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EDITOR'S PAGE

CMR Global Longitudinal Strain

A Better Tool for Unraveling the Links to Heart Failure Mortality

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Tissue tracking methods follow the fundamental principle of recognizing trackable features or irregularities over successive images. As a unique parameter of myocardial deformation, displacement is the vector distance that a trackable feature has moved between 2 consecutive frames. Summating displacements in a myocardial segment, myocardial strain is the fractional change in the length of a myocardial segment during the cardiac cycle in 3 principal directions (circumferential, radial, and longitudinal). In addition, by averaging the directional strain values from all myocardial segments, global strains can be derived. These methods have great potential clinical value because it has been shown that strain as a measurement of myocardial deformation is more sensitive for early or subtle contractile dysfunction, and less affected by cardiac loading, than ventricular volume-based methods such as left ventricular ejection fraction (LVEF) (1). Developed more than 3 decades ago and generally considered the gold-standard method, cardiac magnetic resonance (CMR) tagging (known as spatial modulation of magnetization) quantifies myocardial deformation by directly placing grid lines onto the myocardium with the advantage of an open imaging field and unrestricted scan planes. Speckle-tracking echocardiography, which detects backscattered ultrasound from small myocardial structures, has been increasingly adopted clinically due to its advantages of having high temporal resolution and relative ease of data acquisition and post-processing. Feature tracking by cine cardiac magnetic resonance (CMR-FT) is a relatively new method that derives regional strain values from standard cine steady-state free precession (SSFP) images. It has the advantages of not requiring additional data acquisition, high signal-to-noise and contrast-to-noise ratios in distinguishing the myocardial-blood border, and a high in-plane spatial resolution of 1 to 2 mm. However, CMR-FT has several limitations. Averaging of data obtained from electrocardiography-gated periodic sampling over 10 to 15 cardiac cycles, at a limited temporal resolution of 40 to 50 ms, may lead to an inability and specifically an underestimation of myocardial strains during the short and rapid phases of the cardiac cycle. Cine SSFP has homogeneous signals within the myocardium; CMR-FT is therefore possible primarily at the myocardial-blood border (or extending to the epicardial border) and not within the myocardium (1). Similar to 2-dimensional (2D) echocardiography, CMR-FT cannot resolve through-plane motion when the tracked features move out of the imaging plane. Despite these technical challenges, both global longitudinal and circumferential strains by CMR-FT have shown emerging and promising prognostic values in various cardiac conditions (2,3).

In this issue of *iJACC*, Romano et al. (4) reported a stronger association of global longitudinal strain (GLS)

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by CMR FT with patient mortality than LVEF and late gadolinium enhancement (LGE) combined, from a dataset of 1,021 patients with cardiomyopathy from various causes. This study is the largest multicenter experience to date illustrating the prognostic value of GLS that could easily be derived from the 3 cine radial long-axis views of standard CMR imaging protocols. Adjusted to common risk markers including LVEF and LGE, each 1% worsening in GLS was associated with an 89% increased risk of death. Continuous net reclassification improvement demonstrated broad effectiveness in reclassification of patients' risks (continuous net reclassification index: 1.148). In addition, the robustness of GLS's adjusted prognostic value appeared to be maintained in both ischemic and nonischemic subgroups of cardiomyopathy. This study demonstrates that GLS derived from current routinely acquired 2D cine SSFP is a new and better scalable marker of patients' mortality risk due to ventricular dysfunction than LVEF. Compared with LVEF, GLS has less spatial misregistration between CMR images acquired at different breath-holds. The authors should be commended for their efforts constructing this large multicenter cohort using relatively standardized cine and LGE pulse sequence parameters across 4 contributing sites. Compared with echocardiography, CMR suffers from lower temporal resolution; it is unclear how the current CMR-measured GLS fares against echocardiographic-derived GLS, which is easier and cheaper to perform. The use of LVEF in decision-making has been deeply ingrained in clinicians, in part based on many large-scale therapeutic trials employing LVEF as a risk arbiter. Nonetheless, the findings from Romano et al. (4) are among many that call for potential incorporation of GLS in the designs of future trials.

Tissue tracking technology by CMR will likely experience future significant breakthroughs. It is currently developed for and applied onto 2D images, but could in principle be extended to track 3-dimensions without a need for major conceptual change (1). Currently, the typical short-axis 2D stack of cine from a clinical CMR study suffers from low spatial resolution in the through-plane direction (6 to 10 mm) and also limited temporal resolution (~40 to 50 ms). A rapid signal processing method by compressed sensing may resolve the problems from through-plane motion and limited spatial resolution by allowing the acquisition of 3D isotropic cine volumetric datasets across phases of a cardiac cycle (5). It may also substantially improve temporal resolution to allow interrogation of fine myocardial deformation during isovolumic phases of the cardiac cycles. There is still much to be explored.

iJACC has often tried to comprehensively address the utility of CMR in defining prognosis in heart failure (6). More recently, we have tried to encourage papers elucidating the role of strain in a number of different conditions associated with heart failure over the last 5 years (7,8) and have many more papers are coming this year. What is remarkable in the current paper is the additive effect of CMR strain over and above one of the most potent predictive factors in cardiomyopathies, namely LGE (9,10). CMR is also showing promise in some conditions where echocardiography has reigned supreme (11), and comparative studies looking at prognosis from CMR-derived strain versus echo-derived strain might be very revealing. This is an exciting time for myocardial mechanics and *iJACC* hopes to be an enthusiastic partner for you in this journey.

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