New indices of left ventricular function: let's move from ejection fraction to more physiological parameters

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The assessment of myocardial function in the context of valvular heart disease (VHD) remains highly challenging.[1] The myocardium deforms simultaneously in three-dimensions, and global left ventricular (LV) function parameters such as volume and ejection fraction (EF) may remain compensated despite alterations in myocardial deformation properties.[1] In VHD, the decline in myocardial deformation parameters precedes the onset of symptoms and portends a poor outcome. Nevertheless, it has not been demonstrated that LV global longitudinal strain (GLS) has independent prognostic value in patients with VHD[2] and GLS does not figure in current recommendations for the management of these patients.[2,3]

The advent of novel tissue-tracking echocardiography techniques offers new opportunities for clinical identification of early abnormalities in LV-function. In this issue of the Journal of Physiology, Hulshof et al.[4] propose a new noninvasive measure of LV performance based on electrocardiographic estimates of simultaneous LV longitudinal deformation and volume. They present strain-volume loops evaluated throughout the cardiac cycle and have tested the value of this elegant index of LV-function in 27 patients with aortic valve stenosis (AS) or aortic regurgitation (AR). These volume-strain loops were able to distinguish the hemodynamic cardiac impact of AS and AR. As yet, these results are preliminary only and much work remains to be done in order to demonstrate the advantages of this new approach over the assessment of LV longitudinal strain on its own.[5; 6]

LV pressure-strain loops (PSLs) are another interesting and closely related approach. Clinical use of the PSL has been limited by the need for instantaneous LV pressure recordings. However, nonvasive methods for acquiring these data have been developed.[6; 7] The reliability of PLS as an index of LV function has been validated in animal models and confirmed in preliminary studies conducted in CRT candidates and in patients with ischemic heart disease.[6-9]

An advantage of LV pressure-strain analysis is that it allows the estimation of regional and global LV work (quantified by calculating the rate of segmental shortening (strain rate) and multiplying it by instantaneous LV-pressure). During LV ejection, work performed during segmental elongation represents energy loss, defined as negative work (NW), while work performed during segmental shortening represents positive work (PW). The dispersion of cardiac work may be expressed as a work wasted ratio (WWR) and calculated as NW/PW. Work efficiency (WE) evaluates the proportion of total work dissipated during systole and can be estimated as: (1- NW)/(PW+NW))*100%.[6; 8] This simple index of LV mechanical dispersion which is highly reproducible and have already been tested in several conditions.[10; 11]

We have recently completed a preliminary assessment of PLS as an index of LV myocardial in patients with severe AS and preserved LVEF undergoing aortic valve replacement (AVR) using echocardiographic data recorded at baseline and 1 year after the aortic valve replacement. LV pressure was estimated from an empiric, normalized reference curve adjusted according to the duration of the isovolumic and ejection phases, defined by mitral and aortic valve opening and closure times. Our preliminary results are consistent with those presented here by Hulshof et al.[4] In marked contrast to LVEF, both strain-volume and strain-pressure-derived parameters distinguish the LV systolic properties of AS and AR patients clearly, and describe the changes of LV performances before and after AVR.

Heart failure (HF) with preserved ejection fraction (a condition frequently in patients who remain breathless following AVR) may be another interesting field of application of these newly introduced parameters. GLS alone has not proved to be an effective prognostic index in HF in HF with preserved ejection fraction,[12; 13] but it seems probable that strain-volume loops and/or pressure-volume loops could better describe intrinsic myocardial function in this setting.

The findings presented here[4] are very preliminary, but they encourage further research to determine the extent to which these promising new indices can be translated to everyday clinical practice.

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