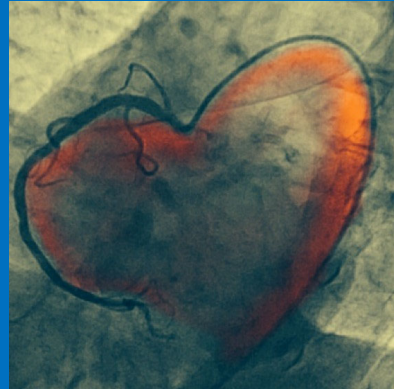


# Cardiac stress tests

- Leigh Ann Jenkins, MD, FACC



## History

William Heberden 1710 - 1801



## History

- *There is a disorder of the breast, marked with strong and peculiar symptoms, considerable for the kind of danger belonging to it, and not extremely rare, of which I do not recollect any mention among medical authors. The seat of it, and sense of strangling and anxiety with which it is attended, may make it not improperly be called angina pectoris. Those who are afflicted with it are seized, while they are walking, and more particularly when they walk soon after eating, with a painful and most disagreeable sensation in the breast, which seems as if it would take their life away, if it were to increase or to continue: the moment they stand still, all this uneasiness vanishes. In all other respects the patients are at the beginning of this disorder perfectly well, and in particular have no shortness of breath, from which it is totally different. After it has continued some months, it will not cease instantaneously by standing still; and it will come on, not only when the persons are walking, but when they are lying down and oblige them to rise up out of their beds every night for many months together.*

## History

- Dr. Heberden presented this to the Royal College of Physicians in 1768
- In the 1940's, Dr. Master wrote extensively about performance of a two-step test in the diagnosis of CAD.

## History

- The Master two-step test is a standardized exercise that permits the making of an electrocardiogram immediately after the activity terminates.
- The main criterion of the result is the behavior of the S-T segment of the tracing; depression of more than 0.5 mm. in any lead is considered a positive result.
- While a negative result did not exclude coronary insufficiency, a positive one strengthened the diagnosis of suspected coronary disease. Although the only conclusive evidence of coronary insufficiency is believed to be ischemic S-T segment depression, fewer cases escaped detection when all of Master's criteria were utilized.
- "When sound clinical judgment is employed in conjunction with the test, overdiagnosis is infrequent."

## History



The Master Two Step exercise stress test.

## Bayes' Theorem

- In probability theory and statistics, **Bayes' theorem** (alternatively **Bayes' law** or **Bayes' rule**) describes the probability of an event, based on prior knowledge of conditions that might be related to the event.
- For example, if cancer is related to age, then, using Bayes' theorem, a person's age can be used to more accurately assess the probability that they have cancer, compared to the assessment of the probability of cancer made without knowledge of the person's age.

## Bayes' Theorem

- In reference to cardiac stress tests, Bayes' theorem would imply that if you know the sensitivity and specificity of the test being ordered and the likelihood that the patient has the disease, you can predict the post-test likelihood that that patient has that disease.
- An exercise ECG stress test has a 65% sensitivity and specificity. This improves to 85% with additional imaging (echo or nuclear.)

## Bayes' Theorem

	Women	Men
Typical chest pain	50%	90%
Atypical pain	10%	70%

## Coronary artery disease

- Most seemingly healthy adult Americans have evidence of coronary atherosclerosis, with approximately 10% having obstructive disease.
- Thus, unlike other diseases, such as cancer or infections, the diagnosis of CAD is typically not categorical, *i.e.* present or absent. Rather, its significance is defined by its quantity and extent.
- CAD is commonly used to describe the condition of stenosed coronary arteries that are associated with symptoms, often termed *obstructive* or *significant* CAD.

## Cardiac stress tests

- When ordering stress tests, consider ordering food:
- One from Column A and one from Column B
- Column A is how to stress the patient
- Column B is how to image the patient

## Cardiac stress tests

- Methods of stress:
  - Exercise
    - Treadmill
    - Bicycle
  - Chemical
    - Adenosine
    - Dipyridamole
    - Regadenoson – A2A adenosine receptor agonist
    - Dobutamine

## Cardiac stress tests

- Methods of imaging:
  - ECG
  - Echocardiogram
  - Nuclear
    - Thallium
    - Technitium 99m

## Cardiac stress tests

- Each method has pitfalls which you must know so that you know which test is correct for your patient.

## Pitfalls: Exercise

- With exercise, the patient must achieve 85% predicted MHR ( $220 - \text{age}$ ) to achieve an adequate stress load on the heart for evaluation to say the test is “negative.”
- A test may be positive at any heart rate
- ACC/AHA guidelines state that the treadmill should be used for everyone as a first method of stress.

## Pitfalls: Exercise

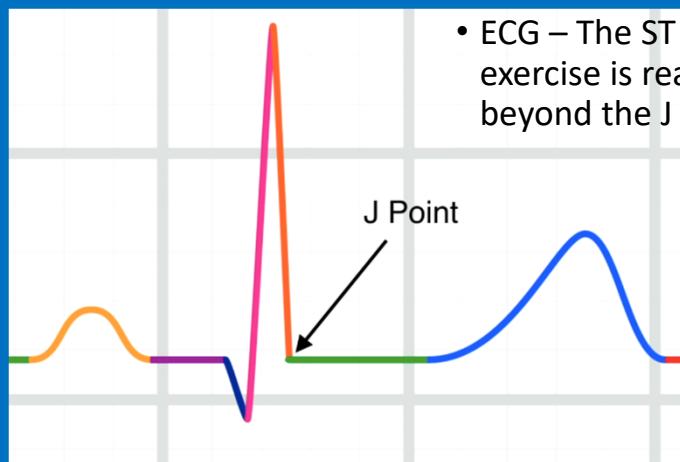
- Patients may be unable to exercise for several reasons:
  - Orthopedic problems
  - Prior stroke
- Medications may prevent increase in heart rate
  - Beta blockers – don’t forget eye drops!
  - Non-dihydropyridine calcium blockers – diltiazem, verapamil
  - Clonidine
- Should medications be discontinued prior to test?
  - Why are you doing the test – Diagnosis or Assessment of treatment???



## Pitfalls: Chemicals

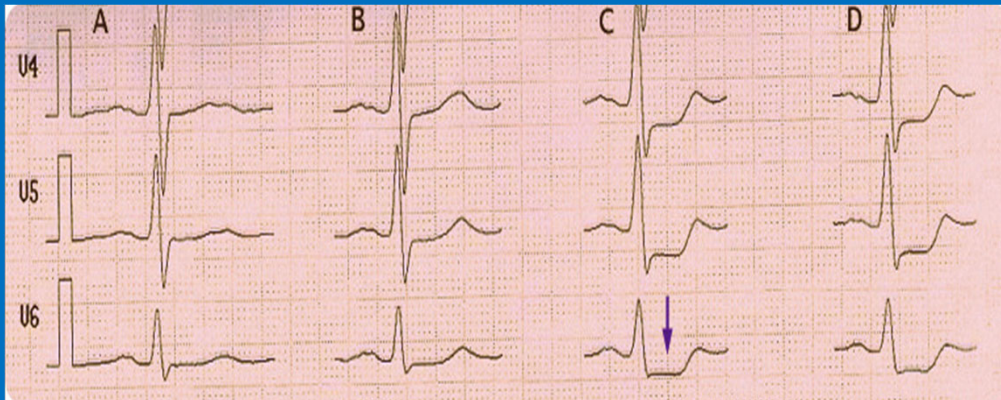
- Dobutamine:
  - Relies on increased heart rate. Therefore, medications which keep heart rate from increasing will be an issue, the same as exercise.
- Adenosine/dipyridamole/regadenoson
  - Cause coronary vasodilation. Arteries with disease cannot dilate. Therefore the normal, dilated arteries “steal” blood from the diseased vessels. Less flow down the diseased vessels delivers less tracer.

## Pitfalls: Imaging - ECG



- ECG – The ST segment with exercise is read at 0.08msec beyond the J point.

## Pitfalls: Imaging - ECG



## Pitfalls: Imaging - ECG

- Baseline abnormal ECG may present problems:
  - Left bundle branch block
  - Right bundle branch block
  - Left ventricular hypertrophy with strain
  - Baseline ST depression: Digitalis
- Consider other methods of imaging in addition to ECG

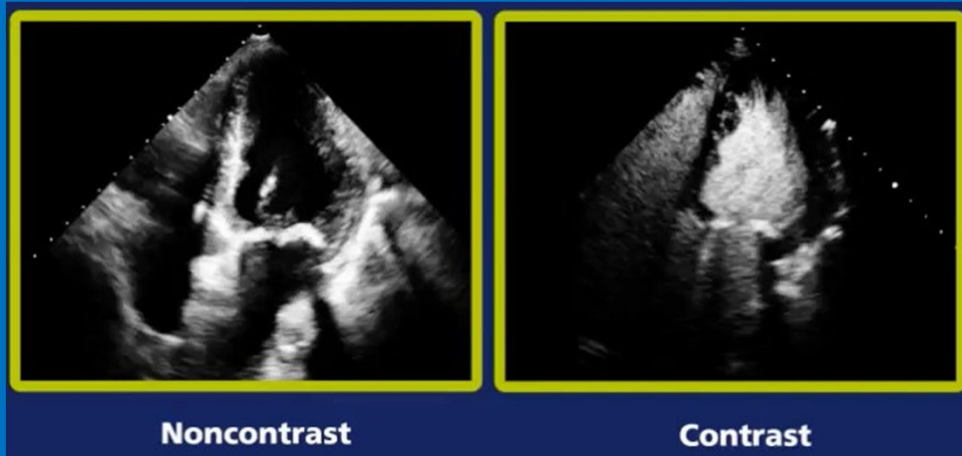
## Pitfalls: Imaging - Echocardiogram

- Echocardiogram –
  - With ischemia, the patient develops a regional wall motion abnormality.
  - If, at baseline, the echocardiogram is limited, it will not be better with exercise – Polar bear eating ice cream in a blizzard...
  - This may be helped with the addition of “contrast.”

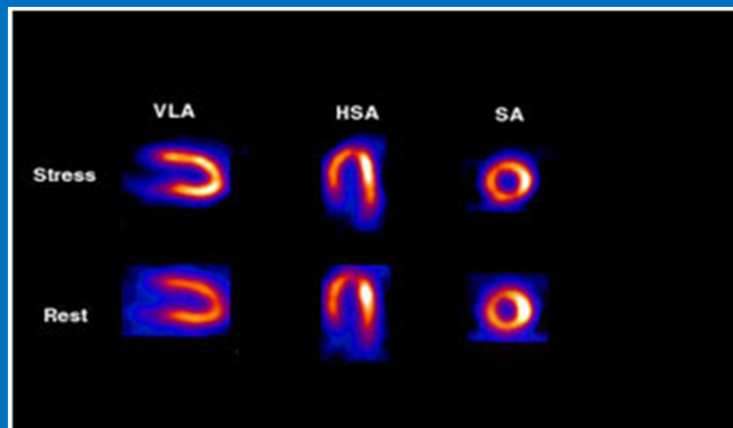
## Pitfalls: Imaging - Echocardiogram

- Definity (**perflutren lipid microsphere**) **Injectable Suspension** is a contrast agent used to brighten and clarify images of the heart during echocardiograms.
- According to the American Society of Echocardiography (ASE) guidelines, there is an indication for contrast echocardiography when the endocardial border definition is poor in two or more segments.

## Pitfalls: Imaging – Echocardiogram

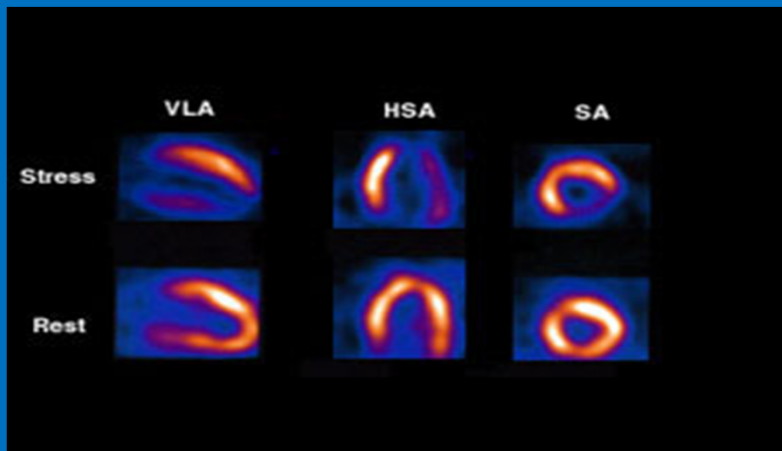


## Pitfalls: Imaging – Nuclear



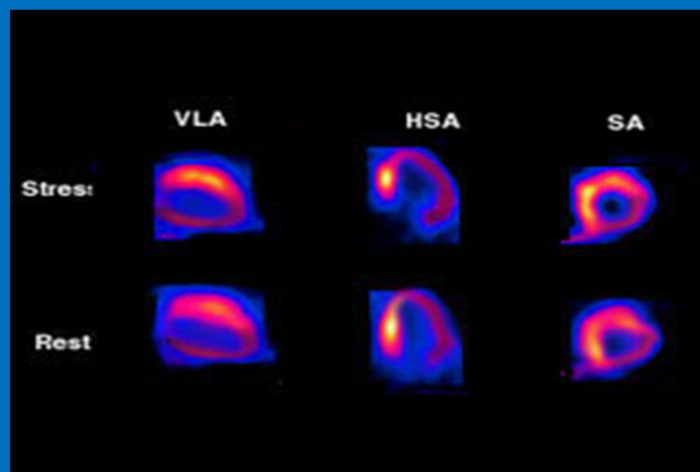
## Pitfalls: Imaging – Nuclear Ischemia

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## Pitfalls: Imaging – Nuclear Scar

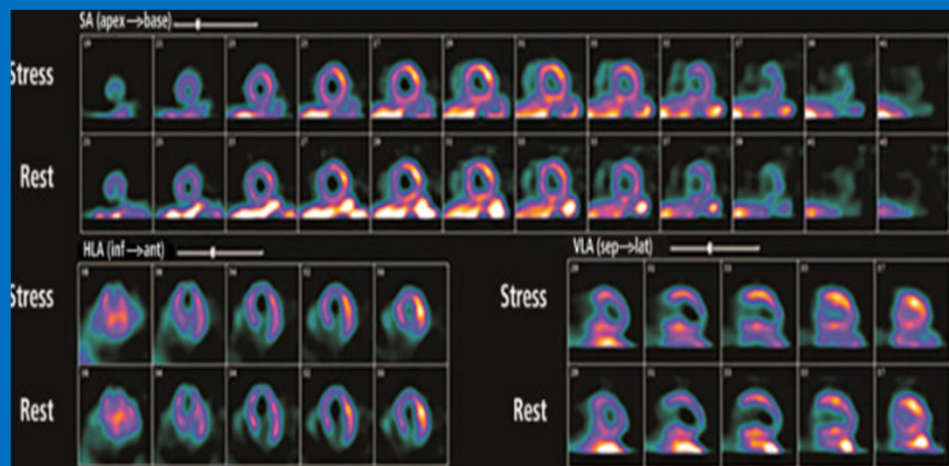
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## Pitfalls: Imaging – Nuclear LBBB

- Exercise nuclear single-photon emission computed tomography (SPECT) myocardial perfusion imaging in patients with left bundle branch block is challenging, due to the development of septal perfusion defects at rest and during exercise in the absence of obstructive disease in the left anterior descending artery.
- Possible explanations for this phenomenon are asynchronous contraction of the septum, with resulting compression of the septal arteries, decreased flow demands to the septal region and attenuation artifacts.

## Pitfalls: Imaging – Nuclear - LBBB



## Pitfalls: Imaging - Nuclear

- For the gamma camera to see a “defect,” there must be a normal area for comparison.
- If all vessels are diseased (TVD), there is no “normal” area for comparison and the camera believes there is no defect.
- This is called balanced ischemia and the scan will appear normal.
- New parameters such as LHR and TID may be helpful
  - LHR – Lung-Heart ratio
  - TID – Transient Ischemic Dilation

Thank you!

