Editorial

Is Echocardiographic Assessment of Strain Essential In Daily Routine?

Carlos Eduardo Suaide Silva[1]
Dasa,[1] Barueri, SP – Brazil

The assessment of myocardial fiber deformation (myocardial strain) during the cardiac cycle is a direct measurement of muscle function, which can be obtained by conventional imaging tests such as echocardiography and magnetic resonance.

Strain measurement can identify abnormalities in global and regional myocardial function, in addition to making the differential diagnosis of some cardiomyopathies. Furthermore, it is an earlier marker of ventricular dysfunction than ejection fraction and may predict adverse cardiovascular events.

The most used parameter to assess the global ventricular function is the ejection fraction, and the choice of diagnostic method depends on the patient's clinical situation. Magnetic resonance imaging has been considered the gold standard, but the ideal method would be minimally invasive, low-cost, reproducible with little interobserver variation, without irradiation or use of contrasts, and repeatable as many times as necessary. Magnetic resonance imaging is highly accurate, and it is able to assess both anatomy and ventricular function; however, it is expensive, more time-consuming, and not widely available. Contrast allergy is also a relatively limiting factor to its use. This makes echocardiography the most widely available and least uncomfortable method for patients in order to assess cardiac physiology.

Strain is a dimensionless measurement that expresses the deformation of a myocardial segment as a percentage and, therefore, provides information on the contractile function of that segment.[1] We can assess longitudinal, circumferential, and radial contractile function. The most widely used method is longitudinal strain, in part because most of the initial studies used this parameter, in part because the equipment does not calculate the radial or circumferential strain, except with specialized software, and, finally, because of the absence of well-defined normal values for age, sex, and race. Only recently have world societies established these values through the World Alliance Societies of Echocardiography Study.[2]

Keywords

Cardíac Imaging Techniques; Ventricular Function; Echocardiography

Mailing Address: Carlos Eduardo Suaide Silva •
Diagnósticos da America AS, Cardiologia. Av. Jurua 434. Postal code: 06455-010. Barueri, SP – Brazil.
E-mail: csuaide@cardiol.br
Editor responsible for the review: Daniela do Carmo Rassi Frota

DOI: https://doi.org/10.36660/abcimg.20230063i

Cardiac muscle fibers are arranged in different directions according to their subendocardial, middle, and subepicardial layers, causing the myocardium to shorten longitudinally and circumferentially and to thicken radially during systole.

Strain quantification by echocardiography was initially performed using the tissue Doppler technique. By measuring the speed of movement of two points of the myocardium and dividing by the distance between them, we can quantify the deformation of a given segment. As it was a technique based on the Doppler effect, it was influenced by the angle of incidence of the ultrasound, which limited its use. mainly in the apical segments, where the direction of the muscle movement vector is practically perpendicular to that of the ultrasound beam, making it extremely unfavorable for speed calculation and demanding great expertise on the part of the operator. In addition, there was reasonable interobserver variation. Strain measurement by Doppler was soon replaced by the speckle-tracking technique based on two-dimensional echocardiography.[3] Software designed to follow the positions of the speckles (bright dots on the ultrasound image) frame by frame made it possible to quantify the myocardial deformation more accurately, eliminating angle dependence, with a more satisfactory signal-to-noise ratio, making it possible to measure strain in two dimensions (rather than just in the direction of the Doppler beam).[4] This is the universally used technique for measuring strain to this day.

Global longitudinal strain (GLS) values are more reliable and more relevant than ejection fraction in the early detection of ventricular dysfunction.[5] The prediction of cardiovascular events is more reliable using GLS than ejection fraction.[6] Although it does not replace ejection fraction, this information alone would be a good reason to include GLS among the parameters routinely displayed on echocardiography.

Myocardial deformation is influenced by both preload (the strain value increases with the increase in the size of the ventricular cavity) and afterload (strain decreases with the increase in arterial pressure).

A major clinical contribution of strain is the fact that it can detect myocardial dysfunction early, even before the ejection fraction begins to decrease. This applies to many clinical situations. In ischemia, for example, myocardial impairment begins in the subendocardial layer, predominantly composed of longitudinal fibers, which facilitates assessment by echocardiography through the measurement of longitudinal strain in apical views. This impairment may be subclinical, without any decrease in

ejection fraction, but the longitudinal shortening of the fibers may already be altered by ischemia and affect the strain curve. The identification of post-systolic contraction can also alert us to the presence of ischemia, even before any more evident contractile alteration appears on the two-dimensional test. In addition to diagnosis, this technique has great prognostic value and is an excellent tool for the follow-up of these patients. Figure 1 shows the 13-year follow-up of a patient who had his first infarction in 2010, which slightly altered the GLS, and a second one in 2014, which compromised the apex. Nine years later, a worsening could be observed in the affected area. Strain maps give us a perfect idea of the evolution of myocardial damage.

In athletes, strain measurement is very important in assessing both systolic and diastolic function.[7] It can help make the differential diagnosis between physiological and pathological hypertrophy and help detect early ventricular dysfunction in users of anabolic steroids, which are, unfortunately, becoming more and more frequent in our setting.

In valve diseases, strain serves as an important prognostic tool and, in situations bordering on surgical indication, reduced strain can be the missing piece of information for clinical decision making.

In cardio-oncology, the role of strain in the early detection of cardiotoxicity has been amply defined. Numerous studies have shown a reduction in strain values before the drop in ejection fraction occurs. According to the consensus of the American Society of Echocardiography and the European Association of Cardiovascular Imaging,[8] a drop of 15 percentage points in the GLS value is highly suggestive of cardiotoxicity. It is fundamental to perform strain echocardiography before initiating chemotherapy to compare with future sequential echocardiograms and observe whether there is a drop in GLS.

In cardiomyopathies, the presence of specific patterns on the polar map may even suggest the etiology of the disease. When contraction is preserved in the apical region and decreased in the middle and basal segments (apical sparing), it is highly suggestive of amyloidosis (Figure 2). A decrease in strain values in the septal region alone, even without a large increase in myocardial thickness, leads us to suspect hypertrophic cardiomyopathy (Figure 3).

In our opinion, the quantification of myocardial strain is indeed essential in daily routine. As previously set forth, in almost all heart diseases, strain assessment always has something to add, whether to diagnosis, prognosis, or therapeutic follow-up. Only patients who are known to be normal, who come to us for routine evaluations, perhaps do not need to undergo strain echocardiography. Even so, from time to time, there are some surprises. Given that we carry out routine tests in our service, occasionally, young people who practice physical activities, with absolutely normal echocardiograms, present a reduction in the GLS and, with a more focused anamnesis, we discover that they use or have used anabolic steroids, which is very important information for the requesting physician. In other cases, a decrease in strain in a slightly thickened localized segment may suggest the presence of hypertrophic cardiomyopathy that could have gone unnoticed; however, it alerts us to continue the investigation. Another situation that we have observed with a certain frequency is the decrease in strain in some segments, without any other echocardiographic alteration, in post-COVID patients. When they are referred for magnetic resonance imaging, myocarditis is detected.

In conclusion, whenever possible (if there is appropriate equipment and the routine permits), we believe that the few extra minutes to perform the procedure are rewarded by the enormous gain in diagnostic quality that this method has to offer.

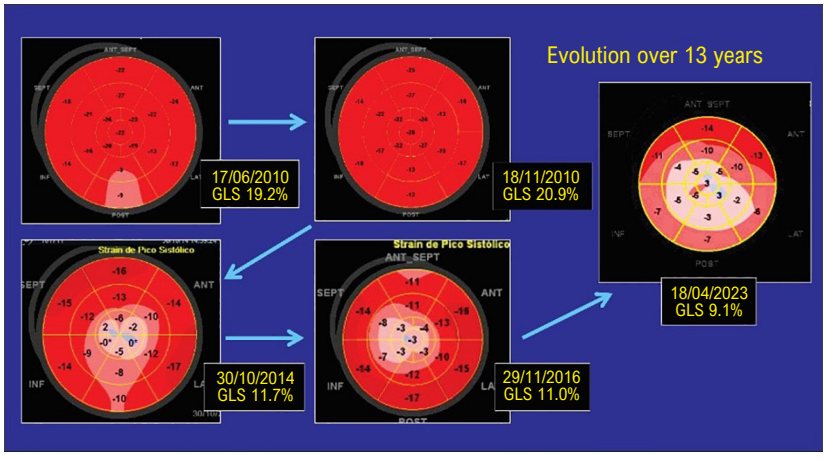

Figure 1 – *Strain maps for follow-up of the evolution of a patient with coronary disease who had a first infarction in 2010 and a second one in 2014. GLS: Global longitudinal strain*

Editorial

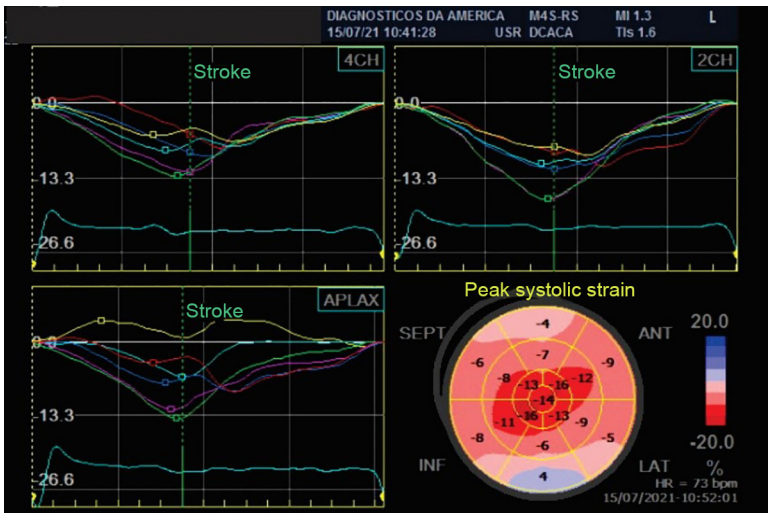

Figure 2 – *Apical sparing in a patient with amyloidosis AVC: Acidente Vascular Cerebral.*

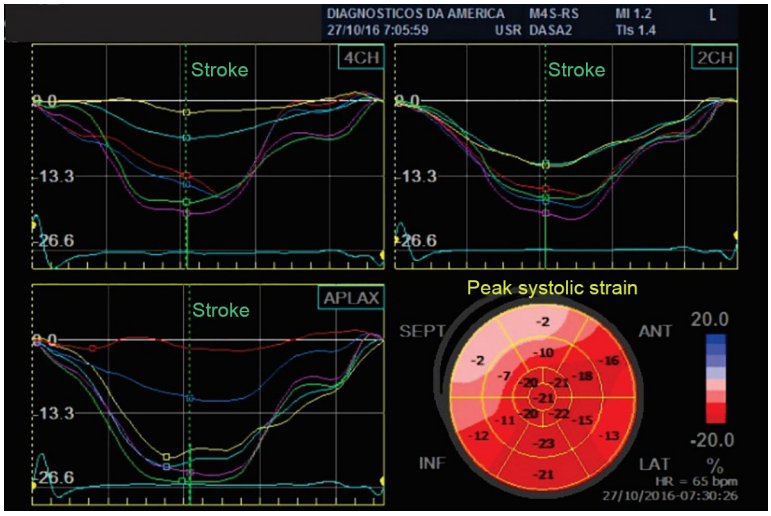

Figure 3 – *Decreased strain in the septal region of a patient with hypertrophic cardiomyopathy*

References

1. Mirsky I, Parmley WW. Assessment of Passive Elastic Stiffness for Isolated Heart Muscle and the Intact Heart. Circ Res. 1973;33(2):233-43. doi: 10.1161/01.res.33.2.233.
2. Singulane CC, Miyoshi T, Mor-Avi V, Cotella JI, Schreckenberg M, Blankenhagen M, et al. Age-, Sex-, and Race-Based Normal Values for Left Ventricular Circumferential Strain from the World Alliance Societies of Echocardiography Study. J Am Soc Echocardiogr. 2023;36(6):581-590.e1. doi: 10.1016/j.echo.2022.12.018.
3. Marwick TH. Measurement of Strain and Strain Rate by Echocardiography: Ready for Prime Time? J Am Coll Cardiol. 2006;47(7):1313-27. doi: 10.1016/j.jacc.2005.11.063.
4. Heimdal A, Støylen A, Torp H, Skjaerpe T. Real-Time Strain Rate Imaging of the Left Ventricle by Ultrasound. J Am Soc Echocardiogr. 1998;11(11):1013-9. doi: 10.1016/s0894-7317(98)70151-8.
5. Venneri L, Khattar RS. Cancer and Myocardial Dysfunction: Is There a Link? Expert Rev Cardiovasc Ther. 2016;14(11):1207-9. doi: 10.1080/14779072.2016.1226129.
6. Luis SA, Chan J, Pellikka PA. Echocardiographic Assessment of Left Ventricular Systolic Function: An Overview of Contemporary Techniques, Including Speckle-Tracking Echocardiography. Mayo Clin Proc. 2019;94(1):125-38. doi: 10.1016/j.mayocp.2018.07.017.

7. Silva CES. Appropriate Use of Diastolic Function Guideline When Evaluating Athletes: It is not Always what it Seems to Be. Arq Bras Cardiol. 2020;115(1):134-8. doi: 10.36660/abc.20190689.

8. Plana JC, Galderisi M, Barac A, Ewer MS, Ky B, Scherrer-Crosbie M, et al. Expert Consensus for Multimodality Imaging Evaluation of Adult Patients During and after Cancer Therapy: A Report from the American Society of Echocardiography and the European Association of Cardiovascular Imaging. J Am Soc Echocardiogr. 2014;27(9):911-39. doi: 10.1016/j.echo.2014.07.012.