Δυναμική υπερηχογραφία: Πόσα έχουμε κατανοήσει για την μέθοδο;

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### Functional Testing for Ischaemia
(From ISCHEMIA trial database)

<table>
<thead>
<tr>
<th>Modality</th>
<th>Overall</th>
<th>US/ CAN</th>
<th>ROW</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nuclear</td>
<td>62%</td>
<td>82%</td>
<td>48%</td>
</tr>
<tr>
<td>Stress Echo</td>
<td>23%</td>
<td>17%</td>
<td>28%</td>
</tr>
<tr>
<td>CMR</td>
<td>9%</td>
<td>1%</td>
<td>14%</td>
</tr>
<tr>
<td>ExECG</td>
<td>6%</td>
<td>1%</td>
<td>9%</td>
</tr>
</tbody>
</table>
Echocardiography is well recognized for its noninvasive application.

- It does not require isotopes—there is no risk of radiation
- It does not require magnetic resonance
- It’s patient-friendly
- It’s portable
- It provides both anatomy and function
- It’s the sine qua non to detect and elucidate or to exclude structural cardiac disease.
- It’s the tool to follow up…
In the stress echocardiography laboratory we assess not only left ventricular function, but also coronary artery flow, valve gradients, intraventricular pressures, and pulmonary hemodynamics....

We stress not only coronary arteries, but also the valves, myocardium, vessels, alveolar–capillary barrier in the lung, and peripheral and pulmonary circulation.
It’s known.....

- Stress echocardiography is relatively simple and widely available, but training recommendations should be followed.
- Which is the proper stress???
- A flexible use of exercise, vasodilator and dobutamine stress maximizes versatility, avoids specific contraindications of each and makes it possible to tailor the appropriate stress to the individual patient.
- In general, many parameters used in stress echo applications beyond CAD can be more difficult to acquire but are easier to measure and more amenable to quantification than regional wall motion assessment; therefore, these applications may be less dependent upon the subjectivity of interpretation and operator experience.
Contrast Enhanced STRESS ECHO

It’s not only a *Multiparametric ECHO technique*

*It’s a Multiparametric technique offers diagnostic and prognostic information*

- Angina
- ECG changes
- Exercise tolerance
- Wall motion abnormalities
- Perfusion abnormalities
- Arrhythrias
Multimodality echo approach of myocardial ischemia/viability

- Myocardial perfusion
- Wall motion
  - Contractile reserve
- Myocardial thickness
- Myocardial mechanics
- Scar Tissue
Different stressors - different protocols

EXERCISE STRESS
ECHO
TREADMILL TEST
BICYCLE TEST

DOBUTAMINE STRESS
ECHO
MCE infusion as bolus 0.3ml or continuous infusion

THREE GENERATIONS OF ADENOSINERGIC STRESS
ADENOSINE
DIPYRIDAMOLE
REGADENOSONE
No stress is 100% “pure”....

Major determinants of myocardial oxygen consumption in resting conditions and during some stresses

Flow misdistribution
LEFT VENTRICULAR SEGMENTATION
The pathways of ischemia
The three main pathophysiological conditions that may provoke myocardial ischemia
Epicardial arteries, myocardium, small vessels
Ischemic burden evaluation
The role of Contrast Enhanced Stress Echo in different clinical scenarios

- Evaluating a patient with acute chest pain and no ECG changes and negative troponin
- Evaluating a patient with stable angina
- Evaluating myocardial viability
ΑΣΘΕΝΗΣ ΜΕ ΠΡΟΚΑΡΔΙΟ ΑΛΓΟΣ
The Diagnostic Value of Adenosine Stress-Contrast Echocardiography for Diagnosis of Coronary Artery Disease in Hypertensive Patients - Comparison to Tl-201 Single-Photon Emission Computed Tomography


Myocardial ischemia at the lateral wall using SPECT and MCE.
Transient ST-Segment Depression During Paroxysms of Atrial Fibrillation in Otherwise Normal Individuals: Relation With Underlying Coronary Artery Disease


<table>
<thead>
<tr>
<th></th>
<th>Treadmill Stress Test*</th>
<th>Thallium-201 Myocardial Scintigraphy</th>
<th>Myocardial Contrast Stress Echocardiography</th>
</tr>
</thead>
<tbody>
<tr>
<td>Patients with CAD (+/- for ischemia) (n = 27)</td>
<td>18/6</td>
<td>23/4</td>
<td>24/3</td>
</tr>
<tr>
<td>Patients without CAD (+/- for ischemia) (n = 56)</td>
<td>21/27</td>
<td>23/33</td>
<td>7/49</td>
</tr>
<tr>
<td>Sensitivity, % (95% CI)</td>
<td>75.0 (53.3–90.2)</td>
<td>85.2 (66.3–95.8)</td>
<td>98.9 (70.8–97.6)</td>
</tr>
<tr>
<td>Specificity, % (95% CI)</td>
<td>56.3 (41.2–70.5)</td>
<td>58.9 (45.0–71.9)</td>
<td>87.5 (75.9–94.8)</td>
</tr>
<tr>
<td>PPV, % (95% CI)</td>
<td>46.2 (30.1–62.8)</td>
<td>50.0 (34.9–65.1)</td>
<td>77.4 (58.9–90.4)</td>
</tr>
<tr>
<td>NPV, % (95% CI)</td>
<td>81.8 (65.4–93.0)</td>
<td>89.2 (74.6–97.0)</td>
<td>94.2 (84.1–96.8)</td>
</tr>
</tbody>
</table>
Absence of myocardial viability at the apex of LV
“Catch two or more ... birds with one stone.”

Coronary flow, microcirculatory reserve, and ventricular function

**Rest**

- Coronary flow velocity

**Stress**

- No increase

**MCE**

- Normal perfusion
- Abnormal perfusion defect

**LV function (2D strain)**

- Normal (global longitudinal strain = -19.2%)
- Abnormal (global longitudinal strain = -6.9%)

**Global LV function (LV elastance)**

- SBP = 103 mmHg, ESP = 0.9 x SBP = 92.7 mmHg, ESV = 120 mL, Elast = ESP/ESV = 0.8
- SBP = 149 mmHg, ESP = 134 mmHg, ESV = 80 mL, Elast = 1.7

**RV function**

- TAPSE = 1.5 cm
- TAPSE = 1.4 cm
In early stages of heart failure, when resting ejection fraction is still normal or nearly normal, a blunted cardiac contractile reserve can identify incipient, pre-clinical myocardial damage.

SE is also useful at a more advanced, overt stage of dilated cardiomyopathy, in patients with depressed ejection fraction in whom the presence of a significant contractile reserve is associated with better prognosis.
Right vs. left ventricular contractile reserve in one-year prognosis of patients with idiopathic dilated cardiomyopathy: Assessment by dobutamine stress echocardiography


Hypertrophic cardiomyopathy

- ACCF/AHA guidelines for the diagnosis and treatment of HCM assign exercise echocardiography a class IIa recommendation for the detection and quantification of exercise-induced dynamic LV outflow tract (LVOT) obstruction in patients who have a resting peak instantaneous gradient of 50mmHg or less (level of evidence B). Additionally, SE may be used to identify transient regional wall motion abnormality due to functionally significant epicardial CAD and reduction in CFR (in absence of regional wall motion abnormalities) due to microvascular disease.
Stress echocardiography increasingly used for the detection of coronary artery involvement in Kawasaki Disease and transplant CAD. Outside CAD, emerging SE applications focus mainly on the assessment of contractile reserve of:

- the systemic morphological right ventricle,
- in aortic coarctation and
- isolated subaortic stenosis.
Usefulness of Dobutamine Stress Echocardiography with Tissue Doppler Imaging for the Evaluation and Follow-Up of Patients with Repaired Tetralogy of Fallot

Stella Brili, MD, FACC, Ilias Stamatopoulos, MD, John Barbetseas, MD, Christina Chrysohooou, MD, Nikolaos Alexopoulos, MD, Maria Misailidou, MD, Athanasios Bratsas, MD and Christodoulos Stefanidis, MD, FACC, Athens, Greece

Journal of the American Society of Echocardiography
October 2008
Ventricular pressures, filling, volumes and lung water at rest and during stress

- **LV filling**
  - Rest: E = 80 cm/s, E/e' = 11
  - Stress: E = 150 cm/s, E/e' = 21

- **TDI, e wave**
  - Rest: e' = 7 cm/s
  - Stress: e' = 7 cm/s

- **PASP**
  - Rest: PASP = 62 mmHg
  - Stress: PASP = 86 mmHg

- **Ventricular volumes**
  - Rest: EDV = 126 mL, ESV = 56 mL, SV = 67 mL, EF = 54%
  - Stress: EDV = 132 mL, ESV = 69 mL, SV = 62 mL, EF = 47%

- **Lung ultrasound**
  - Rest: A lines
  - Stress: B lines
Low-dose dobutamine stress echo to quantify the degree of remodelling after cardiac resynchronization therapy

Chirine Parsai¹*, Aigul Baltabaeva¹, Lisa Anderson¹, Marinela Chaparro¹, Bart Bijnens²,³, and George R. Sutherland¹

European Heart Journal (2009) 30, 950–958
Assessment of intraventricular and transvalvular gradients and flows

- **LVOT gradient**
  - Rest: < 10 mmHg
  - Stress: > 150 mmHg

- **Mitral valve insufficiency**
  - Mild: ERO 12 mm²

- **Mitral valve stenosis**
  - 5 mmHg

- **Aortic stenosis**
  - Rest: MPG = 35 mmHg
  - Exercise: MPG = 57 mmHg

- **Aortic coarctation**
  - MPG = 13 mmHg
  - Stress: MPG = 20 mmHg
Dobutamine protocol has a different role in the contest of ischemic MR. Dobutamine infusion has the ability to decrease MR volume due to a reduction of afterload and mitral orifice size that may occur as a result of the vasodilatory and inotropic effects of dobutamine.
AORTIC STENOSIS

Low Gradient
(Mean gradient < 30)
Low CO
AVA < 1 cm²

Dobutamine Stress

Severe Stenosis
Mean gradient > 40
CO ↑
AVA ↑ (≤ 1 cm²)

Mild Stenosis
Mean gradient < 30
CO ↑
AVA ↑ (> 1 cm²)

Incidental Stenosis
Contractile reserve ↑
Mean gradient < 30
CO ↔
AVA ↔ ↑
Αντενδείξεις της δυναμικής υπερηχογραφίας

- STEMI, NSTEMI
- Επεισόδια εμμένουσας κοιλιακής ταχυκαρδίας (VT)
- Παρουσία πρόσφατου θρόμβου στην κορυφή της αριστερής κοιλίας.
- Οξεία φλεγμονή
Σχετικές αντενδείξεις της δυναμικής υπερηχογραφίας

- Αρρύθμιστη αρτηριακή υπέρταση
- Διαταραχές κολποκοιλιακής αγωγής
- Διαταραχές καλίου
Επιπλοκές της δυναμικής υπερηχογραφίας

- Βαγοτονικά επεισόδια
- Κοιλιακές αρρυθμίες (SVT, NSVT)
- Υπερκοιλιακές αρρυθμίες-κολπική μαρμαρυγή
- Οξύ έμφραγμα μυοκαρδίου
- Ρήξη καρδιάς ως case report

Heart 2008 Dec;94(12):1571-7
Take a home message…
E. Picano, P. Pellika, Eur H J 2013

- From a stress echo era with a one-fits-all approach (wall motion by 2D-echo in the patient with known or suspected coronary artery disease) now we have moved on to an omnivorous, next generation laboratory employing a variety of technologies (from M-Mode to 2D and pulsed continuous and colour Doppler, to lung ultrasound and real-time 3D echo, 2Dspeckle tracking and myocardial contrast echo) on patients covering the entire spectrum of severity (from elite athletes to patients with end-stage heart failure) and ages (from children with congenital heart disease to the elderly with low-flow, low-gradient aortic stenosis).

- For each patient, we can tailor a dedicated stress protocol with a specific method to address a particular diagnostic question.