STRESS ECHOCARDIOGRAPHY 101

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Objectives

- Case-based approach to using Stress Echo for assessing...
  - Coronary Artery Disease (CAD)
    - Diagnosis of CAD
    - Assessing viability
  - Valvular Heart Disease (VHD)
- Comparison with other diagnostic modalities
Question 1

• In detecting CAD, diagnostic sensitivity and specificity for stress echo versus nuclear perfusion scan is:

  A. Better
  B. Worse
  C. Same
Stress Echocardiography

- Treadmill exercise echocardiography
  - Most traditional
  - Greatest experience/data
- Supine Bicycle exercise echocardiography (available at St. Michael’s Hospital)
  - Growing experience
  - Imaging at peak stress
- Dobutamine Stress Echocardiography (DSE)
- Dipyridamole Stress Echocardiography
Ischemic Cascade

Exercise ECG testing

Stress echocardiography

Nuclear perfusion stress

Angina

ECG changes

Systolic dysfunction

Diastolic dysfunction

Metabolic changes

Myocardial malperfusion

Ischemic cascade/progression
Stress Echocardiography

Diagnostic criteria - wall thickening/motion

- Peak and immediate post-exercise increase in function compared to rest
- Decrease in end-systolic volume, increase in LVEF (especially with dobutamine)
- Peak and immediate post-exercise decrease in function compared to rest
- Increase in end-systolic volume (rarely with DSE), decrease in LVEF (multivessel CAD or left main disease)

Normal response

Ischemic response
### Stress Echocardiography

#### Pros
- Excellent long term experience, with good prognostic data
- Similar sensitivity (88%) and specificity (83%) for CAD detection compared to nuclear SPECT techniques
- No nephrotoxicity
- No radiation exposure
- Diagnosis of CAD in “real-time”
- Identify other causes of angina - AS, HOCM, pulm HTN

#### Cons
- Unable to detect <50% stenosis
- Reduced sensitivity (single-vessel CAD, especially LCx)
- Acquire images in first minute post-stress (treadmill)
- False positive tests - DCMP, HCM, valvular disease (AS)
- False negative tests with concentric LVH (especially DSE)

Stress Echocardiography

Comparison to Nuclear SPECT techniques

- Pooled analysis - 18 studies of 1304 patients
- Exercise or pharmacologic stress echo in conjunction with Thallium or Tc-based SPECT
- Slightly lower sensitivity, higher specificity

Schinkel et al. Eur Heart J 2003;24:789-800
Comparing Stress Echo vs. Myocardial Perfusion Imaging

<table>
<thead>
<tr>
<th>Comparative Advantages of Stress Echocardiography and Nuclear Perfusion Imaging in Diagnosis of CAD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Advantages of Stress Echocardiography</td>
</tr>
<tr>
<td>1. Higher specificity</td>
</tr>
<tr>
<td>2. Versatility – more extensive evaluation of cardiac anatomy and function</td>
</tr>
<tr>
<td>3. Greater convenience/efficacy/availability</td>
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Adapted from ACC/AHA/ACP-ASIM Guidelines for the Management of Patients with Chronic Stable Angina: a report of the ACC/AHA Task Force on Practice Guidelines (Committee on Management of Patients with Chronic Stable Angina) (Gibbons, 2002a)
Stress Echocardiography
Supine Bicycle Stress Echo
Comparison to Treadmill exercise

- Work load (METS) and peak HR less, but similar Rate Pressure Product (RPP)
- Greater provoked ischemia with greater WMSI - imaging during peak stress, as opposed to post stress (reduced false negative)
- Able to detect ischemic threshold - better prediction of severity


Black bars - Supine bike; Grey bars - Treadmill
Stress Echocardiography

Similar prognostic information as SPECT MPI

- Meta-Analysis
  - 17 exercise MPI studies (8,008 pts)
  - 4 exercise Echo studies (3,021 pts)

- NPV for MI and CV death
  - 98.8% [95% CI 98.5-99.0] for Ex MPI
  - 98.4% [95% CI 97.9-98.9] for Ex Echo

- Annualized event rates for negative test
  - 0.45% per year for Ex MPI
  - 0.54% per year for Ex Echo

## Assessment of Viability

<table>
<thead>
<tr>
<th>Diagnosis</th>
<th>Resting Function</th>
<th>Low Dose (20 mcg/kg/min)</th>
<th>Peak Dose (40 mcg/kg/min)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Normal</td>
<td>Normal</td>
<td>Normal</td>
<td>Hyperkinetic</td>
</tr>
<tr>
<td>Ischemic</td>
<td>Normal</td>
<td>Normal (Unless severe CAD)</td>
<td>Reduction versus Rest</td>
</tr>
<tr>
<td>Viable, patent infarct-related artery (IRA)</td>
<td>Hypokinetic/Akinetic</td>
<td>Improvement</td>
<td>Sustained improvement</td>
</tr>
<tr>
<td>Viable, stenosed infarct-related artery (IRA)</td>
<td>Hypokinetic/Akinetic</td>
<td>Improvement</td>
<td>Reduction (Compared w/ low dose)</td>
</tr>
<tr>
<td>Infarction</td>
<td>Akinetic/Dyskinetic</td>
<td>No change</td>
<td>No change</td>
</tr>
</tbody>
</table>

*Tuesday, May 25, 2010*
Assessment of Viability

Figure 16-10. Meta-analysis of sensitivity and specificity of different techniques for assessing viability. C-MRI, contrast magnetic resonance imaging; Db-MRI, dobutamine stress magnetic resonance imaging; FDG PET, fluorodeoxyglucose positron emission tomography; LDDE, low dose dobutamine echocardiography; MIBI, [(99m)Tc]methoxyisobutylisonitrile SPECT; TI RR, thallium rest-redistribution; TI SSR, thallium stress-rest-redistribution.
Stress Echo - Future

3D in Stress Echo
Myocardial Contrast Echo (MCE) Myocardial Perfusion

- Detection of CAD
  - Pharmacologic stress - adenosine, dobutamine
- Acute myocardial infarction
  - Risk area, presence of collateral flow
  - Adequacy of reperfusion/Presence of no-reflow
- Post MI risk stratification
- Myocardial viability

Shimoni S, et al, JACC 2001
Porter TR, et al, JACC 2001
Wei K, et al, Circulation 2001
Wei K, et al, Am J Cardiol 2003
Nagsh S, et al, JACC 1997
Peltier M, et al JACC 2004
Swinburn JM, et al, JACC 2001
Balcells E, et al. JACC 2003
Senior R, et al, Am Heart J 2004
Moir S et al, Circulation 2004

Apical-4 Rest
Apical-4 Dipyridamole
Dobutamine Stress Echo Perfusion (MCE)

WM vs Perfusion: Single vs Multivessel

* Cut off of >50% on angiography

Stress echocardiography: Clinical Utility - Summary

- Detection of CAD
- Post-MI risk stratification
- Pre-op cardiac risk assessment
- Myocardial viability (DSE)
- Assessment of provokable gradients with HOCM
- Assessment of valvular heart disease
- Low gradient, low flow Aortic Stenosis
Stress echocardiography: Clinical Utility - Take home message

“Stress echo - similar diagnostic accuracy and prognostic data as current non-invasive imaging tests to detect CAD ....................... but offers additional information (valves, RV, pulm HTN), at less cost and without radiation”
CardioMath

- Echocardiography
- dP/dt (RV contractility)
- Left atrial pressure (MR)
- LA Volume (Biplane Method)
- LV EF (Dumesnil Method)
- LV EF (Mod Quinones Eqn)
- LV EF (Simp Quinones Eqn)
- LV Fractional Shortening
- LV Mass and LV Mass Index

Input:
- LVEDD: 56 mm
- LVESD: 34 mm
- Apex: +10% Normal

Result:
- LVEF: 73.1%