Stress Echocardiography Basics

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No disclosures

Stress Echo

- CAD
  - Diagnosis
  - Prognosis
  - Special issues
- Valve disease
  - Exercise induced pulmonary hypertension
- Diastolic function
  - Dyspnea evaluation

Why add an echo to a stress test?

- Addition of any imaging modality to ETT increases accuracy
- Advantages of echo
  - noninvasive, no radiation, portable
  - 20-30 min test; no delayed imaging, rapid results
  - closely spaced, repeated testing is highly feasible
  - beat by beat, stage by stage analysis
  - global and segmental function (resting and stress)
  - relative cost
  - other info obtained - pericardium, valves, chambers, etc.
  * for other sources of chest pain

...
Stress Echo

• Other advantages
  – imaging before during and after stress
  – multiple views of the LV
  – short acquisition times
  – wall motion, myocardial thickening, global function
  – good for patients with high false + rate of ETTs (women, digoxin)
  – Real time assessment

Adding echo to a stress test

• Disadvantages
  – < 100% imaging success rate
    • improving with harmonics, contrast
  – operator dependent
    • sonographer and interpreter
  – learning curve to interpretation (subjective)
    • wall motion during ischemia is subtle and transient
  – subjective interpretation
    • quantitation under development
  – assessing end result of ischemia
  – ? ischemia within region of prior infarct

Rate-pressure product

- Angina
- Ischemic ST segment
- PCW elevation
- Significant perfusion defect
- Regional myocardial dysfunction
- Flow heterogeneity

Stress Time

Modified from Beller, Am J Card 1988;61:2
**Appropriate use of stress echo**

*Douglas et al. 2011 March JACC and JASE*

- Detection of CAD and Risk Assessment
  - Symptomatic or ischemic equivalent
  - Asymptomatic (without ischemic equivalent)
  - Asymptomatic (without ischemic equivalent) in populations with defined co-morbidities
- After prior test results
- Risk Assessment
  - Peri-op evaluation for non-cardiac surgery without active cardiac conditions
  - Within 3 months of an ACS
  - Postrevascularization (PCI or ACS)
- Assessment of viability/ischemia
- For hemodynamics (includes Doppler during stress)
- Contrast use

**Wall motion abnormality due to CAD:**

*what is the eye and brain integrating?*

- Decreased inward systolic motion
- Decreased systolic thickening
  - Systolic thinning in extreme cases
- Regional diastolic thinning when chronic CAD
- Systolic motion is simplest to assess but Systolic Thickening is critical and most specific
### Exercise echo - interpretation

<table>
<thead>
<tr>
<th></th>
<th>Rest</th>
<th>Peak exercise</th>
<th>Recovery</th>
</tr>
</thead>
<tbody>
<tr>
<td>Normal</td>
<td>Normal</td>
<td>Hyperkinetic</td>
<td>Normal</td>
</tr>
<tr>
<td>Infarct</td>
<td>Abnormal</td>
<td>Abnormal</td>
<td></td>
</tr>
<tr>
<td>Ischemia</td>
<td>Normal</td>
<td>Abnormal</td>
<td>Normal</td>
</tr>
<tr>
<td>Mixed same territory</td>
<td>Abnormal</td>
<td>Worse ± larger</td>
<td>Abnormal</td>
</tr>
<tr>
<td>Mixed new territory</td>
<td>Abnormal</td>
<td>New territory abnl</td>
<td>abnormal</td>
</tr>
</tbody>
</table>

### Dobutamine stress echo - interpretation

<table>
<thead>
<tr>
<th></th>
<th>Rest</th>
<th>Low dose</th>
<th>Peak dose</th>
<th>recovery</th>
</tr>
</thead>
<tbody>
<tr>
<td>Normal</td>
<td>Nl</td>
<td>Augment</td>
<td>Hyperkinetic</td>
<td>Nl</td>
</tr>
<tr>
<td>Ischemia</td>
<td>Nl</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Infarct nonviable</td>
<td>Abnl</td>
<td>No ∆</td>
<td>Stable</td>
<td>Abnl</td>
</tr>
<tr>
<td>Infarct viable</td>
<td>Abnl</td>
<td>Improves</td>
<td>Abnl</td>
<td>Abnl</td>
</tr>
<tr>
<td>Mixed same territ</td>
<td>Abnl</td>
<td></td>
<td>Worse ± larger</td>
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</tr>
<tr>
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<td>Abnl</td>
<td></td>
<td>New territ abnl</td>
<td>abnormal</td>
</tr>
</tbody>
</table>

### Accuracy of exercise echo

<table>
<thead>
<tr>
<th>Method</th>
<th>Sens SVD</th>
<th>Sens MVD</th>
<th>Spec</th>
</tr>
</thead>
<tbody>
<tr>
<td>Armstrong</td>
<td>ETT</td>
<td>81</td>
<td>93</td>
</tr>
<tr>
<td>Crouse</td>
<td>ETT</td>
<td>93</td>
<td>100</td>
</tr>
<tr>
<td>Quinones</td>
<td>ETT</td>
<td>58</td>
<td>89</td>
</tr>
<tr>
<td>Marwick</td>
<td>ETT</td>
<td>79</td>
<td>96</td>
</tr>
<tr>
<td>Galanti</td>
<td>Bike</td>
<td>93</td>
<td>92</td>
</tr>
<tr>
<td>Pozzoli</td>
<td>Bike</td>
<td>60</td>
<td>94</td>
</tr>
<tr>
<td>Hecht</td>
<td>Bike</td>
<td>84</td>
<td>100</td>
</tr>
<tr>
<td>Ryan</td>
<td>Bike</td>
<td>84</td>
<td>100</td>
</tr>
</tbody>
</table>

Sensitivity greatest in MVDs, prior MI
**Dobutamine stress echo: review of 28 studies**

<table>
<thead>
<tr>
<th></th>
<th>Sens</th>
<th>Spec</th>
<th>Accuracy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Overall</td>
<td>80 %</td>
<td>84 %</td>
<td>81 %</td>
</tr>
<tr>
<td>1 VD</td>
<td>74 %</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2 VD</td>
<td>86 %</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3 VD</td>
<td>92 %</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Geleijnse et al, JACC 1997;30:595-606

**DSE: CAD detection in individual arteries**

<table>
<thead>
<tr>
<th></th>
<th>Sens</th>
<th>Spec</th>
</tr>
</thead>
<tbody>
<tr>
<td>All vessels</td>
<td>69 %</td>
<td>91 %</td>
</tr>
<tr>
<td>LAD</td>
<td>72 %</td>
<td>88 %</td>
</tr>
<tr>
<td>LCx</td>
<td>55 %</td>
<td>93 %</td>
</tr>
<tr>
<td>RCA</td>
<td>76 %</td>
<td>89 %</td>
</tr>
</tbody>
</table>

Geleijnse et al, JACC 1997;30:595-606

**Factors reducing sensitivity + specificity of stress echo**

- Single vessel ds
- Mild cor stenoses
- Lt circumflex ds
- Inadequate stress
- Rapid recovery
- Late imaging
- Poor image quality
- Beta-blockers

- Cardiomyopathy
- Septal motion abnormality
  - Post-op, RVVO, LBBB
- Overcalling basal septum
- Marked hypertensive response
- Interpreter bias

**Sens (false -)**

**Spec (false +)**
Stress echo: more than just WMA to factor into interpretation

- Duration of exercise
- Resting EF
- HR achieved
- BP response
- Extent of WMA
- Rapidity of normalization
- LV response
- Coronary distribution
- Stress ECG

Potential pitfalls in stress echo influences on accuracy of test

- timing of peak images
  - exercise echo
- influence of beta blockers
- lack of “augmentation” is an abnormal response

Stress echo: interpreting the septum in the presence of left bundle branch block

- Examine thickening rather than inward motion
- View only second half of systole
  - edit digital loop
  - change speed
Pretest probability of CAD influences stress testing results

- If low pre-test probability
  - Potential for high rate of false positive tests
  - False negative tests will be low

- If high pre-test probability
  - False positive tests will be low
  - Potential for higher rate of false negative tests

Pre-test probability affecting stress test results

100 pts
Pretest likelihood
10 %

CAD +
10 pts

CAD –
90 pts

False –
2 pts

True +
8 pts

False +
9 pts

True –
81 pts

Sensitivity = 80%
Specificity = 90%
False Positive rate = 53%
False Negative rate = 2%

Pre-test probability affecting stress test results

100 pts
Pretest likelihood
90 %

CAD +
90 pts

CAD –
10 pts

False –
18 pts

True +
72 pts

False +
1 pts

True –
9 pts

Sensitivity = 80%
Specificity = 90%
False Positive rate = 1%
False Negative rate = 66%

Borrowed from T Ryan
Biggest pitfall in stress echo: identifying wall motion abnormalities

- Image quality
  - Contrast

- Future
  - Rapid acquisition of wall motion
    - "Real time" three dimensional echo
  - Quantification of wall motion
    - Myocardial strain (Doppler or Speckle)
      - Regional, global strain

American Society of Echocardiography Consensus Statement on the Clinical Applications of Ultrasonic Contrast Agents in Echocardiography

JASE 2008; 21:1179-1201

Appropriate use criteria for stress echo and contrast combined

Douglas et al, JACC + JASE March 2011

70 yo M with HTN, hyperlipidemia, severe osteoarthritis (unable to exercise on treadmill). Increasing chest pain with activity

DSE - 79% MPHR; chest pain at peak dose, ST dep on ECG
• Coronary angiogram
  – Mixed dominance
    – LAD: 70% proximal stenosis; tandem 70% stenosis mid vessel; 70% stenosis distal
    – CX: 30% stenosis proximal; occl mid vessel; OM1 70% ostial and 99% distal
    – RCA: Occluded proximally

• Stents placed

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**Use contrast in stress echo**

• Reduced dosing during stress (increased stroke volume)
• If infusing pharmacologic stress agent use a different IV line for contrast
  – Avoid bolus of pharmacologic stressor
  – If using same line must withdraw all of infusate
• Image contrast enhanced apical views first
• Timing of injection

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**Advantages of integrating contrast with stress echo**

• Increased proportion of adequately visualized segments
• Improved concordance between readers
• Better learning experience for novice sonographers and novice interpreters

Pulerwitz et al, JASE 2006;19:540-5