EDITORIAL

Warm and Strained Heart: the new Normal in the Stress Echo lab

Corazón cálido y fuerte con Strain: la nueva normalidad en el laboratorio de eco estrés

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There are three innovative aspects in the paper by Diego Lowenstein Haber et al. published in the current issue of the Journal. (1) First, regional apical left ventricular strain measurement is feasible, helpful, and gives consistent results with vasodilator stress since no image degradation or important tachycardia is observed, differently from other stress modalities. Second, regional strain can be abnormal when regional wall motion is normal. Third, strain alteration during stress has important physiologic and prognostic meaning, since patients with decreased regional strain in the apical region also have a reduced coronary flow velocity reserve in the left anterior descending coronary artery and more likelihood of events in the follow-up. These data have far-reaching pathophysiological and clinical implications. They add another brick in the wall of the growing evidence of coronary flow reserve as an integral part of functional stress testing and they open a new road to quantitative assessment of regional mechanics with deformation imaging during stress.

THE VALUE OF CORONARY FLOW VELOCITY RESERVE

Coronary flow velocity reserve has prognostic value, and adds independent and incremental information over the value of inducible wall motion abnormalities. A reduction in coronary flow reserve is an established predictor of adverse outcomes and death, as is now established by a meta-analysis including 79 studies with 59740 patients across multiple modalities of coronary flow reserve measurements. The relative risk of a reduced coronary flow reserve is 3.78 for all-cause death, with a linear increase of risk of 16% for each 0.1 units reduction in coronary flow reserve. (2) European Society of Cardiology 2019 and American College of Cardiology-American Heart Association 2022 guidelines emphasize the importance of the assessment of coronary flow reserve with invasive or noninvasive techniques. (3,4) Stress echo specialty guidelines accept vasodilator stress as the best way to do it in chronic coronary syndromes and for applications outside coronary artery disease. (5-7) It is true that with transthoracic echocardiography only large primary vessels can be reliably imaged, and *"difficulty in imaging all three major coronary arteries is a significant limitation, preventing the wide clinical use of this technique"* (8), but this limitation applies to diagnostic applications of the technique which are clearly out of its reach. We are more interested in the identification of phenotypes and risk stratification. This can be easily done with transthoracic echocardiography and flow velocity imaging in the mid-distal left anterior descending artery during pharmacological stress echo, as shown by Jorge Lowenstein and his group for the first time in the world 23 years ago, (9,10) and now proven based on large scale multicenter studies on thousands of patients. Coronary flow reserve reduction assessed with transthoracic echocardiography predicts death, and its value is independent and additive over established clinical and echocardiographic predictors. The heart with normal hyperemic flow during stress is the "warm heart", since flow increases the local temperature in the myocardium, while the diseased heart with reduced coronary flow velocity reserve is a "cold heart" during stress. Only the warm heart is at low risk for future events, independently of regional wall motion abnormalities. (11)

THE VALUE OF REGIONAL STRAIN: A TOP PLAYER IN THE PENALTY BOX

We already know that global longitudinal strain adds prognostic information in patients with preserved left ventricular ejection fraction at rest, since alterations in longitudinal function are sensitive to subtle damage of the subendocardial layer. (8) Now we learn that regional apical longitudinal strain adds prognostic information in patients with preserved regional wall motion also during vasodilator stress. (1) Myocardial mechanics is something more than regional wall motion, in the same way as global left ventricular function is more than a simple ejection fraction. During ischemia, regional strain changes may occur more frequently in presence of a reduced coronary flow velocity reserve, and this is true in patients with either

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normal coronary arteries or epicardial coronary artery disease. These strain changes are not prognostically innocent and are associated with a higher likelihood of adverse events. The stage is now set to test the original 2022 Lowenstein (or Lowenstrain) hypothesis (1), that a lower strain with normal wall motion is synonymous with a worse outcome. After the pilot study, the hypothesis needs to be tested in thousands of patients followed up for hard endpoints for an adequate period of time. Regional strain doesn't seem to work too much during stress, but this has been shown with stress modalities such as dobutamine or exercise, that increase heart rate, degrade image quality and produce artifacts with unfavorable signal-to-noise ratio for strain signal during stress (5,8). After the disruptive approach of more than 20 years ago with coronary flow reserve (9), Lowenstein's group, pioneer of flow-function imaging in the stress echo lab and South–American father of stress echocardiography, may be right again. The endothelial layer is large as a football pitch, and with coronary flow reserve, we are playing in the penalty box of the coronary bed where every action counts for the game prognosis. No surprise that we have to follow carefully in the footsteps of our Argentinian players; here we go again in the road to innovation!

Conflicts of interest

None declared.

(See authors' conflict of interests forms on the web/Additional material.)

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