ABCDE Protocol in Stress Echocardiography

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The clinical evaluation of coronary artery disease (CAD) is an individualized, winding road to be followed every day in cardiology practice. It is based on the need for an appropriate diagnosis, considering the optimization of different conducts, with the primary goal of improving patients' quality of life and, at times, avoiding hard endpoints, such as infarction and death.

An ideal method for this complex purpose is the assumption of not causing damage to the person being assessed in order to extract as much physiological information as possible in a kind manner with the least financial (and, therefore, environmental) impact to allow for a large-scale application, as this is a highly prevalent disease.[1]

Non-invasive functional imaging for myocardial ischemia is recommended as an initial test for diagnosing CAD in symptomatic patients as well as for those subjected to coronary angiotomography, which revealed CAD of uncertain functional significance or non-diagnostic CAD.[2]

Stress echocardiography (SEC) is an established CAD diagnosis and stratification method, and the imbalance caused in the bloodstream, and its repercussion on myocardial contractility is a common basis for all modalities. This classic form of semi-quantitative characterization is subject to such factors as the examiner's experience and subjectivity, and its high point is the specificity of the findings. Non-invasive functional tests are associated with high precision in detecting flow-limiting coronary stenosis, when compared to invasive functional tests — fractional flow reserve (FFR). However, non-ischemic, low-grade coronary atherosclerosis is still poorly detected by the functional test.[3]

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In 2017, Picano et al.[1] published a multicenter observation study design to be developed in laboratories with a high volume of SEC tests, including Brazilian laboratories, called Stress Echo 2020. The study was endorsed by the Italian Society of Cardiovascular Echography and organized in 10 subprojects with focus on: contractile reserve for cardiac resynchronization forecast or response to medication therapy; stress B-lines in heart failure; hypertrophic cardiomyopathy; heart failure with preserved ejection fraction; mitral failure after transcatheter or surgical aortic valve replacement; outdoors SEC under extreme physiology; right ventricle contractile reserve in repaired Tetralogy of Fallot; suspected or early pulmonary arterial hypertension; coronary flow velocity, left ventricular elastance reserve and B-lines in known or suspected CAD; identification of subclinical familial disease in genotype-positive, phenotype-negative healthy relatives of inherited disease (such as hypertrophic cardiomyopathy).

Based on the study's results, a new protocol has been proposed for the execution of SEC to increase the test power, and assist in better performing its function in different heart disease scenarios. The coronary artery stenosis-centered model has changed over the past decades, and is now accepted as not the only, nor probably the most important, patient prognostic vulnerability, within and beyond the CAD context. Plaque composition is even more important than its geometry and obstruction level.[4] Pulmonary congestion and diastolic function, left ventricular structure and contractile reserve, coronary microcirculation, and cardiac autonomic balance are equally important risk determinants; however, they are difficult to assess in a non-invasive manner using the methods that are currently available.[5] An international consensus has been reached in recent years concerning the role played in the scenario of non-ischemic, valvular, and pulmonary diseases.[6]

ABCDE SEC constitutes a broad approach, seeking the assessment of other significant prognostic aspects. Leveraging the echocardiography method's versatility and simplicity ("one-stop-shop"),[5] Doppler data and 2D image readings are conceptually increased. Their parameters are conceptually unified, synchronized, and harmonized as the acronym[7] (Figure 1).

A for Asynergy

This is based on the presumable myocardial contractility alteration induced by stress in the presence of flow-limiting coronary stenosis. The substrate supply-demand imbalance leads to a reduction in myocardial radial thickening, a parameter sometimes limited by its semi-quantitative and subjective nature. Operator dependency can be minimized (but not eliminated) by specialized training and the adoption of conservative reading measures, as well as the accreditation and quality control of advanced echocardiography laboratories.

Keywords

Echocardiography; Echocardiography, Stress; Clinical Protocols

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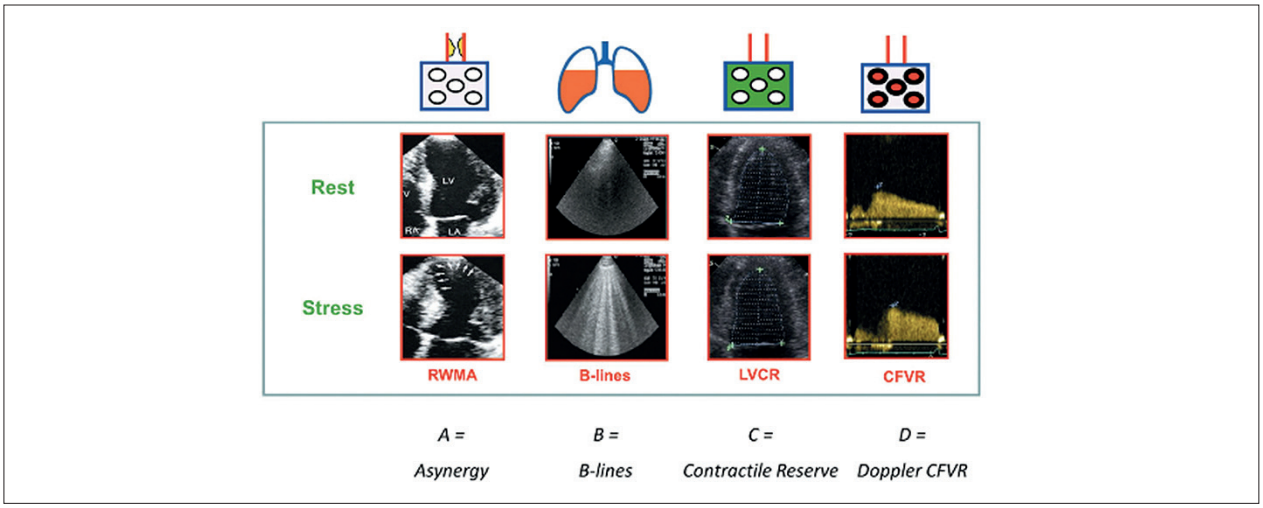

Figure 1 – *The targets of integrated quadruple imaging stress echo. The four pathophysiological targets are epicardial coronary artery stenosis (with RWMA); pulmonary water (with B-lines); myocardial function (with LVCR); coronary microvascular function (with CFVR) [Picano et al. Cardiovascular Ultrasound (2018)].*

The regional motility assessment indicates that the higher the number of affected segments (universally defined), the worse the prognosis. This parameter is viewed as stenosis centered and has its value limited outside the epicardial coronary disease context.[7]

B for B-lines

Increased left atrial pressure forms the basis of a myriad of conditions. Its pathophysiological consequence has the liquid outflow in the pulmonary pericapillary interstitium as hydrostatic substrate. In its acute form, this liquid may be detected by ultrasound in the form of echo lines that reverberate it. During the physical SEC, the induction of physiological processes that potentially provoke the disease homeostasis limit is a parameter that has prognostic significance.[8]

C for Contractility

Contractility is the myocardium's inherent ability to contract regardless of changes in pre- or afterload.

During the SEC, the left ventricle end-systolic volume (ESV) is progressively lower, resulting in higher arterial tension peaks, and increased subsequent afterload. The ratio between arterial pressure (SAP) and ESV predicts the ventricle's ability to empty up to different afterload values.[9]

The left ventricle elastance measures the chamber's contractile reserve by comparing its performance in rest and stress conditions, by dividing the SAP/ESV ratio in stress conditions by the ratio in rest conditions. Physical stress and dobutamine validated values are above 2.0, and with the use of vasodilators, the ratio that indicates appropriate contractility is above 1.1.

D for coronary artery Doppler

The coronary flow may be affected under epicardial stenosis pathological conditions, and muscular dysfunction. In the first scenario, at a given flow measurement point, a limitation with compromised blood intake may occur downstream of the obstruction under stress situations. In the second, several conditions may take place, such as perivascular hypertrophy and ruptured endothelium function caused by inflammation and atherosclerosis, preventing adequate blood flow.

The coronary flow reserve in an echocardiogram is measured, by Doppler, using the velocity ratio at the medial distal section of the anterior descending artery under stress and rest conditions. Normal values are those above 2.0 in any SEC modality.

E for Electrocardiogram

The heart rate variability in response to stress may provide information about the autonomic function of the cardiac conduction system, constituting a status marker for it during the test. This parameter, heart rate reserve, is obtained by dividing the maximum heart rate attained by the value under rest conditions. It is classified as a positive criterion if the ratio is under 1.80, for physical stress and dobutamine, and under 1.22 for vasodilators. Beta blockers reduce heart rate values under rest and stress conditions, with no impact on the ratio for prognostic purposes.[8]

In 2021, Q. Ciampi et al.[10] published the concept that the functional test with SEC may detect other biomarkers, in addition to myocardial ischemia, which could improve the risk stratification for patients with suspected or known CAD. In this multicenter study, the authors prospectively recruited 3,574 patients with suspected or known CAD referred to SEC. All findings were normal for 31% of the patients, and all findings were abnormal for 5% of the patients. Among those with normal SEC who underwent coronary cineangiography, 30% exhibited obstructive CAD, while among those whose SEC findings were all abnormal, 95% exhibited significant CAD. The mortality rate was 0.4% per year for normal SEC, in comparison to 2.7% per year

when all SEC findings were abnormal. These data reinforce the feasibility and improvement of risk stratification information provided by the ABCDE - SEC protocol.

When added to the traditional SEC assessment, these parameters result in a broader spectrum of variables evaluated by the stress protocol. Together, they allow for better risk stratification as well as assist in defining the diagnosis. The application in other scenarios, especially of heart failure in all systolic function spectra, makes this protocol an important complement in these patients' evaluations. Patients with microvascular disease and diastolic dysfunction sometimes have atypical presentations and may benefit from this new protocol, as it broadens the traditional test's diagnostic power.

A new patient recruitment stage was recently launched to evaluate other scenarios, including congenital disease (Tetralogy of Fallot), post-COVID infection, valvular diseases, among others.

The systematic use of SEC reduces test costs, lowers the volumes of myocardial scintigraphy tests, reduces the need for non-invasive and invasive coronary angiography, and poses a substantial barrier, even in medical-legal terms, to a shortcut for anatomy induced coronary revascularization procedures, which are futile and inadequate in terms of prognosis.[7] The ABCDE protocol proposes the full use of this consolidated tool in a simplified and intuitive manner, systematizing the different additional parameters.

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