Stress Echo in coronary artery disease

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Conflicts: none
### Stress echo protocols

<table>
<thead>
<tr>
<th>Equipment</th>
<th>Protocols</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Exercise</strong></td>
<td>Semi-supine bycicle ergometer 25 W x 2' with incremental loading</td>
</tr>
<tr>
<td><strong>Dobutamine</strong></td>
<td>Infusion Pump 5 mcg/Kg/min 10-20-30-40 + atropine (0.25 x 4) up to 1 mg</td>
</tr>
<tr>
<td><strong>Dipyridamole</strong></td>
<td>Syringe 0.84 mg/Kg in 6’ or 0.84 mg/Kg in 10’ + atropine (0.25 x 4) up to 1 mg</td>
</tr>
<tr>
<td><strong>Adenosine</strong></td>
<td>Syringe 140 mcg/Kg/min in 6’</td>
</tr>
<tr>
<td><strong>Pacing</strong></td>
<td>External Pacing From 100 bpm with increments of 10 beats/min up to target heart rate</td>
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DSE protocol

• Resting two-dimensional echocardiographic examination from the standard apical and parasternal views.

• Dobutamine is administered intravenously by infusion pump, starting at: 5 μg/kg/min for 3 minutes, followed by 10 μg/kg/min for 5 minutes and increasing by 10 μg/kg/min every 3 minutes to a maximum of 40 μg/kg/min (stage 5), and continued for 6 minutes. (Dobutamine exerts its effect by stimulation of β1, β2, and α1-adrenergic receptors)

• During the test, a 12-lead ECG is recorded every minute. Blood pressure was measured every 3 minutes.
DSE protocol

• Stop if a target heart rate (85% of a theoretic maximal heart rate (men: (220 – age) x 85%; women: (200 – age) x 85%) is achieved.

• If the target heart rate is not achieved and patients have no symptoms or signs of ischemia, atropine (starting with 0.25 mg, increased to a maximum of 1.0 mg) is given intravenously at the end of stage 5 while the dobutamine administration is continued.

• IV beta-blocker is administered (1.0 to 5.0 mg) intravenously according to heart rate response and systolic blood pressure, and after peak stress images are acquired to achieve a recovery phase, defined as heart rate within 10% range of resting heart rate.

(Acute β-blockade interacts with dobutamine β1 receptors leaving unopposed β2 and primarily α1-adrenergic vasoconstriction and therefore leading to reduction of coronary flow reserve.)
The criteria for stopping the test are:

(1) achievement of the target heart rate

(2) severe and extensive NWMA

(3) symptomatic decline in systolic blood pressure of more than 40 mmHg, or a systolic blood pressure $\leq 90$ mmHg

(4) hypertension (blood pressure $>240/140$ mmHg)

(5) the occurrence of sustained cardiac arrhythmias

(6) severe angina pectoris

(7) intolerable adverse effects considered to be the result of dobutamine or atropine.
CAD detection (DIAGNOSIS)

• Regional function is scored according to a 16/17 segment, five point scoring model: 1, normal; 2, mildly hypokinetic; 3, severely hypokinetic; 4, akinetic; and 5, dyskinetic.

• The extent and location of ischemia are evaluated. Wall-motion score index (WMSI) (total score divided by the number of segments scored) is calculated, at rest, low dose, during peak stress, and during the recovery phase.

• The results of DSE are considered positive if NWMA occur (i.e., if wall motion in any segment worsens by \( \geq 1 \) grades during the test, with the exception of akinesis becoming dyskinesis).

NWMA : look at thickening
Δυναμική μελέτη με έγχυση Δοβουταμίνης (Stress Echo-DSE)

Ονοματεπώνυμο:
Ηλικία:
Ημ/νια:
Κλινικές Πληροφορίες:
Έκθεση:
Μετά λήψη εικόνων σε ηρεμία, έγινε έγχυση δοβουταμίνης με ρυθμό 5, 10, 20, 40 μg/kg/min, handgrip και έγχυση ηχοαντιθετικού μέσου και mg atropine.

ΑΠ: ηρεμία (rest): mmHg
ΑΠ: μέγιστη φόρτιση (peak): mmHg
ΑΠ: αποκατάσταση (recovery): mmHg

HR: ηρεμία (rest): bpm
HR: μέγιστη φόρτιση (peak): bpm
HR: αποκατάσταση (recovery): bpm

Στη αρχή της φάσης αποκατάστασης (recovery) έγινε έγχυση ενδοφλεβίως mg μετοπρολόλης.

Συνολικό score στην ηρεμία: 17
Συνολικό score στη μέγιστη φόρτιση: 17
Συνολικό score στην αποκατάσταση (recovery): 17

Δείκτης τμηματικής κινητικότητας (WMSI) στην ηρεμία: 1,00
Δείκτης τμηματικής κινητικότητας (WMSI) στη μέγιστη φόρτιση: 1,00
Δείκτης τμηματικής κινητικότητας (WMSI) στην αποκατάσταση (recovery): 1,00

Κλάσμα εξώθησης στην ηρεμία: %
Κλάσμα εξώθησης στην μέγιστη φόρτιση: %
Κλάσμα εξώθησης στην αποκατάσταση: %

1) Πρόσθιο τοίχωμα (κορυφαία λήψη 2 κοιλοτήτων) (τμήματα 2,7):
2) Πρόσθιο μεσοκοιλιακό (κορυφαία λήψη 3 κοιλοτήτων) (τμήματα 1,6):
3) Οπίσθιο μεσοκοιλιακό (κορυφαία λήψη 4 κοιλοτήτων) (τμήματα 5,10):
4) Πλάγιο τοίχωμα (κορυφαία λήψη 4 κοιλοτήτων) (τμήματα 3,8):
5) Κατώτερο τοίχωμα (κορυφαία λήψη 2 κοιλοτήτων) (τμήματα 4,9):
6) Οπίσθιο τοίχωμα (κορυφαία λήψη 3 κοιλοτήτων) (τμήματα 15,16):
7) Κορυφαία τοίχωμα (τμήματα 11,12,13,14):

Παρατηρήσεις:
Συμπέρασμα:
**Stress echocardiography limitations**

1. Depends on image quality (patient habitus / system requirements)
2. Subjective interpretation
3. Interobserver variability
4. Recognition of ischemia within areas of abnormal resting wall motion
5. Influence of LV cavity size
6. Lower diagnostic accuracy of single vessel CAD
7. Recognition of multivessel CAD
8. Follow-up difficult
Myocardial viability estimation (VIABILITY)

Myocardial viability is assessed only in severely dysfunctional segments; 4 types of wall motion responses are observed:

(1) biphasic pattern: improvement of wall motion at 5, 10, or 20 mg/kg/min dobutamine with worsening at higher dosages

(2) worsening

(3) sustained improvement

(4) no change

- Severely dysfunctional segments exhibiting a biphasic, worsening or sustained response are considered viable, whereas segments with unchanged wall motion are considered scarred.

- A patient is considered to have viable myocardium in the presence of ≥4-5 viable segments (WMSI>0.25) and as non-viable in the presence of ≤4 viable segments (50% viable myocytes in a given segment)
Table: Comparison of sensitivities and specificities of different stress imaging modalities in detecting CAD (table 1A) or myocardial viability (table 1B).

*Concluding results from meta-analyses.

### Table 1A: Ischemia detection

<table>
<thead>
<tr>
<th>Method</th>
<th>Sensitivity</th>
<th>Specificity</th>
</tr>
</thead>
<tbody>
<tr>
<td>DSE</td>
<td>80-85%</td>
<td>87-92%</td>
</tr>
<tr>
<td>SPECT</td>
<td>83-95%</td>
<td>73%</td>
</tr>
<tr>
<td>MRI</td>
<td>84-91%</td>
<td>80%</td>
</tr>
<tr>
<td>PET</td>
<td>93%</td>
<td>82%</td>
</tr>
</tbody>
</table>

### Table 1B: Viability Estimation

<table>
<thead>
<tr>
<th>Method</th>
<th>Sensitivity</th>
<th>Specificity</th>
</tr>
</thead>
<tbody>
<tr>
<td>DSE</td>
<td>84-86%</td>
<td>81-90%</td>
</tr>
<tr>
<td>SPECT</td>
<td>84%</td>
<td>54-69%</td>
</tr>
<tr>
<td>MRI</td>
<td>96%</td>
<td>86-100%</td>
</tr>
<tr>
<td>PET</td>
<td>100%</td>
<td>90%</td>
</tr>
</tbody>
</table>

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Circ Cardiovasc Imaging. 2017 Nov;10(11). 10.1161/CIRCIMAGING.117.006530
European Society of Cardiology. Eur Heart J. 2013;34:2949–3003

Task Force on the management of stable coronary artery disease.
Enhanced Sensitivity of Dobutamine Stress Echocardiography by Observing Wall Motion Abnormalities During the Recovery Phase After Acute Beta Blocker Administration.
Am J Cardiol. 2006 Feb 15;97(4):462-5
Myocardial viability estimation during recovery phase of stress echocardiography after acute beta-blocker administration

Dobutamine stress echocardiography for the detection of myocardial viability in patients with left ventricular dysfunction taking β blockers: accuracy and optimal dose

T Zaglavara, R Haaverstad, B Cumberledge, T Irvine, H Karvounis, G Parharidis, G Louridas and A Kenny

*Heart* 2002;87;329-335

**B-blocker withdrawal is not necessary** before DSE when viability is the clinical information in question. However, a completed protocol with continuous image recording is required to detect the full extent of viability.
In medically treated patients with severe global left ventricular dysfunction early after acute uncomplicated myocardial infarction, the presence of myocardial viability identified as inotropic reserve after low-dose dobutamine is associated with a higher probability of survival. The higher the number of segments showing improvement of function, the better the impact is of myocardial viability on survival. The presence of inducible ischemia in this set of patients is the best predictor of cardiac death.

Myocardial viability assessed by dobutamine stress echocardiography predicts reduced mortality early after acute myocardial infarction: determining the risk of events after myocardial infarction (DREAM) study

J M A Swinburn and R Senior

Heart 2006;92;44-48; originally published online 14 Apr 2005;
CRI is strongly associated with exercise-induced ischemia in patients with CAD. The greater severity of atherosclerotic disease observed in patients with CRI may in part explain the association of CRI with increased cardiovascular risk among individuals with CAD.
Prognostic significance of renal function in patients undergoing dobutamine stress echocardiography

Dobutamine Stress Echocardiography in Patients With Diabetes Mellitus

Enhanced Prognostic Prediction Using a Simple Risk Score

Nithima Chaowalit, MD, Ana Lucia Arruda, MD, Robert B. McCully, MD, FACC, Kent R. Bailey, PhD, Patricia A. Pellikka, MD, FACC

*Rochester, Minnesota*

**OBJECTIVES**

We sought to determine the prognostic value of dobutamine stress echocardiography (DSE) for predicting long-term outcomes in a large cohort with diabetes mellitus and to develop a simple risk score using clinical and echocardiographic data.

**BACKGROUND**

Neither risk scores nor long-term prognostic value of DSE has been described in a large diabetic population.

**METHODS**

We studied 2,349 patients with diabetes mellitus (1,338 men, 67 ± 11 years of age) during a follow-up of 5.4 ± 2.2 years.

**RESULTS**

Mortality and morbidity (myocardial infarction and late coronary revascularization) occurred in 1,044 (44%) and 309 (13%) patients, respectively. Addition of stress echocardiographic variables to the clinical and rest echocardiographic model provided incremental prognostic information for predicting mortality (chi-square = 243 to 270, p < 0.0001) and morbidity (chi-square = 38 to 78, p < 0.0001). For each end point, a simple risk score was derived according to the estimated values of beta coefficients of multivariate predictors (insulin therapy, smoking, failure to achieve target heart rate, percentage of ischemic segments, and impaired left ventricular systolic function) and resulted in an assessment of risk among all age groups. The C-statistic values were 0.60 to 0.64, indicating modest discrimination. The estimated five-year event-free survivals of patients in three risk categories were 94%, 86%, and 80% for morality (p < 0.00001) and 69%, 60%, and 47% for mortality (p < 0.0001).

**CONCLUSIONS**

In patients with diabetes mellitus, a simple and practical risk score using clinical variables and results of DSE stratified patients into three risk groups for mortality and cardiovascular morbidity. (J Am Coll Cardiol 2006;47:1029–36) © 2006 by the American College of Cardiology Foundation
Perioperative risk assessment for non cardiac vascular surgery


In pts with more than two clinical risk factors and poor functional capacity (Class I, Evidence C)


Perioperative Cardiac Assessment for Noncardiac Surgery: Eight Steps to the Best Possible Outcome
Debabrata Mukherjee and Kim A. Eagle
Circulation 2003;107;2771-2774

A meta-analysis comparing the prognostic accuracy of six diagnostic tests for predicting perioperative cardiac risk in patients undergoing major vascular surgery. Kertai MD, Boersma E, Bax JJ, et al
Heart. 2003;89:1327–34.

Stress echocardiography is now an everyday clinical tool. However, the substantial evidence base that supports its use is largely derived from expert centres, and concerns have been expressed about the performance of the test in less expert hands. A unifying feature of the problems of stress echocardiography is its subjective assessment. This review examines the consequences of qualitative interpretation and the benefits of developing a quantitative approach. Although no quantitative approach is in widespread clinical use, several alternative techniques are feasible, and this area warrants further study.

(Eur J Echocardiography 2002; 3: 171–176) © 2002 Published by Elsevier Science Ltd on behalf of The European Society of Cardiology

Key Words: stress echocardiography; interpretation; quantitation.

Characteristics and outcomes of patients with abnormal stress echocardiograms and angiographically mild coronary artery disease (<50% stenoses) or normal coronary arteries. From AM, Kane G, Bruce C, Pellikka PA, Scott C, McCully RB. Echocardiography Laboratory, Division of Cardiovascular Diseases, Department of Internal Medicine, Mayo Clinic, Rochester, Minnesota 55905, USA. J Am Soc Echocardiogr. 2010 Feb;23(2):215-6.

BACKGROUND: Abnormal cardiac stress imaging findings are not always associated with angiographically significant coronary artery disease. The outcomes of patients with such false-positive findings have not been extensively examined. The aim of this retrospective study was to describe the characteristics and outcomes of patients with abnormal stress echocardiographic findings who had false-positive results compared with those who had true-positive results. METHODS: Of 1,477 consecutive patients (mean age, 66 +/- 12 years; 61% men) with abnormal stress echocardiographic findings who underwent coronary arteriography within 30 days, death from any cause was ascertained. RESULTS: At coronary arteriography, 997 patients (67.5%) had true-positive results, defined by the presence of angiographically significant coronary artery disease (> or = 50% stenoses), and 480 (32.5%) had false-positive results, defined by <50% stenoses or normal coronary arteries. Of the subgroup of patients with markedly abnormal stress echocardiographic findings (n = 605), 28% had <50% stenoses or normal coronary arteries. During an average follow-up period of 2.4 +/- 1.0 years, there were 140 deaths. The adjusted likelihood of subsequent death for patients with <50% stenoses compared to patients with > or = 50% stenoses after abnormal stress echocardiography was 1.05 (95% confidence interval, 0.86-1.31; P = .62). CONCLUSIONS: A sizable proportion of patients with abnormal stress echocardiographic results who are referred for coronary angiography have false-positive findings. The outcomes of patients with false-positive results were similar to those of patients with true-positive results. This finding suggests that patients with false-positive results on stress echocardiography should still receive intensive risk factor management and careful clinical follow-up.
Ischemic Cascade

Classical

Alternative
Rest
3Ch
00:15
117 bpm

Low
3Ch
00:18
132 bpm

Peak
3Ch
00:20
113 bpm

Recovery
3Ch
00:19
96 bpm

10:20:42 am
10:21:18 am
10:21:53 am
10:23:06 am