

Diagnosis of Coronary Artery Disease: Computed Tomography



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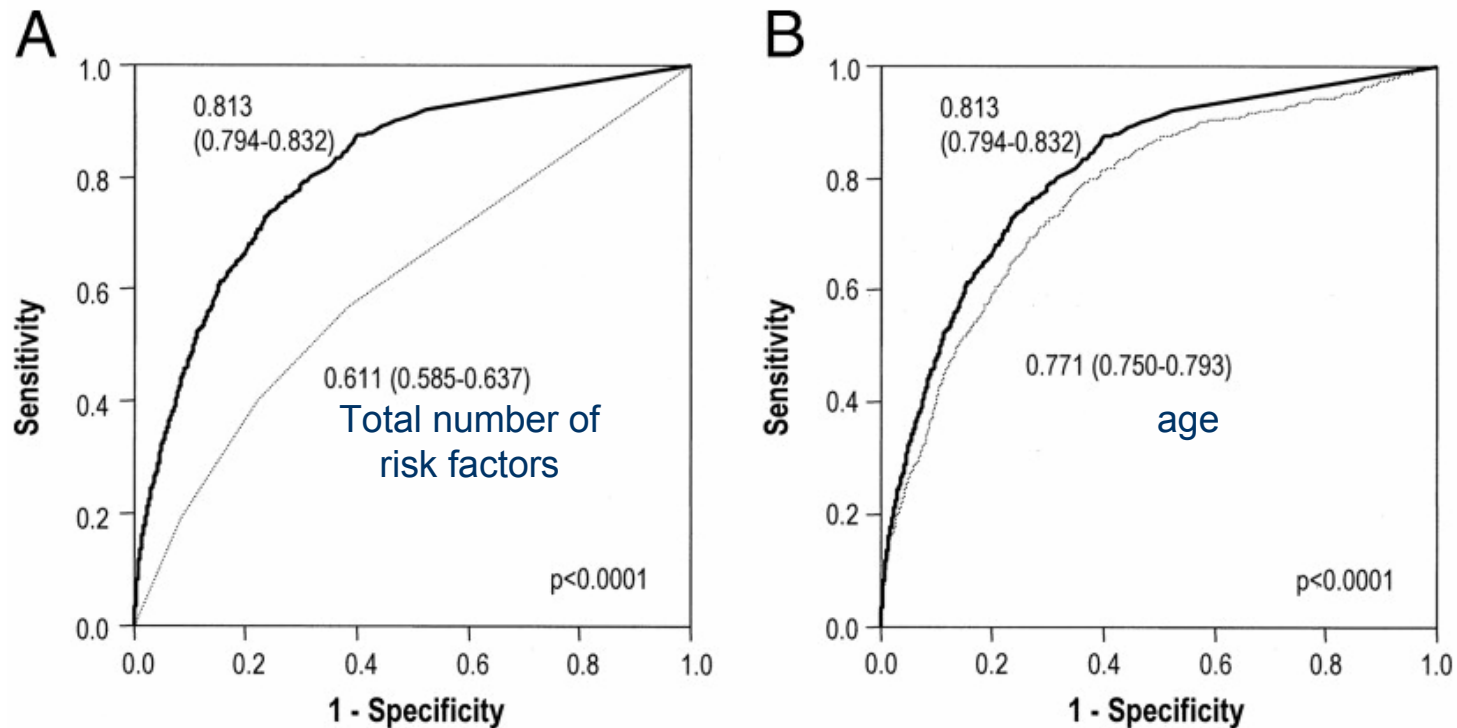
Noninvasive Diagnosis of CAD

- Detection of hemodynamic consequences (“ischemia”)
 - Nuclear imaging, stress Echo or MRI
- Detection of atherosclerosis
 - CAC scoring
 - CCTA

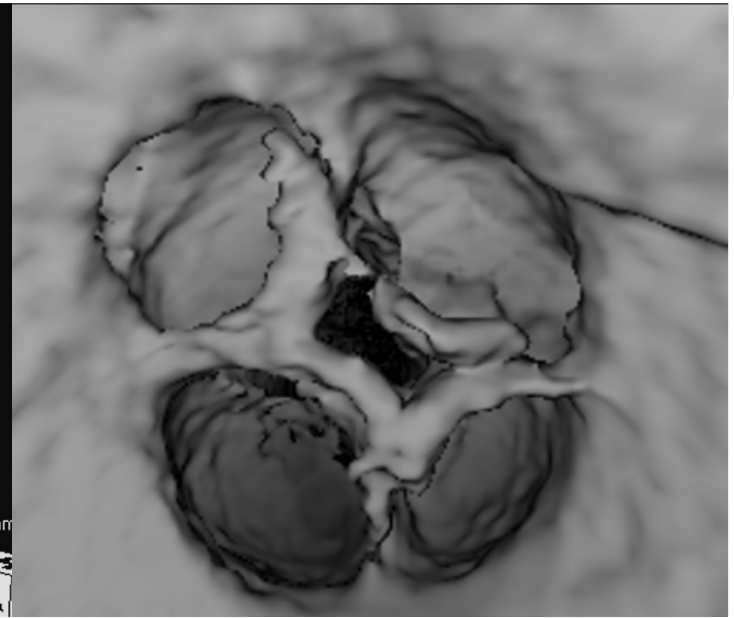
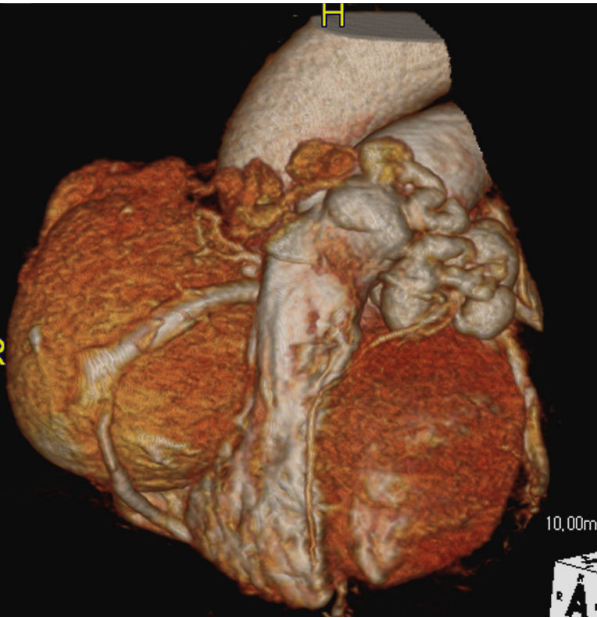
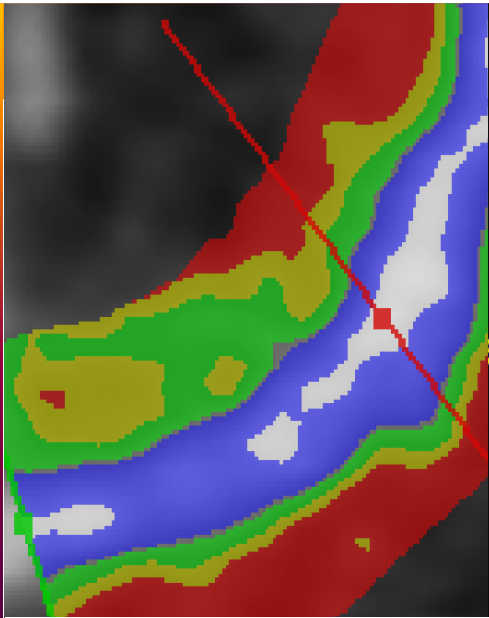
Value of CAC scoring

- CAC \approx total atherosclerotic plaque burden
- Not site-specific
- Independent incremental information in addition to traditional risk factors for prediction of all-cause mortality
- Most useful for prognostification rather than detection of CAD

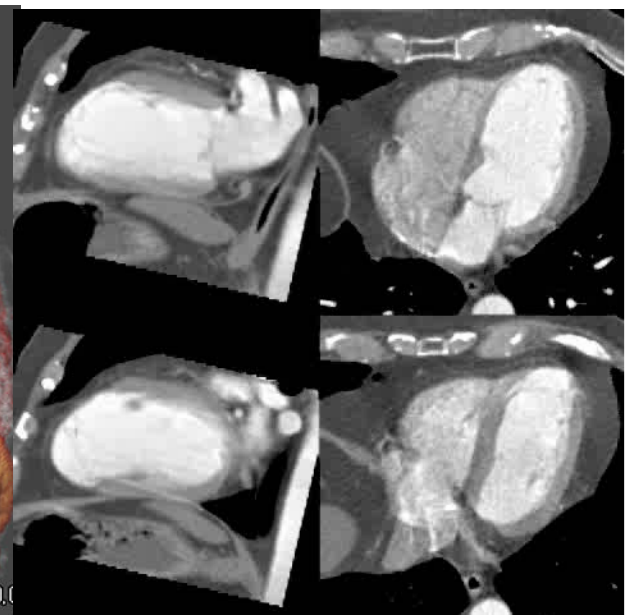
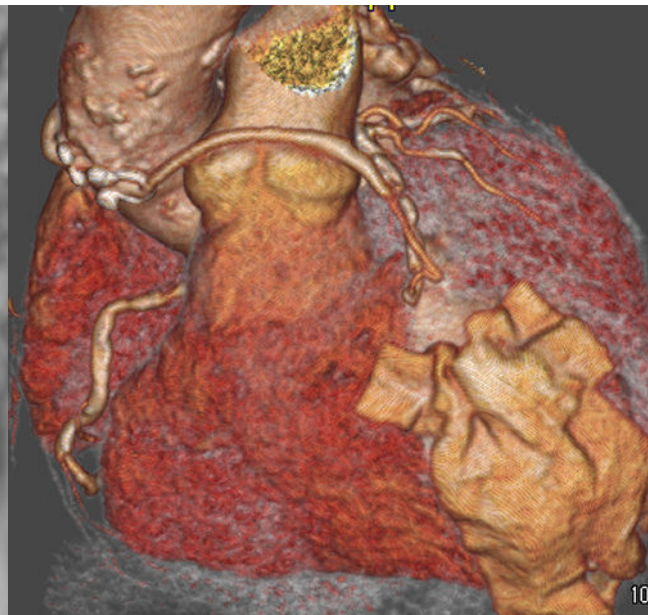
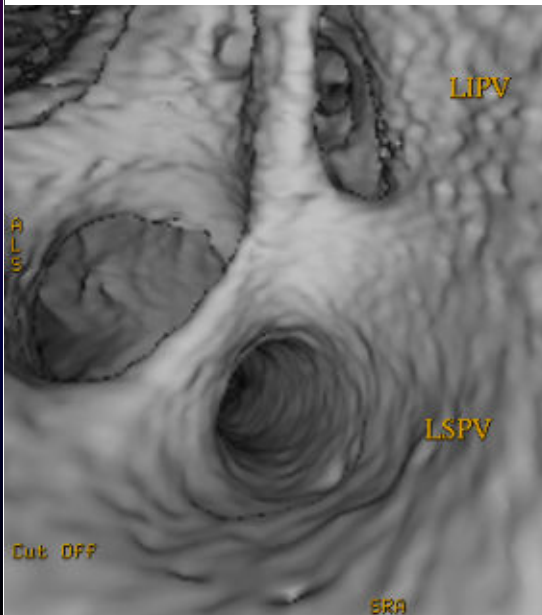
Value of CAC scoring



From a registry of 25,253 patients
C-index; CAC 0.757, age 0.771, gender <math>< 0.586</math>, FHx 0.440,
smoking 0.573, DM 0.577, ethnicity 0.518, hyperlipidemia 0.484,
HTN 0.562



Computed Tomography



Value of Cardiac MDCT

- Assessment of coronary artery stenosis
- Plaque imaging
 - Plaque composition
 - Total plaque burden
- Additional information
 - It's just not coronaries!
 - Cardiac/Extracardiac

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Pooled Sensitivity and Specificity and Overall Diagnostic Performance of Multidetector CT Angiography according to Type of Analysis and CT Scanner

| Analysis and CT Scanner Type | No. of Studies | Combined Data* | Sensitivity [†] | Specificity [†] | <i>D</i> Value [†] |
|------------------------------|----------------|----------------|--------------------------|--------------------------|-----------------------------|
| Per-segment analysis | | | | | |
| Four detector | 18 | 8209 | 0.84 (0.81, 0.88) | 0.93 (0.91, 0.95) | 4.47 (4.00, 4.94) |
| 16 detector | 25 | 17 340 | 0.83 (0.76, 0.90) | 0.96 (0.95, 0.97) | 5.00 (4.26, 5.74) |
| 64 detector | 6 | 5030 | 0.93 (0.88, 0.97) | 0.96 (0.96, 0.97) | 5.78 (4.96, 6.60) |
| Per-vessel analysis | | | | | |
| Four detector | 3 | 491 | 0.87 (0.78, 0.96) | 0.87 (0.73, 1.00) | 3.97 (2.09, 5.85) |
| 16 detector | 6 | 1601 | 0.93 (0.89, 0.97) | 0.92 (0.89, 0.96) | 4.88 (3.93, 5.84) |
| 64 detector | 2 | 597 | 0.95 (0.91, 0.99) | 0.93 (0.90, 0.95) | 5.51 (4.54, 6.48) |
| Per-patient analysis | | | | | |
| Four detector | 7 | 357 | 0.91 (0.87, 0.95) | 0.83 (0.68, 0.99) | 3.41 (2.46, 4.37) |
| 16 detector | 11 | 704 | 0.97 (0.94, 0.99) | 0.81 (0.72, 0.90) | 4.06 (3.00, 5.12) |
| 64 detector | 6 | 363 | 0.99 (0.97, 1.00) | 0.93 (0.89, 0.98) | 5.00 (3.89, 6.11) |

* Data are the combined number of segments, vessels, or patients from the studies included in the per-segment, per-vessel, or per-patient analysis, respectively.

[†] Data are proportions. Numbers in parentheses are 95% confidence intervals (CIs). *D* = log of diagnostic odds ratio.

Current status of MDCT in assessing CAD

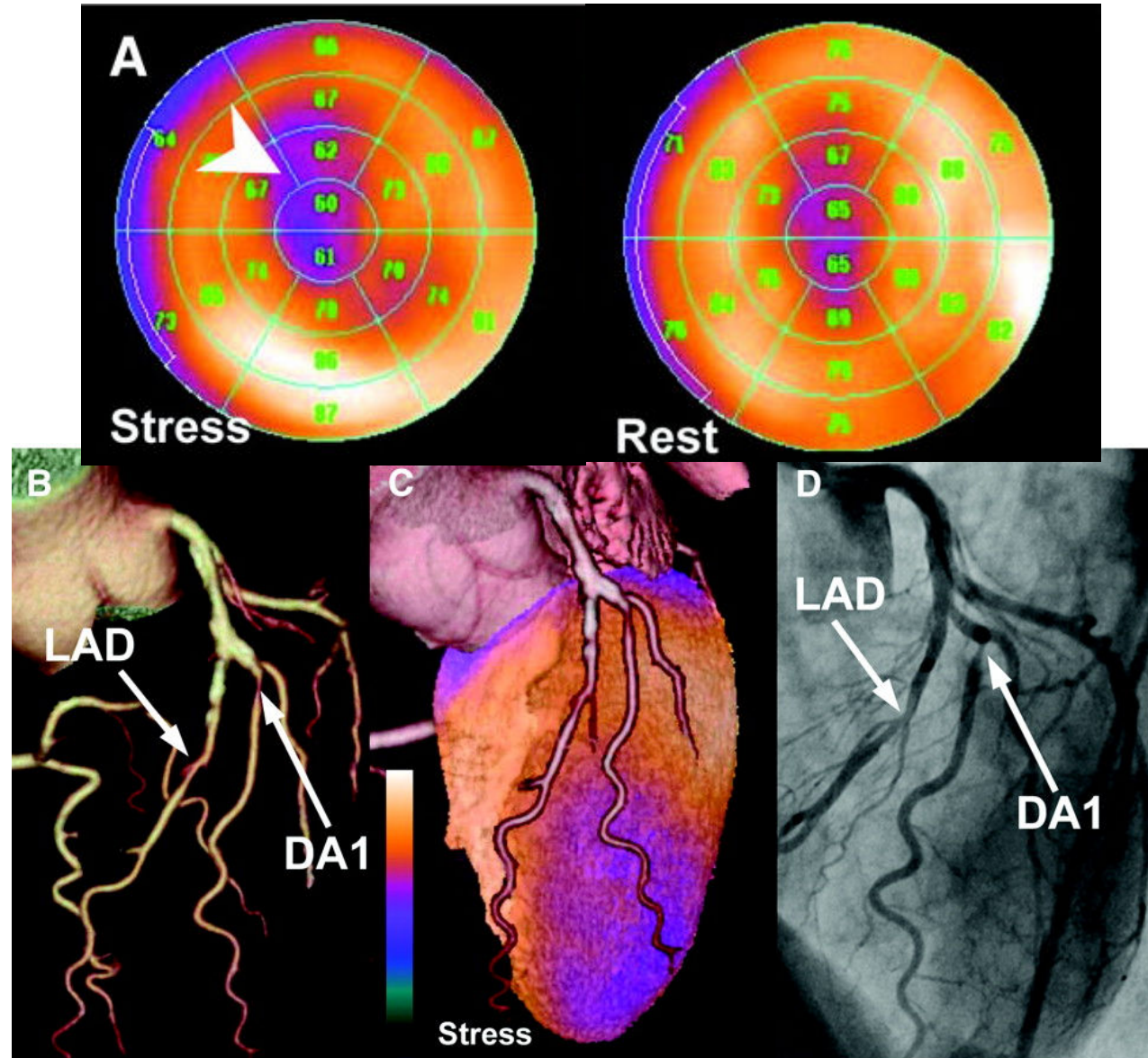
- ↑ detector number
 - ↓ ↓ nonassessable segments
 - ↑ diagnostic performance
- Excellent sensitivity and NPV in patient-based analysis! (MPI- lower specificity)
- Temporal resolution 83ms/ Spatial resolution 0.4mm/ Beta blocker/ Arrhythmia
- Limitation of study population

Coronary CTA for ER patients with chest pain

- 2.1% of AMI, 2.3% of unstable angina mistakenly discharged
- Rubinshtein et al (*Circulation* 2007;115:1762-8)
 - 58 ED patients /c chest pain of uncertain origin
 - Dx of ACS; sens 100%, spec 92%, PPV 87%, NPV 100%
 - During f/u(15mo)- no MACE in 35 pts discharged from ED after initial triage
 - CT provides early direct PCI

Real Culprit lesion?

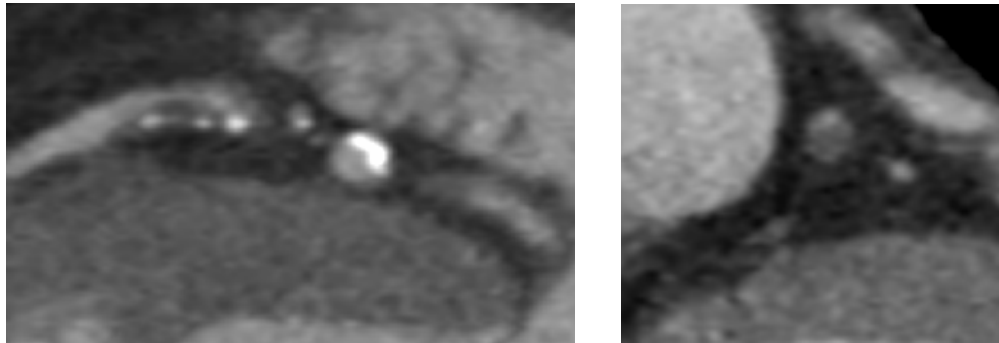
Cardiac SPECT/CT Fusion



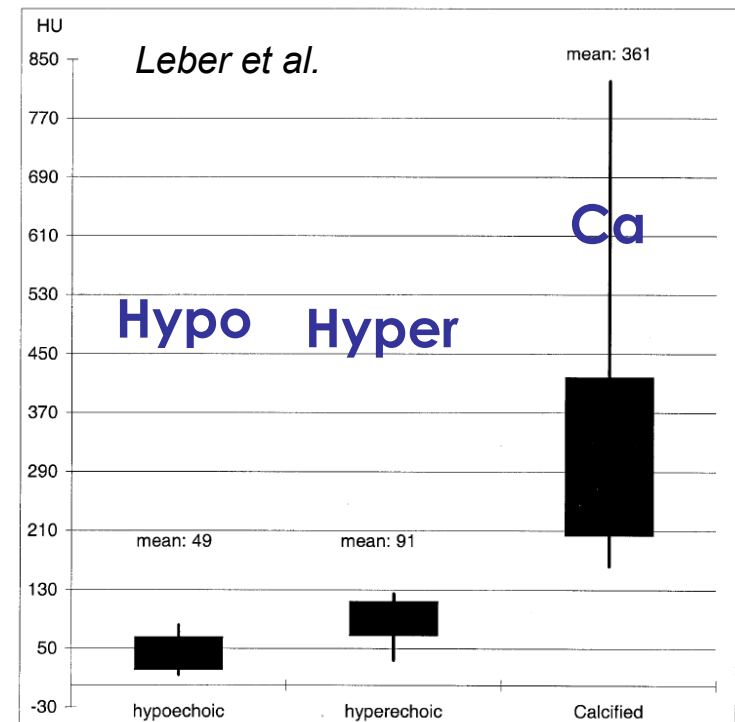
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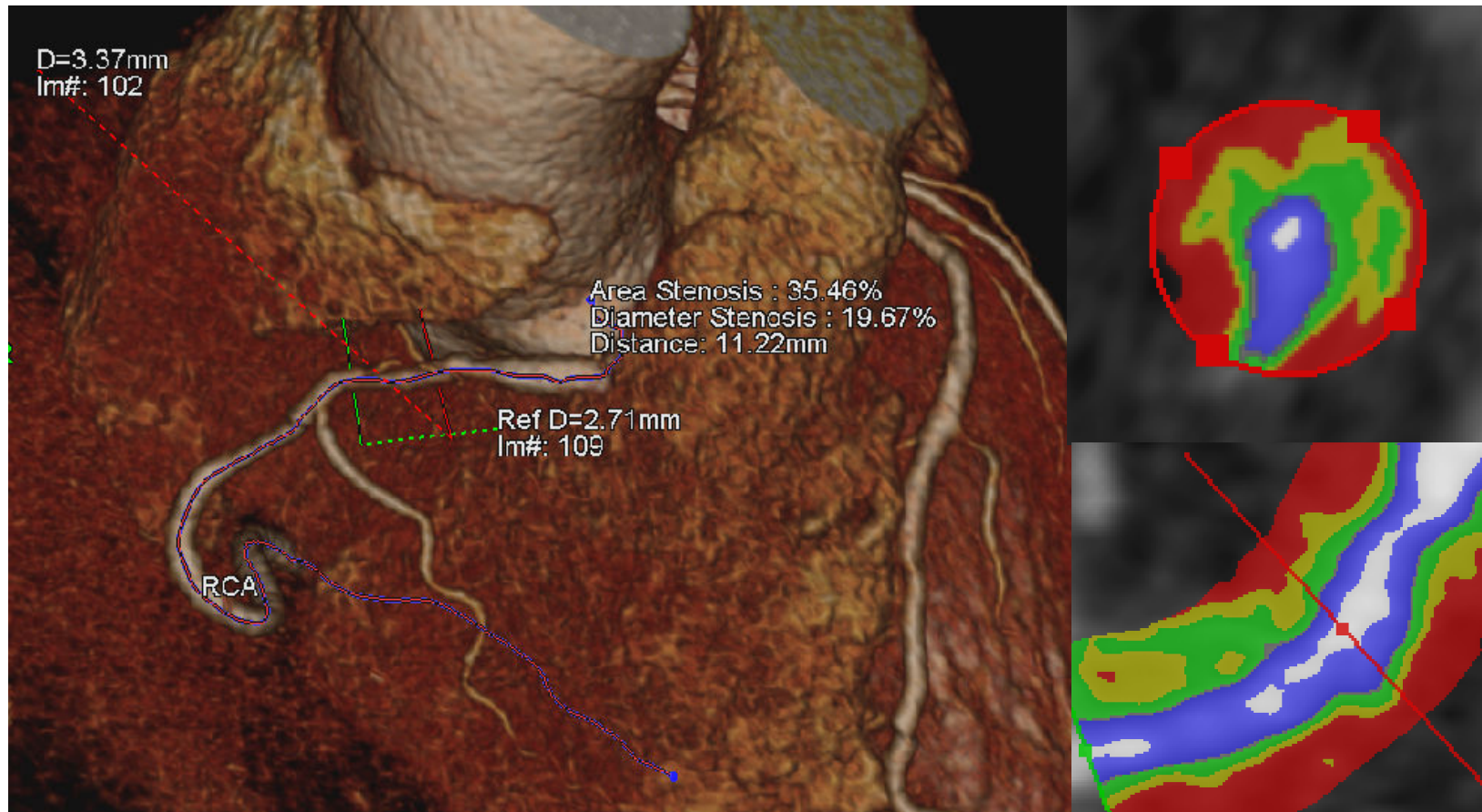
Plaque characterization using CT



| | Hypoechoic plaque | Hyperechoic plaque | Calcified plaque |
|----------------------|-------------------|--------------------|------------------|
| Leber et al. | 49±22 | 91±22 | 391±156 |
| Schroeder et al. | 14±26 | 91±21 | 419±194 |
| Rasouli et al. (EBT) | 30±33 | 105 | 395±230 |

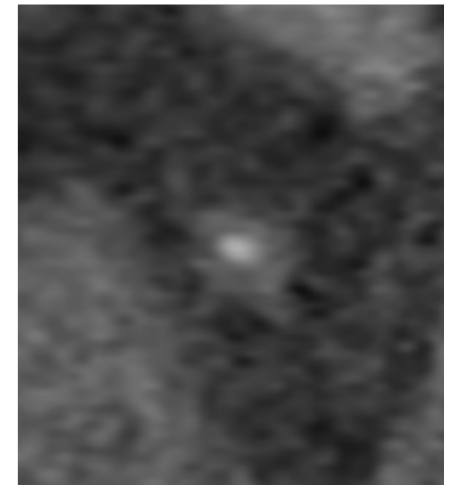


Plaque Characterization & Volume Quantification

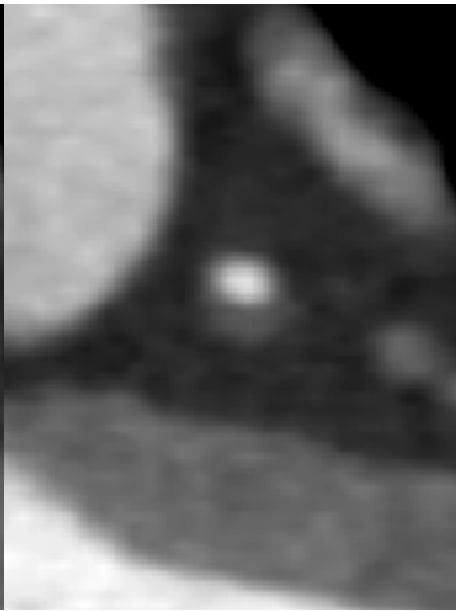
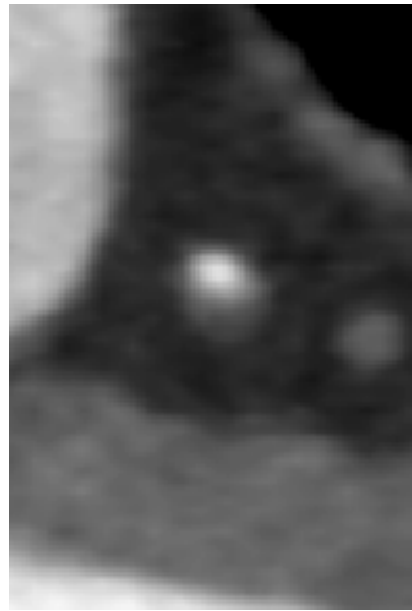
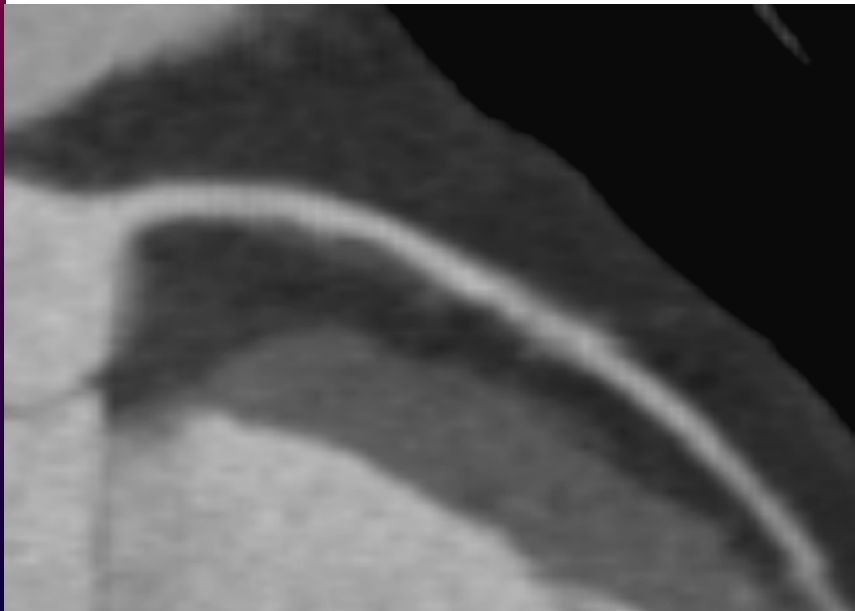


Accuracy of Plaque Volume Quantification

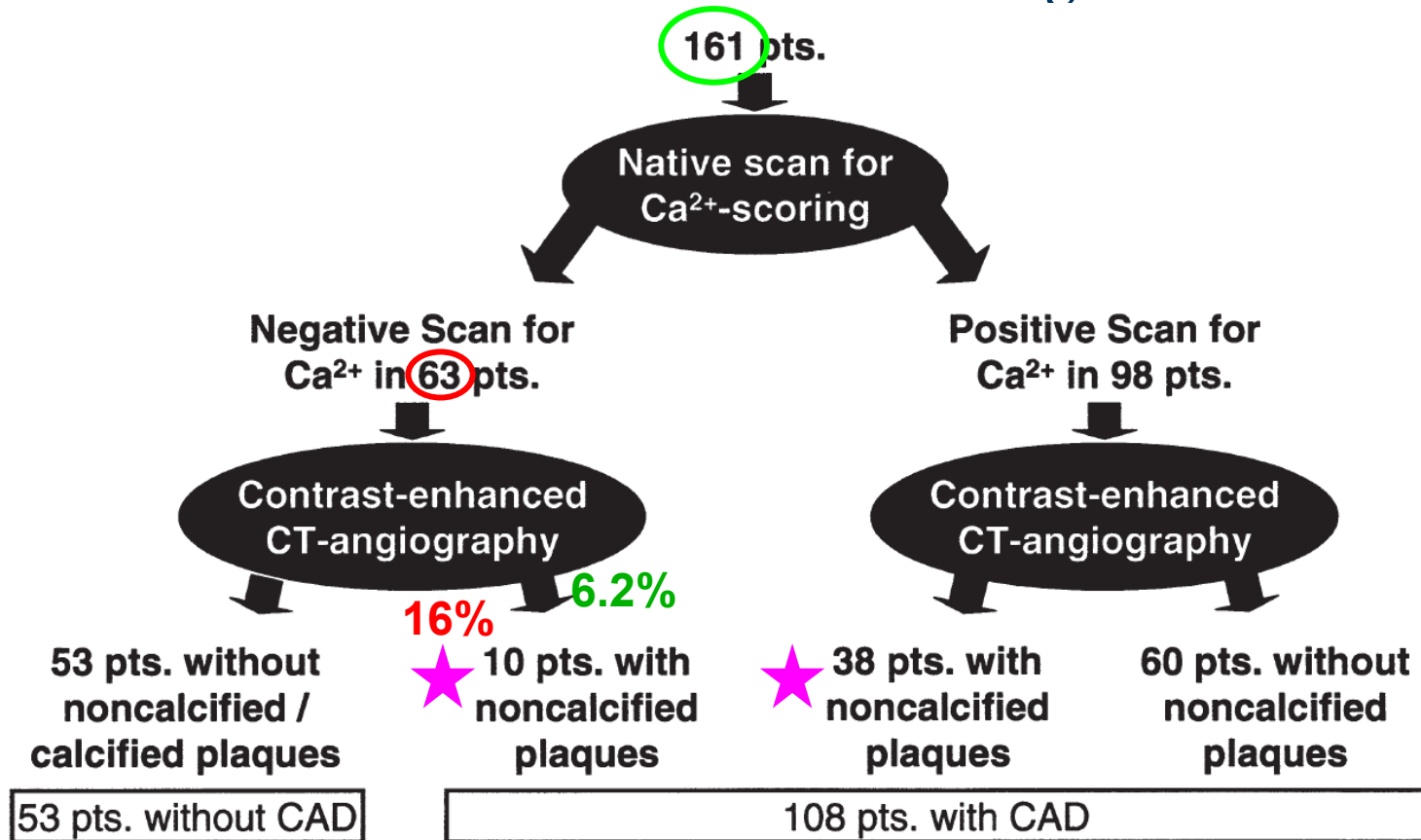
- MDCT substantially underestimates plaque volume per segment as compared with IVUS.
- Technical restrictions prevent an exact separation of lumen, plaque, and vessel wall.-- Edge definition of the outer vessel boundary



F/49
Atypical chest pain
CAC-0, hypercholesterolemia

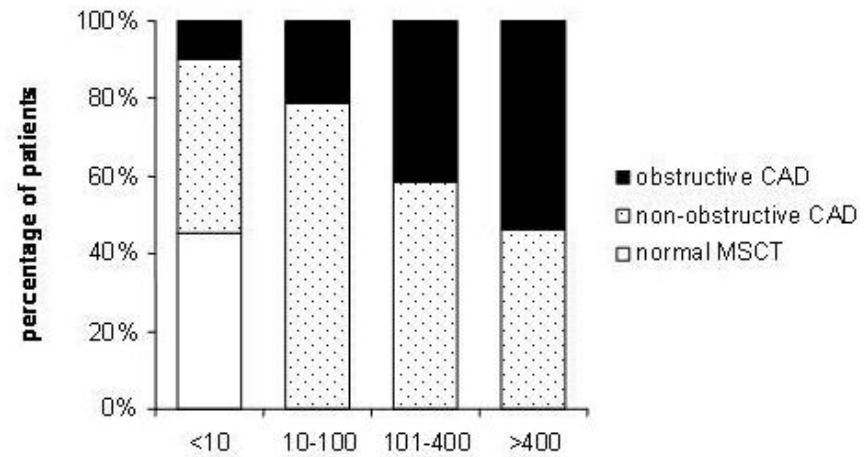
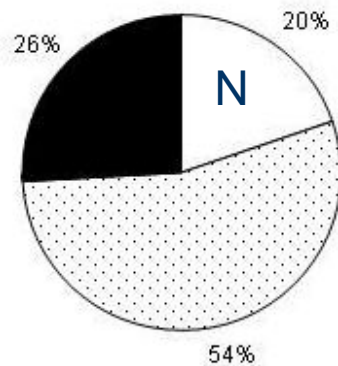
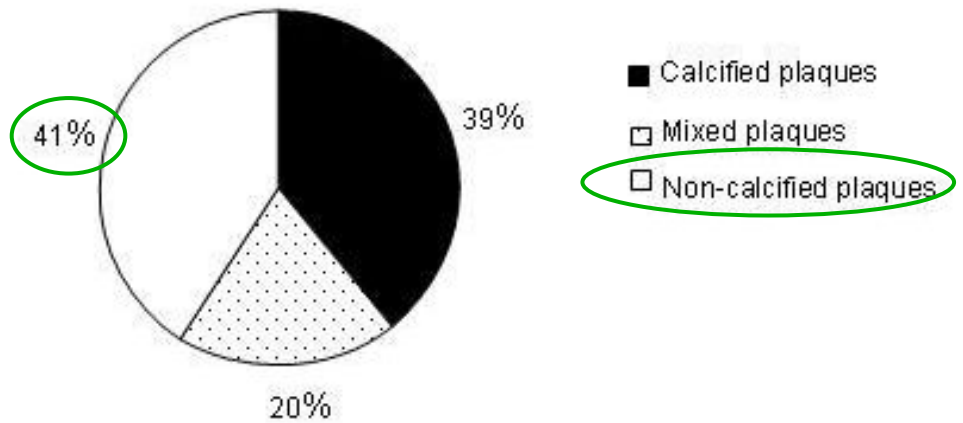
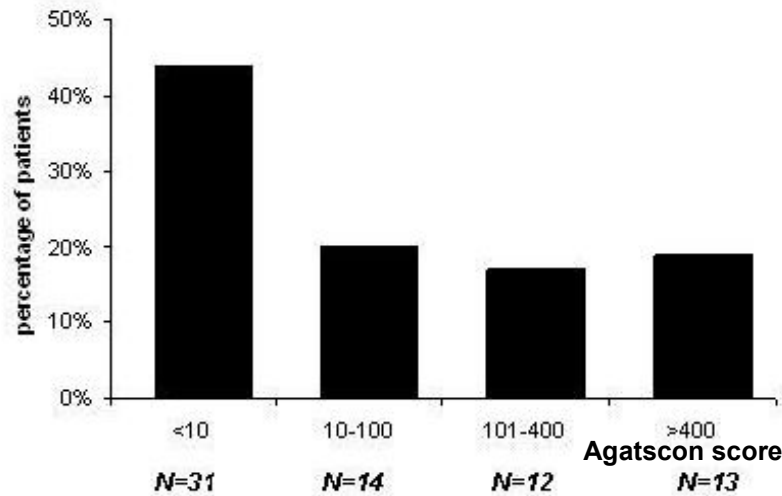


Prevalence of Noncalcified Plaque by 64-CT in Patients with an Intermediate Risk for Significant CAD



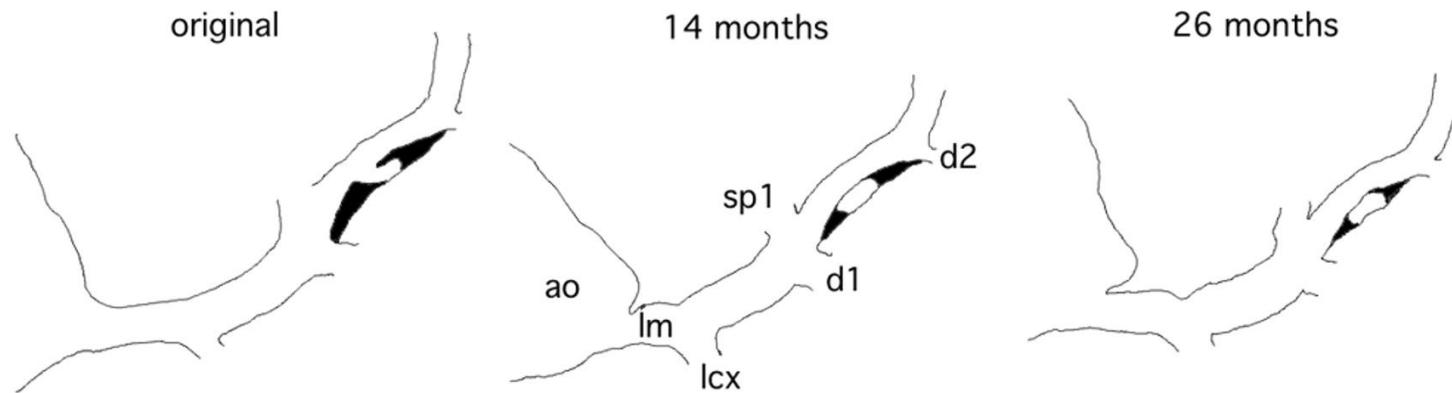
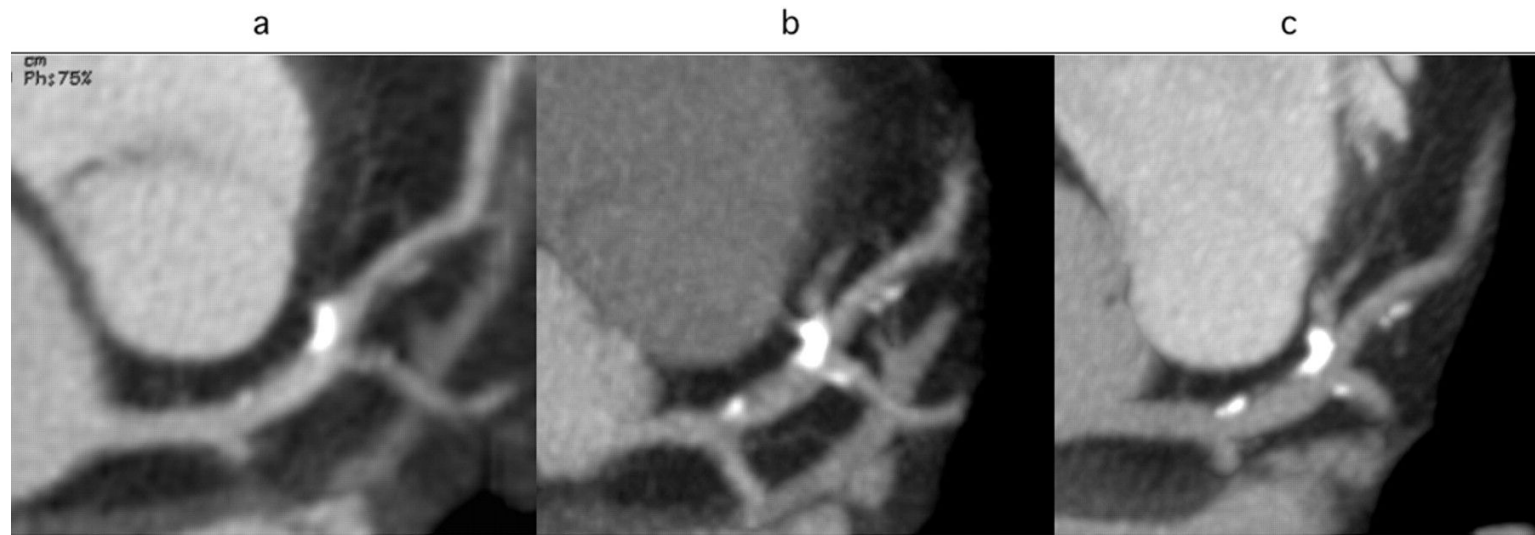
★ Patients with noncalcified plaques
- higher TChol, LDL, and CRP/ more DM

CAD in asymptomatic diabetics



Prevalence of CAD and plaque morphology in Asx DM patients
Scholete et al. Heart 2007

Regression of Coronary Atherosclerotic Plaque as Shown by CT Arteriography



during atorvastatin therapy

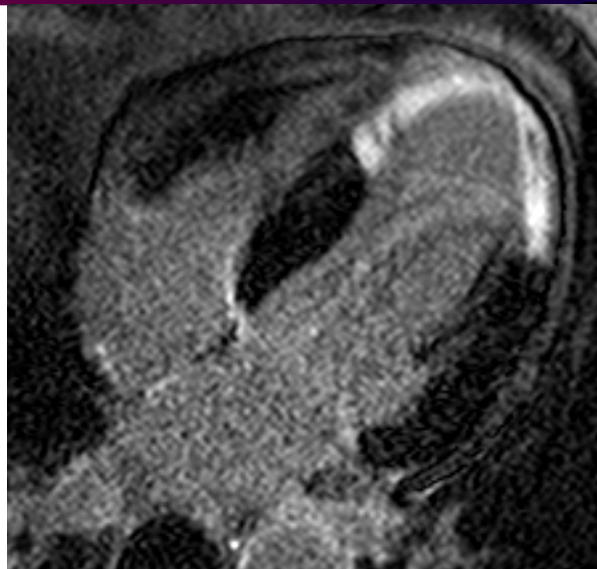
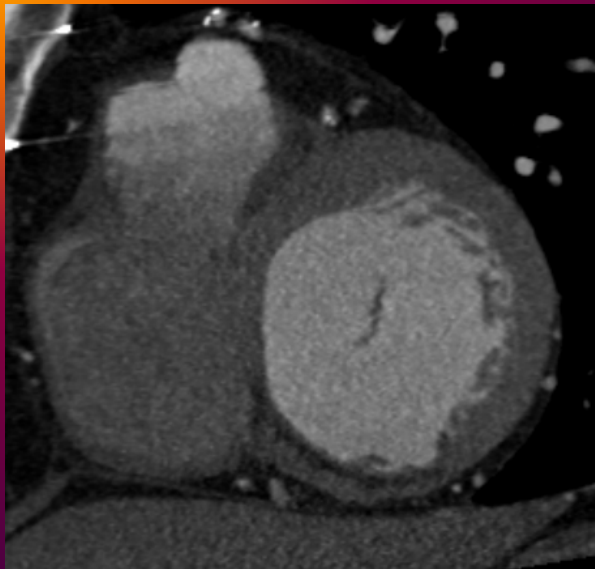


Potential of plaque CT

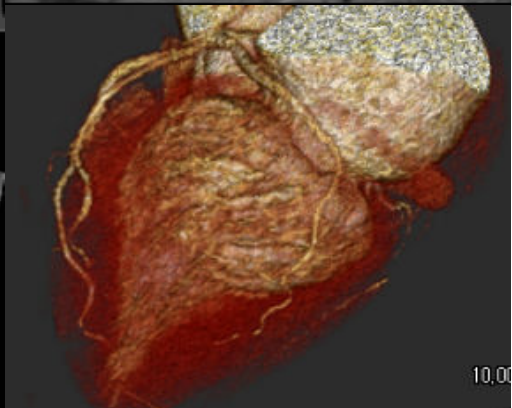
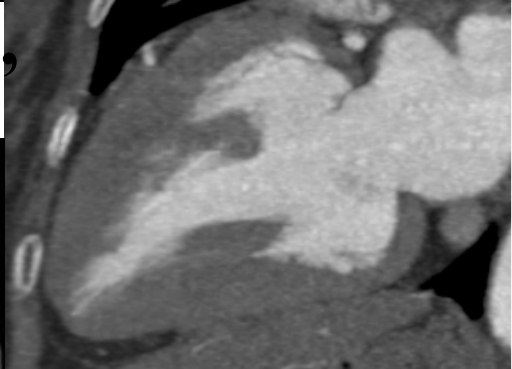
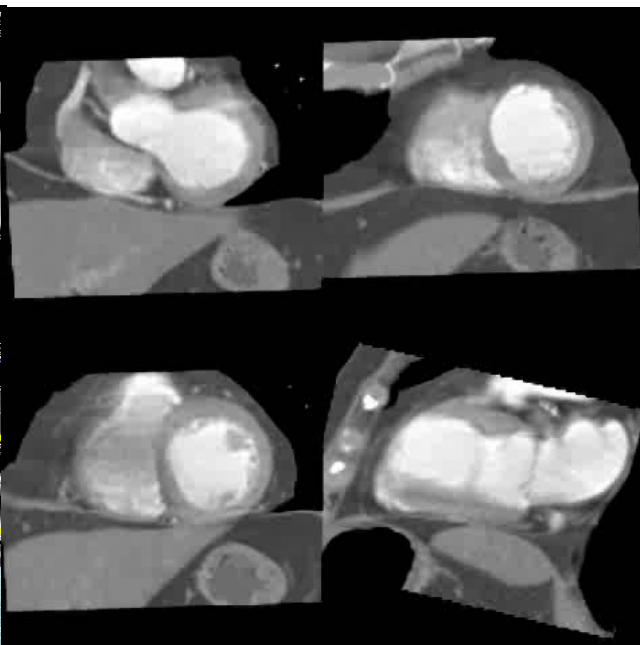
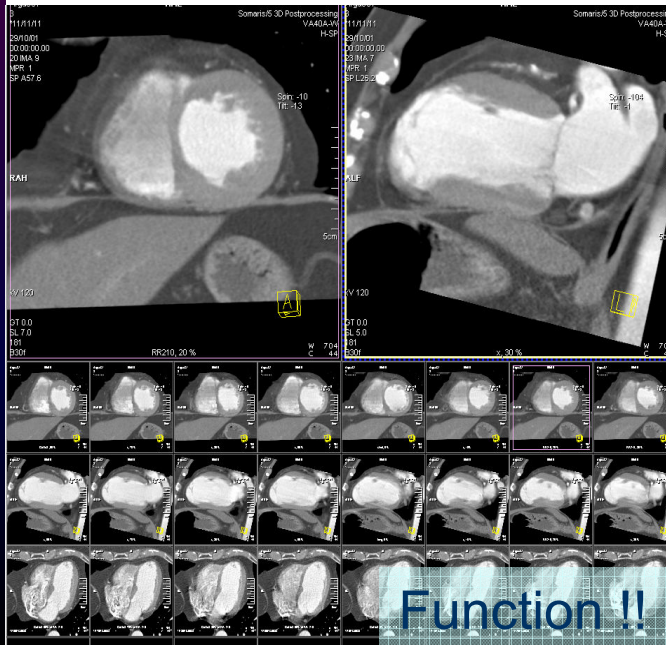
- Early detection of CAD
- Prognostic information/ risk stratification
- Therapeutic monitoring
- Pathogenesis of atherosclerosis

Value of Cardiac MDCT

- Assessment of coronary artery stenosis
- Plaque imaging
 - Plaque composition
 - Total plaque burden
- **Additional information**
 - It's just not coronaries!
 - Cardiac/extracardiac

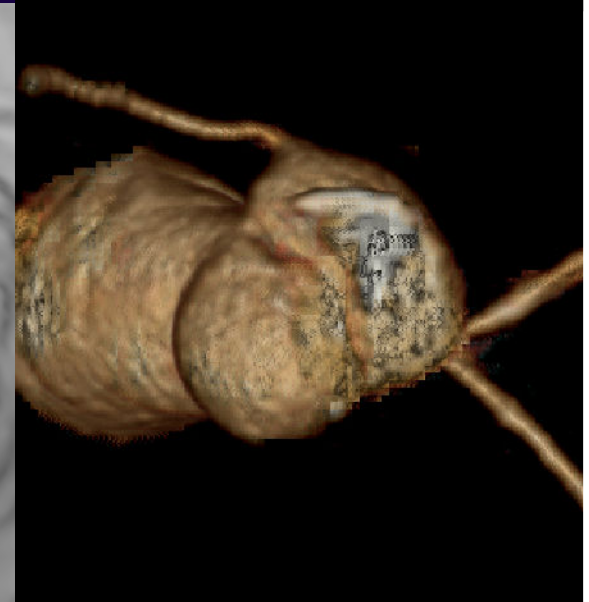
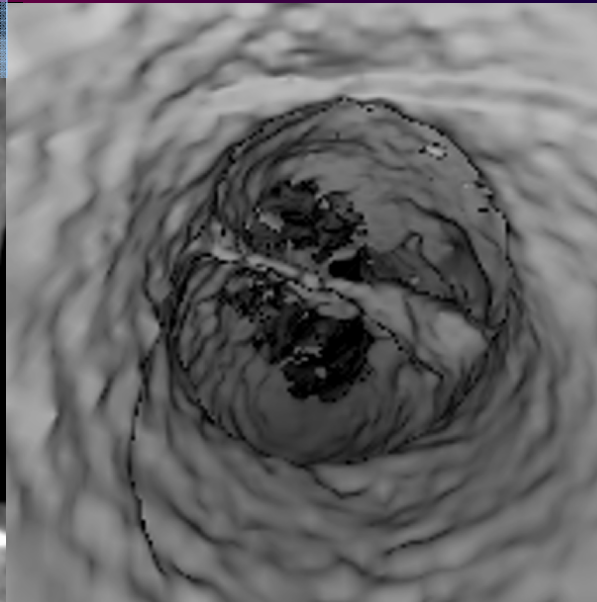


“It’s not just coronaries!”



Function !!

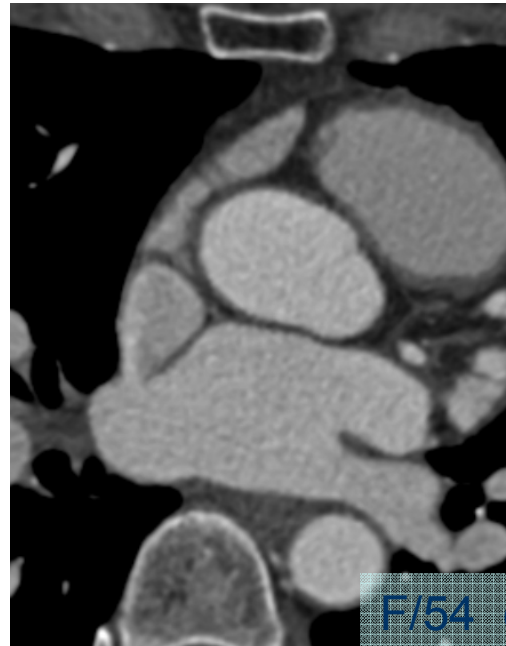
M/62 squeezing chest pain



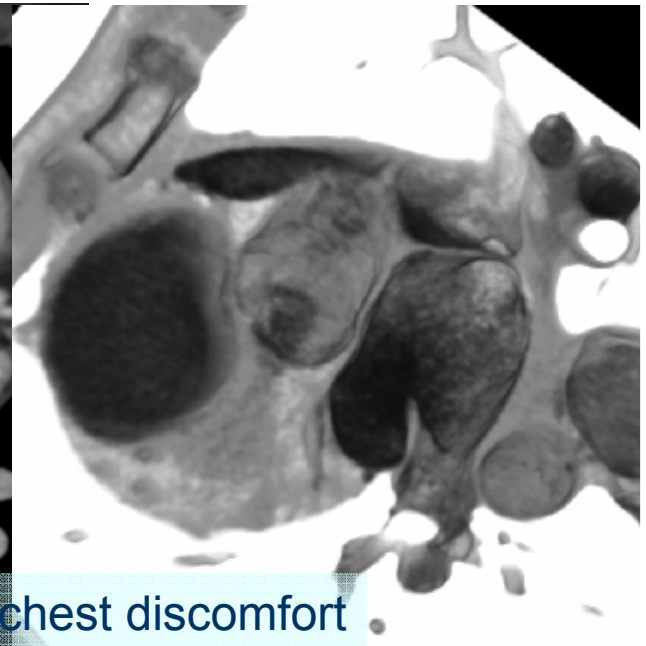
“It’s not just coronaries!”

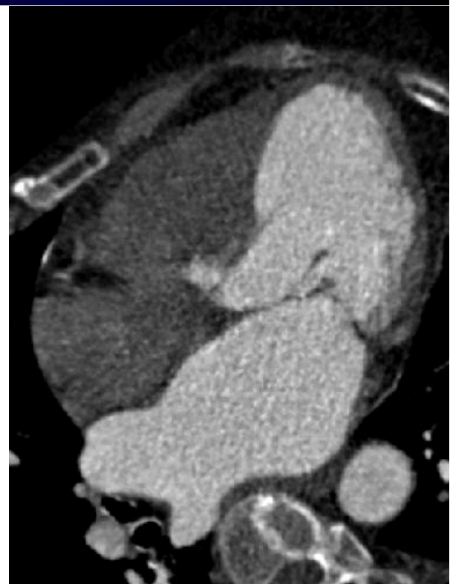
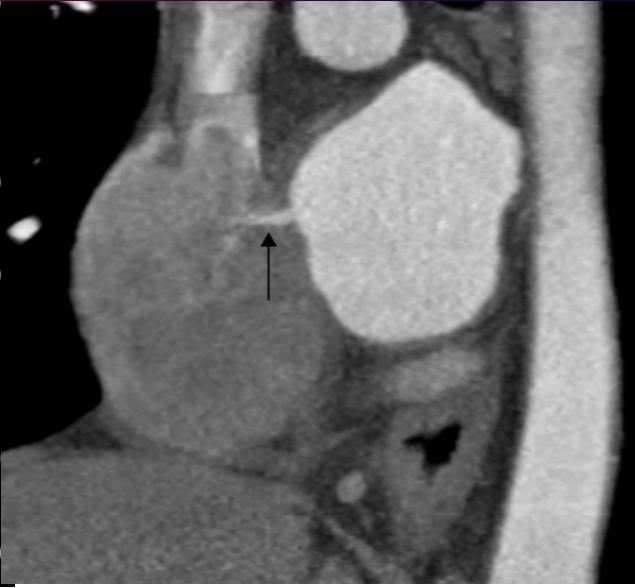


M/34 chest discomfort

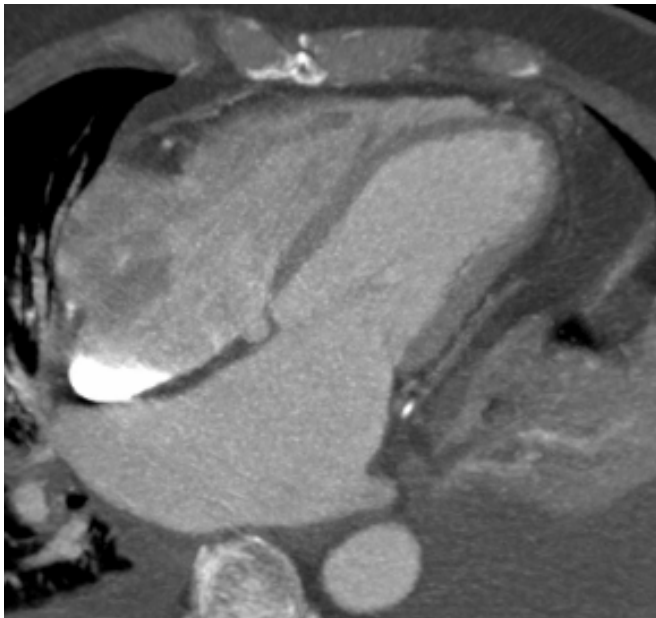
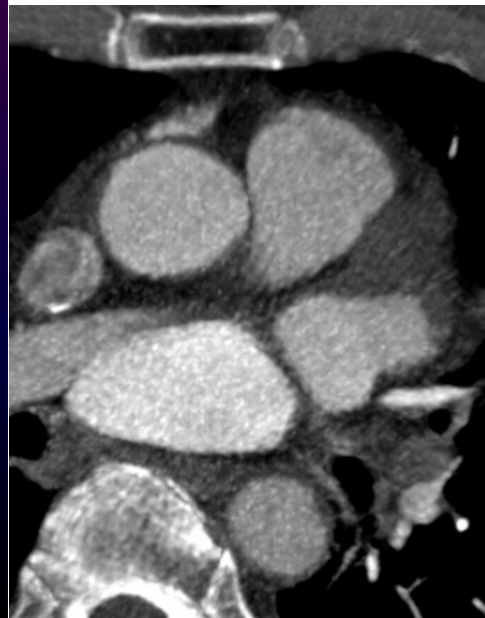


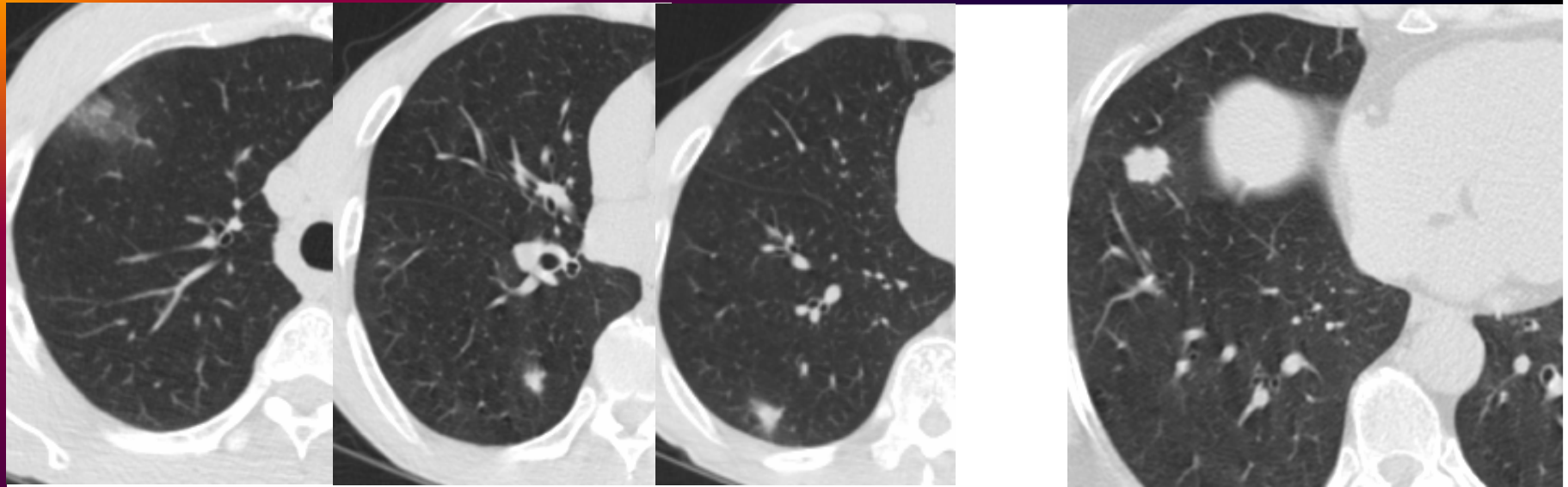
F/54 chest discomfort



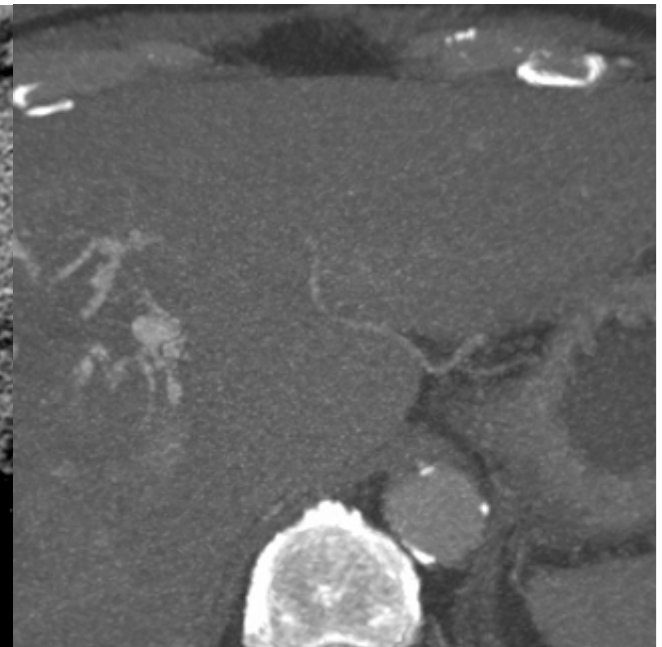
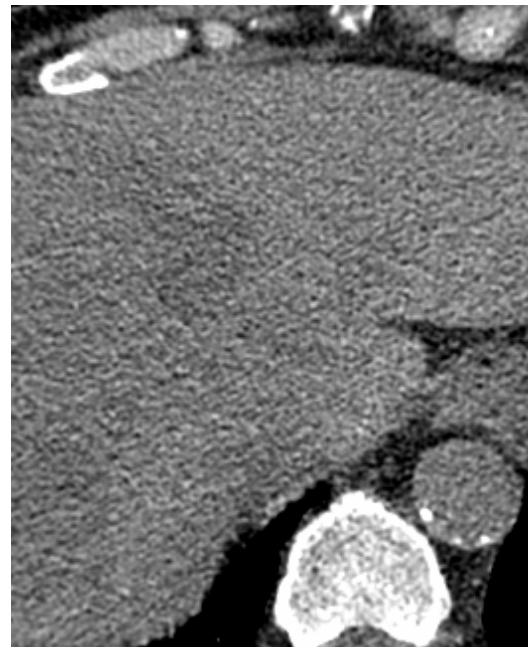
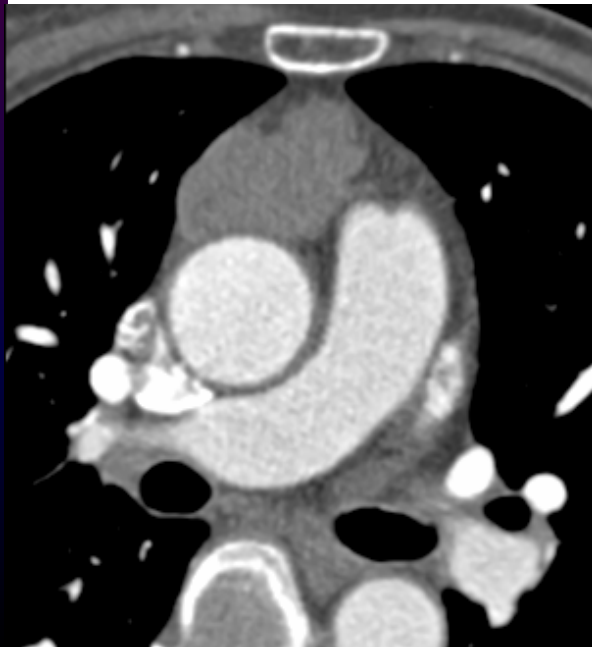


“It’s not just coronaries!”





“It’s not just coronaries!”



Extracardiac Findings at Cardiac CT

- Noncardiac findings (*2007 JTI*)
 - 25~61% of cases
 - Major findings: 5~10%
- Haller et al (*2006 AJR*)
 - 41 extracardiac findings of 166 pts
 - 2 lung ca, 3 pneumonia, 1 PE
- Patel et al (*2005 AJR*)
 - 60 extracardiac findings of 98 pts
 - 16 nodules(>4mm, 2 lung ca), 12 LNE, 3 mediastinal mass, 1 PE, 7 liver lesions



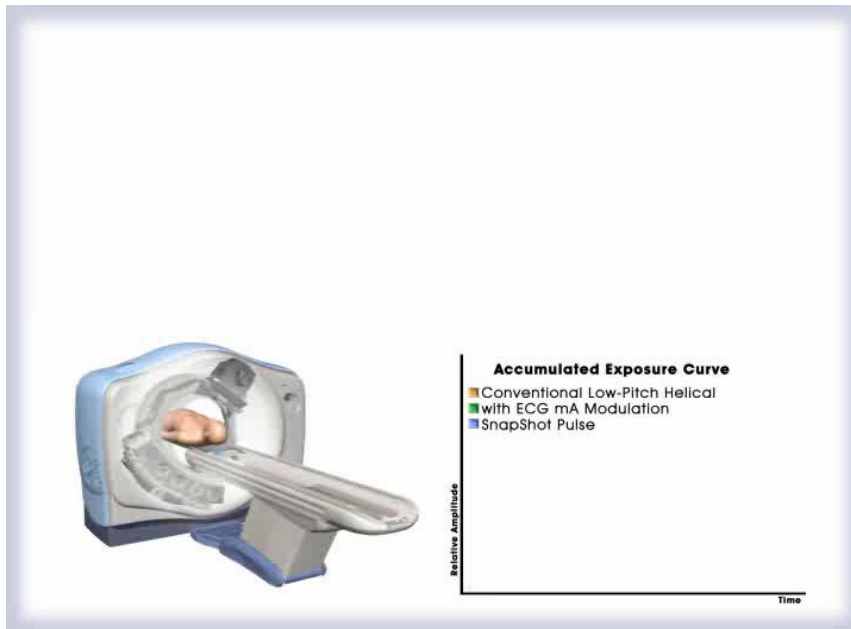
As a first-line imaging

- Accuracy
- Radiation dose
- Iodine contrast
- Cost effectiveness

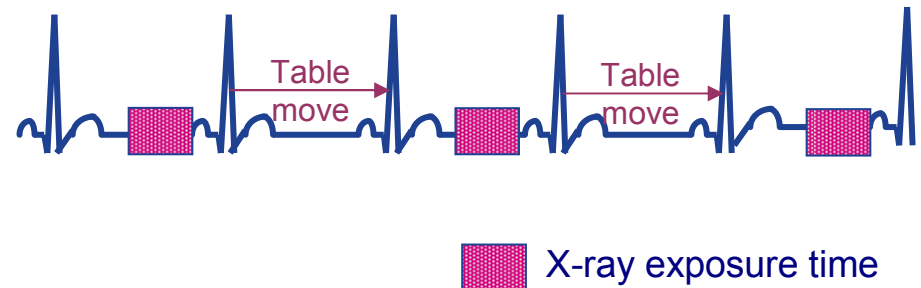
Radiation dose

- ECG based dose modulation
 - Minidose: low dose plateau- 4% of max. dose
- Adaptive pitch
- ECG gating
 - Retrospectively gated helical mode
 - Prospectively gated axial mode

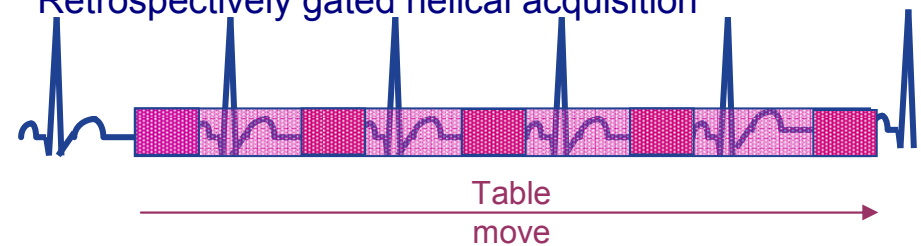
MDCT with Prospective Gating



Prospectively gated axial acquisition



Retrospectively gated helical acquisition



Radiation dose

| Protocols with uncompromised image Quality | Dose |
|--|------------|
| Cardiac Helical CT | 20-25 mSv* |
| Cardiac Helical CT with ECG modulation | 6-15 mSv* |
| Cardiac Axial CT with prospective ECG gating | 3-6 mSv* |
| Calcium Scoring | ~0.6mSv |

| Dose References | Dose |
|---|------------------------------------|
| Chest radiographs – 2 views | 0.08 mSv |
| Mammogram | 0.13 mSv |
| Natural Background (Annual) | 3 mSv |
| Diagnostic Cath | 1-10 mSv |
| Nuclear Tc-99m MIBI (rest only) Tc-99m MIBI (rest+stress) Tl-201 (rest+stress) | 4 – 5 mSv 9 – 13 mSv ~34 mSv |

Summary; CT in CAD

- Intermediate likelihood of CAD or aSx high-risk patients -1st line noninvasive imaging
- Value of CT as plaque imaging
- Valuable additional information
- Atherosclerosis vs Ischemia
 - Therapeutic modality
 - Risk factor modification