MU Health Care

Coronary CT in Chest Pain
A Paradigm Shift

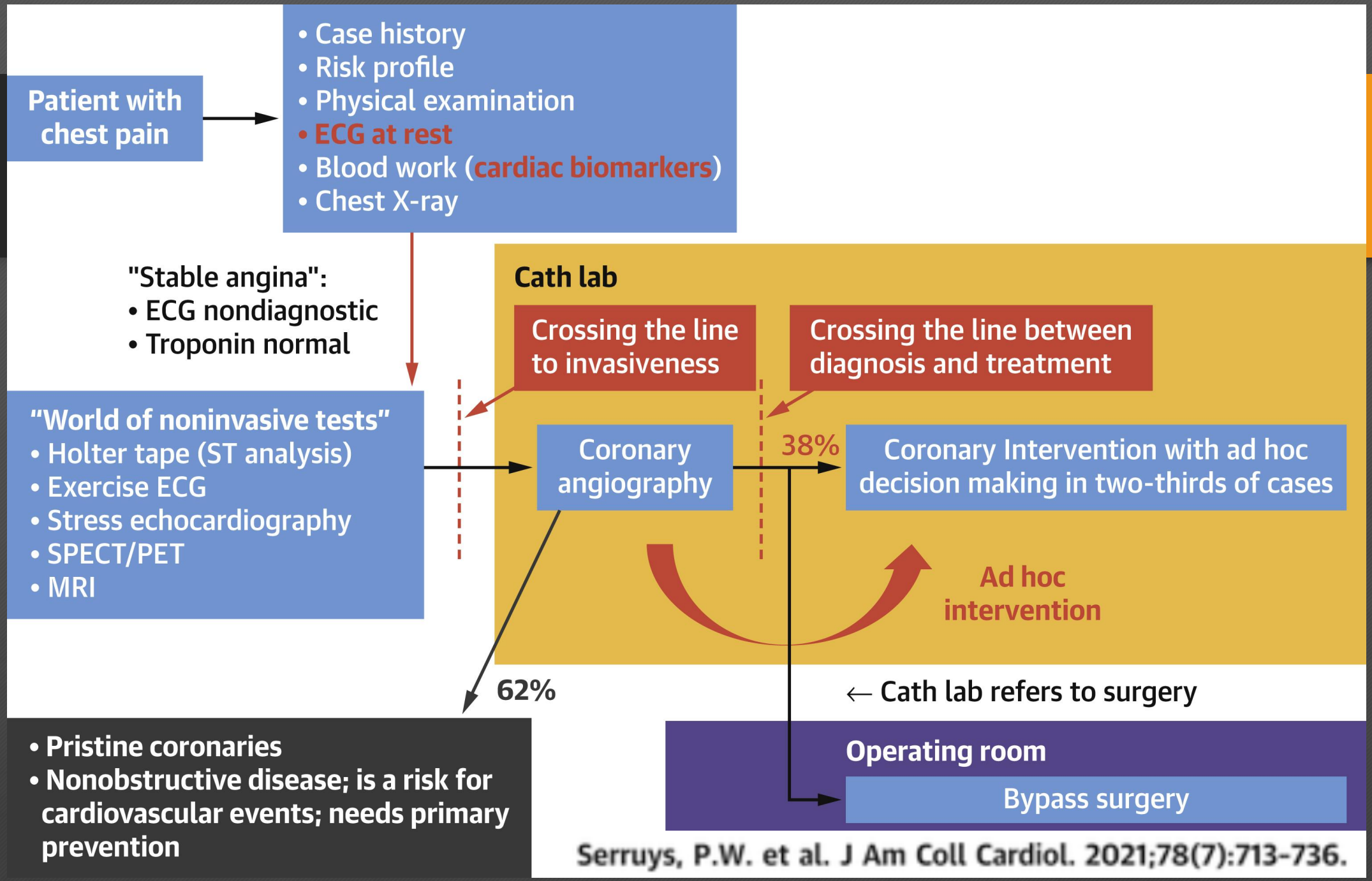
Z Luebbering DO

Disclosures

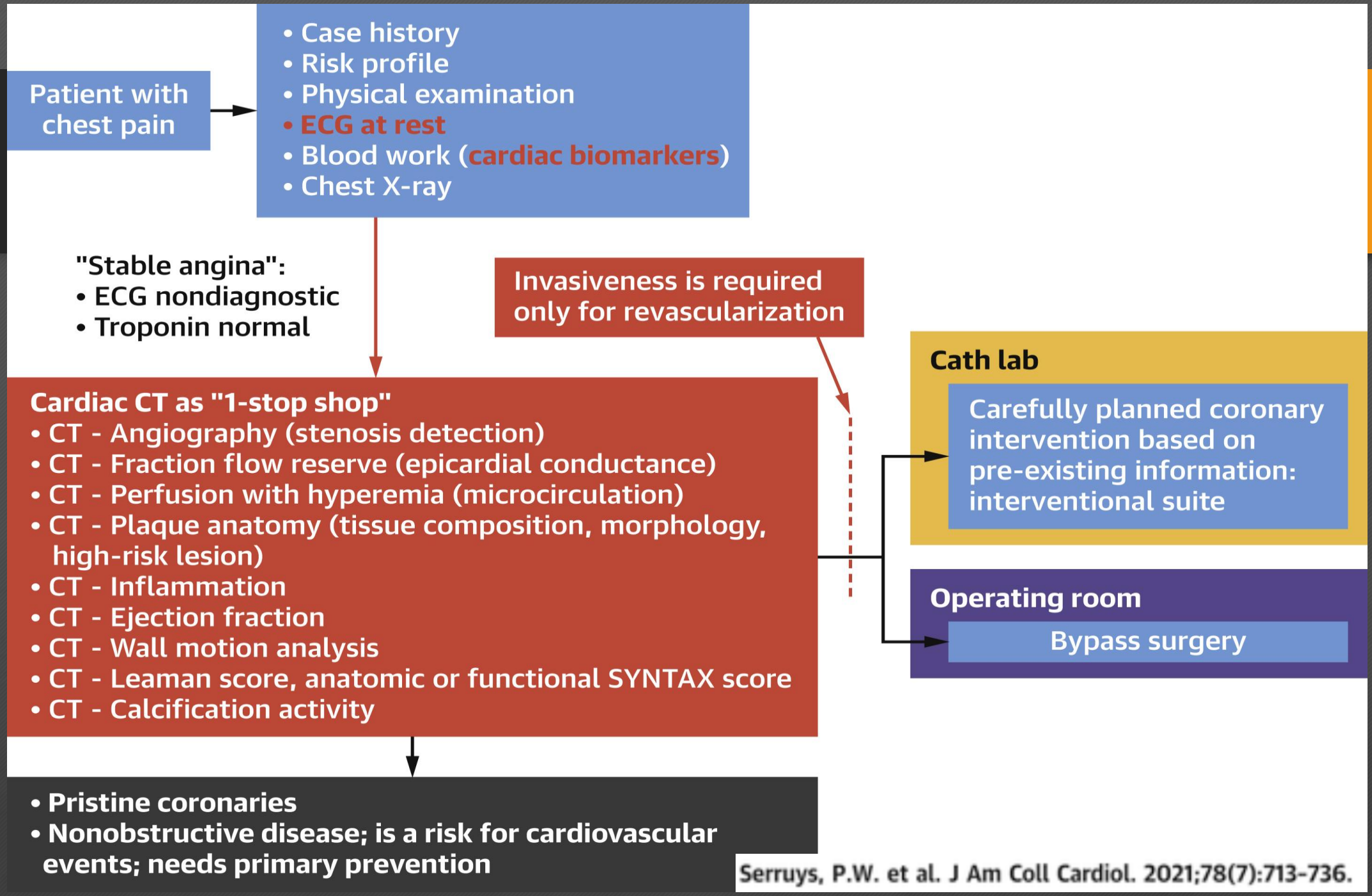
- None of the speakers for this educational activity have relevant financial relationship(s) to disclose with ineligible companies whose primary business is producing, marketing, selling, reselling, or distributing healthcare products used by or on patients.

Objectives

- Briefly assess how Cardiac CT and calcium scoring are acquired and technological improvements in CCTA technology to make this possible
- Explain differences of calcium scoring from CCTA and its clinical utility in cardiovascular risk stratification
- Discuss landmark trials and evidence for clinical use of CCTA for assessment of cardiovascular risk, along with diagnosis of coronary artery disease
- Review guidelines from the ACC for chest pain and the incorporation of CCTA
- Discuss future directions and uses of Cardiac CT



Serruys, P.W. et al. J Am Coll Cardiol. 2021;78(7):713-736.


Patient with chest pain
• Case history
• Risk profile
• Physical examination
• ECG at rest
• Blood work (cardiac biomarkers)
• Chest X-ray
"Stable angina":
• ECG nondiagnostic
• Troponin normal
Invasiveness is required only for revascularization
Cardiac CT as "1-stop shop"
• CT - Angiography (stenosis detection)
• CT - Fraction flow reserve (epicardial conductance)
• CT - Perfusion with hyperemia (microcirculation)
• CT - Plaque anatomy (tissue composition, morphology, high-risk lesion)
• CT - Inflammation
• CT - Ejection fraction
• CT - Wall motion analysis
• CT - Leaman score, anatomic or functional SYNTAX score
• CT - Calcification activity
Cath lab
Carefully planned coronary intervention based on pre-existing information: interventional suite
Operating room
Bypass surgery
• Pristine coronaries
• Nonobstructive disease; is a risk for cardiovascular events; needs primary prevention
Serruys, P.W. et al. J Am Coll Cardiol. 2021;78(7):713-736.

Catching Up

European countries have led in CORONARY CT (CCTA) use.

First-line modality in evaluation of chest pain

- Guidelines from the United Kingdom in 2016
- European Society of Cardiology in 2019.

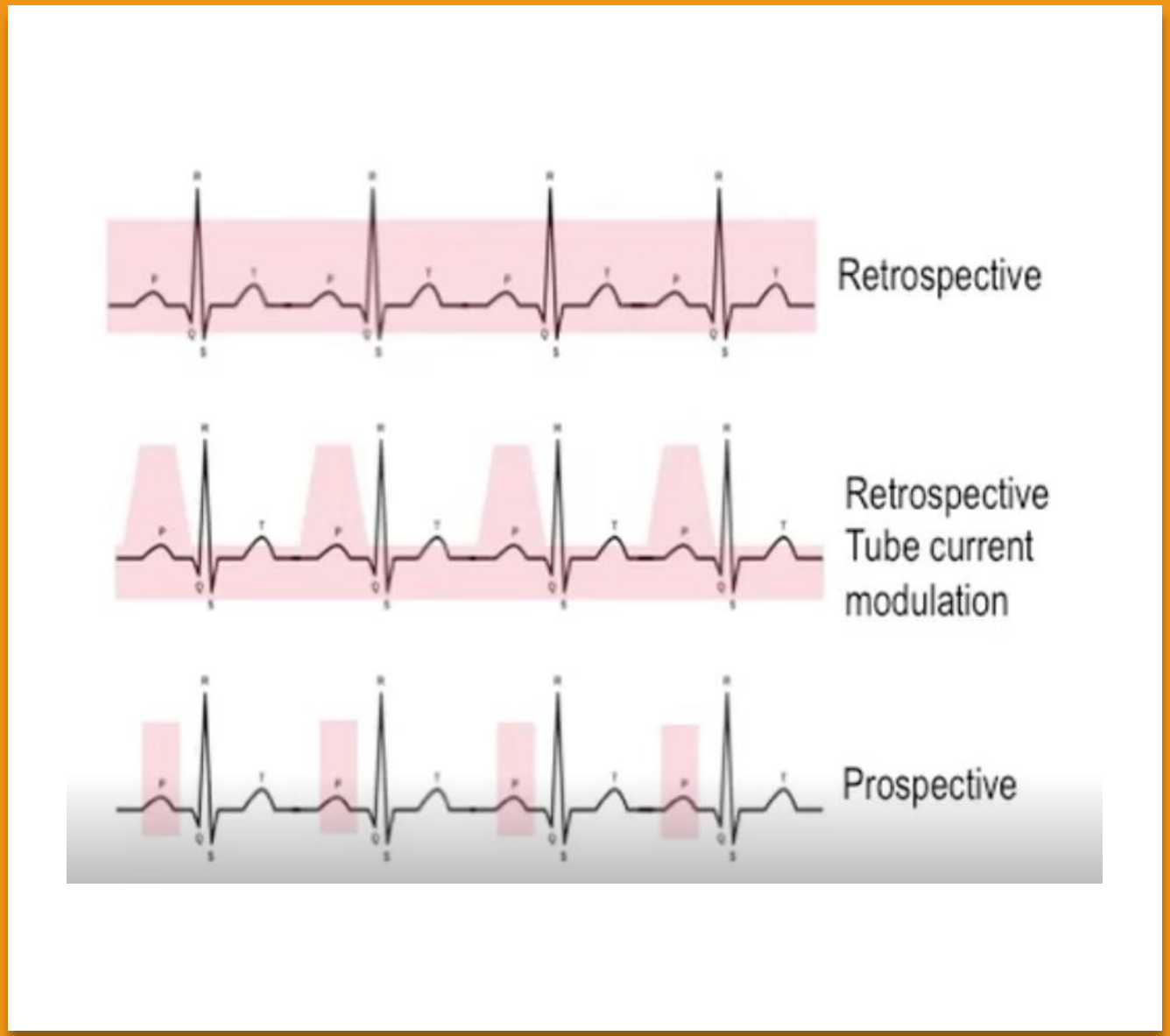
CP guidelines (AHA, ACC, ASE, CHEST, SAEM, SCCT, SCMR, Nov 2021)

1	A	**1. For intermediate-high risk patients with stable chest pain and no known CAD, CCTA is effective for diagnosis of CAD, for risk stratification, and for guiding treatment decisions.**

1	A	1. For intermediate-risk patients with acute chest pain and no known CAD eligible for diagnostic testing after a negative or inconclusive evaluation for ACS, CCTA is useful for exclusion of atherosclerotic plaque and obstructive CAD (1-11).

Tech that makes Cardiac CT possible

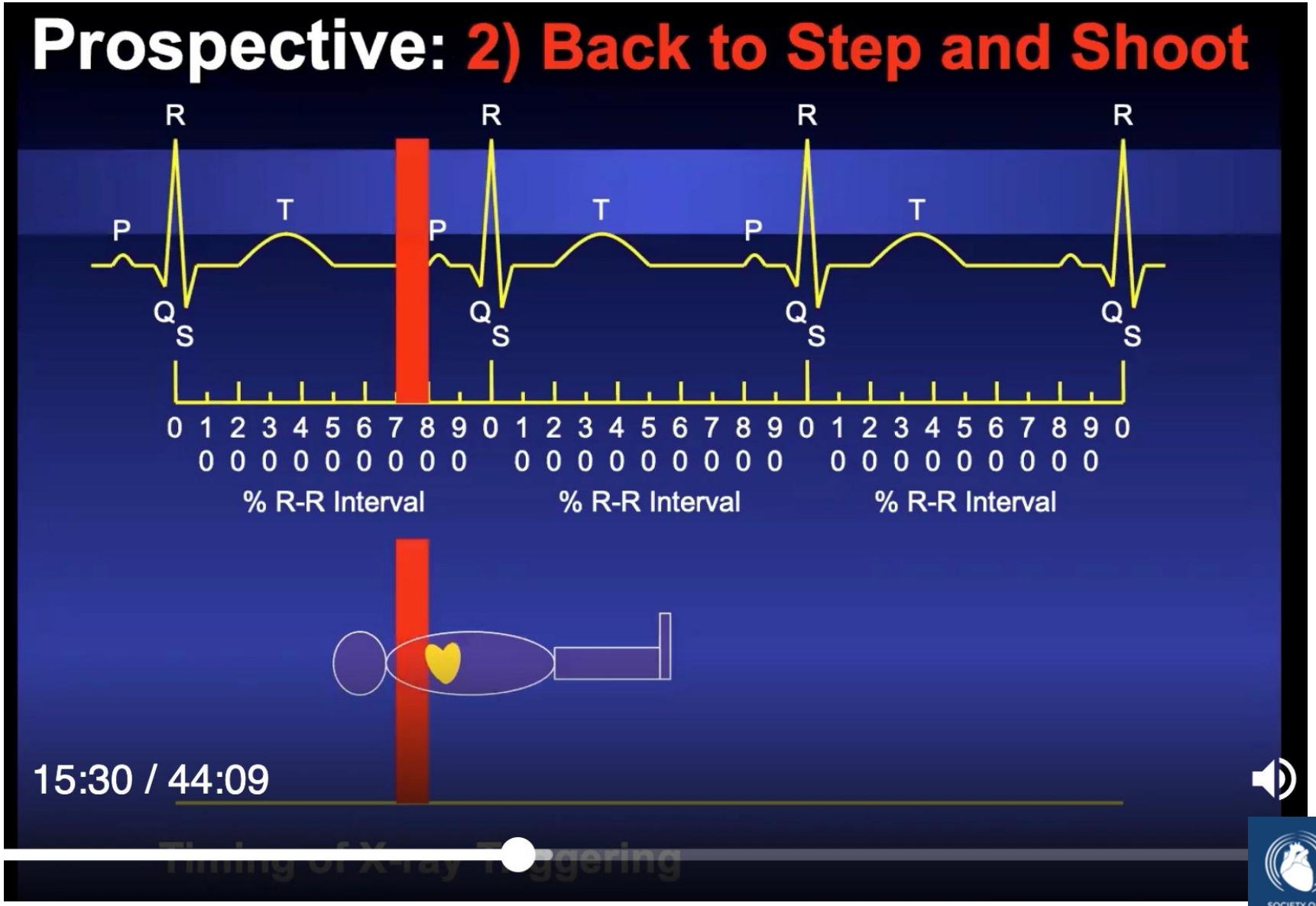
- Coronary arteries are mobile so gating is required to overcome motion
- imaging during the phases where they are least mobile is paramount to image quality
- Protocols modulating X-ray tube during specific phases greatly reduce radiation
- Heart rate control with beta blockers is essential



Technological Advancements

- Increased gantry spin times
- Increased number of detector rows (256 and 320 slice)
- Dual source scanning

https://www.siemens-healthineers.com/


Prospective: 2) Back to Step and Shoot
R
R
R
R
P
T
P
T
P
T
Q
S
Q
S
Q
S
Q
S
0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0
0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
% R-R Interval
% R-R Interval
% R-R Interval
15:30 / 44:09

Differences between Coronary CT and Coronary Calcium Scores

https://www.ucsfhealth.org/medical-tests/heart-ct-scan

Calcium Scoring

Table 1:

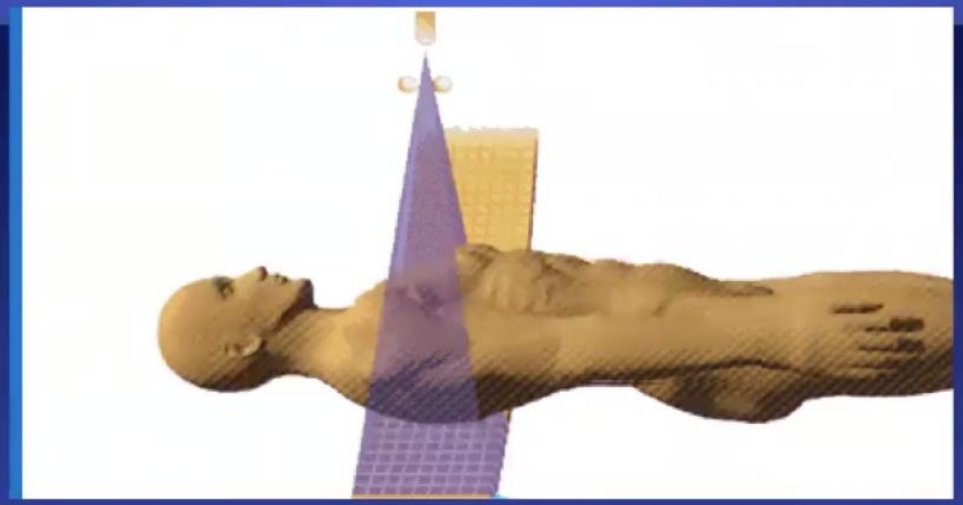
The Calculation of an Agatston Calcium Score

Agatston Calcium Score
Density in Hounsfield units (HU): • 1: 130–199 HU • 2: 200–299 HU • 3: 300–399 HU • 4: >400 HU This weighted score is then multiplied by the area mm^2.

www.ncbi.nlm.nih.gov/pmc/articles/PMC7066830/

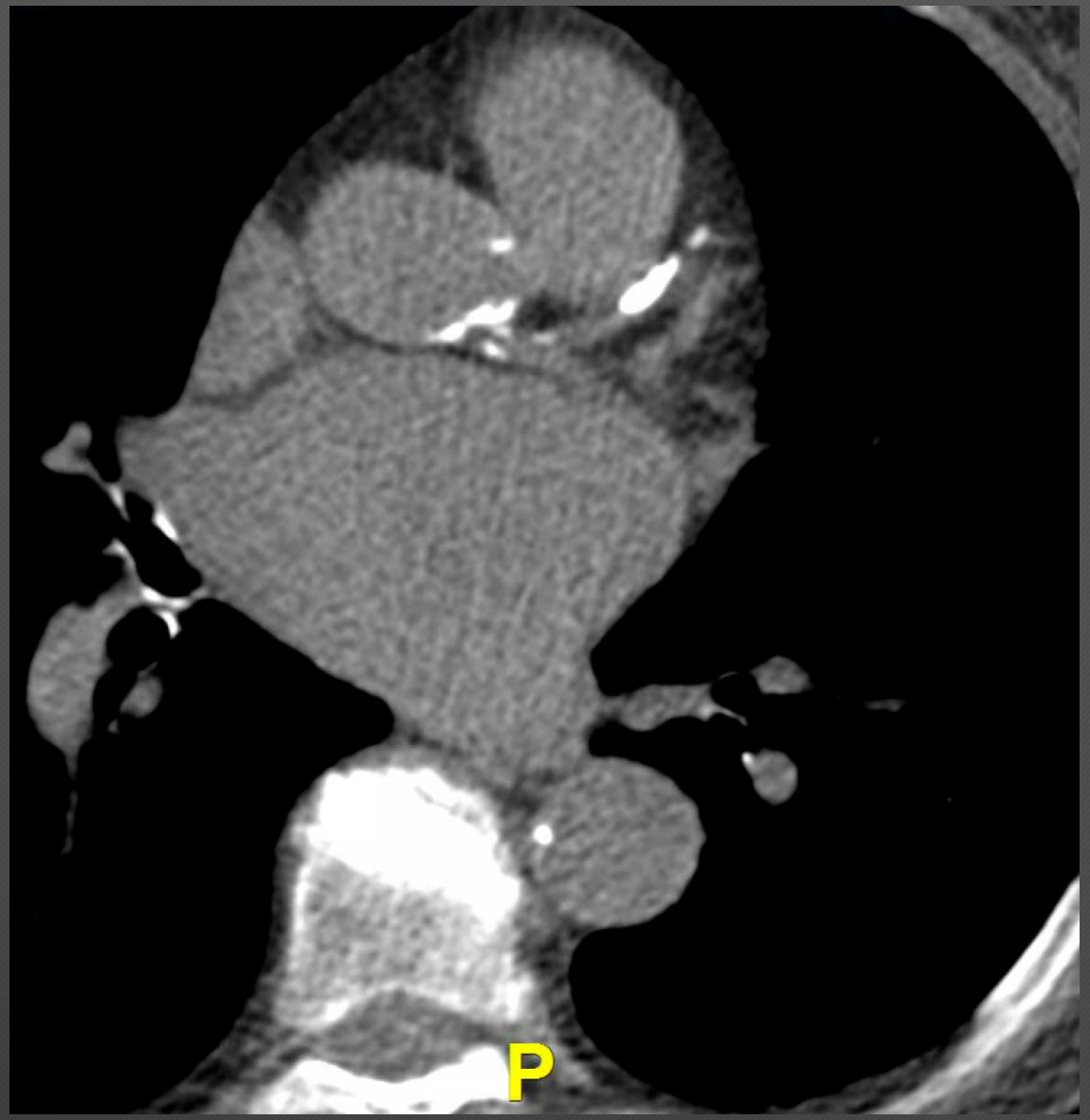
- Initially developed in 1990 to quantify the degree of calcium within the coronary
- Agatston score relies on calcium density and total area of calcification
- Gated, non contrast scan
- Relatively low radiation (1mSv NIH.gov)

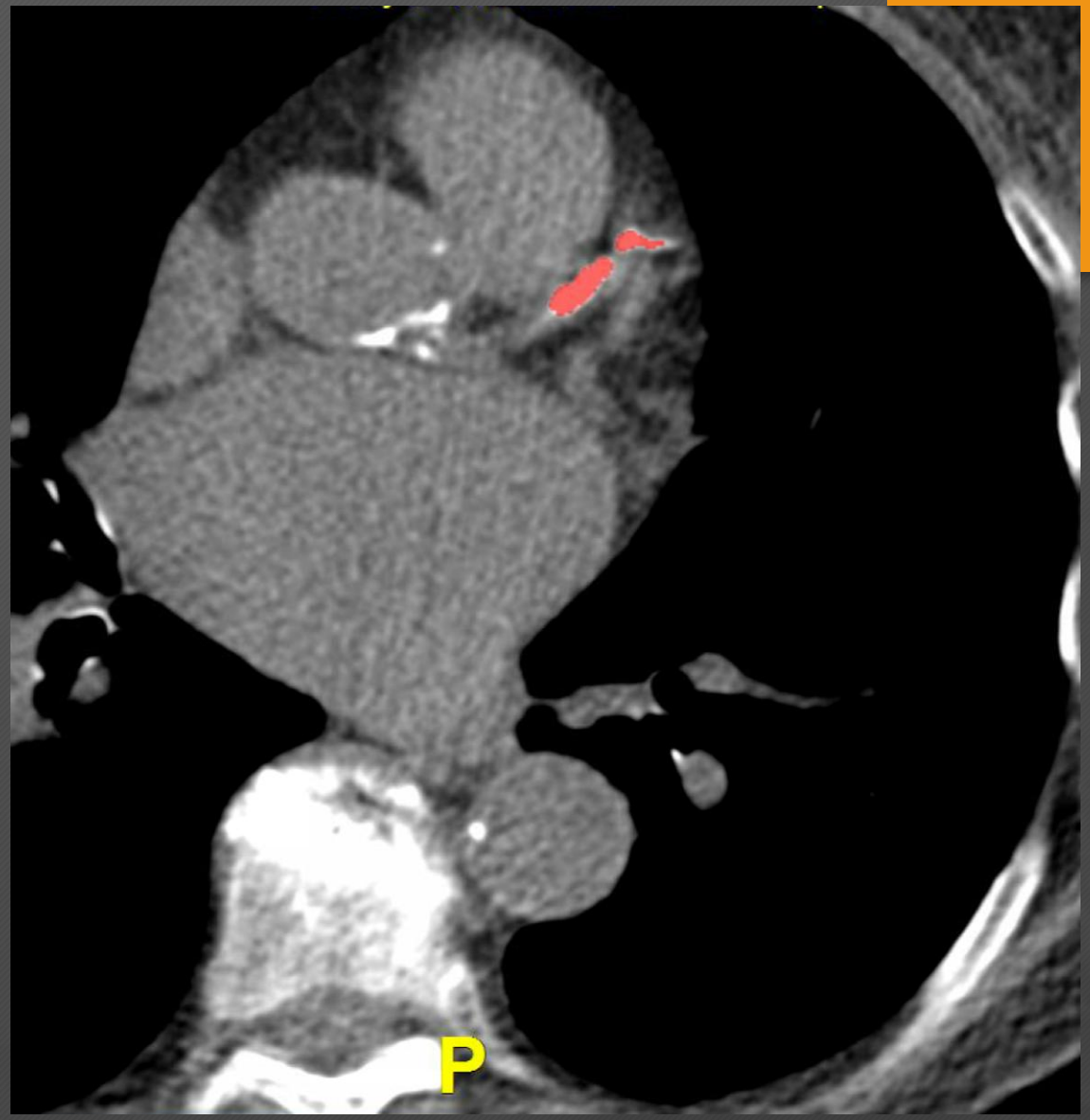
Calcium Score Acquisition



- Slice thickness: 3mm
- Prospectively triggered scan
- Target exposure depends on heart rate (40-75%)
- Tube potential 120 kV, tube current variable
- No contrast

SCCT
SOCIETY OF CARDIOVASCULAR COMPUTED TOMOGRAPHY


P


P

Common Indications

- Age: >40 y
+
- Risk: Intermediate
+
- Symptoms: Asymptomatic population

Common Treatment Threshold

- CAC = 0: downgrade risk, withhold statin
- CAC >100: Initiate / consider statin

Specialty Guidelines

NATIONAL LIPID ASSOCIATION

- CAC = 0: No statin, repeat 3-7 years.
- CAC >100: High intensity statin + ASA 81 mg.

SCCT
SOCIETY OF CARDIOVASCULAR COMPUTED TOMOGRAPHY

- CAC = 0: No statin.
- CAC >100: High intensity statin + ASA 81 mg.

Golub IS, et al. J Am Coll Cardiol Img. 2023;16(1):98-117.

Patient's 10-year atherosclerotic cardiovascular disease (ASCVD) risk estimate:	<5%	5-7.5%	>7.5-20%	>20%
Consulting ASCVD risk estimate alone	Statin not recommended	Consider for statin	Recommend statin	Recommend statin
Consulting ASCVD risk estimate + CAC				
If CAC score =0	Statin not recommended	Statin not recommended	Statin not recommended	Recommend statin
If CAC score >0	Statin not recommended	Consider for statin	Recommend statin	Recommend statin
Does CAC score modify treatment plan?	✗ CAC not effective for this population	✓ CAC can reclassify risk up or down	✓ CAC can reclassify risk up or down	✗ CAC not effective for this population

Greenland, P. et al. J Am Coll Cardiol. 2018;72(4):434-47.

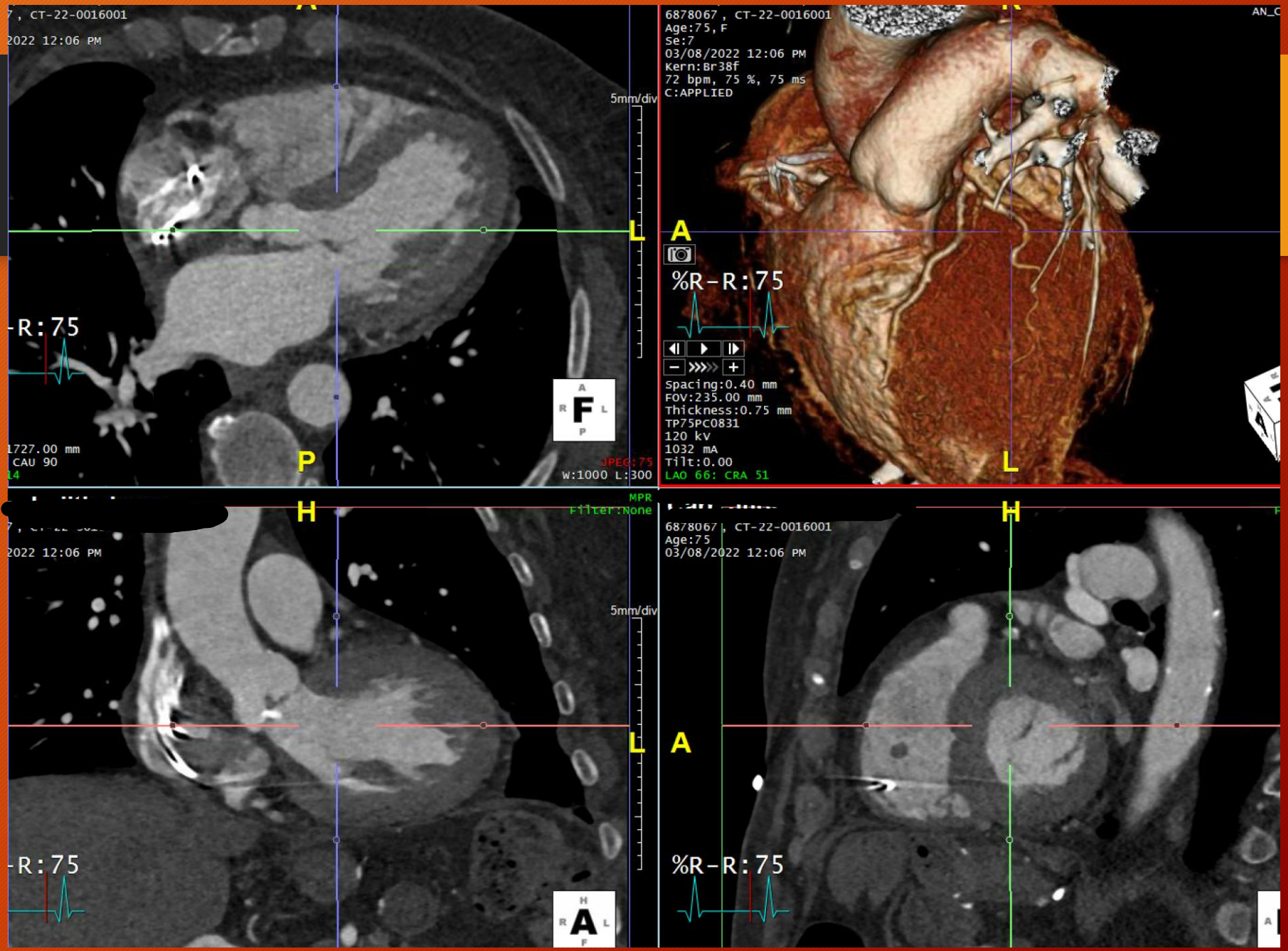
Multiple reconstructions are created each with benefits and shortfalls but combined gives this imaging modality its power.

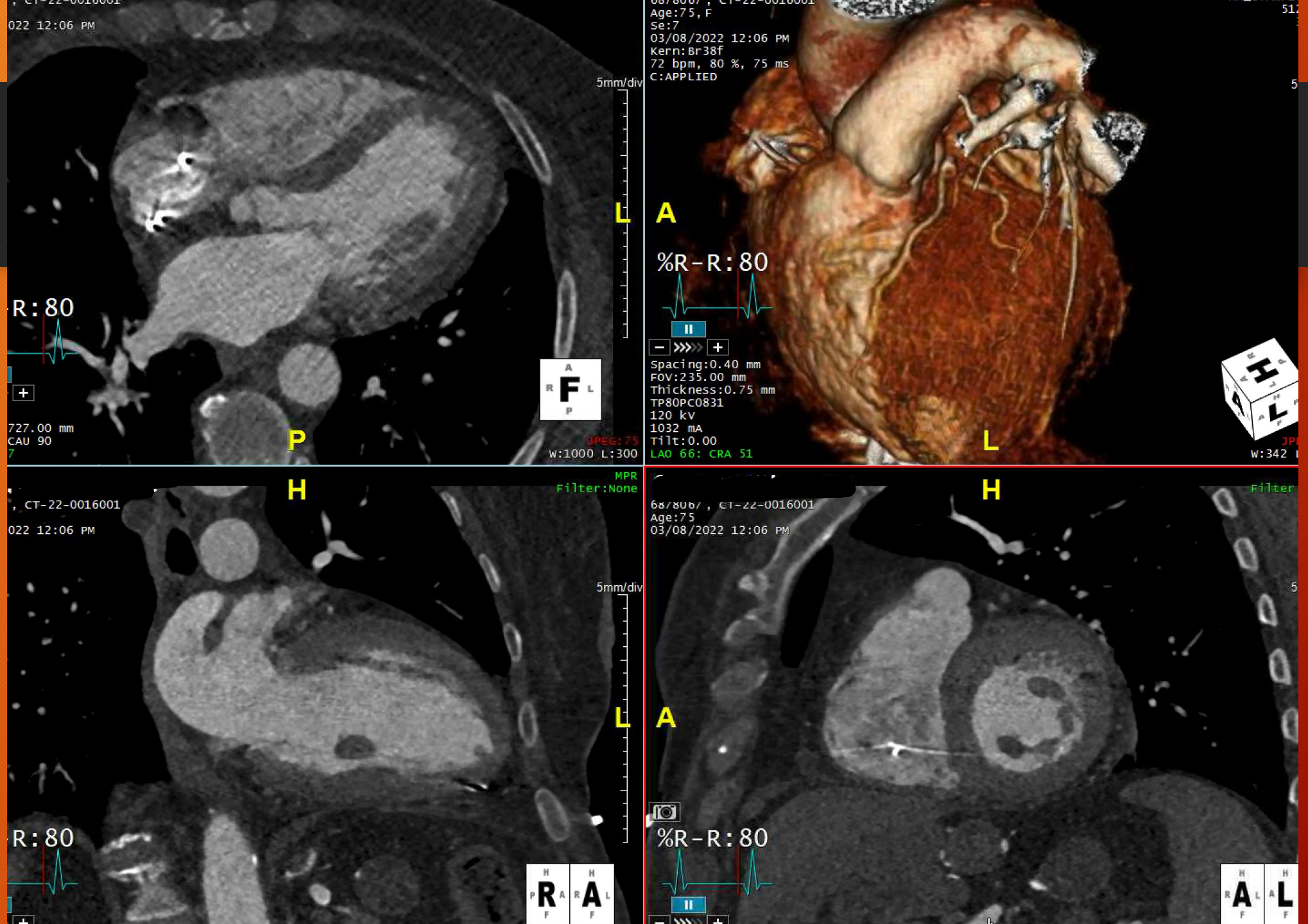
Interpretation of Coronary CT Angiograms

https://www.ucsfhealth.org/medical-tests/heart-ct-scan

MPR (*Multi-planar reformations*)

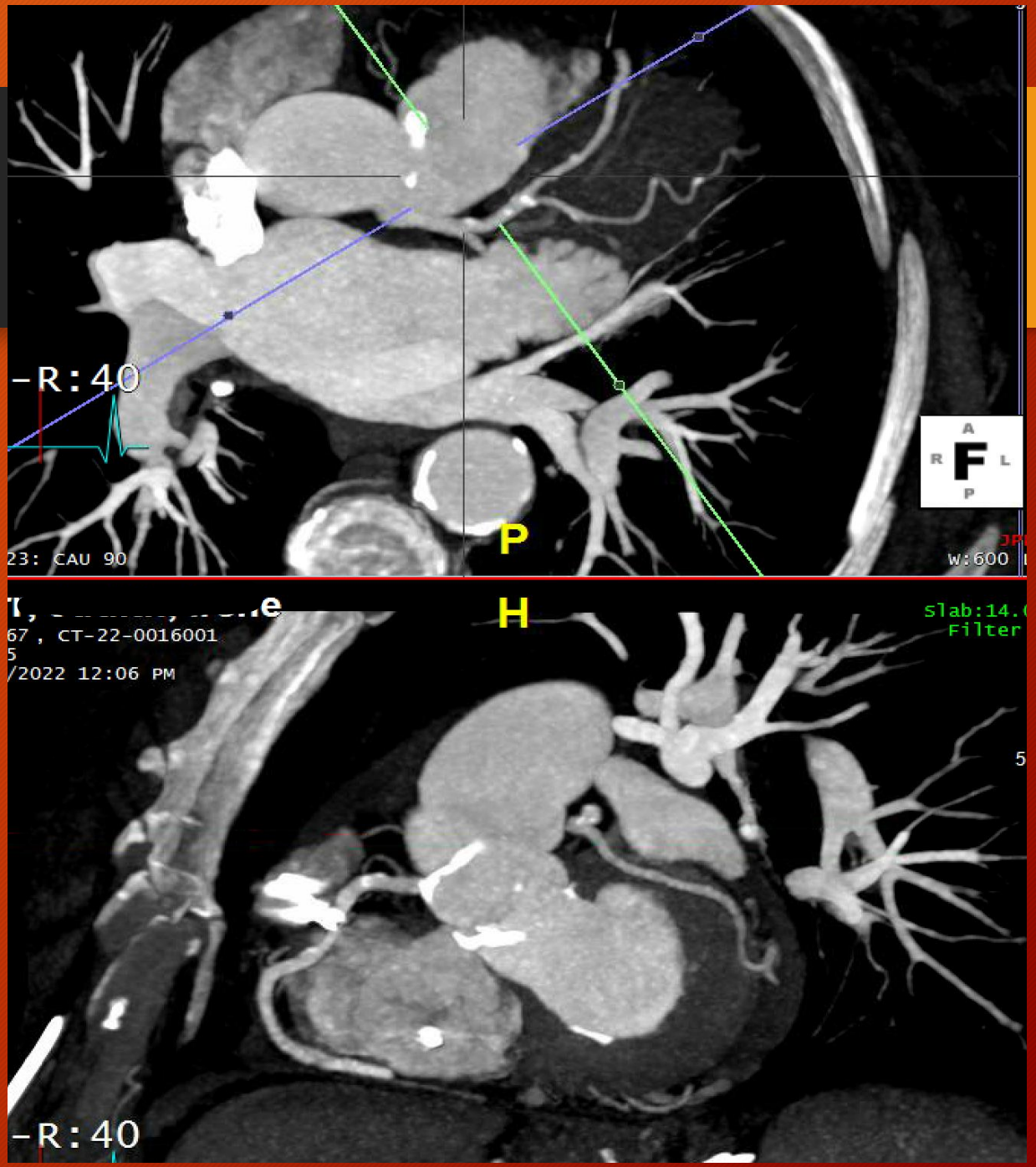
Displays the dataset in any imaging plane of the 3D space




Age:75, F
Se:7
03/08/2022 12:06 PM
Kern:Br38f
72 bpm, 80 %, 75 ms
C:APPLIED
%R-R:80
Spacing:0.40 mm
FOV:235.00 mm
Thickness:0.75 mm
TP80PC0831
120 kV
1032 mA
Tilt:0.00
LAO 66: CRA 51
W:342
5mm/div
727.00 mm
CAU 90
W:1000 L:300
MPR
Filter:None
Age:75
03/08/2022 12:06 PM

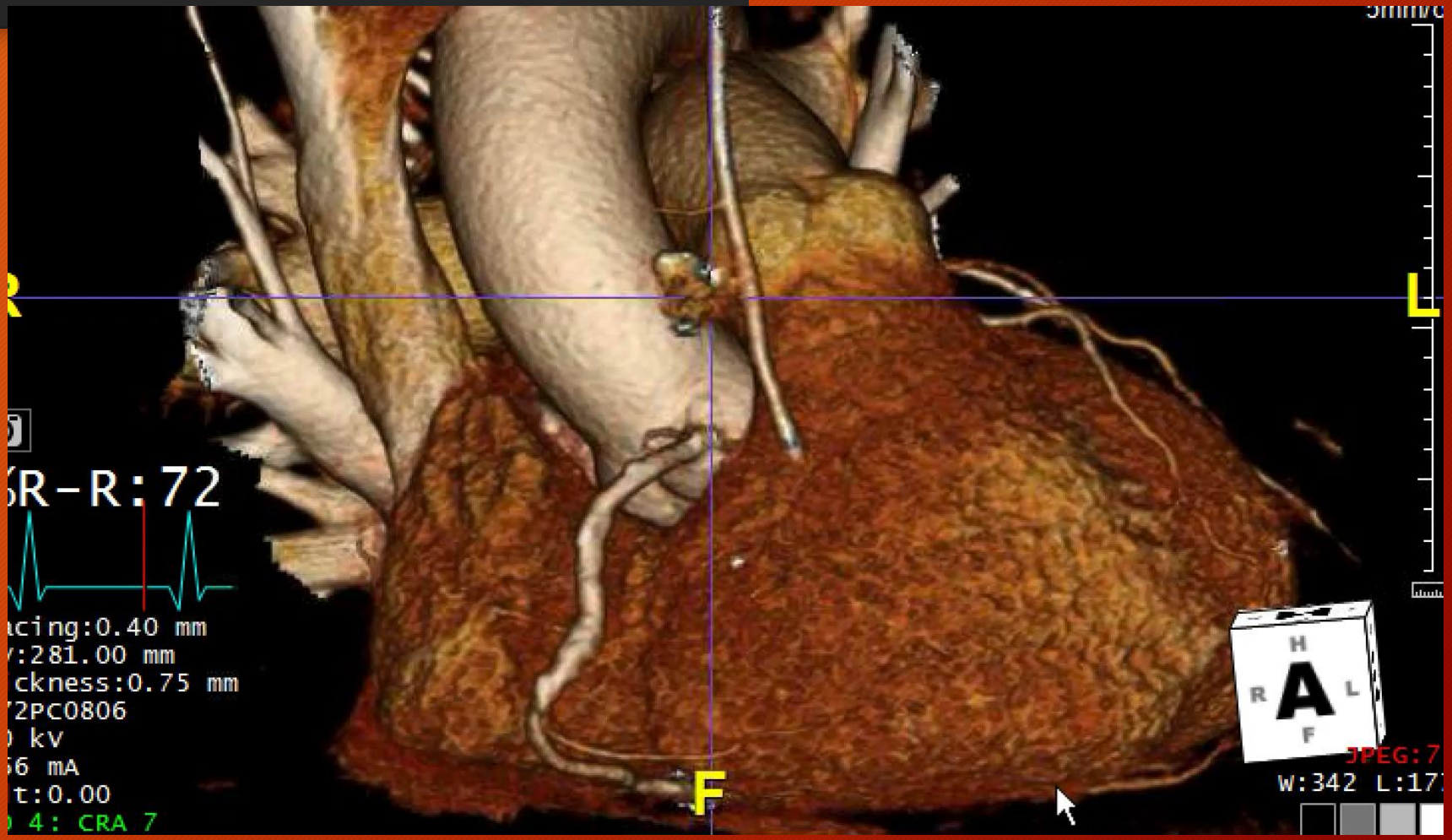
MIP (Maximal Intensity Projection)

- Displays the voxels of highest attenuation within a volume in the direction of view
- provides an angiography-like image



3-Dimensional Volumetric Reconstruction

- Provides a 3D overview of the anatomy
- Assess for coronary anomalies, dominance
- Bypass grafts can be nicely illustrated.
-



Curved Planar Reformation (CPR)

- MPR reconstructed along a vessel centerline,
- Long and tortuous coronary visualization is possible on a single image

Utility of CT

According to several clinical trials, CCTA may predict obstructive CAD better than traditional functional testing.

PROMISE trial

10,003 patients with CP randomized to CTA vs functional testing

The NEW ENGLAND JOURNAL of MEDICINE

ESTABLISHED IN 1812 APRIL 2, 2015 VOL. 372 NO. 14

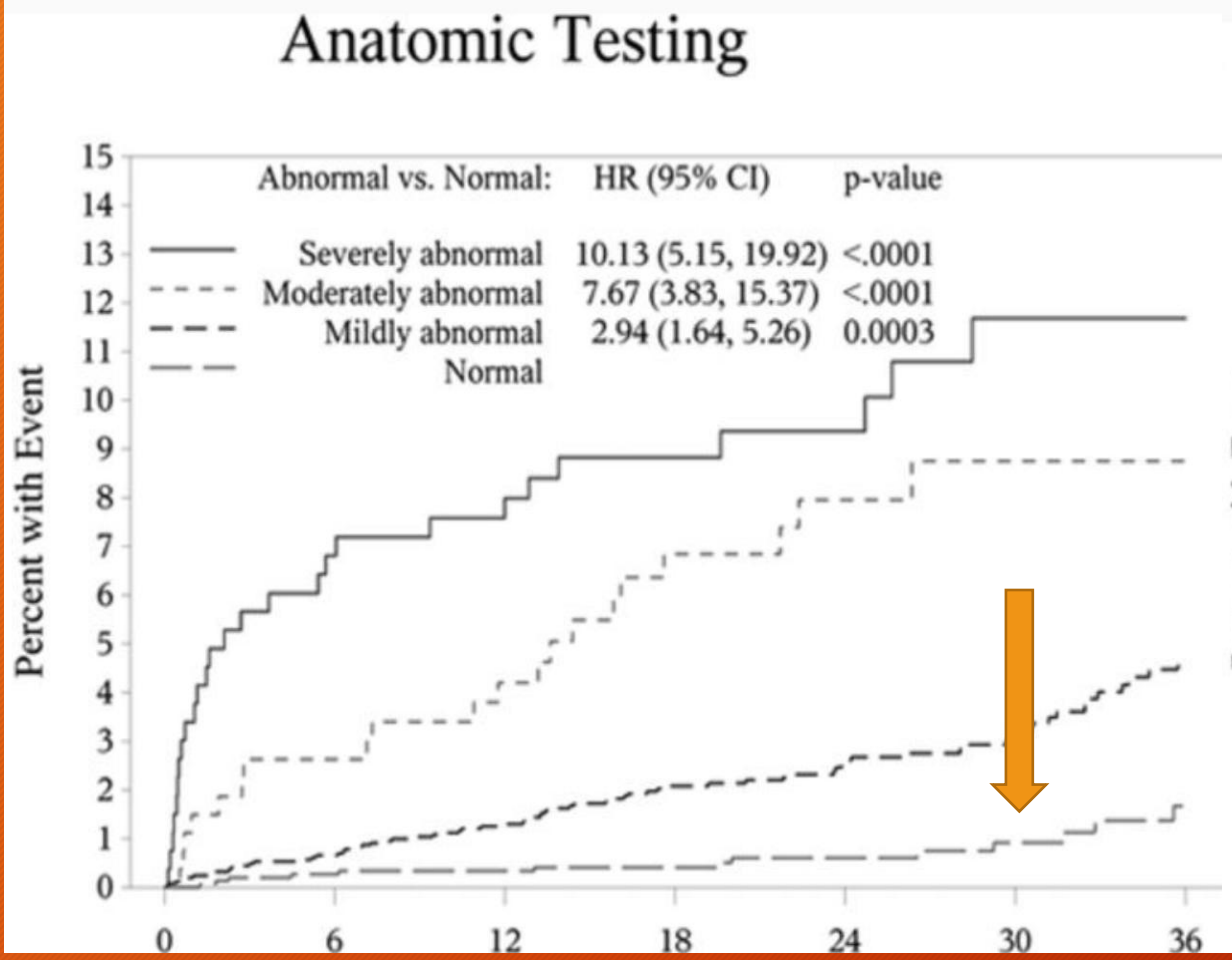
Outcomes of Anatomical versus Functional Testing for Coronary Artery Disease

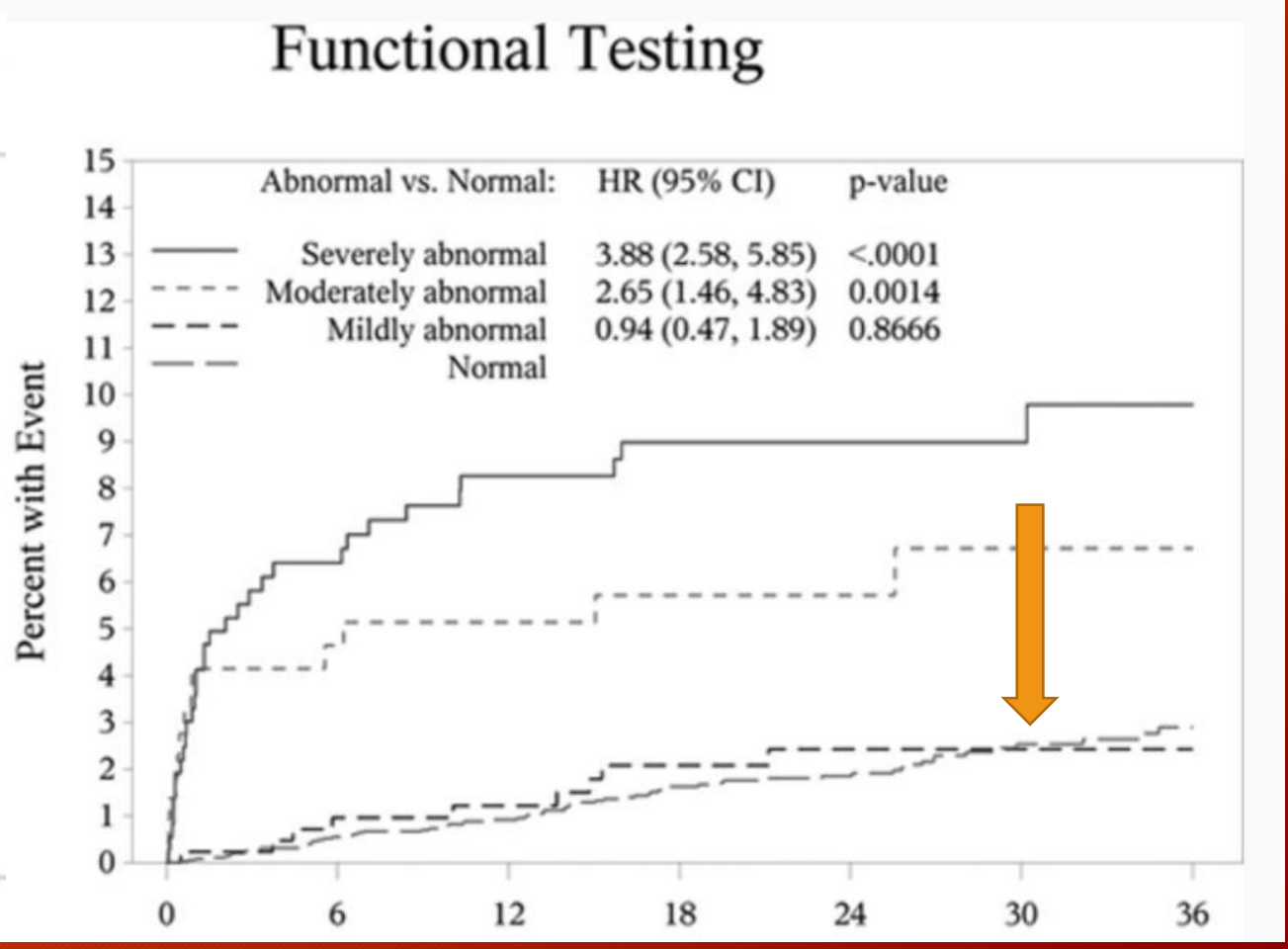
Pamela S. Douglas, M.D., Udo Hoffmann, M.D., M.P.H., Manesh R. Patel, M.D., Daniel B. Mark, M.D., M.P.H., Hussein R. Al-Khalidi, Ph.D., Brendan Cavanaugh, M.D., Jason Cole, M.D., Rowena J. Dolor, M.D., Christopher B. Fordyce, M.D., Megan Huang, Ph.D., Muhammad Akram Khan, M.D., Andrzej S. Kosinski, Ph.D., Mitchell W. Krucoff, M.D., Vinay Malhotra, M.D., Michael H. Picard, M.D., James E. Udelson, M.D., Eric J. Velazquez, M.D., Eric Yow, M.S., Lawton S. Cooper, M.D., M.P.H., and Kerry L. Lee, Ph.D., for the PROMISE Investigators*

End Points According to Study Group

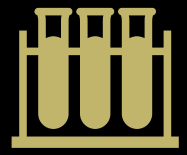
End Point	CTA Strategy (N=4996)	Functional-Testing Strategy (N=5007)	Adjusted Hazard Ratio (95% CI)	P Value
Clinical end point — no. of patients				
Primary composite end point	164	151	1.04 (0.83–1.29)	0.75
Death from any cause	74	75		
Nonfatal myocardial infarction	30	40		
Hospitalization for unstable angina	61	41		
Major procedural complication	4	5		
Primary end point plus catheterization showing no obstructive CAD	332	353	0.91 (0.78–1.06)	0.22
Death or nonfatal myocardial infarction	104	112	0.88 (0.67–1.15)	0.35
Death, nonfatal myocardial infarction, or hospitalization for unstable angina	162	148	1.04 (0.84–1.31)	0.70
Test-related end point				
Invasive catheterization showing no obstructive CAD — no. (%)	170 (3.4)	213 (4.3)	—	0.02

Negative Predictive Value





The PROMISE Trial: The CTA Perspective



If CTA performed is “negative”, no further testing is necessary

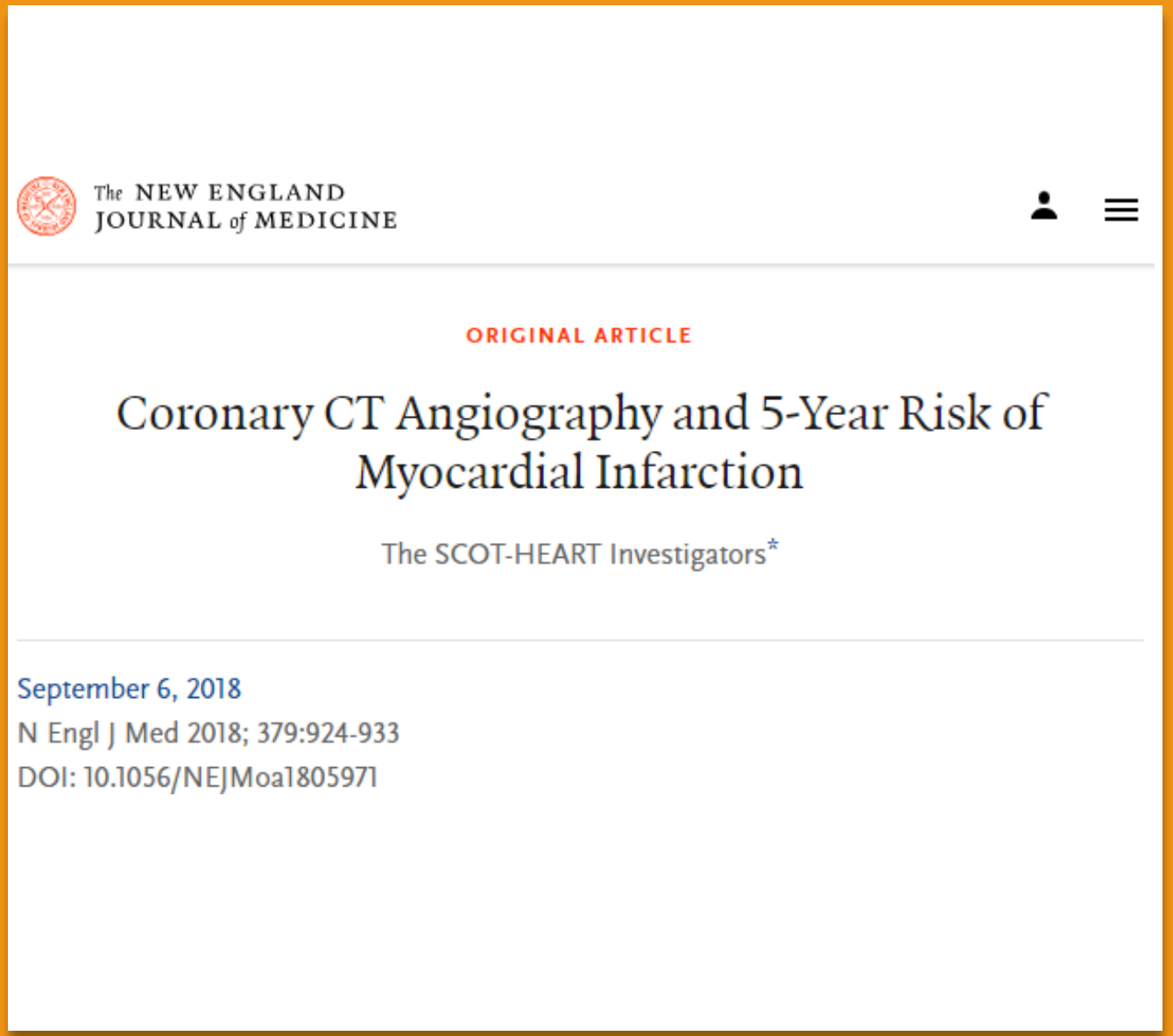
CTA was equivalent to stress testing, no difference in event rates at 2-year follow-up

Prevalence of nonobstructive CAD on cath was significantly higher with stress testing 52% vs 27% demonstrating the high negative predictive value

SCOT-HEART

Patients with chest pain randomized to standard of care plus CTA vs standard care alone

Primary end point: death from coronary heart disease or nonfatal MI



The NEW ENGLAND JOURNAL of MEDICINE

ORIGINAL ARTICLE

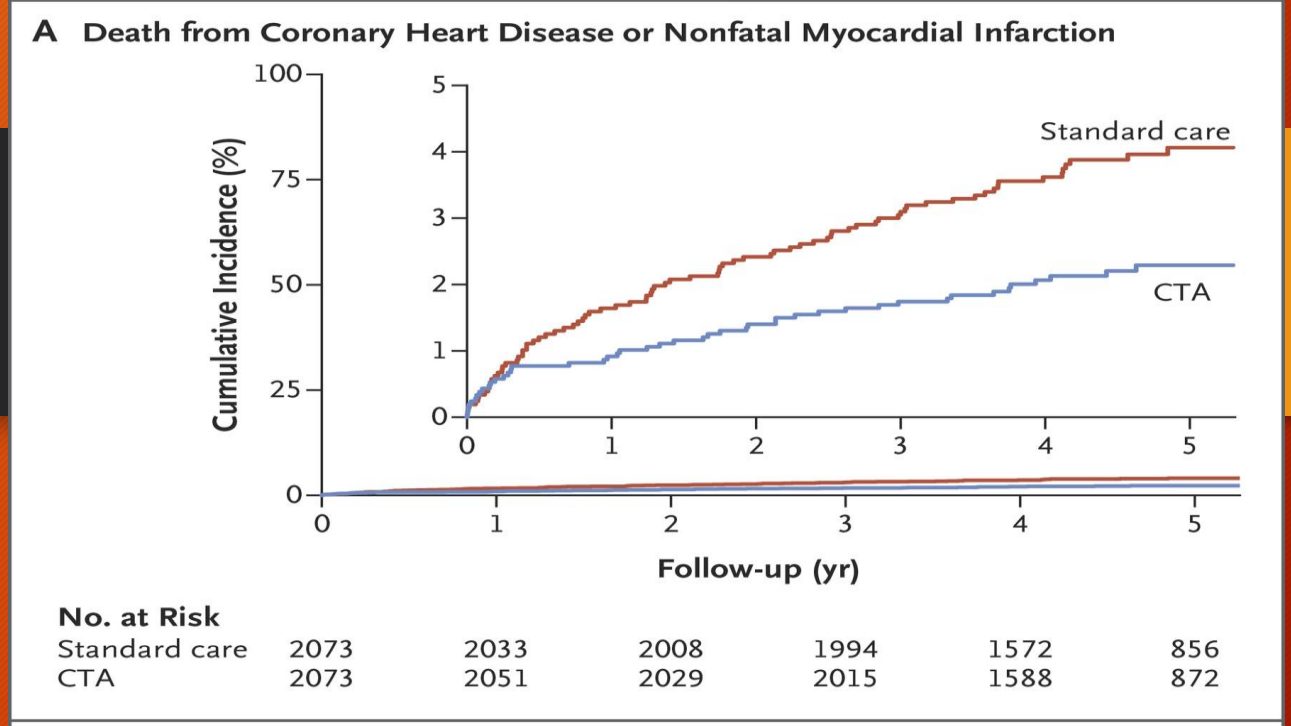
Coronary CT Angiography and 5-Year Risk of Myocardial Infarction

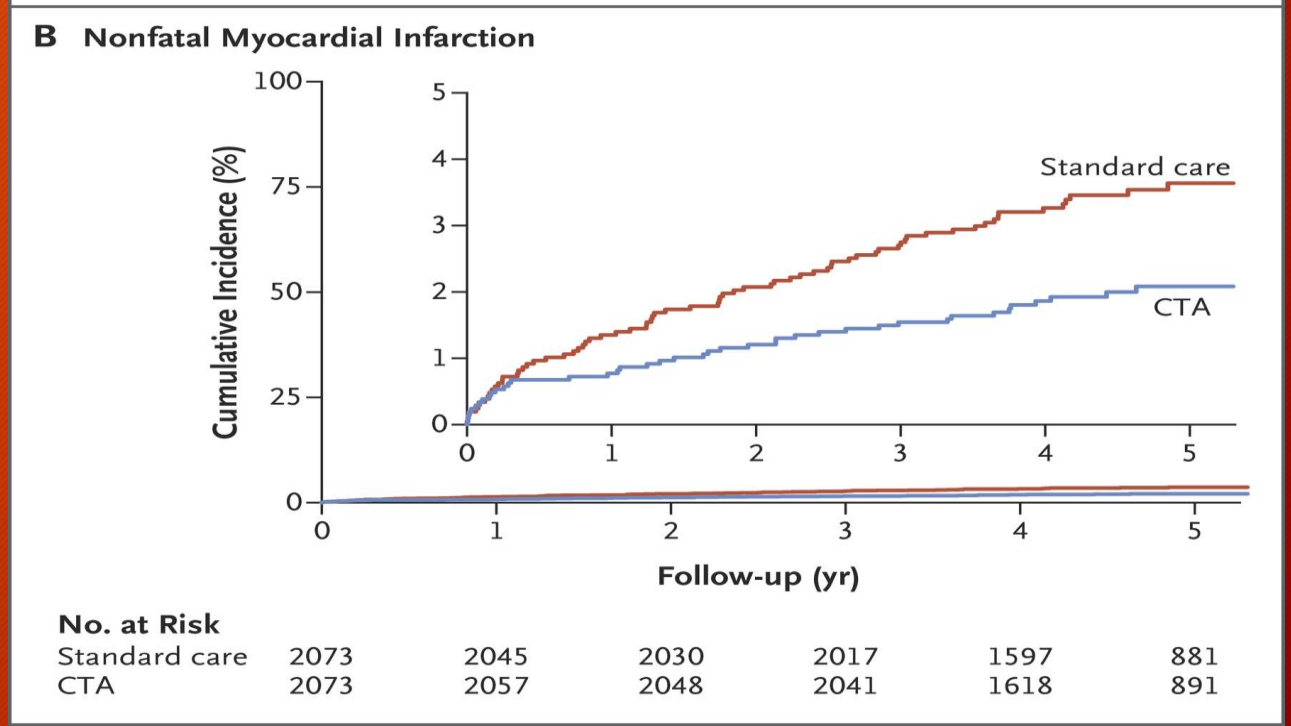
The SCOT-HEART Investigators*

September 6, 2018
N Engl J Med 2018; 379:924-933
DOI: 10.1056/NEJMoa1805971

SCOT-HEART

Incidence of Death from Coronary Heart Disease or Nonfatal MI

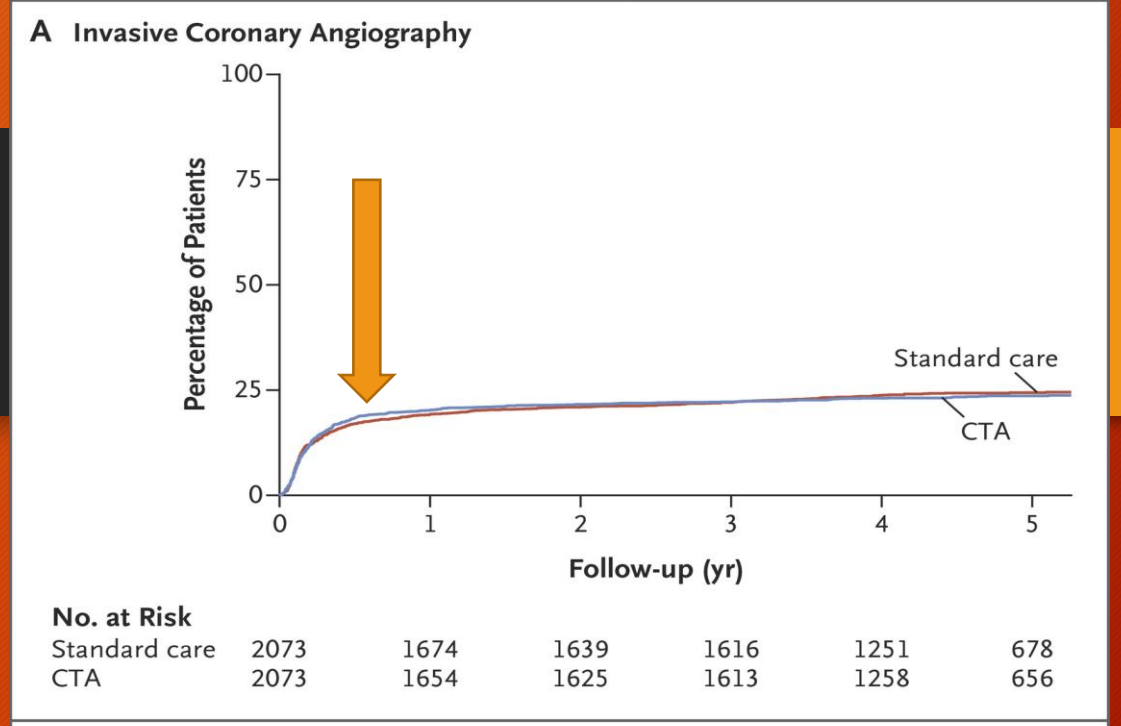


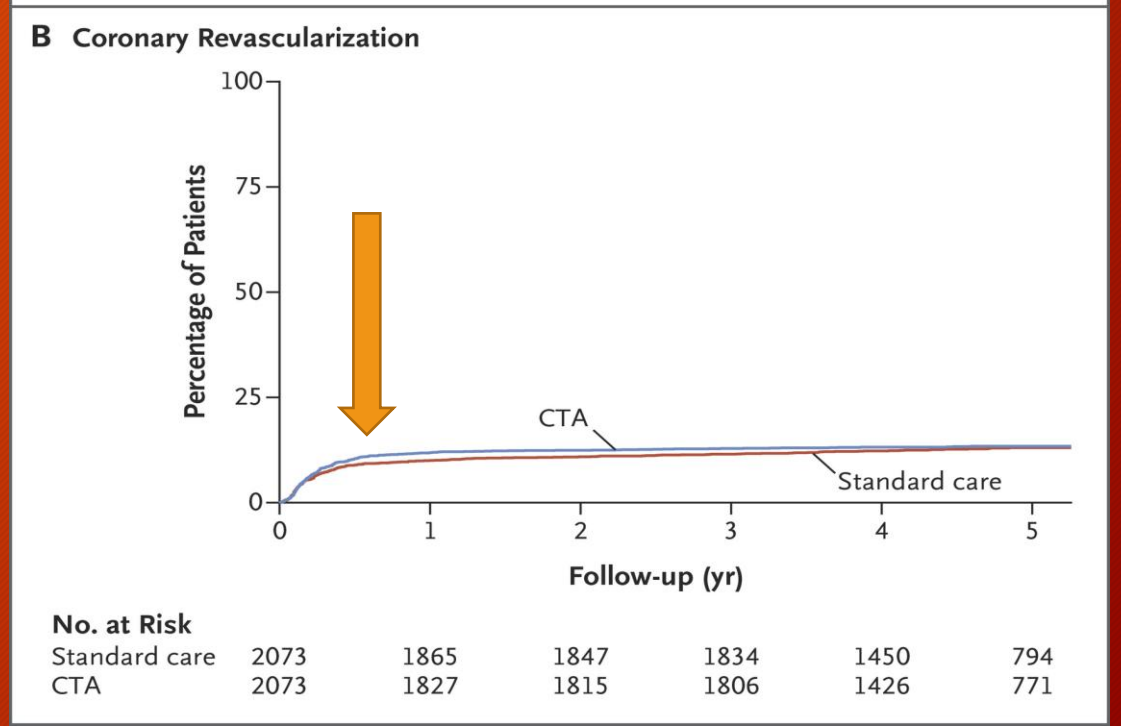


SCOT Heart

Patient Who Underwent Cath and Revascularization

? Initiation of medical therapy





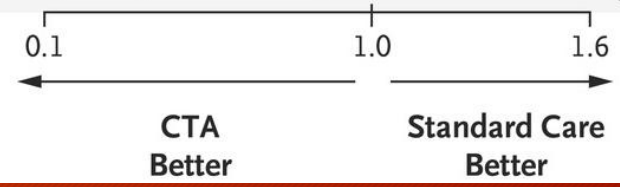
SCOT HEART

Primary and Secondary End Points after a Median Follow-up of 4.8 Years

End Point	All Participants (N=4146)	Standard Care (N=2073)	Standard Care plus CTA (N=2073)	Hazard Ratio (95% CI)†
	number of patients (percent)			
Primary end point: death from CHD or non-fatal myocardial infarction‡	129 (3.1)	81 (3.9)	48 (2.3)	0.59 (0.41–0.84)§
Secondary end points				
Death from CHD, nonfatal myocardial infarction, or nonfatal stroke‡	160 (3.9)	97 (4.7)	63 (3.0)	0.65 (0.47–0.89)
Nonfatal myocardial infarction	117 (2.8)	73 (3.5)	44 (2.1)	0.60 (0.41–0.87)
Nonfatal stroke	35 (0.8)	20 (1.0)	15 (0.7)	0.74 (0.38–1.44)
Death				
From CHD‡	13 (0.3)	9 (0.4)	4 (0.2)	0.46 (0.14–1.48)
From any cause	86 (2.1)	43 (2.1)	43 (2.1)	1.02 (0.67–1.55)
Cardiovascular	17 (0.4)	12 (0.6)	5 (0.2)	0.43 (0.15–1.22)
Noncardiovascular	69 (1.7)	31 (1.5)	38 (1.8)	1.24 (0.77–2.00)
Procedures				
Invasive coronary angiography	993 (24.0)	502 (24.2)	491 (23.7)	1.00 (0.88–1.13)
Revascularization¶	546 (13.2)	267 (12.9)	279 (13.5)	1.07 (0.91–1.27)
Percutaneous coronary intervention	431 (10.4)	212 (10.2)	219 (10.6)	1.06 (0.88–1.28)
Coronary-artery bypass grafting	131 (3.2)	62 (3.0)	69 (3.3)	1.12 (0.80–1.58)

SCOT HEART

Subgroup	No. of Patients	CTA	Standard Care	Hazard Ratio for Death from Coronary Heart Disease or Nonfatal Myocardial Infarction (95% CI)	P Value for Interaction
		no. of events/total no. (%)			
All patients	4146	48/2073 (2.3)	81/2073 (3.9)	0.59 (0.41–0.84)	
Age					0.68
<65 yr	3092	32/1538 (2.1)	51/1554 (3.3)	0.62 (0.40–0.96)	
≥65 yr	1054	16/535 (3.0)	30/519 (5.8)	0.53 (0.29–0.98)	
Sex					0.57
Female	1821	11/911 (1.2)	22/910 (2.4)	0.50 (0.24–1.04)	
Male	2325	37/1162 (3.2)	59/1163 (5.1)	0.63 (0.42–0.95)	
10-yr cardiovascular risk					0.21
<15	2036	15/969 (1.5)	21/1067 (2.0)	0.78 (0.40–1.51)	
≥15	2110	33/1104 (3.0)	60/1006 (6.0)	0.50 (0.33–0.77)	
NICE classification					0.58
Nonanginal chest pain	1447	8/712 (1.1)	18/735 (2.4)	0.45 (0.19–1.03)	
Possible angina	2323	27/1174 (2.3)	44/1149 (3.8)	0.60 (0.37–0.96)	
Previous CHD					0.68
No	3774	35/1887 (1.9)	62/1887 (3.3)	0.57 (0.37–0.86)	
Yes	376	13/187 (7.0)	19/189 (10.1)	0.65 (0.32–1.32)	
Diabetes					0.40
No	3702	41/1850 (2.2)	64/1852 (3.5)	0.63 (0.43–0.94)	
Yes	444	7/223 (3.1)	17/221 (7.7)	0.36 (0.15–0.87)	



Subgroup Analyses for the Primary End Point (Death from Coronary Heart Disease or Nonfatal Myocardial Infarction at 5 Years)

SCOT HEART (5-year outcomes)

CTA was associated with a significant reduction in cardiac death or MI at 5 years.

CTA was associated with an increase in revascularization in the short-term but no difference at 5 years.

We were able to identify high risk pts earlier.

Low-attenuation plaque burden was the strongest predictor for MI compared with risk scores, calcium score, and stenosis.

JOURNAL OF THE AMERICAN COLLEGE OF CARDIOLOGY
VOL. 78, NO. 22, 2021

PUBLISHED BY ELSEVIER

CLINICAL PRACTICE GUIDELINE: FULL TEXT

2021 AHA/ACC/ASE/CHEST/SAEM/ SCCT/SCMR Guideline for the Evaluation and Diagnosis of Chest Pain

A Report of the American College of Cardiology/American Heart Association
Joint Committee on Clinical Practice Guidelines

Chest Pain Guidelines

1A Recommendation

Clinical trials report a higher diagnostic sensitivity for CCTA compared with stress testing for detecting obstructive CAD

COR	LOE	RECOMMENDATIONS
		Index Diagnostic Testing
		Anatomic Testing
1	A	1. For intermediate-high risk patients with stable chest pain and no known CAD, CCTA is effective for diagnosis of CAD, for risk stratification, and for guiding treatment decisions (1-12).

Exquisite Sensitivity

Journal of the American College of Cardiology
Volume 52, Issue 25, 16–23 December 2008, Pages 2135-2144

Clinical Research
Clinical Trial

Diagnostic Accuracy of 64-Slice Computed Tomography Coronary Angiography: A Prospective, Multicenter, Multivendor Study

W. Bob Meijboom MD *†, Matthijs F.L. Meijs MD §||, Joanne D. Schuijf MD, PhD ¶#, Maarten J. Cramer MD, PhD §, Nico R. Mollet MD, PhD *†, Carlos A.G. van Mieghem MD *†, Koen Nieman MD, PhD *†, Jacob M. van Werkhoven MD ||#, Gabija Pundziute MD ||#, Annick C. Weustink MD *†, Alexander M. de Vos MD §||, Francesca Pugliese MD *†, Benno Rensing MD, PhD **, J. Wouter Jukema MD, PhD ¶, Jeroen J. Bax MD, PhD ¶, Mathias Prokop MD, PhD ||, Pieter A. Doevendans MD, PhD §, Myriam G.M. Hunink MD, PhD ††, ... Pim J. de Feyter MD, PhD *†

360 symptomatic patients (acute and stable angina)

	Prevalence of Disease, %	n	TP	TN	FP	FN	Sensitivity, %	Specificity, %	PPV, %	NPV, %
Patient-based analysis	68	360	244	73	41	2	99 (98–100)	64 (55–73)	86 (82–90)	97 (94–100)
Stable angina pectoris	63	233	145	56	31	1	99 (98–100)	64 (53–74)	82 (76–88)	98 (95–100)
Non–ST-segment elevation acute coronary syndrome	79	127	99	17	10	1	99 (97–100)	63 (45–81)	91 (85–96)	94 (84–100)
Men	76	245	185	38	20	2	99 (97–100)	66 (53–78)	90 (86–94)	95 (88–100)
Women	51	115	59	35	21	0	100 (100–100)	63 (50–75)	74 (64–83)	100 (100–100)
Typical angina pectoris	70	151	104	31	15	1	99 (97–100)	67 (54–81)	87 (81–93)	97 (91–100)
Atypical angina pectoris	50	82	41	25	16	0	100 (100–100)	61 (46–76)	72 (60–84)	100 (100–100)
Unstable angina pectoris	75	77	57	13	6	1	98 (95–100)	68 (48–89)	90 (83–98)	93 (79–100)
Non–ST-segment elevated myocardial infarction	84	50	42	4	4	0	100 (100–100)	50 (15–85)	91 (83–99)	100 (100–100)

Acute Chest Pain

Intermediate-Risk Patients With Acute Chest Pain and No Known CAD

	Recommendations for Intermediate-Risk Patients With No Known CAD Referenced studies that support the recommendations are summarized in Online Data Supplements 14 and 15.	
COR	**LOE**	**Recommendations**
Anatomic Testing		
1	**A**	**1. For intermediate-risk patients with acute chest pain and no known CAD eligible for diagnostic testing after a negative or inconclusive evaluation for ACS, CCTA is useful for exclusion of atherosclerotic plaque and obstructive CAD.**

2021 AHA/ACC/ASE/CHEST/SAEM/SCCT/SCMR Guideline for the Evaluation and Diagnosis of Chest Pain

The NEW ENGLAND JOURNAL of MEDICINE

ORIGINAL ARTICLE

CT Angiography for Safe Discharge of Patients with Possible Acute Coronary Syndromes

Harold I. Litt, M.D., Ph.D., Constantine Gatsonis, Ph.D.,
Harjit Singh, M.D., Chadwick D. Miller, M.D., Daniel W
James M. Leaming, M.D., Laurence J. Gavin, M.D., Charis
and Judd E. Hollander, M.D.

- Randomized controlled study comparing CCTA with standard of care
- 2012

Table 3. Outcomes and Use of Resources within 30 Days after Presentation.

Variable	CCTA-Based Strategy (N=908)	Traditional Care (N=462)	Difference, CCTA-Based Strategy – Traditional Care (95% CI)
	no./total no. (%)		*percentage points*
Cardiovascular event			
Death	0	0	0
Acute myocardial infarction*	10/908 (1)	5/462 (1)	0.02 (–5.6 to 5.7)
Composite of death or acute myocardial infarction	10/908 (1)	5/462 (1)	0.02 (–5.6 to 5.7)
Revascularization	24/893 (3)	6/457 (1)	1.4 (–4.3 to 7.0)
Resource used			
Cardiologist office visit	62/878 (7)	17/451 (4)	3.3 (–2.4 to 9.0)
Emergency department revisit	71/885 (8)	34/452 (8)	0.5 (–5.2 to 6.2)
Hospital admission after index visit	28/889 (3)	11/456 (2)	0.7 (–4.9 to 6.4)

Outcomes during Index Visit

- Increased discharge rate from the ED
- Decreased length of stay
- Increase rate in diagnosis of CAD

Table 4. Outcomes during the Index Visit.

Outcome	CCTA-Based Strategy (N=908)	Traditional Care (N=462)	Difference, CCTA-Based Strategy – Traditional Care (95% CI)
			percentage points
Disposition — no. (%)			
Discharge	450 (50)	105 (23)	26.8 (21.4 to 32.2)
Admission or observation	458 (50)	357 (77)	
Length of stay — hr			
Overall*			
Median	18.0	24.8	
Interquartile range	7.6 to 27.2	19.2 to 30.5	
Patients with negative test*			
Median	12.3	24.7	
Interquartile range	7.0 to 24.3	19.7 to 29.6	
Medications prescribed at discharge — no. (%)			
Aspirin	233 (26)	110 (24)	1.9 (–3.8 to 7.5)
Thienopyridines	24 (3)	7 (2)	1.1 (–4.5 to 6.7)
Statins	153 (17)	75 (16)	0.6 (–5.0 to 6.2)
Cardiovascular events — no. (%)			
Death	0	0	0
Acute myocardial infarction	9 (1)	4 (1)	0.1 (–5.5 to 5.7)
Acute coronary syndrome without acute myocardial infarction	28 (3)	7 (2)	1.6 (–4.0 to 7.2)
Diagnosis of coronary disease	82 (9)	16 (3)	5.6 (0 to 11.2)
Revascularization	23 (3)	4 (1)	1.7 (–3.9 to 7.3)

Repeat visits for similar symptoms

TABLE 7 Warranty Period for Prior Cardiac Testing

Test Modality	Result	Warranty Period
Anatomic	Normal coronary angiogram CCTA with no stenosis or plaque	2 y
Stress testing	Normal stress test (given adequate stress)	1 y

2021 AHA/ACC/ASE/CHEST/SAEM/SCCT/SCMR Guideline for the Evaluation and Diagnosis of Chest Pain

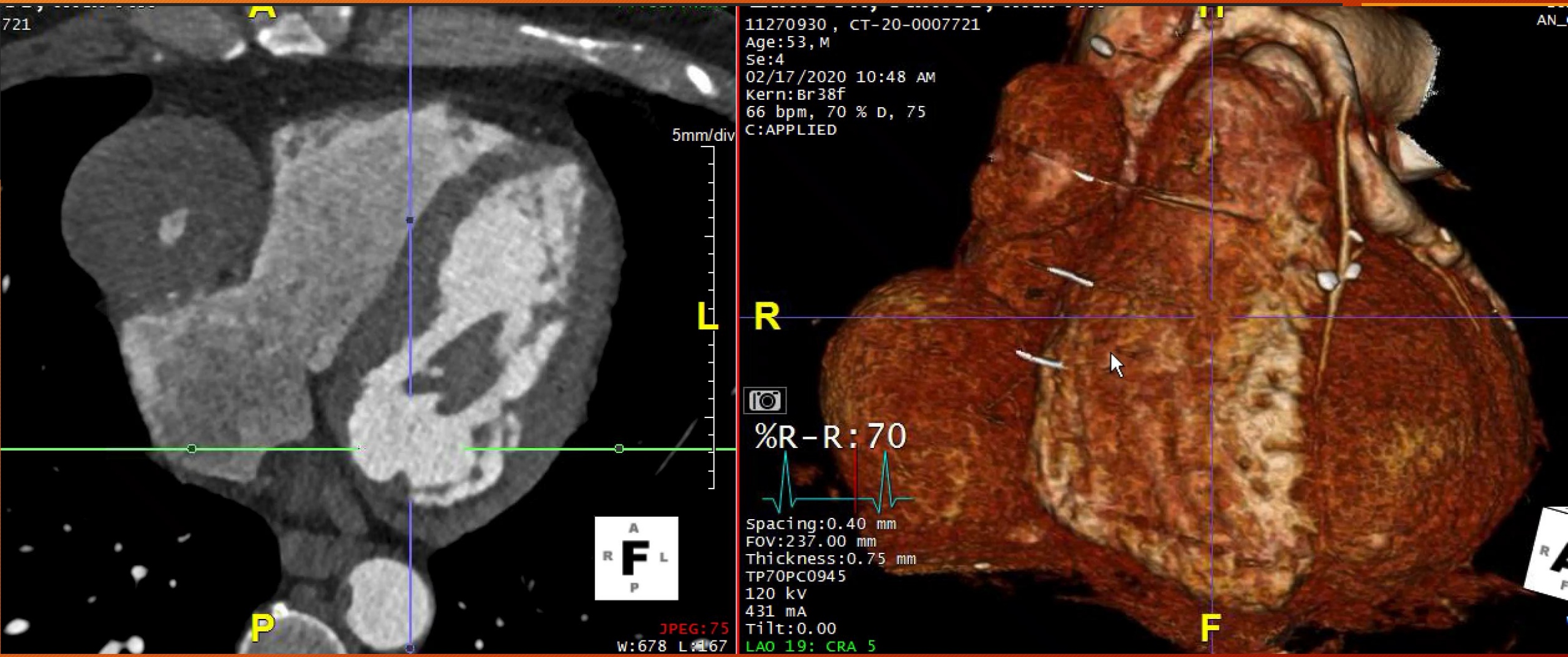
Chest Pain with Bypass Grafts

COR	LOE	RECOMMENDATIONS
1	C-LD	1. In patients with prior CABG surgery presenting with acute chest pain who do not have ACS, performing stress imaging is effective to evaluate for myocardial ischemia or CCTA for graft stenosis or occlusion (1-7).

CCTA has a great degree of accuracy with a sensitivity and specificity of detecting graft occlusions, 99% and 99%, respectively

Large size of these vessels, decreased calcification, and decreased motion of grafts when compared with native arteries

2021 AHA/ACC/ASE/CHEST/SAEM/SCCT/SCMR Guideline for the Evaluation and Diagnosis of Chest Pain


721
A
5mm/div
L
A
R F L
P
P
JPEG:75
W:678 L:167
11270930 , CT-20-0007721
Age:53,M
Se:4
02/17/2020 10:48 AM
Kern:Br38f
66 bpm, 70 % D, 75
C:APPLIED
R
%R-R:70
Spacing:0.40 mm
FOV:237.00 mm
Thickness:0.75 mm
TP70PC0945
120 kv
431 mA
Tilt:0.00
LAO 19: CRA 5
F

Economic Considerations

- Total ED costs of care were reduced by 38.2%

- CCTA $2,137
- Nuclear Pefusion $3,458
- Cardiac Cath $2,838

The CT-STAT (Coronary Computed Tomographic Angiography for Systematic Triage of Acute Chest Pain Patients to Treatment) Trial

Clinical Trial

James A. Goldstein, Kavitha M. Chinnaiyan, Aiden Abidov, Stephan Achenbach, Daniel S. Berman, Sean W. Hayes, Udo Hoffmann, John R. Lesser, Issam A. Mikati, Brian J. O'Neil, Leslee J. Shaw, Michael Y.H. Shen, Uma S. Valeti, ... SEE ALL AUTHORS

J Am Coll Cardiol. 2011 Sep, 58 (14) 1414–1422

Limitations

- Spatial and temporal resolution. (very small structures, high/variable heart rates)
- Other tests are preferable for patients with multiple stents, extensive calcifications, or lesions of uncertain hemodynamic significance

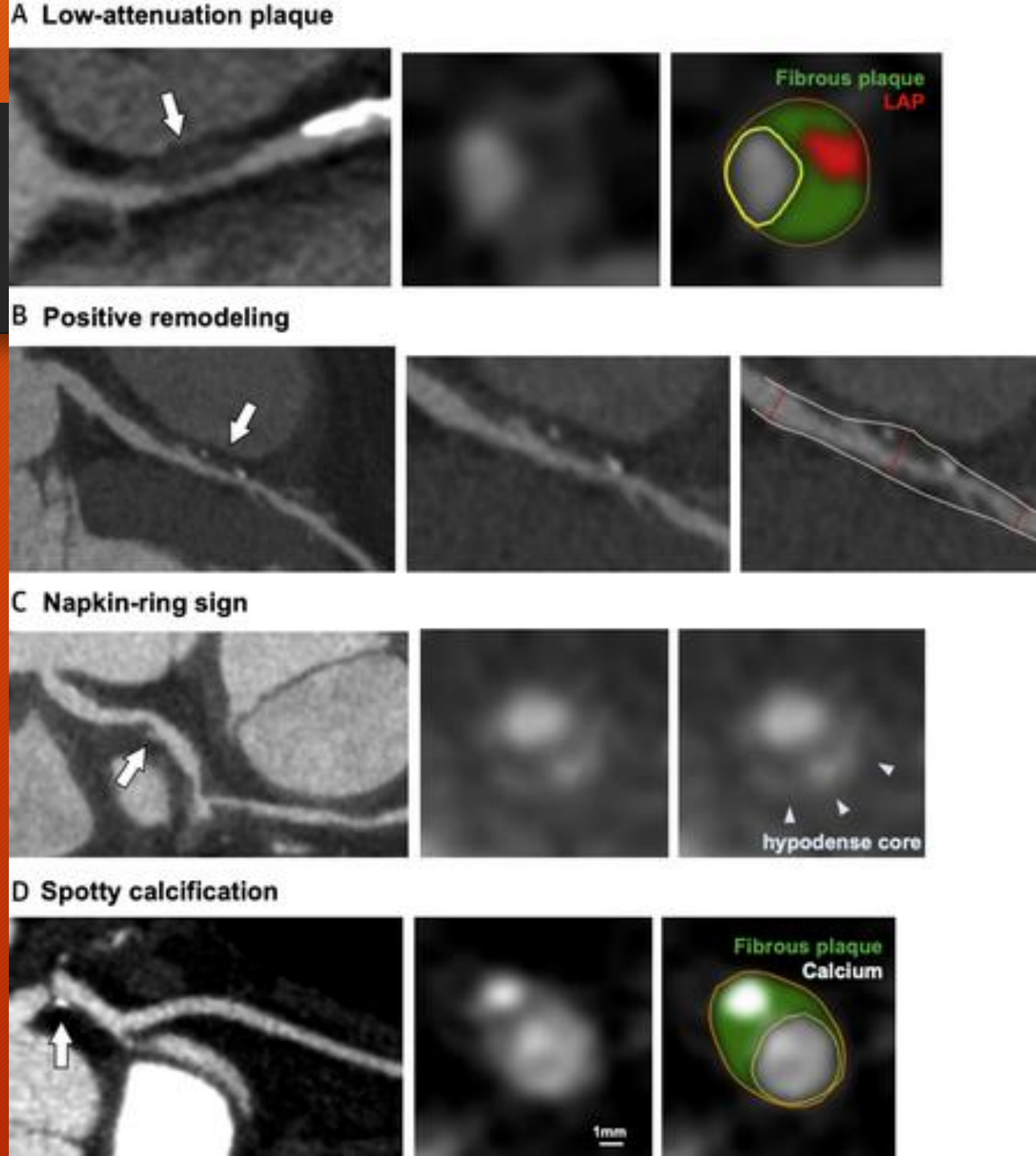
Contraindications

- Allergy to iodinated contrast
- Inability to cooperate with scan acquisition and/or breath-hold instructions
- Clinical instability (eg, acute respiratory distress, severe hypotension, unstable arrhythmia)
- Renal impairment as defined by local protocols
- Contraindication to beta blockade in the presence of an elevated heart rate
- Heart rate variability and arrhythmia (relative)

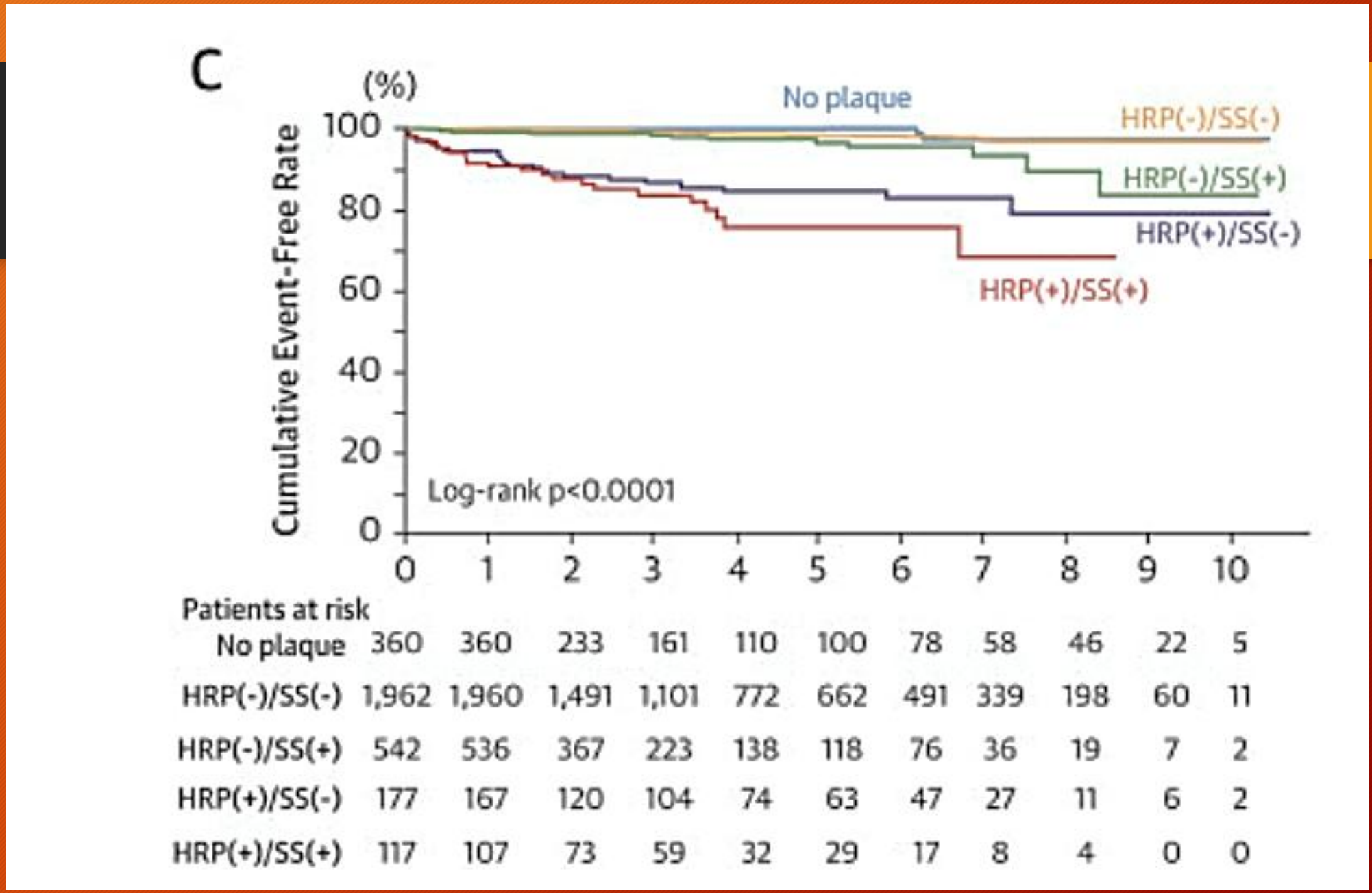
2021 AHA/ACC/ASE/CHEST/SAEM/SCCT/SCMR Guideline for the Evaluation and Diagnosis of Chest Pain

The Future of CCTA

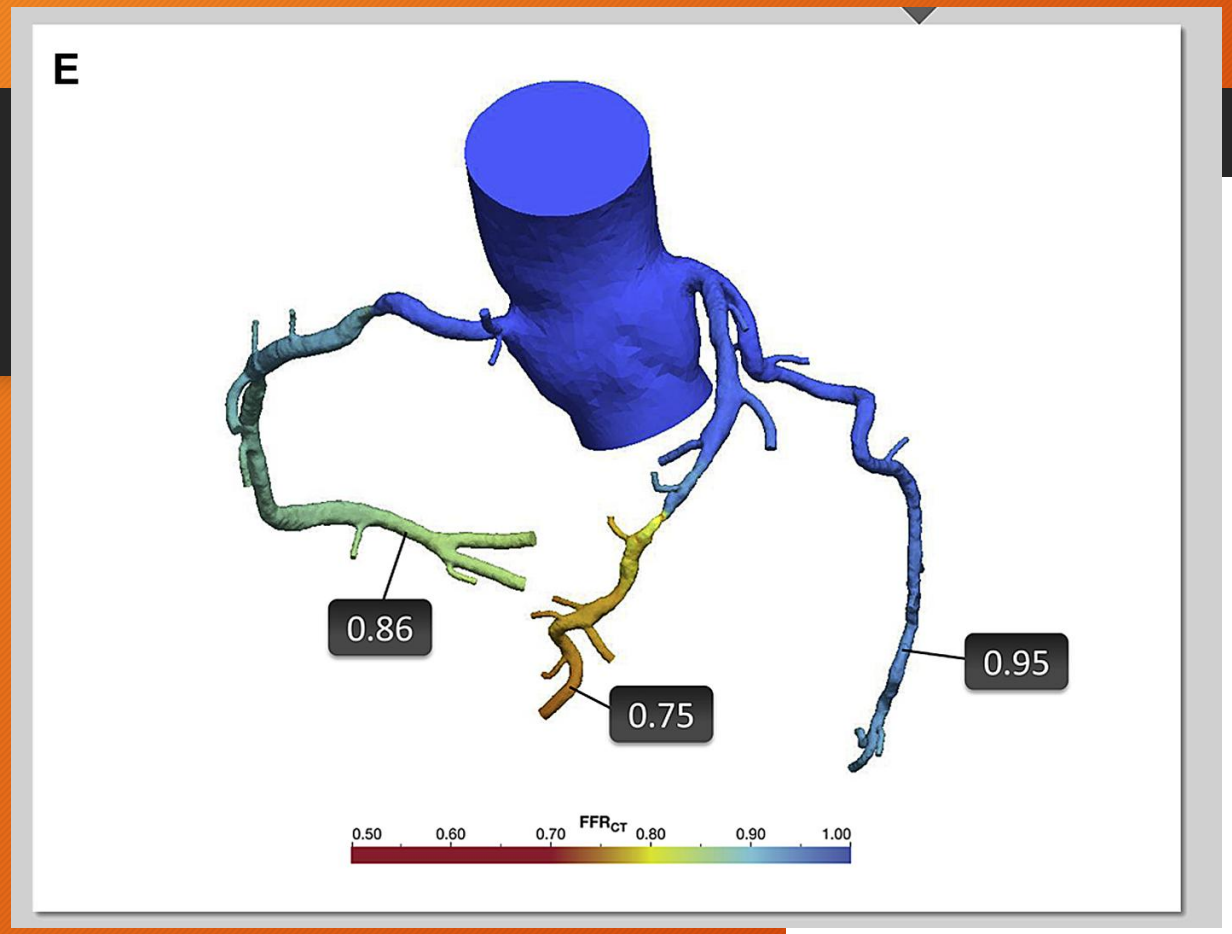
Plaque assessment on CTA helps predict the risk of adverse cardiac events.

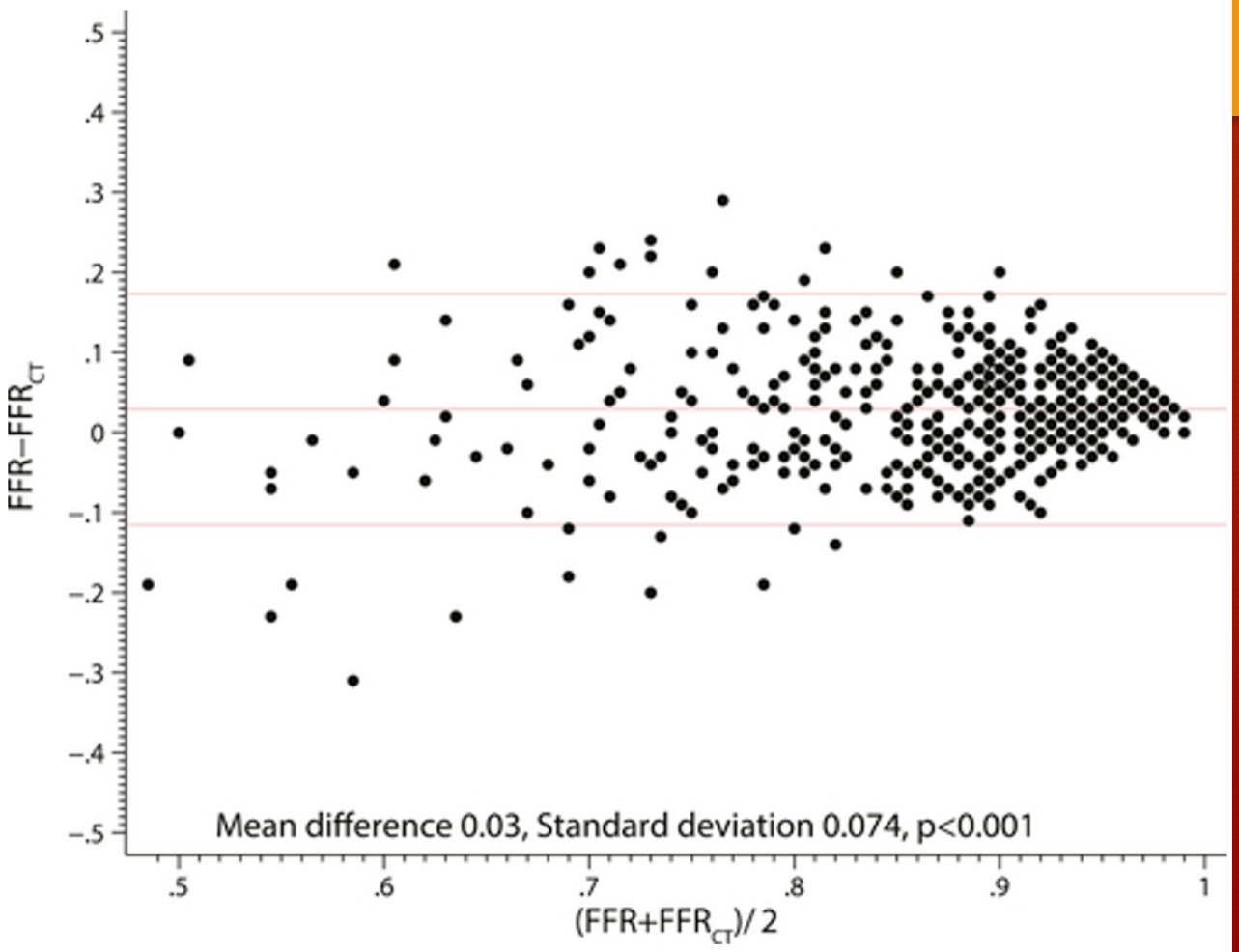


Motoyama et al. Plaque Characterization by CCTA and the Likelihood of Acute Coronary Events in Mid-Term Follow Up JACC 2015



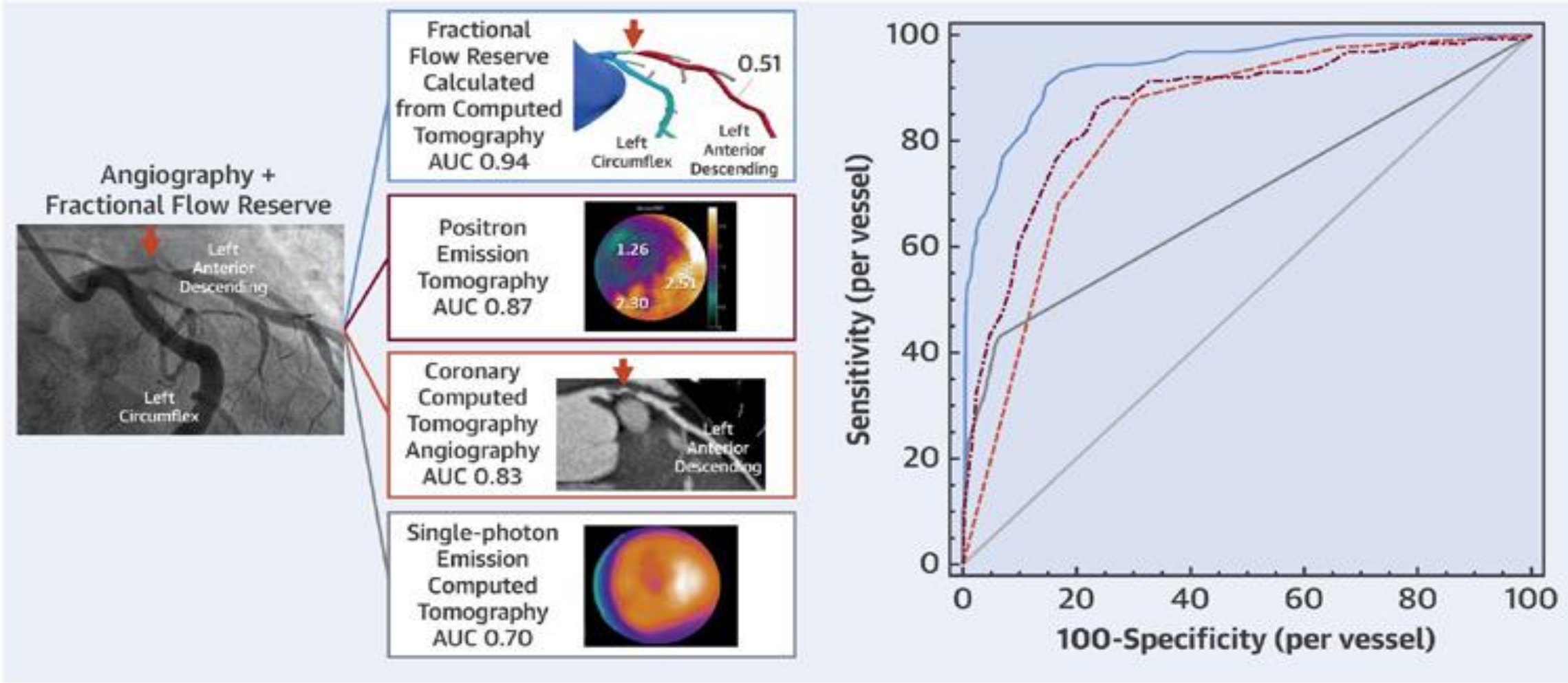
Motoyama et al. Plaque Characterization by CCTA and the Likelihood of Acute Coronary Events in Mid-Term Follow Up JACC 2015





Bjarne L. Nørgaard et al. *J Am Coll Cardiol* 2014; 63:1145-1155.

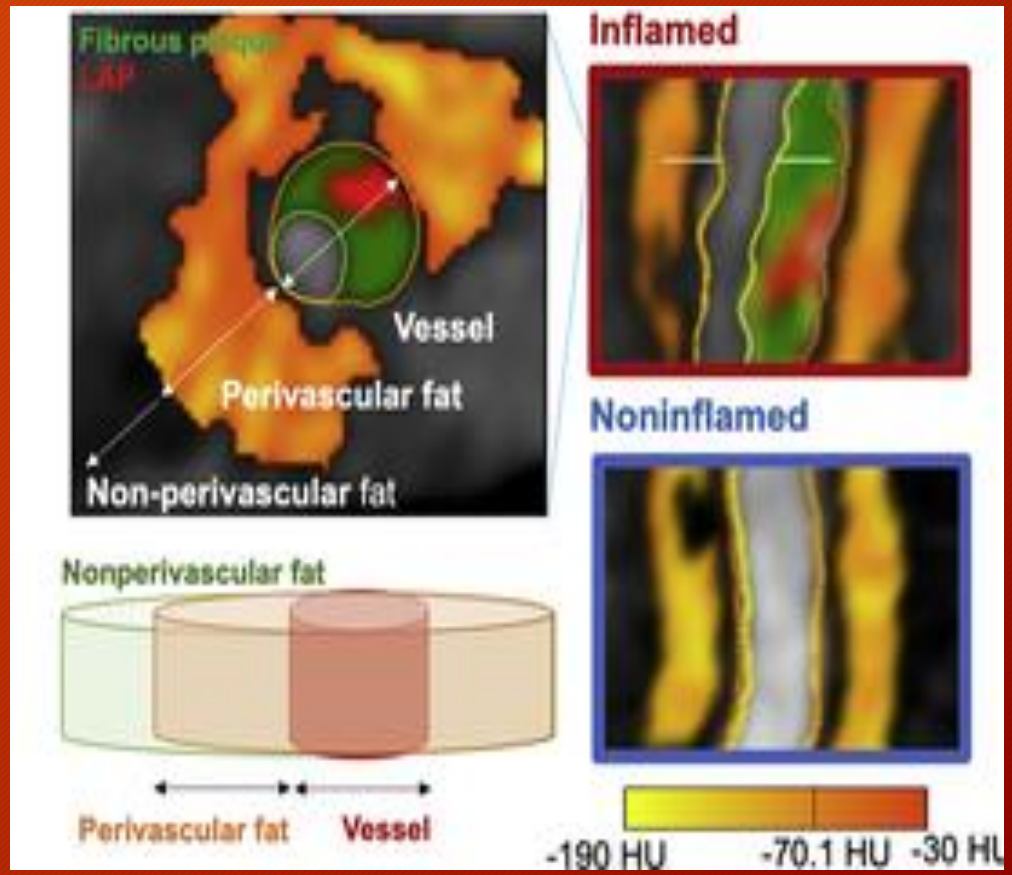
CENTRAL ILLUSTRATION: Discriminative Ability of Imaging Modalities for the Detection of Per-Vessel Fractional Flow Reserve-Defined Ischemia



Driessen, R.S. et al. J Am Coll Cardiol. 2019;73(2):161-73.

Other Future Advances

- Techniques to reduce radiation exposure
- Dramatic improvements in stenosis visualization and characterization with software applications/AI
- Imaging biomarkers such as perivascular fat attenuation index, which identifies and quantifies inflammation
- On site CT FFR



Choosing the right test

	Favors use of CCTA	Favors use of stress imaging
Goal	• Rule out obstructive CAD • Detect Nonobstructive CAD	• Ischemia guided management
Availability and expertise	• High quality imaging and exert interpretation routinely available	• High quality imaging and expert interpretation routinely available
Likelihood of obstructive CAD	• Age <65	• Age ≥65
Prior test results	• Prior functional study inconclusive	• Prior CCTA inconclusive
Other compelling indications	• Anomalous coronary arteries • Require evaluation of aorta or pulmonary arteries	• Suspect scar (especially if PET or stress CMR available) • Suspect coronary microvascular dysfunction (when PET or CMR available)

2021 AHA/ACC/ASE/CHEST/SAEM/SCCT/SCMR Guideline for the Evaluation and Diagnosis of Chest Pain

?

END

References

- 2021 AHA/ACC/ASE/CHEST/SAEM/SCCT/SCMR Guideline for the Evaluation and Diagnosis of Chest Pain: A Report of the American College of Cardiology/American Heart Association Joint Committee on Clinical Practice Guidelines. *J Am Coll Cardiol* 2021;Oct 28:[Epub ahead of print].
- Abdelrahman et al, Coronary Computed Tomography Angiography From Clinical Uses to Emerging Technologies: JACC State-of-the-Art Review. J Am Coll Cardiol. 2020 Sep 8
- Gulati M, et al. 2021 AHA/ACC/ASE/CHEST/SAEM/SCCT/SCMR Guideline for the Evaluation and Diagnosis of Chest Pain: A Report of the American College of Cardiology/American Heart Association Joint Committee on Clinical Practice Guidelines. Circulation. 2021 Nov 30
- Motoyama S, Ito H, Sarai M, Kondo T, Kawai H, Nagahara Y, Harigaya H, Kan S, Anno H, Takahashi H, Naruse H, Ishii J, Hecht H, Shaw LJ, Ozaki Y, Narula J. Plaque Characterization by Coronary Computed Tomography Angiography and the Likelihood of Acute Coronary Events in Mid-Term Follow-Up. J Am Coll Cardiol. 2015 Jul 28;66(4):337-46. doi: 10.1016/j.jacc.2015.05.069. PMID: 26205589.
- PROMISE Investigators, Prognostic Value of Noninvasive Cardiovascular Testing in Patients With Stable Chest Pain: Insights From the PROMISE Trial (Prospective Multicenter Imaging Study for Evaluation of Chest Pain). Circulation. 2017 Jun 13
- SCCT Cardiovascular CT Board Prep on demand educational course 2023