Exercise and Dobutamine Stress Echocardiography: A Case Based Approach

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Stress Echocardiography

- Exercise Echocardiography
- Pharmacologic Echocardiography
Case #1

- 82 y/o vigorous female
- PMHx of HTN, anemia, A fib and moderate AS.
- Reason for test: atypical chest pain.
- EKG: NS ST T wave changes.

What would be your next step?
## Appropriate Use of Stress Echocardiography
### Detection of CAD/Risk Assessment: Symptomatic

<table>
<thead>
<tr>
<th>Indication</th>
<th>Evaluation of Chest Pain Syndrome or Anginal Equivalent</th>
<th>Appropriateness Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Low pre-test probability of CAD</td>
<td>I (1)</td>
</tr>
<tr>
<td></td>
<td>ECG interpretable AND able to exercise</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Low pre-test probability of CAD</td>
<td>A (7)</td>
</tr>
<tr>
<td></td>
<td>ECG uninterpretable OR unable to exercise</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Intermediate pre-test probability of CAD</td>
<td>A (7)</td>
</tr>
<tr>
<td></td>
<td>ECG interpretable AND able to exercise</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Intermediate pre-test probability of CAD</td>
<td>A (9)</td>
</tr>
<tr>
<td></td>
<td>ECG uninterpretable OR unable to exercise</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>High pre-test probability of CAD</td>
<td>A (7)</td>
</tr>
<tr>
<td></td>
<td>Regardless of ECG interpretability and ability to exercise</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>Prior stress ECG test is uninterpretable or equivocal</td>
<td>A (8)</td>
</tr>
</tbody>
</table>

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_J. Am. Coll. Cardiol. 2008;51;1127-1147_
Exercise Stress Echocardiogram

PSLAX
SAX
98 % MPHR, 5 METS
No CP
This Exercise Stress Echo is

A. Normal
B. Positive for Ischemia in RCA territory
C. Positive for Ischemia in the Diagonal territory
D. Positive for Ischemia in the LAD territory
E. Positive for Ischemia in the LAD and Cx territory
LHC Performed Based on Stress Echo Result
Prognostic Value of SE in Patients with Atypical Chest Pain Without Known Coronary Artery Disease

Cumulative Survival


*Events included death, nonfatal MI, UA, CHF, revascularization

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Event Free Survival for a Normal Exercise Stress Echocardiogram

Event-Free Survival, %

Follow-up, Years

n=1325

p = 0.0001

Outcome for a Normal Exercise Stress Echocardiogram

Prognostic Implications of an Abnormal Exercise Echocardiogram

Prognosis and Location of Wall Motion Abnormalities During Exercise Echocardiography


n=4347

*This risk was independent of resting EF and extent of exercise induced myocardial ischemia
Survival of patients with normal results, ischemia, scar, and combined scar and ischemia by exercise echo

5375 patients

Follow-up (yrs)

Survival (%)
Prediction of Outcome in Hypertensive Patients with Suspected CAD

Association of Risk with Increasing Extent of Abnormal Wall Motion at Rest and During Stress

Risk Stratification of Diabetic Patients by Exercise Echocardiography


32% event rate at 5 yrs

n=563
Case #2

- 63 y/o male with DM and S/P CABG 5 years earlier who presents for pre op assessment prior to AAA repair. Asymptomatic, fairly active. BMI 32. Checks Blood glucose levels routinely. Hba1c within normal range. BB, ASA, Statin, ACEI.

  a. Clear the patient for AAA surgery
  b. Dipyridamole stress SPECT thallium imaging
  c. Coronary angiography
  d. Echocardiogram, and if left ventricular function is normal, clear the patient for surgery
  e. Exercise stress echocardiography
## Appropriate Use of Stress Echocardiography

<table>
<thead>
<tr>
<th>Indication</th>
<th>Risk Assessment Post Revascularization</th>
<th>Appropriateness Score</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Symptomatic</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>35</td>
<td>Evaluation of Chest Pain Syndrome Not in the Early Post Procedure Period</td>
<td>A (8)</td>
</tr>
<tr>
<td><strong>Asymptomatic</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>36</td>
<td>Less than 5 years after CABG</td>
<td>I (2)*</td>
</tr>
<tr>
<td>37</td>
<td>Asymptomatic (e.g., silent ischemia) prior to prev. revasc. Greater than or equal to 5 years after CABG</td>
<td>U (6)</td>
</tr>
<tr>
<td>38</td>
<td>Symptomatic prior to previous revascularization Greater than or equal to 5 years after CABG</td>
<td>U (5)</td>
</tr>
<tr>
<td>39</td>
<td>Asymptomatic (e.g., silent ischemia) prior to previ. revasc. Less than 2 years after PCI</td>
<td>I (3)*</td>
</tr>
<tr>
<td>40</td>
<td>Symptomatic prior to previous revascularization Less than 2 years after PCI</td>
<td>I (2)</td>
</tr>
<tr>
<td>41</td>
<td>Asymptomatic (e.g., silent ischemia) prior to prev. revasc. Greater than or equal to 2 years after PCI</td>
<td>U (5)</td>
</tr>
</tbody>
</table>
Use of Contrast With Stress Echo

<table>
<thead>
<tr>
<th>Indication</th>
<th>Appropriateness Score</th>
</tr>
</thead>
</table>
| 50  Routine use of contrast  
    All segments visualized on noncontrast images                           | I (1)                  |
| 51  Selective use of contrast  
    2 or more contiguous segments are NOT seen on noncontrast images        | A (8)                  |
Temporal Trends in Contrast Use in Stress Echocardiography
Cleveland Clinic (1998-2007)

<table>
<thead>
<tr>
<th>Year</th>
<th>Dobutamine Stress Echocardiography</th>
<th>Exercise Stress Echocardiogram</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Total no. DSE</td>
<td>Contrast DSE</td>
</tr>
<tr>
<td>1998</td>
<td>2035</td>
<td>18</td>
</tr>
<tr>
<td>1999</td>
<td>2267</td>
<td>52</td>
</tr>
<tr>
<td>2000</td>
<td>2136</td>
<td>97</td>
</tr>
<tr>
<td>2001</td>
<td>1840</td>
<td>132</td>
</tr>
<tr>
<td>2002</td>
<td>1788</td>
<td>180</td>
</tr>
<tr>
<td>2003</td>
<td>1915</td>
<td>178</td>
</tr>
<tr>
<td>2004</td>
<td>2002</td>
<td>244</td>
</tr>
<tr>
<td>2005</td>
<td>1922</td>
<td>431</td>
</tr>
<tr>
<td>2006</td>
<td><strong>1804</strong></td>
<td>532</td>
</tr>
<tr>
<td>2007</td>
<td>1700</td>
<td>158</td>
</tr>
</tbody>
</table>

*BMS Notification of Adverse Events
CC Enacted Revised Protocol require MD ordering, consent and 1 hr monitoring
# Serious Adverse Events

## Stress Echocardiography

Cleveland Clinic 1998-2007

<table>
<thead>
<tr>
<th>Event</th>
<th>Dobutamine Stress Echocardiogram</th>
<th>Exercise Stress Echocardiogram</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Contrast</td>
<td>No Contrast</td>
<td>p value</td>
</tr>
<tr>
<td>Death within 24 hours of test</td>
<td>0 (0%)</td>
<td>2 (0.1%)</td>
<td>0.1</td>
</tr>
<tr>
<td>Cardiac Arrest</td>
<td>2 (0.1%)</td>
<td>1 (0.05%)</td>
<td>0.54</td>
</tr>
<tr>
<td>Anaphylaxis</td>
<td>0 (0%)</td>
<td>0 (0%)</td>
<td>0</td>
</tr>
<tr>
<td>Severe Hypoxia</td>
<td>1 (0.05%)</td>
<td>0 (0%)</td>
<td>0.23</td>
</tr>
</tbody>
</table>
Predicted cost to identify CAD following improvements in false-positive and negative rates. A 3.7% improvement in the false-negative rate resulted in a negative cost to identify CAD. However, costs to exclude CAD were in the range of $255 to $200 even after 15% to 20% improvements in the false-positive rate.
Case 3

- 73 y/o female with a PMHx of HTN, HLP, TIA ('02) and somewhat limited due to RA.
- Reason for test: “She reports some pain on her left side of her chest. Occurs in the morning and is better by the end of the day”.

  a. Attribute symptoms to RA and reassure
  b. Stress SPECT MIBI imaging
  c. Coronary angiography
  d. Exercise Stress Echocardiography
  e. Dobutamine Stress Echocardiography
Dobutamine Protocol

Resting echo
5 mg/Kg/min
10 mg/Kg/min
20 mg/Kg/min
30 mg/Kg/min

Atropine 0.25-2 mg
Handgrip
40 mg/Kg/min
73 y/o female with a PMHx of HTN, HLP, TIA ('02) and RA.

Apical 4 chamber

- Rest
- 10mcg/kg/min
- 20mcg/kg/min
- 40mcg/kg/min
Dobutamine Stress Echocardiogram

Apical 2 chamber

Rest

10mcg/kg/min

20mcg/kg/min

40mcg/kg/min
LHC Performed Based on DSE Result
<table>
<thead>
<tr>
<th></th>
<th>Baseline</th>
<th>Low-dose</th>
<th>Peak</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Normal</strong></td>
<td>Normal</td>
<td>↑</td>
<td>↑↑</td>
</tr>
<tr>
<td><strong>Scar</strong></td>
<td>Akinetic</td>
<td>→</td>
<td>→</td>
</tr>
<tr>
<td><strong>Ischemic</strong></td>
<td>Normal/Hypoken</td>
<td>→</td>
<td>↓↓</td>
</tr>
<tr>
<td><strong>Uniphasic</strong></td>
<td>Hypo/Akinetic</td>
<td>↑</td>
<td>↑↑</td>
</tr>
<tr>
<td><strong>Biphasic (V&amp;I)</strong></td>
<td>Hypo/Akinetic</td>
<td>↑</td>
<td>↓↓</td>
</tr>
</tbody>
</table>
Transmurality of Myocardial Scar

Baseline | Low-dose | Peak
---|---|---
Akinetic |  |  
Hypokineti | ↑ | ↓↓
Hypokineti | ↑ | ↑↑

LV

Severity of Coronary stenosis

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Prediction of Cardiac Mortality Based on Results of Dobutamine Stress Echocardiography

Marwick T et al. JACC 2001;37:754-60

\[ n=3156 \text{ 1988-1994} \]
Outcome Relative to the Extent of Abnormal Function at Peak Stress with DSE

 Cumulative Survival (%)

Follow-up (years)

No abnormality

1 Territory

2 Territories

3 Territories

P<0.0001

n=3156

Marwick T et al. JACC 2001;37:754-60
Dobutamine Stress Echocardiography - an Independent Predictor of Death Incremental to Clinical and Resting Echocardiogram

Global Chi-square

Clinical  |  Clin + DbE  |  Clin + DbE + angio
0  |  40  |  60
10  |  50  |  70
20  |  60  |
30  |  70  |
40  |  80  |
50  |  90  |
60  | 100  |
70  | 110  |
80  | 120  |
90  | 130  |
100  | 140  |

Marwick T et al. JACC 2001;37:754-60
Sensitivity of Dobutamine Echo and LV Cavity Obliteration

Prognosis in Patients with Dilated Cardiomyopathy Undergoing DSE

Incremental information from stress echo

**Global chi square**

- Clinical
- Clin+Rest LV
- Clin+Rest LV+Stress test

**P<0.001**

--

**Global chi square**

- Clinical
- Clin+DbE
- Clin+DbE+angio

**P<0.001**
PROGNOSTIC ASSESSMENT WITH STRESS ECHO

Incremental value of function and perfusion

Area Under the Curve

Clin + ECG
Clin + ECG + Rest Echo
Clin + ECG + $^{201}$TI
Clin + ECG + Ex Echo

$p < .05$

Olmos et al, Circ ‘98

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Stress Echocardiography in Valvular Heart Disease

- Focus of the Exam often other than Regional Wall Motion Abnormalities
- Ventricular size and function
- Estimated RVSP
- RV function
- Valvular severity (MS>>>>>AS,MR,AR)
- Functional Capacity
Hypertrophic Cardiomyopathy

SAM at Rest and at Peak Stress in HOCM

Rest

Stress
LVOT Gradients in Patient with HOCM

**Rest**

**Stress**
Mitral Regurgitation in HOCM

Rest

Stress
Advantages of Stress Echocardiography

• Lower cost for similar overall accuracy

• More patient friendly
  – Shorter test
  – No radiation exposure
  – Minimizes multiple testing in patients needing exam of valves, LV function

• Fewer false positives
  – Specificity greater overall esp. with LVH and LBBB
Advantages of Nuclear Scintigraphy

• Greater Sensitivity (esp. single vessel dz)
  – Evaluation of “functional significance”

• Detection of ischemia in regions with RWMA

• Poor echo images (COPD, Obesity)

• Unable to exercise or tolerate dobutamine
Summary

- Stress echocardiography is a widely use technique for diagnosis of myocardial ischemia.
- Compared to nuclear, SE has better specificity and slightly lower sensitivity.
- Best diagnostic yield in patients with intermediate probability of CAD.
- Exercise echo is preferable to Db echo as Dx test.
  - Provides useful physiologic information
  - HR recovery, Functional capacity, Duke score.
- Stress echo useful for evaluation of VHD.
- Stress echo limited by poor echocardiographic windows
  - Use of contrast greatly improves image quality.
- Db echo useful for diagnosis of viability
  - Demonstration of contractile reserve.