EDITORIAL

Is LV Deformation Parameter-Global Longitudinal Strain a Better Predictor of LV Dysfunction than LVEF in Patients Undergoing Valve Replacement/Repair Surgery for Aortic and Mitral Valve Regurgitant Lesions

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Strain measurement has been in practice for a long time in the evaluation of myocardial function in various disease conditions. Still, it has not been included in the guidelines to decide on the timing of surgery or prognosticate the postoperative outcome after interventions. An editorial deliberated the use of strain measurement in perioperative settings for monitoring myocardial function in various procedures, including both adult and pediatric patients.[1]

Valvular heart disease (VHD) and valvular surgeries remain the major bulk of cardiovascular surgeries done worldwide. It is known that VHD is related to the development of cardiac dysfunction and low cardiac output syndrome, especially the moderate and severe one that was found in 15% of patients with heart failure (HF).[2] The management of VHD is based on clinical symptoms and evidence of cardiac function impairment; imaging examination is essential in evaluating the valve and determining cardiac dysfunction.[2] Echocardiography is widely available and is an excellent diagnostic tool for evaluating cardiac function in patients with suspected VHD. Assessing left ventricular ejection fraction (LVEF) is an essential indicator to determine the need for an invasive management strategy.[3,4] However, a disruption in myocardial function might not be evident while assessing LVEF in the initial stages of the disease. When the LVEF is already impaired, the myocardial damage may be irreversible. Therefore, an examination to detect cardiac dysfunction at the earliest before LVEF impairment may prevent further damage to the myocardial structure and will optimize the timing for surgery.[5,6] Global longitudinal strain (GLS) can be used to identify subclinical myocardial dysfunction making it a superior parameter to LVEF. GLS also shows good operator feasibility and is beneficial in evaluating mild and subclinical cardiac dysfunction.[7–9]

The majority of research on left ventricular global longitudinal strain (LVGLS) and VHD focused on high-gradient aortic stenosis. Increasingly, LVGLS has also been shown to be prognostic in low-flow and low-gradient severe aortic stenosis with preserved LVEF and in low-flow, low-gradient severe aortic stenosis with reduced LVEF. The role of LVGLS in patients with aortic regurgitation (AR) and mitral regurgitation (MR) is less well established.[7]

Hemodynamic compensation in chronic volume overload in regurgitant valvular lesions can preserve LVEF because of the low resistance offered to the left ventricle by the leaky valve despite a decline in myocardial contractile function. This may progress to adverse remodeling changes in the absence of clinical symptoms.

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These changes are often unmasked by changes in hemodynamic and loading conditions after surgical intervention of placing a competent valve and making the left ventricle eject against greater resistance, leading to HF. Class I indications for mitral valve intervention for MR, according to European Society of Cardiology (2017) guidelines, are symptomatic patients with LVEF >30% and asymptomatic patients with LVEF <60% or left ventricular end systolic dimension >45 mm. Echocardiographic measurements of LVEF have considerable intraobserver and interobserver variability.[10,11] Therefore, there is a need for reproducible, accurate, and load-independent echocardiographic parameters like LV strain that can detect early subclinical LV dysfunction in asymptomatic patients.

The study of GLS in primary MR is a growing interest, indicating diagnostic and prognostic value. GLS by speckle tracking echocardiography has a strong positive correlation with LVEF, especially in LV systolic impairment. Guidelines for echocardiography acknowledge that strain and strain rate are reasonable markers for a quantitative assessment of myocardial function in asymptomatic patients with LVEF = 60–65% or LV end-systolic dimension approximately 40 mm or 22 mm/m^2.[12] However, GLS markers are not currently incorporated in clinical guidelines as an indication for surgery. GLS shows promise in being a solution to the challenge that clinicians face in identifying asymptomatic patients with subclinical LV impairment as candidates for early mitral valve surgery. According to a review by Dona et al., a baseline GLS ranging from –17.9 to –21.7% is an independent predictor of postoperative outcomes. A significant

negative correlation was observed between preoperative GLS and postoperative LVEF. Impaired baseline GLS was associated with higher mortality rates. Better long-term survival rates were seen in patients who underwent early surgery. This systemic review included studies where GLS was measured by transthoracic echocardiography (TTE), and patients had various follow-up periods ranging from days to up to 8 years. The authors have recommended measuring preoperative GLS to identify asymptomatic patients for deciding on the optimal time for mitral valve surgery or predicting the postoperative course.[13]

Santoro et al., in their study titled "Global longitudinal strain is a hallmark of cardiac damage in mitral regurgitation–the Italian arm of the European Registry of mitral regurgitation," found that LVEF and GLS were independently associated with LV and left atrial size in the pooled population and in mild and moderate/severe MR. GLS, but not LVEF, was also independently associated with pulmonary artery systolic pressure in patients with mild and moderate to severe MR and thus concluded that both LVEF and GLS are independently associated with LV and left atrium size, but only GLS is related to pulmonary arterial pressure. GLS is a powerful hallmark of cardiac damage in MR.[8] Shanishwara et al. studied adult patients with severe MR of rheumatic etiology with preserved LVEF of >60%, undergoing mitral valve replacement with total chordal preservation surgery. TTE was done for LVEF, LV dimension, and GLS measurement at two-time points, one before surgery and the second at follow-up at 3 months postoperatively. A GLS value of <–19% was demonstrated as an independent predictor of short-term LV dysfunction after mitral valve surgery; an LV end-systolic dimension of ≥40 mm was also verified additional parameter to predict LV dysfunction postmitral valve regurgitation. In this study, the immediate postop echocardiographic measurements are not done, which might have value in managing patients in the immediate postoperative period.[14]

Kim et al. demonstrated that in univariate analysis, LVEF, atrial fibrillation, left atrial dimension, age, previous ischemia, concomitant coronary artery bypass graft, and both GLS and global circumferential strain were predictive of cardiac events post mitral valve surgery for severe primary MR. On multivariate Cox models, age [hazard ratio (HR), 1.429; 95% confidence interval (CI), 1.116–1.831; *p,* 1⁄4 0.005], left atrial dimension (HR, 1.034; 95% CI, 1.006–1.063; *p,* 1⁄4 0.019), and GLS (HR, 1.229; 95% CI, 1.135–1.331; $p < 0.001$) were independent predictors of cardiac events. In subgroup analysis, LV GLS was a significant predictor of cardiac outcome, regardless of the presence of LV dysfunction, the presence of atrial fibrillation, and the type of surgery. Impaired GLS was associated with all-cause mortality (HR, 1.068; 95% CI, 1.003–1.136; *p,* 1⁄4 0.040), thus concluded that GLS appears to be a better predictor of cardiac events all-cause death than conventional parameters, including LVEF. Measuring preoperative GLS is helpful in predicting postoperative outcomes and determining optimal timing for surgery in patients with severe primary MR.[15]

In patients with secondary MR, Namazi et al. found that patients with a more impaired LV GLS showed significantly higher mortality rates at 1, 2, and 5-year follow-ups (13, 23, and 44%, respectively) when compared with patients with more preserved LV systolic function (5, 14, and 31%, respectively). On multivariable analysis, LVGLS < 7.0% was associated with increased mortality (HR, 1.337; 95% CI, 1.038–1.722; *p,* 1⁄4 0.024), whereas LVEF ≤ 30% was not (HR, 1.055; 95% CI, 0.794–1.403; *p,* 1⁄4 0.711), thus concluding that in patients with secondary MR, impaired LV GLS was independently associated with an increased risk for all-cause mortality, whereas LVEF was not.[16]

The management of asymptomatic patients with chronic severe AR and preserved LVEF remains challenging and is based on LV dimensions with ongoing controversy regarding the appropriate timing of AV surgery. In patients with ≥3+ chronic AR and preserved LVEF undergoing AV surgery, a baseline LVGLS value worse than –19% was associated with reduced survival. In a subgroup of patients who returned for 3 and 12-month follow-up examinations, persistently impaired LVGLS was associated with increased mortality.[5] Ewe et al., in their study in patients with significant AR and preserved LVEF—found that speckle tracking echocardiographic analysis with impaired baseline LV longitudinal (per 1% decrease, HR 1⁄4 1.21, *p,* 1⁄4 0.04) or circumferential (per 1% decrease, HR 1⁄4 1.22, *p,* 1⁄4 0.04) strain was independently associated with the need for early surgery thus emphasizing the role of GLS in optimizing the timing for surgery.[5] Alashi et al., in the observational study of asymptomatic patients undergoing aortic valve surgery for chronic AR ≥3+ and preserved LVEF, a baseline LVGLS value worse than –19% was associated with reduced survival. In a subgroup of patients who returned for 3 and 12-month follow-up examinations, persistently impaired LVGLS was associated with increased mortality.[5] In another study by the same author in asymptomatic patients with significant chronic AR and preserved LVEF, it was confirmed that worsening LVGLS was associated with long-term mortality, providing incremental prognostic value and improved reclassification.[9]

There are inherent limitations of strain measurement at this stage due to vendor variability; hence the actual cutoff values for prognostication of a disease condition are not standardized. Myocardial deformation is dependent on myocardial loading conditions and contractility. Again, these parameters vary a lot in the immediate cardiac surgical perioperative period. Hence the clinician should be cognizant of these parameters before interpreting the data. The clinical application of LV GLS in VHD is currently followed only in the assessment of aortic stenosis and has been included in recent guidelines.[17] Contrary to this, its role in the assessment of patients with regurgitant lesions is limited. Its measurement definition needs standardization as well as cutoff values need further studies. Most of the available data is based on TTE examination and done beyond the perioperative period. We, as cardiac anesthesiologists, have the opportunity to do TTE and transesophageal echocardiography (TEE) in the perioperative period and anticipate LV dysfunction in the postoperative period requiring inotropic support and plan vigilant postoperative care. Also, we have an opportunity to see the agreement among the two modalities (TTE and TEE) of strain measurement and find out the cutoff limits of strain, which can predict LV dysfunction postoperatively.

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