Nuclear Cardiology and Cardiac CT
Present and Future

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Director, Cardiac Imaging
Cedars-Sinai Heart Institute

Kaiser
2011

Professor of Medicine
David Geffen School of Medicine at UCLA
DISCLOSURE

Daniel S. Berman, M.D.

declares the following relationships:

Consultant:
  Lantheus Medical Imaging
  Astellas
  Gilead
  Cardium Therapeutics

Grants
  Lantheus, Siemens, GE, Astellas

Equity
  Cedars-Sinai Software Royalties
  Spectrum-Dynamics
Noninvasive Imaging in CAD

- Identify patient in need for specific therapy
  - Prevention
  - Diagnosis
  - Guiding management
- Contain rising costs
Radiation dose

The New York Times

Health

THE CONSUMER
With Rise in Radiation Exposure, Experts Urge Caution on Tests
By RONI CARYN RABIN
Published: June 19, 2007

Advances in radiology have radically transformed medical practice, with CT scans and nuclear medicine exams providing physicians with the ability to quickly pinpoint internal bleeding, diagnose kidney stones or confirm appendicitis, assess thyroid function and identify and open blockages in the blood vessels to the heart.

The downside is that Americans are being exposed to record amounts of ionizing radiation, the most energetically damaging and potentially hazardous form of radiation.

According to a new study, the percentage of radiation from clinical imaging exams has increased almost 600 percent from the past, natural background radiation of human exposure; that has been driven by imaging procedures, the authors say.

Los Angeles Times

HEALTH

Too much radiation from medical testing?
August 26, 2009 | 4:22 pm
Coronary CTA 2011

- High resolution
- Low radiation (<1 mSv)

Courtesy of S Achenbach
New Detector Material

HD/HR/Standard/30% ASIR  HD/HR/Detail/30% ASIR

0.23 mm spatial resolution
Positive remodeling (+), Soft plaque (+),
Fibrous plaque (+), Calcification (-)

Motoyama et al. JACC 2007;50:319-26
% of Patients Subsequently Having ACS
Adverse Plaque Features (F) on CCTA

Adverse features (F):
positive remodeling
low-attenuation plaques

1,059 pts with CCTA followed up for 27 10 mo
ACS developed in 15 patients.
None had >75% stenosis in the culprit lesion at time of CCTA
Motoyama et al. JACC 2009;54:49-57
Cardiac CT

Strengths

• 3D high spatial resolution
• Non-contrast: proven role of CAC for prevention
• Contrast: CCTA
  – Highest sensitivity and specificity for CAD
  – Strong prognostic value

Weaknesses

• Densely calcified plaques: nondiagnostic
• Dependence on low HR and regular rhythm
• Uncertainty of functional stenosis
Very low-dose Tc-99m Stress Only Protocol by High-Speed MPI (<1 mSv)

Tc-99m tetro/mibi (3 mCi)

End of procedure

REST

STRESS

12 min

Courtesy of A. Einstein, MD, PhD

Tim Bateman, et al
Automatic Quantitative Analysis of SPECT/PET

4D M-SPECT

Emory Cardiac Tool Box

Cedars-Sinai QGS/QPS/QPET
Automatic Quantitative Analysis of SPECT/PET

4D M-SPECT

Emory Cardiac Tool Box

Cedars-Sinai QGS/QPS/QPET

Reproducible automated assessment will become routine
Total Perfusion Deficit (TPD)*
Combines Defect Extent & Severity

Changes in Analytic Software
Automatic Total Perfusion Deficit

New CZT Cardiac SPECT Systems

CZT Detectors
No PMT
spatial resolution
energy resolution
smaller size
Thallium Stress DI

Vitals
- 6’0” / BMI – 75.9
- Reason for test:
  - Pre-Op- Bariatric Surgery
  - R/O CAD

Study
- No walk Adenosine
- 6 Min-TL Stress / 6 Min Tc Rest
- 4 mCi TI/ 40 mCi Tc- Sestamibi

560 lb
55 year old male
Very low-dose Tc-99m Stress Only Protocol by High-Speed MPI (<1 mSv)

Tc-99m tetro/mibi (3 mCi) → End of procedure

STRESS → REST → MPI

12 min

A. Einstein, MD, PhD, Tim Bateman, et al
MBF Assessment With Rb-82 PET

Impaired Myocardial Flow Reserve (MFR) on Rb-82 PET Predicts Adverse Outcomes

619 patients; median follow-up: 387 days
Ziadi, et al, JACC 2011
Reclassification of Cardiac Death Risk by Rb-82 PET Coronary Flow Reserve (CFR)

2783 patients; median f/u: 1.4 years  
Murthy V L et al. Circulation 2011
Nuclear Cardiology

Strengths

• High technical success rate
• Objective measurements of perfusion and function
• Documented for risk-stratification/management
• Validated for myocardial viability

Limitations

• No detection of early atherosclerosis*
• Frequently underestimates extent of ischemia/CAD

*unless hybrid with routine coronary calcium scanning
Nuclear Cardiology and Cardiac CT

- Asymptomatic Prevention
- Symptomatic Diagnosis
- Known disease Intervention
Framingham Risk Score (FRS): Limitations

- Not included
  - Important risk factors:
    - Family history
    - Activity, fitness
    - Obesity
      - Chronicity of risk factors (RF)
      - Magnitude of RF over time (smoking, BP)
- Based on volunteers not patients
- Risk score ≠ disease marker
Coronary Artery Calcification (CAC)

- CAC: a marker of CAD
  - extent of coronary atherosclerosis built up over lifetime
- Overcomes the limitations of FRS
CCS 502 99th percentile
Near- & Long-Term Survival by CAC Score
Nashville, TN and Los Angeles, CA

n=10,377

n=25,257

CAC Score Difference

$\chi^2=1503$, $p<0.0001$, interaction
$p<0.0001$

Budoff, et al
JACC, 2007
CAC 0 vs CAC >0 in Asymptomatic Patients

Risk Ratio for Events

Sarwar, et al JACC Imaging 2009
NIH-NHLBI Multiethnic Study of Atherosclerosis

MESA: Coronary Calcium as Predictor of CV Events in 4 Ethnic Cohorts

6,724 asymptomatic subjects ages 45-84 y

Detrano NEJM 2008;358:1336-45.
NIH-NHLBI Multiethnic Study of Atherosclerosis
MESA: Coronary Calcium as Predictor of CV Events in 4 Ethnic Cohorts
6,724 asymptomatic subjects ages 45-84 y

Incremental prognostic value over FRS in all ethnicities

Detrano NEJM 2008;358:1336-45.
Net Reclassification Index (NRI)*

- NPI = Net proportion of with and without events correctly reclassified as high and low risk

*Clinically intuitive alternative to ROC curve area

NRI in MESA

– Overall population: NRI .25
  • Additional 23% of pts with CHD events classified as high risk
  • Additional 13% of pts without CHD events classified as low risk.

5,878 pts: 5.8 year follow-up; 209 CHD events
Polonsky et al. JAMA 2010;303:1610
NRI in MESA

– Overall population: NRI .25
  • Additional 23% of pts with CHD events classified as high risk
  • Additional 13% of pts without CHD events classified as low risk.

– Subjects with intermediate risk (3-10% 5 year risk): NRI .55 (29% up and 26% down)

5,878 pts: 5.8 year follow-up; 209 CHD events
Polonsky et al. *JAMA* 2010;303:1610
**Early Identification of Subclinical Atherosclerosis by Noninvasive Imaging Research (EISNER) Trial**

- **2047 eligible patients**
  - Randomized in 2:1 ratio
  - **675 assigned to no-scan group**
    - 584 had 4 year clinic evaluation
      - 52 (7.7%) lost to f/u
      - 4 (0.6%) died
  - **1372 assigned to CAC scan group**
    - 1256 had for 4 year clinic evaluation
      - 61 (4.5%) lost to f/u
      - 17 (1.2%) died
Primary Endpoint: Change in Framingham Risk Score

Scan vs No-Scan favorable Δ in:
- SBP (p=0.02)
- LDL-Cholesterol (p=0.04)
- Waist Circumference for those w/ ↑ abdominal girth (p=0.01)
- Weight Loss (among overweight) (p=0.07)

Rozanski JACC 2011;57:1622-1632.
EISNER Trial

**Primary Endpoint:**
Change in Framingham Risk Score

- Scan vs No-Scan favorable $\Delta$ in:
  - SBP ($p=0.02$)
  - LDL-Cholesterol ($p=0.04$)
  - Waist Circumference for those w/ ↑ abdominal girth

No increase in overall cost: Higher costs in high calcium score patients balanced by lower costs in the CAC 0 group

Rozanski JACC 2011;57:1622-1632.
CAC may lead to better treatment / lifestyle:

- Improvement in risk factor profile\(^1\)
- Intensification of Rx\(^2\)
- Better adherence to Rx\(^3\)
- Dietary modifications\(^4\)
- Increased exercise\(^4\)

\(^1\) Rozanski et al, JACC 2011 (EISNER Study)
\(^2\) Nasir K et al, Circ Cardiovasc Qual Outcomes 2010 (MESA)
\(^3\) Kalia NK et al, Atherosclerosis. 2006
\(^4\) Orakzai RH et al, Am J Cardiol 2008
The 2nd SHAPE Guideline
Society for Heart Attack Prevention and Eradication (SHAPE)

Apparently Healthy Men 45-80yr and Women 55-80yr

Calculate 10yr Risk using Risk Calculators such as Framingham Risk Score

Step 1

Notest: Follow Preventive Recommendations as in Low Risk

Diabetics >40yr or family history of premature coronary artery disease

Atherosclerosis Test

Step 2

Carotid IMT & Plaque

CIMT <75th% or Plaque<1.5mm

Coronary Artery Calcium Scan (CACS)

Step 3

Very Low Risk

Low Risk

Intermediate Risk

High Risk

CACS =0

CACS <100 & <75th%

CACS 100-399 & <75th%

CACS ≥400 or ≥75th%

+++++

+++++

+++++

+++++

<160 mg/dl

<130 mg/dl

<100 mg/dl

<75 mg/dl

No RX

Rx

Rx

Intensive RX

See the SHAPE II Task Force report for further cardiac imaging tests in selected High Risk individuals.

1 Elevate to High Risk if 1.4<Ankel Brachail Index<0.9

2 Elevate to High Risk if 1.4<Ankel Brachail Index<0.9
Nuclear Cardiology and Cardiac CT

Screening for Subclinical Atherosclerosis

- CT coronary calcium: effective
  - Class IIa ACC/AHA prevention guidelines (2010) (including diabetics)
- Coronary CTA: uncertain role at present
- No primary role for nuclear cardiology
Nuclear Cardiology and Cardiac CT

Screening for Subclinical Atherosclerosis

- CT coronary calcium: effective
  - Class IIa ACC/AHA prevention guidelines (2010) (including diabetics)
- Coronary CTA: uncertain role at present
- No primary role for nuclear cardiology
- Stress imaging: useful for guiding management when CCS is high (~10%)
Nuclear Cardiology and Cardiac CT

• Asymptomatic Prevention
• Symptomatic Diagnosis
• Known disease Intervention
• ACC National Cardiovascular Data Registry
• 397,954 patients with elective cath (663 hospitals)
• 37.6% had obstructive CAD (>70% stenosis)

Patel et al. NEJM 2010;362:886-95
• ACC National Cardiovascular Data Registry
• 397,954 patients with elective cath (663 hospitals)
• 37.6% had obstructive CAD (>70% stenosis)

Patel et al. NEJM 2010;362:886-95
## Diagnosis of obstructive CAD

<table>
<thead>
<tr>
<th>Test</th>
<th>Sensitivity</th>
<th>Specificity</th>
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</thead>
<tbody>
<tr>
<td>Exercise ECG treadmill</td>
<td>68%</td>
<td>77%</td>
</tr>
<tr>
<td>Exercise Echo treadmill</td>
<td>86%</td>
<td>81%</td>
</tr>
<tr>
<td>Dobutamine Echo</td>
<td>~85%</td>
<td>~85%</td>
</tr>
<tr>
<td>Exercise nuclear treadmill</td>
<td>87%</td>
<td>73%</td>
</tr>
<tr>
<td>Pharmacologic nuclear</td>
<td>89%</td>
<td>75%</td>
</tr>
<tr>
<td>Coronary CTA</td>
<td>95%</td>
<td>83%</td>
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</tbody>
</table>

1. ACC/AHA 2002 Guideline Update for Exercise Testing
2. ACC/AHA/ASE 2003 Guideline Update for the Clinical Application of Echocardiography
3. ACC/AHA/ASNC Guidelines for the Clinical Use of Cardiac Radionuclide Imaging
4. ACCURACY study
Coronary CTA

• Sensitivity and specificity: ~ 95%/90%
• Higher than all other modalities
  – Per patient
  – Per vessel
  – Per segment
Coronary CTA

- Sensitivity and specificity: ~ 95%/90%
- Higher than all other modalities
  - Per patient
  - Per vessel
  - Per segment
- Very unlikely to miss high risk disease
64-slice Coronary CTA

- Sensitivity and specificity: ~ 95%/90%
- Higher than all other modalities
  - Per patient
  - Per vessel
  - Per segment
- Very unlikely to miss high risk disease
- Very high negative predictive value for events
Point of view: In SYMPTOMATIC patients:
• CCTA will become a common initial test in intermediate likelihood of CAD:
  • ~10% will need further ischemia testing
CONFIRM Registry
(COronary CT evaluationN For clinical outcomes: An InteRnational Multicenter registry)

Results from the multinational CONFIRM Registry

James Min, MD
Principal Investigator

27,000 patients November 2010
CONFIRM Registry:
K-M Survival by Per-Vessel Obstructive CAD

Survival Probability vs. Survival Time (Years)

- Normal
- Non-Obstructive (p<0.0001)
- 1-Vessel CAD (p<0.0001)
- 2-Vessel CAD (p<0.001)
- 3-Vessel/Left Main (p<0.0001)

Source: Min et al. J Am Coll Cardiol 2011
Comparison of observed Ob-CAD prevalence in MEN to probabilities based on DFC and CASS

<table>
<thead>
<tr>
<th>Age (years)</th>
<th>Nonanginal Chest Pain</th>
<th>Atypical Angina</th>
<th>Typical Angina</th>
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</thead>
<tbody>
<tr>
<td>30-39</td>
<td>Observed prevalence</td>
<td>DFC and CASS</td>
<td></td>
</tr>
<tr>
<td>40-49</td>
<td>Observed prevalence</td>
<td>DFC and CASS</td>
<td></td>
</tr>
<tr>
<td>50-59</td>
<td>Observed prevalence</td>
<td>DFC and CASS</td>
<td></td>
</tr>
<tr>
<td>60-69</td>
<td>Observed prevalence</td>
<td>DFC and CASS</td>
<td></td>
</tr>
<tr>
<td>70+</td>
<td>Observed prevalence</td>
<td>DFC and CASS</td>
<td></td>
</tr>
</tbody>
</table>

CONFIRM: Cheng et al Circulation 2011
Comparison of observed Ob-CAD prevalence in MEN to probabilities based on DFC and CASS

CONFIRM: Cheng et al Circulation 2011
Pre-test likelihood of CAD

- Low (<15%)
- Intermediate (15%-85%)
- High (>85%)

Symptomatic

1. Prevention
2. Prevention
Catheterization +/- Revasc.
Pre-test likelihood of CAD

Low (< 15%)

Intermediate (15% - 85%)

High (> 85%)

CTA

Symptomatic

NL

1  Prevention

2  Prevention

Catheterization +/- Revasc.
Pre-test likelihood of CAD

- Low (< 15%)
- Intermediate (15% - 85%)
- High (> 85%)

Symptomatic

- CTA
- Prevention

Likely 10 year warranty with normal CCTA

- Prevention
- Prevention
- Catheterization +/- Revasc.
Pre-test likelihood of CAD

Low (<15%)
Intermediate (15% - 85%)
High (>85%)

Symptomatic

CTA

NL
ABNL*

*No critical stenosis

1 Prevention
2 Prevention
Catheterization +/- Revasc.
Pre-test likelihood of CAD

Low (< 15%)

Intermediate (15% - 85%)

High (> 85%)

Symptomatic

CTA

NL

ABNL*

Equiv

1 Prevention

2 Prevention

*Catheterization +/- Revasc.

*No critical stenosis
Pre-test likelihood of CAD

Low (< 15%)

Intermediate (15% - 85%)

High (> 85%)

Symptomatic

CTA

NL

ABNL*

Equiv

*No critical stenosis

1 Prevention

2 Prevention

Catheterization +/- Revasc.
Predictive Value by Five Studies for CTA to Detect Ischemia with MPI Perfusion

Hachamovitch et al. *JNC* 2007;14:634-44
Need for Ischemia Testing after CCTA
Most Common Circumstances

• Borderline stenosis (50-69%)
• Non-diagnostic CCTA
  – Dense coronary calcium
  – Other artifact (motion, arrhythmia)
Pre-test likelihood of CAD

Low (< 15%)
- CTA
  - NL
  - ABNL*
    *No critical stenosis
  - Equiv

Intermediate (15% - 85%)
- Symptomatic
  - 1 Prevention

High (> 85%)
- Stress SPECT/PET
  - 2 Prevention
  - Catheterization +/- Revasc.
Pre-test likelihood of CAD

- Low (< 15%)
  - CTA
    - NL
    - ABNL*
    - Equiv
      - *No critical stenosis

- Intermediate (15% - 85%)
  - Symptomatic
    - Stress SPECT/PET

- High (> 85%)
  - Catheterization +/- Revasc.
Atypical chest pain; hypertension; cholesterol
Medications: Statin, beta blocker
Relationship between Stenosis Severity by CCTA and Ischemia on SPECT MPI

Tamarappoo et al, J Nucl Card 2010;17:791-802
PROspective Multicenter Imaging Study for Evaluation of Chest Pain (PROMISE)

Symptoms suspicious for significant CAD, requiring non-emergent noninvasive testing

Randomization

Anatomic strategy
- 64+ slice CTA

Functional strategy
- Pharmacologic stress imaging
- Exercise ECG or Exercise Imaging

Clinical results immediately available to care team; subsequent testing/mgmt per care team + guideline care

1° = 30 mo death, MI, complications, UA hosp
2° = MACE components, Costs, QOL

Nuclear Cardiology and Cardiac CT

- Asymptomatic Prevention
- Symptomatic Diagnosis
- Known disease Intervention
Adjusted† Risk of Cardiac Death vs MPS ischemia

Revascularization vs Medical Rx

†Adjusted for predictors of revascularization as well as clinical, hx, stress SPECT data


Adjusted for predictors of revascularization as well as clinical, hx, stress SPECT data

*p<0.001
Adjusted Risk of Cardiac Death vs EF and Ischemia

Revascularization vs Medical Rx

Revascularization: All levels of ischemia

Medical Rx: % ischemic

Hachamovitch, et al
_J Nucl Cardiol_ 2006;13:768-78

⇒ change in risk with revasc
Adjusted ACD Rates as a Function of MPS Results and Post-MPS Rx in the Elderly (≥75)

- **Medical Therapy**
- **Early Revascularization**

<table>
<thead>
<tr>
<th>Condition</th>
<th>Medical Therapy</th>
<th>Early Revascularization</th>
</tr>
</thead>
<tbody>
<tr>
<td>Abnormal, Ischemia (≥15%)</td>
<td>58%</td>
<td>47%</td>
</tr>
<tr>
<td>Abnormal, Ischemia (&lt;15%)</td>
<td>47%</td>
<td>53%</td>
</tr>
<tr>
<td>Abnormal, No Ischemia</td>
<td>50%</td>
<td>77%</td>
</tr>
<tr>
<td>Normal</td>
<td>39%</td>
<td>43%</td>
</tr>
</tbody>
</table>

P for interaction: <0.02

Hachamovitch et al. Circ in press

N=684; f/u: 6.2 2.9 yrs; 320 ACD
Adjusted ACD Rates as a Function of MPS Results and Post-MPS Rx in the Elderly (≥75)

- Medical Therapy
- Early Revascularization

Abnormal, Ischemia (≥15%)
- Medical Therapy: 58%
- Early Revascularization: 47%

Abnormal, Ischemia (<15%)
- Medical Therapy: 47%
- Early Revascularization: 53%

Abnormal, No Ischemia
- Medical Therapy: 50%
- Early Revascularization: 77%

Normal
- Medical Therapy: 39%
- Early Revascularization: 43%

P for interaction: <0.02

N=684; f/u: 6.2 2.9 yrs; 320 ACD

Hachamovitch et al. Circ in press
Therapeutic Benefit among Patients with <10% Myo Fixed

Hachamovitch et al. EHJ 2011

n = 11,880
FU 8.7±3.3 yrs
ISCHEMIA Trial

International Study of Comparative Health Effectiveness with Medical and Invasive Approaches

Study Chair: Judith Hochman
Principal Investigator: David Maron

Sponsor: NHLBI; Submitted: February 2010
ISCHEMIA Trial

≥10% Ischemia*
LVEF ≥35%

Blinded CCTA to R/0 LM, NCA

RANDOMIZE

Cath (Revasc+ OMT)

• 3-6 yr. F/U

No Cath (OMT)

• 3-6 yr. F/U

*SPECT, PET, echo, CMR
Core lab verification

• 8,000 stable CAD patients
• 3-6 yr. F/U
Pre-test likelihood of CAD

- Low (< 15%)
- Intermediate (15% - 85%)
- High (> 85%)

1. Prevention
2. Prevention
Catheterization +/- Revasc.

Stress SPECT/PET
Pre-test likelihood of CAD

Low (<15%)

Intermediate (15%-85%)

High (>85%)

Stress SPECT/PET

- No/minimal ischemia (<5%)
- Mild-Moderate ischemia (5-10%)
- Extensive ischemia (>10%)

ancillary high risk markers?

1 Prevention

2 Prevention

Catheterization +/- Revasc.
Pre-test likelihood of CAD

Low (< 15%)

Intermediate (15% - 85%)

High (>85%)

Stress SPECT/PET

- No/minimal ischemia (<5%)**
- Mild-Moderate ischemia (5-10%)
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ancillary high risk markers?

1 Prevention

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Catheterization +/- Revasc.
Pre-test likelihood of CAD

Low (< 15%)

Intermediate (15% - 85%)

High (> 85%)

Stress SPECT/PET

No/minimal ischemia (<5%)**

Mild-Moderate ischemia (5-10%)

Extensive ischemia (>10%)

? CCTA, cath if high risk suspected

anillary high risk markers?

1 Prevention

2 Prevention

Catheterization +/- Revasc.
Pre-test likelihood of CAD

Low (< 15%)
- CTA/CCS
  - 1 Prevention

Intermediate (15% - 85%)
- CTA/CCS
  - 2 Prevention
- Stress SPECT/PET
  - Equivocal/Discordant

High (>85%)
- Stress SPECT/PET
  - Mild-Moderate ischemia (5-10%)
  - Extensive ischemia (>10%)
  - Catheterization +/- Revasc.
Assessment of Myocardial Viability with FDG PET

Rest MIBI/FDG
13% mismatch
3% match
Increasing Benefit from Revascularization Is Associated with Increasing Amounts of Myocardial Hibernation (A Substudy of the PARR-2 Trial)

Effect of Revascularization or Medical Therapy

182 (of 207) pts (complete data) with LVEF <35% randomized to PET FU 1 yr for cardiac death, MI, or cardiac repeat hospital stay; ↑creat ↓EF also risk predictors

D’Egidio et al. ACCImg2009;2:1060-8
Delayed Enhancement CMR Predicts Functional Recovery in Chronic CAD

Kim et al NEJM, 2000, 343: 1445
Delayed Enhancement CMR Predicts Functional Recovery in Chronic CAD

Kim et al. NEJM, 2000, 343: 1445
Which Test for Assessment of Patient with Atherosclerosis

Asymptomatic (imaging for prevention)
- Coronary calcium scanning

Symptomatic (imaging for diagnosis/intervention)
- Selection of Initial Test Depends on CAD Likelihood
  - Limiting symptoms: Direct catheterization
  - Lower likelihood: favors CTA first
  - Higher likelihood: favors ischemia testing first

Indications for Sequential Imaging
- initial test + clinical evaluation not definitive
Which Test for Assessment of Patient with Atherosclerosis

Known CAD or CHF

• Little data supports the application of coronary CTA in this setting

• Extensive data supports SPECT/PET and MRI:
  • the extent of ischemic myocardium (stress)
  • the extent of dysfunctional but viable myocardium
  • MIBG
  • Phase analysis
Nuclear Cardiology and Cardiac CT

Future Considerations
Adverse Plaque Features (APF) on CCTA

Controlling for stenosis on CCTA.
Ischemia by MPI Increases with Increasing number of APFs

Shmilovich, Cheng, et al., SNM 2010
APFs Predict Ischemia

Shmilovich, Cheng, et al., SNM 2010
Automatic Quantification of Non-Calcified Plaq (AutoPlaq)

Non-calcified plaque

Dey et al. Radiology 2010
Automatic Quantification of Non-Calcified Plaq (AutoPlaq)

Comparison with IVUS (N=22)

Correlation

Bland-Altmanman Comparison

R=0.94, p<0.0001

Dey et al. Radiology 2010
CT Perfusion Defects During Vasodilator Stress: Comparison with SPECT-MPI

Tamarappoo JACC Cardiovascular Imaging, 2010
Comparison of CCO in Arteries With and Without Obstructive Coronary Artery Disease
FFR by CT predicts FFR by ICA

**CCTA**

- >50% diameter stenosis

**FFR\textsubscript{CT}**

- FFR\textsubscript{CT} 0.74 $\rightarrow$ ischemia

**Invasive angiography**

- >50% diameter stenosis

---

**FFR\textsubscript{CT}**

- FFR\textsubscript{CT} 0.85 $\rightarrow$ no ischemia

**PCR**

- >50% diameter stenosis
FFR by CT predicts FFR by ICA
Fewer False Positives than % CT Stenosis

$\text{FFR}_\text{CT}$ offers a four-fold reduction in false positives.
First-pass uptake in isolated rabbit hearts
BMS747158 vs. $^{201}$TI and $^{99m}$Tc-sestamibi

BMS747158 (n=4)
$^{201}$TI (n=3)
$^{99m}$Tc-sestamibi (n=3)

* Indicates $p<0.05$

Stress 7.2 mCi 5 min  Rest 2.3 mCi 10 min
### FINGRE 87 F

#### #5527-1789

<table>
<thead>
<tr>
<th>BMS 7476158</th>
<th>APICAL</th>
<th>MID</th>
<th>BASAL</th>
<th>VLA</th>
<th>HLA</th>
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<tbody>
<tr>
<td>ADENO</td>
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</table>

Berman, et al CSMC
FINGRE

SPECT

PET

RAW

Stress Perfusion (%)

EXTENT

Stress Extent (%)

Stress Extension (%)

Stress Extent (%)

Stress Extent (%)

Figure: 69-year old female patient (weight: 130 lbs, BMI: 23.8) administered with 8.6 mCi of flurpiridaz F 18 injection and acquired in dual -cardiac and respiratory - mode. Short axis, vertical and horizontal axis views of adenosine stress images.
I-123 MIBG Imaging to Predict the Need for ICD

Pt with ICD discharge

Pt without ICD discharge

Arora et al. JNC 2003;10:121-31
MIBG H/M Ratio Predicts Cardiac Death in Patients with Low EF

2-Year Cardiac Mortality Rate (%)

- <1.20: N = 92, p<0.00001
- 1.20 - 1.59: 668, p<0.01
- ≥ 1.60: 201, p<0.01

961 pts with NYHA Class II-III CHF and LVEF ≤ 35%: 2 yr FU

Jacobson et al. ADMIRE-HF JACC 2010.
Imaging Inflamed Plaque to Monitor Therapy

Baseline

Post-Treatment

# Culprit Lesions in ACS

<table>
<thead>
<tr>
<th>ACS: New Stent</th>
<th>Stable Syndrome; Old Stent</th>
<th>Stable Syndrome; New Stent</th>
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<table>
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<th>FDG Uptake</th>
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$p=0.02$

$p=0.006$

I. Rogers et al JACC CV Imaging 2010
Imaging 3 days after PCI to proximal RCA with BMS (Courtesy Le Meunier, PhD)
FDG Visualization of Inflamed Coronary Plaque

Imaging 3 days after PCI to proximal RCA with BMS

Cheng et al JNM under review 2011
Molecular Imaging Across CAD Spectrum

Conventional Imaging

Coronary Atherosclerosis

Coronary Calcium/Plaque

Stenosis/Perfusion

Myocardial Ischemia/Infarction

Heart Failure

Function Geometry

Guiding Specific therapy

Remodeling

Disease Activity Plaque Vulnerability

Molecular Imaging

Coronary Atherosclerosis

Disease Activity Plaque Vulnerability