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Global Longitudinal Shortening:

A Positive Step Towards Reducing Confusion Surrounding Global Longitudinal Strain

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Quantitative evaluation of the mechanical deformation of the myocardium during the cardiac cycle, or strain, is becoming an integral part of echocardiographic, cardiac magnetic resonance (CMR), and cardiac computed tomography examinations (1–4). Many studies have demonstrated the prognostic power of strain in different clinical conditions. The most

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common myocardial strain parameter used clinically is longitudinal strain, which is obtained by measuring shortening and lengthening of the myocardium in a longitudinal (i.e., apico-basal) direction in the left and right ventricles. This is the basis for the derivation of left ventricular global longitudinal strain (GLS), which takes into account all myocardial segments in the longitudinal direction.

The standard definition of (Lagrangian) strain is $\varepsilon = (L_1 - L_0)/L_0$, where ε is strain, L_0 is the myocardial length at baseline (usually end-diastole), and L_1 is myocardial length at the end of the considered time interval (usually at end-systole). If applied to longitudinal myocardial shortening during systole, the resulting values are negative, because L_1 is shorter than L_0. Although regional systolic lengthening may occur in disease states, leading to positive regional strain values, the global left (or right) ventricular strain value always reflects shortening, because otherwise no stroke volume would be generated. Thus, more shortening (i.e., in general, better myocardial function) leads to more negative values. A normal GLS of −20% is more negative with a mathematically lower value than −10%, with the latter corresponding to a substantially decreased amount of global systolic left ventricular longitudinal shortening. The negative sign and its implication for myocardial function have been confusing. This is further magnified because GLS strain is becoming increasingly used in reports provided to non-cardiologists (e.g., oncologists, internists, endocrinologists).

To avoid this confusion and enhance the use of strain, we propose using GLS without the minus sign (i.e., as an absolute, positive value). Thus, a larger number would imply more systolic longitudinal shortening. To distinguish this always positive value from the classic negative GLS notation, we suggest using the term “global longitudinal shortening” instead of GLS. This suggestion, unanimously endorsed by the editors of *iJACC*, was inspired by recently accepted manuscripts in which the investigators used an absolute (positive) value of GLS in reporting their data (5,6).

We acknowledge that the practice of the collective scientific community, informed by recommendations and guidelines from professional cardiovascular societies, will be the final arbiter of this proposal. In our discussion of this matter, we would like to address a few anticipated concerns:

1. Compromising the existing literature. There is now more than a decade of literature on GLS with a negative sign. Thus, we propose adoption of the term global longitudinal shortening for the new positive notation. The data, cutoffs, and implications as to outcome will still be directionally similar.

2. How to address regional (segmental) longitudinal strain, because it can be either positive or negative, in contrast to GLS? At this time, we propose using the new notation exclusively for global longitudinal shortening and/or strain.

The proposed approach of converting the sign of GLS to positive would minimize confusion. Because our proposed terminology is applicable to all cardiovascular imaging modalities that assess strain (e.g., echocardiography, CMR, cardiac computed tomography), we hope that cardiovascular imaging societies, imagers, and researchers take this suggestion to heart and adopt this terminology. Similarly, we envision that this change will also be implemented by our industry partners in imaging equipment, where these data are generated.

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REFERENCES

1. D'hooge J, Heimdal A, Jamal F, et al. Regional strain and strain rate measurements by cardiac ultrasound: principles, implementation and limitations. Eur J Echocardiogr 2000;1: 154–70. [PubMed: 11916589]
2. Mor-Avi V, Lang RM, Badano LP, et al. Current and evolving echocardiographic techniques for the quantitative evaluation of cardiac mechanics: ASE/EAE consensus statement on methodology and indications endorsed by the Japanese Society of Echocardiography. Eur J Echocardiogr 2011;12 167–20. [PubMed: 21385887]
3. Lang RM, Badano LP, Mor-Avi V. Recommendations for cardiac chamber quantification by echocardiography in adults: an update from the American Society of Echocardiography and the European Association of Cardiovascular Imaging. Eur Heart J Cardiovasc Imaging 2015; 16:233–70. [PubMed: 25712077]
4. Claus P, Omar AMS, Pedrizzetti G, Sengupta PP, Nagel E. Tissue tracking technology for assessing cardiac mechanics: principles, normal values, and clinical applications. J Am Coll Cardiol Img 2015;8 1444–6.
5. Park JJ, Park JB, Park JH, Cho GY. Global longitudinal strain to predict mortality in patients with acute heart failure. J Am Coll Cardiol 2018;71:1947–57. [PubMed: 29724346]
6. Kagiyama N, Sugahara M, Crago EA, et al. Neurocardiac injury by strain imaging is associated with in-hospital mortality in patients with subarachnoid hemorrhage. J Am Coll Cardiol Img 2019 5 9 [E-pub ahead of print].