Simultaneous 4-Chamber Strain
More and Faster Analysis, But Is It Good Enough?

Tomasz Baron, MD, PhD; Frank A. Flachskampf, MD, PhD

Analysis of myocardial deformation, or strain imaging, is becoming part of routine echocardiography. The most widely accepted parameter to date has been global longitudinal strain as a measure of global left ventricular (LV) function. Global longitudinal strain (LS) of the LV, in (negative) percent, is the average of the maximal shortening (in percent) in the apico-basal direction of each of 18 LV segments visualized in the 3 standard apical views. The strain curves are computed using speckle tracking to determine myocardial velocity in a region of interest from which local strain is derived. LS is defined as deformation (shortening or lengthening) along the midline of LV walls, that is, in an apico-basal direction, but following the curvature of the LV walls. Similarly, global left or right atrial or right ventricular LS can be obtained as average of segmental peak LS. Strain data are highly dependent on image quality and frame rate, as well as physiological parameters as blood pressure.

The authors found higher strain values in women than in men and a decrease of peak left and right atrial strain with age, findings generally in line with the literature, and new for the right ventricular free wall, a normal range of $-23\pm6\%$ was found, again lower than currently recommended normal values from $-29\pm4.5\%$. Given the smooth appearance of the strain curves, postprocessing may have contributed to under-estimation, which re-emphasizes that strain values are dependent on underlying software and hardware.

Peak LV LS values, calculated from the 6 segments of the 4-chamber view, were $-18\pm2\%$. This is lower than a recent meta-regression from the published literature reported for classic global LS (calculated from the 18 segments of the 3 apical views), namely $-19.7\%$; 95% confidence interval, $-20.4\%$ to $-18.9\%$. Although the reduction compared with published values may seem low, $1.7\%$ absolute percent difference corresponds to $9\%$ relative change. Because strain measurements are typically used to detect small, subtle, sub-clinical changes, this is not a negligible difference.

A puzzling detail of the left ventricular and atrial strain curves is their timing. From Figure 1 of Addetia et al (the only one with an electrocardiographic tracing), it seems that LV and left atrial strain curves both start at zero at the end of the electrocardiographic QRS complex. However, physiologically, left atrial (LA) expansion in sinus rhythm starts at the onset or even before the QRS complex (see Figure), and LV longitudinal shortening also starts during QRS.

The main attraction of the presented technique is that from one view and within one heart beat, function (more properly, LS) of all 4 chambers is evaluated quantitatively in a semiautomatic way. Is this the future for time-pressured echocardiographers? Several caveats apply. Echocardiographic acquisition of an apical 4-chamber view is usually optimized for showing LV structures as well as possible, mostly the LV endocardium and the mitral valve. Recognizing this, current guidelines for right ventricular (RV) assessment explicitly call for an extra, optimized, RV-focussed view to best evaluate right ventricular morphology and function. Similarly, renewed interest in LA volume as a marker of diastolic function and general prognosis has reminded us that in many 4-chamber views, the LA is foreshortened, and often LA-optimized views are necessary to better delineate this structure, sometimes at the expense of detail in other chambers. Thus, it is likely that
dial mass of the left atrium (15–45 g at autopsy) is much affected by the adjacent myocardium. Because the myocardium depends on preload and afterload, which are measures of local deformation, this deformation itself physiology is questionable. Because atrium and ventricle are tethered to each other in mechanical continuity, longitudinal shortening of 1 of the 2 must be associated with lengthening of the other, and vice versa, because the total volume and the apico-basal dimension of the heart are constant throughout the cardiac cycle. Although strain measures local deformation, this deformation itself physiologically depends on preload and afterload, which are affected by the adjacent myocardium. Because the myocardial mass of the left atrium (15–45 g at autopsy) is much smaller than the LV mass, it is likely that peak left atrial strain, which occurs at LV end-systole, heavily depends on LV mechanics.

In conclusion, Addetia et al present a first experience with a formidable feat of image postprocessing, allowing a quick glimpse of deformation in all 4 chambers from one echo view and one heartbeat. The place of this approach in the clinical arena remains to be determined.

Disclosures

None.

References


Key Words: Editorials cardiovascular imaging deformation longitudinal strain strain
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_Circ Cardiovasc Imaging_. 2016;9:e004544
doi: 10.1161/CIRCIMAGING.116.004544

_Circulation: Cardiovascular Imaging_ is published by the American Heart Association, 7272 Greenville Avenue, Dallas, TX 75231
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Print ISSN: 1941-9651. Online ISSN: 1942-0080

The online version of this article, along with updated information and services, is located on the World Wide Web at:
http://circimaging.ahajournals.org/content/9/3/e004544

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