Choosing the Right Cardiac Test

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Disclosures: None

Outline

• Focus on choosing the optimal tests for coronary disease evaluation

• Overview of stress testing, imaging options and how tests are performed

• Instructive case scenarios with discussion
Test the Audience

Which one of the following is true regarding stress testing?

• A. All patients who can exercise should have an exercise stress test (with/without imaging as appropriate).
• B. Patients undergoing conventional SPECT nuclear stress testing need to be able to lie flat.
• C. Beta blockers do not need to be stopped prior to a Dobutamine stress test.
• D. Patients with COPD cannot have a vasodilator stress test.

To Stress or not to Stress

• A paradigm shift has occurred for management of most stable CAD with medical therapy first rather than routine PCI.
• Significant cost and harm is associated with unnecessary testing, false positives, and additional procedures.
• Information from stress testing should be meaningful to direct management.
Broad Indications for Stress Testing

• For diagnosis and risk stratification in those with suspected CAD, or known CAD with a change in clinical status.
• Assess location and degree of ischemia in those with known CAD for the purposes of revascularization.
• Determine if medical therapy and/or revascularization therapy is adequate for CAD.
• Evaluate severity and symptoms of valvular or congenital heart disease or evaluate arrhythmic therapy (non CAD related).

Contraindications - Question

Which of the follow is not an absolute contraindication to stress testing?
A. Acute myocarditis
B. Decompensated heart failure
C. Acute MI
D. Severe uncontrolled hypertension
E. Symptomatic severe aortic stenosis
Contraindications

**Absolute**
- Acute MI within 2 days, or active unstable angina
- Symptomatic severe aortic stenosis
- Decompensated heart failure
- Aortic dissection
- Acute myocarditis or pericarditis
- Uncontrolled arrhythmias
- Acute PE

**Relative**
- Left main disease
- Severe uncontrolled hypertension
- Hypertrophic obstructive cardiomyopathy
- High degree AV block

How does stress testing work?

- Different tests interrogate different portions of this ischemic cascade.
- Each method employs a “stressor” and a “detector.”
Mix and Match

**Stressors**
- Exercise
  - Treadmill
  - Supine bike
- Vasodilator
  - Adenosine
  - Dipyridamole
  - Regadenoson
- Dobutamine

**Detectors**
- EKG (used for all tests)
- Echocardiography
- Radionuclide imaging
  - Thallium $^{201}$, Technetium$^{99M}$
- PET
- MRI

Exercise on Treadmill

- Need to get to 85% max predicted HR (220-age), for an optimal test
- Usual Bruce Protocol starts at 1.7mph at a 10% grade and increases in speed and grade every 3 minutes.
- Test may be stopped early for significant chest pain, severe hypertensive or hypotensive response, marked ST changes, or arrhythmia.
Exercise on Supine Bike

- Allows for echo imaging in real time during different phases of exercise
- Graded protocol with increase in workload every 3 minutes
- Good for valvular disease assessment in those who are functional, but cannot use the treadmill

Pharmacologic Stressors - Vasodilators

- Increases coronary blood flow 3 to 5 fold in normal arteries
- Diseased arteries do not augment flow well
- Effects can be reversed with aminophylline after radiotracer injection
- Contraindicated with active bronchospasm, high grade AV block, & significant hypotension

- **Adenosine**
  - A2A (coronary vasodilation),
  - A1 (AV delay),
  - A2B, A3, A4 (bronchospasm)
  - Short half life

- **Dipyridamole** (Persantine)
  - Blocks re-uptake of adenosine
  - Longer half life

- **Regadenoson**
  - Selective A2A agonist
  - Shorter half life than Dipyridamole
Pharmacologic Stressors - Dobutamine

- Positive inotrope and chronotrope (β1)
- Also some vasodilation properties (β2)
- Contraindicated in those with arrhythmias, significant hypertension, and marked LV outflow obstruction
- Infusion protocol is with escalating doses of dobutamine in 3 min increments
- Goal to get to target HR of 85% max predicted
- Atropine (vagolytic) and hand/leg exercises are also used to augment heart rate

Detectors - EKG

- Consistent horizontal or downsloping ST depressions in contiguous leads is positive
- ST depressions do not localize diseased vessel
- Not always a binary yes/no outcome. Can have equivocal/non diagnostic results

ACC/AHA Guidelines 2001
Question - EKG

In which of the following is treadmill EKG only (i.e. no imaging) stress testing still appropriate?

A. Left Bundle Branch Block
B. LVH with repolarization abnormality
C. WPW
D. Ventricular pacing
E. Digoxin use
F. Right Bundle Branch Block

When should you consider imaging?

• Baseline EKG is abnormal or uninterpretable for ischemia
• Known CAD or prior revascularization with change in clinical symptoms (localize ischemia)
• Another question to be assessed (LV function, viability, hemodynamic significance of valvular disease, changes in PASP with exercise)
Nuclear Scanner

- Patient emits radioactivity which is detected by one or more “cameras.”
- Cameras rotate slowly around the patient to generate a 3D image of the heart.
- Patient must lie flat up to 20-30 min and not move.
- Artifact can occur from motion, and tissue attenuation.

Nuclear Images

<table>
<thead>
<tr>
<th>Normal Stress</th>
<th>Abnormal Stress</th>
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<tbody>
<tr>
<td>Stress</td>
<td></td>
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<tr>
<td>Rest</td>
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<td>Stress</td>
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<td>Rest</td>
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</table>
Echo imaging

Other Considerations

- Radiation Dosage

<table>
<thead>
<tr>
<th>Procedure</th>
<th>Dosage</th>
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</thead>
<tbody>
<tr>
<td>Echo/EKG</td>
<td>None</td>
</tr>
<tr>
<td>Chest X ray (for comparison)</td>
<td>0.1mSv</td>
</tr>
<tr>
<td>Coronary Angiogram</td>
<td>7mSv (~15 if intervention done)</td>
</tr>
<tr>
<td>Cardiac CT Angiography</td>
<td>10-16mSv</td>
</tr>
<tr>
<td>Nuclear Stress - Tc-99</td>
<td>11mSv</td>
</tr>
<tr>
<td>Nuclear Stress – Thallium</td>
<td>17mSv</td>
</tr>
</tbody>
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Source: www.scai.org

- Cost
  - Treadmill EKG < Stress echo < Cardiac CT Angio < SPECT < Coronary Angiogram
- Special patient populations (CT surgery, post transplant, obese, etc)
- Local expertise
<table>
<thead>
<tr>
<th>Test</th>
<th>Pros</th>
<th>Cons</th>
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<tbody>
<tr>
<td>Exercise EKG</td>
<td>Cost effective</td>
<td>False positives</td>
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<tr>
<td></td>
<td>No radiation</td>
<td>Doesn’t localize ischemia</td>
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<tr>
<td></td>
<td>Prognostic information from exercise</td>
<td>Less sensitive/specific</td>
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<tr>
<td>Vasodilator with SPECT</td>
<td>Easy to administer</td>
<td>Radiation</td>
</tr>
<tr>
<td></td>
<td>Good for those with arrhythmias or hypertension</td>
<td>Must lie flat/stay still</td>
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<tr>
<td></td>
<td></td>
<td>Balanced ischemia possible</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Attenuation artifacts</td>
</tr>
<tr>
<td>Exercise or Dobutamine with Echo</td>
<td>No radiation</td>
<td>Baseline wall motion makes interpretation harder</td>
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<tr>
<td></td>
<td>Heart function, structure, valves, diastology, PASP also assessed</td>
<td>Poorer image quality in obese</td>
</tr>
<tr>
<td>Vasodilator with PET</td>
<td>Higher resolution, less artifact</td>
<td>Radiation</td>
</tr>
<tr>
<td></td>
<td>Useful in those who are obese</td>
<td>Short half life of radiotracer</td>
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<td></td>
<td>Viability when FDG used</td>
<td>limits stressor modalities</td>
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<tr>
<td></td>
<td>Quicker nuclear based study</td>
<td></td>
</tr>
<tr>
<td>Vasodilator with MRI</td>
<td>Heart anatomy, structure, function, infarct size, location, viability all can be assessed</td>
<td>Need expertise, time</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Breath holding, lie flat &amp; still</td>
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<td>Regular HR ideal</td>
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</tbody>
</table>

**Viability Studies**

- Use in those with known CAD, prior or recent infarct, LV dysfunction
- To see if revascularization is reasonable to improve LV function
- Several options
  - Dobutamine Echo
  - Rest-redistribution thallium
  - PET/CT – look for FDG uptake
  - MRI – look for extent of delayed enhancement
When to Consider Cardiac Cath

• High risk unstable angina
• A high pretest probability of CAD
• Positive stress test with large burden of reversible ischemia
• Failure of medical management for CAD
• Concern for an ischemic cardiomyopathy
• Preoperative assessment for cardiac valve surgery or high risk transplantation surgery

When to consider a Cardiac CT

• Acute chest pain with low probability of disease (ER setting)
• When there is a non diagnostic stress or when clinical findings and stress tests results are incongruous
• When a coronary anomaly is suspected
• To assess bypass graft patency or if there is a question about graft anatomy
• When traditional stress tests cannot be performed
• Limited use if there is renal insufficiency, tachycardia, arrhythmia, or too much coronary artery calcium
Case 1

A 60 yr old male with diabetes, hypertension, and COPD on home oxygen and theophylline who has chest pain. He has severe chronic back pain and cannot lie flat.

Which stress test is most appropriate?

A. Exercise EKG  
B. Exercise stress echo  
C. Exercise nuclear  
D. Dobutamine stress echo  
E. Dobutamine nuclear  
F. Vasodilator nuclear  
G. Curbside the cardiologist

Case 2

A 62 yr old man with hypertension, hypercholesterolemia and atypical chest pain, that sometimes happens during exercise, but also at rest. He has known chronic Left Bundle Branch Block.

Which stress test is most appropriate?

A. Exercise EKG  
B. Exercise stress echo  
C. Exercise nuclear  
D. Dobutamine stress echo  
E. Dobutamine nuclear  
F. Vasodilator nuclear  
G. Curbside the cardiologist
Case 3

A 45 yr old female with diabetes, on dialysis and s/p BKA, admitted with chest pain, and ruled out for MI by EKG and cardiac enzymes.

Which stress test is most appropriate?

A. Exercise EKG  
B. Exercise stress echo  
C. Exercise nuclear  
D. Dobutamine stress echo  
E. Dobutamine nuclear  
F. Vasodilator nuclear  
G. Curbside the cardiologist

Case 4

A 45 year old woman with moderate RA affecting hands primarily and mild resting pulmonary hypertension who complaints of chest pain and dyspnea on exertion?

Which stress test is most appropriate?

A. Exercise EKG  
B. Exercise stress echo  
C. Exercise nuclear  
D. Dobutamine stress echo  
E. Dobutamine nuclear  
F. Vasodilator nuclear  
G. Curbside the cardiologist
Case 5

A 46 yr old mildly obese diabetic female who wants to start an exercise program to lose weight. Which stress test is most appropriate?

A. Exercise EKG
B. Exercise stress echo
C. Exercise nuclear
D. Dobutamine stress echo
E. Dobutamine nuclear
F. Vasodilator nuclear
G. Curbside the cardiologist

Case 6

A 68 yr old man with chronic atrial fibrillation on digoxin and metoprolol who has chest pain. Which stress test is most appropriate?

A. Exercise EKG
B. Exercise stress echo
C. Exercise nuclear
D. Dobutamine stress echo
E. Dobutamine nuclear
F. Vasodilator nuclear
G. Curbside the cardiologist
Case 7

A 69 yr old male with chest pain, who has significant knee osteoarthritis and an ischemic cardiomyopathy with a known EF of 40%.
Which stress test is most appropriate?

A. Exercise EKG
B. Exercise stress echo
C. Exercise nuclear
D. Dobutamine stress echo
E. Dobutamine nuclear
F. Vasodilator nuclear
G. Curbside the cardiologist

Case 8

A 48 year old 450 lb morbidly obese woman with OSA on CPAP and h/o prior DVT, who complaints of atypical chest pain that is relieved with nitroglycerin. She is not very mobile and cannot lie completely flat.
Which stress test is most appropriate?

A. Exercise EKG
B. Exercise stress echo
C. Exercise nuclear
D. Dobutamine stress echo
E. Dobutamine nuclear
F. Vasodilator nuclear
G. Curbside the cardiologist
Medications Prior to Stress

• Vasodilator Test
  - Hold Theophylline, Pentoxifylline (Trental), and Dipyridamole 48 hrs before
  - Hold all caffeine 12 hrs before
  - Viagra (24hrs before), Cialis (72hrs before), Nitrates (48 hrs before), CCBs (48hrs before)
• Exercise or Dobutamine Test
  – Beta blockers/ Diltiazem/Verapamil (48hrs before)
• Oral diabetes medications – hold in the am
• Do not hold anti anginal medications if goal is to assess for effectiveness of medical therapy

Key Questions for Choosing the Right Test

1. Can the patient exercise?
2. Is the baseline EKG normal?
3. Does the patient have known CAD or arrhythmias?
4. Any comorbid conditions (bronchospasm, heart block, cardiomyopathy, etc)?
5. Are they on medications that can interfere with the type of test?
6. Why are you performing the test and what will you do with the results?
Test the Audience - Answer

Which one the following is true?

• A. All patients who can exercise should have an exercise stress test (with/without imaging as appropriate).
• B. Patients undergoing conventional SPECT nuclear stress testing need to be able to lie flat.
• C. Beta blockers do not need to be stopped prior to a Dobutamine stress test.
• D. Patients with COPD cannot have a vasodilator stress test.

Further Reading