

# **Myocardial Perfusion Imaging With PET**

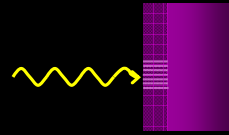
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# PET vs SPECT

**Electronic collimation**  
**PET**



**Mechanical collimation**  
**SPECT**



**Sensitivity:** high

low

**Attenuation:** independent

dependent

**Spatial resolution:** independent

dependent

# Rest/Stress SPECT MPI

## Most Common Artifacts

- Attenuation
  - Breast tissue -anterior wall
  - Diaphragm - inferior wall
  - Lateral chest wall adipose tissue
- Sub-diaphragmatic activity
  - Liver - inferior wall defects
  - Gut - masking of inferior wall
- More prevalent with vasodilator stress
  - increasing usage with increasing incidence of obesity and de-conditioning

# Rest/Stress SPECT MPI

## Advantages and Disadvantages

- Advantages
  - Info on LV perfusion and function
  - Accurate
  - Excellent risk stratifier, provides added info
  - Robust
  - Data suggests cost-effectiveness
- Disadvantages
  - Prone to artifacts
  - Studies are long (rest/adenosine dual isotope MPI ~3-4 hrs)

# RB-PET MPI

## Advantages

- Accurate attenuation correction
- Short protocol duration
- Potential for rest/stress functional imaging
- Potential for quantification of MBF

## Advantages of PET/CT MPI

- Superior sensitivity, specificity, normalcy
- High spatial resolution and contrast
- Images are rarely nondiagnostic
- Streamlined acquisition protocol
- Lower patient and staff radiation exposure

# Cardiac PET

## Perfusion Tracers for Clinical Use

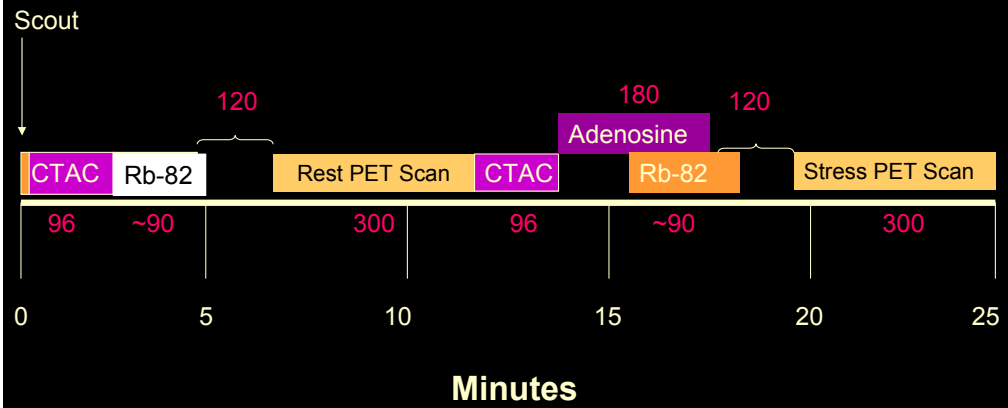
- Rubidium-82
  - generator produced - half-life is 75 sec
  - potassium analog (like thallium-201)
  - renal excretion
  - medicare coverage
- N-13 Ammonia
  - cyclotron-produced - half-life is 9.9 min
  - complex uptake mechanisms (80-90% EF)
  - renal excretion
  - medicare coverage
  - can do exercise stress

# RB-PET - MPI

## Pharmacological Stress - Vasodilators

- Adenosine or dipyridamole
  - Action: via A2a receptor
  - Preparation: no caffeine or theophylline ~24rs prior
  - Major side effects: hypotension, bronchospasm, AV block
  - Contraindications: reactive airway disease, conduction abnormalities
  - Treatment: stop drug, i.v. aminophylline

## 25-minute PET/CT Pharmacologic Stress Protocol



# SPECT Vs. PET

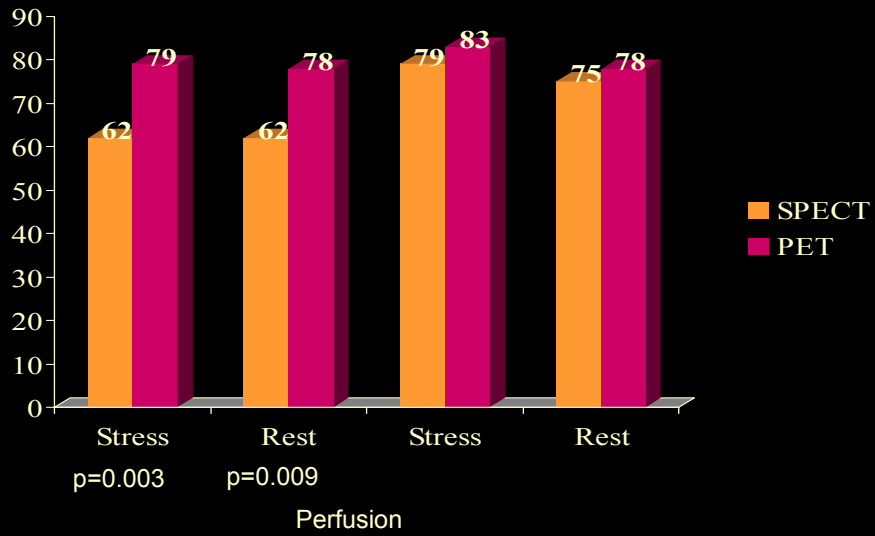
## Patient Characteristics

	SPECT	PET	P-value
N	112	112	1.0
Cath Pts	85	85	1.0
0 VD	11	11	
1 VD	14	14	
MVD	60	60	
Low lkhhd	27	27	1.0
Age	65	66.7	0.25
Male	52%	52%	1.0
BMI	32.5	31.7	0.32

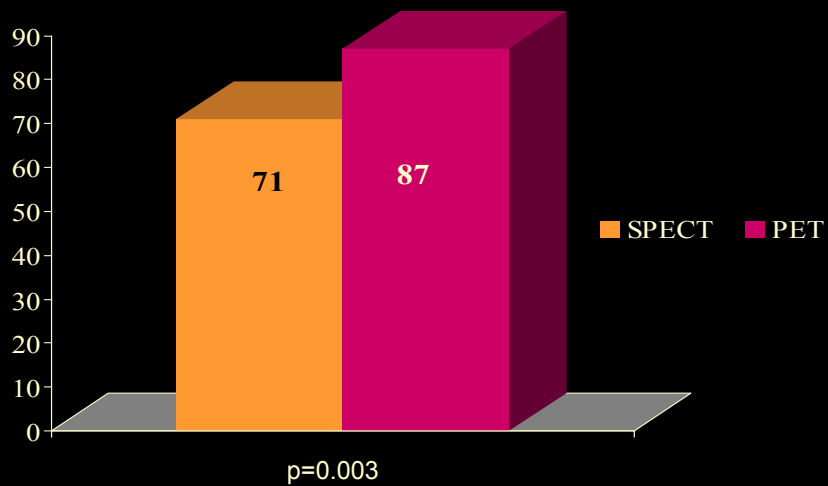
# Image Interpretation

- Image Quality
  - *Excellent, good/average, fair, poor*
- Interpretive certainty
  - *Definitely normal, probably normal, equivocal, prob abnormal, def abnl*
- Diagnostic accuracy in cath pts
  - *Sensitivity, specificity, accuracy*
- Normalcy rate in low likelihood pts

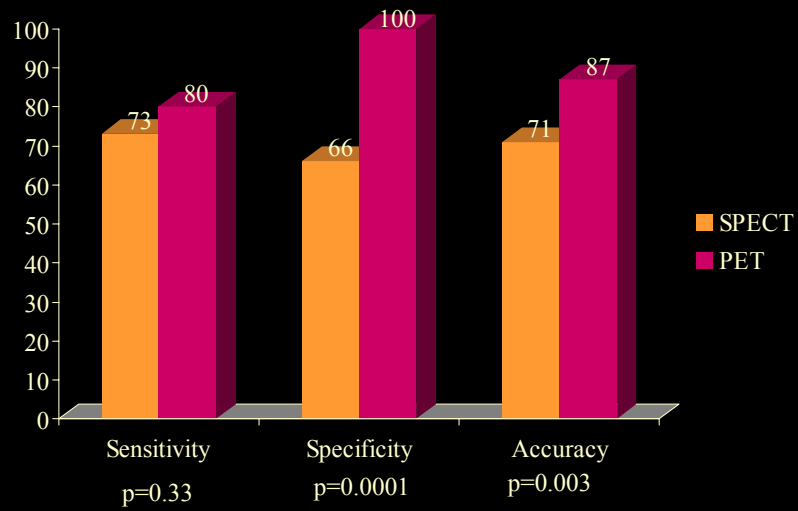
## Image Quality (% excellent)



## Certainty (% definitely nl or abnl)



# Overall Detection of CAD (All Patients)

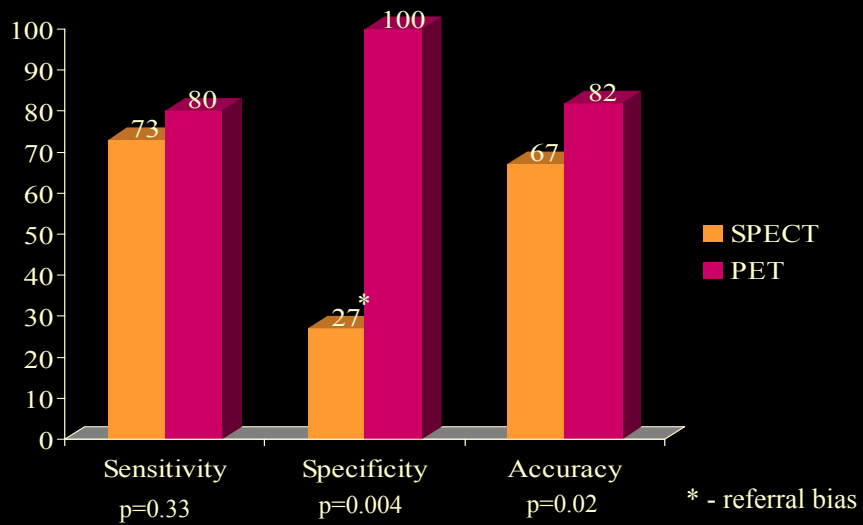


## Detection of Disease by CVT

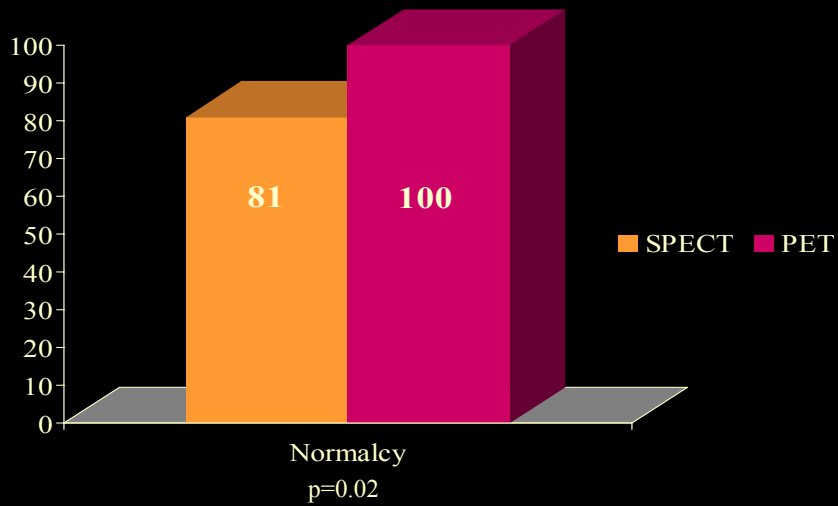
CVT	Modality	Sensitivity	Specificity	Accuracy
LAD	SPECT	61	92	75
	PET	79*	95	87*
LCx	SPECT	33	86	68
	PET	58*	93	79*
RCA	SPECT	60	87	73
	PET	58	100*	78

\* -  $p < 0.05$

## Overall Detection of Disease (Cath Patients, stenoses $\geq 50\%$ )



# Overall Detection of CAD (Low likelihood pts)

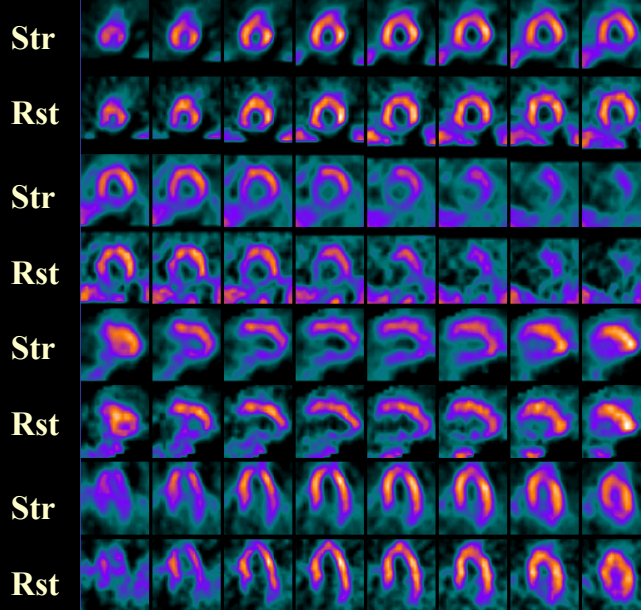


# Clinical Case 1

- **53 yr male**
- **Hx: DM, ESRD**
- **Meds: Ca blocker, nitrates, digoxin, beta blocker**
- **ECG: LVH, repol abn**
- **Indication: evaluate CAD**
- **Stress: IV dipyridamole**
- **Imaging: rest / stress MIBI**

The problems encountered commonly with routine SPECT imaging is illustrated by this example. A 53 year old male with diabetes and end stage renal disease and LVH and repolarization abnormalities on his resting ECG was referred for dipyridamole MIBI SPECT imaging for pre-operative risk evaluation.

## Clinical Case 1 (MIBI str-rst)



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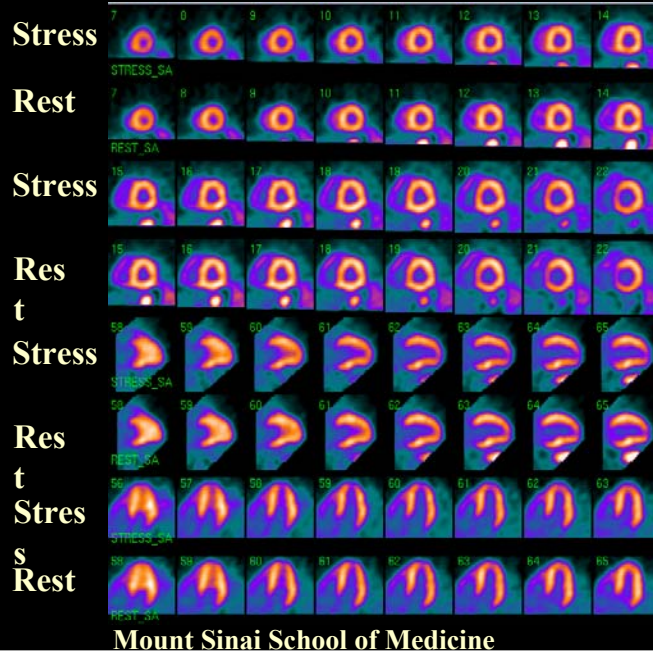
- The stress MIBI SPECT images show a severe inferior defect, moderate apical defects, and a possible mild anterior defect.
- The resting images show no improvement in the inferior wall, mild improvement in the apex, and in the anterior wall.
- The gated SPECT images showed general hypokinesis, particularly in the inferior wall.
- This study was consistent with inferior wall scarring, and mild apical and possibly anterior wall ischemia.

# Clinical Case 1

- **Rest / stress Rb PET MPI study**
- **ECG: NSR, dilated LA, LVH, NSST-T wave abn.**
- **Stress: IV dipyridamole**

The patient underwent a dipyridamole rest and stress CardioGen-82 PET imaging study within a short time.

## Clinical Case 1 CardioGen-82 PET



The stress and rest CardioGen-82 PET images showed uniform distribution. The study was considered normal.

# Clinical Case 1

- **Coronary angiography**
  - **Results: normal coronary arteries. Mild LV dysfunction**

- This patient nonetheless underwent coronary angiography, which showed normal coronary arteries, with mild diffuse LV dysfunction, confirming the diagnosis of mild cardiomyopathy, probably due to chronic hypertension.
- The abnormalities seen on SPECT images appeared to be due to attenuation artifact.

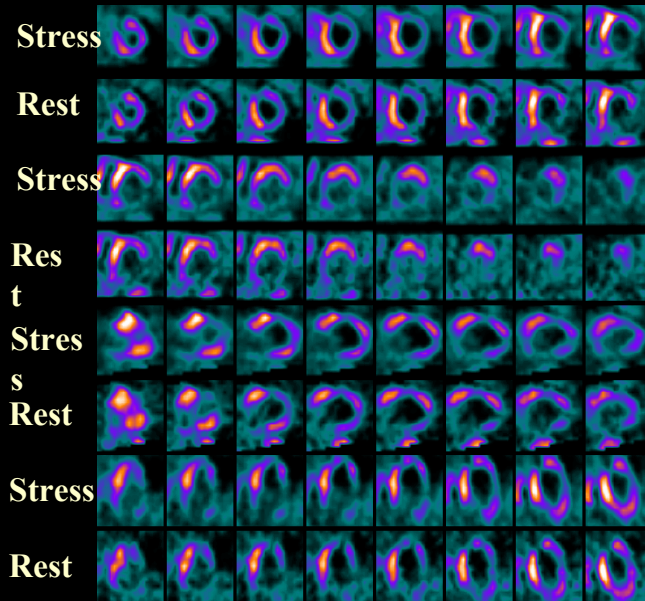
## Clinical Case 2

- 49 year old male
- Hx: CHF, MI, s/p CABG, s/p stent
- Meds: ACE, ASA, Statin
- ECG: NSR, inferior/lateral Q waves, NSSTTW abn
  
- 12/01 Exercise MIBI SPECT imaging study
- 01/02 Dipyridamole stress/rest Rb-82 and FDG PET

The next example is that of a 49 year old male, with history of MI in the past, CABG, stenting and congestive heart failure.

- The patient had inferior and lateral Q waves on his resting ECG.
- The patient underwent an exercise MIBI SPECT imaging study.

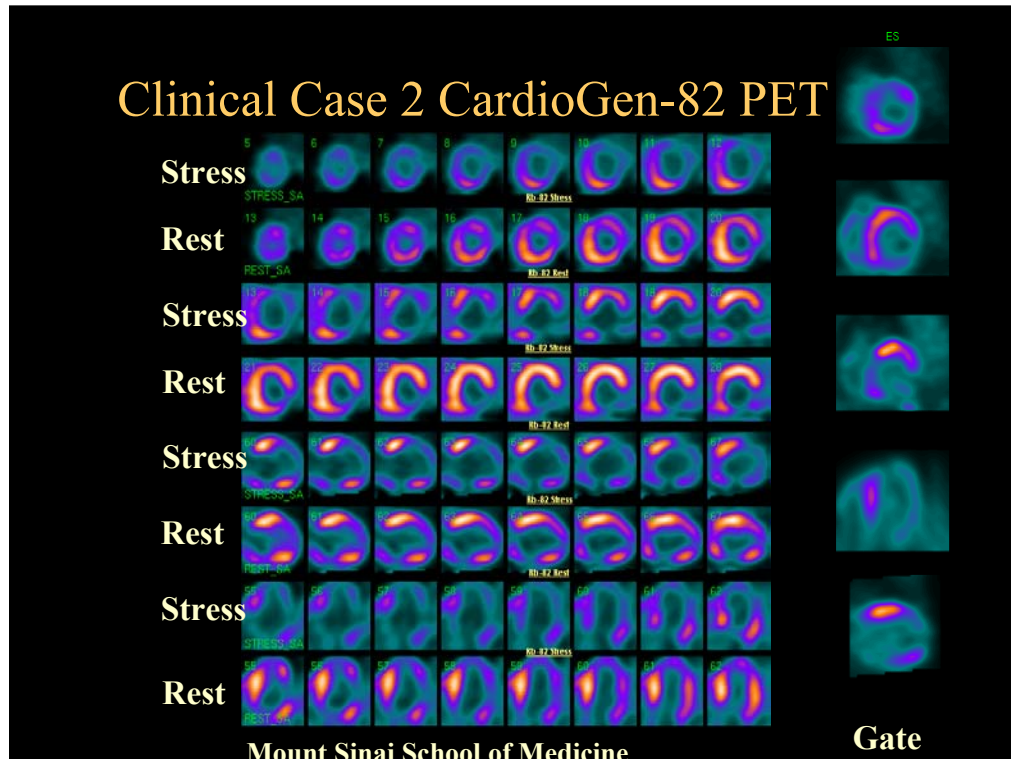
## Clinical Case 2 (MIBI str-rst)



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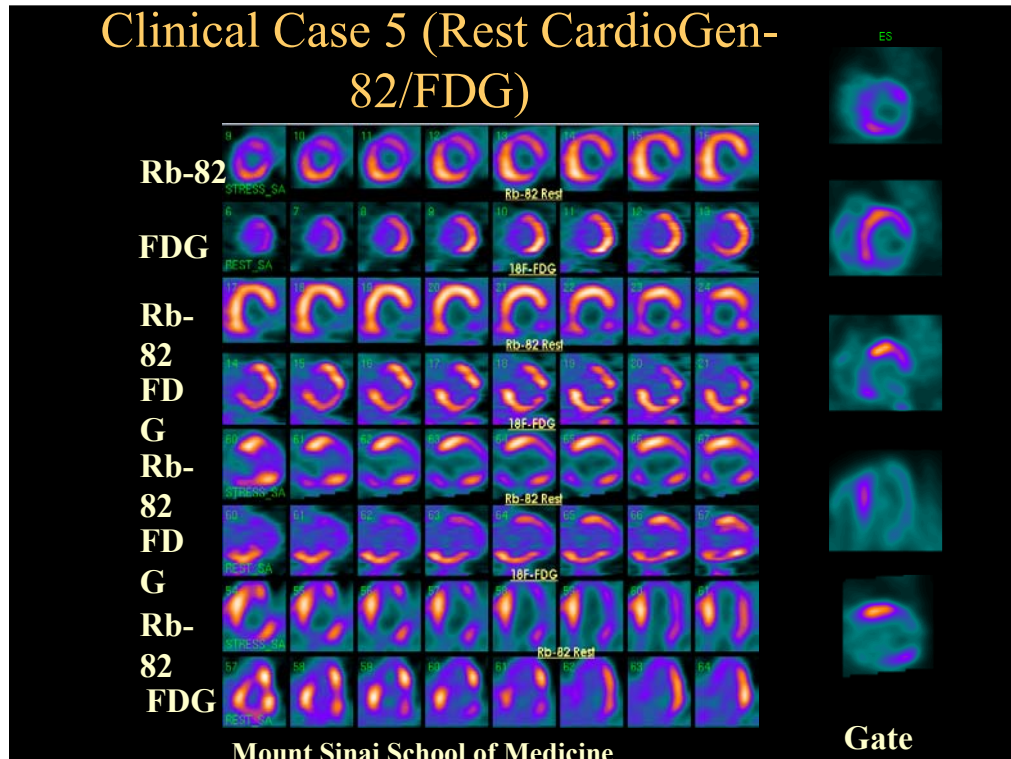
- The stress MIBI images showed severe apical, anterior, lateral, and inferior defects.
- On the rest MIBI images, there was no improvement.
- This was consistent with extensive severe scarring, and no evidence of stress-inducible ischemia.

## Clinical Case 2 CardioGen-82 PET



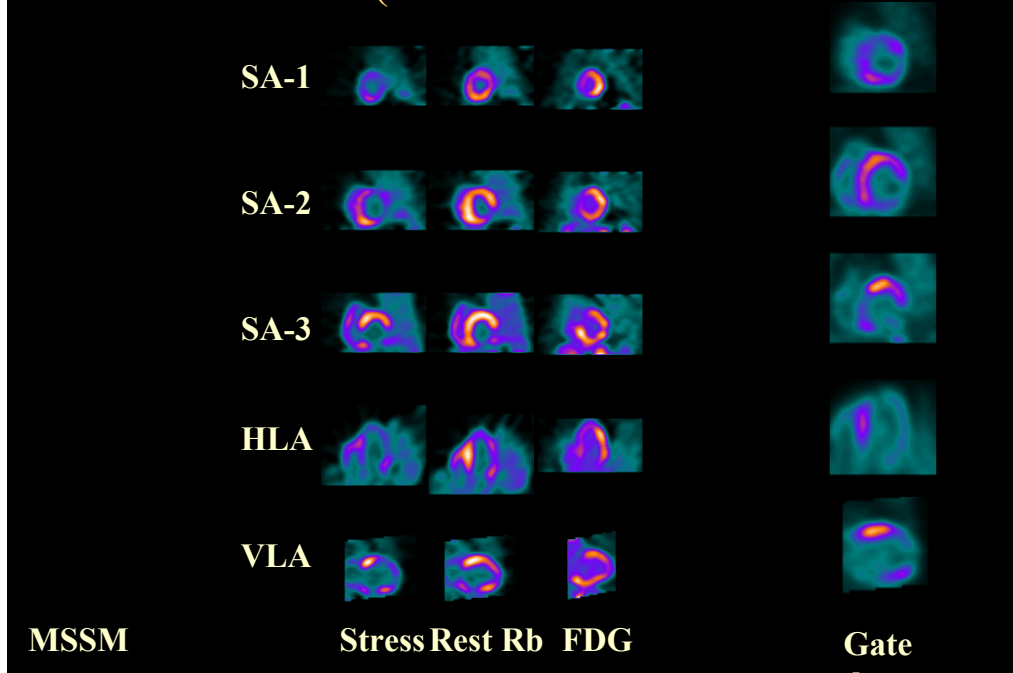
- Less than two months later, with no change in the patient's clinical status, the patient underwent CardioGen-82 PET imaging for viability.
- The dipyridamole stress CardioGen-82 images showed severe apical, anterior, lateral and posterior defects, and a moderate to severe septal defect.
- The extent of stress-inducible ischemia was at least 50% of the myocardium.
- The resting images showed marked anterior, septal and anterolateral improvement, and mid-inferior improvement.

## Clinical Case 5 (Rest CardioGen-82/FDG)



- The FDG PETimages showed preserved or increased activity in the anterolateral, lateral inferior and posterior walls, demonstrating a classical mismatch pattern in these regions, occupying at least 50% of the myocardium.
- The end-result is that about 75% of the myocardial mass shows either stress-inducible ischemia, or hibernation, including most of the regions considered scarred by MIBI SPECT imaging.

## Clinical Case 2 (str-rst CardioGen-82/FDG)



These are selected short axis (SA-1, SA-2, SA-3), the horizontal long axis, and vertical long axis cuts from the same patient.

	<b>PET/CT MPI</b>	<b>SPECT MPI</b>
Sensitivity	95	89
Specificity	95	86
Normalcy	100	95
Resolution/Contrast	5-8 mm/1.5M cts	15-18 mm/40M cts
Time of Study	25 minutes	2 hours
False-positives	±	+++
Radiation exposure	1040 mR	4700 mR
24 x 7 Isotope	Yes	No
Integrated Imaging	Yes	No
Quantitative MBF	Yes	No

# Advantages of PET/CT MPI

- Isotope is always available
- Ventricular function with ECG-gating
- Quantitative myocardial blood flow & flow reserve
- Integrate perfusion data with coronary anatomy (CTA)
- Other PET modalities: F-18 FDG, PET probes & new high energy isotopes