

What Is the Role of CT Imaging in Risk Stratification?

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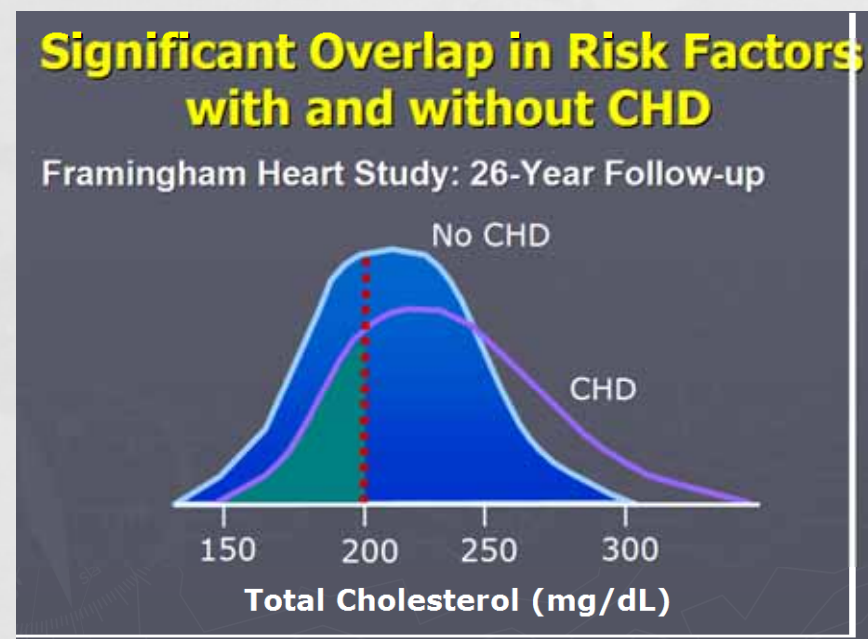
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Risk Stratification in the “NO” chest pain patients

Determining Pretest Probability Assessment
for Risk Stratification in the chest pain patients

Screening of CAD in Asymptomatic Subjects

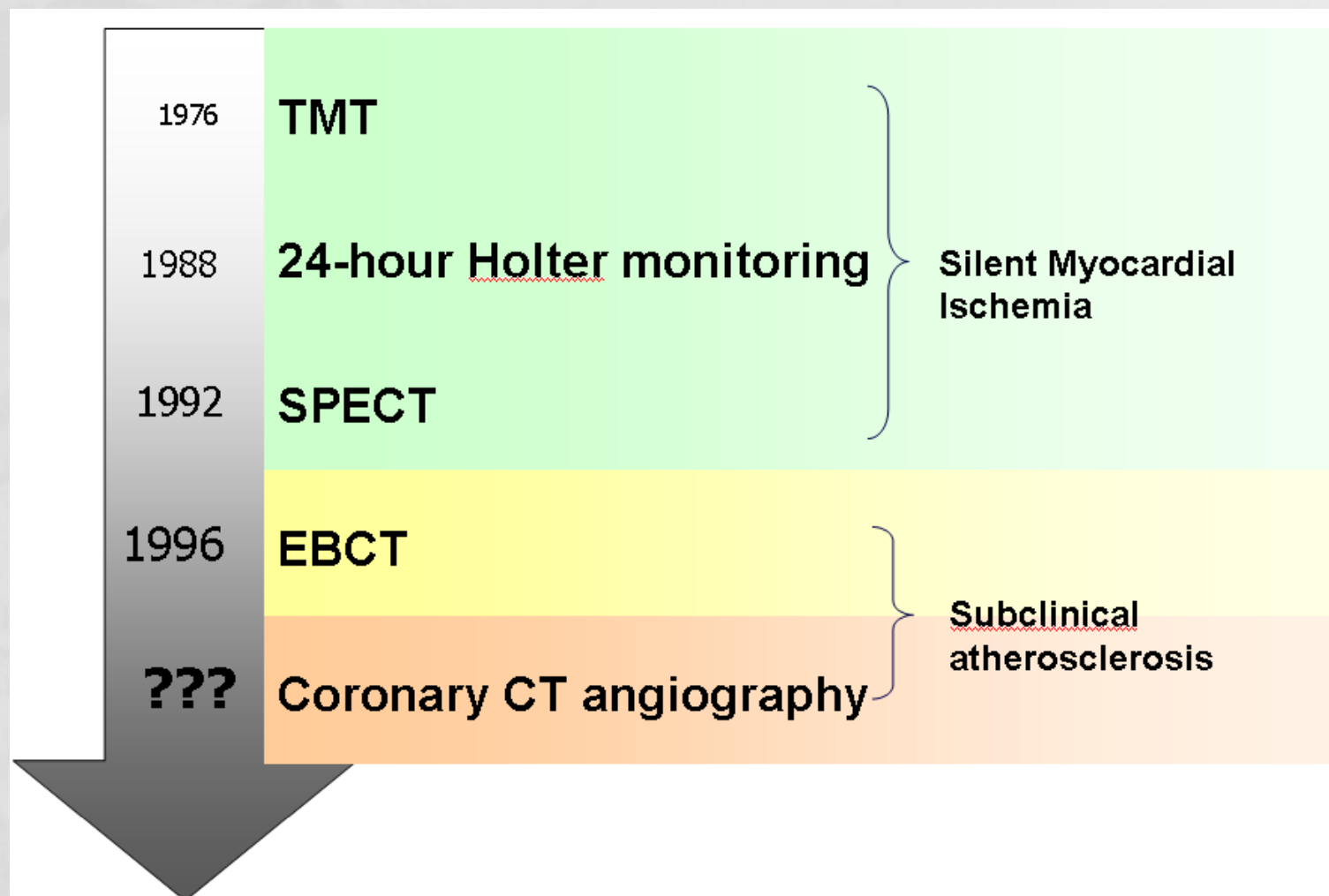
- Number of major coronary risk factors (diabetes, HTN, smoking, dyslipidemia etc)
- Framingham risk equation



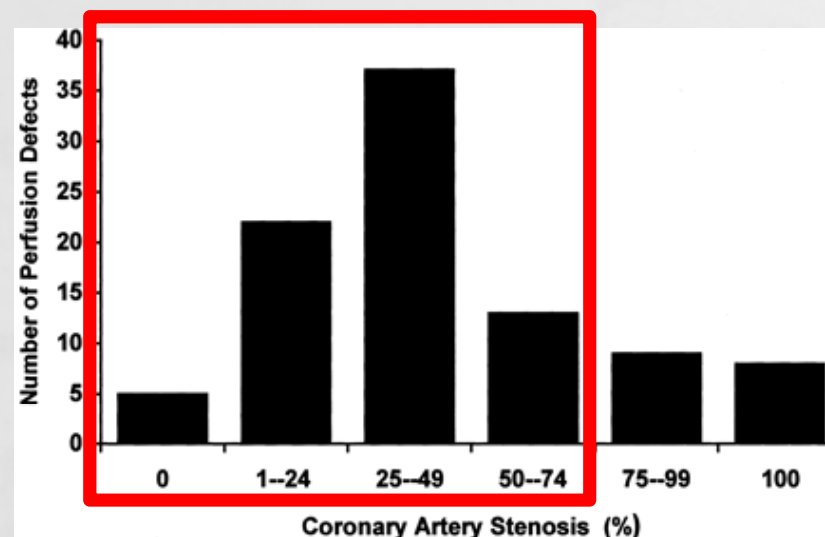
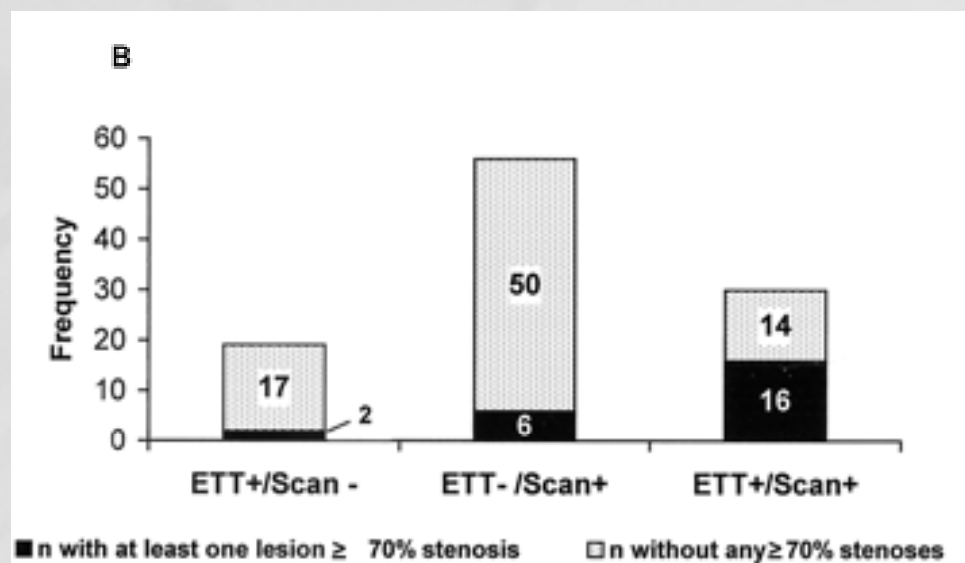
Traditional risk factors may fail to explain up to 50% of CAD morbidity and mortality !

Castelli WP. Atherosclerosis. 1996

Screening of CAD in Asymptomatic Subjects



Screening of CAD in Asymptomatic Subjects



- Abnormal exercise scintigraphy identifies **predominantly mild coronary atherosclerosis**.
- Perfusion defects may be caused by **coronary vasomotor dysfunction** in addition to atherosclerotic plaque.

MDCT as Screening Test for Risk Stratification

- **Coronary calcium scoring (CAC)**
- **Contrast -enhanced CT coronary angiography (CTCA)**

CAC as Screening Test

- Calcium and Atherosclerosis
 - All coronary artery calcium is intimal
 - No medial calcification in coronaries
 - Pathologic evidence of disease
- First proposed using fluoroscopy to screen for coronary artery disease

*Blankenhorn DH, Stern D. Am J Roentgenol Radium Ther Nucl Med
1959 ;81:772(!)*

CAC as Screening Test

- Correlates with
 - Coronary plaque burden
 - Coronary artery stenosis
 - Coronary event risk

*Budoff MJ (1999), Rumberger JA (1999),
Agatston AS (1994), ...*

→ Easiest way to screen with lower radiation dose



	LMA	LAD	LCX	RCA	PDA	A	B	C	Total
AJ-130	130	64	122	149	0	0	0	0	465
Volume130	97	58	103	117	0	0	0	0	375

Just Click over
130 HU!!

<1mSv
Radiation !!

CAC interpretation

- Agatston score (Total calcium score)
 - System for scoring amount of calcified plaque

Area of plaque x weighting factor = lesion score

Weighting based on brightest pixel in lesion

Sum of lesion scores = vessel score

Sum of vessel scores = total calcium score

Agatston, Janowitz, et al. JACC 1990

→ Workstations **automatically calculate!!** It's **easy!**

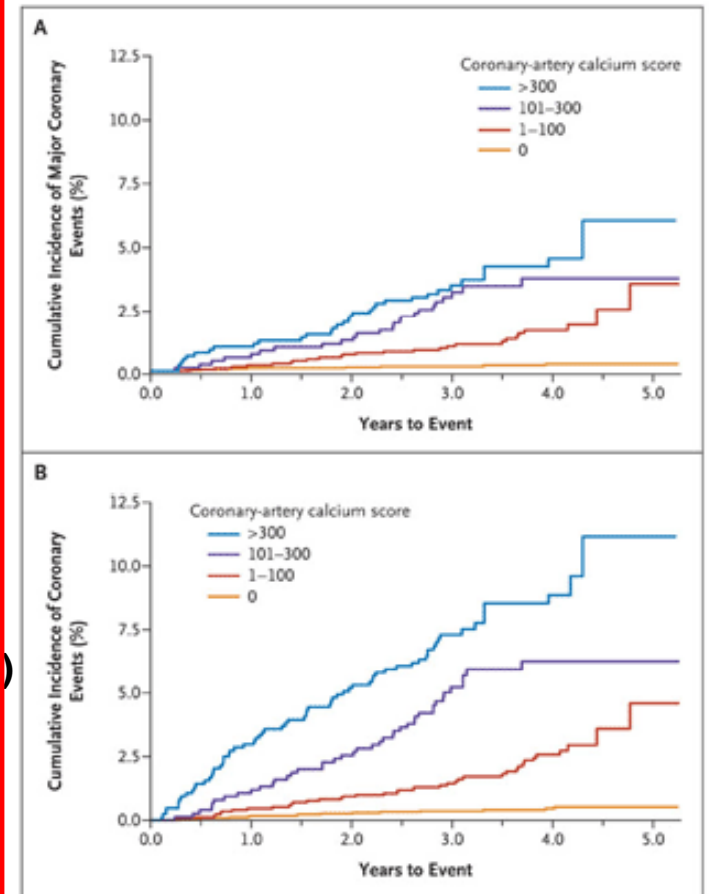
Guidelines for Calcium Score (Agastson score)

Calcium Score	Plaque Burden (†)	Probability of Significant CAD (†)	Coronary Event (‡) 5-Year Incidence	Hazard Ratio
0	No identifiable plaque	Very low, generally < 5%	0.5%	1.00
1	Minimal identifiable plaque burden	Very unlikely, < 10%	1	
10	Definite, at least mild atherosclerotic plaque burden	Mild or Minimal coronary stenosis	4.6%	3.61 (1.96-6.65)
100	Definite, at least moderate atherosclerotic plaque burden	Nonobstructive CAD highly likely, although obstructive disease possible	6.2%	7.73 (4.13-14.47)
400	Extensive atherosclerotic plaque burden	High likelihood (> 90%) of at least 1 "significant" stenosis	11.2%	9.67 (5.20-17.98)

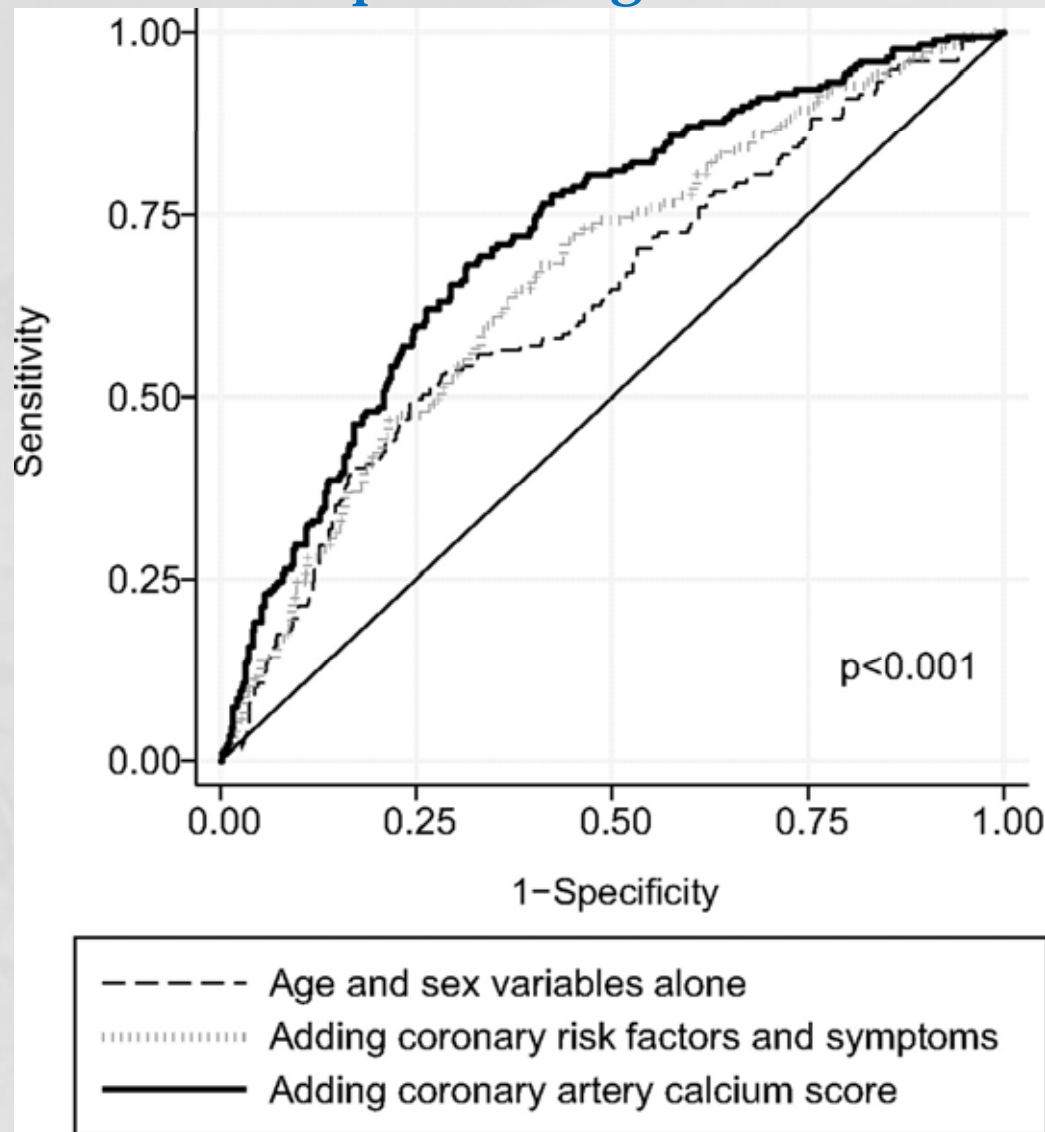
CAD = coronary artery disease

(†) *Mayo Clin Proc* 1999;74:243-252

(‡) *NEJM* 2008;358:1336-1345



Receiver operating characteristic curve analysis: the incremental value of CAC score for predicting ischemic PET MPI



Schenker, M. P. et al. Circulation 2008;117:1693-1700

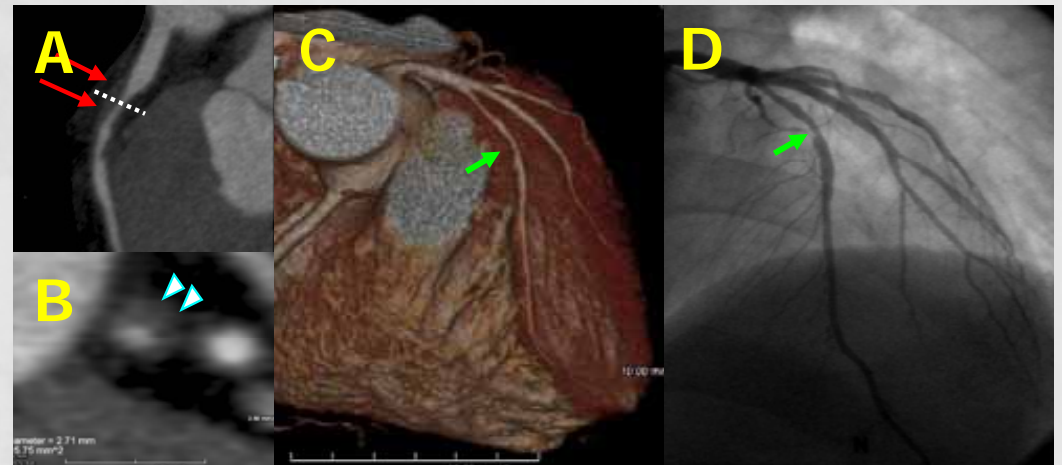
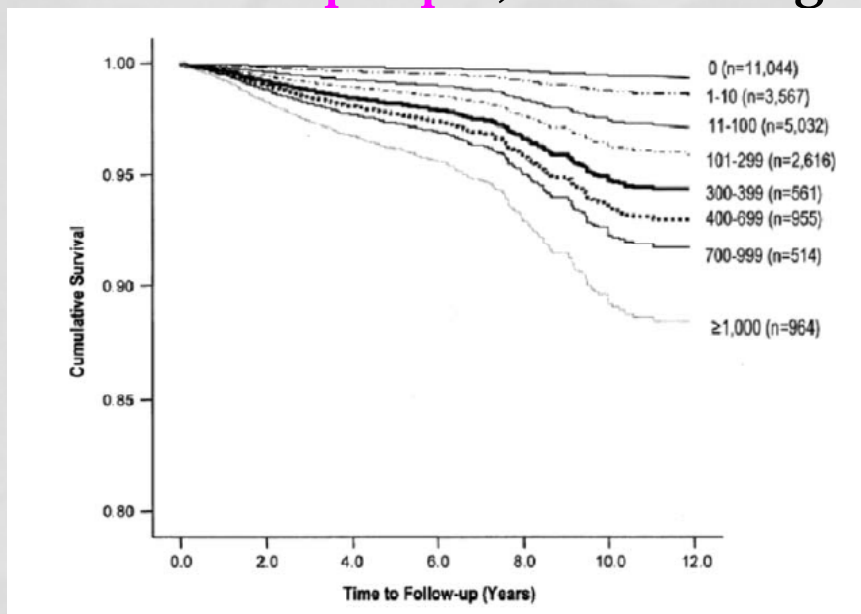
Appropriate Indications of Cardiac CT: CAC

Risk Assessment: General Population Asymptomatic (Use of Calcium Score)		
14	- Moderate CHD risk (Framingham)	A (7)
15	- High CHD risk (Framingham)	A (7)
Detection of CAD With Prior Test Results Evaluation of Chest Pain Syndrome (Use of Cardiac CT)		
16	- Uninterpretable or equivocal stress test (exercise, perfusion, or stress echo)	A (8)
CAD detection in pediatric patients with Kawasaki disease Asymptomatic (Use of Cardiac CT)		
22	- Previous tests (invasive angiography, CMR or CCT) documented coronary aneurysm/stenosis, for follow up	A (7)

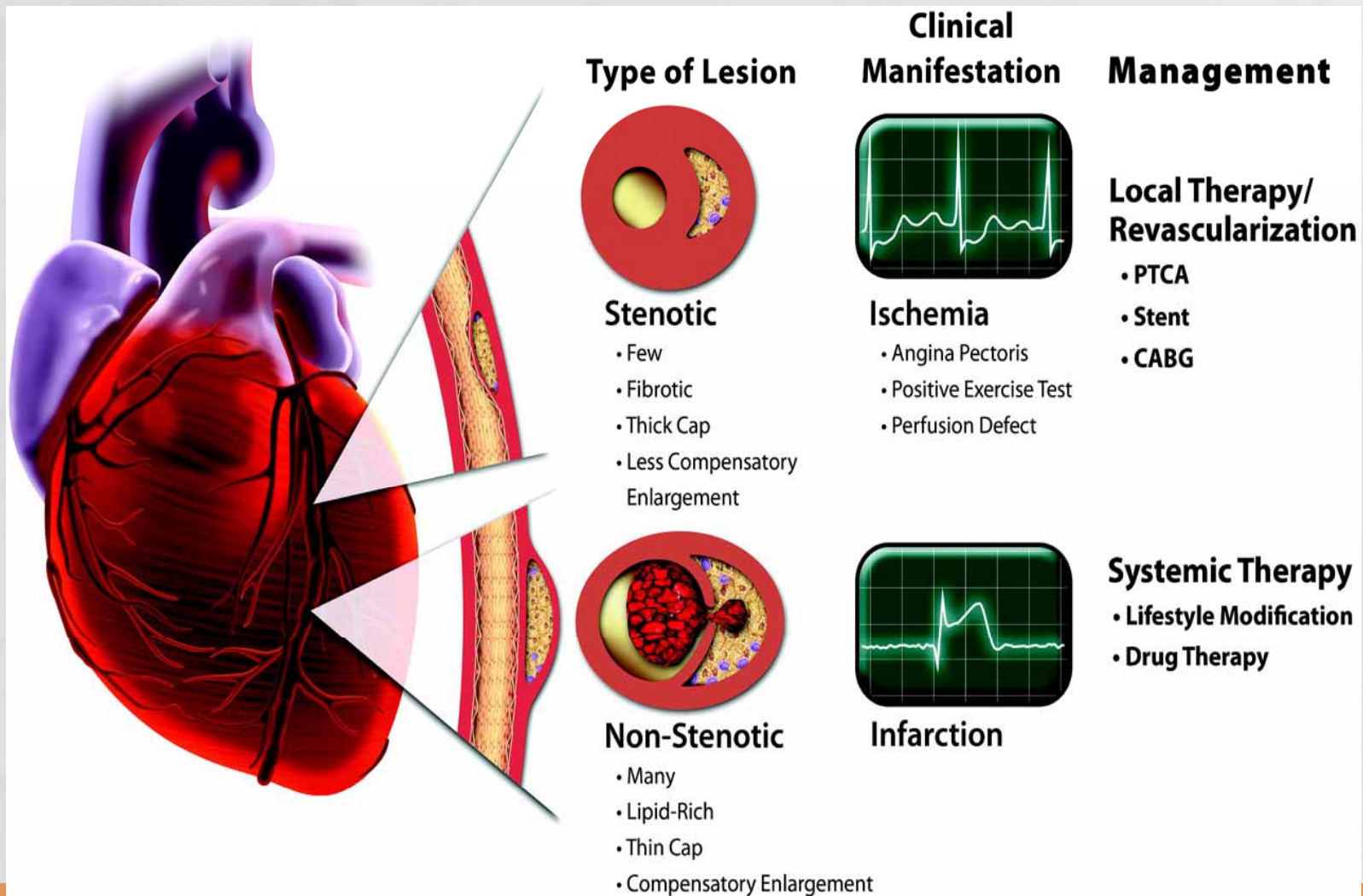
*ASCI 2010 appropriateness criteria for cardiac computed tomography.
Int J Cardiovasc Imaging 2010; 26(supp1):1-15*

CAC as Screening Test

- **Incremental prognostic information** in addition to the assessment of conventional risk factors
- **Limitation** to represent the whole spectrum of atherosclerosis (**non-calcified plaque**) and to diagnose **obstructive CAD**

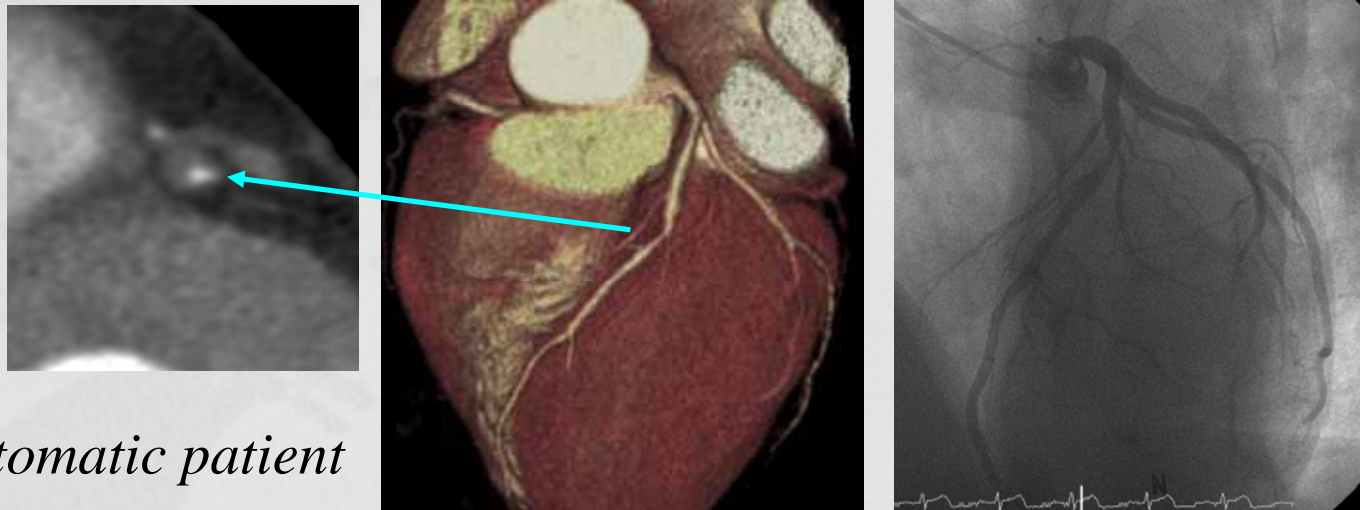


Diversity of Lesions in Human Coronary Atherosclerosis



CTCA as a Screening Test

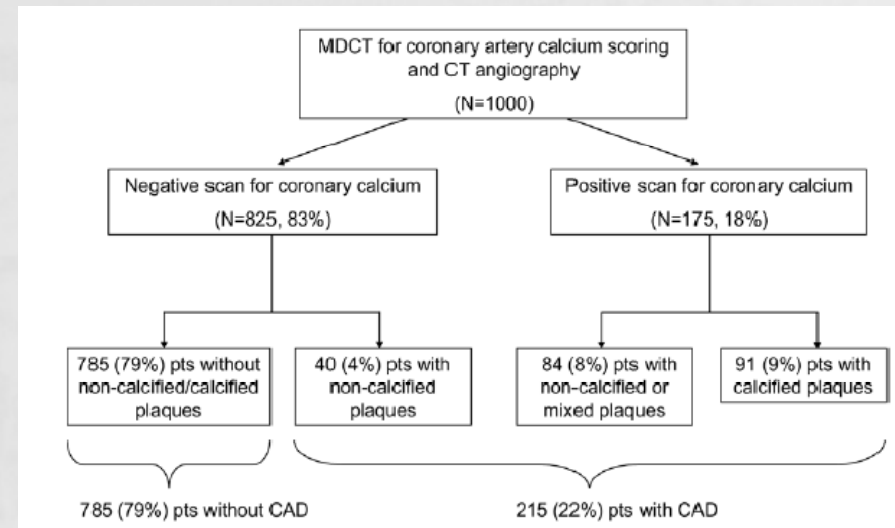
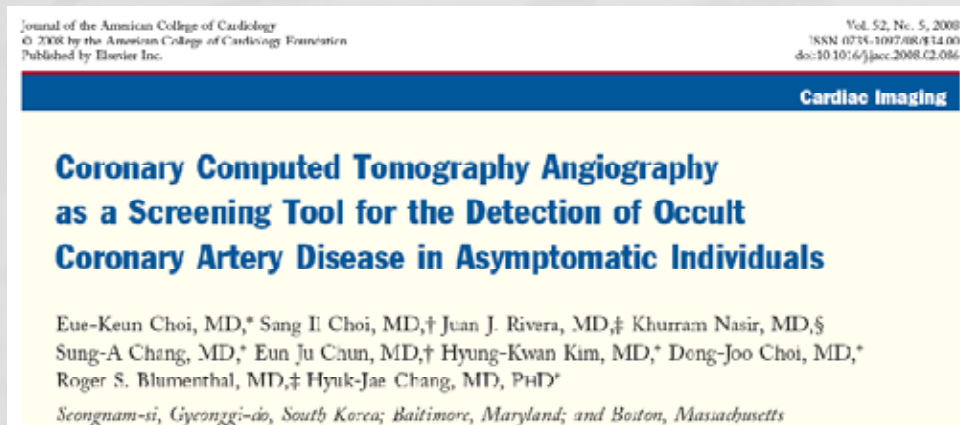
- potential to provide comprehensive information regarding the **location, severity, and characteristics** of atherosclerotic plaque.
- potential tool for providing a better insight about the **occult CAD** in asymptomatic individuals.



M/44, Asymptomatic patient

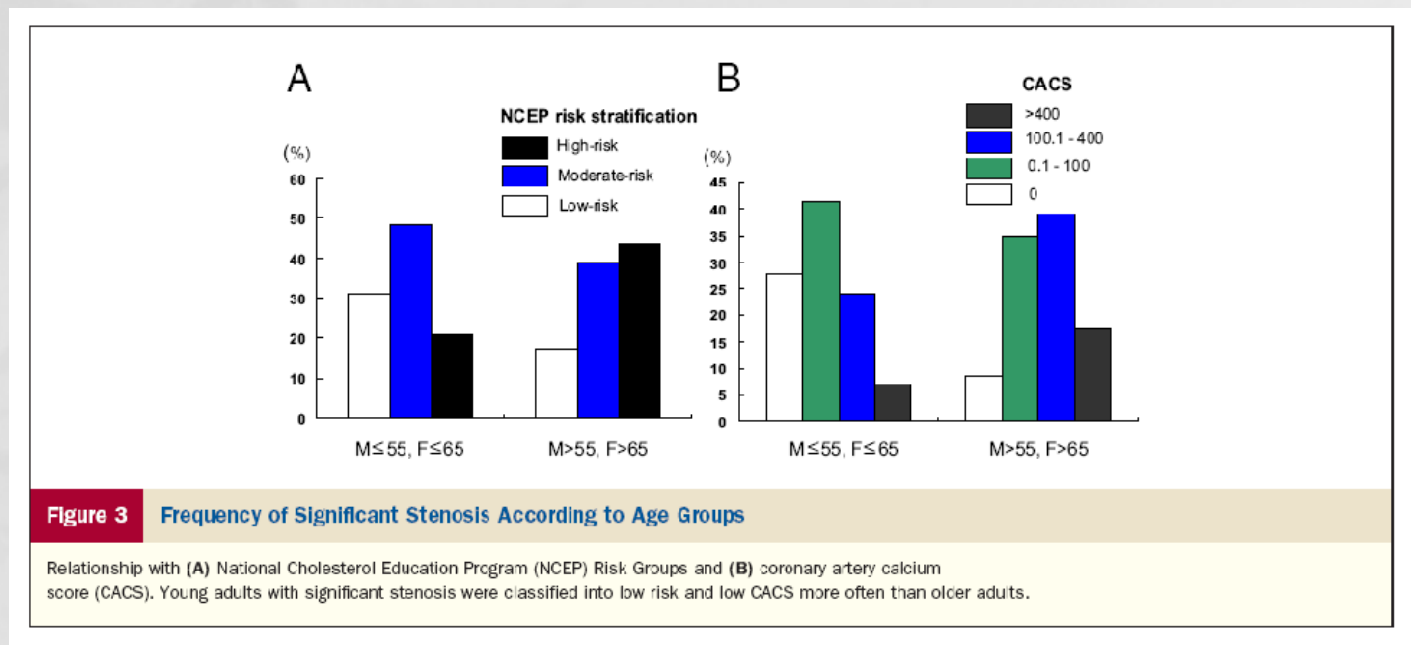
IVUS: Vulnerable plaque with positive arterial remodeling

CTCA as a Screening Tool in Asymptomatic Subjects



- The prevalence of **occult CAD** in apparently healthy individuals **was not negligible**, although their midterm prognosis was good.

CTCA as a Screening Tool in Asymptomatic Subjects



- A number of individuals with occult CAD might be **misclassified with conventional risk stratification** algorithms.
- CCTA has the potential to identify these patients.

CTCA as a Screening Tool: Specific Condition in Asymptomatic DM

- Coronary artery disease (CAD):
65% to 80% of deaths in diabetic patient
- American Diabetes Association (ADA):
a consensus recommendation
“Clinicians consider *a risk factor–guided screening approach to early diagnosis of CAD* in both symptomatic and asymptomatic patients.”

Diabetes care 1998;21:1551-1559

CTCA as a Screening Tool: Specific Condition in Asymptomatic DM Subclinical CAD in Type II DM and IFG

- 64% had occult CAD findings.
- 26% had a significant stenosis
- **more noncalcified and mixed** plaques in subjects with Type II DM (19%) and IFG (11%) than normal (7%).

Distribution of CACS and CCTA findings

Categories	CACS = 0 (n=90)	CACS 1-10 (n=21)	CACS 11-100 (n=53)	CACS 100-399 (n=39)	CACS ≥ 400 (n= 14)	p value
Maximal diameter stenosis						
No plaque	77 (86)	0 (0)	0 (0)	0 (0)	0 (0)	<0.0001
1-50%	10 (11)	20 (84)	42 (79)	27 (69)	5 (36)	
>50%	3 (3)	1 (6)	11 (21)	12 (31)	9 (64)	

Rivera JJ et al. Atherosclerosis 2009;203:442-448

Lim S et al. Atherosclerosis 2009; 205: 156-162

Screening in DM with Other Modality: The DIAD Study using MPI

Cardiac Outcomes After Screening for Asymptomatic Coronary Artery Disease in Patients With Type 2 Diabetes

The DIAD Study: A Randomized Controlled Trial

Table 2. Events in No-Screening vs Screening Group

	No. (%) of Patients		HR (95% CI) ^a	Log-Rank P Value ^b
	No Screening (n = 562)	Screening (n = 561)		
Primary events	17 (3.0)	15 (2.7)	0.88 (0.44-1.8)	.73
Myocardial infarction	10 (1.7)	7 (1.3)	0.82 (0.34-2.0)	.66
Cardiac death	7 (1.2)	8 (1.4)	1.1 (0.41-3.1)	.80
Secondary events	14 (2.5) ^c	21 (3.7)	1.5 (0.77-3.0)	.23
Unstable angina	3 (0.5)	4 (0.7)	1.3 (0.30-6.0)	.70
Heart failure	7 (1.2)	7 (1.2)	1.0 (0.35-2.9)	.99
Stroke	5 (0.9)	10 (1.8)	2.0 (0.69-5.9)	.20
Revascularizations	44 (7.8) ^d	31 (5.5)	0.71 (0.45-1.1)	.14
PTCA	27 (4.8)	15 (2.7)	0.90 (0.48-1.7)	.74
CABG surgery	20 (3.6)	16 (2.9)	0.81 (0.42-1.6)	.76
Death				
All cause	15 (2.7)	18 (3.2)	1.2 (0.69-2.4)	.60
Noncardiac	8 (1.4)	10 (1.8)	1.3 (0.49-3.2)	.63

Abbreviations: CABG, coronary artery bypass graft; CI, confidence interval; HR, hazards ratio; PTCA, percutaneous transluminal coronary angioplasty.

^aHazard ratios represent the ratio of screening vs no-screening participants from unadjusted Cox proportional hazards regression analysis.

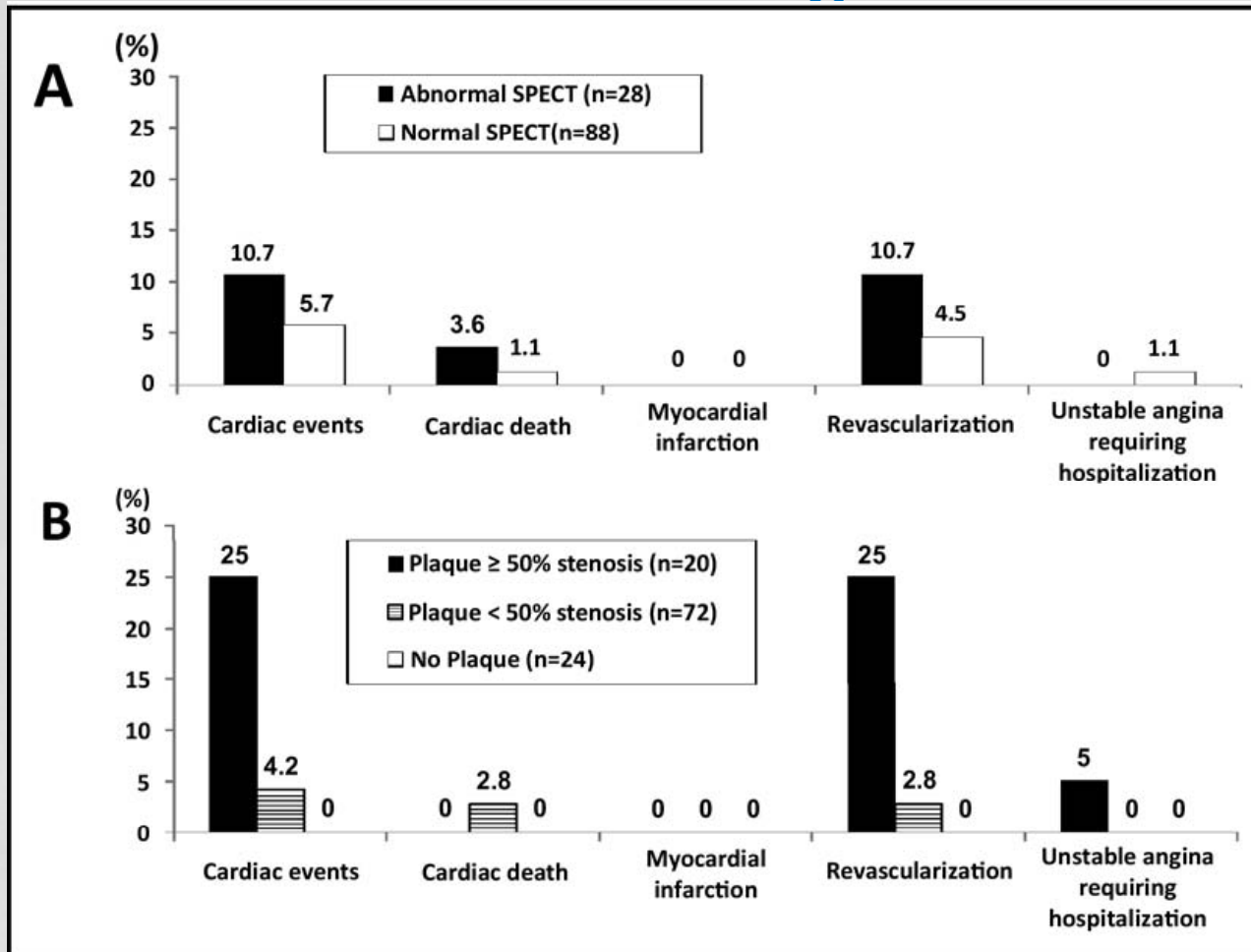
^bLog-rank P values are derived from unadjusted actuarial survival analysis.

^cOne patient had 2 secondary events.

^dThree patients underwent both PTCA and CABG surgery.

- Cardiac event rates were low and were not significantly reduced by MPI screening for myocardial ischemia over 4.8 years.

CTCA as a Screening Tool in Asymptomatic DM



SPECT showed **limited** capability to differentiate the coronary risk

CTCA: **Higher prognostic power** than SPECT in prediction of MACE and cardiac mortality.

CTCA as a Screening Tool in Asymptomatic DM: Multi-center Clinical Trial -ACCREDIT STUDY

ClinicalTrials.gov
A service of the U.S. National Institutes of Health

Home Search Study Topics GI

Study 1 of 1 for search of: ACCREDIT study
[← Previous Study](#) [Return to Search Results](#) [Next Study →](#)

Full Text View [Tabular View](#) [No Study Results Posted](#) [Related Studies](#)

Assessment With CCTA and MRI in Asymptomatic Patients With Type 2 Diabetes for Detection of Unrecognized Myocardial Scar in Subclinical Coronary Atherosclerosis (ACCREDIT)

This study is currently recruiting participants.
 Verified on December 2010 by Guerbet

First Received on October 13, 2010. Last Updated on December 13, 2010 [History of Changes](#)

Sponsor:	Guerbet
Information provided by:	Guerbet
ClinicalTrials.gov Identifier:	NCT01254552

► **Purpose**

This **study** is aimed to answer the clinical question of the prevalence of myocardial scar in asymptomatic patients with type 2 Diabetes Mellitus with a special focus on the diagnostic efficacy of Xenetix® 350-enhanced 64-rows MDCT for the visualisation of the coronary arterial tree and secondarily for the assessment of myocardial viability when using Dotarem® enhanced-cardioMR as the go standard examination.

Condition	Intervention	Phase
Type 2 Diabetes Mellitus Coronary Atherosclerosis	Drug: Iobitridol	Phase IV

Study Type: Interventional
 Study Design: Allocation: Non-Randomized
 Endpoint Classification: Safety/Efficacy Study
 Intervention Model: Single Group Assignment
 Masking: Open Label
 Primary Purpose: Diagnostic

Official Title: Assessment With Cardiac Computed Tomography Angiography (CCTA) and Magnetic Resonance Imaging (MRI) in Asymptomatic Patients With Type 2 Diabetes for Detection of Unrecognized Myocardial Scar in Subclinical Coronary Atherosclerosis



Study Centers (6 sites)



PI: Tae-Hwan Lim, Asan Medical Center

(C01) Joon-Won Kang, Asan Medical Center



(C02) Sang-il Choi, SNU Bundang Hosp.



(C03) Sung-Min Ko, Kunkook U. Medical Center



(C04) Yeon-Hyeon Choi, Samsung Medical Center



(C05) Byoung-Wook Choi, Yonsei U. Sererance Hosp.



(C06) Whal Lee, Seoul National U. Hosp.

CTCA as a Screening tool in Asymptomatic DM

Multi-center Clinical Trial -ACCREDIT STUDY

Resource links provided by NLM:

[Genetics Home Reference](#) related topics: [6q24-related transient neonatal diabetes mellitus](#)

[MedlinePlus](#) related topics: [Atherosclerosis](#) [Coronary Artery Disease](#) [Diabetes](#) [Scars](#)

[Drug Information](#) available for: [lobitridol](#)

[U.S. FDA Resources](#)

Further study details as provided by Guerbet:

Primary Outcome Measures:

- Prevalence of occult myocardial scar on DE-MRI in asymptomatic patients with type 2 diabetes mellitus [Time Frame: one year] [Designated as safety issue: No]

Estimated Enrollment: 340
Study Start Date: August 2010
Estimated Study Completion Date: December 2016
Estimated Primary Completion Date: December 2011 (Final data collection date for primary outcome measure)

Intervention Details:

Drug: lobitridol
Xenetix 350

► Eligibility

Ages Eligible for Study: 50 Years to 75 Years
Genders Eligible for Study: Both
Accepts Healthy Volunteers: No

Criteria

Inclusion Criteria:

- Patient with onset of type 2 diabetes occurred at age 30 years or older
- Patient between the ages of 50 and 75 years at enrolment time
- Patient with at least two identified cardiac risk factors who will undergo a CMR and a CCTA examinations to evaluate his/her coronary and cardiac status

Exclusion Criteria:

- Patient with angina pectoris or chest discomfort
- Patient with stress test or invasive coronary angiography within the prior 3 years
- Patient with history of myocardial infarction, overt non compensated heart failure, or coronary revascularization
- Patient with hemodynamic instability.
- Patient with a contraindication or intolerance to Beta-Blocker administration

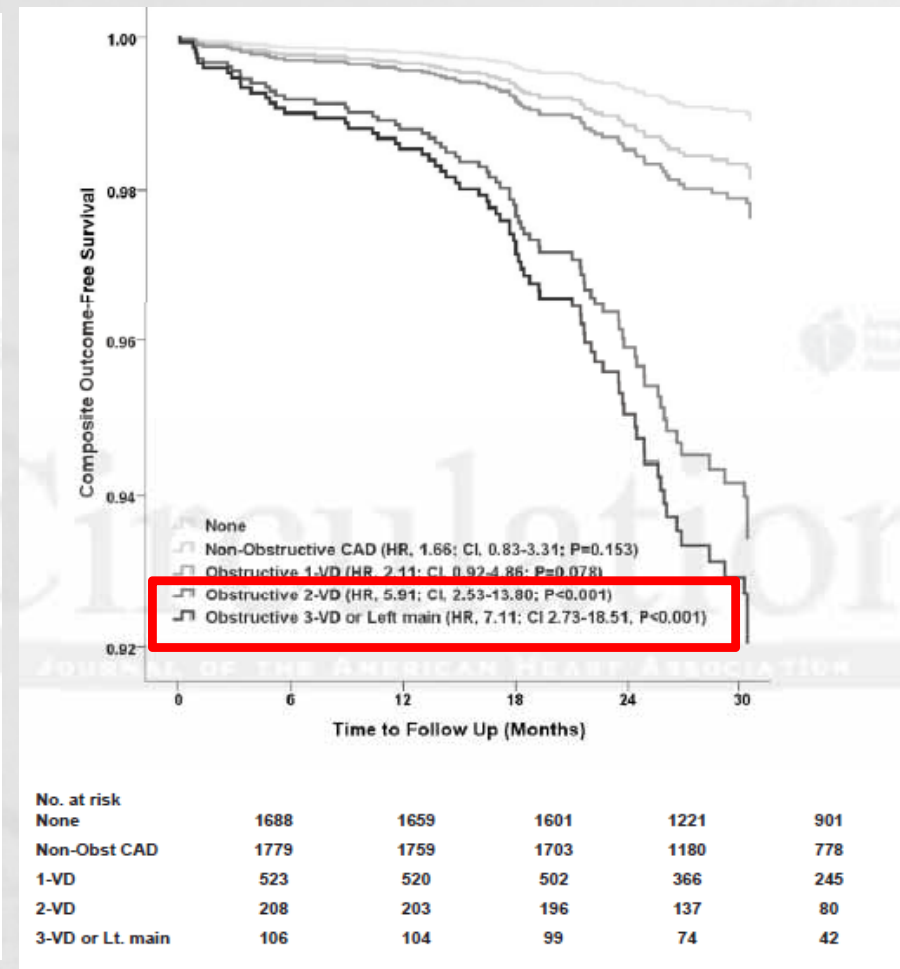
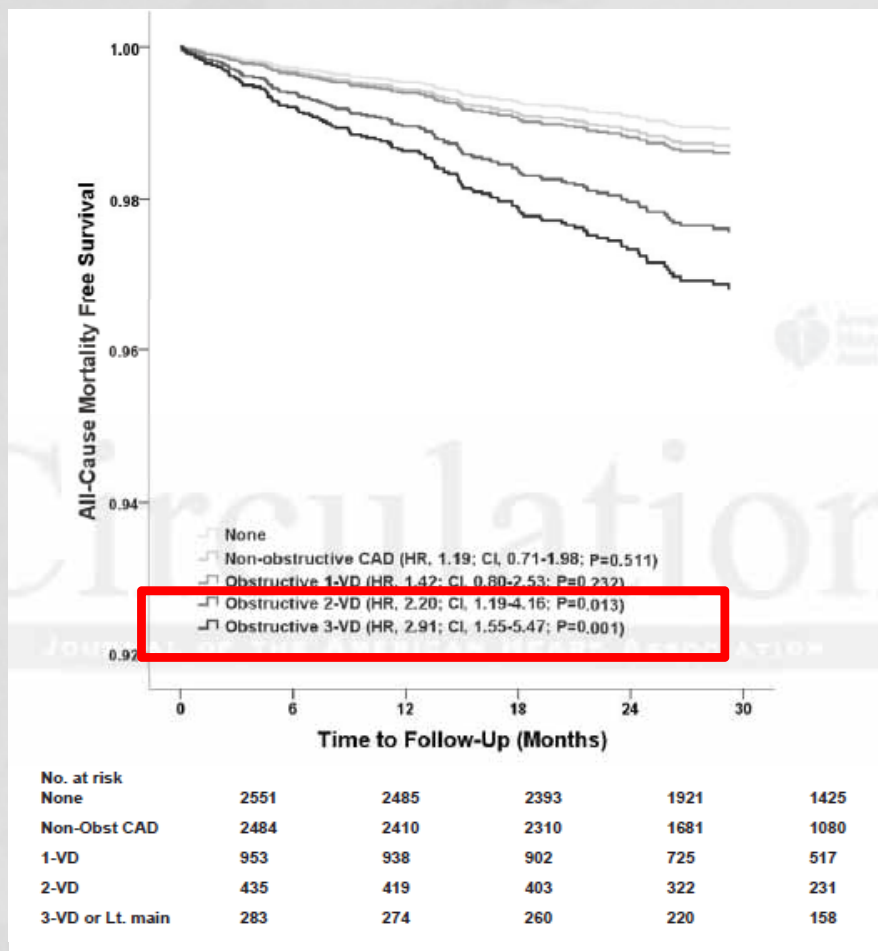
Prognostic value of CTCA in Asymptomatic Patients

Table 3. C Statistics for Prediction of 2.5-Year Risk of All-Cause Mortality and Composite Outcome of All-Cause Mortality and Non-Fatal MI using Combined Models of Framingham Risk Factors plus CACS or cCTA

Model	C statistics*	
	FRS	Individual Risk Factors*
	All-Cause Mortality (N=3,900)	
Model I: RFs only	0.62 (0.55 ~ 0.69)	0.76 (0.70 ~ 0.83)
Model II: RFs + CACS	0.71 (0.65 ~ 0.77)	0.78 (0.65 ~ 0.84)
Model III: RFs + CACS+NIV	0.73 (0.67 ~ 0.78)	0.78 (0.67 ~ 0.84)
Model IV: RFs + CACS+ Duke	0.72 (0.66 ~ 0.78)	0.78 (0.66 ~ 0.84)
Model V: RFs + CACS+ SSS	0.72 (0.66 ~ 0.78)	0.78 (0.66 ~ 0.84)
Model VI: RFs + CACS+ SIS	0.72 (0.66 ~ 0.78)	0.78 (0.66 ~ 0.84)
	Composite Outcome of All-Cause Mortality and Non-fatal MI (N=3,217)	
Model I: RFs only	0.59 (0.52 ~ 0.67)	0.71 (0.63 ~ 0.78)
Model II: RFs + CACS	0.71 (0.64 ~ 0.78)	0.75 (0.68 ~ 0.81)
Model III: RFs + CACS+NIV	0.74 (0.66 ~ 0.81)	0.77 (0.70 ~ 0.84)
Model IV: RFs + CACS+ Duke	0.74 (0.67 ~ 0.81)	0.76 (0.69 ~ 0.83)
Model V: RFs + CACS+ SSS	0.74 (0.67 ~ 0.81)	0.76 (0.69 ~ 0.83)
Model VI: RFs + CACS+ SIS	0.74 (0.68 ~ 0.81)	0.76 (0.69 ~ 0.83)

* Baseline risk factors were entered as a combined score in the FRS (Framingham Risk Score) column and as individual Framingham risk variables (age, gender, hypertension, diabetes, current smoking, and dyslipidemia) in the Individual Risk Factors column
 CACS indicates coronary artery calcium score; CAD, coronary artery disease; cCTA, coronary computed tomographic angiography; CI, confidence interval; Duke, Duke CAD prognostic index; FRS, Framingham risk score; N, number of patients; NIV, number of involved vessels (categorized as none, non-obstructive CAD, obstructive 1-VD, 2-VD, 3-VD or left main CAD); RFs, Framingham risk factors; SIS, segment involvement score; SSS, segment stenosis score ;VD, vessel disease

Prognostic value of CTCA in Asymptomatic Patients



CTCA as screening tool: in Asymptomatic DM - Limitation

- Not accepted as appropriate indication

Table 2 Detection of CAD: asymptomatic (without chest pain syndrome)

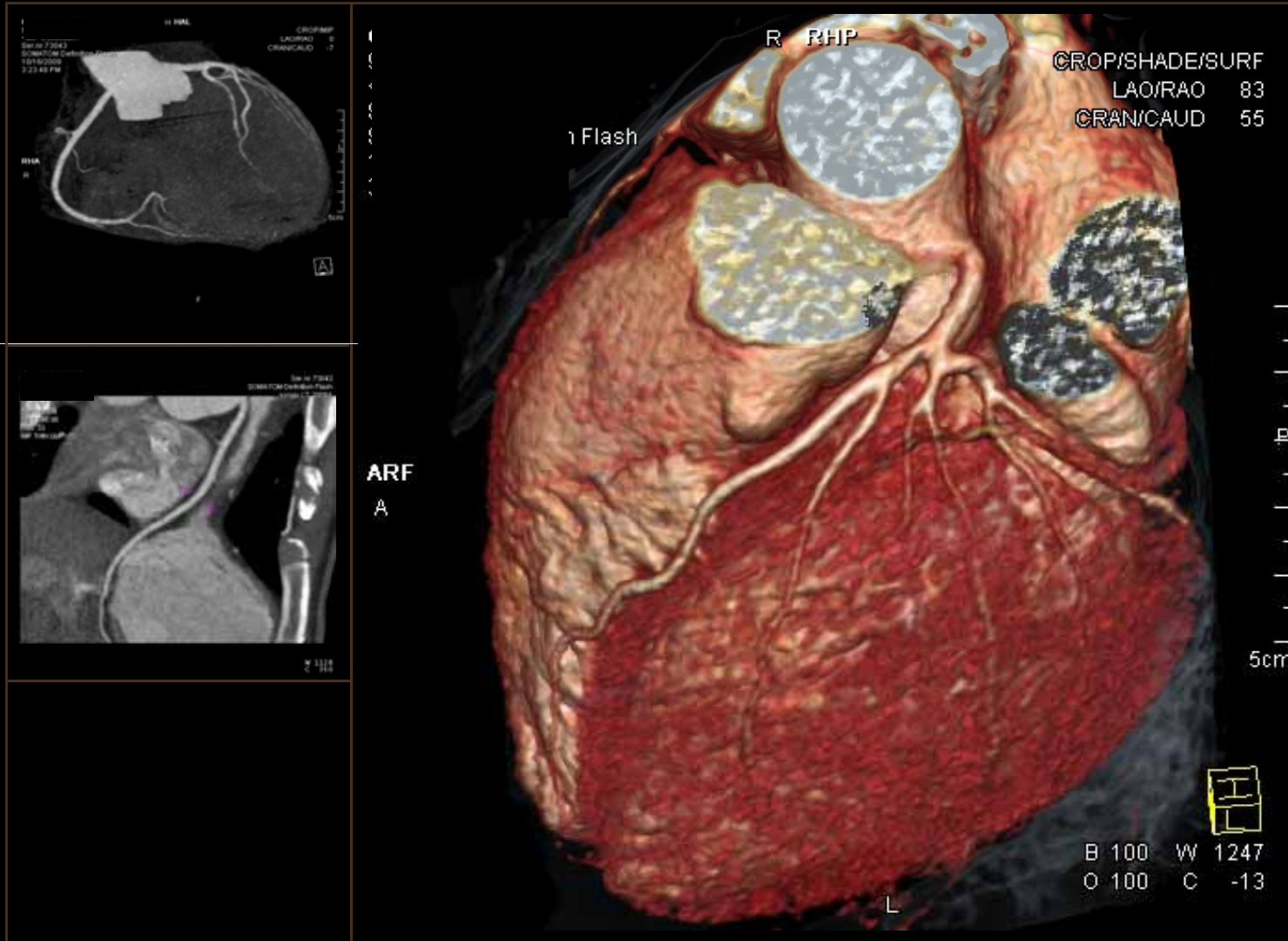
Indication		Appropriateness Criteria (Median Score)	Note
Asymptomatic (Use of Cardiac CT)			
10	- Low CHD risk (Framingham risk criteria)	I (2)	- Highly agreed - ACCF indication no. 10
11	- Moderate CHD risk (Framingham)	U (5)	- ACCF indication no. 11
12	- High CHD risk (Framingham)	A (7)	- ACCF indication no. 12

* CHD = coronary heart disease

Int J Cardiovasc Imaging 2010; 26(suppl):1-15

- Radiation Exposure
 - Solution: Low dose coronary CT

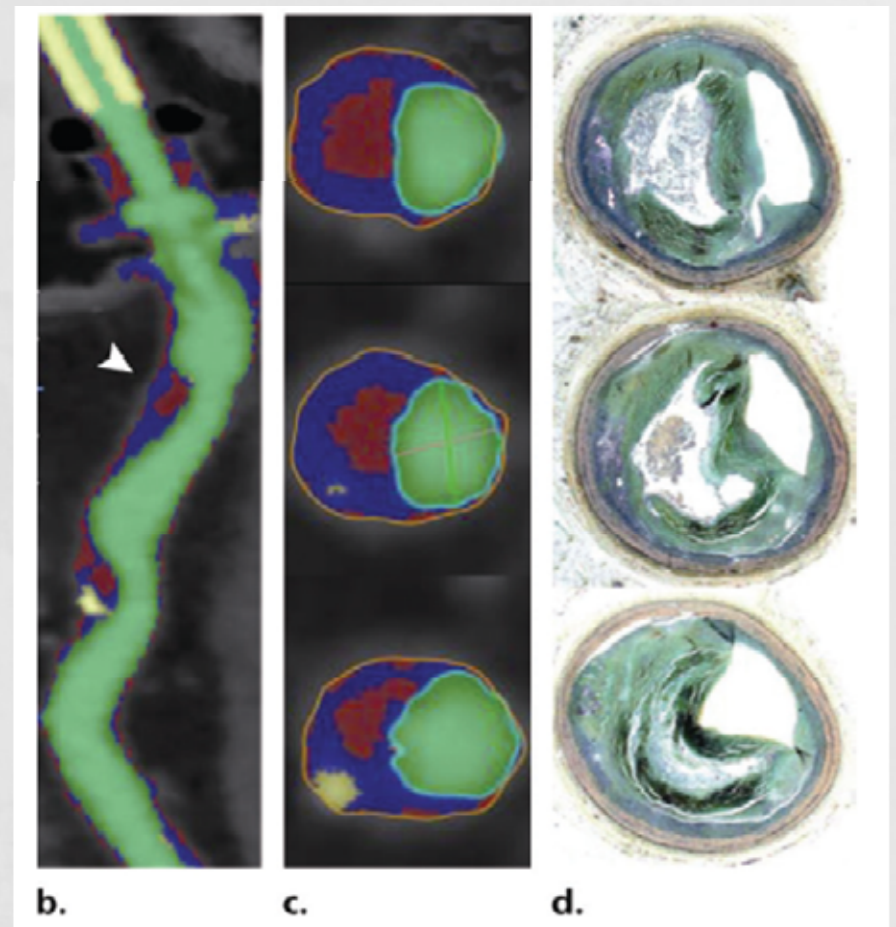
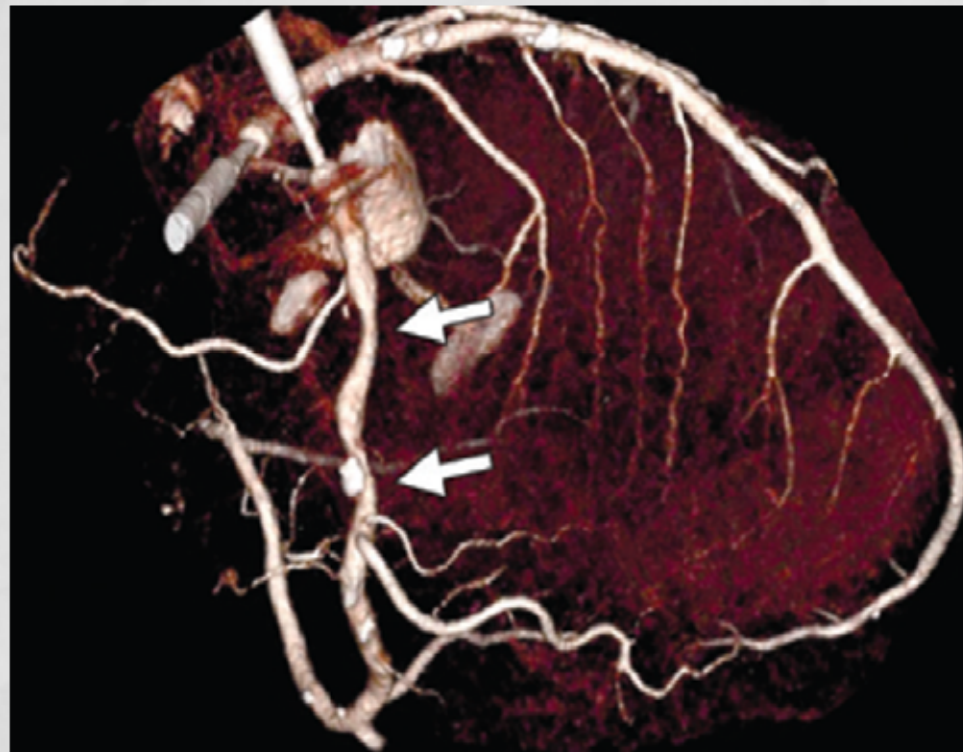
Low dose CT using 0.9 mSv



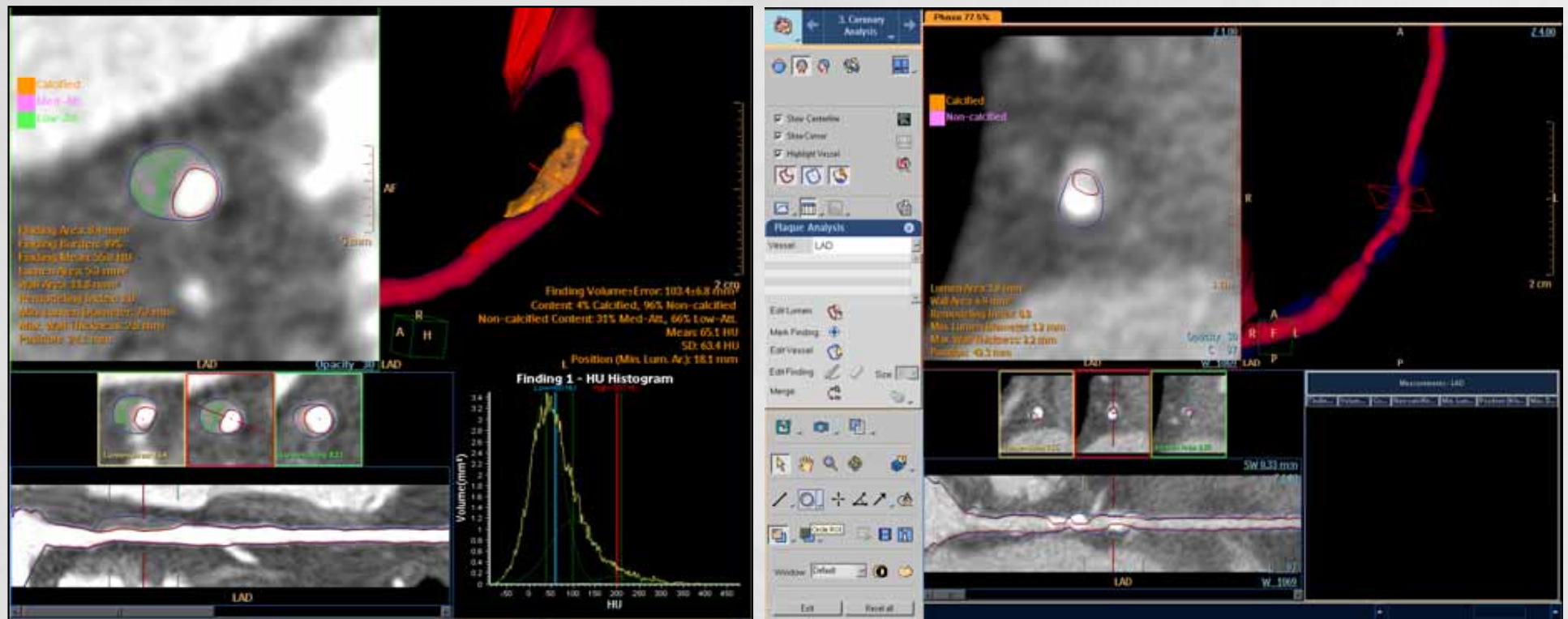
0.9 mSv
temp res. 75 ms
spatial res. 0.33
mm
100 kV, 320
mAs/rot

Courtesy by
Choo, KS
PNUH

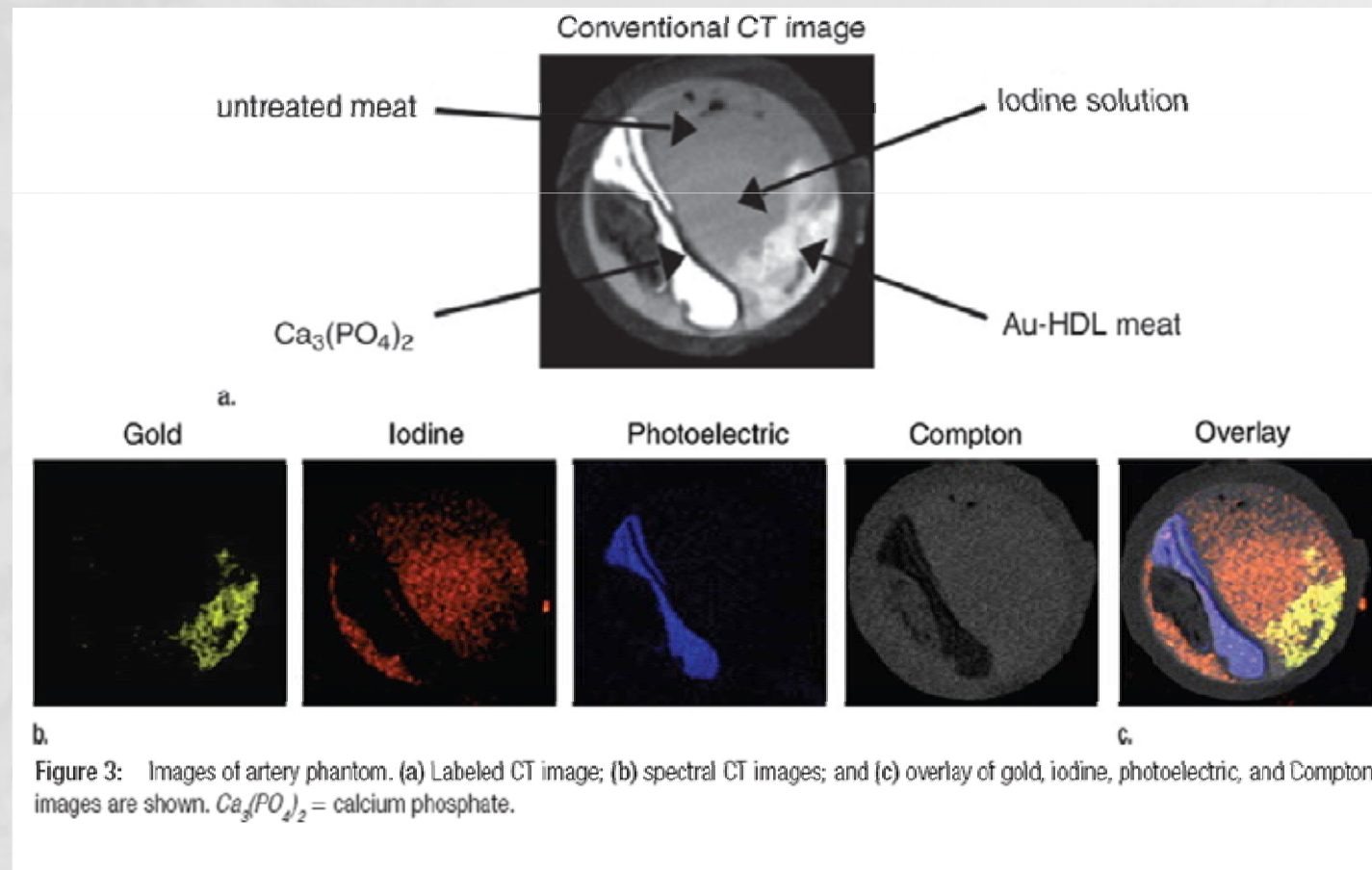
Future of CCTA: Plaque Imaging



Future of CTCA: Plaque Imaging + Quantification



Future of CTCA: Nano-particles & multi-energy imaging



Role of CT Imaging in Risk Stratification

- CAC
 - **Incremental prognostic information** in addition to the assessment of conventional risk factors
 - **Limitation** to represent the whole spectrum of atherosclerosis (**non-calcified plaque**) and to diagnose **obstructive CAD**
- CTCA
 - Potential to provide comprehensive information regarding the **location, severity, and characteristics** of atherosclerotic plaque.
 - Potential tool for providing a better insight about the **occult CAD** in asymptomatic individuals.
 - **Limitations** of radiation exposure, lack of evidences

Acknowledgement

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