Assessing Contractile Function When Ejection Fraction Is Normal

A Case for Strain Imaging

Tor Biering-Sørensen, MD, PhD; Scott D. Solomon, MD

Two-dimensional (2D) speckle-tracking echocardiography has, in recent years, emerged as a new method for assessing left ventricular systolic and diastolic function. The technique measures the movement of nonrandom coherent speckles in 2D echocardiographic images. Speckle-tracking measures myocardial deformation through the heart cycle rather than volumetric changes between end-diastole and end-systole, the standard method for calculating left ventricular ejection fraction (LVEF), which is dependent on image quality, the ability to accurately trace the endocardial border, and geometric assumptions required to estimate volumes from a 2D image.

The opinions expressed in this article are not necessarily those of the editors or of the American Heart Association.

From the Cardiovascular Medicine Division, Department of Medicine, Brigham and Women’s Hospital, Harvard Medical School, Boston, MA (T.B.-S., S.D.S.); and Department of Cardiology, Herlev and Gentofte Hospital, University of Copenhagen, Denmark (T.B.-S.).

Correspondence to Tor Biering-Sørensen, MD, PhD, Cardiovascular Division, Brigham and Women’s Hospital, 75 Francis St, Boston, MA 02115. E-mail tor.biering@gmail.com

(Circ Cardiovasc Imaging. 2015;8:e004181. DOI: 10.1161/CIRCIMAGING.115.004181.) © 2015 American Heart Association, Inc.

Circ Cardiovasc Imaging is available at http://circimaging.ahajournals.org
DOI: 10.1161/CIRCIMAGING.115.004181
between these 2 spirals ranging from +60° to −60°.17 Although both the subendocardial and the subepicardial longitudinal fibers contribute to longitudinal deformation, in the normal heart, they counterbalance each other’s ability to produce circumferential deformation. The subendocardial fibers seem more susceptible to dysfunction10,18 than the mid and epicardial fibers. This impairment of the subendocardial longitudinal fibers also leads to attenuated subendocardial right-handed helix fiber shortening during systole, potentially resulting in a failure to fully counterbalance the subepicardial left-handed helix fiber shortening and resulting in increased circumferential deformation.2,4,13,19 This putative mechanism for early alterations in LV deformation is consistent with the previously reported results that GLS is impaired despite preserved LVEF in various populations, including increasing age,7 hypertension,8 diabetes mellitus,9 stable angina,10 renal dysfunction,11 obesity,12 and HF with preserved LVEF.21 Indeed, this increased circumferential deformation, which accompanies a reduced longitudinal deformation, merely because of the anatomic fiber direction within the cardiac wall, might be one of the major determinants of why LVEF remains within the normal range despite an ailing heart. In addition, this mechanism, therefore, also explains why subclinical impaired longitudinal deformation seems to provide prognostic information beyond LVEF in the setting of preserved LVEF conditions.

Yet another reason for longitudinal myocardial deformation to be especially useful in the setting of a preserved LVEF might simply be because of the difference in methodology. As previously mentioned, the assessment of LVEF is based on the percentage difference in volume between end-diastole and end-systole, whereas GLS is a measure of the percentage the LV myocardial walls shorten in length during the cardiac cycle.1 Furthermore, cardiac function has traditionally been divided into systolic and diastolic function, where LVEF is the echocardiographic measure of systolic function, while several flow and tissue Doppler measures, in conjunction with the left atrium size, defines echocardiographic determined diastolic function. However, these theoretically determined definitions on cardiac function seem less relevant when assessing cardiac function using LV longitudinal deformation. Several diseases, which formerly were considered as associated with isolated impaired diastolic function, such as hypertension and hypertrophy, are now recognized to display impaired longitudinal deformation with preserved LVEF.5,8,13 During systolic contraction, the ventricular cardiomyocytes shorten to less than their equilibrium length, which stores potential energy in the elastic myocardial components (the extracellular collagen surrounding the myocytes and the titin filaments within the myocytes). This accelerates the relaxation process, contributes to relengthening during early diastole, and aids filling by moving the mitral annulus around the column of the incoming blood.16,20 Systolic function as determined by longitudinal deformation is therefore indeed a determinant of the diastolic function and vice versa.21 LV longitudinal deformation might therefore identify subtle impairments in cardiac function, which previously was recognized as being isolated diastolic dysfunction in the setting of preserved LVEF, and these impairments have been demonstrated to be strong prognosticators.3,4,6

Palmieri et al15 add yet another clinical disease to the continued expanding list of diseases, where assessing LV longitudinal deformation might improve risk stratification. In addition, the authors also add to the increasing evidence demonstrating that LV longitudinal deformation identifies subtle cardiac dysfunction, regardless of LVEF, which provides prognostic information above and beyond what we can obtain from our conventional echocardiographic measures, and further supports the argument that it may be time to move beyond LVEF in assessment of cardiac function.2

Sources of Funding
Dr Biering-Sørensen received a research grant from the P. Carl Petersen foundation. In addition, Dr Biering-Sørensen received a Sapere Aude research talent grant from The Danish Council for Independent Research (DFF-4004-00248B). The sponsors had no role in the writing of this article.

Disclosures
None.

References
Biering-Sørensen and Solomon  Usefulness of GLS When LVEF Is Preserved


Key Words: Editorials  ◼  echocardiography  ◼  sepsis  ◼  shock  ◼  strain  ◼  ventricular ejection fraction
Assessing Contractile Function When Ejection Fraction Is Normal: A Case for Strain Imaging
Tor Biering-Sørensen and Scott D. Solomon

Circ Cardiovasc Imaging. 2015;8:
doi: 10.1161/CIRCIMAGING.115.004181

Circulation: Cardiovascular Imaging is published by the American Heart Association, 7272 Greenville Avenue, Dallas, TX 75231
Copyright © 2015 American Heart Association, Inc. All rights reserved.
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/8/11/e004181

Permissions: Requests for permissions to reproduce figures, tables, or portions of articles originally published in Circulation: Cardiovascular Imaging can be obtained via RightsLink, a service of the Copyright Clearance Center, not the Editorial Office. Once the online version of the published article for which permission is being requested is located, click Request Permissions in the middle column of the Web page under Services. Further information about this process is available in the Permissions and Rights Question and Answer document.

Reprints: Information about reprints can be found online at:
http://www.lww.com/reprints

Subscriptions: Information about subscribing to Circulation: Cardiovascular Imaging is online at:
http://circimaging.ahajournals.org//subscriptions/