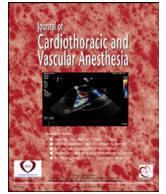


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Editorial

Global Left Ventricular Strain: Exciting Applications In Perioperative Practice



Perioperative assessment of ventricular function by echocardiography is common in the contemporary practice of cardiac anesthesiology.¹ Although left ventricular ejection fraction is a gold standard for evaluating left ventricular function, it has shortcomings, including observer variability, load dependency, and a lack of sensitivity for the detection of early ventricular dysfunction.¹⁻³ Newer echocardiographic modalities, such as strain analysis, can be effective in measuring systolic function for cardiac surgical patients, but still require further validation and broader implementation in the operating room setting.²⁻³ Speckle-tracking echocardiography is a powerful clinical tool for quantifying myocardial strain.³ Multiple trials have demonstrated that strain measured with two-dimensional speckle tracking can accurately quantify global and regional myocardial function as compared to contrast-enhanced magnetic resonance imaging.³⁻⁵ The analysis of left ventricular strain examines myocardial mechanics in three spatial dimensions: longitudinal, circumferential, and radial.³⁻⁴ Global longitudinal strain is a widely reported parameter that determines strain in individual LV segments to predict the estimated average left ventricular function.³⁻⁶ This important strain measure has been shown to be highly reproducible and to predict mortality and morbidity, including the perioperative outcomes in cardiac surgical patients.⁶⁻⁹

The quantification of global longitudinal strain has been validated primarily with transthoracic echocardiography in awake, spontaneously breathing patients rather than with transesophageal echocardiography in anesthetized patients in the setting of mechanical ventilation.^{3,10-12} In this issue of the *Journal*, Labus et al have analyzed the perioperative course of two-dimensional left ventricular global longitudinal strain in an effort to bridge this evidence gap.¹² In their study of 40 patients with preserved biventricular function undergoing cardiac surgery, two-dimensional strain analysis and the left ventricular ejection fraction were assessed at the following four time points: preoperatively, intraoperatively before sternotomy, intraoperatively after sternotomy, and postoperatively.

The preoperative and postoperative assessments were undertaken with transthoracic echocardiography. The intraoperative assessments were undertaken with transesophageal echocardiography. This noteworthy trial by Labus et al has yielded three findings that merit further discussion.

First, the investigators have demonstrated that left ventricular global longitudinal strain did not significantly differ between the awake state with spontaneous ventilation (first time point) and the anesthetized state with mechanical ventilation (second time point).¹² This observation took into account not only differences between the awake and anesthetized states, but also the differences in transthoracic and transesophageal imaging. The investigators have thoughtfully discussed these findings in light of the recent literature, interpreting the context of their study with respect to confounders, such as clinical hemodynamics, heart rhythm, anesthetic technique, and study population.¹² The study context is important since left ventricular function and, consequently, strain assessment may be influenced by multiple variables, such as selected population, anesthetic technique, ventilation strategy, cardiac rhythm, vasopressor and inotrope selection; and surgical considerations, such as sternotomy and cardiopulmonary bypass.¹³⁻¹⁶ In an effort to minimize these confounding effects, Labus et al have evaluated strain in a homogeneous study cohort with preserved biventricular function undergoing coronary artery bypass grafting with cardiopulmonary bypass. Furthermore, the study cohort had a predefined anesthetic regimen without exposure to vasopressors or pacing. By standardizing the patient population and perioperative regimen, this study has highlighted novel data in the assessment of perioperative strain with echocardiography. Although their findings suggested that strain measurements with transthoracic and transesophageal echocardiography likely correlate, future trials are required to explore whether this observation can be extended still further in the perioperative setting.

Secondly, Labus et al also have demonstrated that left ventricular global longitudinal strain was not affected by sternotomy in their study model (second and third time point assessments).¹² Considering the integral spatial relationship

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between the chest wall and cardiac structures, this finding suggested that mechanical deformation and displacement of the ribcage do not necessarily influence myocardial performance. A fortuitous consequence of this finding was that strain assessment can be postponed until after sternotomy. This consequence is significant in the dynamic and busy environment of the operating room, where cardiac anesthesiologists also are managing the anesthetic and patient hemodynamics, as well as echocardiography.

Third, these investigators have demonstrated that left ventricular global longitudinal strain significantly deteriorated in this model of coronary artery bypass surgery with cardiopulmonary bypass, despite the preservation of both the left ventricular ejection fraction and systolic velocity of the lateral mitral annulus (third and fourth time point assessments).¹² This finding was in agreement with previous trials that have reported significant impairment of left ventricular global longitudinal strain in this setting, coupled with minimal changes in left ventricular ejection fraction.¹⁷⁻¹⁸ The study by Labus et al included patients who had an uncomplicated perioperative course. This deterioration in postoperative left ventricular global longitudinal strain, despite preservation of the ejection fraction, suggested that strain assessment is a more sensitive imaging technique for detecting subclinical myocardial damage that may be due to incomplete myocardial protection during the surgical procedure. Further trials likely will explore the clinical implications of the perioperative changes in global longitudinal strain both in cardiac and non-cardiac surgery.

Strain has been shown to predict outcomes with high sensitivity in a variety of advanced cardiac conditions, including chronic heart failure, ischemic cardiac disease, and severe aortic stenosis.¹⁹⁻²² An important concomitant question is whether the type of strain quantification influences the power to predict outcomes after cardiac surgery. A recent trial compared longitudinal, circumferential, and radial strain for the prediction of clinical outcomes after surgical aortic valve replacement with or without coronary artery bypass grafting.²³ In this multivariate analysis, decreases in global longitudinal strain rather than circumferential or radial strain significantly predicted need for inotropic support (odds ratio 1.8; 99% confidence interval 1.10-2.97; $p = 0.002$) and prolonged hospitalization (odds ratio 1.2; 98% confidence interval 1.01-1.46; $p = 0.01$).²³ Further trials have explored the roles of global longitudinal strain and three-dimensional regional strain in the prediction of clinical outcomes after cardiac surgery as part of the ongoing echocardiographic journey beyond ejection fraction as the gold standard for left ventricular function.^{9,24,25}

In summary, Labus et al should be congratulated for highlighting the natural history of strain imaging in the perioperative period for cardiac surgical patients.¹² They have pointed out the value and confounders for strain imaging and analysis with perioperative echocardiography. Their observations have added to the imperative to further evaluate strain imaging in the perioperative period. The important questions in this research domain should be framed with clear criteria for normal values in both adults and children to facilitate interpretation of future findings.²⁶⁻²⁸ Although the normal ranges

for strain parameters in different settings are in development, significant confounders are still present, including clinical setting, patient age, and vendor platform.²⁶⁻²⁸ As a novel and maturing echocardiographic modality, comprehensive strain assessment also can extend beyond the left ventricle to yield further insights into diastolic function.²⁹ Strain imaging also has the potential to assist in the future priorities for investigation in cardiothoracic and vascular anesthesia, including the refined diagnosis of perioperative myocardial ischemia and the optimization of clinical outcomes after valve interventions.³⁰

Conflict of Interest

None.

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