Simultaneous Dual Imaging of Regional Wall Motion and Left Ventricular Force during Stress: Large Scale Validation in Stress Echo 2020.

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Background: The peak stress/rest ratio of left ventricular elastance (systolic arterial pressure/ end-systolic volume), also called force, is a load-independent index of left ventricular contractile reserve (LVCR). A "weak" heart (with blunted LVCR) shows a worse outcome than a "strong" heart (with preserved LVCR), and the prognostic impact of LVCR outperforms stress ejection fraction.

Purpose: to assess the feasibility, positivity rate and relative diagnostic value of RWMA and LVCR in a prospective, multicenter, international, effectiveness study.

Methods: We enrolled 1249 patients (age 60.8 ± 10.8 yrs, 765 males) referred to stress echocardiography (SE) for known or suspected coronary artery disease in 24 laboratories in 6 countries (Italy, Brazil, Russia, Serbia, Hungary, Bulgaria). The majority of patients (n=1100) underwent exercise stress with semi-supine ergometer (n= 1079), upright bicycle (n=14) or treadmill (n= 7) exercise and 149 patients (11.9%) underwent dobutamine SE. All underwent dual imaging SE, with standard evaluation of Wall Motion Score Index (WMSI, with 17-segment model, each segment from 1 = normal to 4= dyskinetic) and simultaneous LVCR assessment with stress/rest ratio of LV force (systolic blood pressure by cuff sphygmomanometer/end-systolic volume from 2D). All readers had passed the upstream quality control reading for RWMA. The methods used for volumetric calculations were Simpson biplane (preferred), single-plane (second choice) or Teichholz (when the former two were not feasible or of acceptable quality for contour detection). Previously established abnormal values of LVCR were <2.0 for exercise and dobutamine. Coronary angiographic verification was available in 368 patients, with 81.8 % (n= 301) displaying at least 1 vessel disease (significant CAD for ≥ 50 % stenosis).

Results: LVCR was measured in 1237/1249 patients (feasibility = 99 %), with no additional imaging time and an extra-analysis time of <3 min per patient. The positivity rate was 33.8 % for RWMA, 63.8 % for LVCR and 68.9% when either of the 2 criteria was considered. WMSI was poorly correlated with LVCR (n= 1237, r= 0.29, p< 0.001). A ‘weak heart’ with reduced LVCR was more often found in presence of inducible RWMA, abnormal (≤ 5%) increase in EF during stress or underlying CAD (see figure). In the selected population of 368 patients with coronary angiography, sensitivity was 37 % (95% CI 31% to 42%) for RWMA, 73% (95% CI 66% to 77%) for LVCR, and 77% (95% CI 71% to 81%) for combined criteria, whereas specificity was 80% (95% CI 69% to 87%) for RWMA, 32 % (95% CI 24% to 45%) for LVCR and 32 % (95% CI 22% to 42 %) for combined criteria.

Conclusions: During exercise or dobutamine SE, simultaneous dual imaging of RWMA and LVCR is highly feasible, does not add complexity or extra-imaging time to the standard SE protocol, minimally increases the analysis time and computational burden, and increases the positivity rate of RWMA alone, with good sensitivity and poor specificity for CAD identification. A "weak heart" with blunted LVCR targets subclinical myocardial disease, which may be independent from physiologically critical epicardial coronary artery stenosis which are the primary determinant of RWMA.
Figure: Distribution of a "weak heart" in different patient subsets