Myocardial Perfusion Imaging—Diagnosis and Risk Stratification in Special Populations  
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Case Presentation 1

- 63 year old female with hyperlipidemia, diabetes and hypertension who had no prior history of CAD or cardiac testing. Patient being planned for left rotator cuff repair for left shoulder pain.

- Patient was referred for cardiac evaluation due to new abnormal EKG changes that showed ischemic ST–T depressions that was new when compared to an EKG done 1 year ago.

Case 1 (cont’d)

- Patient had no clear cardiac symptoms, but due to new abnormal EKG changes she was referred for myocardial perfusion imaging which showed……

Special Populations

- Diabetic Females
- Asymptomatic females with strong family history of premature CAD
- Normal myocardial perfusion with ischemic EKG changes with Regadenoson
- Females with CKD
- Morbidly Obese females presenting for pre-procedural stress testing prior to Bariatric Surgery

EKG

EKG in 2012  
EKG now

Myocardial perfusion imaging
Mycardial perfusion imaging

- Small area of moderate anteroapical ischemia.
- Normal systolic LV wall motion. LVEF 65%.

Cardiac Cath

- LAD proximal 50% stenosis and mid 99% stenosis
- Ostial proximal large OM2 80% stenosis
- Large OM3 mid 90% stenosis
- RCA mid 50% stenosis.

Follow up

- Patient had PCI of the mid LAD and returned to have staged PCI of OM 2 and 3.
- Rotator Cuff Surgery was considered after a year of dual antiplatelet surgery.
- Patient went to cardiac rehab and is doing well exercising daily.

Teaching points

- There should be a high level of suspicion for CAD in the diabetic female.
- Diabetic female patients even with mildly abnormal myocardial perfusion study have a greater rate of MACCE when compared to female patients without DM.

Diabetes Creates Higher Risk for Women With CAD

- 65% of diabetics die from heart disease or stroke
- 4.2 million American women have diabetes
Diabetes: Powerful Risk Factor for CAD in Women

- Framingham Heart Study
- Women with diabetes mellitus are about 5 times more likely to have CAD vs. women without diabetes
- Women with diabetes are approximately twice as likely to have CAD compared to men with diabetes.

- Nurses’ Health Study
- Even if women had diabetes for <4 years, their risk of CAD was significantly elevated

Relative Risk

<table>
<thead>
<tr>
<th>Age group</th>
<th>Men</th>
<th>Women</th>
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<tbody>
<tr>
<td>45-64</td>
<td>3.4</td>
<td>4.6</td>
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<tr>
<td>65-74</td>
<td>2.0</td>
<td>3.1</td>
</tr>
<tr>
<td>75+</td>
<td>1.6</td>
<td>2.0</td>
</tr>
</tbody>
</table>

Kannel W. Am Heart J. 1987

Lowest Survival Rates for Diabetic Women

- CAD mortality rates in diabetics, especially women, have not decreased to the same extent as those in the general population
- Early detection is important and there should be a high level suspicion for the presence of CAD even in the absence of overt symptoms.

Gu K, et al. JAMA. 1999

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Case presentation 2

- 70 y/o female with h/o HTN, Dyslipidemia and Osteoarthritis presented for cardiac risk assessment as her other died of AMI and all three of her brothers and one sister in their early 50s were diagnosed with CAD and had CABG and or PCI. She presented to us for assessment for presence of subclinical CAD.
- Was asymptomatic for CAD with mildly limited exercise capacity due to osteoarthritic knee pain.
- BP 156/88, BMI 30, Lifetime non tobacco smoker, LDL 92, HDL 41.
- 2013 ACC/AHA CVD risk assessment was........
Coronary Calcification Score

Hazard ratios (HR) for coronary heart disease (CHD) events associated with coronary calcium scores: US adults 45 to 84 years of age (reference group, coronary artery calcification [CAC]=0).


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1795 patients with mean age of 71 years followed for over 3 years

Patient had Lexiscan nuclear stress test as patient was unable to tolerate treadmill stress.

No ischemic EKG changes

No angina

Perfusion showed......
Moderate to severe ischemia in the mid and apical anterior wall suggestive of severe stenosis in the mid LAD. LVEF 64% with no wall motion abnormalities.

Patient was referred for cardiac catheterization.

Chronic total occlusion of the mid LAD with some reconstitution of flow distally from collaterals.

Patient had successful PCI of the mid LAD with drug eluting stent. Procedure performed radially.
Post PCI findings....

Screening for CAD in the asymptomatic female

- Risk factor assessment is important—screening for diabetes, checking blood pressure and lipid levels.
- Family history is very important.
- Framingham Risk and NCEP ATP III assessment may underestimate cardiovascular risk.
- Genomic testing, Apolipoprotein and Lipoprotein assessment - Class III indication NO BENEFIT
- Exercise treadmill testing -- Class II b especially if patient is planning to initiate vigorous exercise capacity and need to assess functional capacity.
- Stress Echo - Class III NO BENEFIT
- SPECT MPI -- Class II b in asymptomatic patients with DM or asymptomatic adults with previous risk assessment suggesting a high risk of CAD such as CAC score >400. Is a Class III (not indicated) in CVD risk assessment in asymptomatic intermediate or low risk adults.
- CAC score - Class III indication and is reasonable in asymptomatic adults with intermediate risk for CAD and asymptomatic DM adults >40 yrs of age.
- Cardiac CT - Class III not recommended in asymptomatic patients.

AUC for SPECT in asymptomatic patients

<table>
<thead>
<tr>
<th>Indication</th>
<th>Appropriate use score (1-9)</th>
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</thead>
<tbody>
<tr>
<td>Detection of CAD risk assessment High CVD risk (ATP III risk criteria)</td>
<td>1 (1)</td>
</tr>
<tr>
<td>Intermediate CAD risk (ATP III risk criteria)</td>
<td>1 (1)</td>
</tr>
<tr>
<td>ECG unreassuring</td>
<td>1 (1)</td>
</tr>
<tr>
<td>Intermediate CAD risk (ATP III risk criteria)</td>
<td>1 (1)</td>
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<tr>
<td>ECG interpretable</td>
<td>1 (1)</td>
</tr>
<tr>
<td>Low CVD risk (ATP III risk criteria)</td>
<td>1 (1)</td>
</tr>
<tr>
<td>Low to intermediate CAD risk Apo A score less than 100</td>
<td>1 (1)</td>
</tr>
<tr>
<td>Apo A score between 100 and 400</td>
<td>1 (1)</td>
</tr>
<tr>
<td>Low to intermediate CAD risk Apo A score greater than 400</td>
<td>1 (1)</td>
</tr>
<tr>
<td>High CVD risk</td>
<td>1 (1)</td>
</tr>
<tr>
<td>High CVD risk Apo A score greater than 400</td>
<td>1 (1)</td>
</tr>
</tbody>
</table>

Hendel et al, J. Nucl Cardiol, 2011

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Case Presentation 3

- 56 y/o female with hypertension and hyperlipidemia presented with in 2010 with h/o chest burning that was described as 6/10 in intensity and was exertional and associated with reduced exercise capacity to <3 blocks.

- EKG showed sinus rhythm with ST-T changes in the inferior leads.

- Patient was referred for Regadenoson myocardial perfusion stress test with Tc-99 and EKG at rest and peak perfusion showed...

- EKG at rest
- EKG at peak Regadenoson infusion patient had no angina

Myocardial perfusion imaging

- Nuclear concluded as normal myocardial perfusion with normal wall motion, LVEF 55%.
- However it was also noted and reported that there were ischemic changes with regadenoson infusion.

Follow up

- Findings of nuclear stress test were discussed with the patient and at her follow up visit her chest pain had resolved. She was on isosorbide30 mg, pravastatin 40mg, aspirin 81 mg and metoprolol tartrate 50mg.

- Patient was back to exercising on her treadmill 5 days per week without any symptoms.

- Patient was doing well followed up every 6 months. However, 1½ year later she had recurrence of her symptoms, she was referred for cardiac cath and showed.......

Cardiac Cath

- Pre PCI
- Post PCI
Follow up

- Patient has done well and symptoms resolved.
- 2D Echo showed normal wall motion, LVEF 60%. No valvular disease.

Teaching Points

- The diagnostic and prognostic significance of isolated ST-T changes with normal myocardial perfusion with no angina is yet to be defined.
- However, a more recent study published by Doukky, R., et al. indicated that among patients selected to undergo coronary angiography, regadenoson-induced ST depressions > 0.5 mm was associated with higher rates of severe CAD and MACE, irrespective of MPI finding.

(J Nucl Cardiol 2015;22:700–13.)

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Case #4

- 81 year old female with history of hypertension, chronic renal insufficiency with GFR in the 30s and dyslipidemia presented to Women's Cardiac Center with a history of dyspnea on exertion.
- She was referred for nuclear stress testing.
She was referred for nuclear stress testing.

Pharmacologic nuclear stress test showed:

- Patient was found to have a large area of prior infarction in the LCx and LAD territory with no evidence of peri-infarct ischemia.
- LV was very dilated with a LVEF of 15% with apical dyskinesis.
- This was a diagnostic study as patient had no prior coronary evaluation and no known h/o AMI.
- In view of this she was referred for cardiac cath.

Cath images
Severe triple vessel disease with critical LM disease.

AAA 4.1 cm

Porcelain aorta and transverse aorta

Significant PAD disease

Viability study showed moderate degree of viability in the anterior and anterolateral wall.

Patient was assessed by CT Surgery

She was referred for viability study.

Viability study showed with Thallium-201 rest and 24 hr delay showed moderate degree of viability in the anterior and anterolateral wall.
Mgmt

› CABG was discussed with the patient however, she refused to have open heart surgery therefore patient had high risk PCI of LM with Impella support.

› For her PAD, due to patient’s lack of PAD symptoms and CRI patient’s PAD was treated medically/conservatively.

Cath images

Mgmt (cont’)

› Patient was seen in clinic the following week and was doing remarkably better and her dyspnea had significantly decreased.

› Patient continues to do well in clinic, she had repeat echo 6 mothes later and LVEF improved to 30%. AICD and Bi–V pacemaker device was placed.

› Currently on regimen of aspirin 81mg, clopidogrel 75mg, carvedilol 12.5mg bid, hydralazine 10mg tid, isosorbide 30 mg, lisinopril 5mg, furosemide 20 mg daily, rosvuastatin 20 mg daily.

Teaching points

› In DIAGNOSTIC cases of widespread area of infarction especially in view of severely decreased LVEF, it is important to refer for viability study to determine the presence of hibernating myocardium and to thus consider revascularization to improve myocardial function.

› Chronic renal insufficiency is a very strong risk factor or CAD and have very poor MACCE event free survival in the presence of severe multivessel CAD.

Cardiac death rate (%/year) as a function of perfusion abnormality and EF. The number of patients within each category is indicated below each column.
There is 79.6% reduction in mortality for patients with viability treated by revascularization ($p < 0.0001$).

In patients without myocardial viability, there was no significant difference in mortality with revascularization versus medical therapy.

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**Case Presentation 5**

- **67 y/o morbidly obese female**
  Confined to a walker who also has h/o Diabetes, sleep apnea and hypertension presented for cardiac pre-operative evaluation prior to Bariatric surgery. No prior h/o CAD or cardiac testing. Weight 400 lbs.

Patient was referred for myocardial perfusion imaging which showed........

- **Stress test was reported as a medium sized area of severe ischemia in the inferolateral wall.**
- **Normal wall motion with LVEF 63%.**
Cardiac Cath

- Cardiac catheterization showed normal coronary arteries.
- Right coronary dominant circulation

Case Presentation 6

- 57 y/o female with h/o CABG 4 years ago and h/o DM, HTN and Hyperlipidemia was referred for nuclear stress testing to assess cardiac risk prior to bariatric surgery. BPM 425lbs.
- Myocardial perfusion imaging showed......

Myocardial perfusion imaging

- Fixed anterolateral, anterior and anteroseptal defect with normal wall motion compatible with soft tissue breast attenuation.
- LVEF 60%

Teaching Points

- Myocardial perfusion imaging with SPECT in the morbidly obese female is very challenging.
- Careful selection of these patients for SPECT is important. Attenuation correction increases specificity when compared to non-attenuated corrected images
- Artifacts are common. Myocardial perfusion with PET imaging is better due to being less prone to soft tissue artifacts.

Specificity and Sensitivity of SPECT in the Obese patient

- Figure 2: Sensitivity and specificity of MPI for detecting 70% or greater coronary artery stenosis in normal-weight (open bar), overweight (gray bar), and obese (solid bar) women and men. Annual, P < 0.05 versus norm, P values were not significant for all comparisons among the 3 weight groups.
Use of Supine and Prone imaging

| Table 2: Sensitivities and specificities of quantitative NPS for detection of CAD w/ 50% or greater and 75% or greater stenoses |
|---------------------------------|-----------------|----------------|----------------|
|                                 | Normal weight   | Overweight     | Obese          | Overall         |
| CAD, 50% stenoses              | Sensitivity (%) | Specificity (%) | Sensitivity (%) | Specificity (%) |
| Supine alone                   | 90% (99)        | 85% (80)       | 94% (96)       | 90% (96)        |
| Prone alone                    | 75% (70)        | 80% (65)       | 75% (70)       | 80% (65)        |
| Combined                        | 80% (85)        | 85% (75)       | 90% (90)       | 85% (75)        |
| CAD, 75% stenoses              | Sensitivity (%) | Specificity (%) | Sensitivity (%) | Specificity (%) |
| Supine alone                   | 90% (99)        | 85% (80)       | 94% (96)       | 90% (96)        |
| Prone alone                    | 75% (70)        | 80% (65)       | 75% (70)       | 80% (65)        |
| Combined                        | 80% (85)        | 85% (75)       | 90% (90)       | 85% (75)        |

Value of Attenuation Correction

![Figure 1](image1.png)

Value of PET vs SPECT

![Figure 2](image2.png)