-GLS values during follow-up. Of the 99 patients who had abnormal baseline LV-GLS values, the values normalized in 76 (76.8%), while values remained abnormal in 23 (23.2%) after aortic valve replacement.

At a mean (SD) of 3.9 (2.0) years, there were 38 end point events (15 deaths and 23 admissions for congestive heart failure). On multivariable Cox proportional hazards regression analysis, after adjustment for baseline LV-GLS and left ventricular stroke volume index, a worsening Society of Thoracic Surgeons score (hazard ratio [HR], 1.06; 95% CI, 1.02-1.10; *P* = .001) and abnormal follow-up LV-GLS value (time-dependent covariate HR, 2.76; 95% CI, 1.40-5.45; *P* = .003) were associated with higher composite end point events. Results were similar when coronary artery disease was excluded. Addition of postoperative LV-GLS values to the Society of Thoracic Surgeons score provided incremental prognostic utility (Figure, C). The C statistic for the Society of Thoracic Surgeons score was 0.61 (95% CI, 0.55-0.66), which increased to 0.69 (95% CI, 0.61-0.75) for the Society of Thoracic Surgeons score plus abnormal vs normal follow-up LV-GLS values (Figure, D). An improvement of 1% in absolute LV-GLS value (from preoperative to postoperative echocardiography) was associated with fewer composite events (HR, 0.92; 95% CI, 0.84-0.97; *P* < .01). However, neither base-
line LVEF (HR, 0.98; 95% CI, 0.95-1.06; \( P = .70 \)) or absolute change in LVEF (HR, 0.99; 95% CI, 0.96-1.03; \( P = .40 \)) were associated with composite events.

**Discussion** | In patients with severe aortic stenosis, approximately 20% of patients who survived more than 1 year after aortic valve replacement had an abnormal LV-GLS value on postoperative echocardiography, despite a preserved postoperative LVEF and demonstrable left ventricular mass regression. This finding was independently associated with adverse events. Appropriately timed aortic valve replacement relieves left ventricular wall stress and prevents a decline in LVEF. However, despite a preserved LVEF, there may be irreversible impairment of LV-GLS postoperatively, with resultant adverse outcomes. Whether or not this is due to intrinsic myocardial disease (eg, myocardial fibrosis) remains to be conclusively established. The data are hypothesis generating and need prospective validation.

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