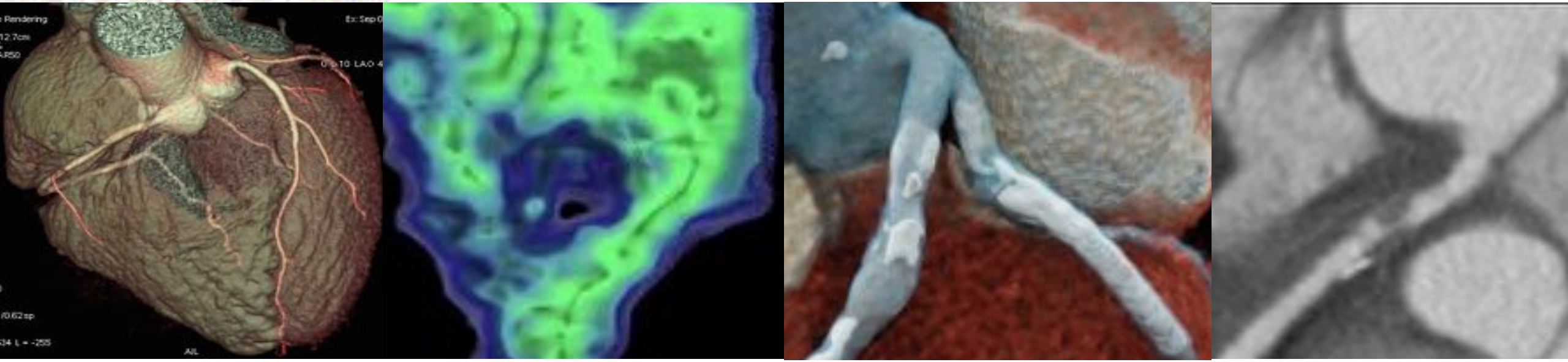
LE COROSCANNER: PERSPECTIVES & FUTURES DIRECTIONS

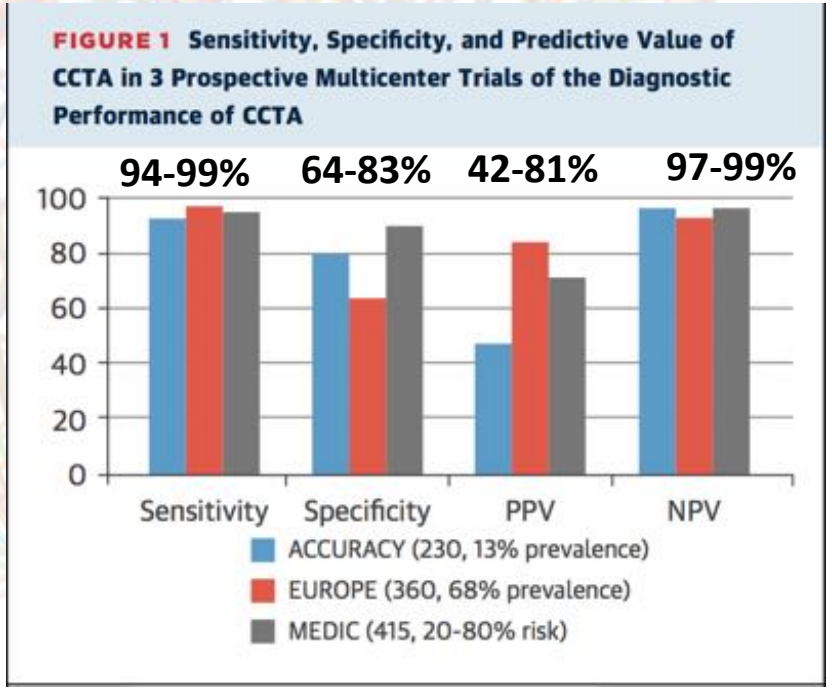


DR LAURENT MACRON - CMC AMBROISE PARÉ HARTMANN-

IMAGERIE CARDIO-VASCULAIRE NON INVASIVE SCANNER & IRM - NEUILLY SUR SEINE

Groupe Ambroise Paré - Hartmann

CCTA DIAGNOSTIC VALUE



From Marwick et al. JACC 2015

Arbab-Zadeh. Heart International 2012

Results from the Meta-analysis of Paech et. BMC Cardiovasc Disord 2011including 3,674 symptomatic patients without history of coronary artery disease enrolled in 28 studies.

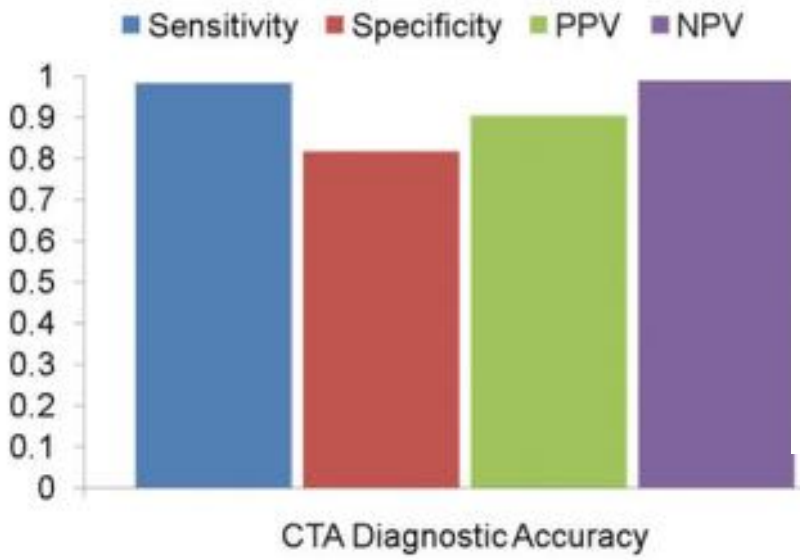


TABLE 1 Diagnostic Accuracy on Computed Tomography Angiography

Study/First Author (Ref. #)	Year	N Patients	Sensitivity	Specificity	PPV	NPV	Accuracy
ACCURACY (8)	2008	230	95	83	64	99	NA
Meijboom et al. (9)	2008	360	99	64	86	97	88
NIMISCAAD (10)	2009	327	94	88	91	91	91
CORE-64 (11)	2012	273	91	87	90	88	NA
EVINCI (12)	2015	475	91	92	83	96	91
Budoff et al. (13)	2017	77	85	90	81	92	NA
PICTURE (14)	2017	230	92	78	82	90	NA
VERDICT (15)	2020	1,023	97	72	91	88	89
Andreini et al. (17): Patients with atrial fibrillation	2017	83	95	98	95	98	96
Andreini et al. (18): patients with heart rate ≥80 beats/min	2018	40	100	82	100	82	90

NA = not available; NPV = negative predictive value; PPV = positive predictive value.

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

"A CT-based approach can effectively rule out anatomic CAD"

Use of diagnostic imaging tests in the initial diagnostic management of symptomatic patients with suspected coronary artery disease

Recommendations	Class[a]	Level[b]
Non-invasive functional imaging for myocardial ischaemia[c] or coronary CTA is recommended as the initial test to diagnose CAD in symptomatic patients in whom obstructive CAD cannot be excluded by clinical assessment alone.[4,5,55,73,78–80]	I	B
It is recommended that selection of the initial non-invasive diagnostic test is done based on the clinical likelihood of CAD and other patient characteristics that influence test performance,[d] local expertise, and the availability of tests.	I	C
Functional imaging for myocardial ischaemia is recommended if coronary CTA has shown CAD of uncertain functional significance or is not diagnostic.[4,55,73]	I	B
Invasive coronary angiography is recommended as an alternative test to diagnose CAD in patients with a high clinical likelihood, severe symptoms refractory to medical therapy or typical angina at a low level of exercise, and clinical evaluation that indicates high event risk. Invasive functional assessment must be available and used to evaluate stenoses before revascularization, unless very high grade (>90% diameter stenosis).[71,72,74]	I	B
Invasive coronary angiography with the availability of invasive functional evaluation should be considered for confirmation of the diagnosis of CAD in patients with an uncertain diagnosis on non-invasive testing.[71,72]	IIa	B
Coronary CTA should be considered as an alternative to invasive angiography if another non-invasive test is equivocal or non-diagnostic.	IIa	C
Coronary CTA is not recommended when extensive coronary calcification, irregular heart rate, significant obesity, inability to cooperate with breath-hold commands, or any other conditions make obtaining good image quality unlikely.	III	C
Coronary calcium detection by CT is not recommended to identify individuals with obstructive CAD.	III	C

ORIGINAL ARTICLE

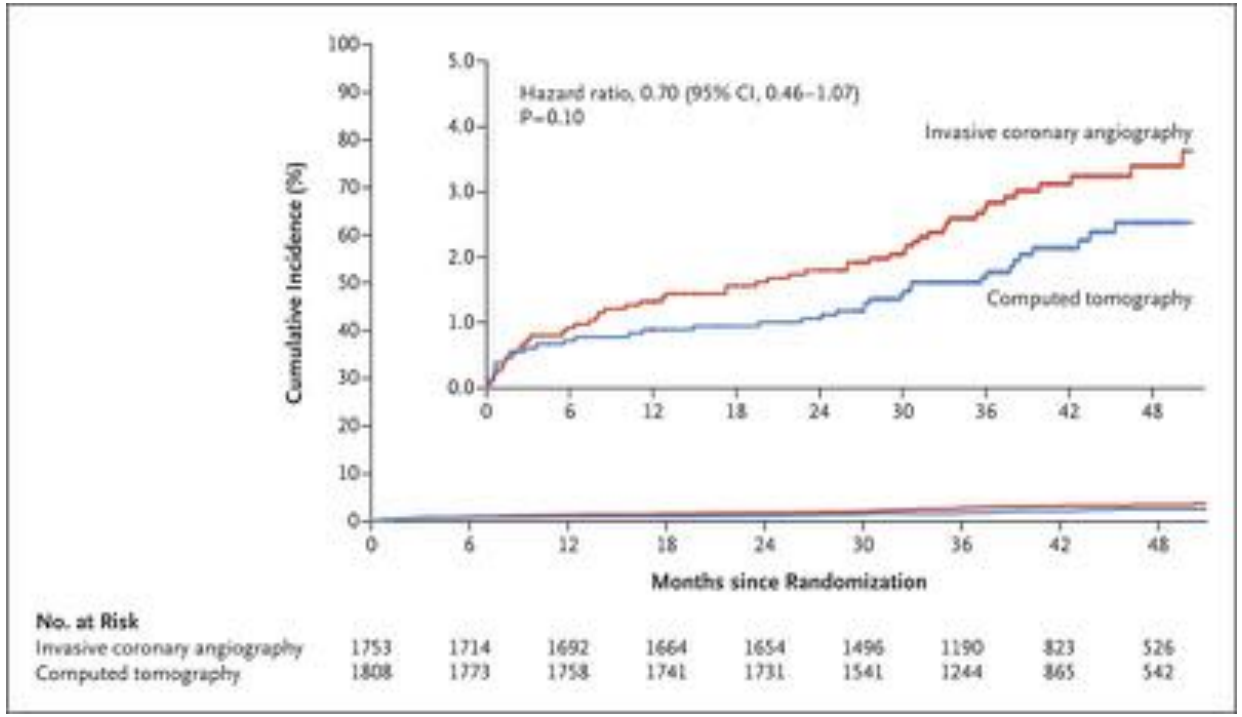
CT or Invasive Coronary Angiography in Stable Chest Pain

The DISCHARGE Trial Group*

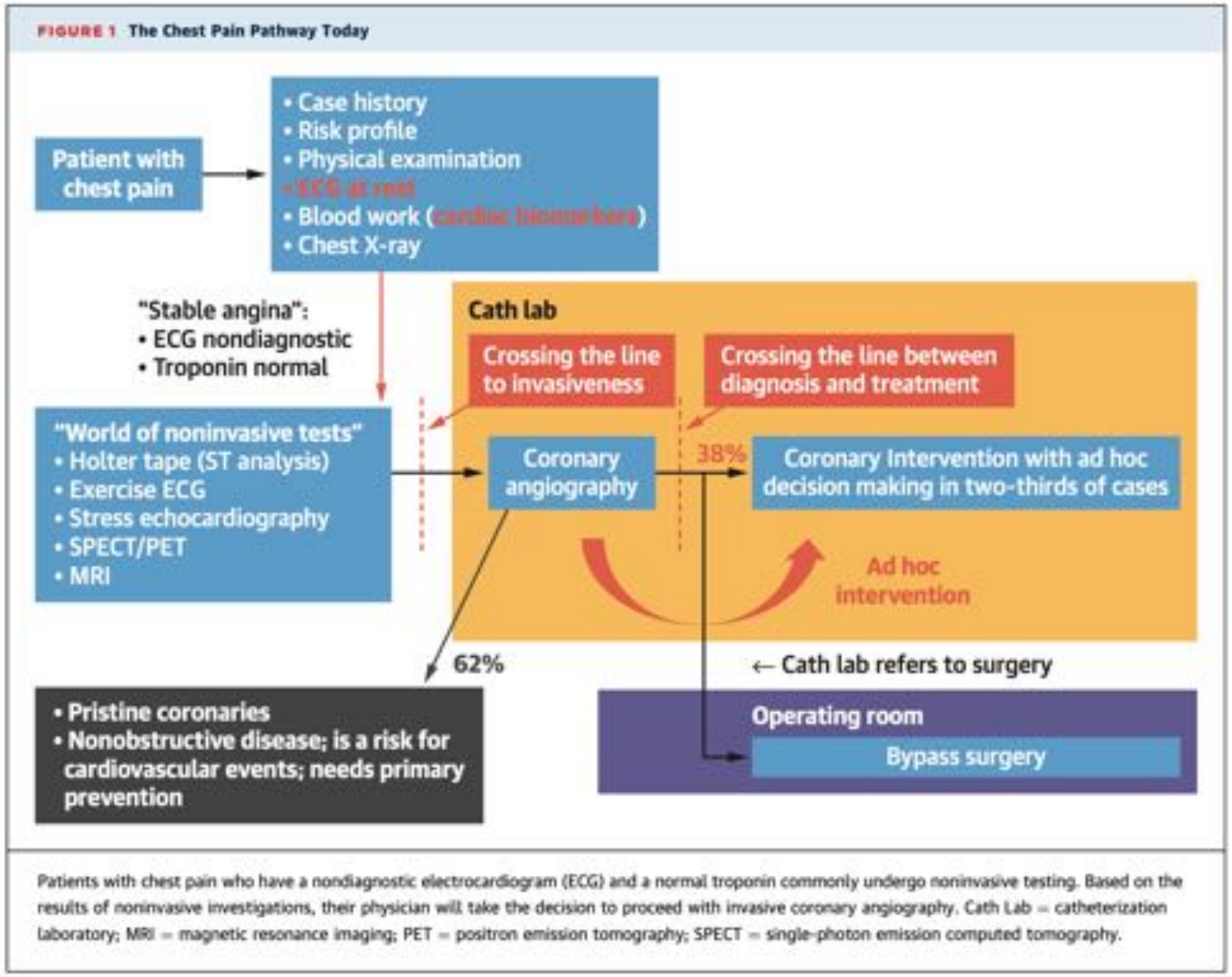
- CCTA vs ICA
- Symptomatic patients
- Intermediate PTP of CAD
- MACE @ 3.5y

- 26 europeans centers

- 3561 patients; complete FU 3523
- No difference of MACE between CCTA vs ICA (2.1% vs 3%)
- More major procedure-related complications w/ ICA (1.9% vs 0.5%, OR 1.17)



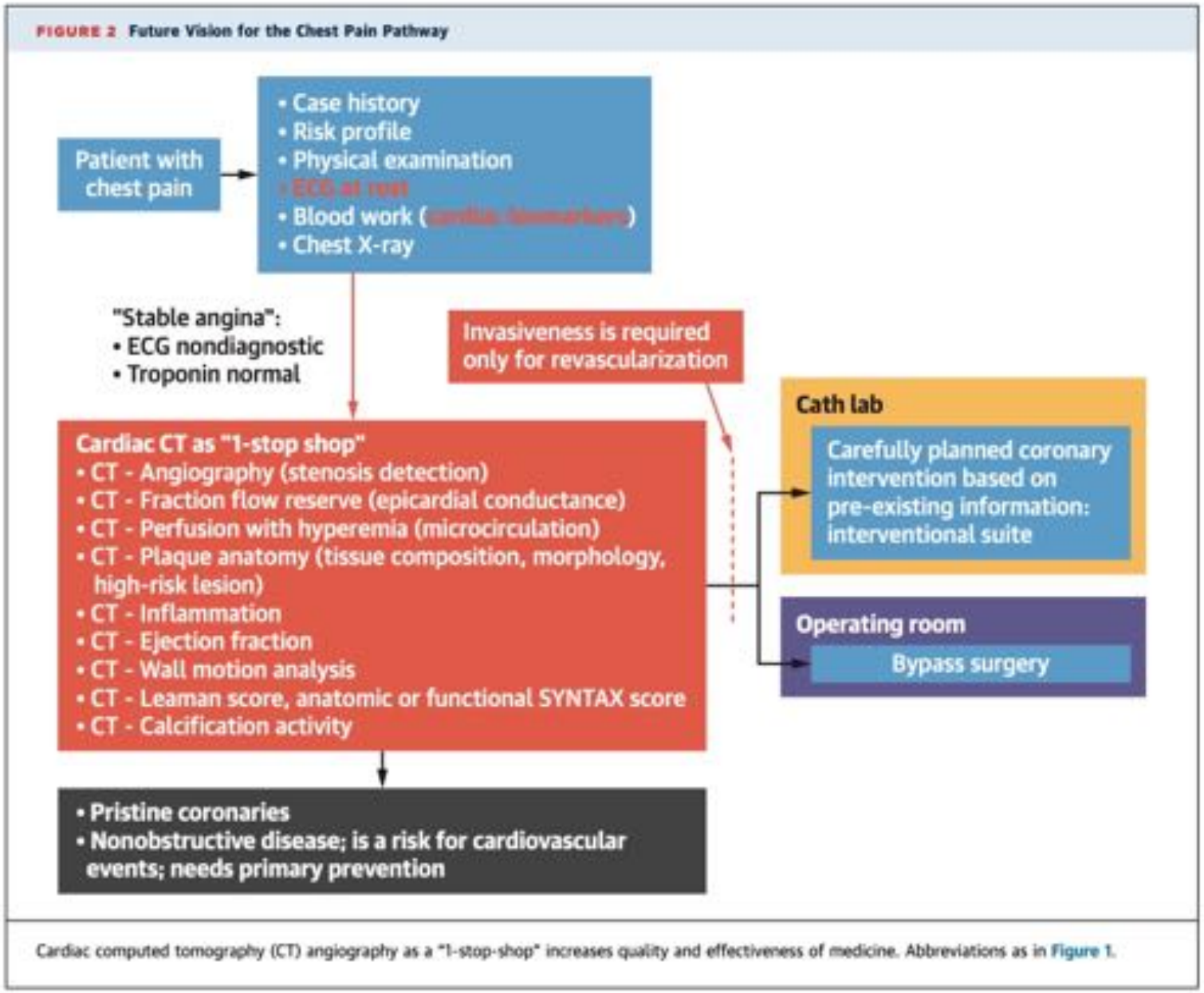
March 4, 2022
DOI: 10.1056/NEJMoa2200963



Patients with chest pain who have a nondiagnostic electrocardiogram (ECG) and a normal troponin commonly undergo noninvasive testing. Based on the results of noninvasive investigations, their physician will take the decision to proceed with invasive coronary angiography. Cath Lab = catheterization laboratory; MRI = magnetic resonance imaging; PET = positron emission tomography; SPECT = single-photon emission computed tomography.

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

FIGURE 2 Future Vision for the Chest Pain Pathway



Cardiac computed tomography (CT) angiography as a "1-stop-shop" increases quality and effectiveness of medicine. Abbreviations as in Figure 1.

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

Market context

Despite enormous technological progress,
there remain limitations for current CT technology

Higher level of detail
comes at expense of higher dose

Some patients remain unscannable

Relevant information
may be missing in scans

Measurements depend on
external parameters, so that
consistency is not ensured

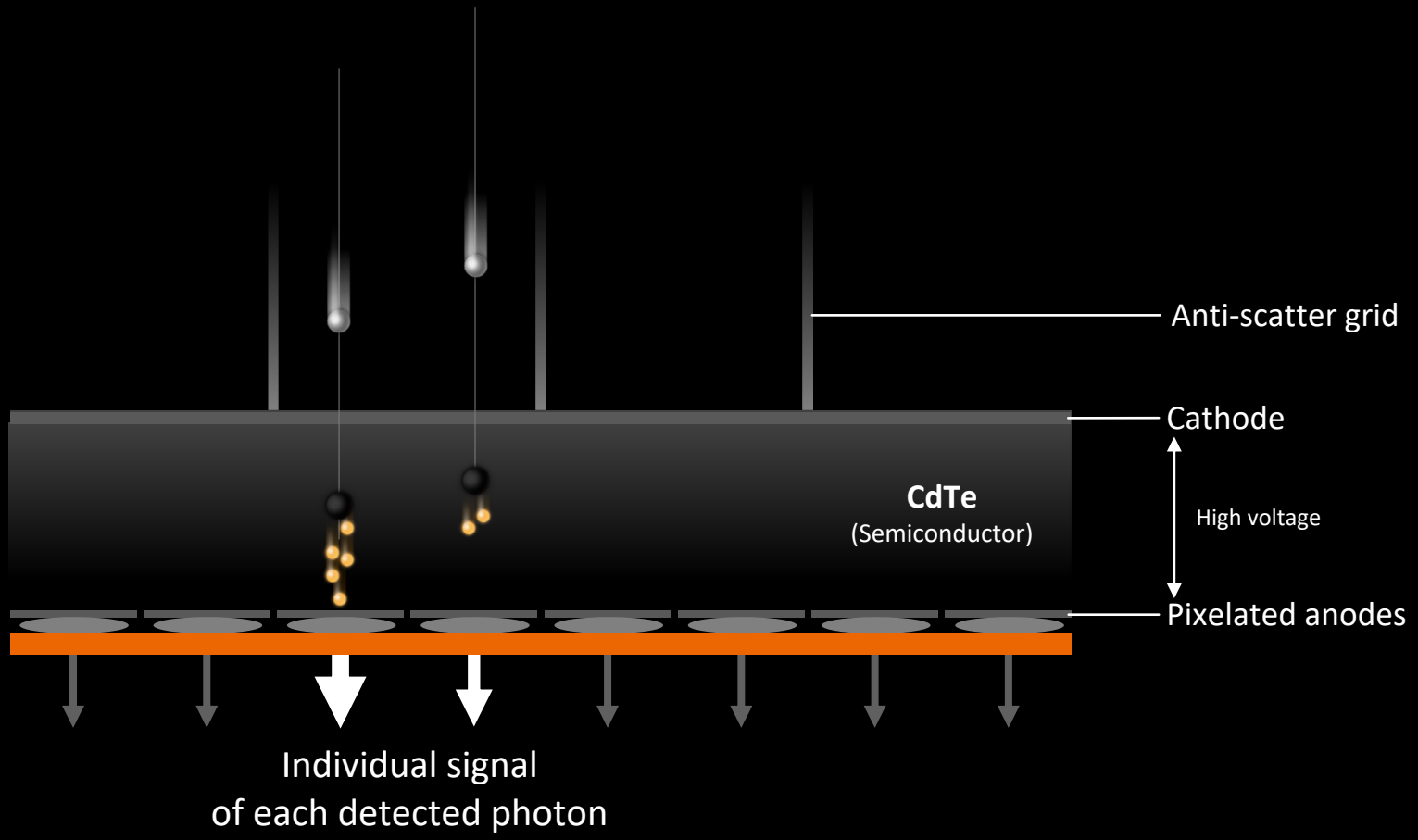
There are physical constraints
to overcoming these limitations

Gantries cannot rotate faster
(photon flux per projection insufficient)

Detectors cannot be wider
(image artifacts)

Pixels cannot be smaller
(dose inefficiency)

Operating principle CT detectors
Photon-counting detector (PCD)



Semiconductor
as direct X-ray converter (CdTe)

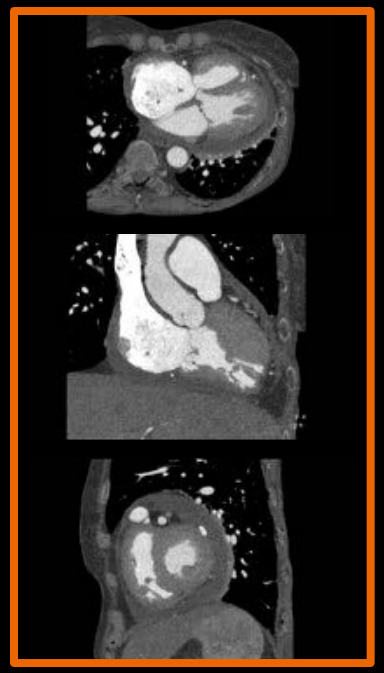
- Photons produce a **charge** proportional to X-ray energy
- Individual photons are measured allowing for measurement of energy information

→ **Energy-selective counter signal**

Single-step direct conversion: X-rays → electric current

Removing the effect of calcification in coronary artery disease

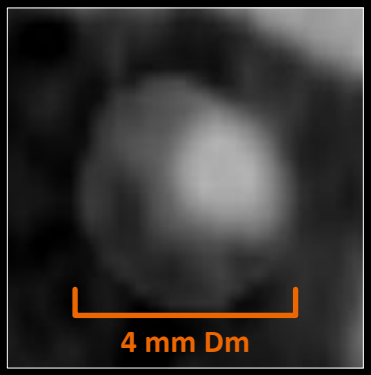
SIEMENS Healthineers



Input
Highly resolved spectral CT data
à **Decomposition of materials and fine resolution**

Patient
- Received **stent** as treatment of severe stenosis
- Severe degree of coronary artery disease with **calcifications**
- Cardiac symptoms persisting

Calcification mask the pathology and "distorts" severity of the stenosis
→ **No value delivered**



real lumen pathologic wall with different composites

Pure Lumen

Reveals the underlying reality of the pathology
à **Able to guide the cardiologist with non-invasive imaging in advanced CAD**

Courtesy of Medical University of South Carolina, Charleston, USA

Computed Tomography

Coronary CTA after stent placement

SIEMENS Healthineers

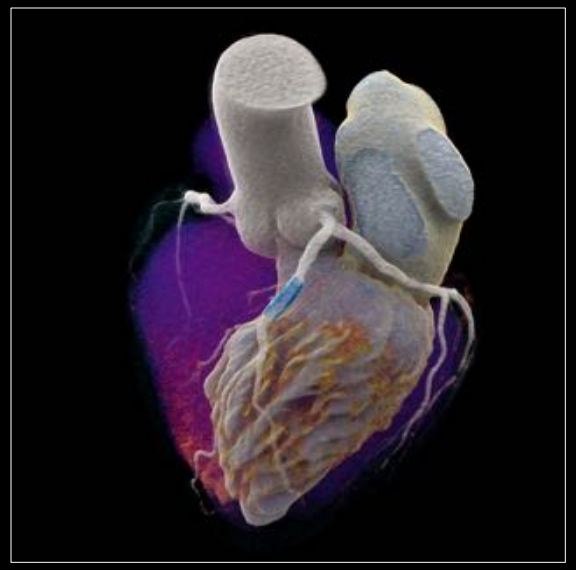
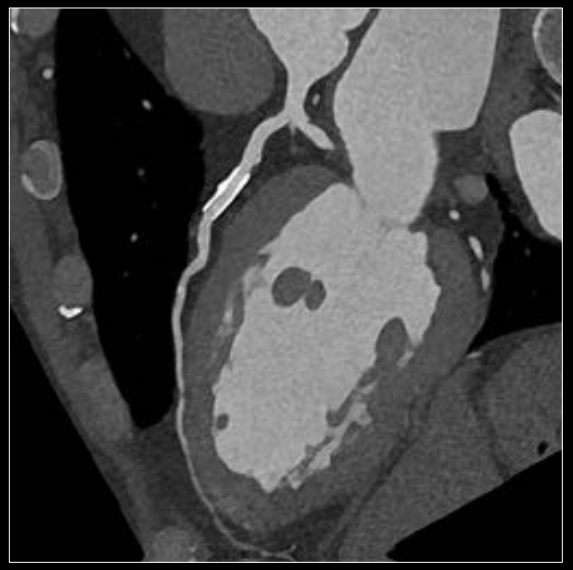


Image type
Cinematic VRT based on 0.4 mm



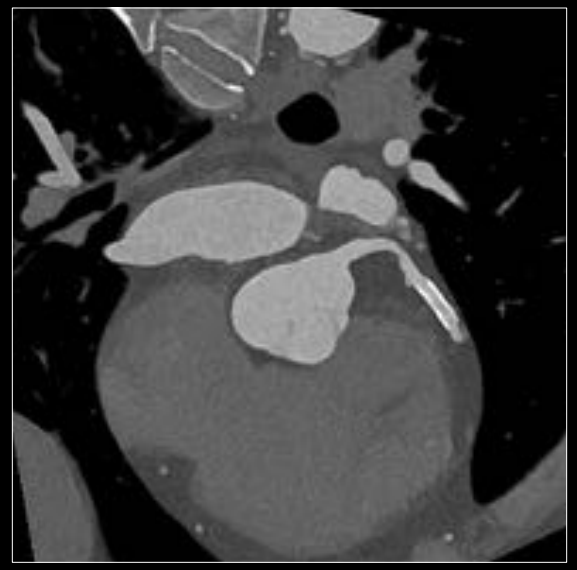
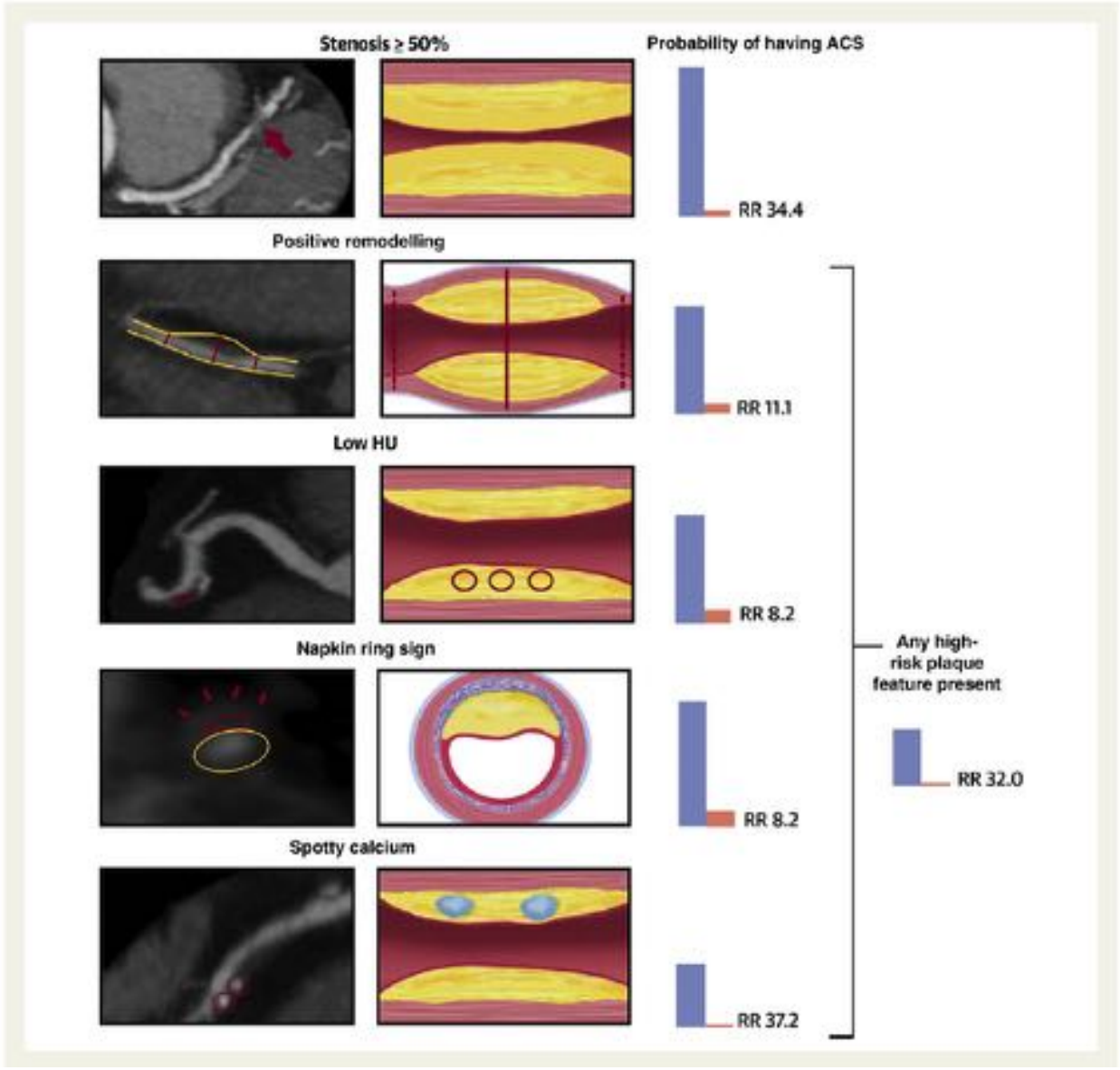


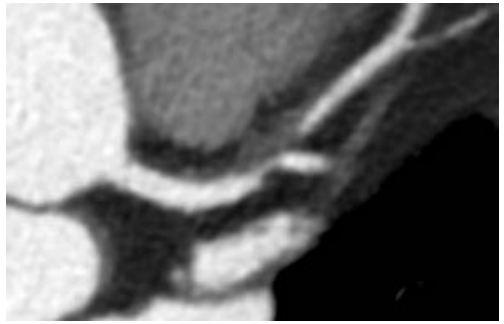
Image type
MPR based on 0.4 mm | 70 keV mono-energetic | Bv 40 kernel

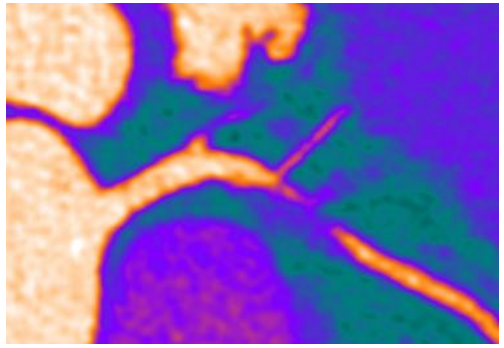
QuantumPlus | $CTDI_{vol}$ 14 mGy | heart rate 56 bpm | Quantum 3 reconstruction strength

Courtesy of Centre Cardio-Thoracique de Monaco, Monaco

HIGH-RISK PLAQUE FEATURES

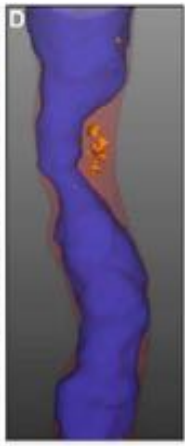


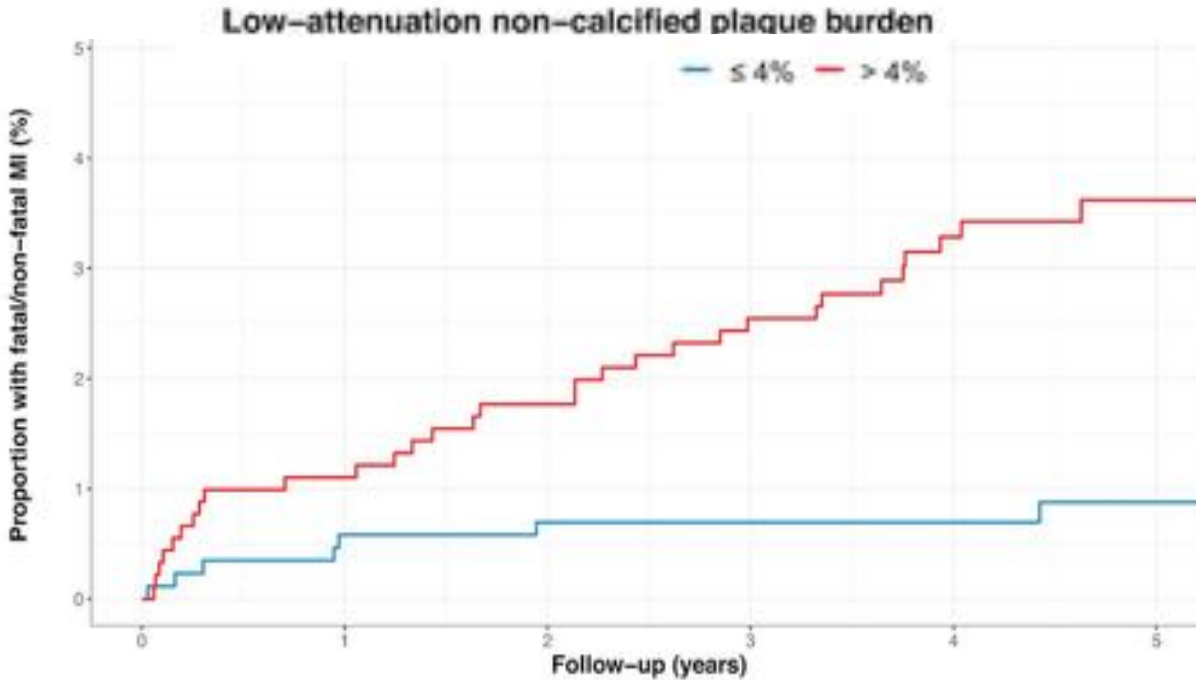




Ferencik et al. EHJ 2016

SCOT-HEART trial:
Low-attenuation non calcified plaque





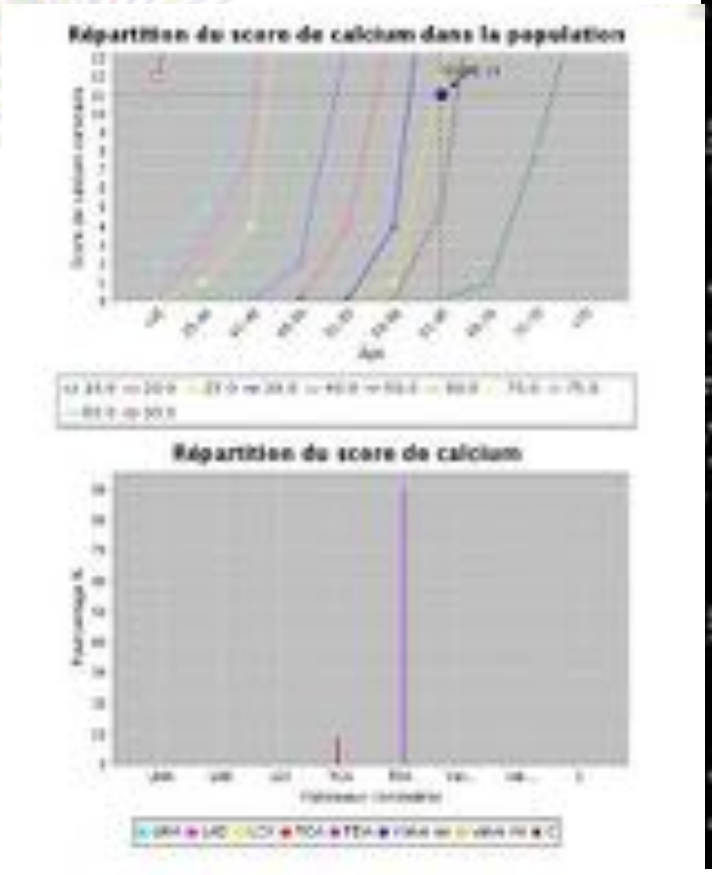
Low-attenuation plaque:

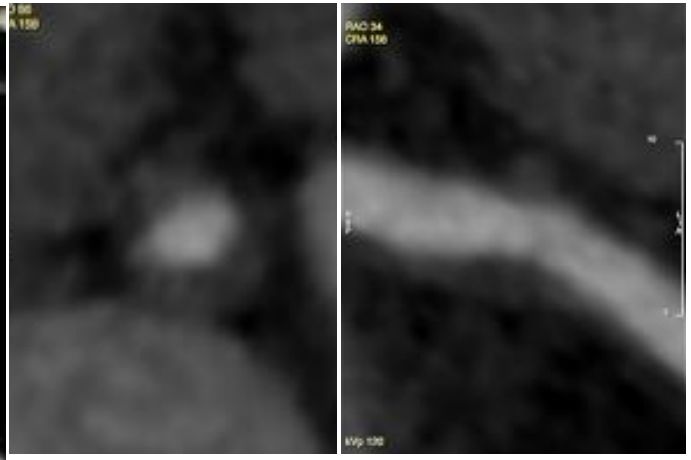
- **strongest predictor** of fatal or nonfatal MI
- exceed other established markers as CV risk scores, CACS and coronary artery stenosis (CCTA)

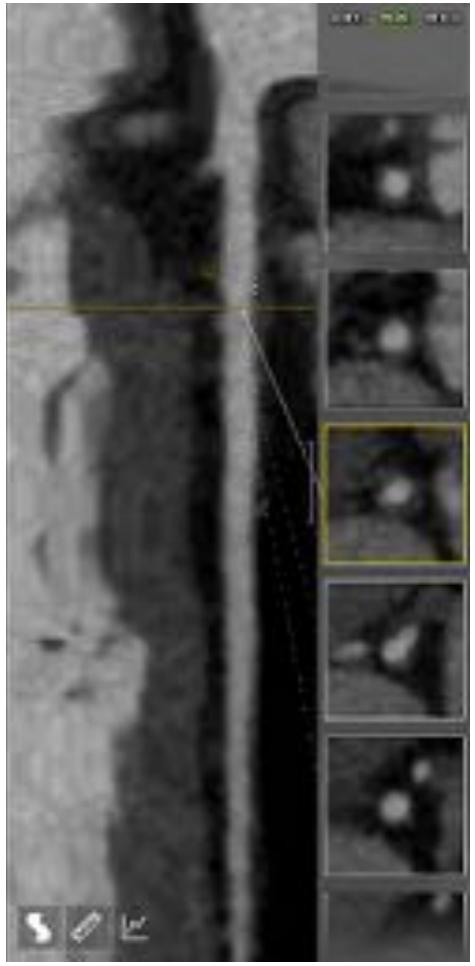
Low-attenuation plaque burden >4% = 5 times more likely of fatal or nonfatal MI

Williams M , Dweck M, Dey D, et al, Circulation 2020 May 5;141(18):1452-1462

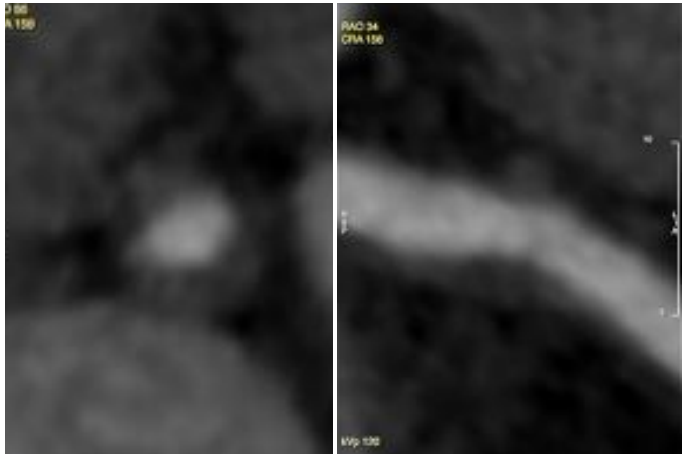
65 yo Man
HTN, Smoker
Acute Chest Pain,
No ECG changes,
Nl hs troponin,

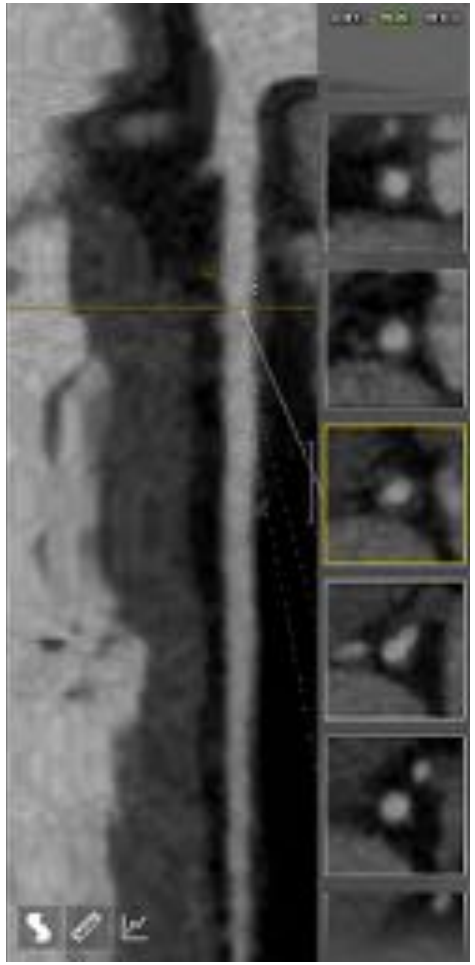




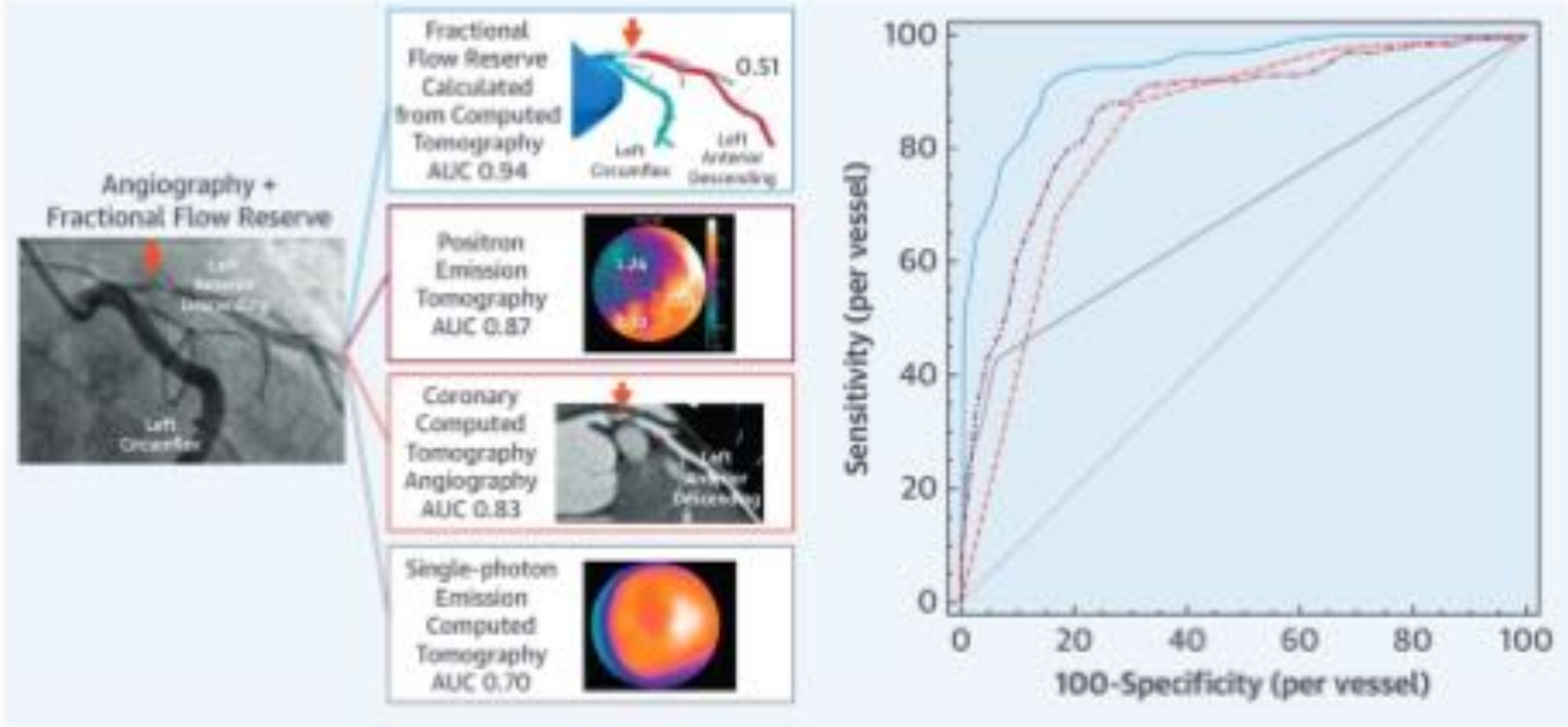



INIQUE
H
o 15
95
995
139
AO 12° / CRAN 38°


PAO 34
CRA 150



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



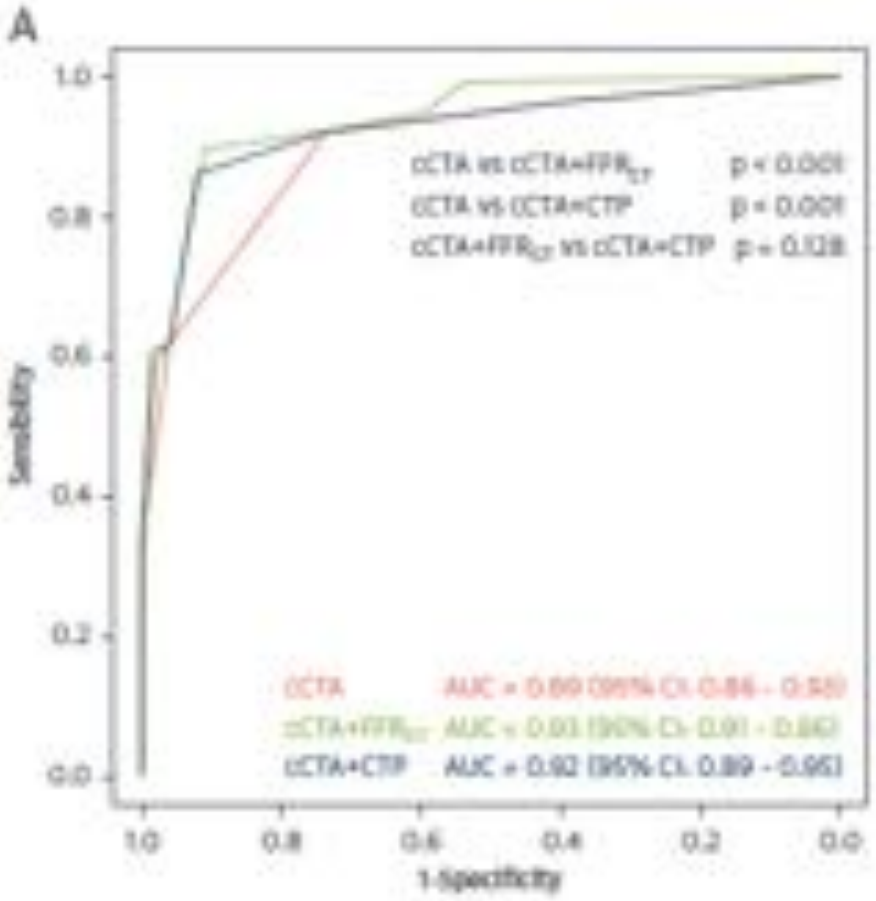
Driessen, R.S. et al. J Am Coll Cardiol. 2019;73(2):161-73.

Significance of stable coronary artery disease, as defined by invasive FFR, was prospectively tested with several noninvasive imaging modalities. Each patient underwent FFR_{CT}, PET, coronary CTA, SPECT, and ICA with FFR, regardless of imaging results as illustrated by the typical imaging findings of a severe left anterior descending artery stenosis in the **colored boxes. Curves with corresponding colors** indicate that FFR_{CT} demonstrated the greatest AUC for the detection of per-vessel ischemia. CTA = coronary computed tomography angiography; FFR = fractional flow reserve; FFR_{CT} = fractional flow reserve calculated from computed tomography; ICA = invasive coronary angiography; PET = positron emission tomography; SPECT = single-photon emission computed tomography.

Stress Computed Tomography PERfusion Versus Fractional Flow REserve CT Derived In Suspected COroNary Artery Disease

PERFECTION study. G.Pontone. JACC Cardiovascular Imaging 2018

147 symptomatic patients scheduled for ICA-FFR evaluated by CCTA/CTP/FFR-CT

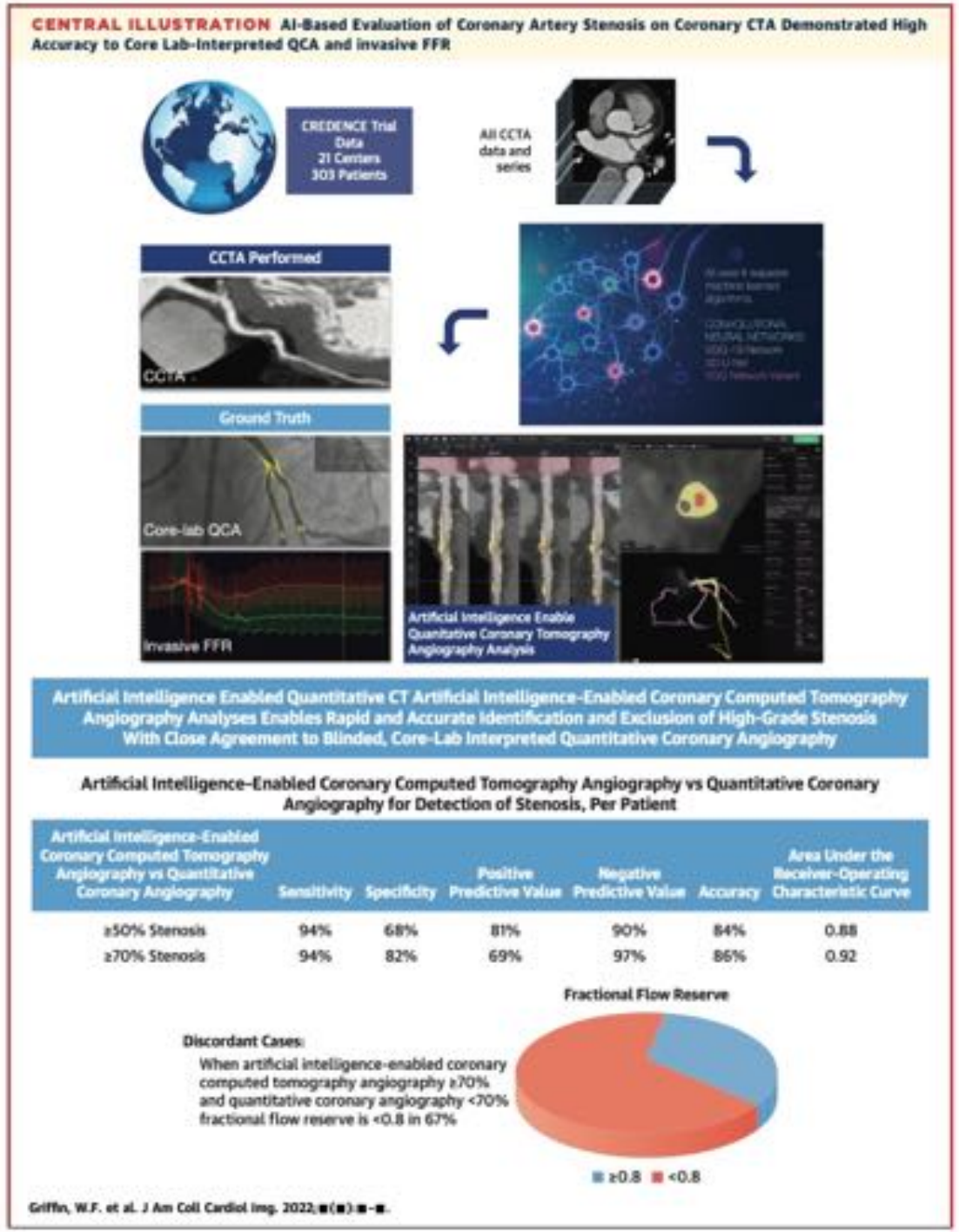


	cCTA (n = 147)	cCTA+FFR$_{CT}$ (n = 140)	cCTA+CTP (n = 144)	p-value cCTA+FFR$_{CT}$ vs. cCTA	p-value cCTA+CTP vs. cCTA	p-value cCTA+FFR$_{CT}$ vs. cCTA+CTP
Vessel-based analysis						
True positive	121	102	109	-	-	-
True negative	241	255	256	-	-	-
False positive	78	20	17	-	-	-
False negative	1	14	10	<0.001	-	-
Sensitivity	99 (96-100)	88 (82-94)	92 (87-97)	<0.001	0.005	0.353
Sensitivity % (CI 95%)	76 (71-82)	94 (91-96)	95 (92-97)	0.849	<0.001	0.611
Negative predictive value % (CI 95%)	100 (99-100)	95 (93-98)	97 (95-99)	<0.001	0.002	0.409
Positive predictive value % (CI 95%)	61 (54-68)	84 (77-90)	87 (81-92)	<0.001	<0.001	0.525
% Accuracy (CI 95%)	82 (79-86)	92 (90-95)	94 (91-96)		<0.001	0.338
Patient-based analysis						
True positive	63	57	64	-	-	-
True negative	44	68	69	-	-	-
False positive	37	12	10	-	-	-
False negative	3	6	1	-	-	-
Sensitivity % (CI 95%)	95 (90-100)	90 (83-96)	98 (95-100)	0.367	0.31	0.098
Specificity % (CI 95%)	54 (43-65)	85 (77-93)	87 (80-95)	<0.001	<0.001	0.668
Negative predictive value % (CI 95%)	94 (87-100)	92 (86-98)	99 (96-100)	0.324	0.15	0.063
Positive predictive value % (CI 95%)	63 (54-72)	83 (74-92)	86 (79-94)	0.005	<0.001	0.530
Accuracy % (CI 95%)	73 (66-80)	87 (82-93)	92 (86-97)	0.001	<0.001	0.164

Values are n or % (CI 95%). *Stenosis >50% diameter reduction or FFR ≤0.8 in intermediate stenosis (30% to 50% diameter reduction).
cCTA = coronary computed tomography angiography; CI = confidence interval; CTP = computed tomography perfusion; FFR = fractional flow reserve.

CTP and FFR-CT: accurate and comparable to evaluate the functional relevance of CAD

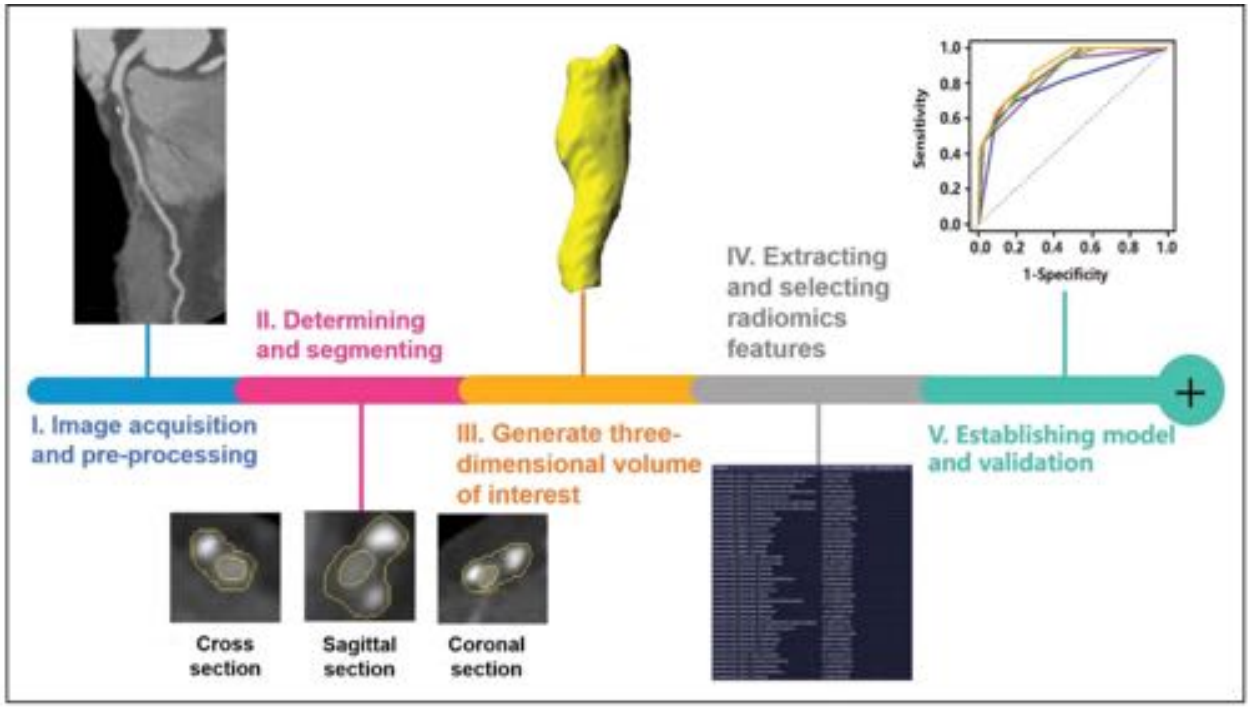
- Stenosis detection & grading
- AI-QCT vs core-lab CCTA/QCA/FFR
- 303 pts
- AI-QCT Time-analysis 10mn
- Rapid and accurate detection/exclusion of high-grade stenosis



ADVANCES IN CARDIOVASCULAR IMAGING

Radiomics

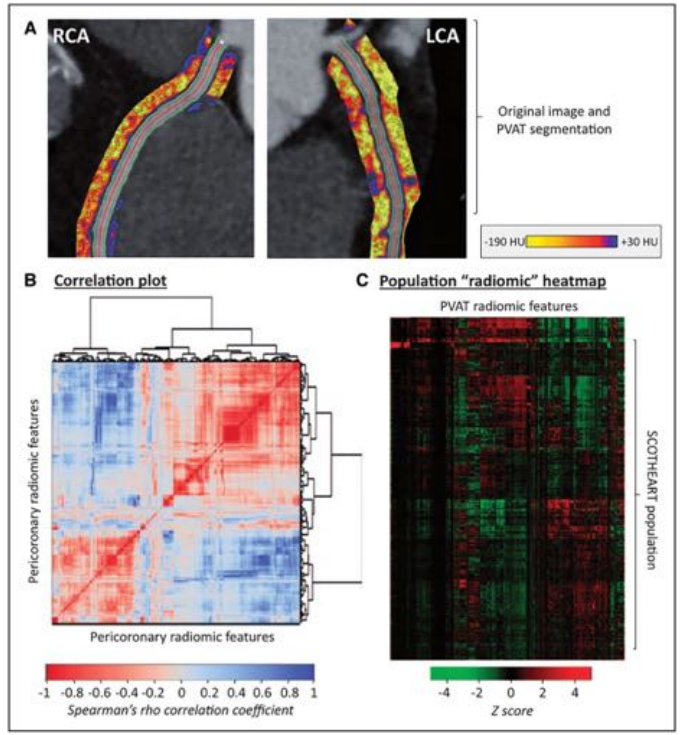
The Next Frontier of Cardiac Computed Tomography



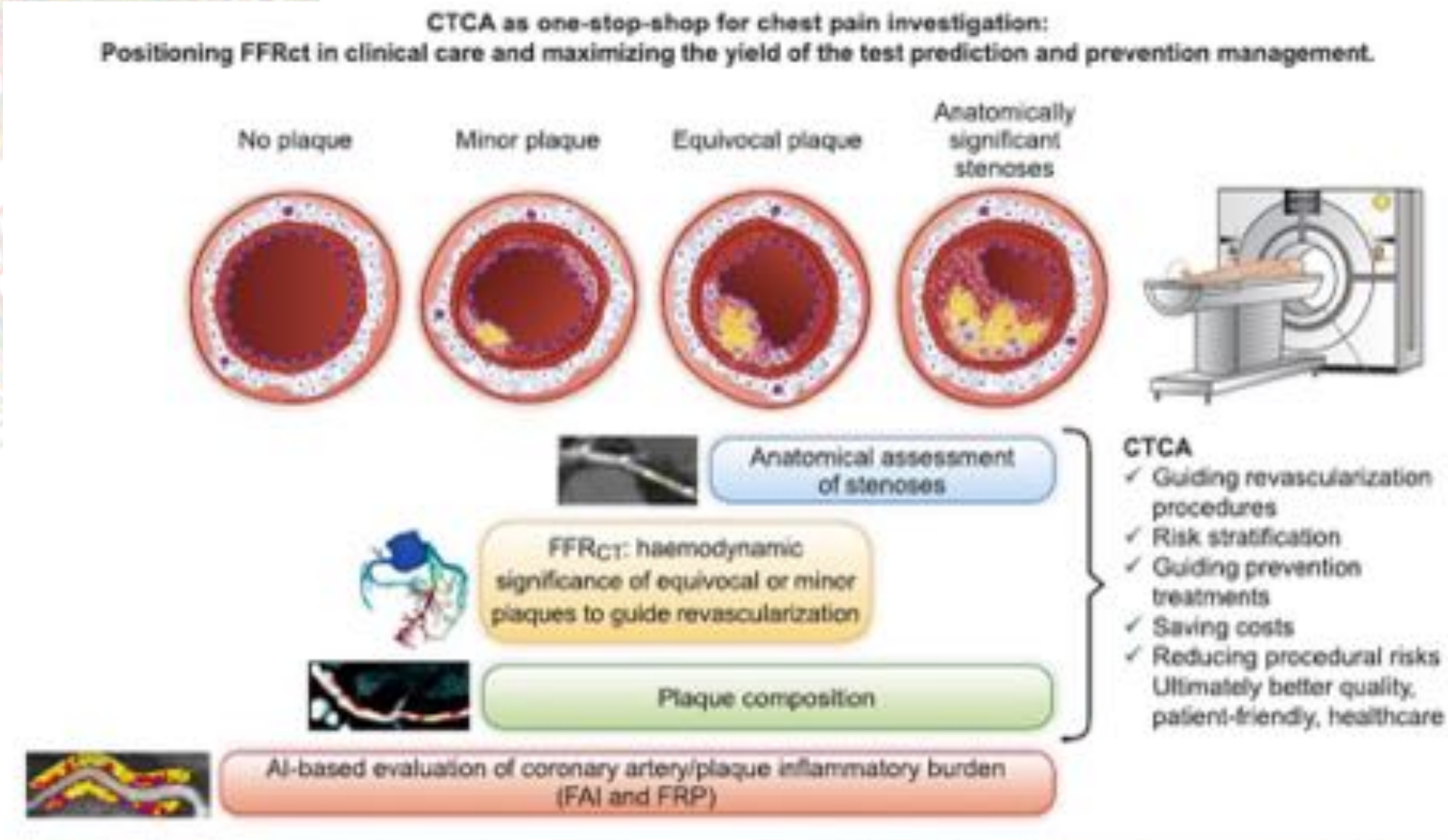
« Radiomics is the process of extracting numerous features from radiological images via high-throughput calcula- tions to create large datasets with hundreds of parameters that quantify the findings in these images ».

CURRENT CLINICAL APPLICATION IN CCTA
RADIOMICS

- Coronary plaque characterization
- Assessment of plaque microenvironnement
- Identification of vulnerable plaque
- Perivascular adipose tissue phenotypic
- Myocardial tissue characterization



Circ Cardiovasc Imaging. 2021;14:e011747. DOI: 10.1161/CIRCIMAGING.120.011747



The year in cardiovascular medicine 2021 European Heart Journal