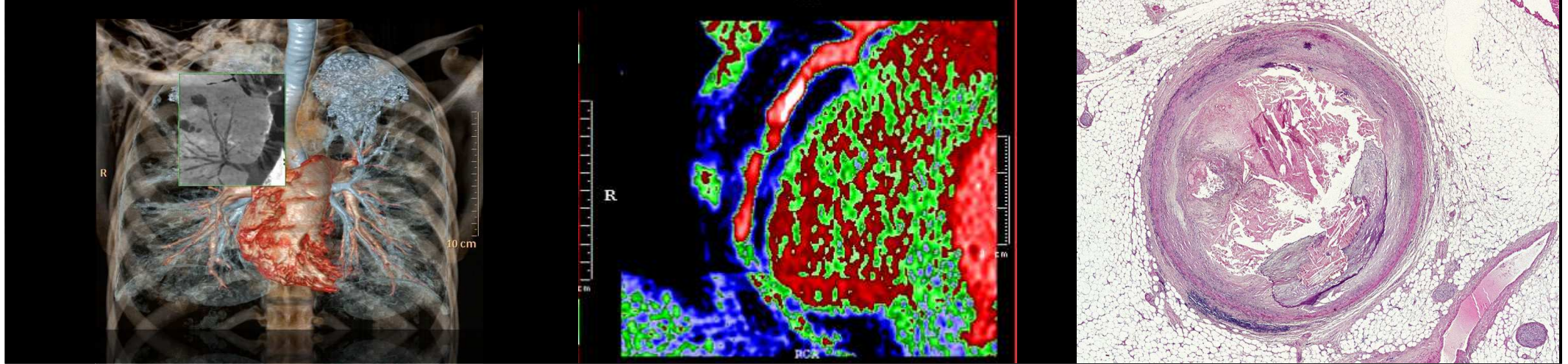




CT du cœur et des artères coronaires

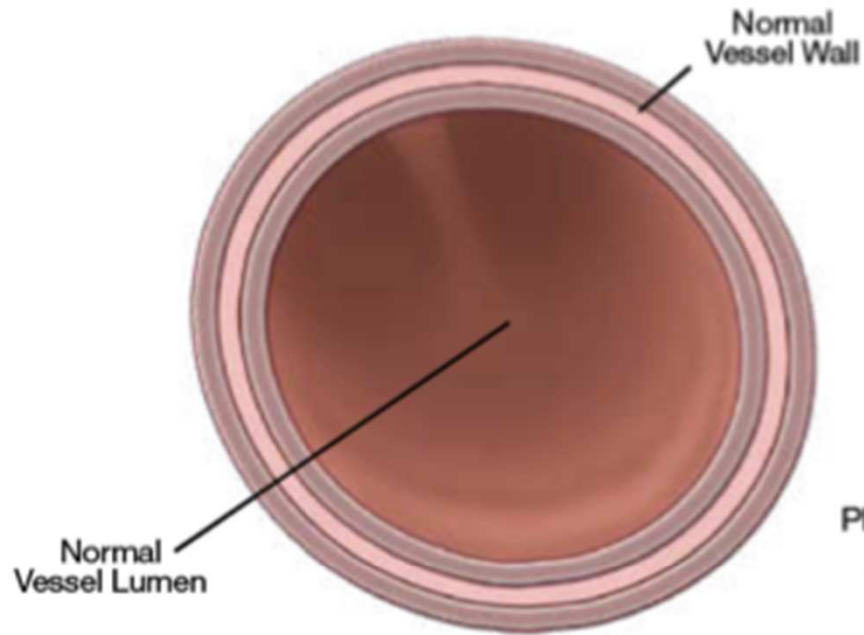
Emmanuel Coche
Cliniques Universitaires St-Luc
Av.Hippocrate, 10
1200 Bruxelles

DES Imagerie
Radiologie
26-02-2016

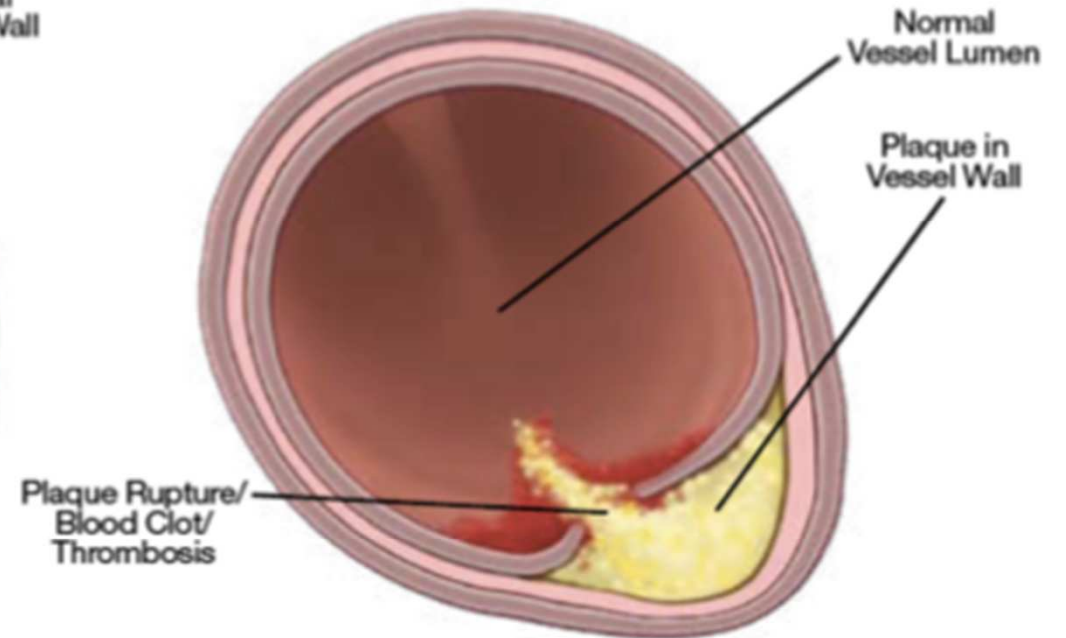
Maladie coronarienne

- Cause principale de mortalité dans les pays occidentalisés
 - $>10^6$ événements cardiaques aigus aux USA
 - $> 500 \cdot 10^3$ †
 - $12 \cdot 10^6$ histoire de maladie coronarienne symptomatique
 - 115 milliards de \$
- Diagnostic par coronarographie
 - Invasive, hématome au pt de pct, embolies..
 - 1/3 seulement s'accompagnent de traitement percutané

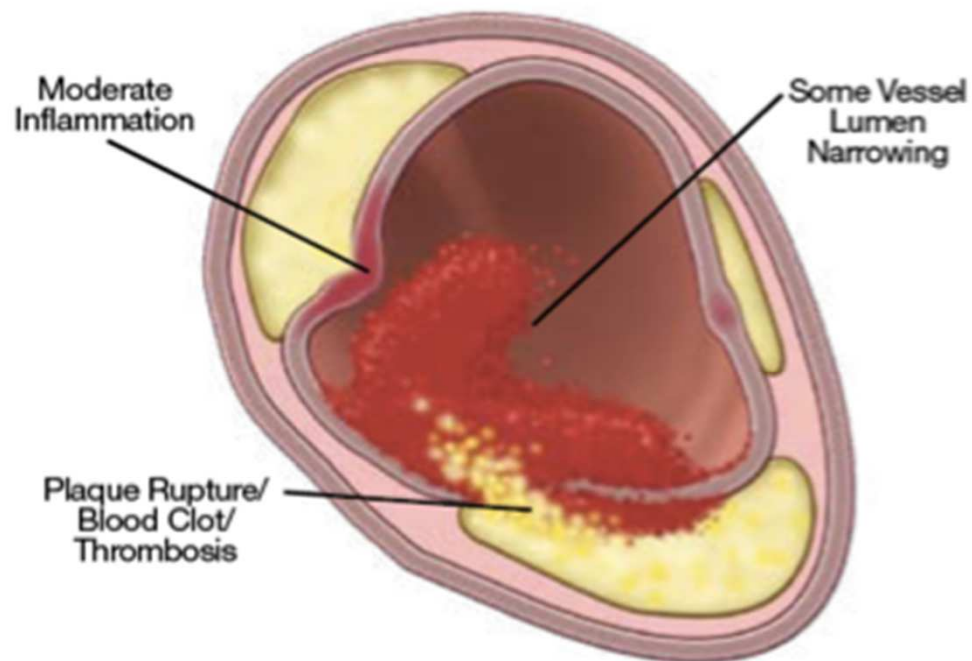
▼ Normal Coronary Artery



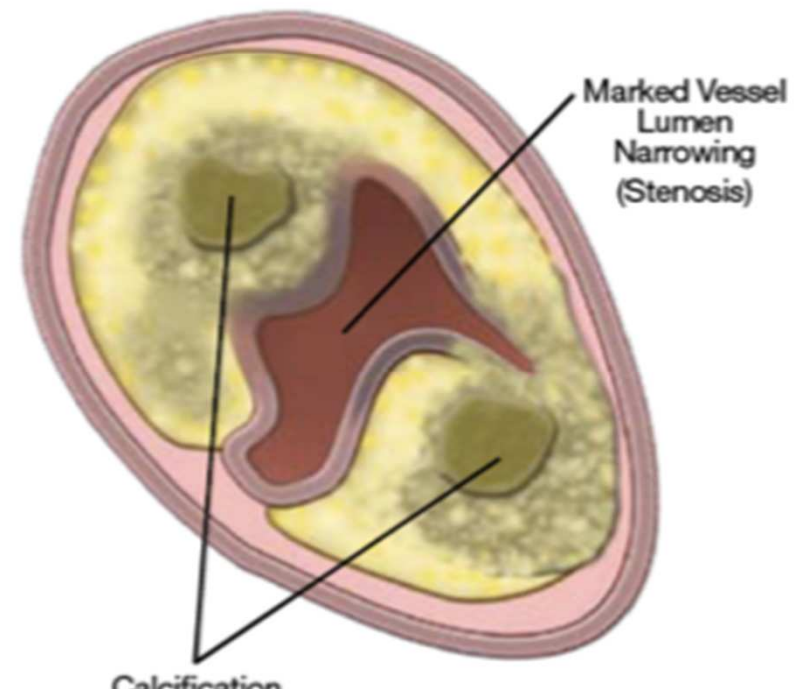
▼ Mild Coronary Artery Disease

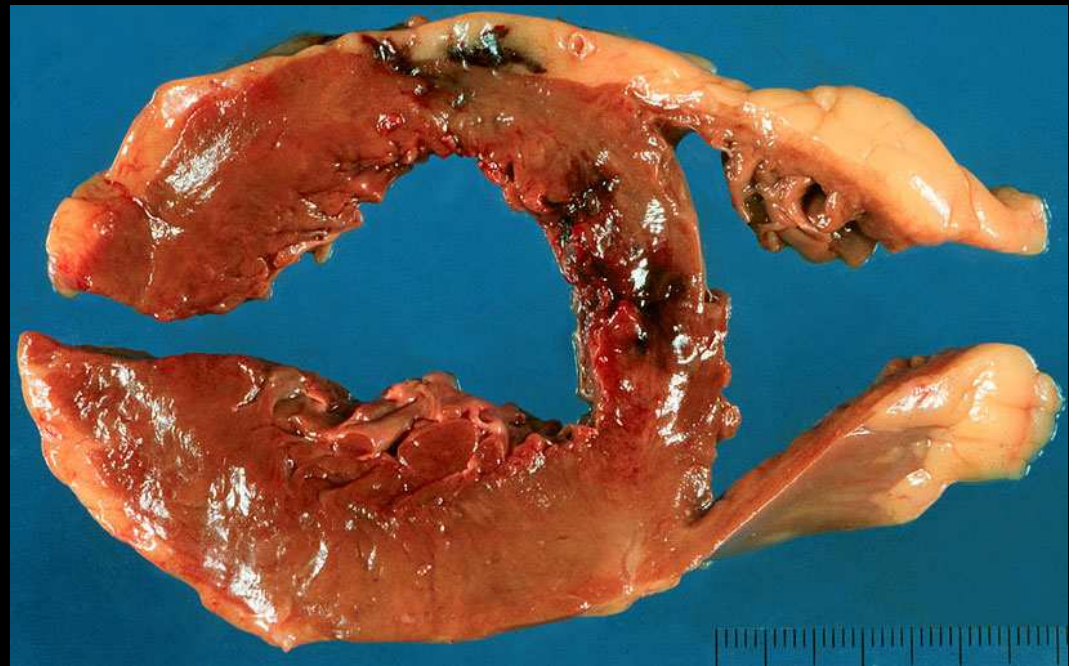
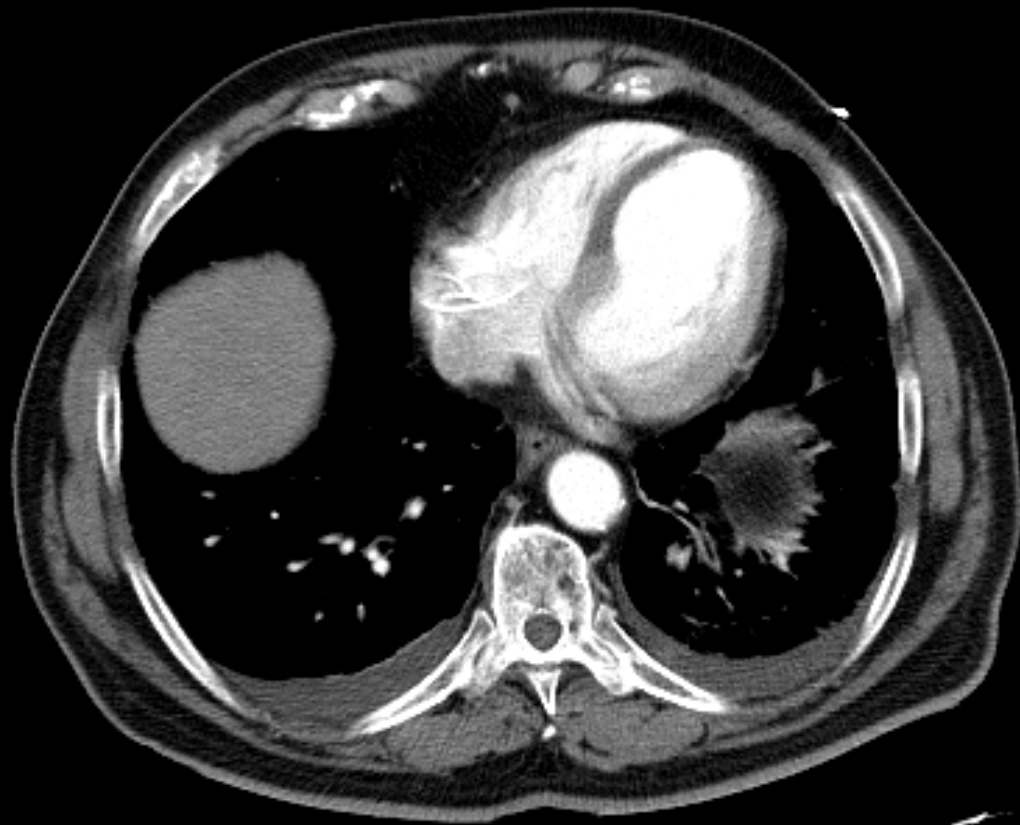
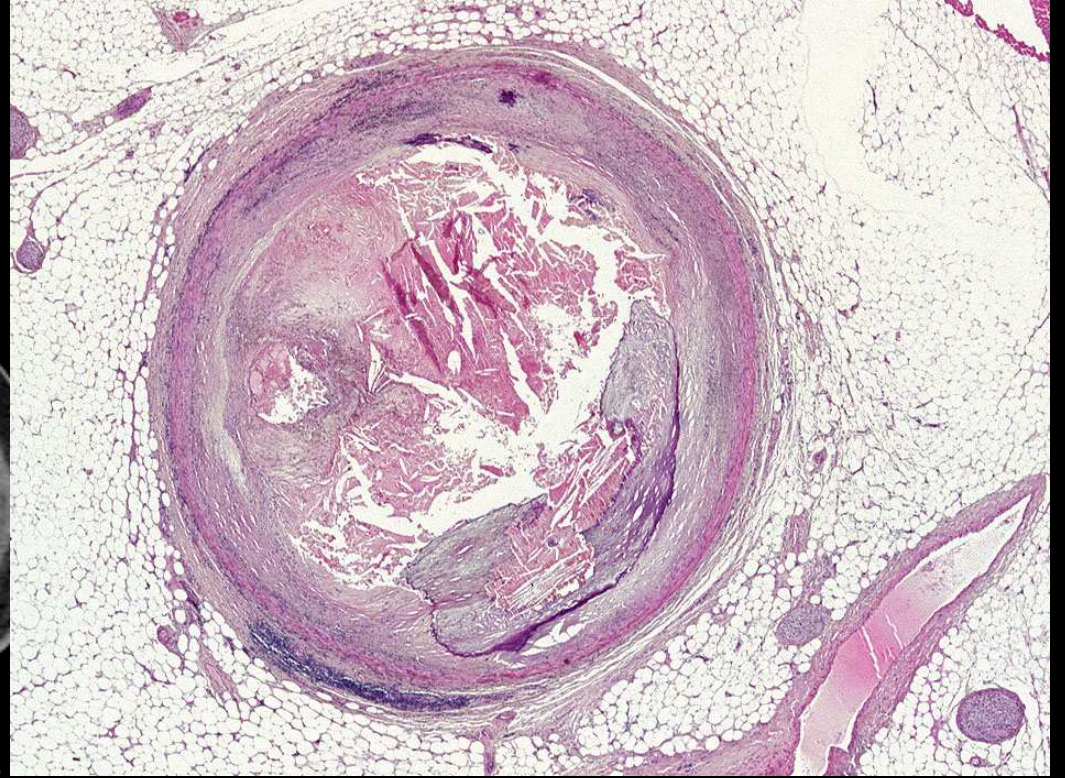
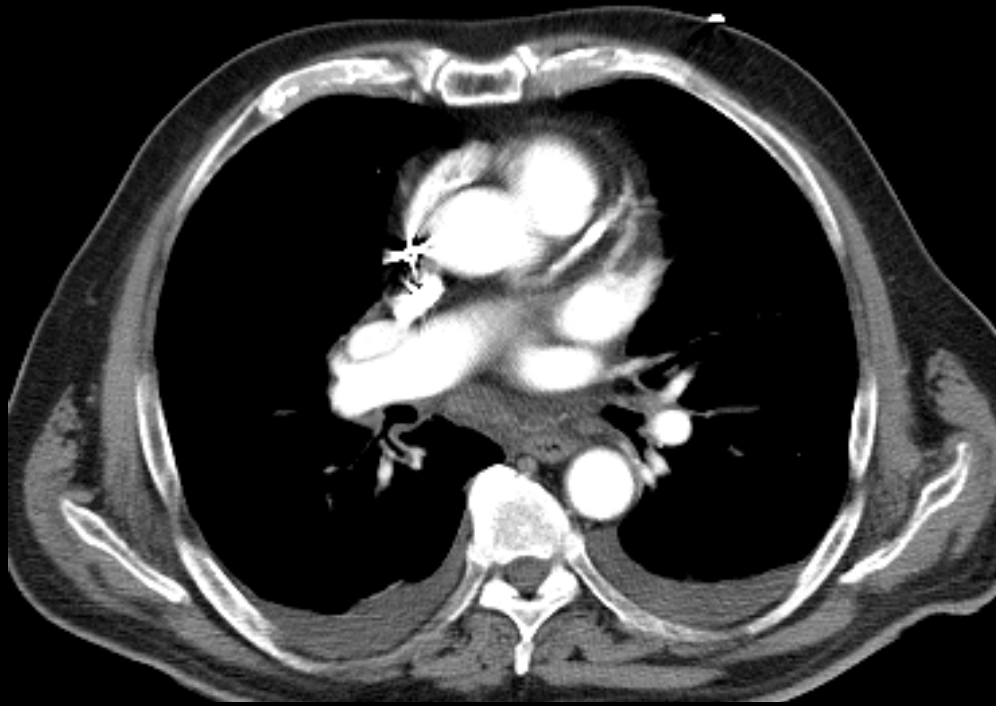


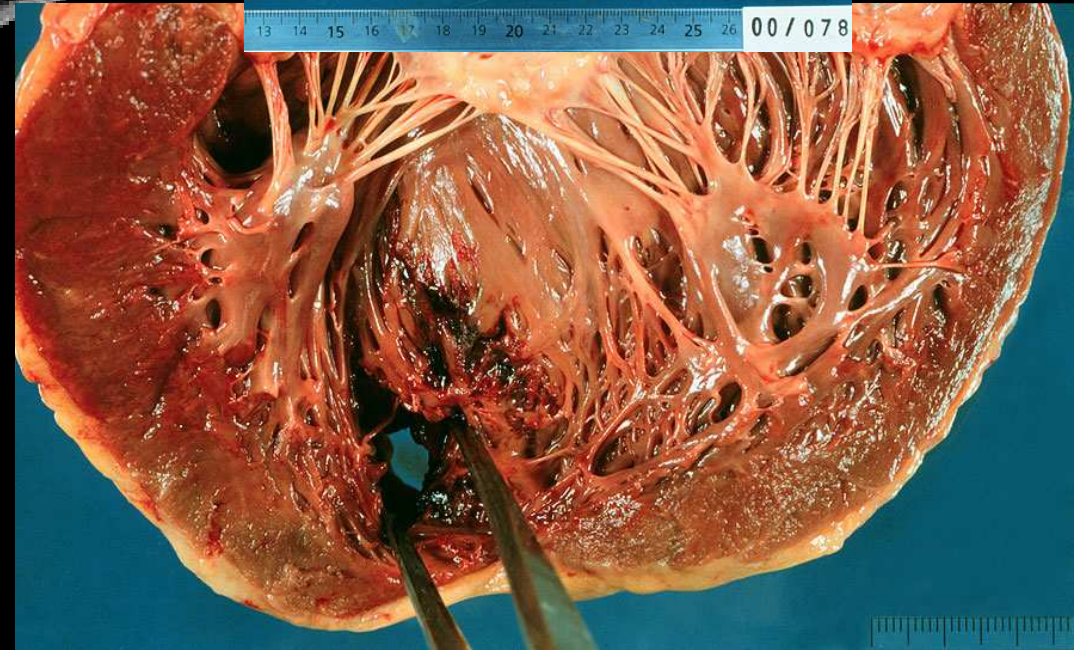
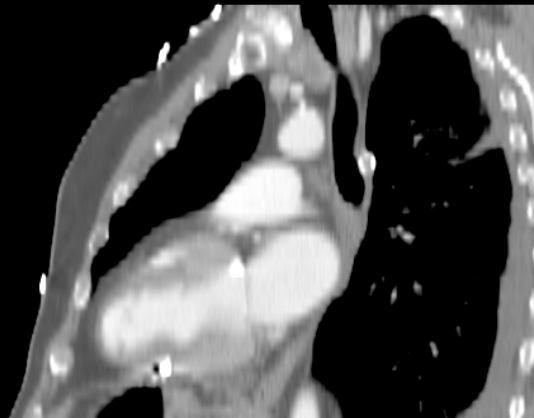
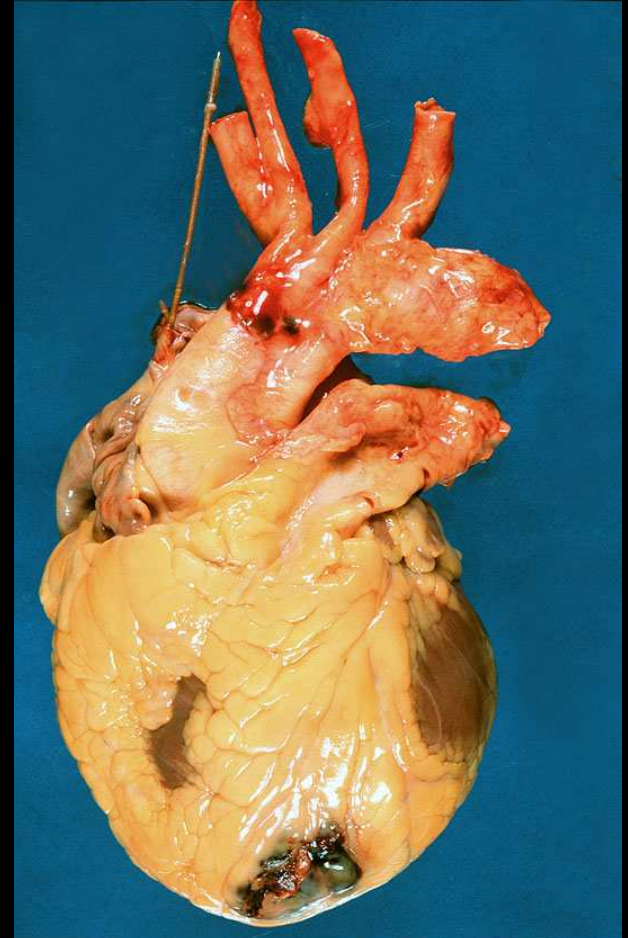
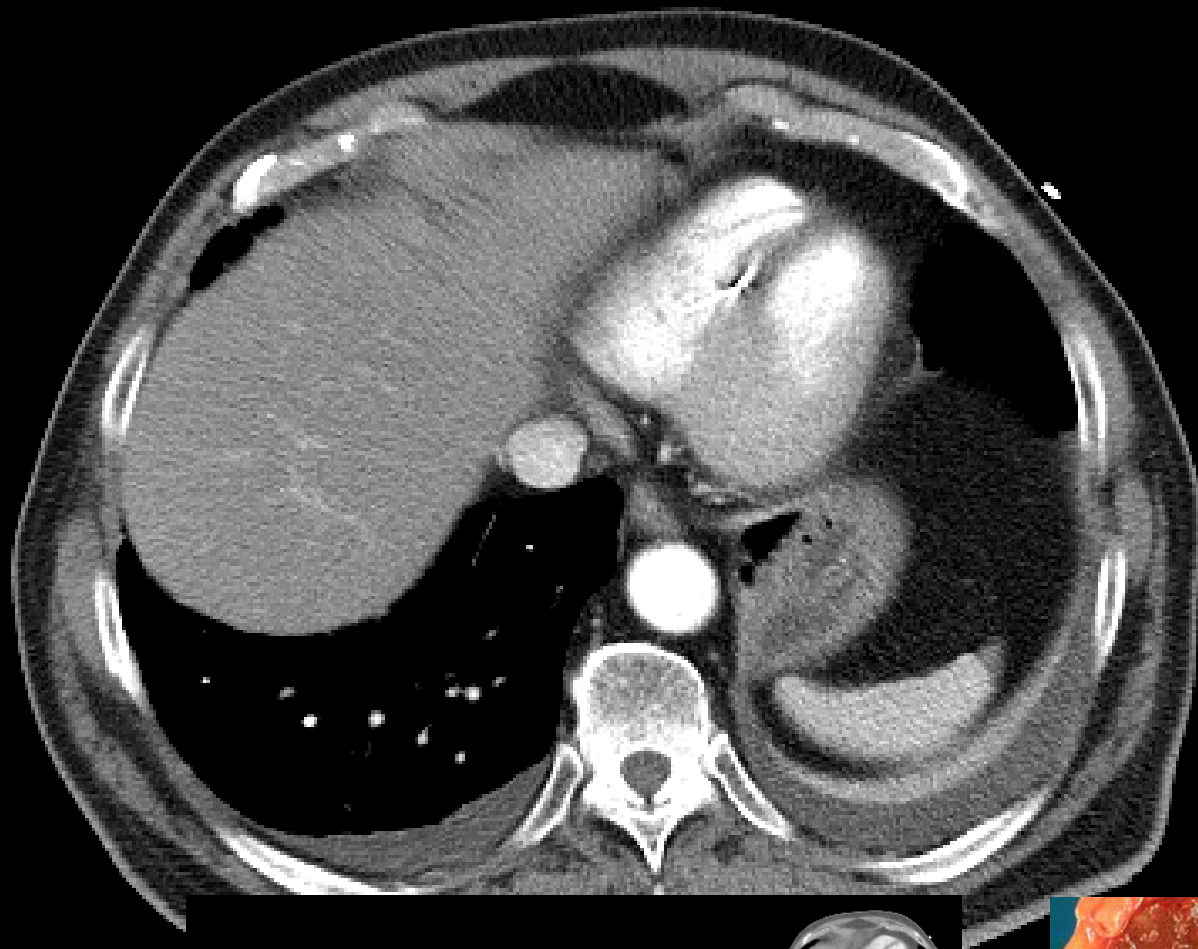
▼ Moderate Coronary Artery Disease



▼ Severe Coronary Artery Disease







CT multidétecteur



40-64 coupes/rotation

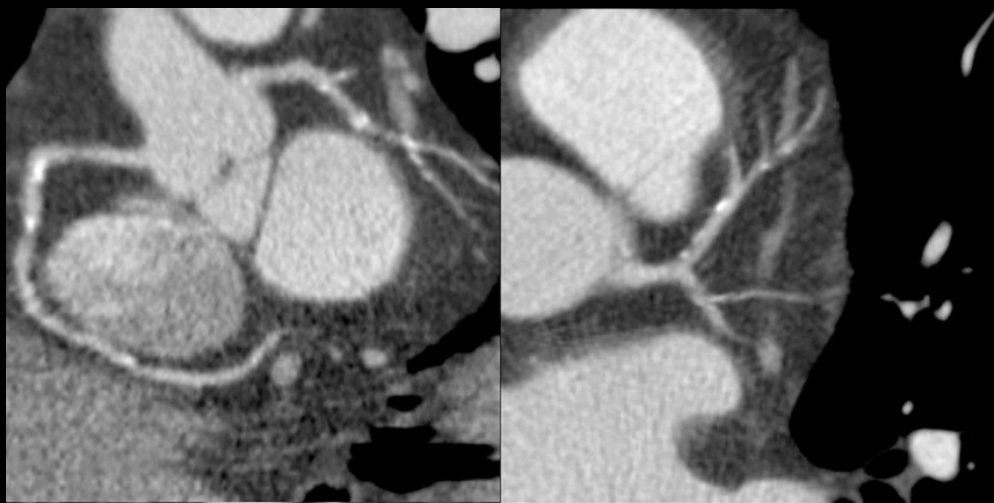
**CT à 256-320
coupes/rotation**

16 cm de couverture

**Imagerie cardiaque en
1 battement**

Dual source CT

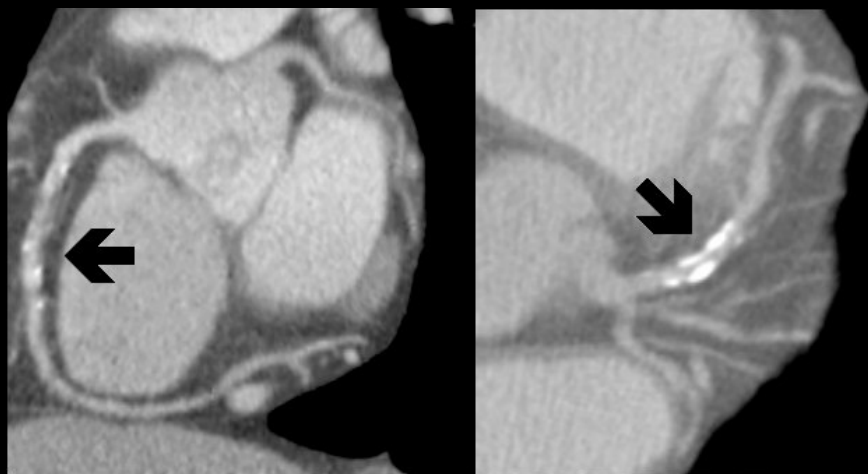
**Reconstructions
itératives**



4 coupes/rotation

2000: 4 x1 mm

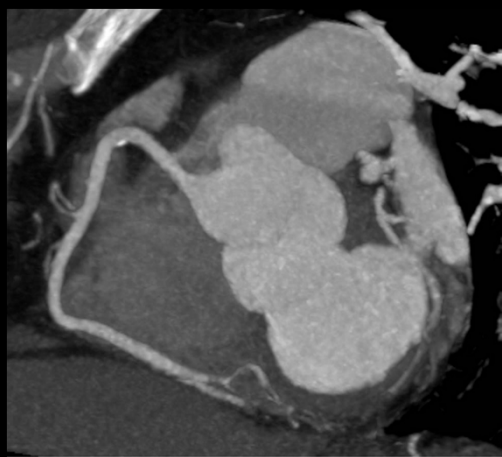
Temps d'acquisition: 45 sec



16 coupes/rotation

2004: 16 x 0.75 mm

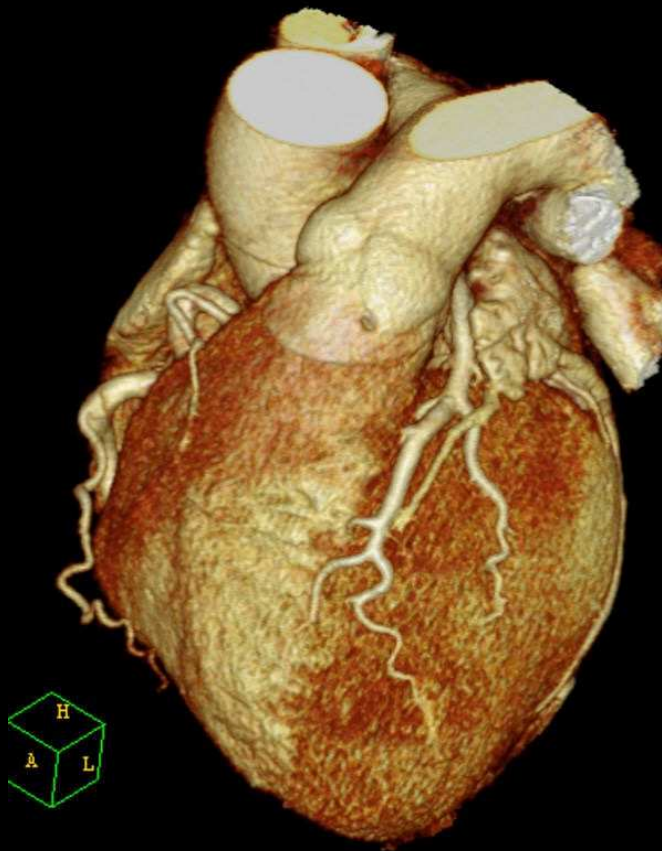
Temps d'acquisition: 25 sec



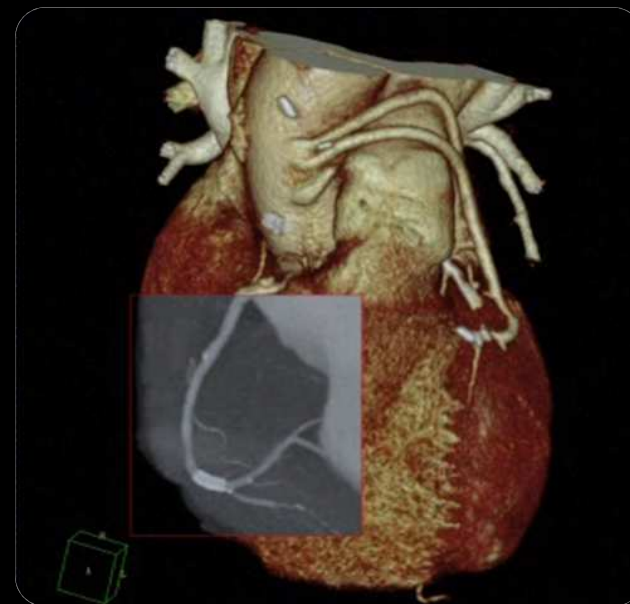
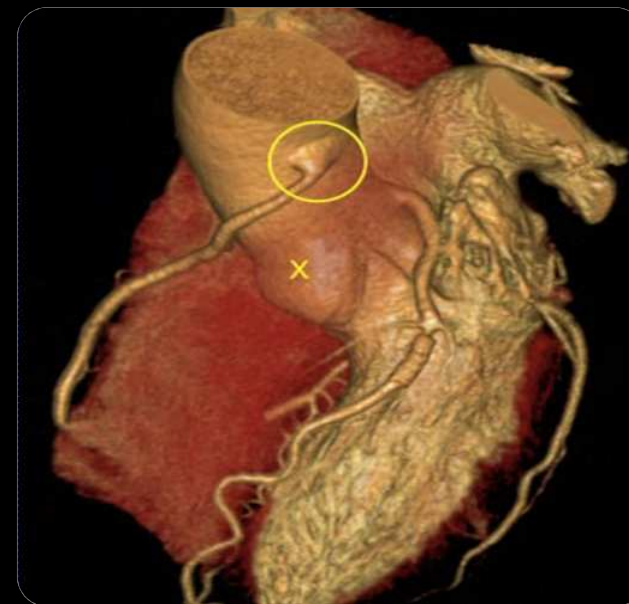
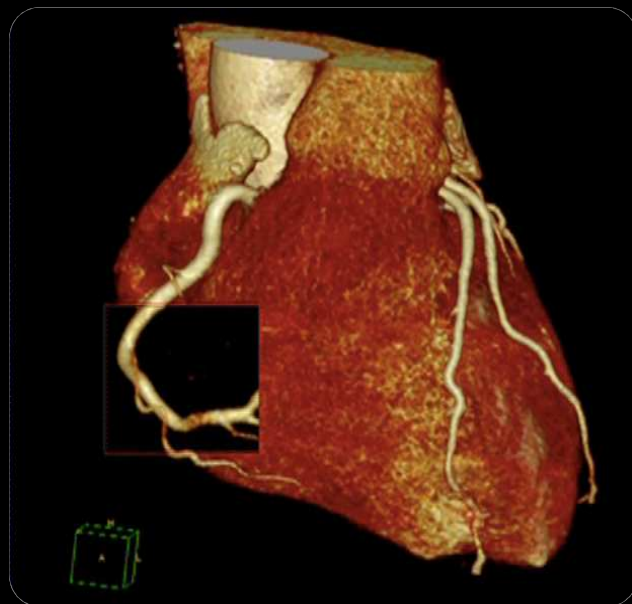
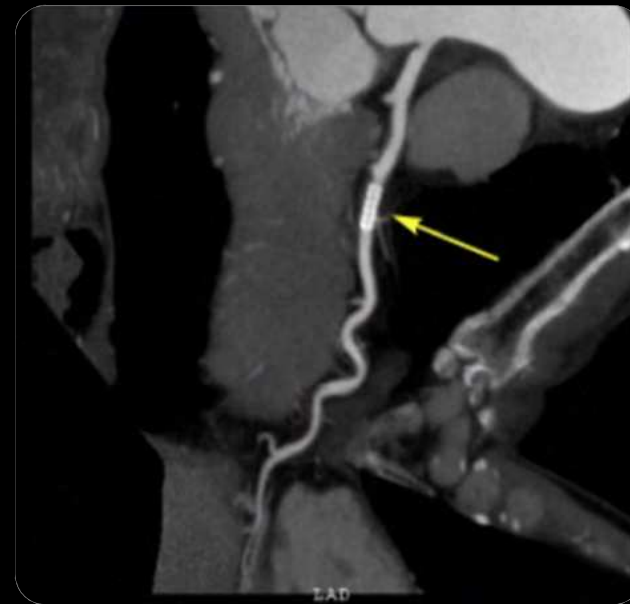
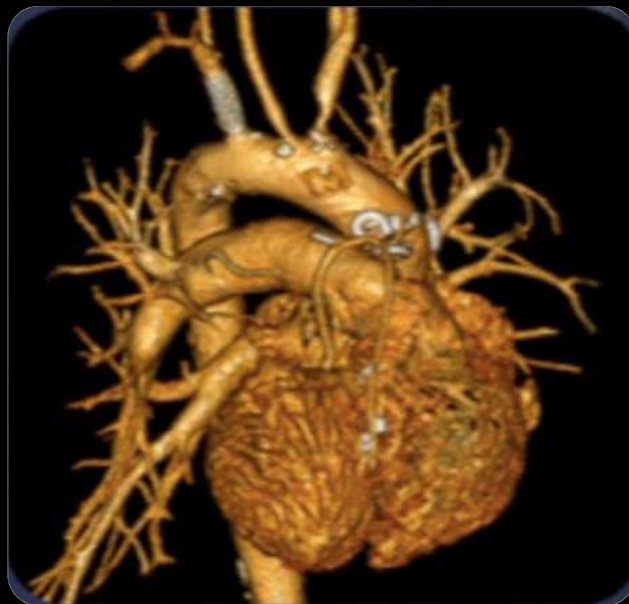
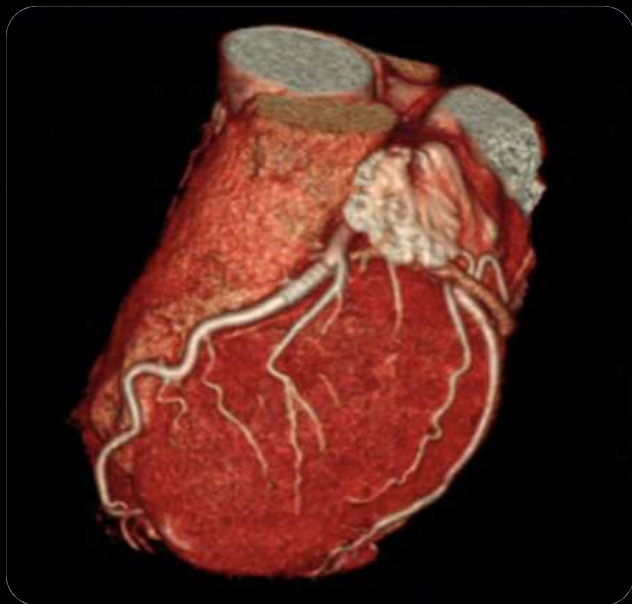
40-64 coupes/rotation-CT dual

2005: 40-64 x 0.625 mm

Temps d'acquisition: 10 sec



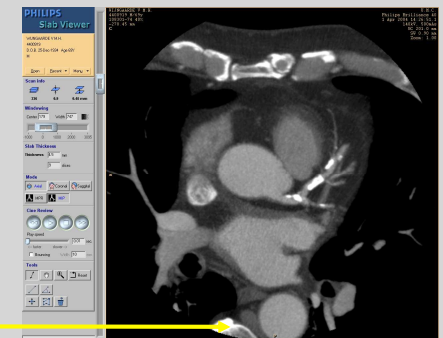
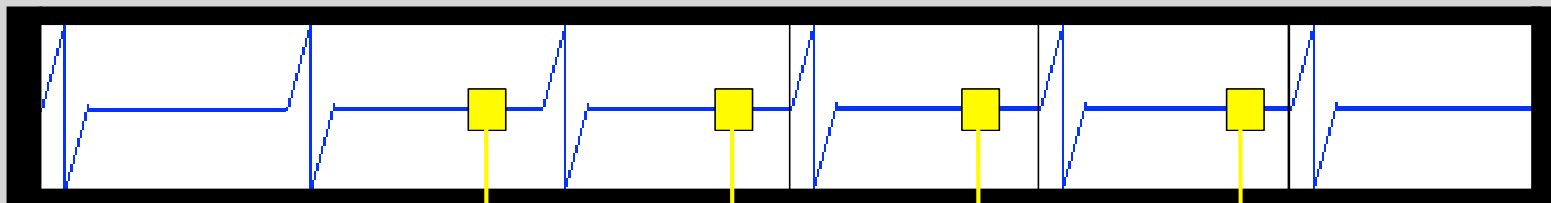
*256-320 coupes/rotation-1 -2
secondes*



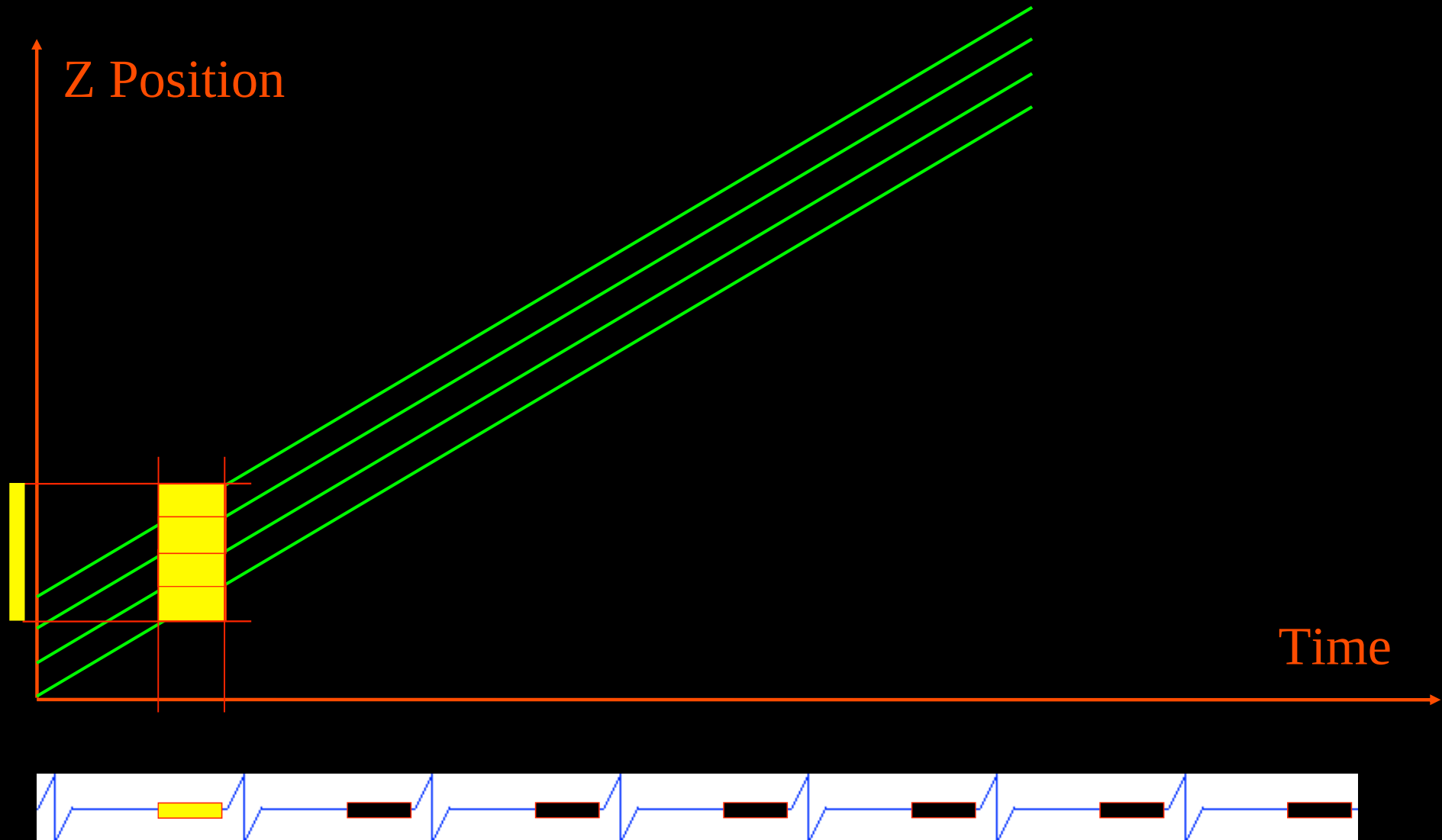
Post-processing des images

Acquisition de l'examen

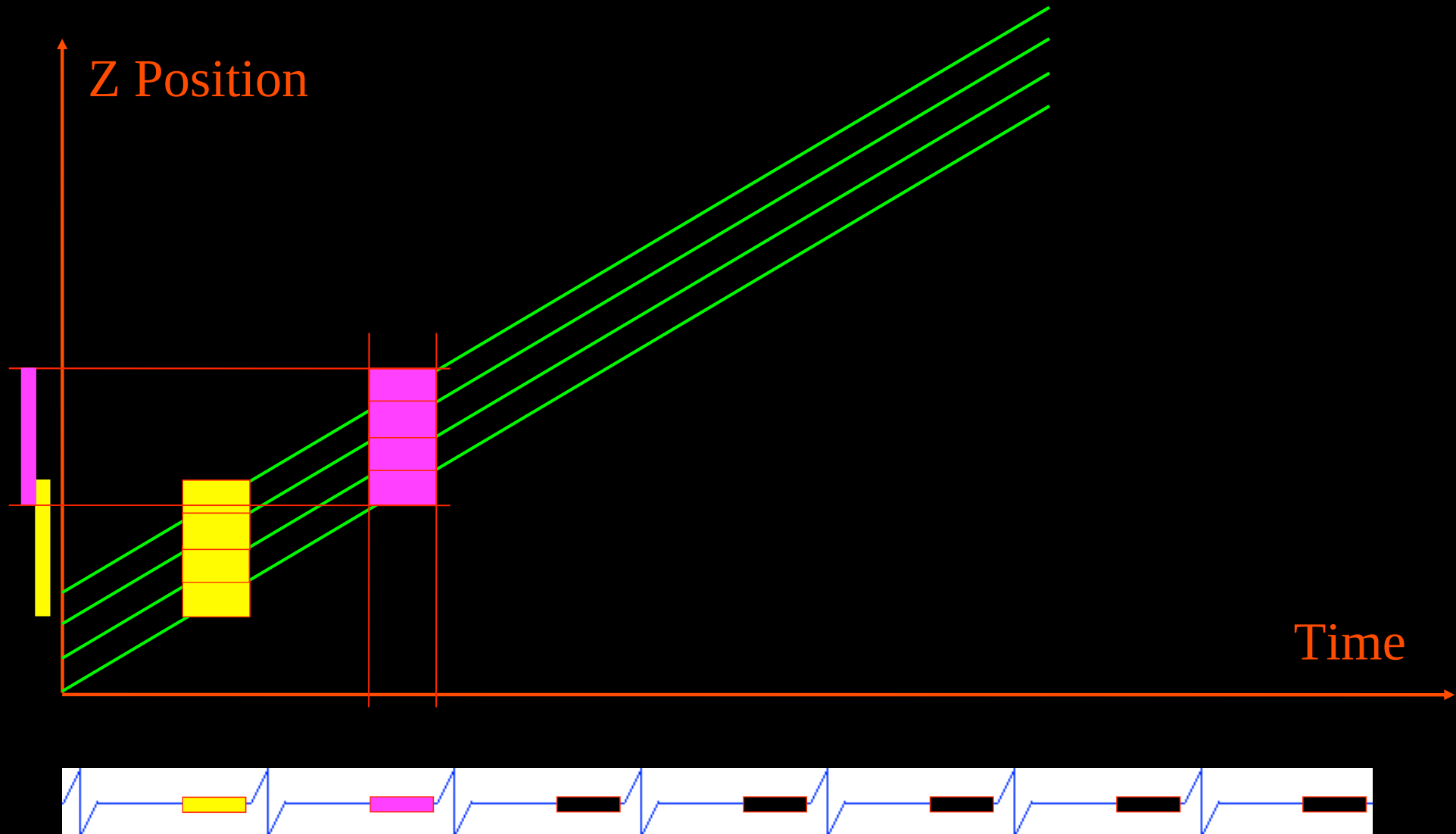
- 256 x 0.625 mm :collimation la plus fine
- Synchronisation cardiaque rétrospective
- Synchronisation cardiaque prospective
- Vitesse rotation la plus élevée
- 100-120 kV (140 kV), 600-800 mAs
- (Reconstructions itératives)



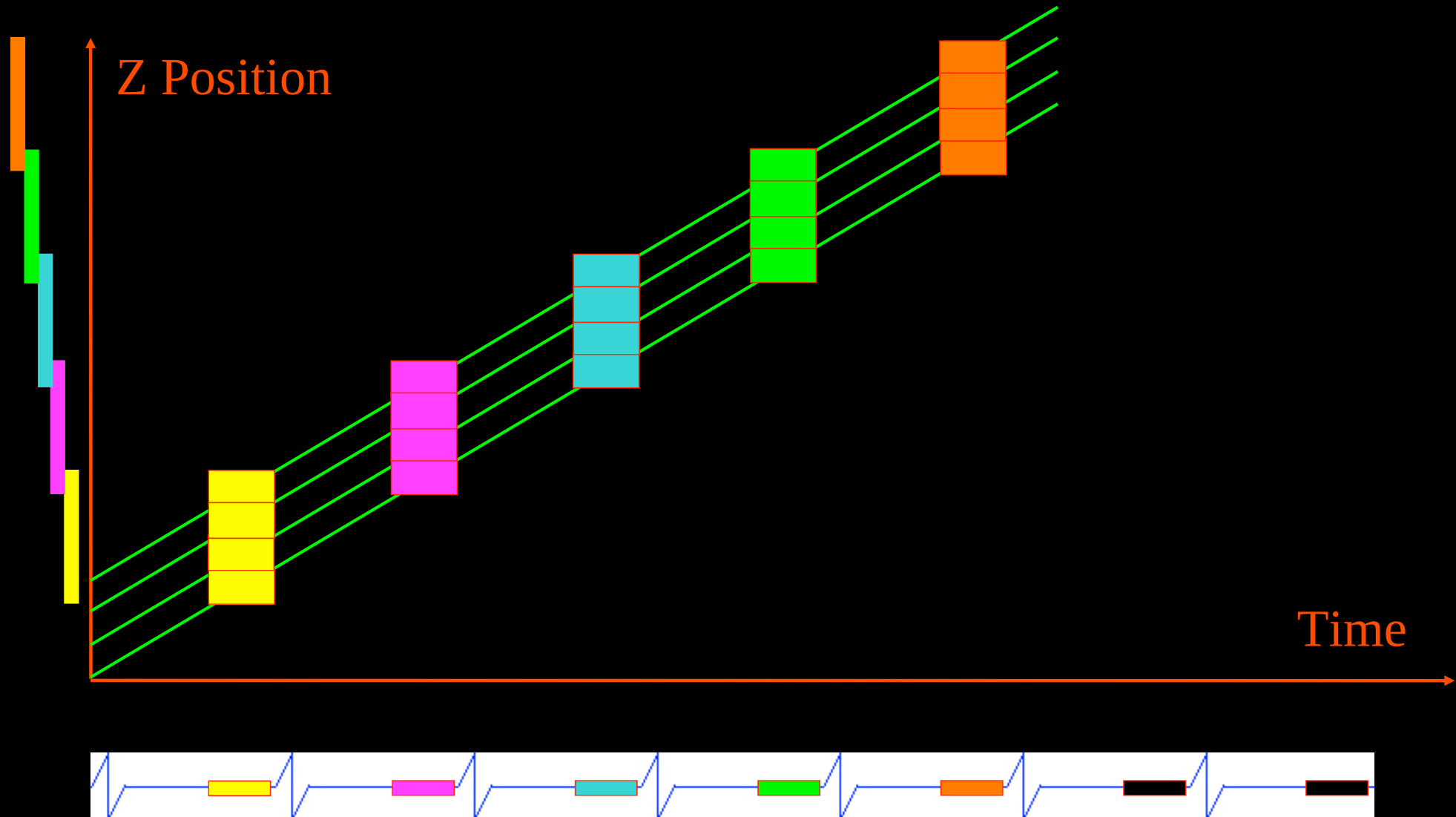
Synchronisation cardiaque rétrospective



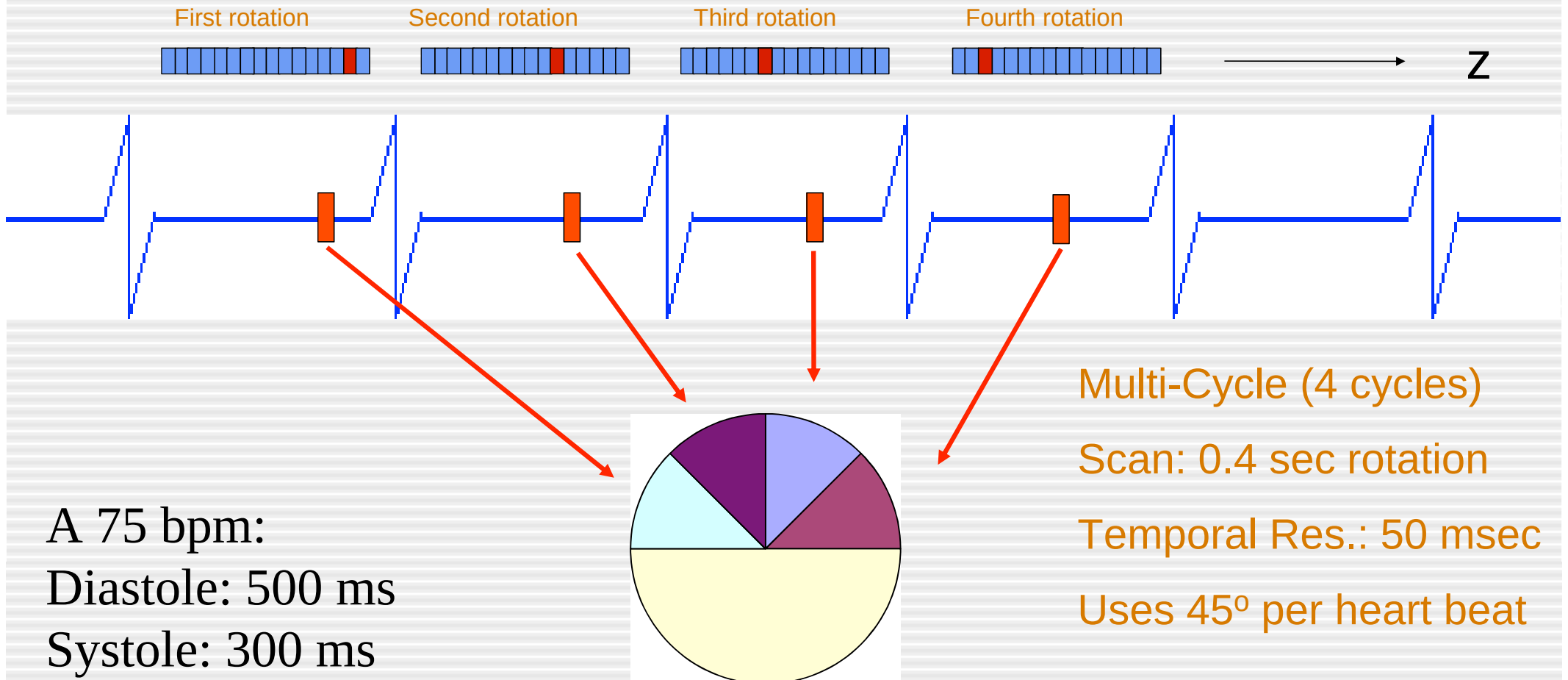
Synchronisation cardiaque rétrospective



Synchronisation cardiaque rétrospective



Algorithme multi-segmenté



Principes du Step & Shoot

Shoot: 1

2

3

4

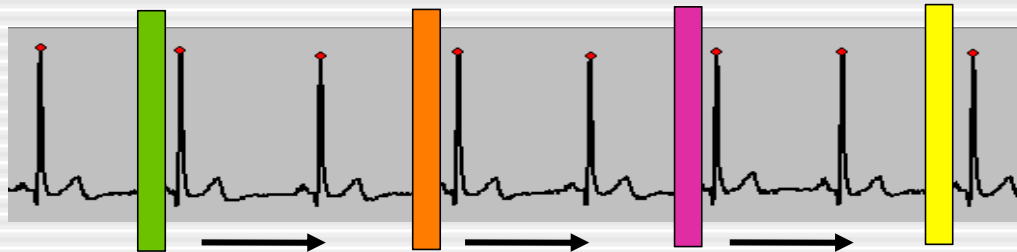
Step & Shoot Cardiac scan (4cm)

Step:

1

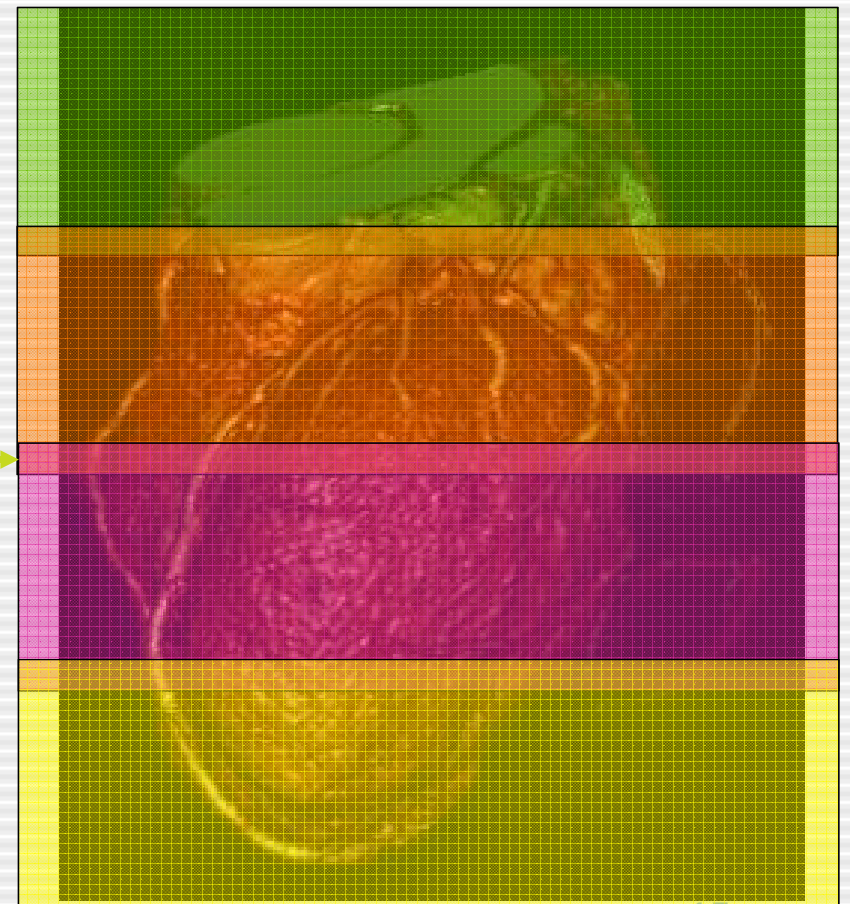
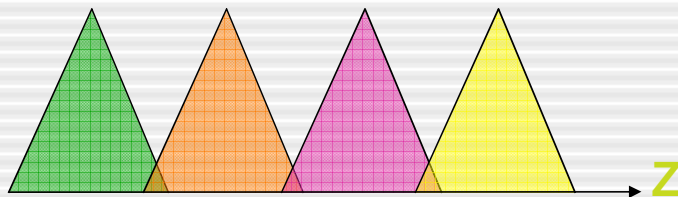
2

3



Move 32.1 mm

Overlap 8 mm



iCT platform

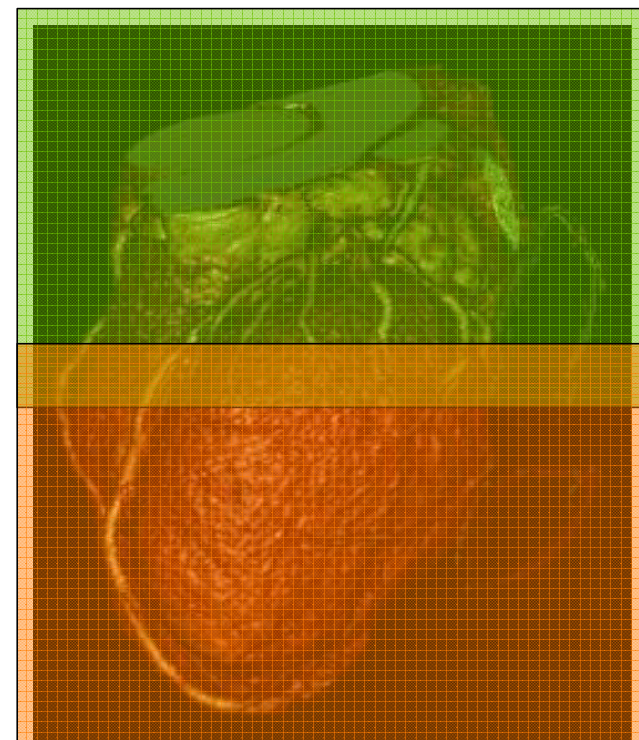
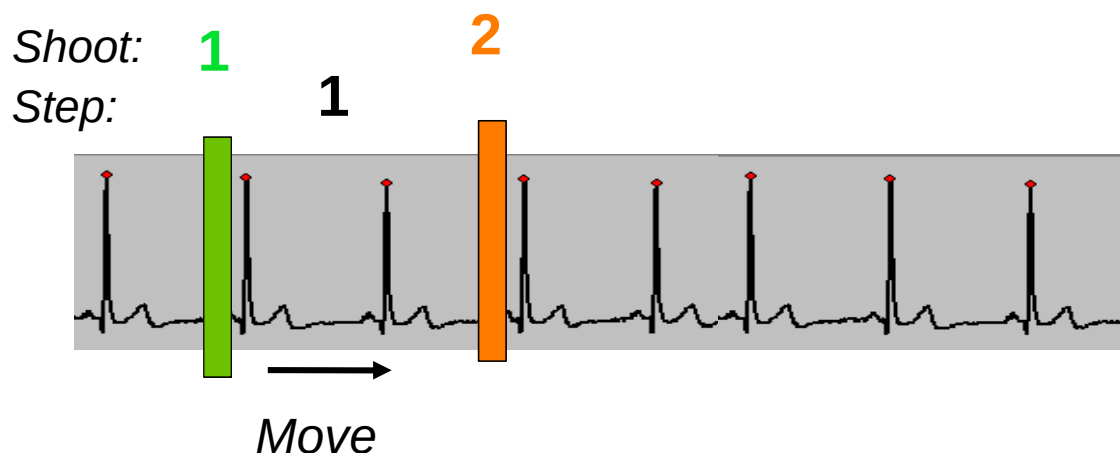
MDCT Requirements

Clinical Advantage

Technological Developments

Step & Shoot: Up to 80% dose reduction

- 2 shots
- 135 ms temporal resolution
- Axial cone beam correction



➤ Dose



®# Accepted
Clinical applications



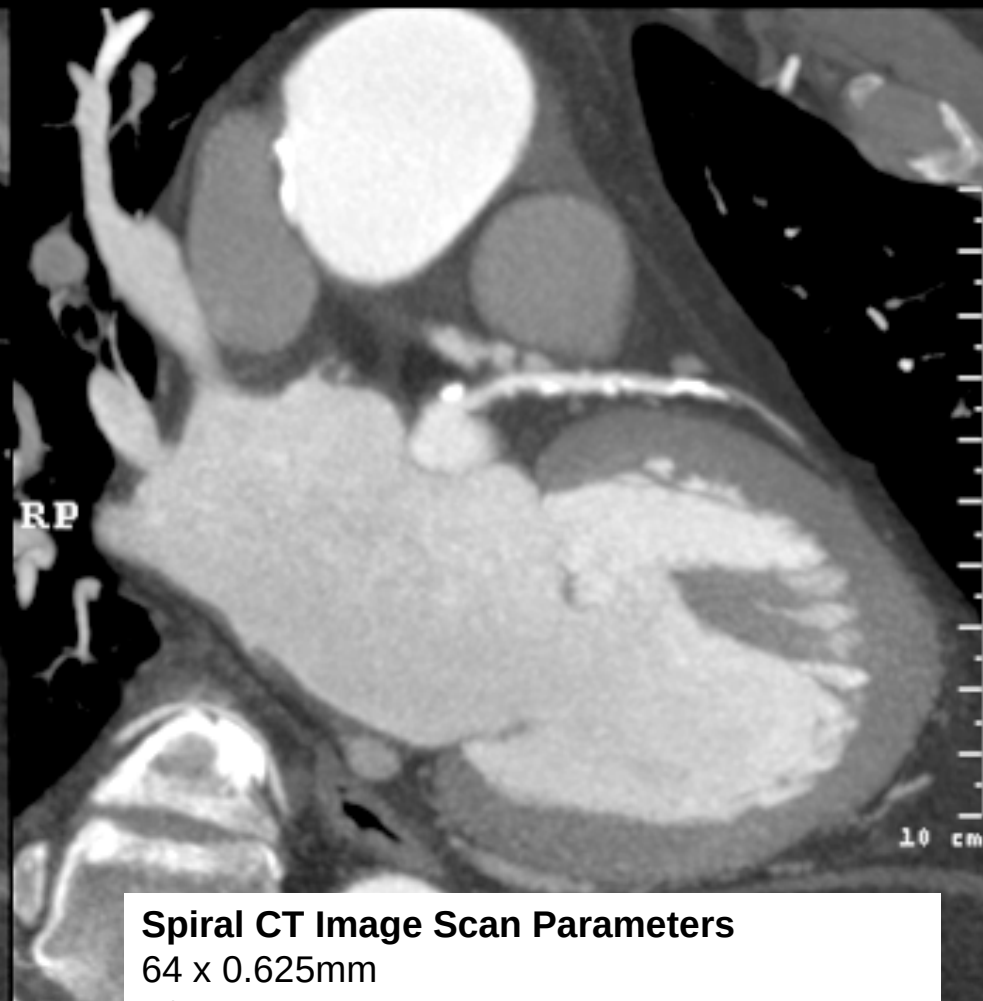
- ✓ Adapted Wedge Filter
- ✓ Eclipse Collimator
- ✓ Step & Shoot

Example 2: Step and shoot



Step & Shoot Cardiac (Axial prospective)

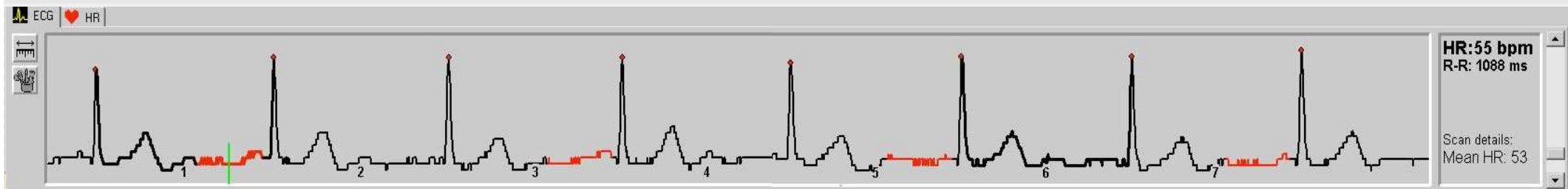
64 x 0.625mm
16cm coverage
Dose = 3.4 mSv



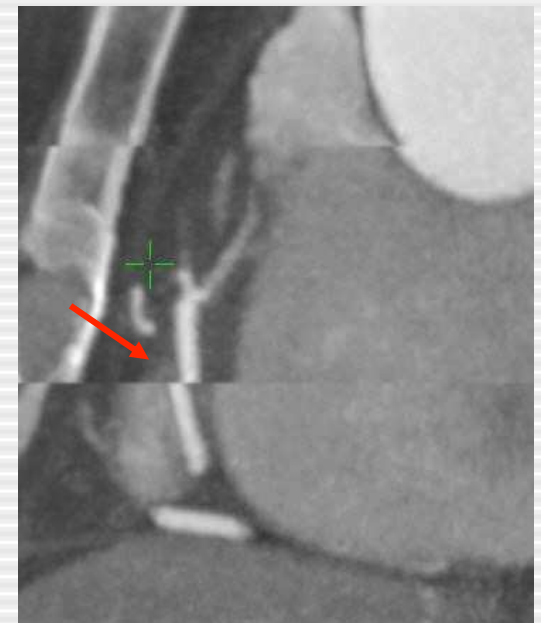
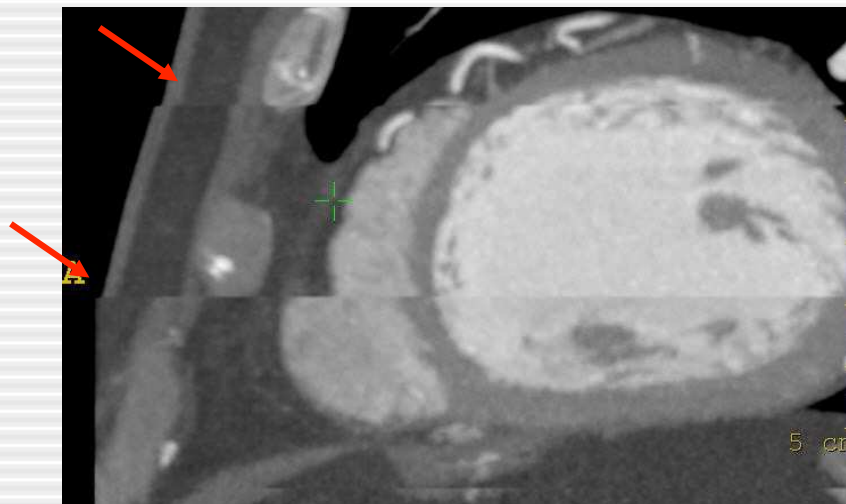
Spiral CT Image Scan Parameters

64 x 0.625mm
16cm coverage
Dose = 14.4 mSv

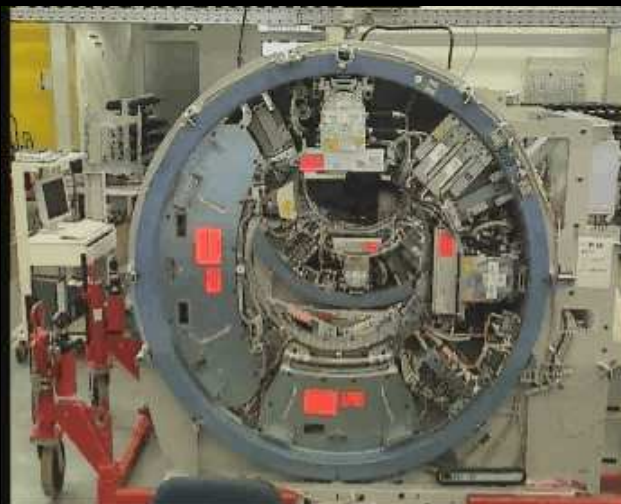
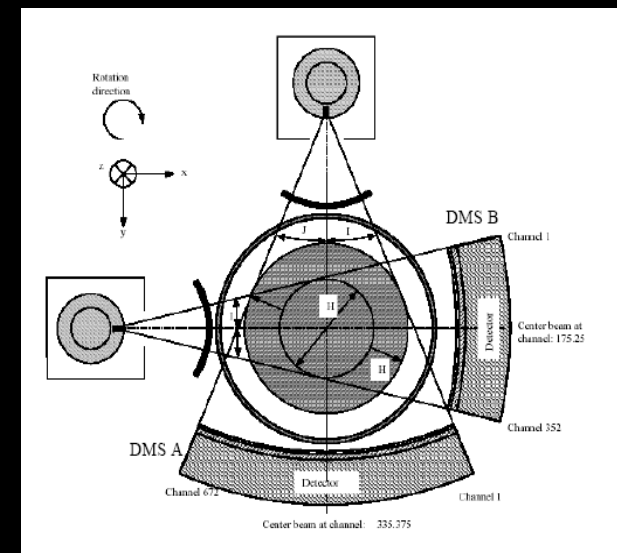
Example 2: Step and shoot



Respiré !!!



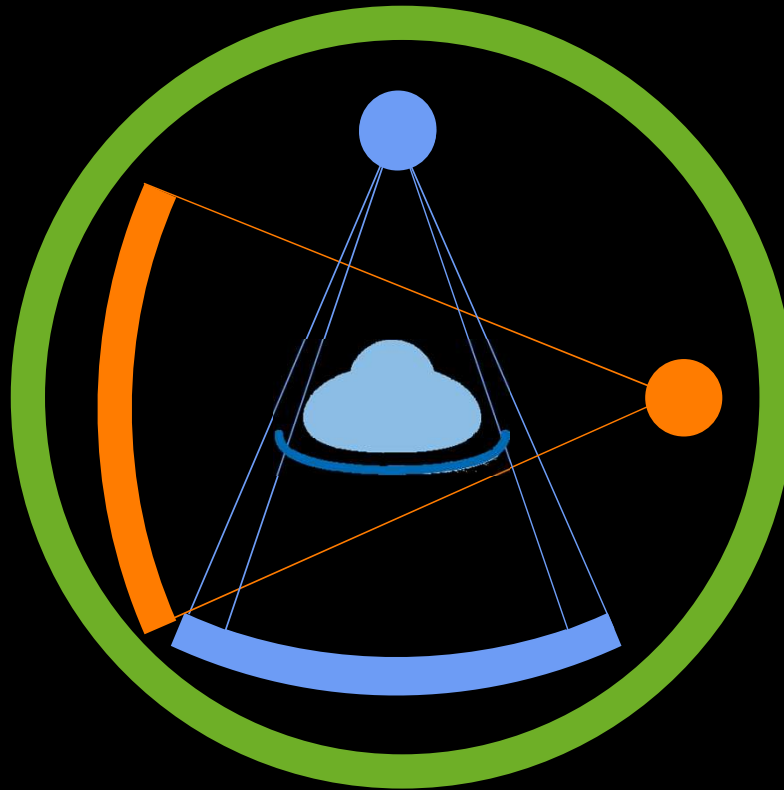
Dual source CT



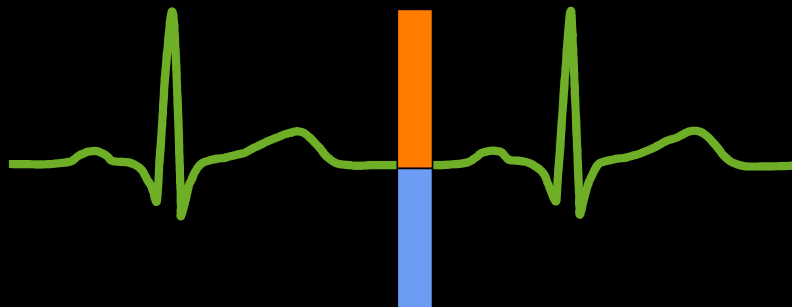
X.Hamoir

ND Tournai

90 degrees



90 degrees



TR (1 seg) = Rot time

4

= 82,5 ms

71 bpm



Dual Source

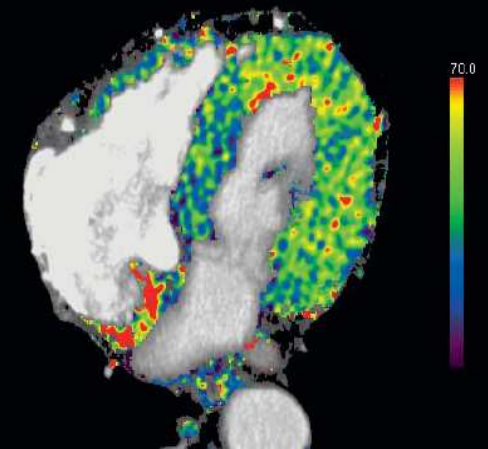
72 bpm



Single Source

X.Hamoir

ND Tournai



Amélioration résolution temporelle

Imagerie spectrale: séparer des matériaux avec le même coefficient d'atténuation et N° atomiques différents

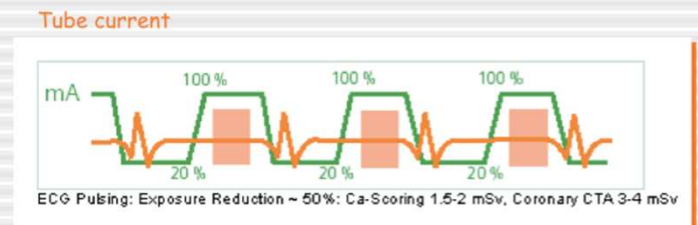
Détecter des matériaux de N° atomique élevés avec coefficient d'atténuation faible

Injection intraveineuse de produit de contraste

- Voie intraveineuse
 - Veine antécubitale
 - Contraste 350-400 mg I/mL
 - Débit: 4-5 mL/sec
 - ROI: Ao descendante
- Injecteur Double chambre
 - Diminution du produit de contraste injecté
 - Diminution artéfacts VCS (streak artefacts)

Recommandations pratiques

- Prise de β bloquants (y compris dual source)
 - 1/2 co tenormin la veille de l'examen
 - 1/2 co le matin de l'examen
 - Obtenir un rythme cardiaque régulier ± 70 /min
- Mise en place d'électrodes
 - Éviter les artefacts dans région d'intérêt
- Examen irradiant: indications à discuter
 - Modulation de dose en fct ECG
 - Appliquer si rythme < 70 /min



IrradiationMDCT

- 6.4 ± 1.9 mSv: 16-slice CT
- 11 ± 4.1 mSv: 64-slice CT
- Dose modulation:
 - 37-40%
- Dose modulation+diminution kV
 - 53-64%
- Dose coronarographie:
 - 2.1-2.5mSv

Hausleiter et al. Circulation Online Mars 2006

Hunold et al. Radiology 2003;226:145-152

Effective Radiation Dosage, Measured in MilliSieverts (mSv)^{3,4}

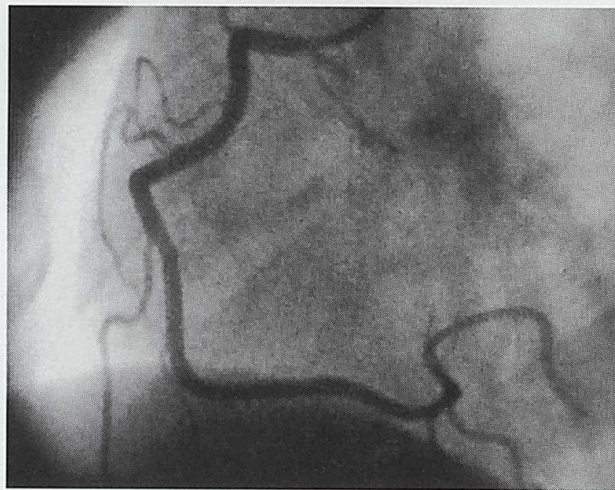
Average Background Dose – U.S.	3.6 mSv/year
Three-Hour Commercial Airline Flight	0.015 mSv
Pa & Lateral Chest X-Ray	0.05 mSv
Head CT Examination	1-2 mSv
Chest CT	5-7 mSv
Abdomen & Pelvis CT	6-8 mSv
Selective Diagnostic Coronary Angiography	3-6 mSv
Diagnostic Coronary Angiography with Intervention . . .	6-30 mSv
Nuclear Medicine Stress Test	
SPECT Thallium	25.3 mSv
SPECT Sestamibi	12.2 mSv
Coronary CT Angiography	
Retrospective CCTA	13 mSv
Retrospective EKG-Modulated CCTA	8-9 mSv
Prospective “Step-and-Shoot” CCTA	2-3 mSv

Reconstructions itératives, «step and shoot»

<<1 mSv

Anatomie des artères coronaires

Artère coronaire droite : vue oblique antérieure gauche



Artériographie

Rameau du nœud
sinu-atrial (SA)

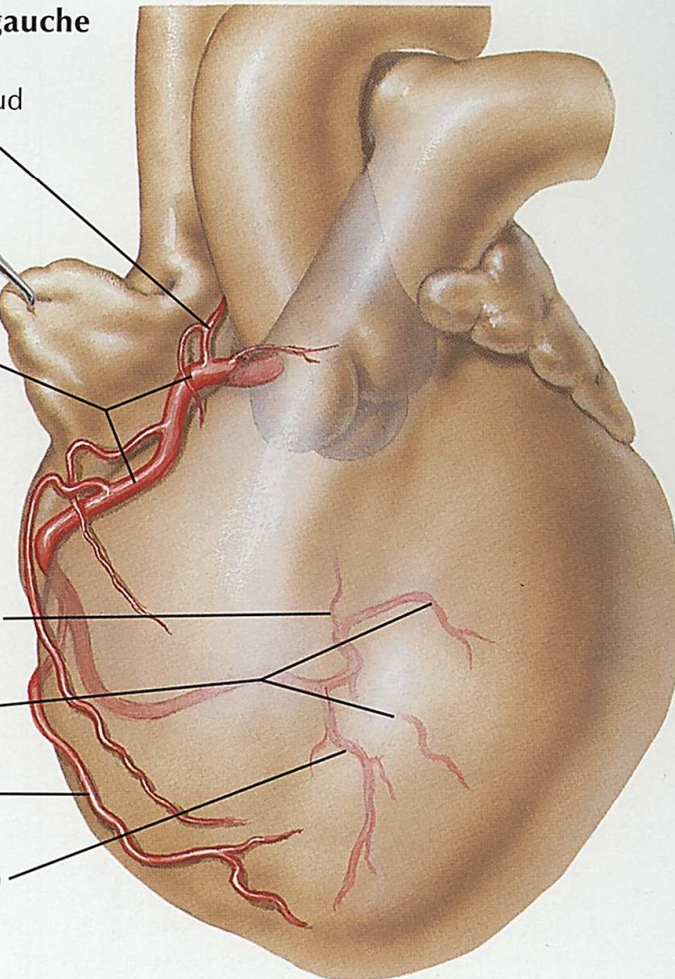
Artère
coronaire droite

Rameau du nœud
atrio-ventriculaire (AV)

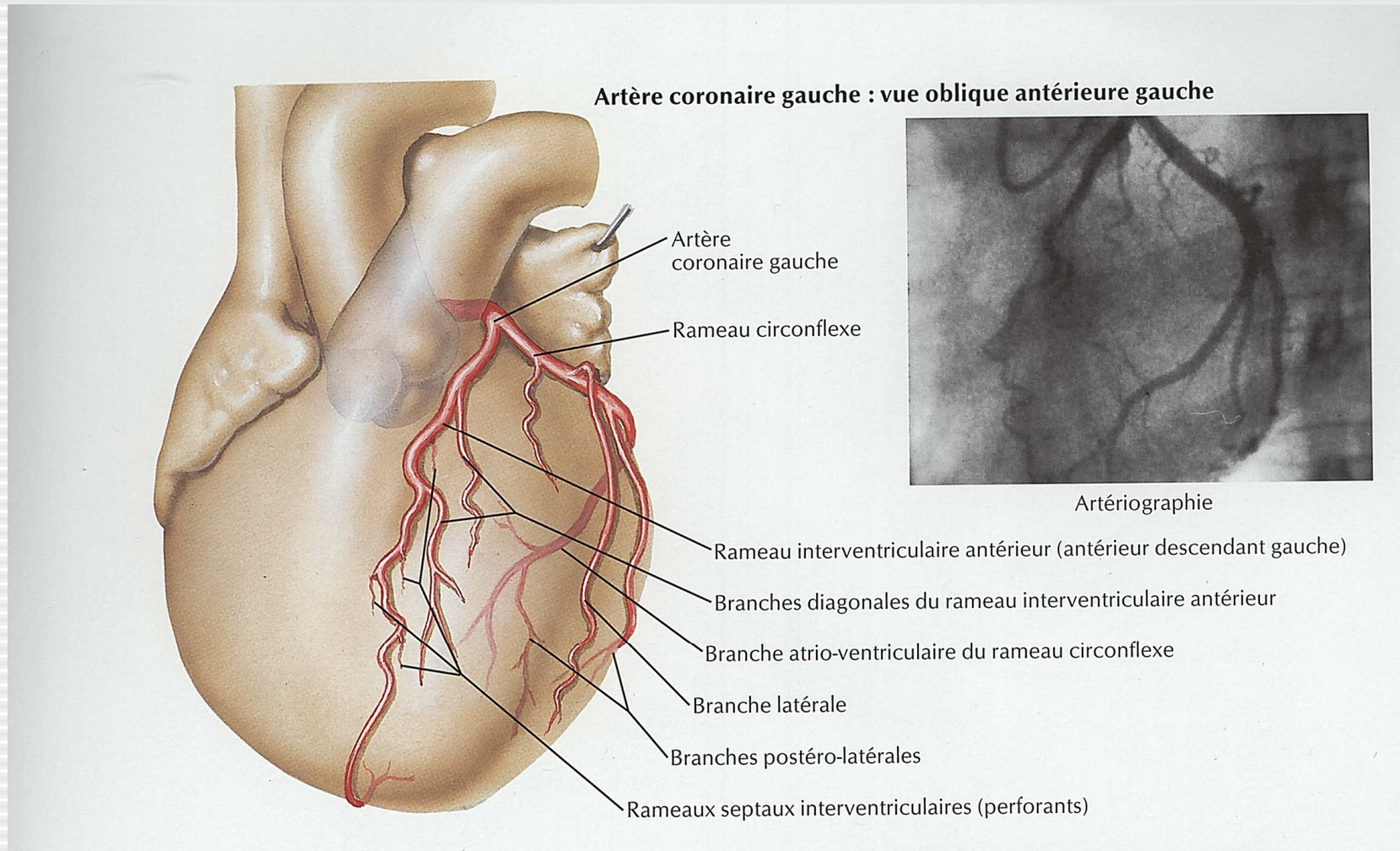
Rameaux de la face dorsale du ventricule gauche

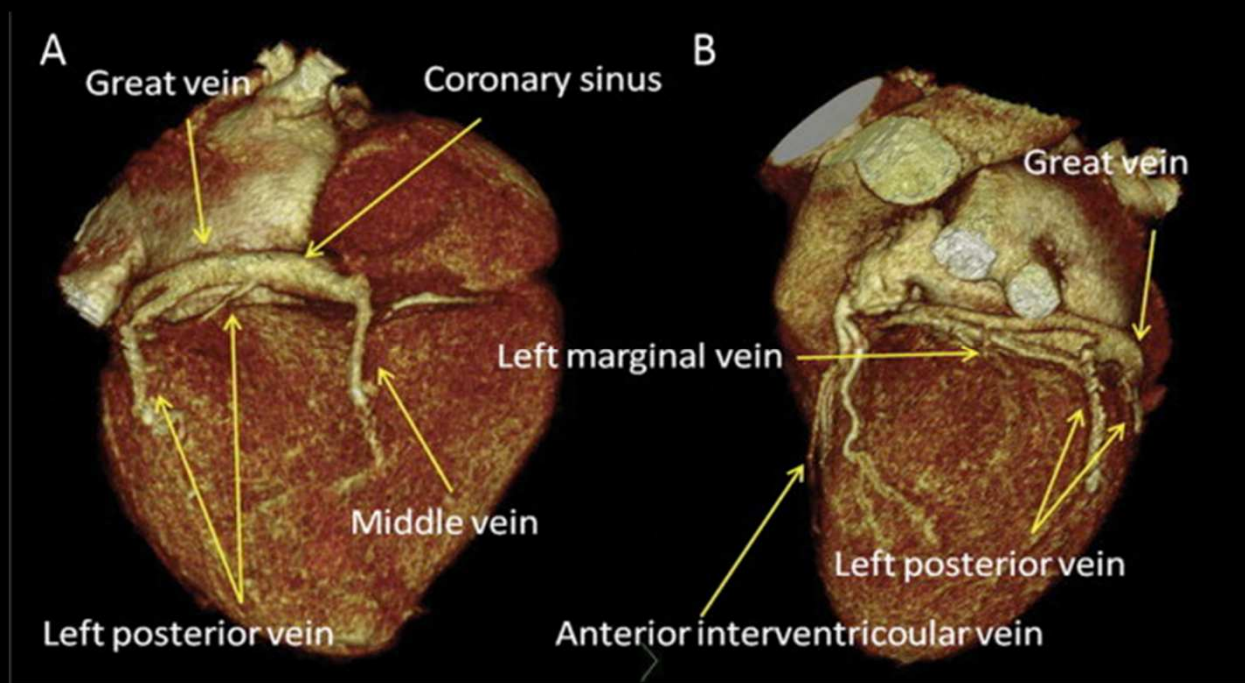
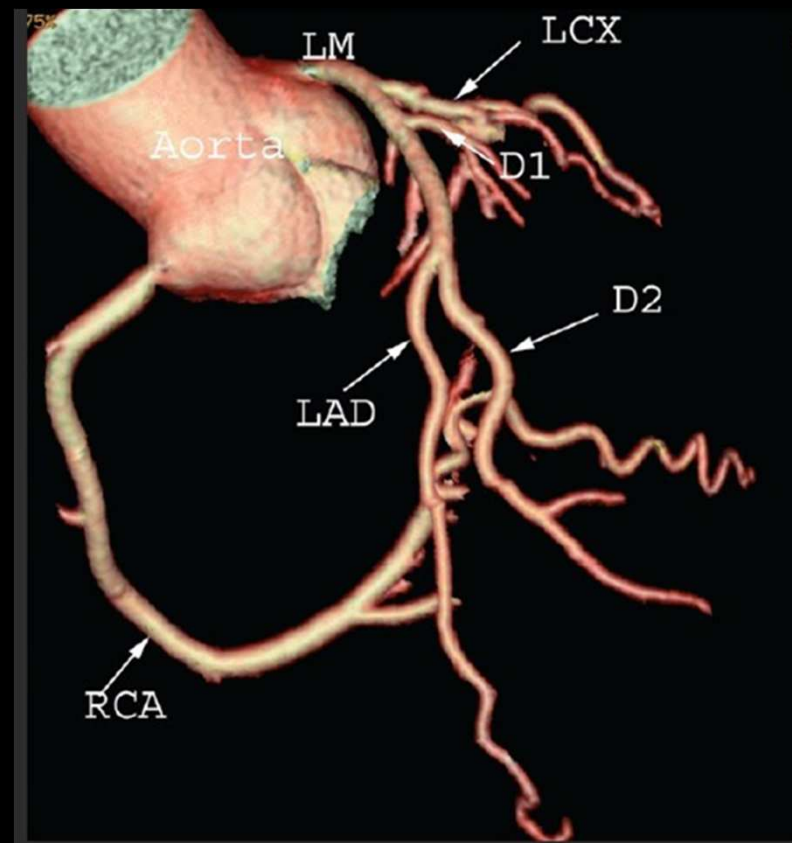
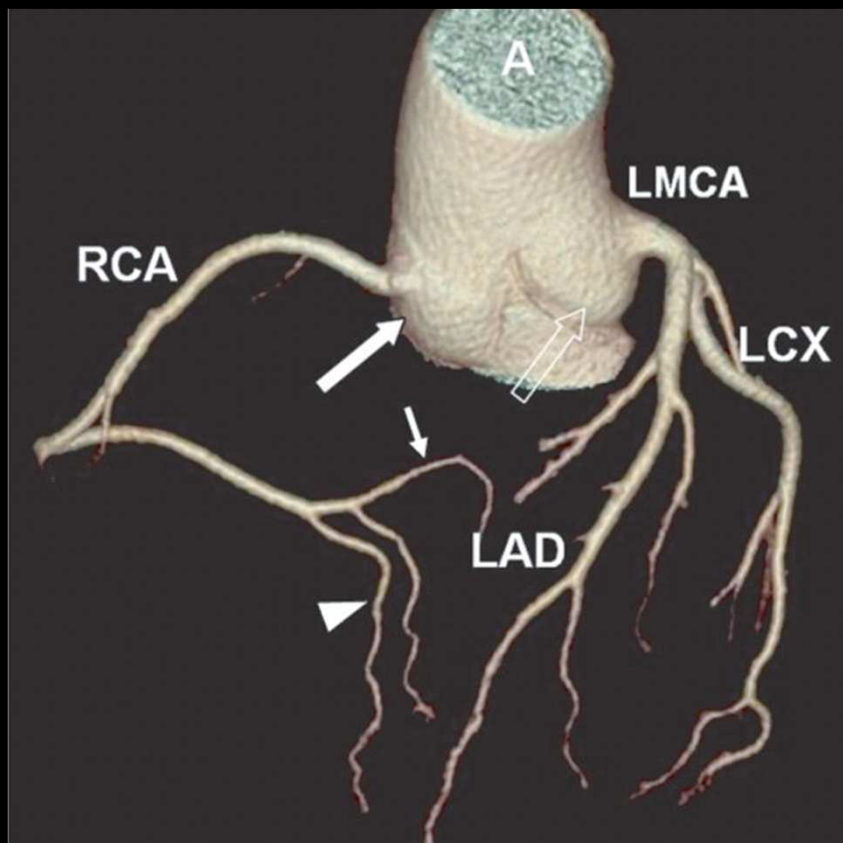
Rameau marginal droit

Rameau interventriculaire postérieur (artère postérieure descendante)

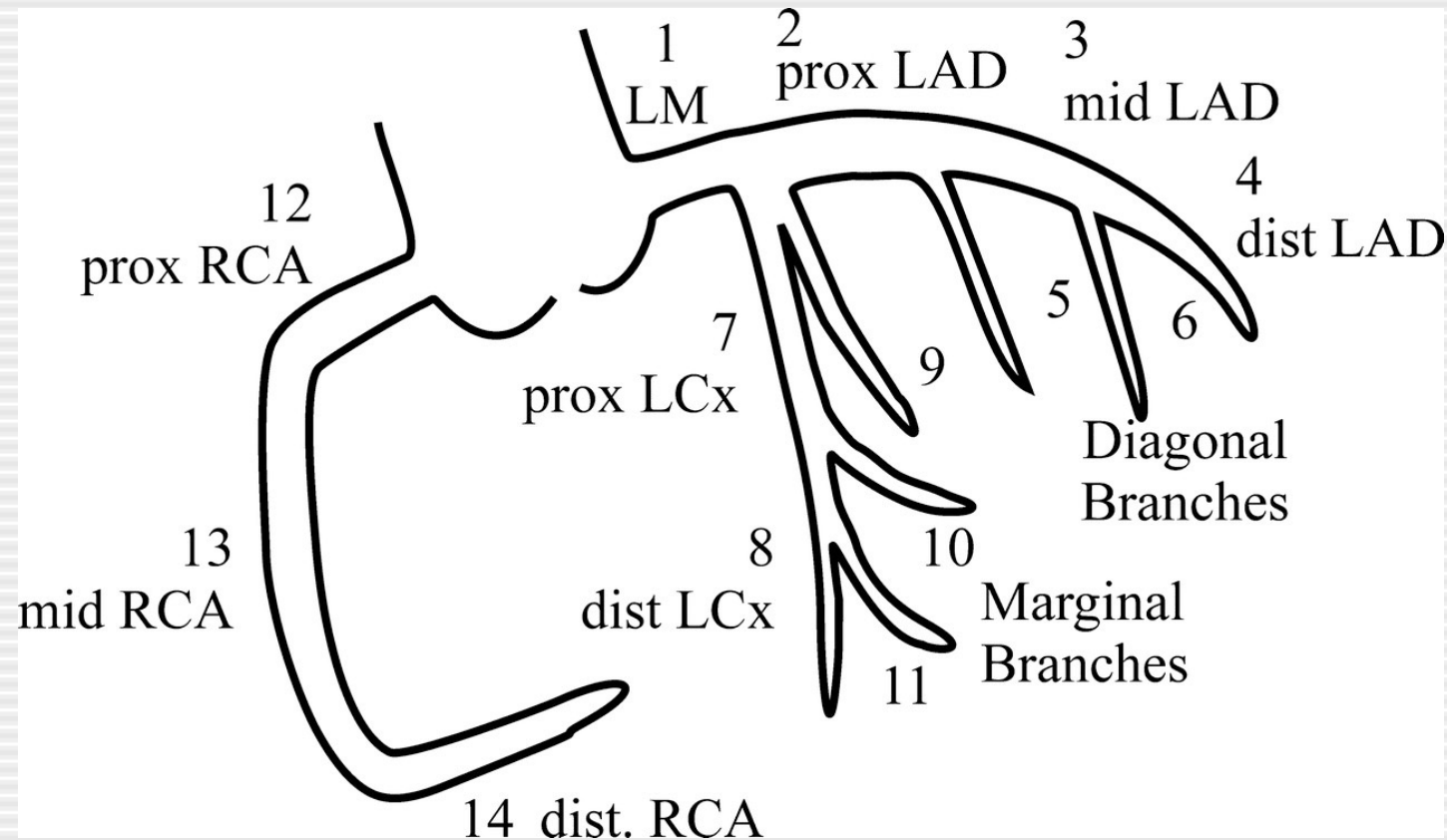


Anatomie des artères coronaires





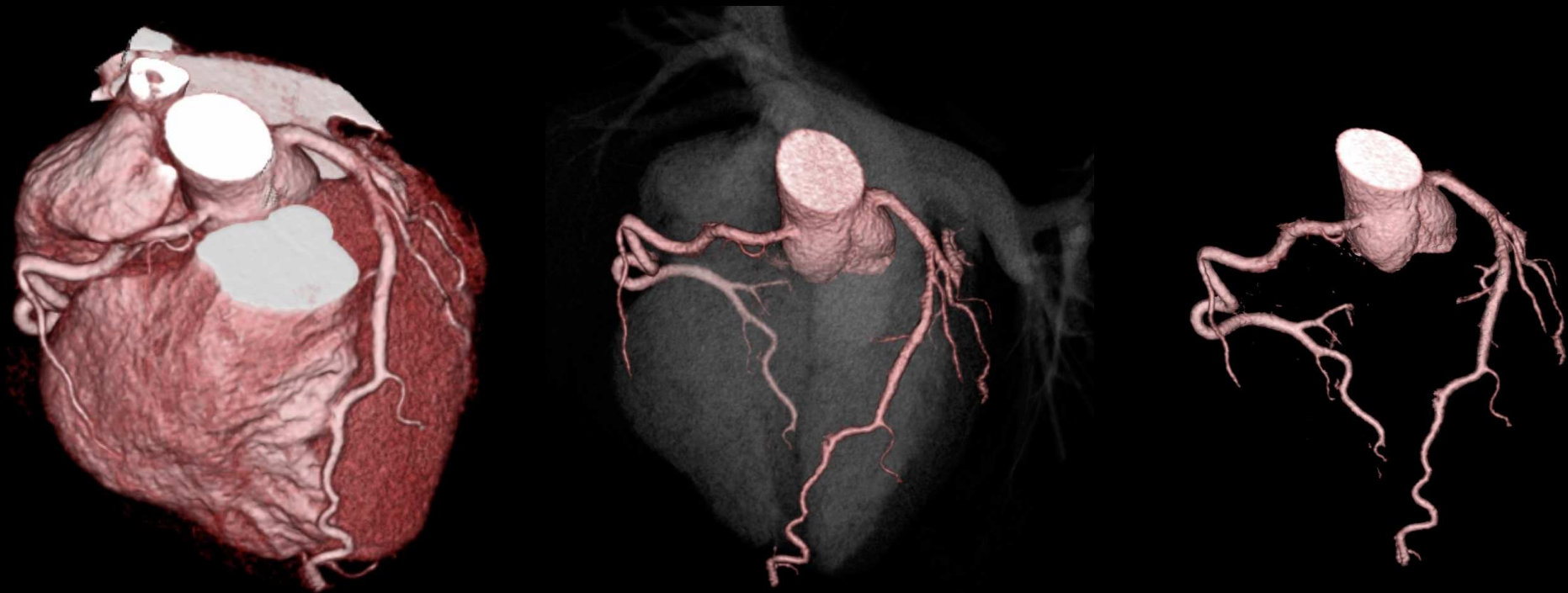
Evaluation des artères coronaires



Interprétation conjointe radiologue-cardiologue

Bien analyser les anomalies extra-cardiaques!!

Post-Processing



64 x 0.625mm, Standard Res., RT = 0.42sec, Pitch = 0.2, Scan Time = 7.5 sec

Post-Processing



64 x 0.625mm, Standard Res., RT = 0.42sec, Pitch = 0.2, Scan Time = 7.5 sec

Comp. Cardiac
Coronaries

Hints
Visualization Tools
Vessel Tools

Vessels

CX

RCA
LAD
CX
Diag1

Define Vessel

Show Centerline

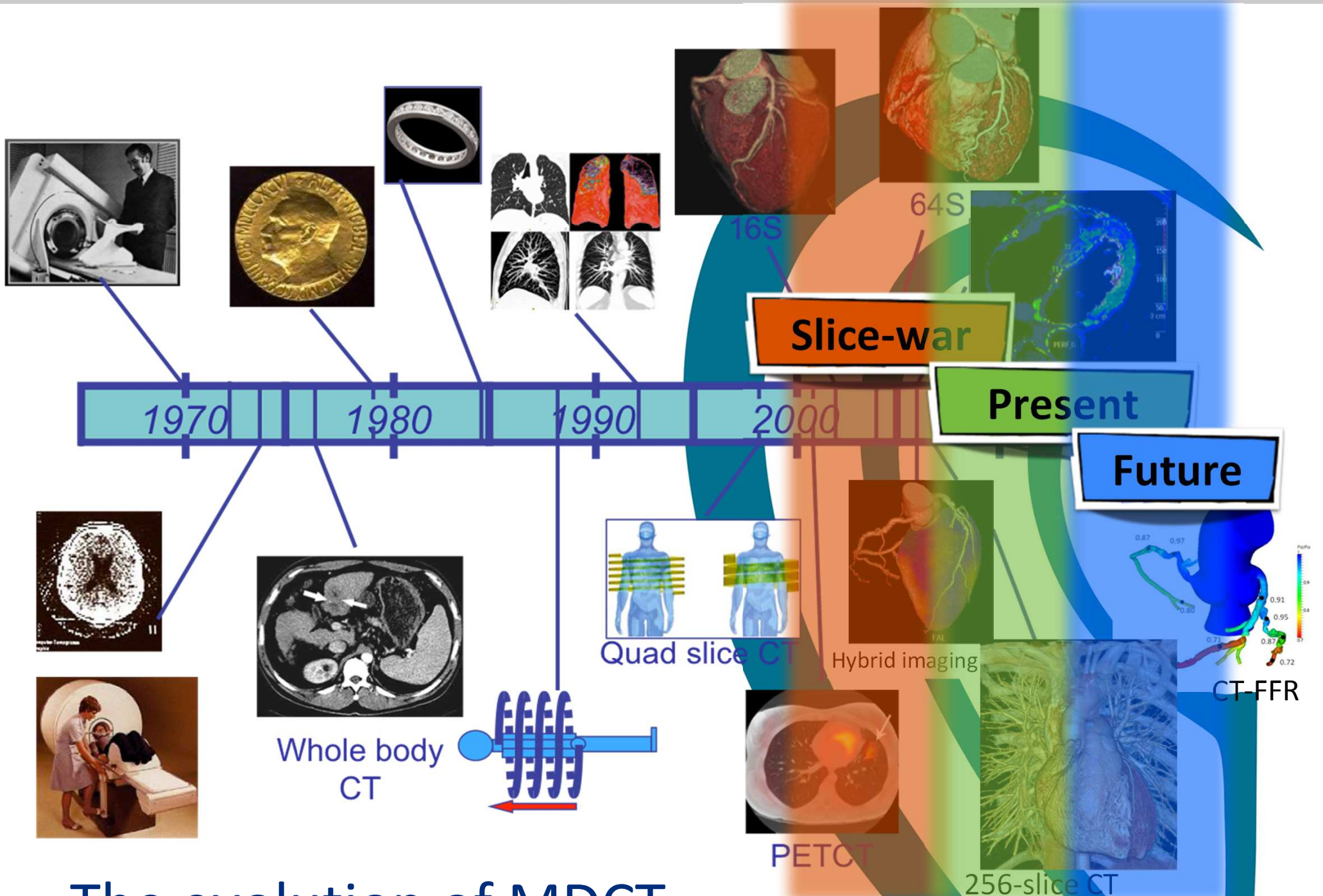
Heart Show Prot
Cardiac View MIP



Windowing Modified
Titles Off

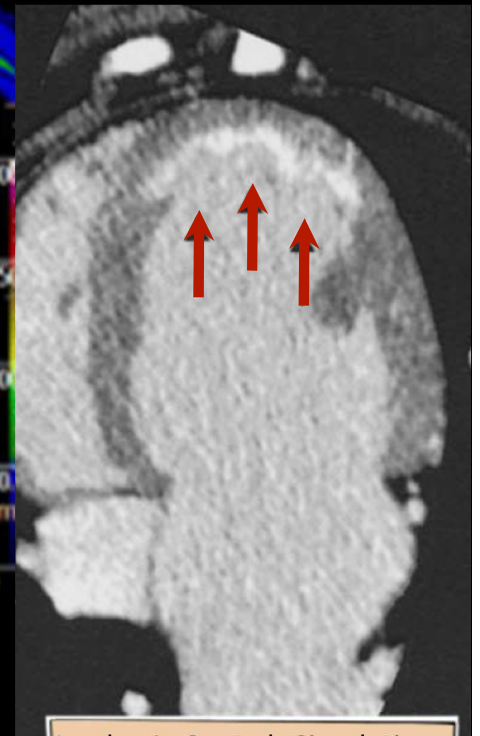
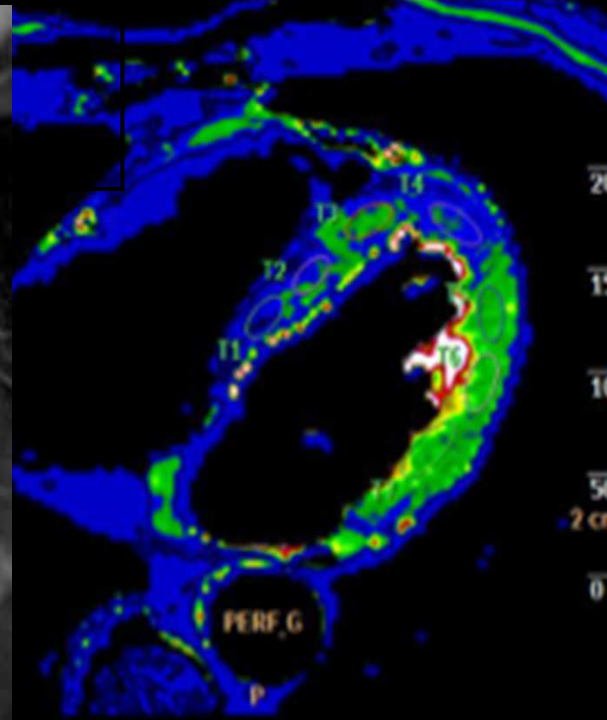
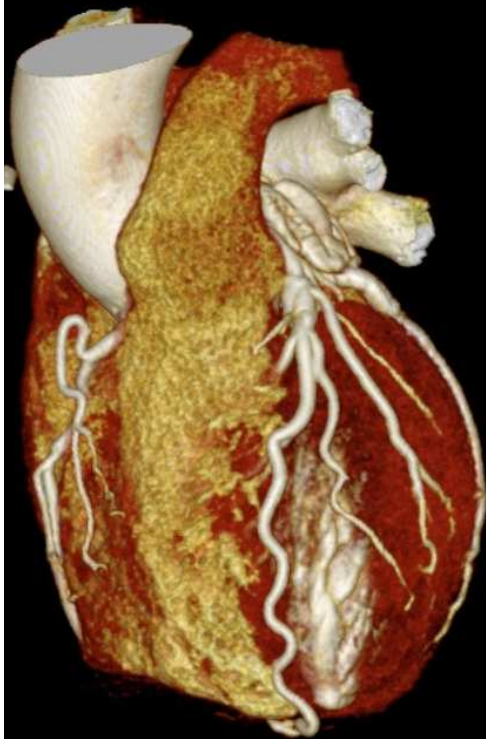
Exit Reset All





The evolution of MDCT

One-stop-shop cardiac evaluation



Images Courtesy of:
Ehime Univ. Matsuyama, Japan

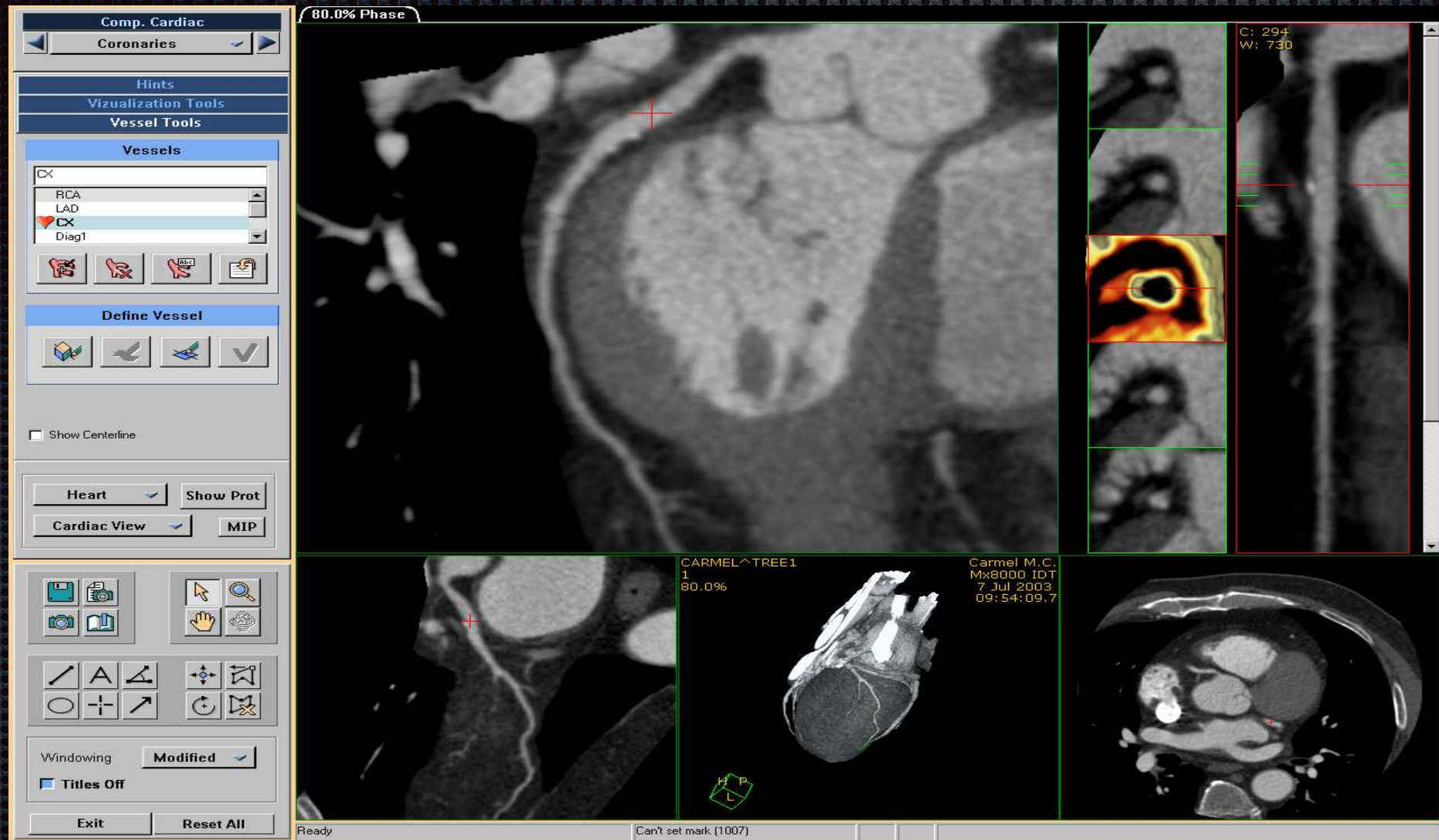
Lardo, A. C. et al. Circulation
113, 394–404 (2006)

Outline

- Coronary luminography and beyond
- Coronary atherosclerotic plaque imaging
- CT viability and perfusion
- Integrated cardio-thoracic Imaging/triple rule out
- Some Perspectives
 - CT-fractional flow reserve
 - Endothelial shear stress mapping

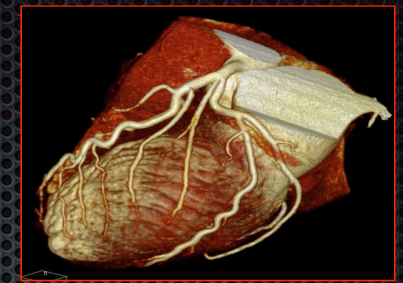


Luminography and beyond



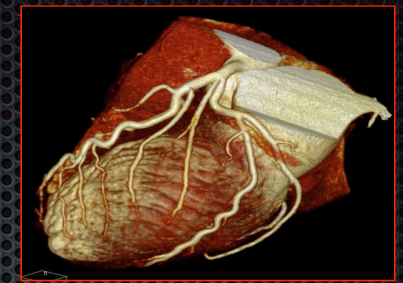
Detection of coronary artery Disease

Diagnostic performances of MDCT



- The diagnostic performance of 16-detector and 64-detector CT are significantly higher than 4-detector CT
- The increase number of detectors significantly reduced the proportion of non-assessable coronary segments
- The use of B-blockers and high number of detectors : all coronary segments are assessable

Diagnostic performances of MDCT



Author	Scanner Type	No. of Patients	Sensitivity (%)	Specificity (%)	PPV (%)	NPV (%)
Raff et al (67)	64-Section CT	70	86	95	66	98
Leschka et al (66)	64-Section CT	67	94	97	87	99
Mollet et al (69)	64-Section CT	51	99	95	76	99
Fine et al (68)	64-Section CT	66	95	96	97	92
Ropers et al (73)	64-Section CT	81	93	97	56	100
Ehara et al (70)	64-Section CT	69	90	94	89	95
Ong et al (72)	64-Section CT	134	82	96	79	96
Oncel et al (71)	64-Section CT	80	96	98	91	99
Meijboom et al (77)	64-Section CT	360	88	90	47	99
Weustink et al (76)	Dual-Source CT	100	95	95	75	99
Johnson et al (75)	Dual-Source CT	35	88	98	78	99
Leber et al (25)	Dual-Source CT	88	94	99	81	99
Ropers et al (26)	Dual-Source CT	100	92	97	68	99
Brodoefel et al (74)	Dual-Source CT	100	91	92	75	97

Bastarrika G, et al. CT of coronary artery Disease. Radiology (2009);2:317-337

Patients selection and clinical indications

- «The clinical indications of coronary CT angiography to detect or rule out coronary artery stenoses seems most beneficial and can be recommended in patients with intermediate risk of CAD in whom the clinical presentation - stable or with acute symptoms- mandates the evaluation of possible underlying CAD»

Table 3 Appropriate clinical indications for the use of computed tomography coronary angiography and cardiac computed tomography imaging according to an expert consensus document endorsed by several professional societies and published in 2006⁷⁰

Detection of CAD with prior test results—evaluation of chest pain syndrome (use of CT angiogram)

- Uninterpretable or equivocal stress test (exercise, perfusion, or stress echo)
- Intermediate pre-test probability of CAD
ECG uninterpretable or unable to exercise

Detection of CAD: symptomatic—acute chest pain (use of CT angiogram)

- Intermediate pre-test probability of CAD
No ECG changes and serial enzymes negative

Detection of CAD: symptomatic—evaluation of intra-cardiac structures (use of CT angiogram)

- Evaluation of suspected coronary anomalies

Structure and function—morphology (use of CT angiogram)

- Assessment of complex congenital heart disease including anomalies of coronary circulation, great vessels, and cardiac chambers and valves
- Evaluation of coronary arteries in patients with new onset heart failure to assess aetiology

Structure and function—evaluation of intra- and extra-cardiac structures (use of cardiac CT)

- Evaluation of cardiac mass (suspected tumour or thrombus)
Patients with technically limited images from echocardiogram, MRI, or TEE
- Evaluation of pericardial conditions (pericardial mass, constrictive pericarditis, or complications of cardiac surgery)

Patients with technically limited images from echocardiogram, MRI, or TEE

- Evaluation of pulmonary vein anatomy prior to invasive radiofrequency ablation for atrial fibrillation
- Non-invasive coronary vein mapping prior to placement of biventricular pacemaker
- Non-invasive coronary arterial mapping, including internal mammary artery prior to repeat cardiac surgical revascularization

Structure and function—evaluation of aortic and pulmonary disease (use of CT angiogram)

- Evaluation of suspected aortic dissection or thoracic aortic aneurysm
- Evaluation of suspected pulmonary embolism

⁷⁰Non-gated CT angiogram which has a sufficiently large field of view for these specific indications.

List of appropriate clinical indications for the performance of coronary CT angiography based on Hendel et al study (54).

1. Detection of CAD
 - 1.1. Acute chest pain in symptomatic subjects
 - Intermediate pretest probability of CAD
 - No ECG changes and serial enzymes negative
 - 1.2. Evaluation of chest pain syndrome in symptomatic subjects
 - Intermediate pretest probability of CAD
 - ECG uninterpretable or unable to exercise
 - 1.3. Evaluation of intracardiac structures in symptomatic subjects
 - Evaluation of suspected coronary anomalies
2. Detection of CAD with prior test results
 - 2.1. Evaluation of chest pain syndrome
 - Uninterpretable or equivocal stress test (exercise, perfusion, or stress echo)
3. Structure and function
 - 3.1. Evaluation of intra- and extracardiac structures
 - Noninvasive coronary arterial mapping, including internal mammary artery prior to repeat cardiac surgical revascularization
 - 3.2. Morphology
 - Assessment of complex congenital heart disease, including anomalies of coronary circulation, great vessels, and cardiac chambers and valves
 - Evaluation of coronary arteries in patients with new onset heart failure to assess etiology

Radiology

Bastarrika G et al. Radiology 2009;253:317-338

Hendel RC et al. J Am Coll Cardiol (2006);48:1475-1497

Estimating the pretest probability of coronary artery disease

Step 1: Categorize the nature of the chest pain symptoms

Coronary symptoms can be reliably characterized by using three clinical questions:

1. Is the chest pain substernal?
2. Are the symptoms precipitated by exertion?
3. Is there prompt relief within 10 minutes with rest or nitroglycerin?

Typical (or classical) angina: all three features are present

Atypical angina: any two features are present

Nonanginal chest pain: one or no features present

Step 2 Estimate the pretest probability of coronary artery disease based on age, gender, and character of chest pain

Low Probability (<10%)

- Asymptomatic men and women of all ages
- Women < 50 years with atypical chest pain

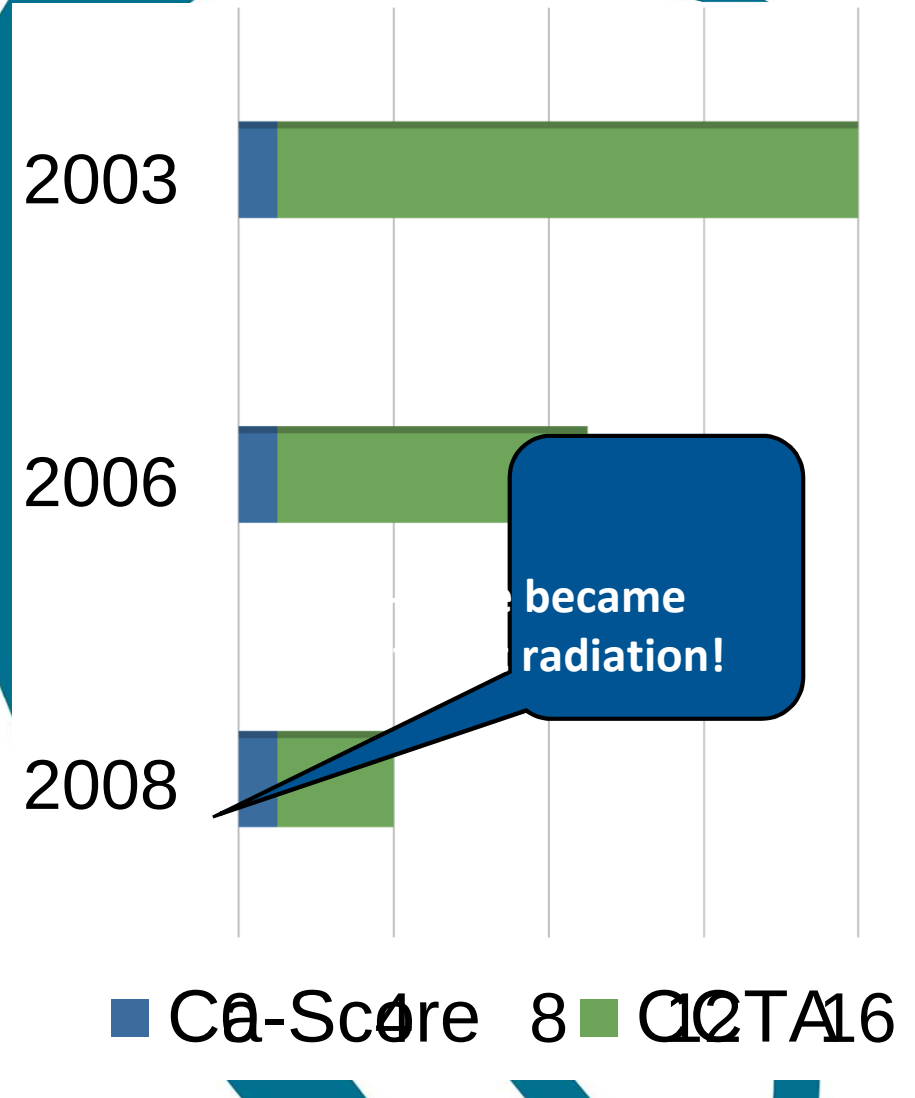
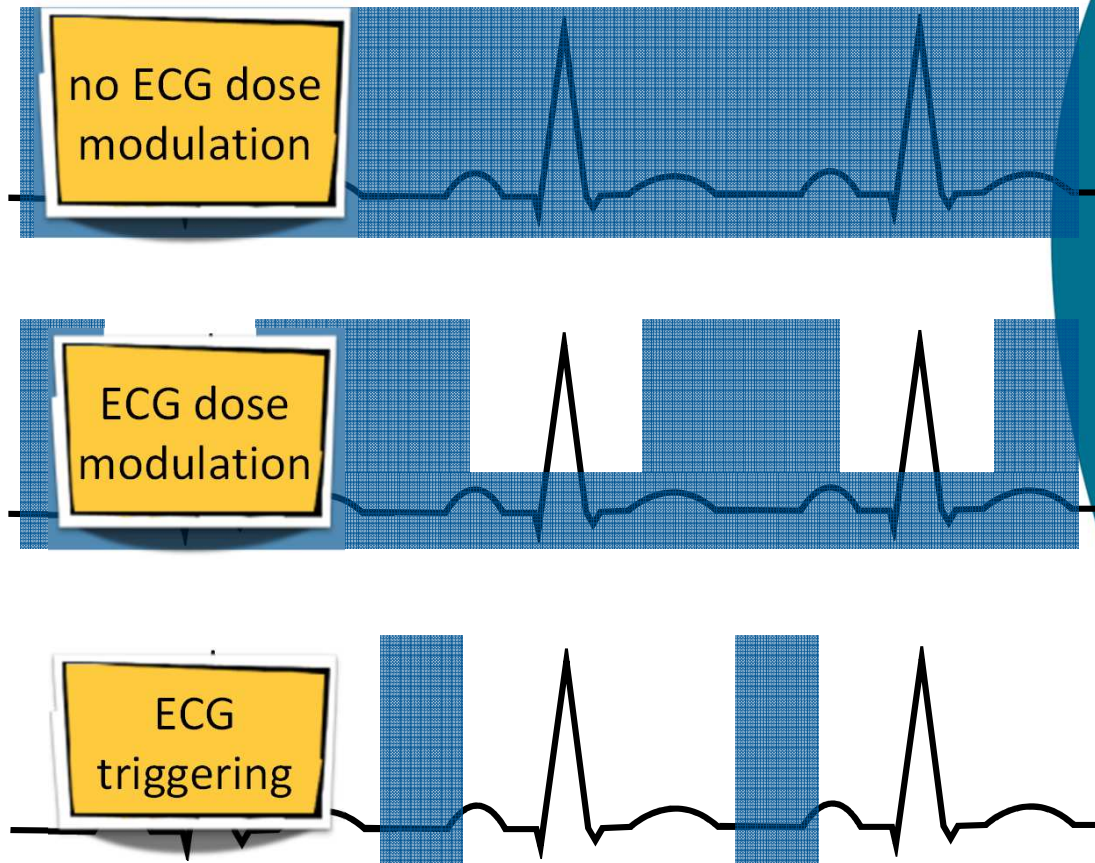
Intermediate Probability (10%-90%)

- Men of all ages with atypical angina
- Women $\geq$ 50 years with atypical angina
- Women 30-50 years with typical angina

High Probability

- Men $\geq$ 40 years with typical angina
- Women $\geq$ years with typical angina

Dose Reduction



Low dose MDCT performance

64-row CT

[Heart. 2011 Sep;97\(17\):1385-90. Epub 2011 Apr 12.](#)

Prognostic performance of low-dose coronary CT angiography with prospective ECG triggering.

[Buechel RR, Pazhenkottil AP, Herzog BA, Brueckner M, Nkoulou R, Ghadri JR, Küest SM, Wyss CA, Husmann L, Kaufmann PA.](#)

Department of Radiology, Cardiac Imaging, University Hospital Zurich, Switzerland.

Abstract

OBJECTIVE: To assess the prognostic value of low-dose 64-slice coronary CT angiography (CCTA) using prospective ECG triggering in a patient population with known or suspected coronary artery disease (CAD).

DESIGN: Longitudinal follow-up study.

SETTING: Tertiary referral cardiac imaging centre.

PATIENTS: 434 consecutive patients who were referred for evaluation of CAD by CCTA.

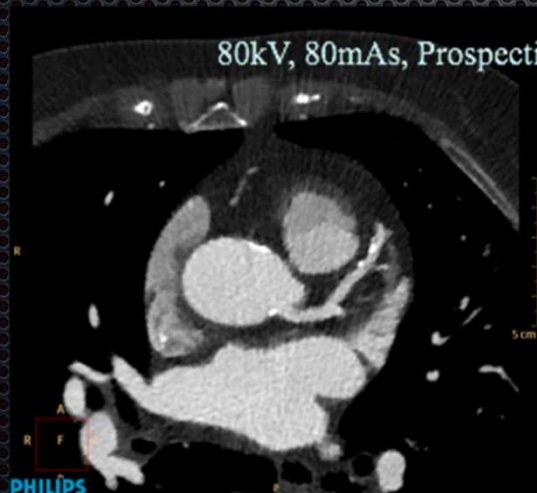
METHODS: The presence, distribution and severity of coronary lesions (non-obstructive <50% vs obstructive ≥50% luminal narrowing) were recorded by low-dose prospective ECG-triggered CCTA for each patient. The prognostic value of low-dose CCTA to predict major adverse cardiac events, defined as cardiac death, non-fatal myocardial infarction, or the need for revascularisation, was assessed using multivariate Cox regression analysis. Each person was followed up by telephone interviews and/or on the basis of clinical records. Thirty-eight early revascularised patients were excluded from outcome analysis.

RESULTS: Completely normal coronary arteries were documented in 171 patients (47%), while exclusively non-obstructive lesions were found in 66 (18%), and obstructive coronary lesions were diagnosed in 130 patients (35%). A mean follow-up of 47 ± 16 weeks was obtained. The first-year event rate was 0% in patients with normal coronary arteries on CCTA but increased to 3% and 26% in patients with non-obstructive and obstructive coronary artery lesions, respectively. In multivariate Cox regression analysis, a significant predictor of events was the presence of obstructive or any coronary lesions. Mean effective radiation dose was 1.8 ± 0.6 mSv.

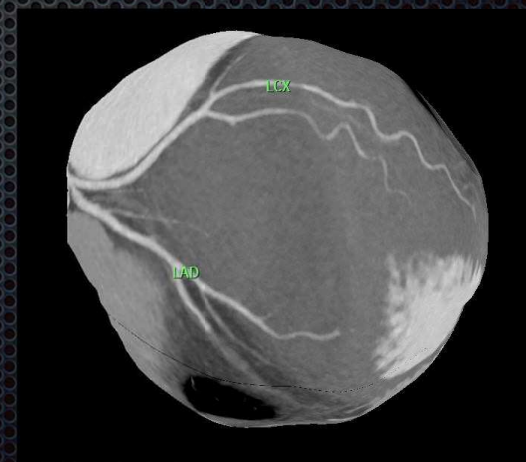
CONCLUSIONS: These data document an excellent prognostic performance of low-dose CCTA.

Comment in

[Heart. 2011 Sep;97\(17\):1363-4.](#)



Courtesy KM M.U.A No.2 Hospital, China



100kV, 100mAs, 4.9 mGy, Prospective Gated Cardiac CTA (Step & Shoot Cardiac), 0.8 mSv

MDCT and congenital coronary heart diseases



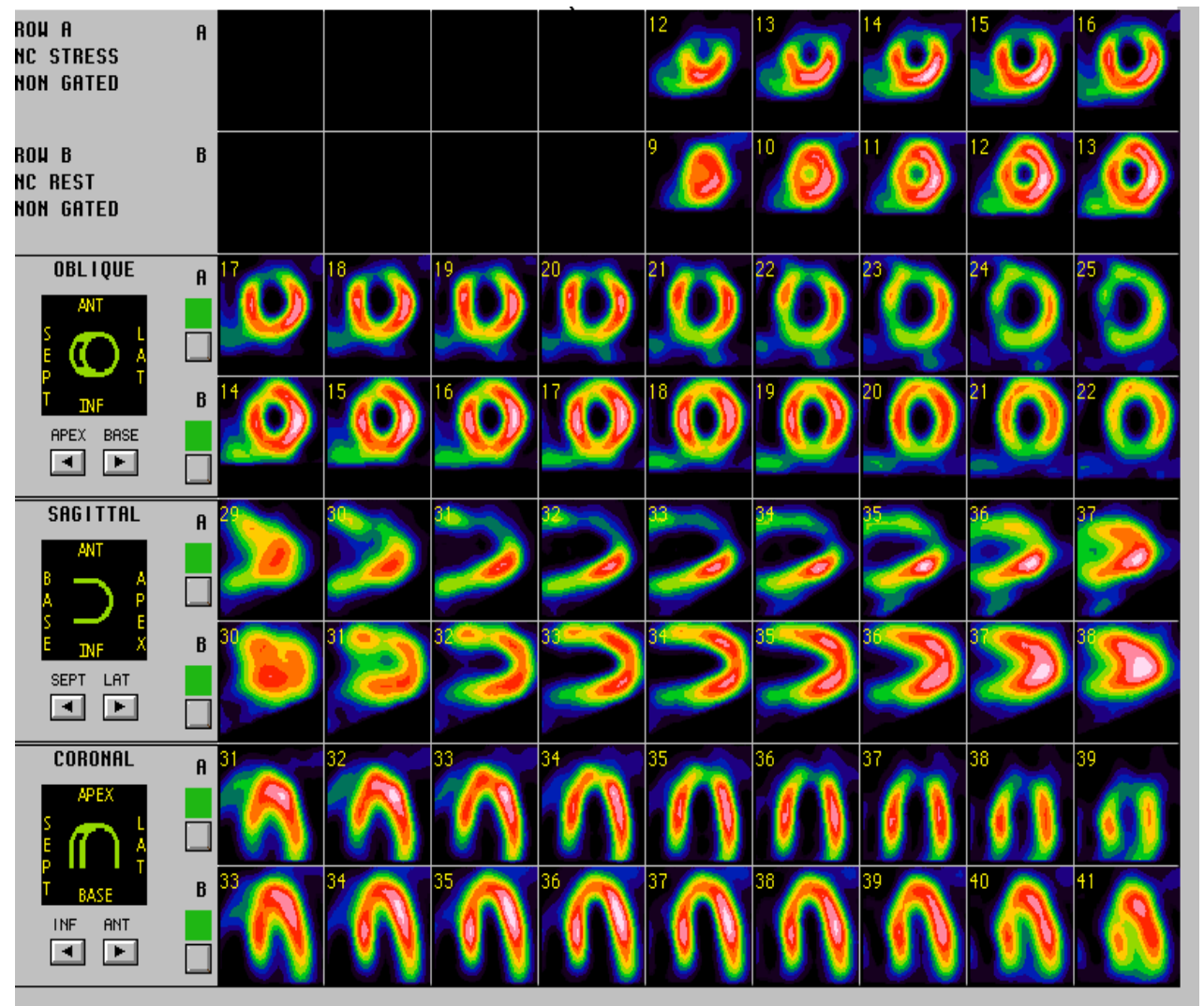
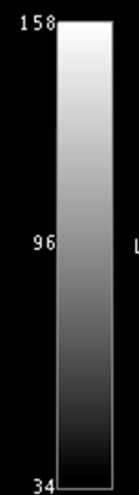
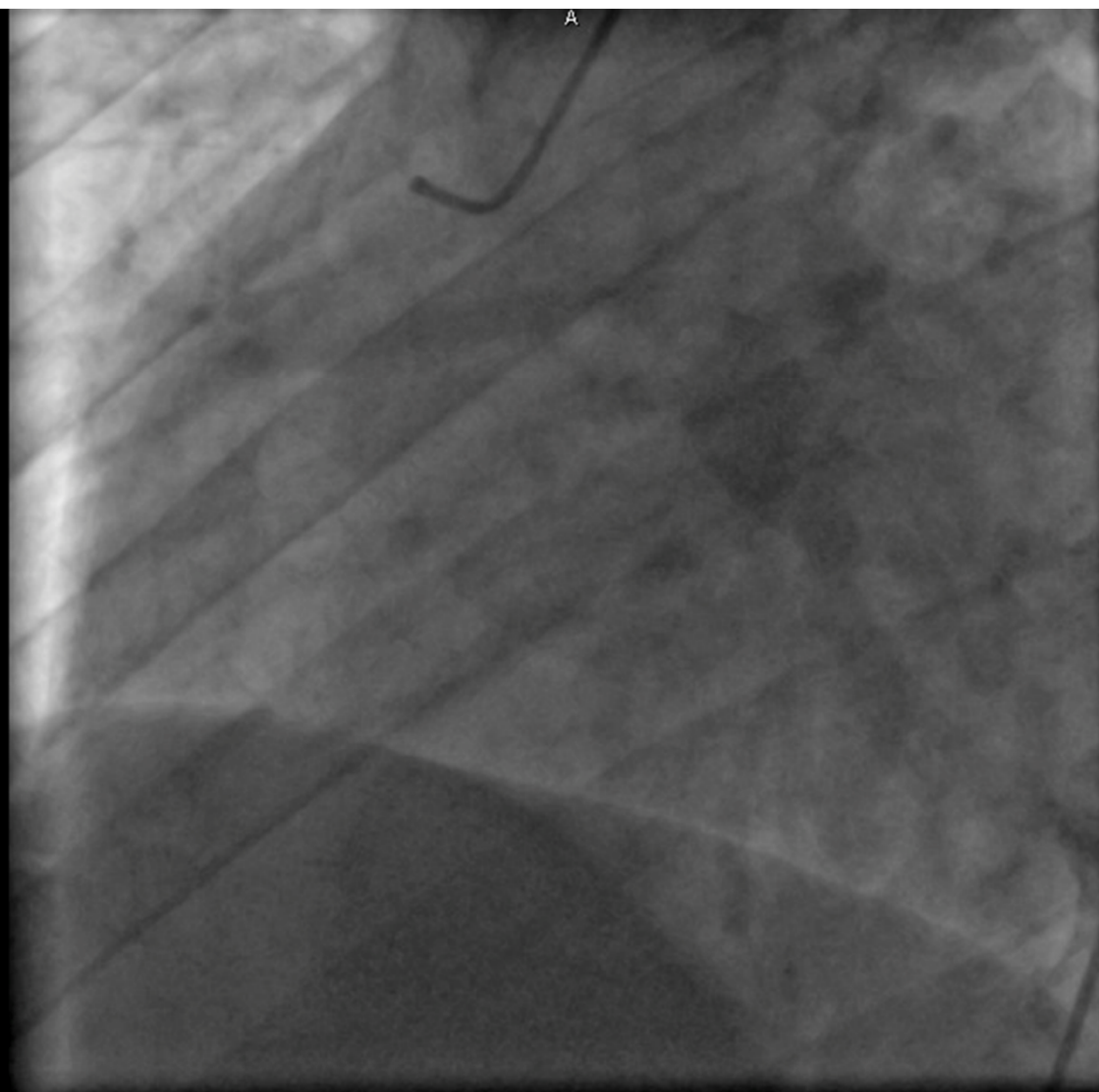


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WL: 96 WW: 124

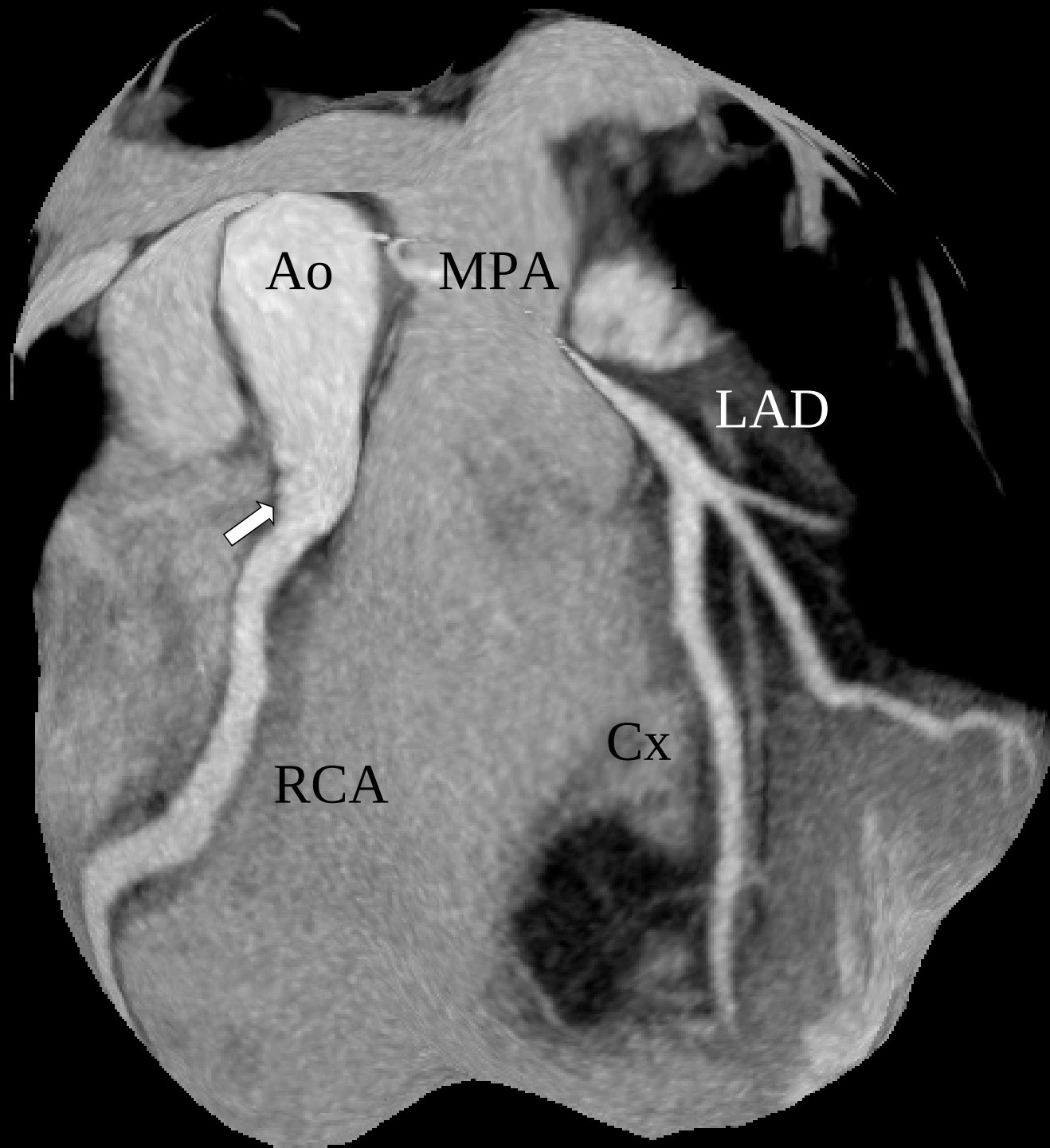
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MPA

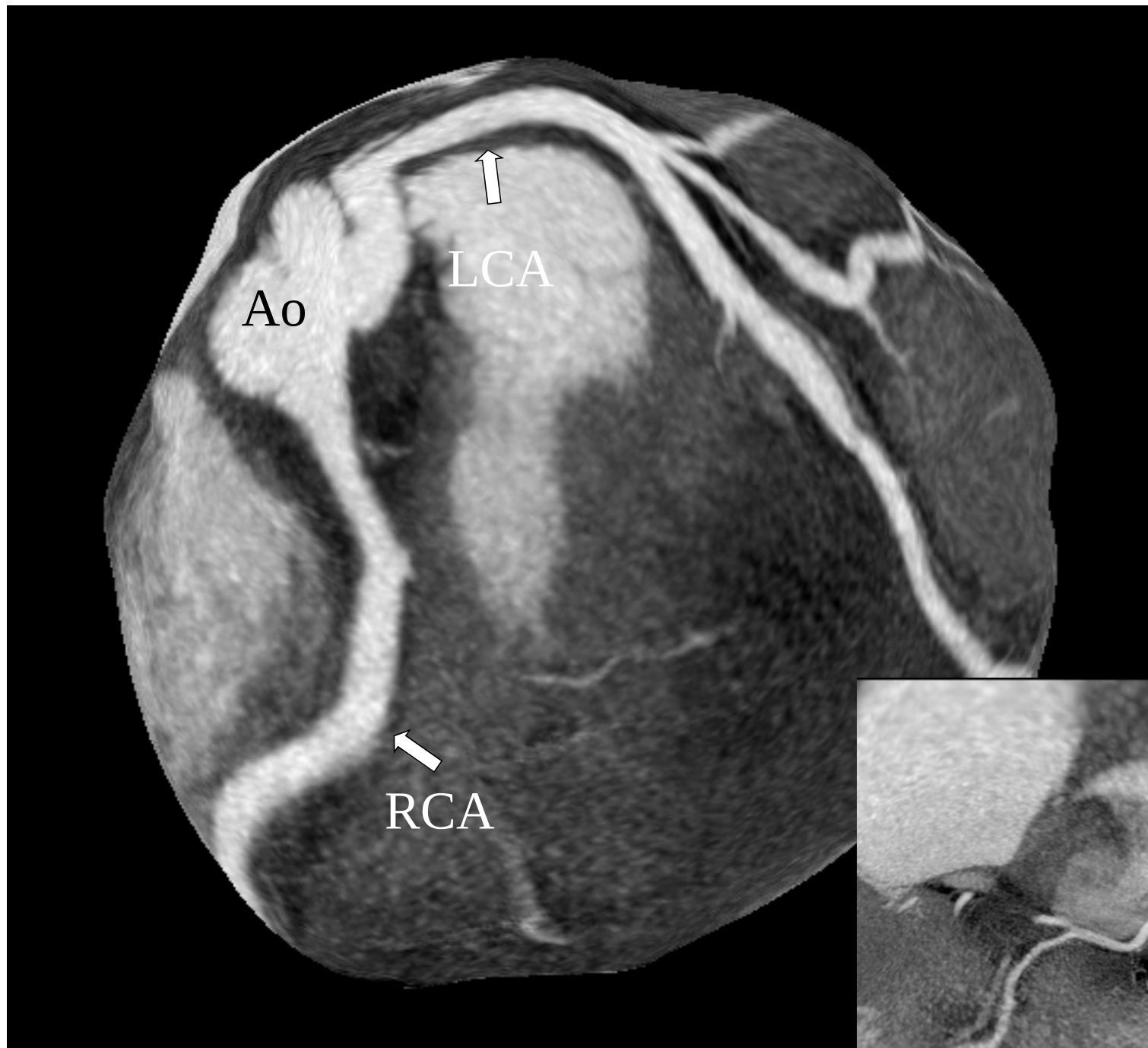
LAD

LAD

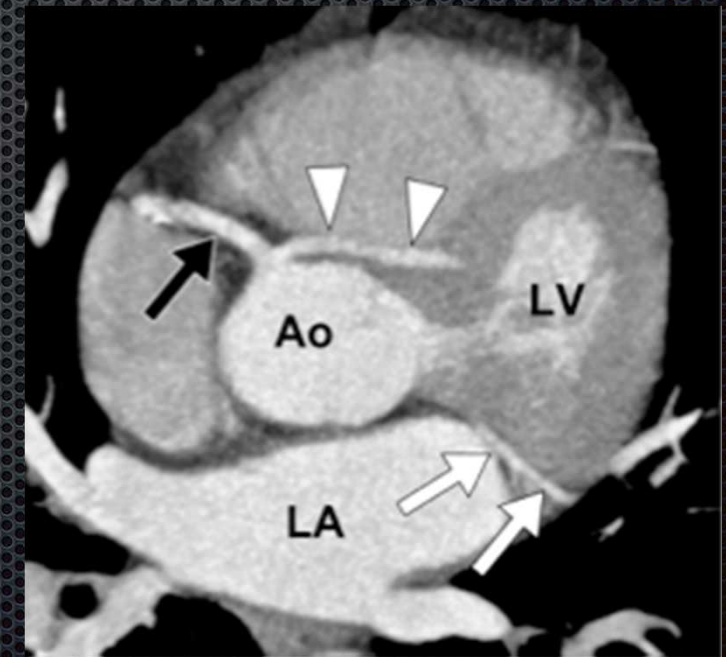
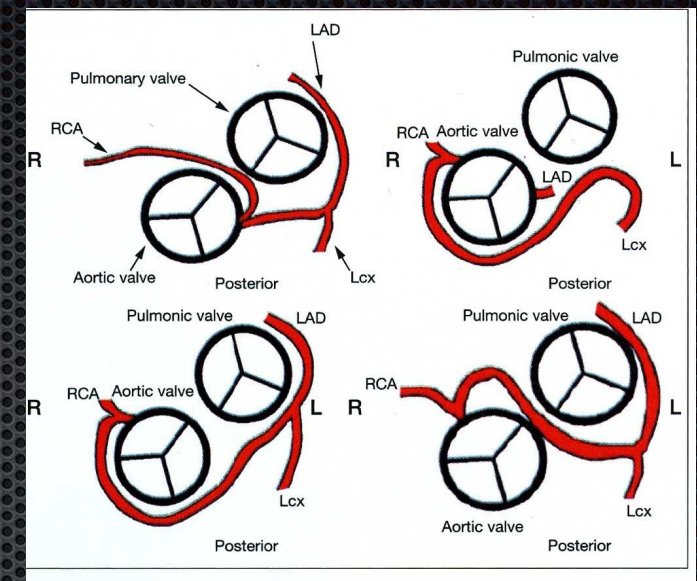
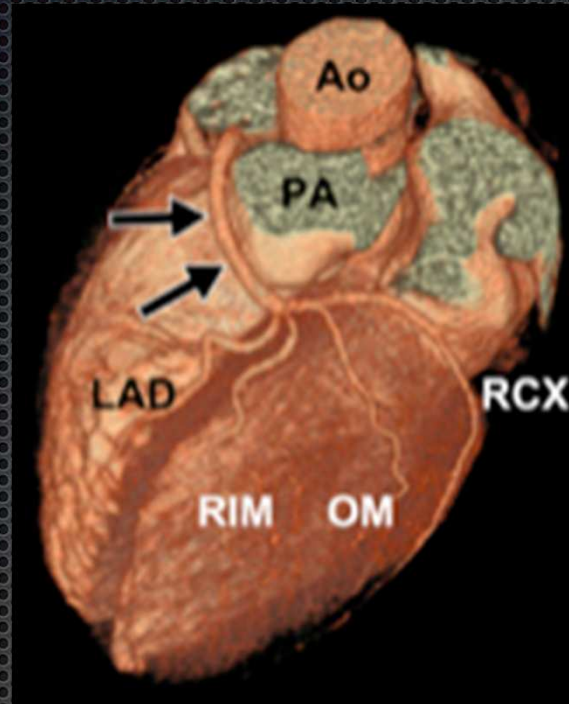
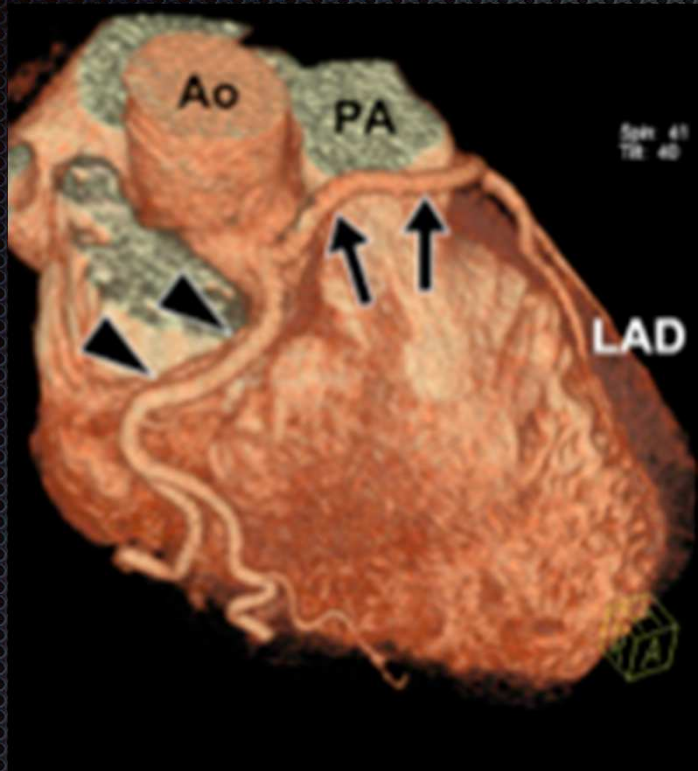


RCA

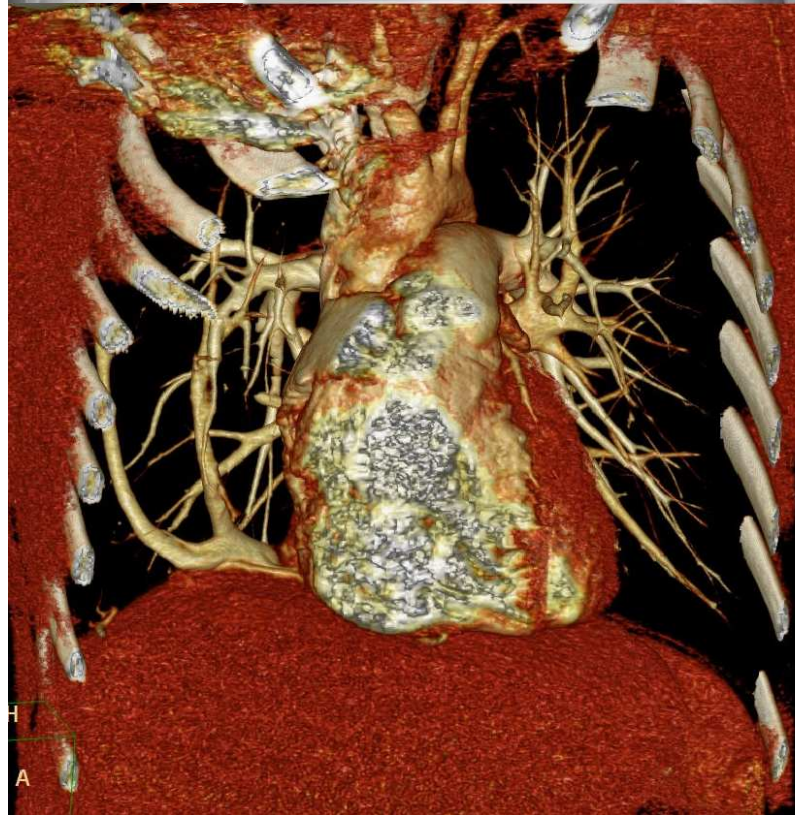
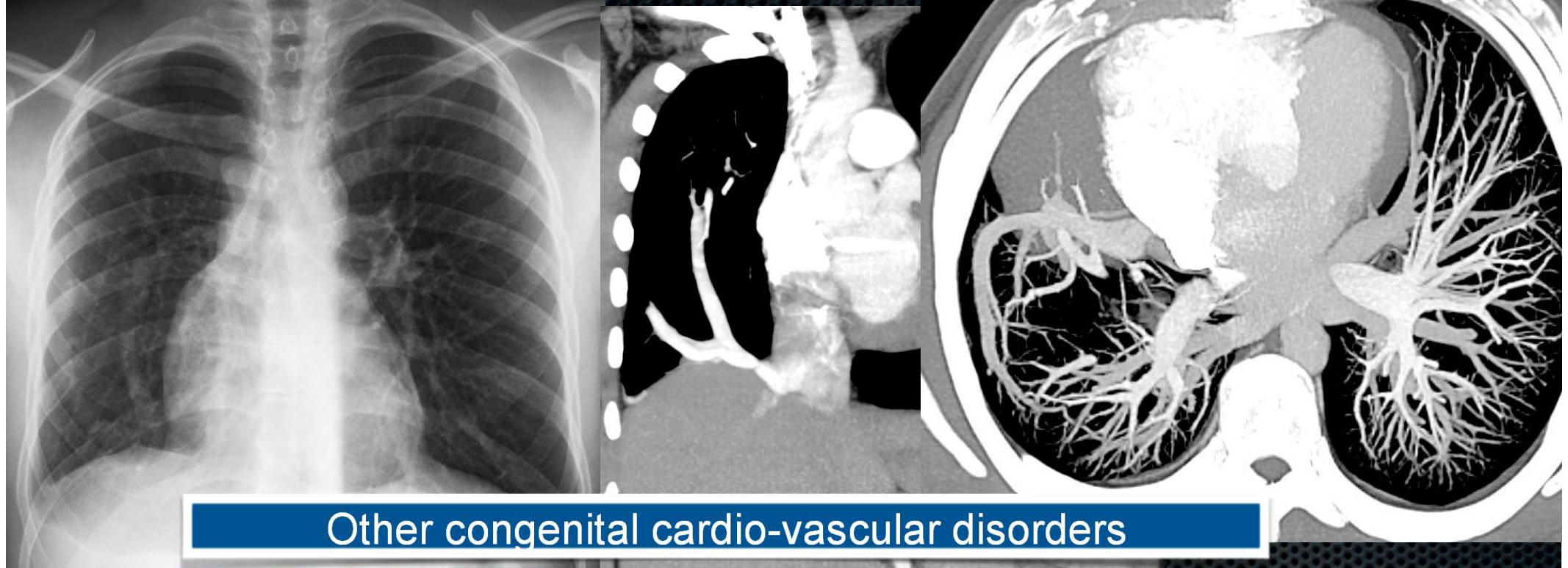
Cx



Congenital abnormalities



Schroeder S, et al. Cardiac computed tomography: indications, applications, limitations, and training requirements: report of a Writing Group deployed by the Working Group Nuclear Cardiology and Cardiac CT of the European Society of Cardiology and the European Council of Nuclear Cardiology. Eur Heart J (2008): 531-56



MDCT Coronary artery bypass graft

- 212 bypass grafts: 115 venous grafts, 97 arterial grafts
- 64 MDCT
- Sensitivity 83.3% and 100% specificity to evaluate occluded arterial grafts
- Sensitivity 100% and 97,7% specificity to evaluate stenosed arterial grafts

Romagnoli A, et al. Diagnostic accuracy of 64-slice CT in evaluating coronary artery bypass grafts and of the native coronary arteries. Radiol med (2010)115:1167-1178

Diagnostic performance of 320-slice multidetector computed tomography coronary angiography in patients after coronary artery bypass grafting

Fleur R. de Graaf · Joëlla E. van Velzen · Agnieszka J. Witkowska ·
Joanne D. Schuijf · Noortje van der Bijl · Lucia J. Kroft · Albert de Roos ·
Johan H. C. Reiber · Jeroen J. Bax · Greetje J. de Grooth · J. Wouter Jukema ·
Ernst E. van der Wall

Abstract

Objectives To evaluate the diagnostic performance of 320-slice computed tomography coronary angiography (CTA) in the evaluation of patients with prior coronary artery bypass grafting (CABG). Invasive coronary angiography (ICA) served as the standard of reference, using a quantitative approach.

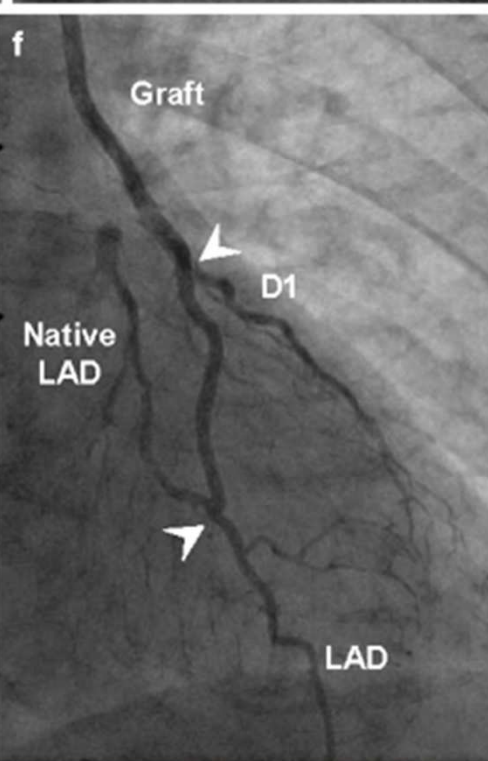
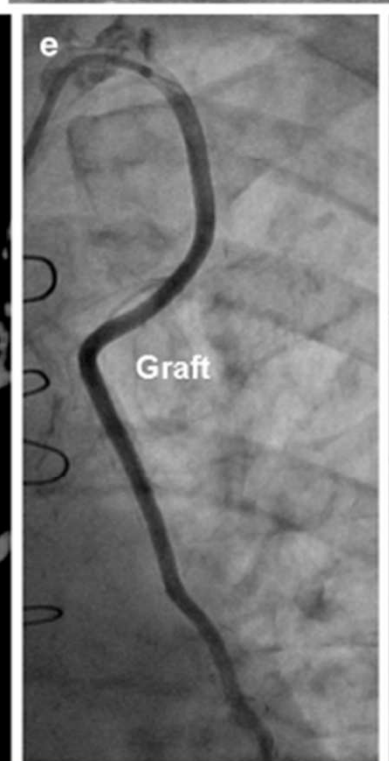
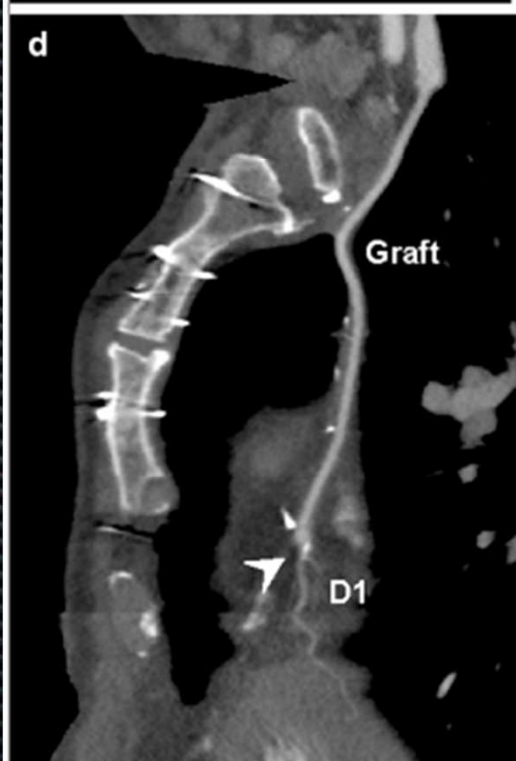
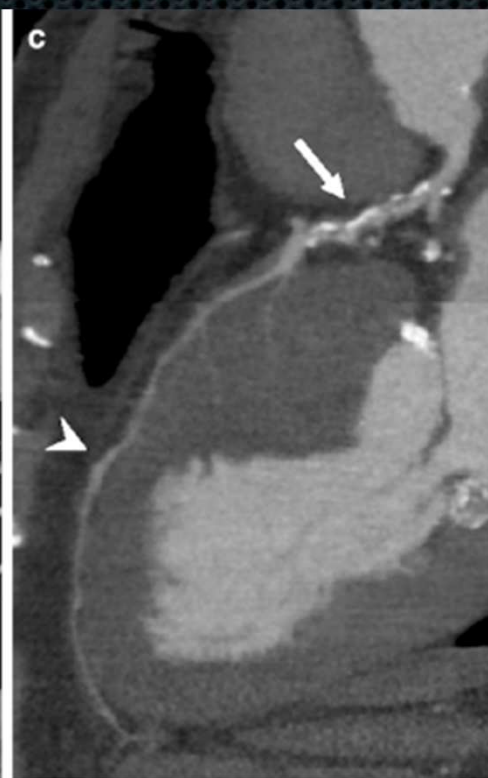
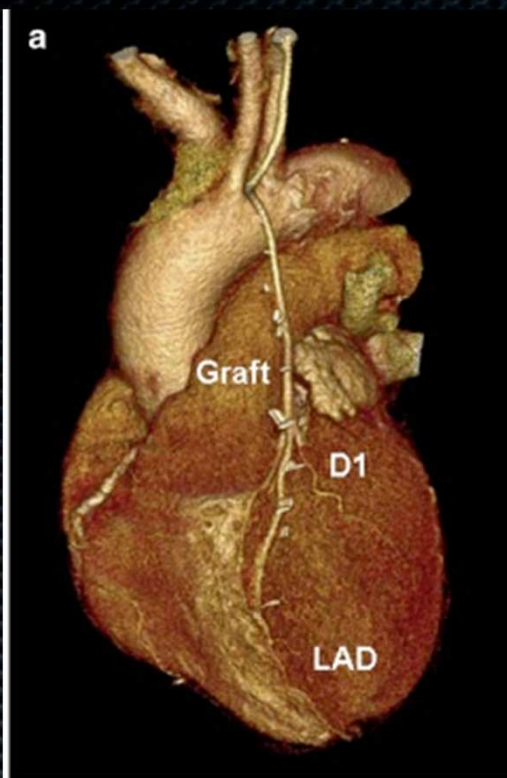
Methods CTA studies were performed using CT equipment with 320 detector-rows, each 0.5 mm wide, and a gantry rotation time of 0.35 s. All grafts, recipient and nongrafted vessels were deemed interpretable or uninterpretable. The presence of significant ($\geq 50\%$) stenosis and occlusion were determined on vessel and patient basis. Results were compared to ICA using quantitative coronary angiography. **Results** A total of 40 patients (28 men, 76 ± 15 years), with 89 grafts, were included in the study. On a graft analysis,

the sensitivity, specificity, positive and negative predictive values in the evaluation of significant stenosis were 96%, 92%, 83% and 98% respectively. The diagnostic accuracy for the assessment of recipient and nongrafted vessels was 89% and 80%, respectively. The diagnostic accuracy for the assessment of graft, recipient and nongrafted vessel occlusion was 96%, 92% and 100%, respectively.

Conclusions 320-slice CTA allows accurate non-invasive assessment of significant graft, recipient vessel and nongrafted vessel stenosis in patients with prior CABG.

Keywords Multidetector computed tomography · Non-invasive coronary angiography · Coronary artery bypass grafts · Cardiac imaging · Cardiac-gated imaging techniques

Abbreviations



A

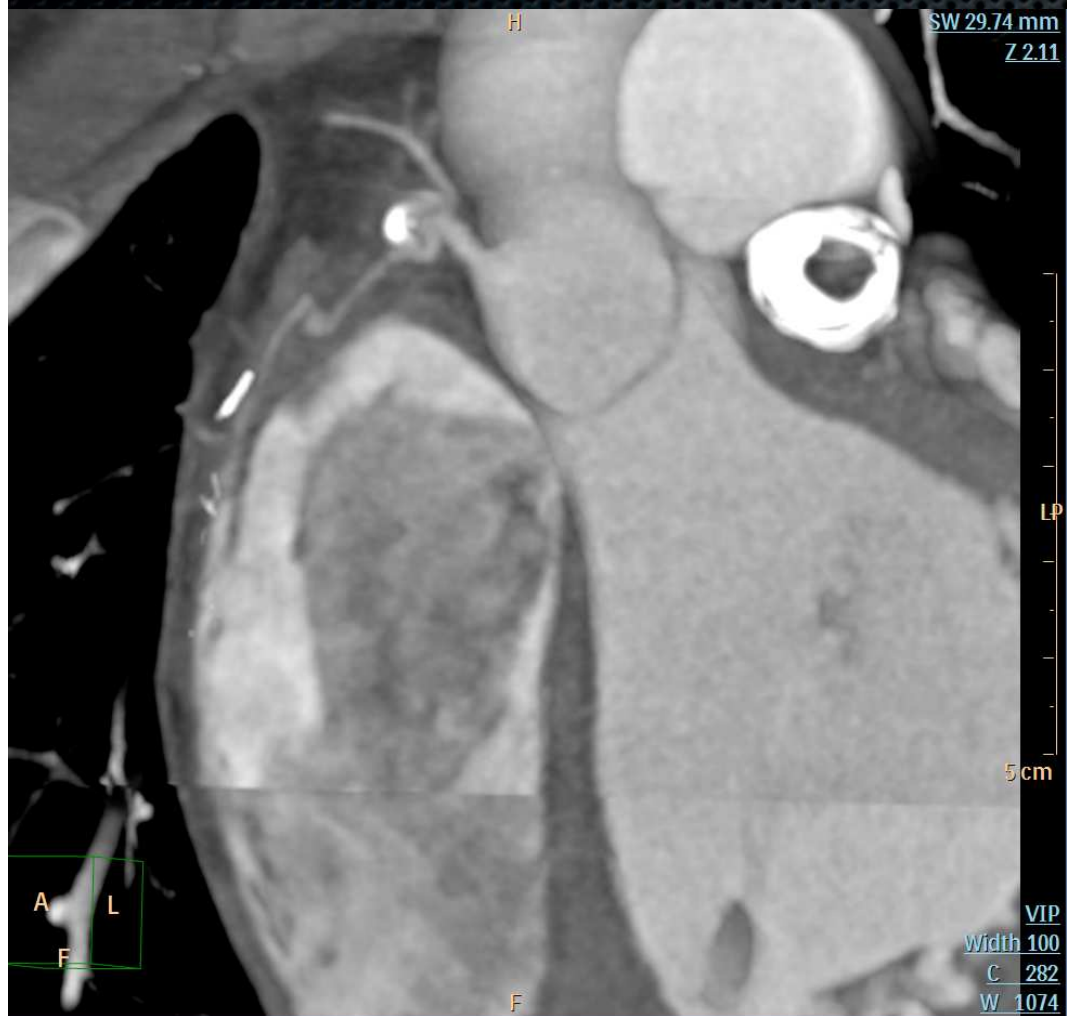
Z 0.99



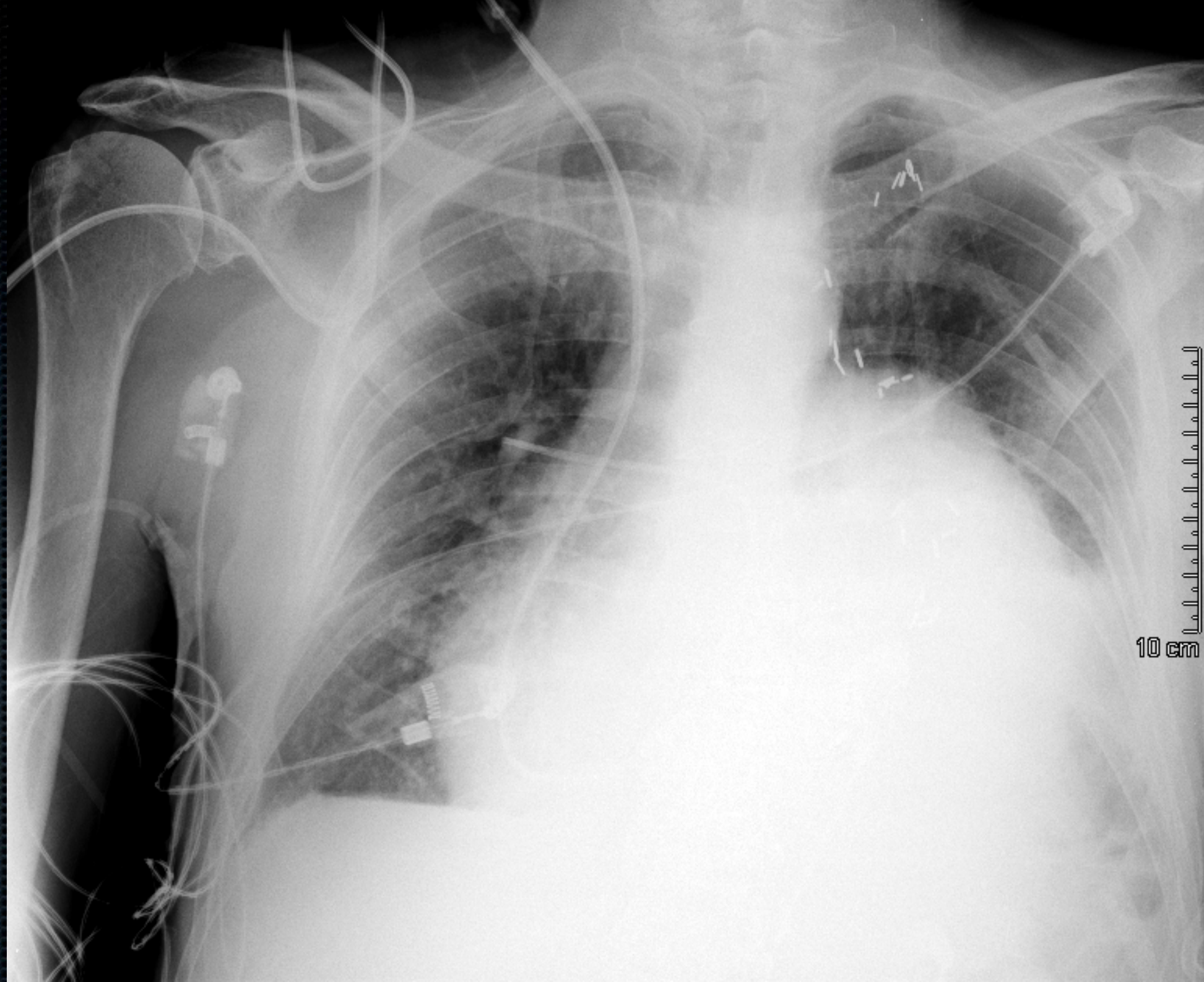
27-year-old woman
Previous arterial Bypass graft for known paediatric disease
Discrete chest pain at exercise

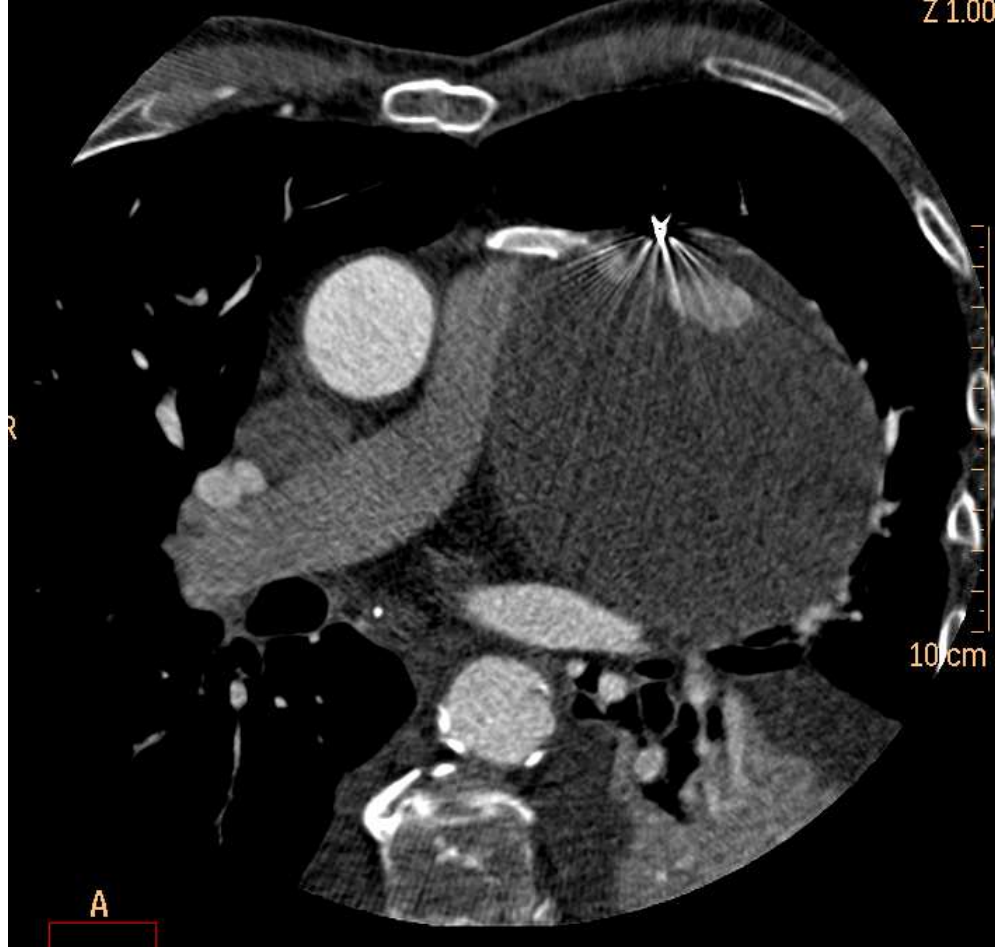
P

C 90
W 750









64 x 0.625 mm (PMS)

Rotation time: 0.40 sec

140 kV

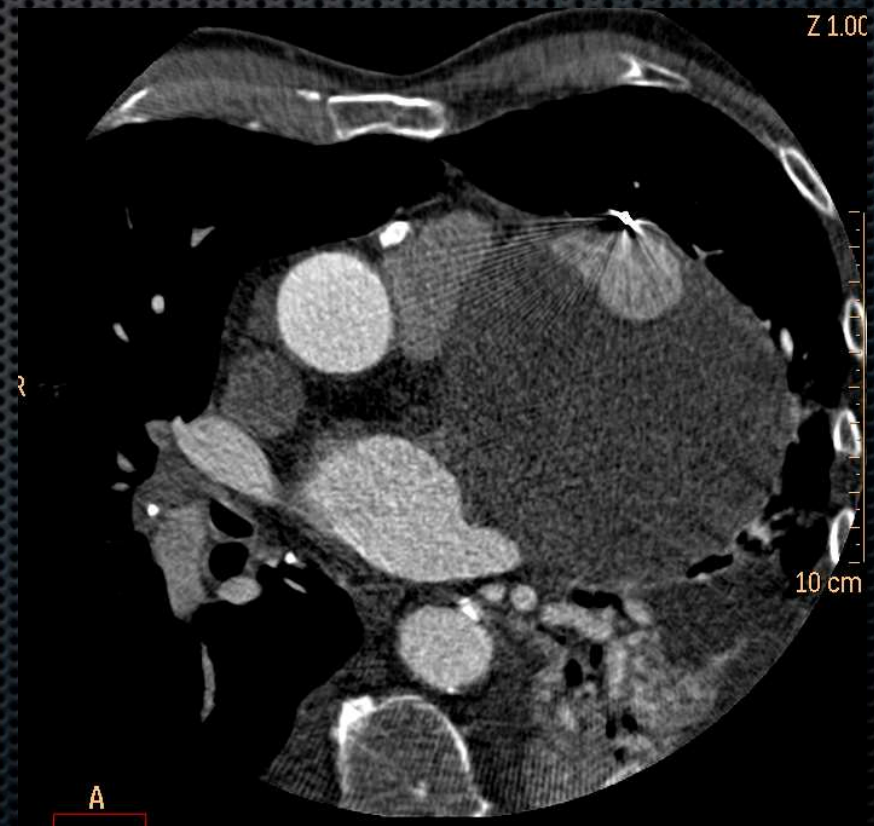
600 mAs

80 mL contrast + 40 mL
saline, 3 mL/sec

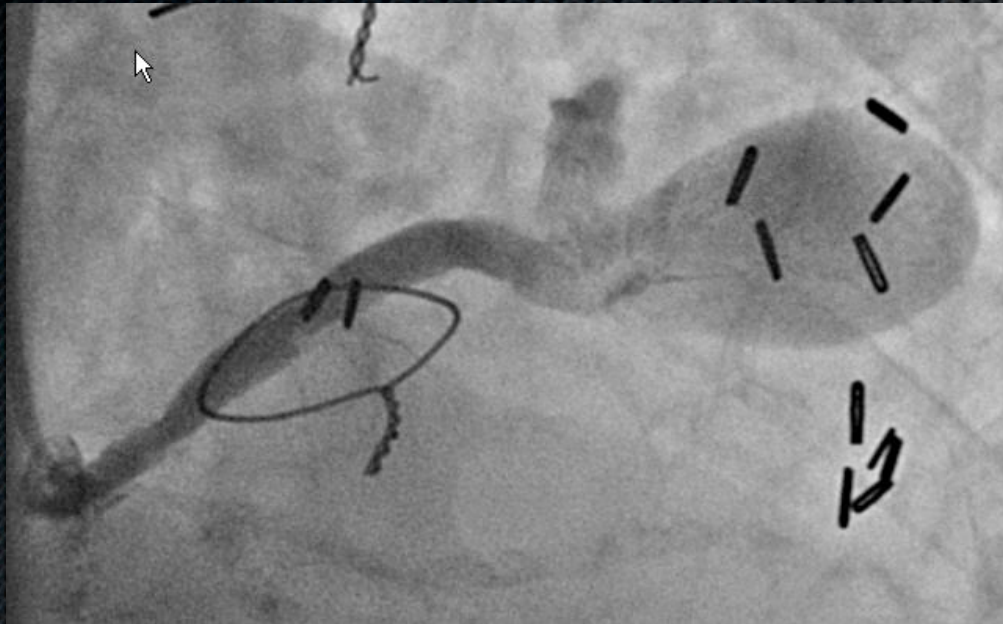
8 x 6 cm mass

Eccentric enhancement

Compression of LIMA



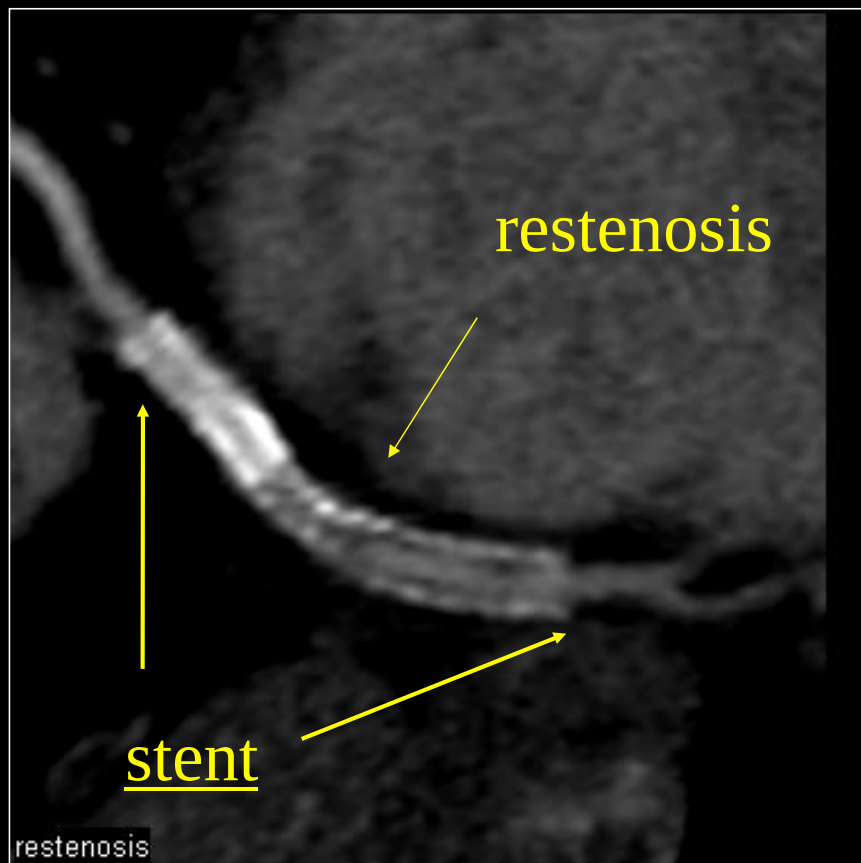
Surgery



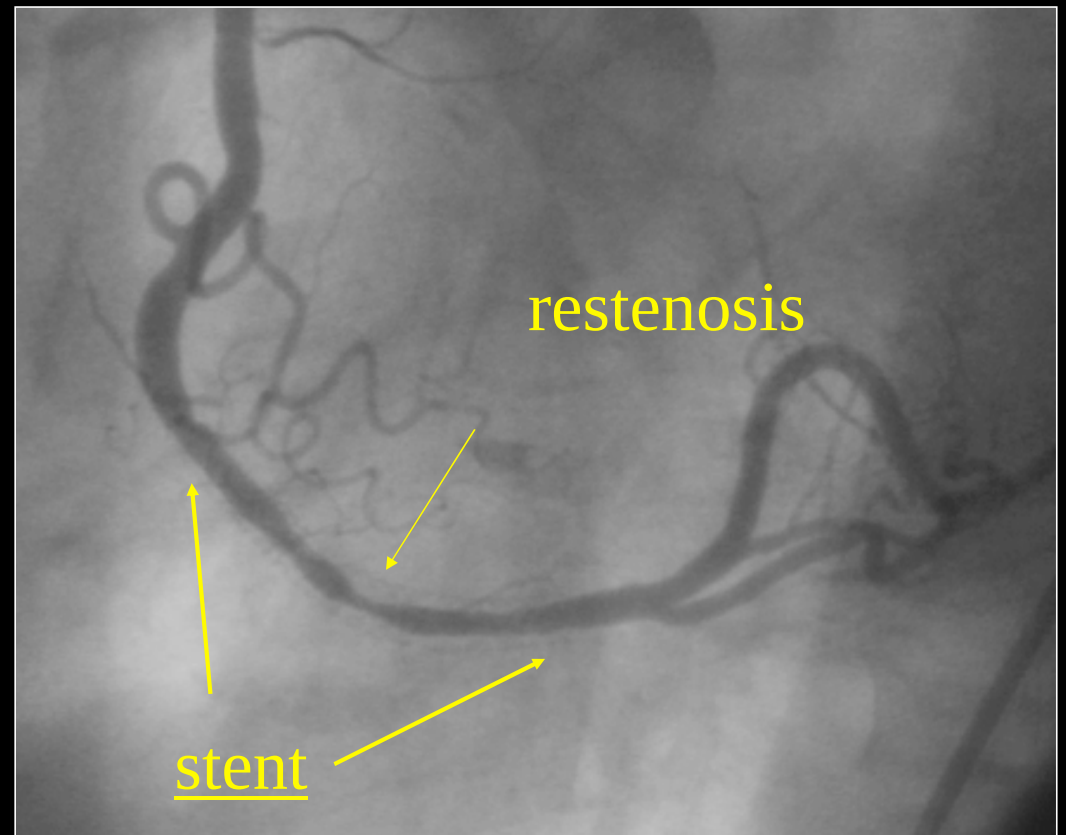
Evaluation of stents

MDCT could be clinically useful for identification of restenosis in patients after coronary stenting

MDCT

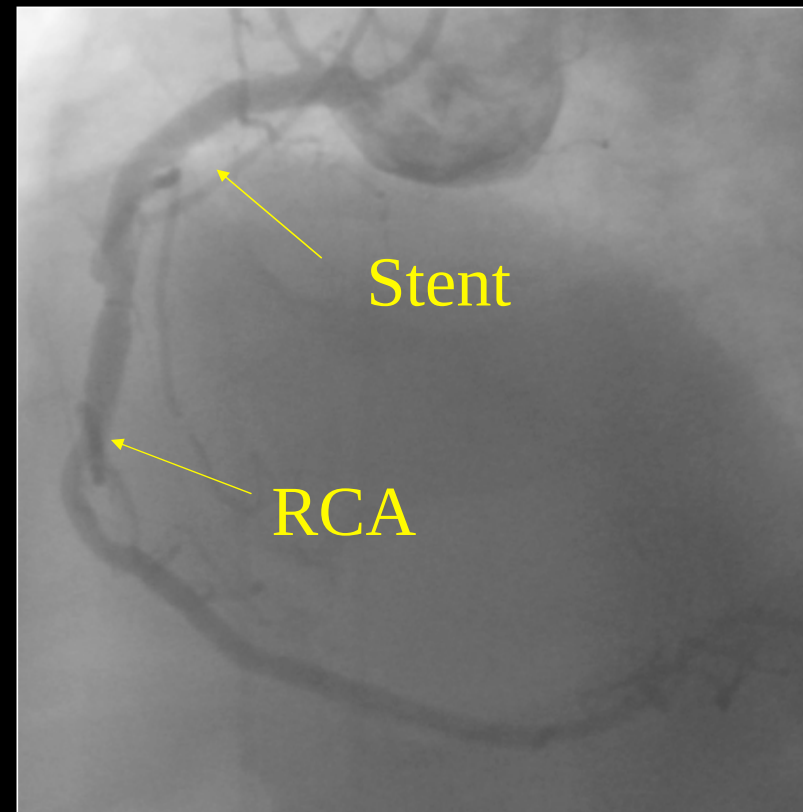
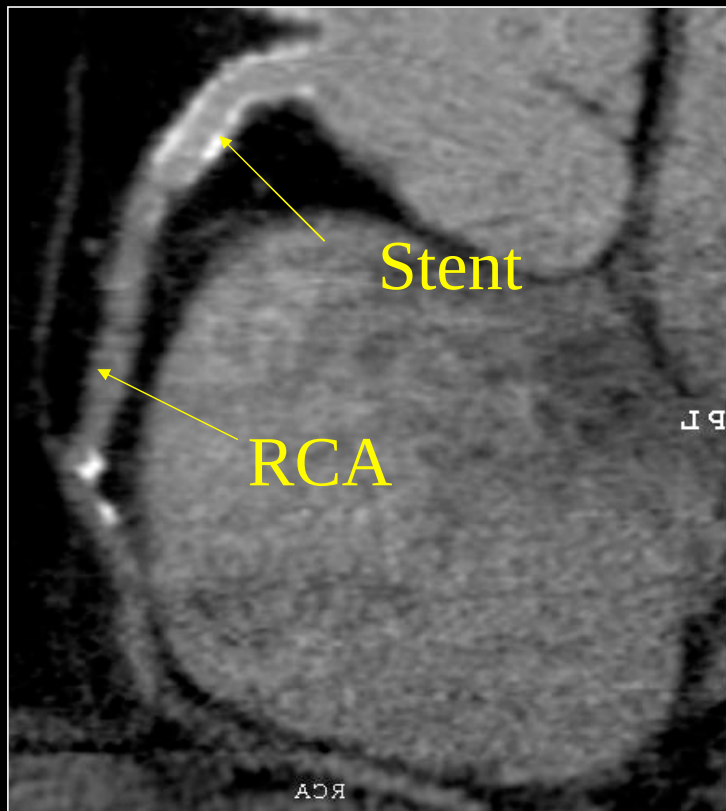


Invasive angiography



Kefer J, et al. Eur Radiol 17(1): 87-96. 50 patients. Sens. 67%, spéc: 98%, Diagnostic accuracy: 98%

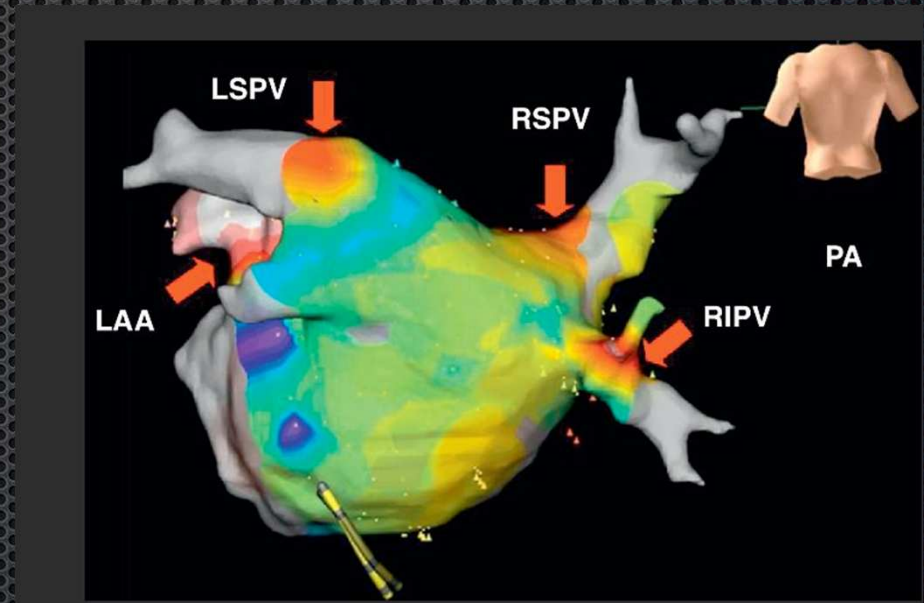
Author	Number of patients/stents	Not evaluable (%)	Sensitivity (%)	Specificity (%)	PPV (%)	NPV (%)
Rixe et al. ⁷⁹	64/102	42 (43/192)	86 (6/7)	98 (51/52)	86 (6/7)	98 (51/52)
Rist et al. ⁷⁸	25/46	2 (1/46)	75 (6/8)	92 (34/37)	67 (6/9)	94 (34/36)
Oncel et al. ⁷⁶	30/39	0 (0/39)	89 (17/19)	95 (19/20)	94 (17/18)	90 (19/21)
Ehara et al. ²³	81/125	12 (15/125)	91 (20/22)	93 (82/88)	77 (20/26)	98 (82/84)
Cademartiri et al. ⁷⁵	182/192	7 (14/192)	95 (19/20)	93 (147/158)	63 (19/30)	99 (147/148)
Pugliese et al. ⁷⁷	100/178	5 (9/178)	94 (37/39)	92 (128/139)	77 (37/48)	98 (128/130)
Total	482/682	12 (82/682) (95% CI 9.7–15)	91 (105/115) (95% CI 85–96)	93 (461/494) (95% CI 91–95)	76 (105/138) (95% CI 68–83)	98 (461/471) (95% CI 96–99)

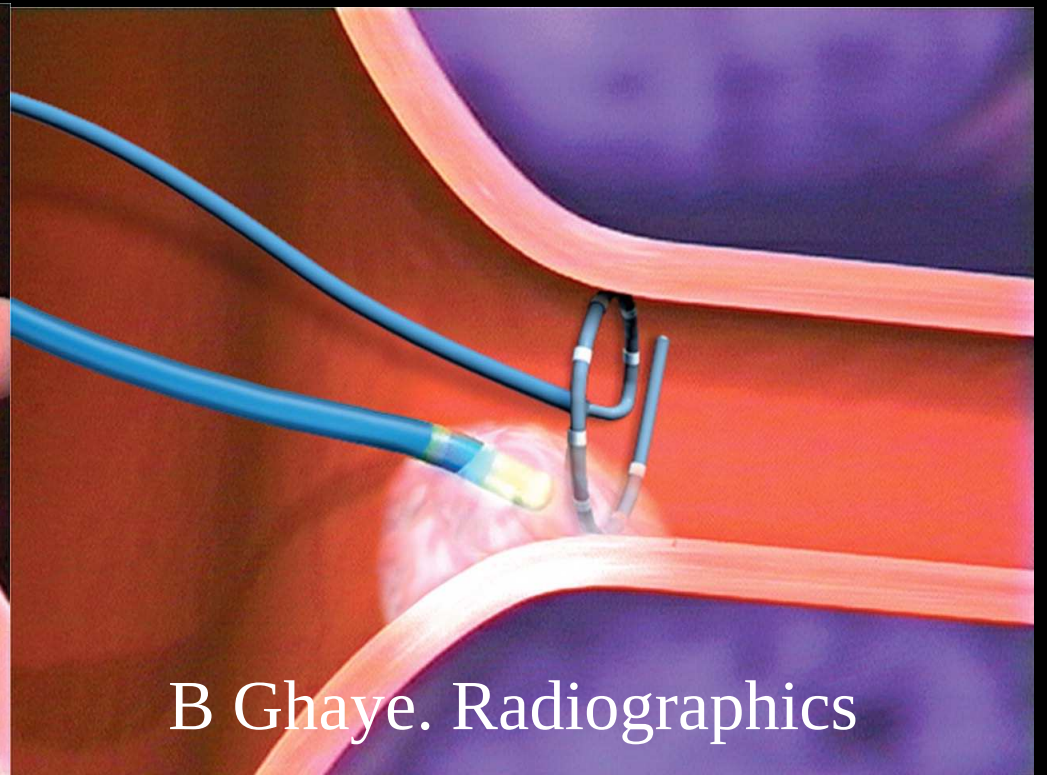
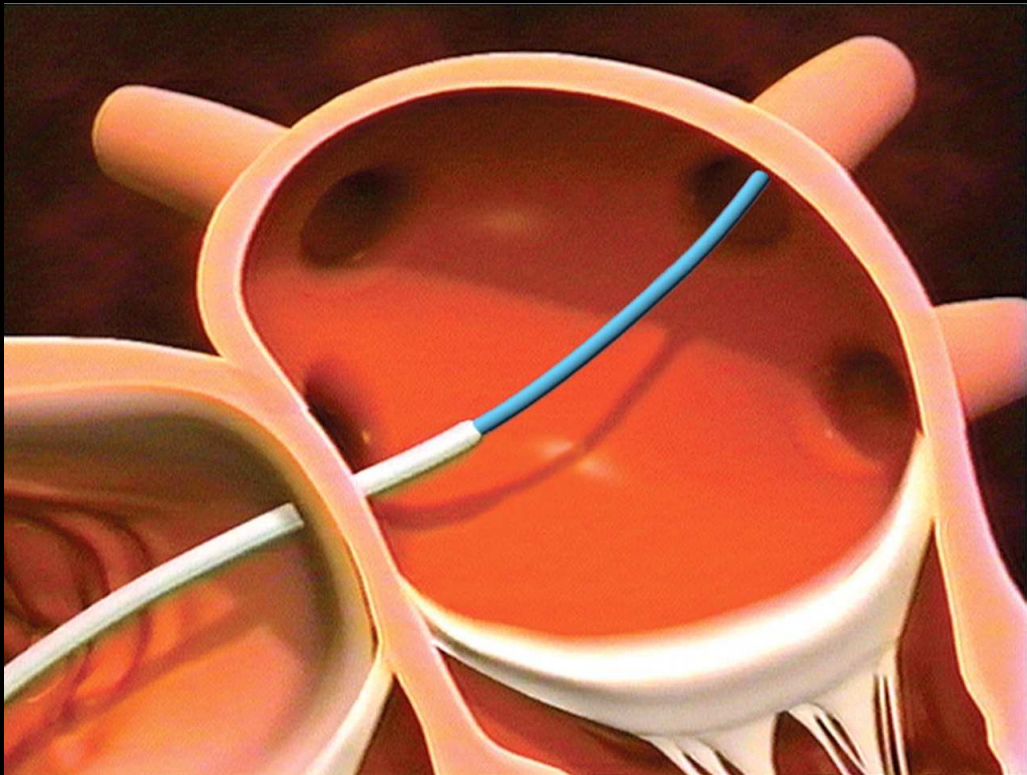
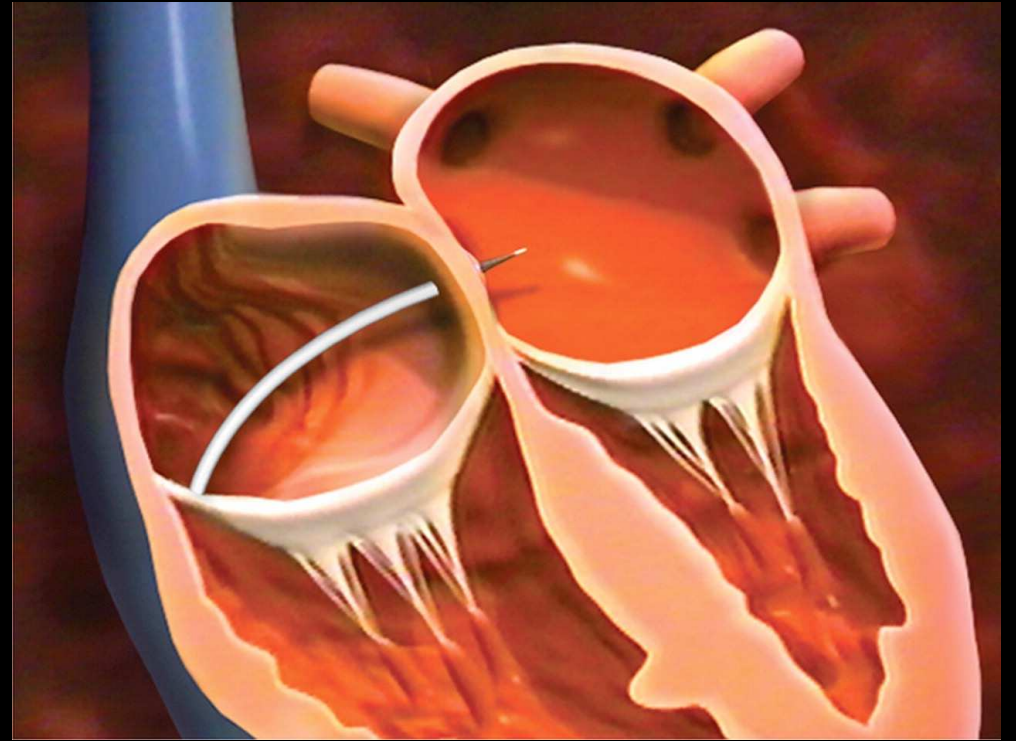
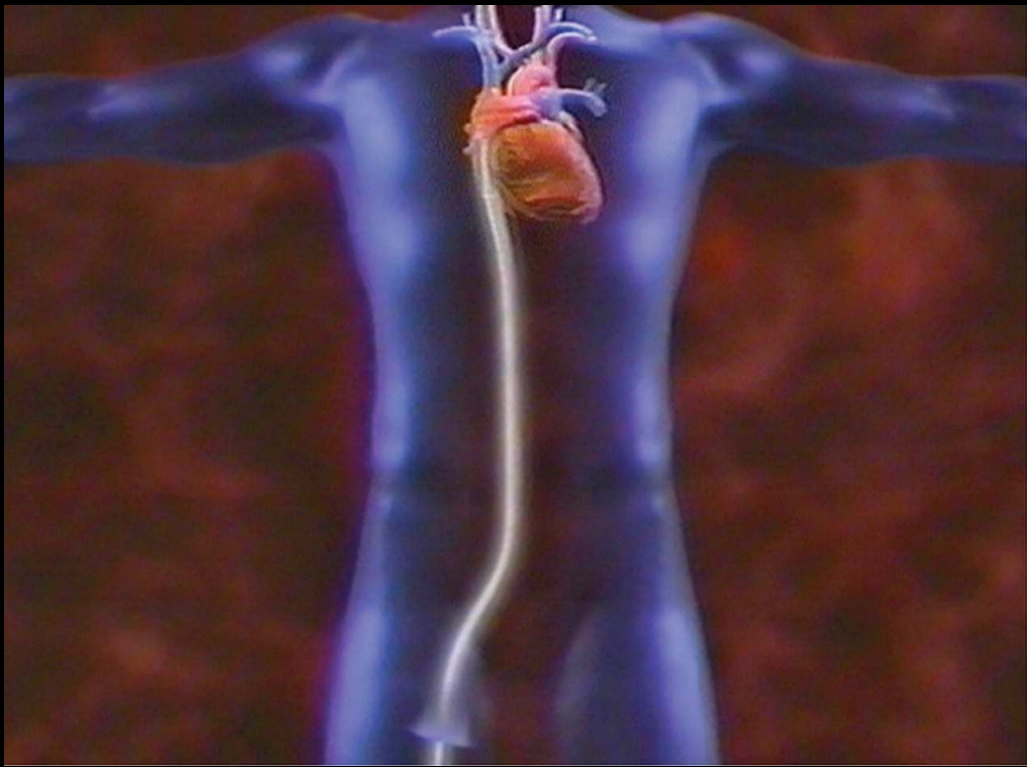


Pulmonary veins and coronary sinus

Anatomy

- Percutaneous treatment of arrhythmogenic sources
 - RF: 500-1000 kHz
 - Cryoablation
- 4 pulmonary veins
 - Left superior and inferior
 - Right superior and inferior
- Anatomical variants
- Complications:
 - stenosis: 1.5-42%
 - Venous thrombosis and pulmonary infarction





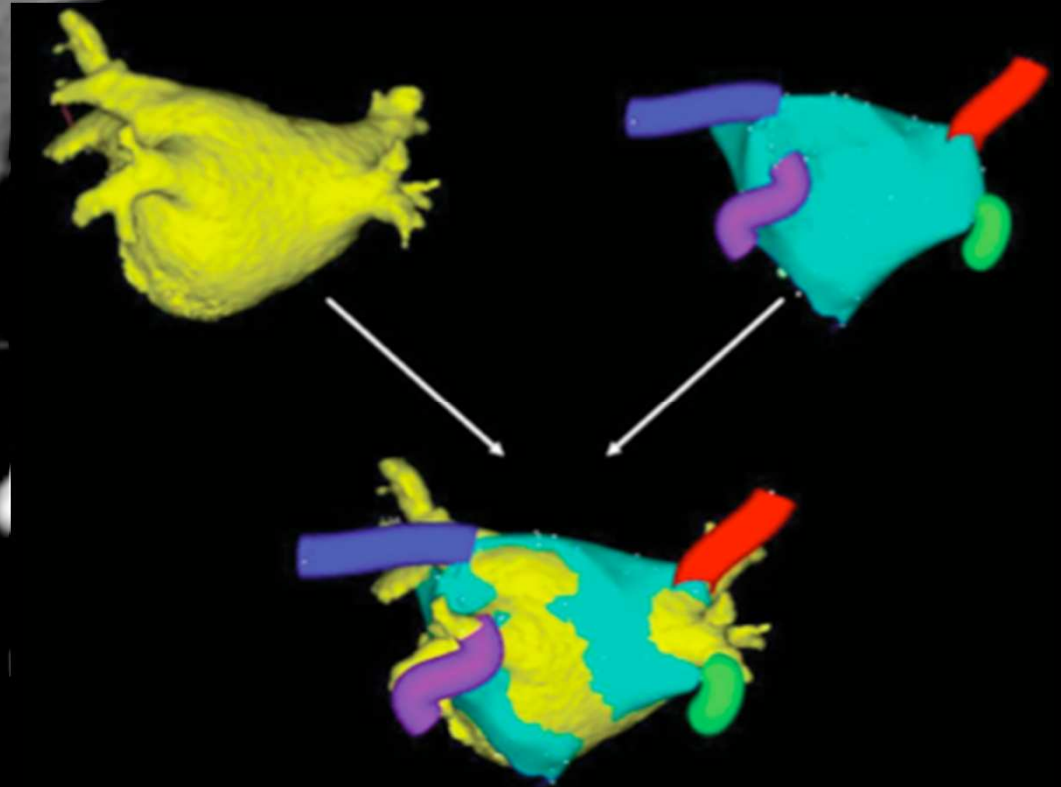
B Ghaye. Radiographics

ie: 4/1
nt: 50/113
sc: 1146.3

12 x 512
STANDARD

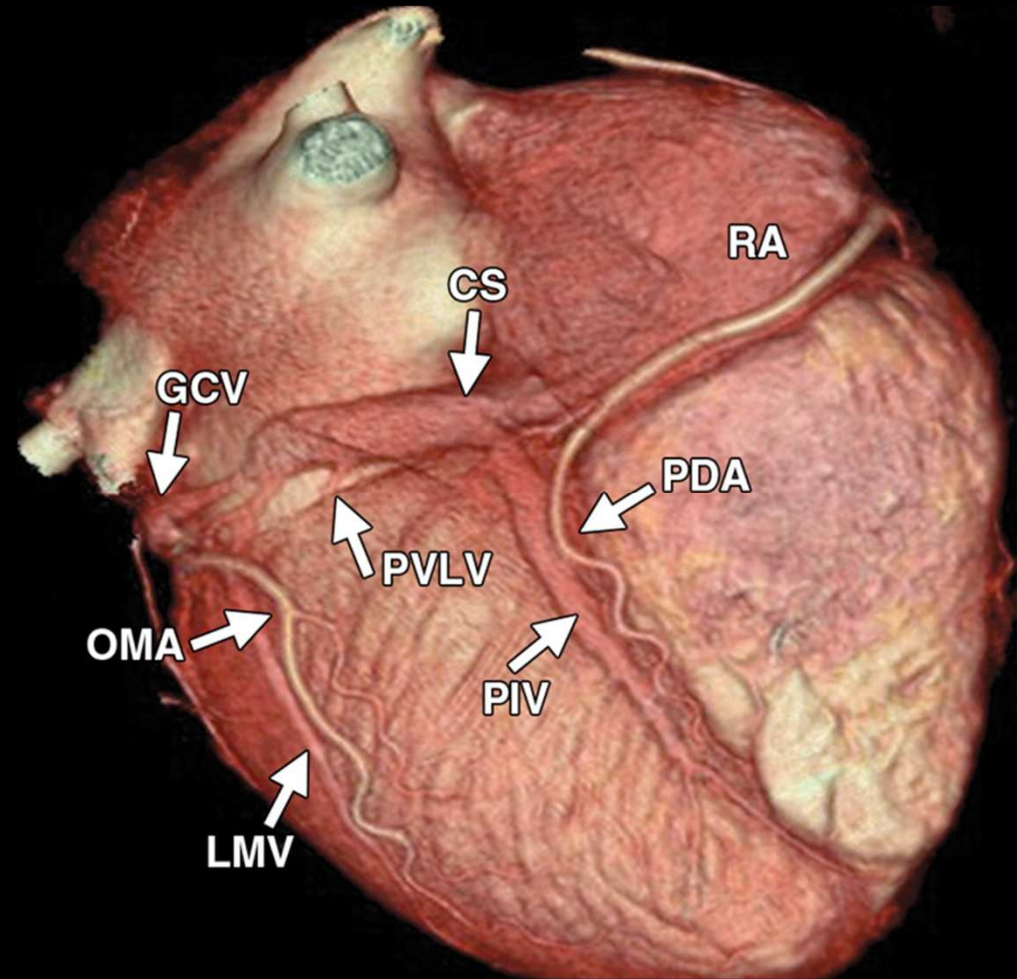
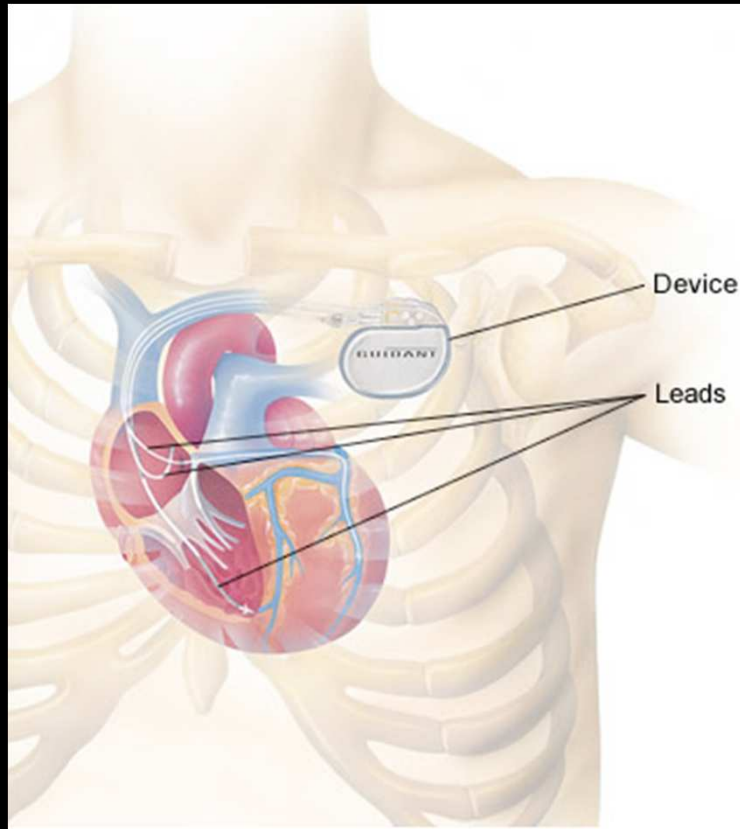
20.0 kV
00.0 mA
5 mm
ilt: 0.0
T: 1.1 s
P: 0.8 s
S: 7.50 mm/s

2002 Sep 20
Acq Tm: 10:16:35

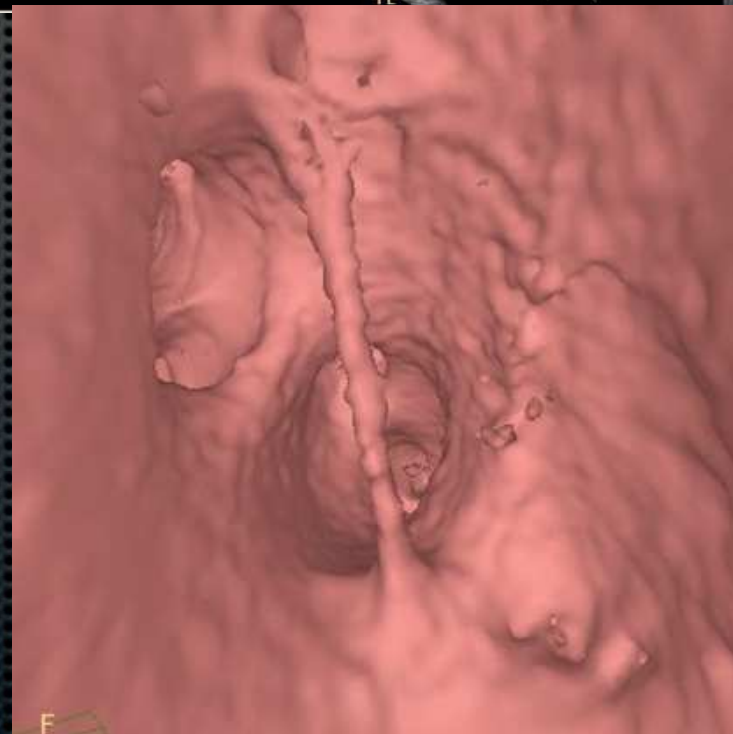
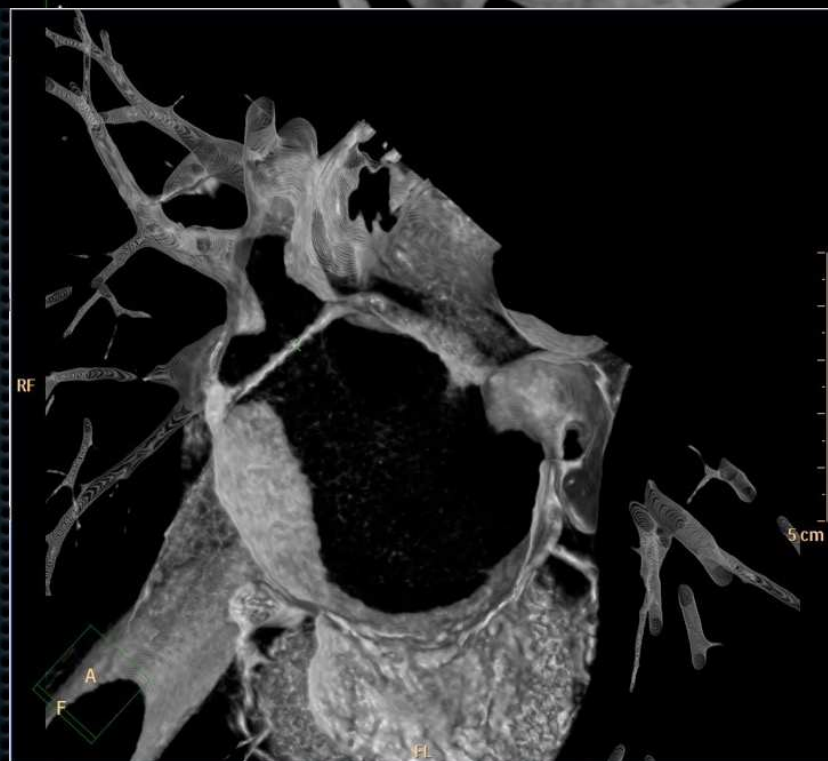
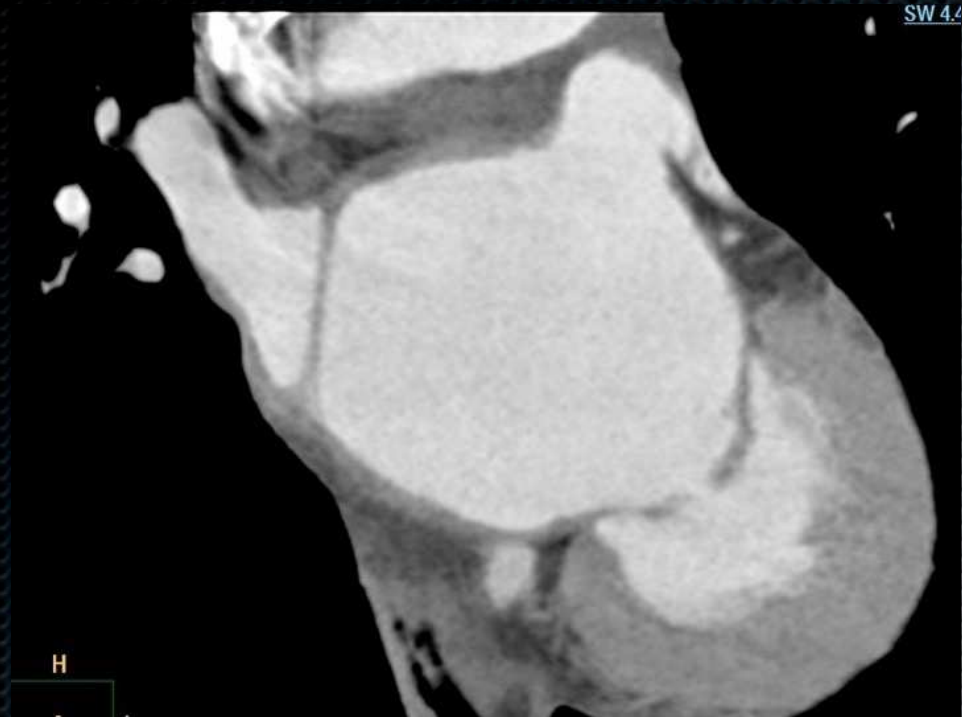


Schroeder S, et al. Cardiac computed tomography: indications, applications, limitations, and training requirements: report of a Writing Group deployed by the Working Group Nuclear Cardiology and Cardiac CT of the European Society of Cardiology and the European Council of Nuclear Cardiology. Eur Heart J (2008): 531-56

CARDIAC RESYNCHRONOUS THERAPY (CRT)



Shah SS, et al. Imaging of the coronary sinus: normal anatomy and congenital abnormalities. Radiographics (2012),32(4):991-1008





Valvular Anatomy

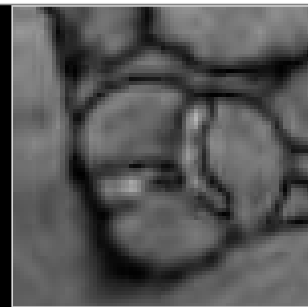
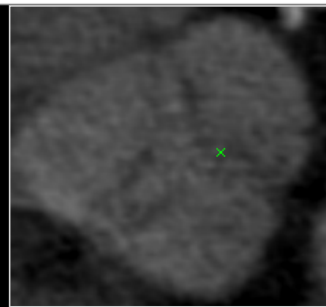
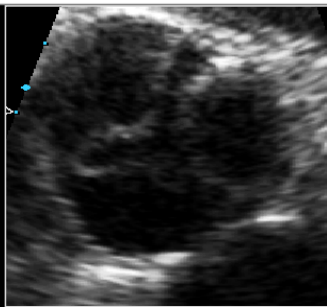


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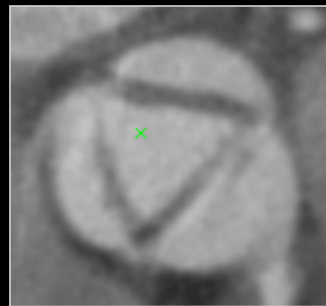
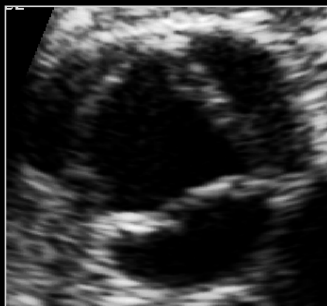
MDCT

MRI

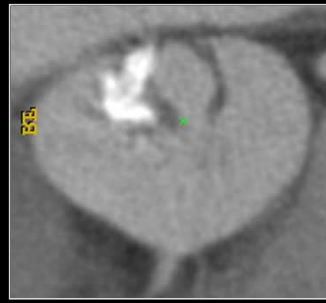
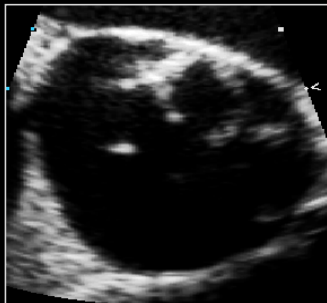
Aortic valve



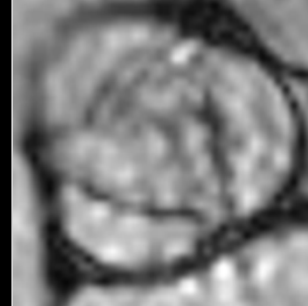
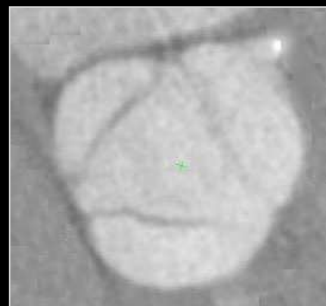
Stenotic
tricuspid



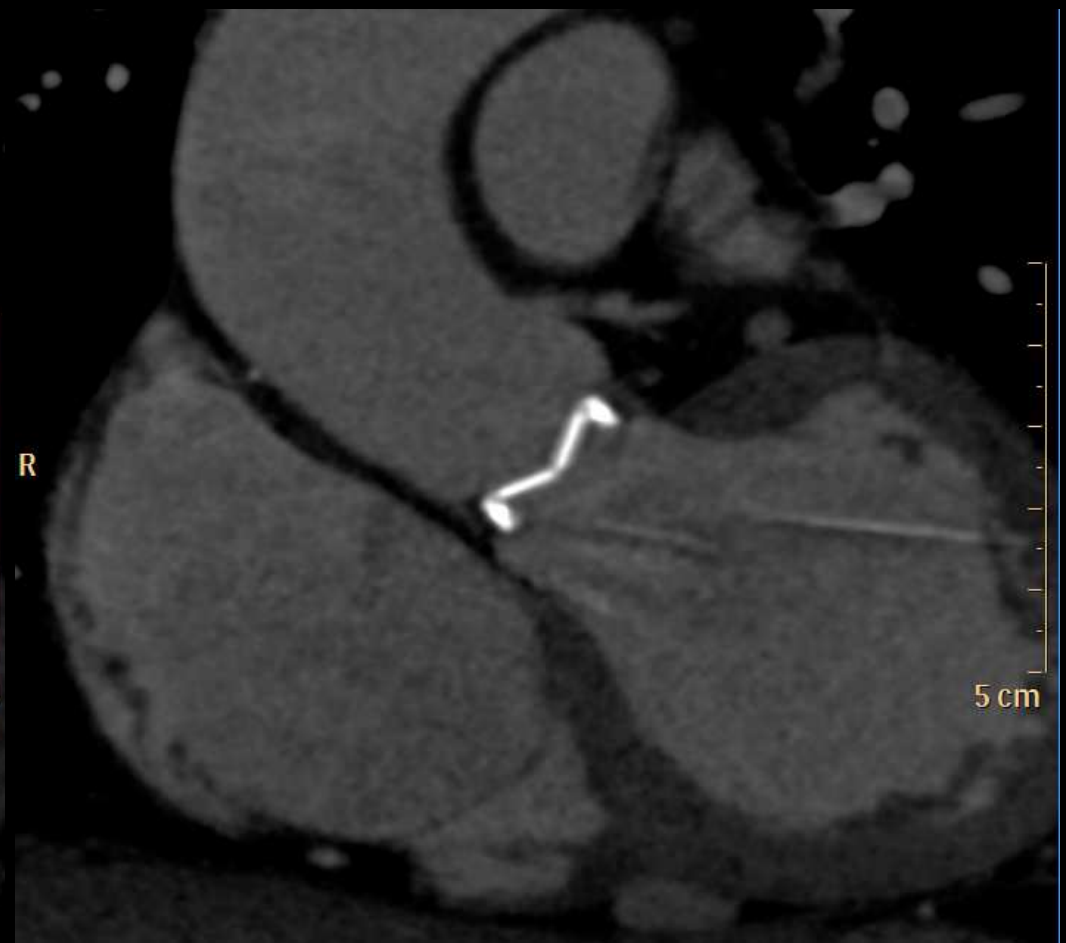
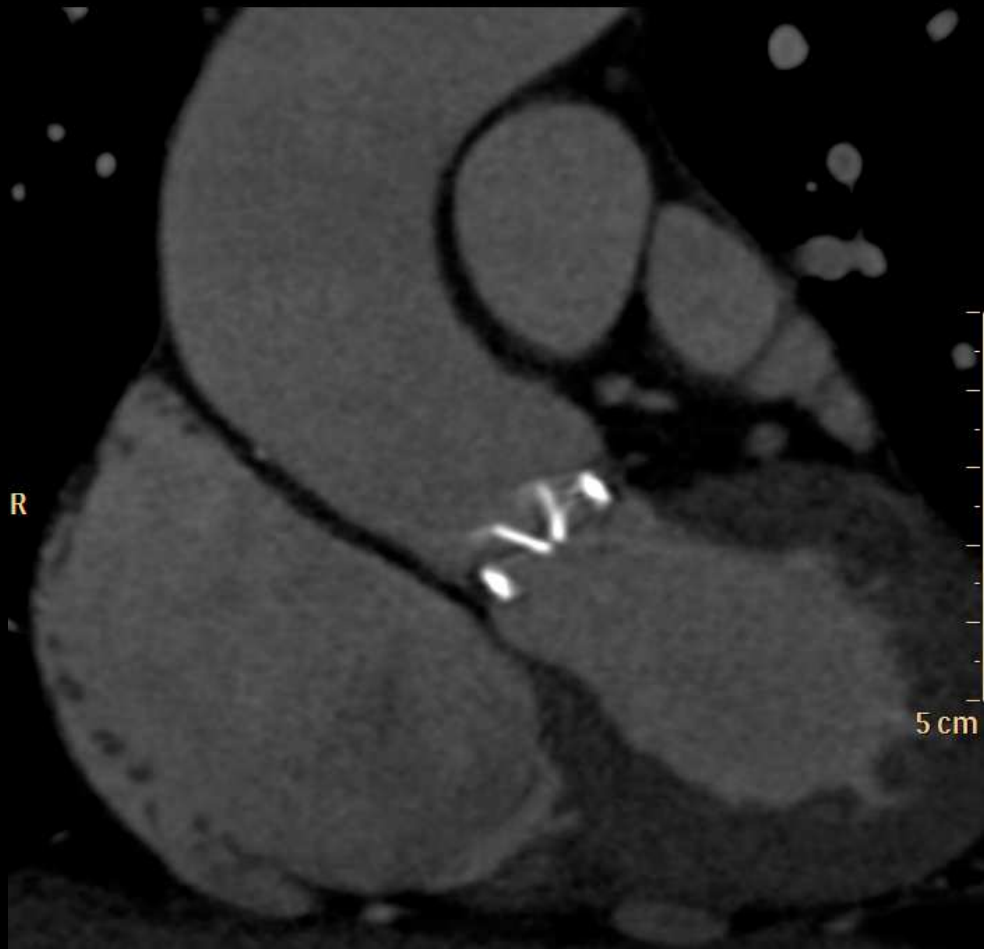
Mild stenotic
tricuspid



Stenotic bicuspid



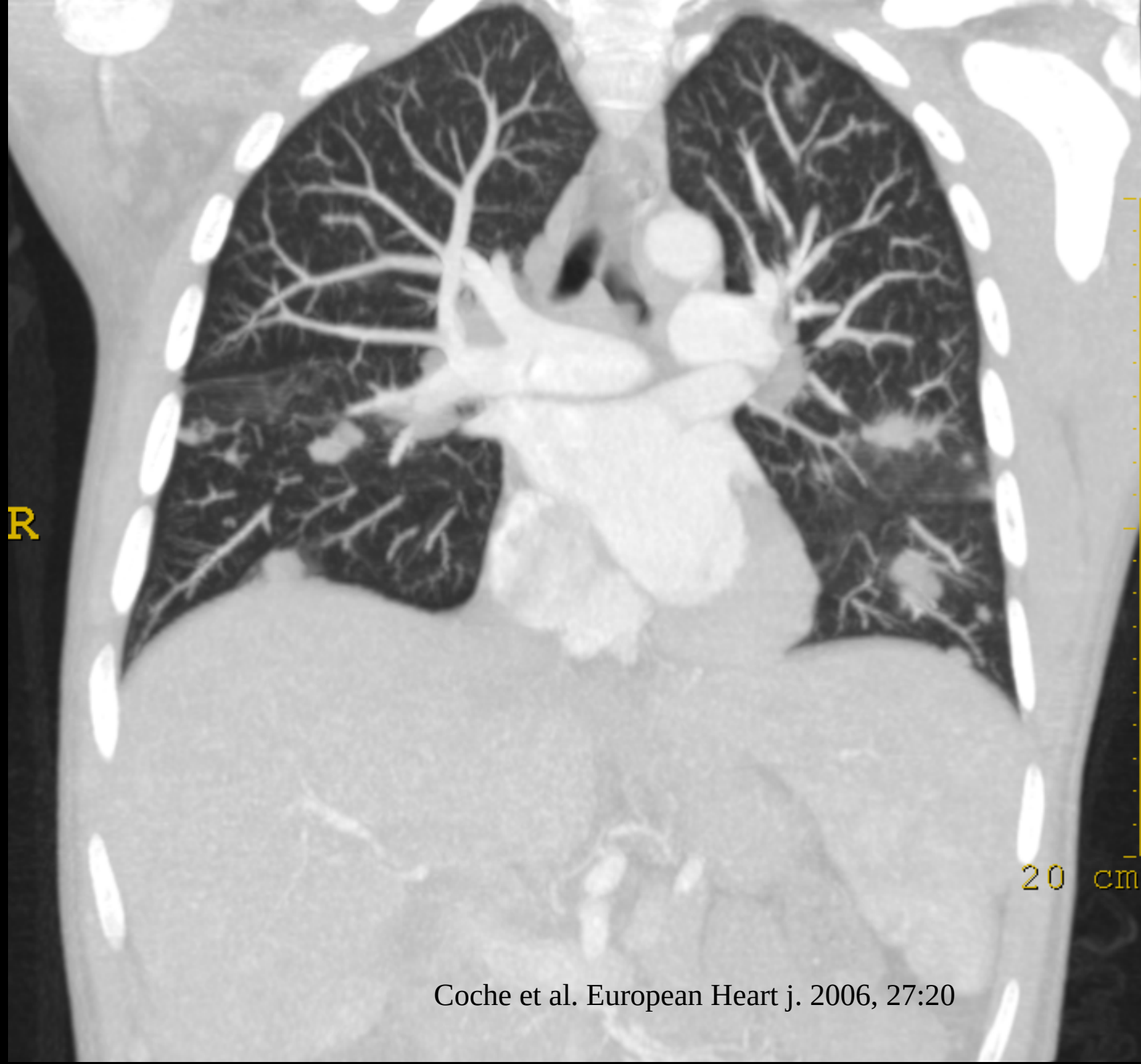
Normal tricuspid

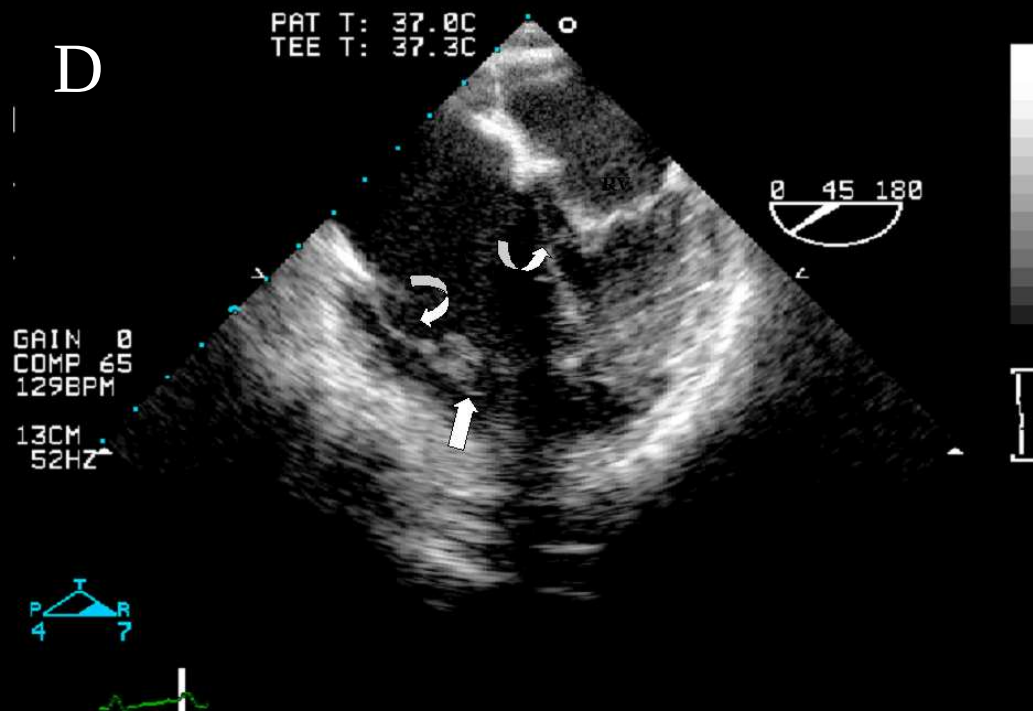
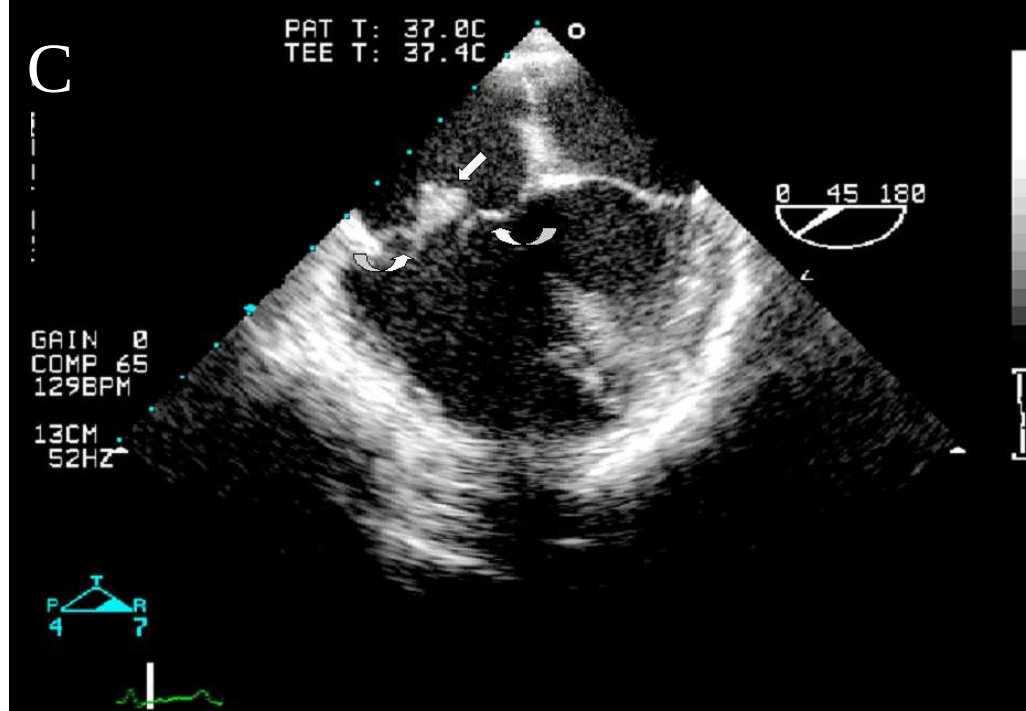
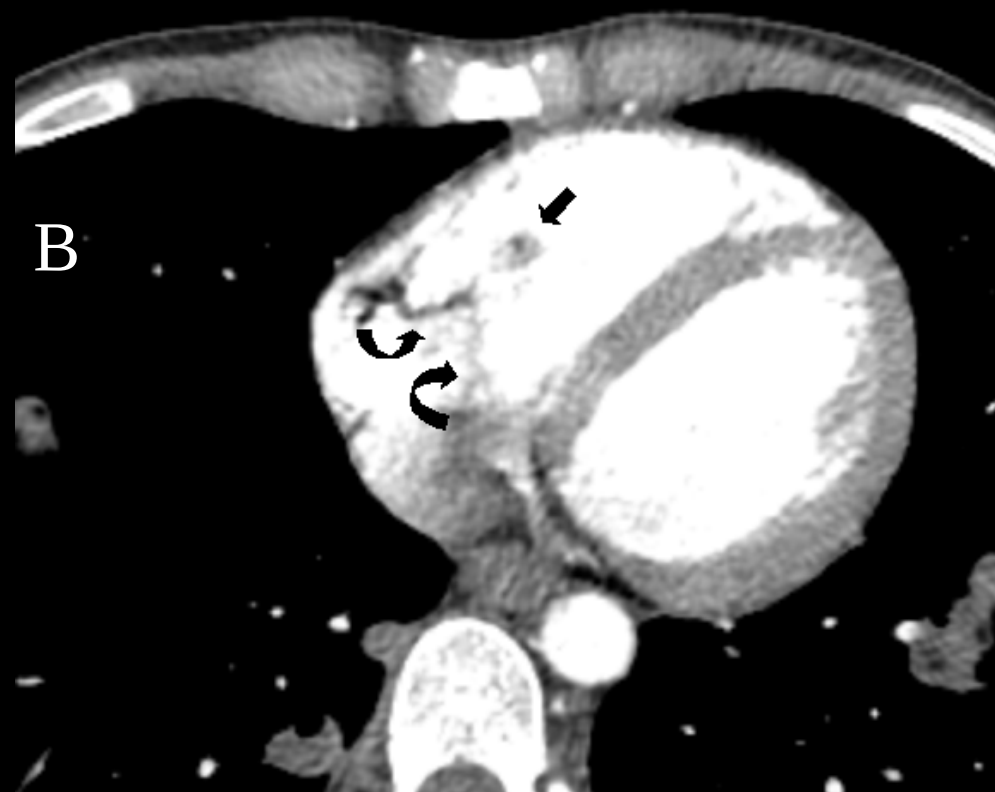
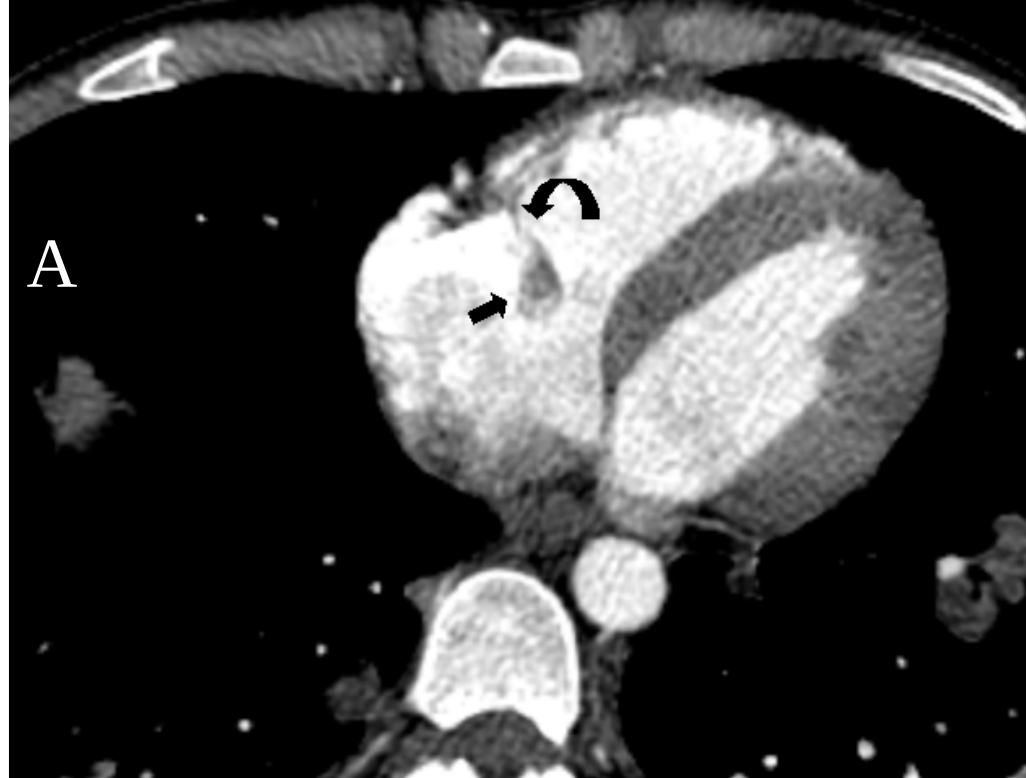


Excellent correlation between the planimetry assessed aortic valve areas in CT and transoesophageal echocardiography

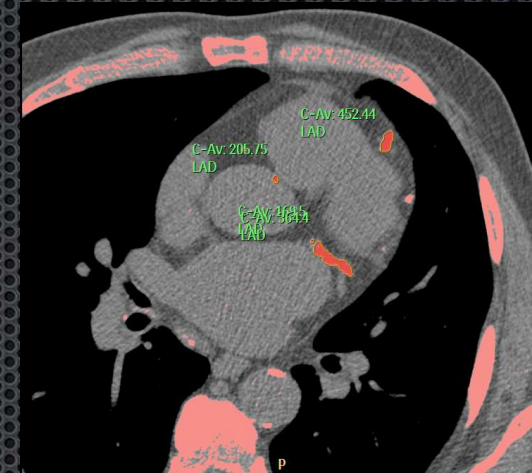
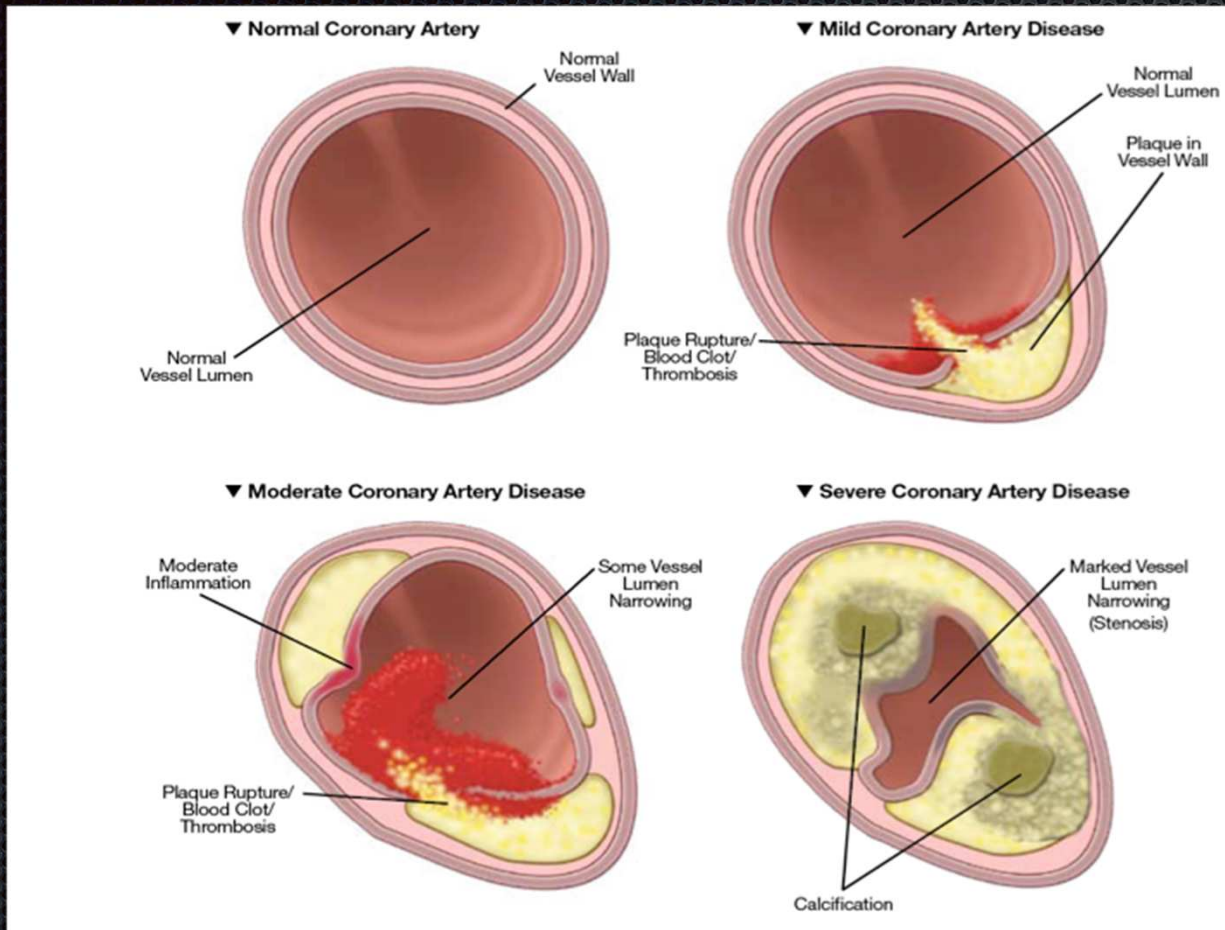
[Evaluation of anatomic valve opening and leaflet morphology in aortic valve bioprosthesis by using multidetector CT: comparison with transthoracic echocardiography.](#)

Chenot F, Montant P, Goffinet C, Pasquet A, Vancraeynest D, Coche E, Vanoverschelde JL, Gerber BL.
Radiology. 2010 May;255(2):377-85.





Coronary atherosclerotic plaque imaging



- Coronary Ca^{++} is a surrogate of the presence of coronary atherosclerotic plaque
- Absence of coronary calcium rule out significant artery stenosis with HPPV
- Large amount of calcium does not indicate the presence of significant stenoses

Coronary atherosclerotic plaque imaging

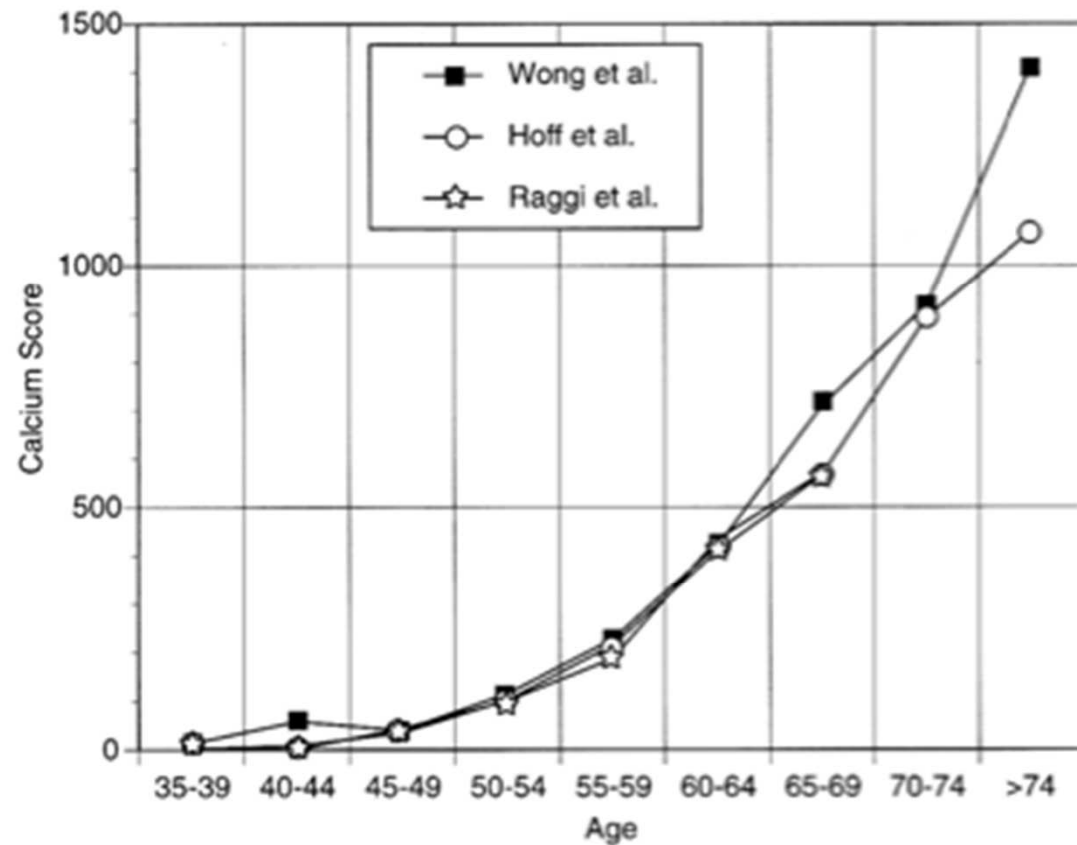
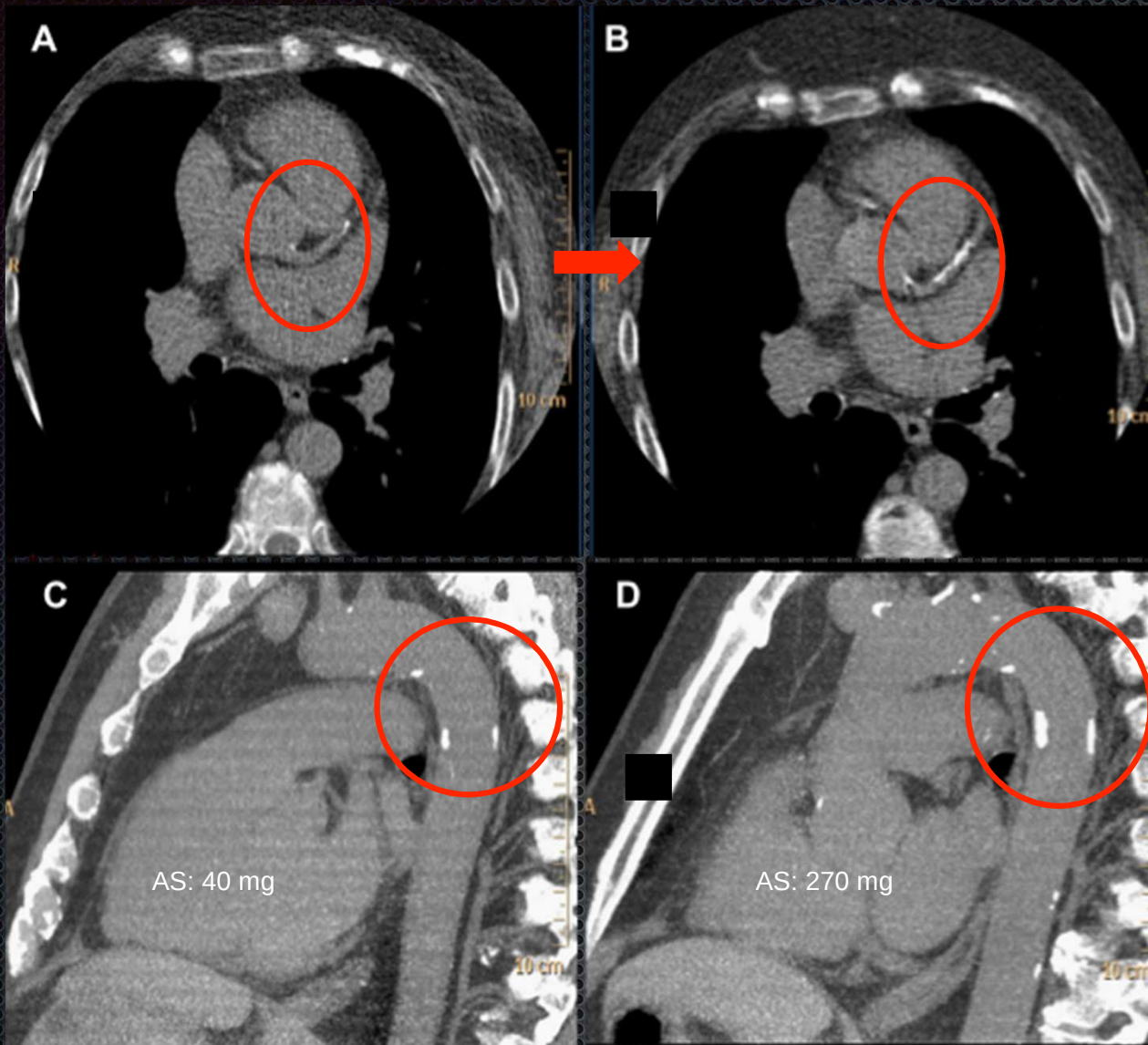


Table 21.1. Prevalence of coronary artery calcification detected by CT in asymptomatic men and women. Adapted from (JANOWITZ et al. 1993)

Age (years)	Asymptomatic	
	Men (%)	Women (%)
<29	11	6
30-39	21	11
40-49	44	23
50-59	72	35
60-69	85	67
70-79	94	89
80-89	100	100

Baseline

Follow-up



Calcium scoring
in patients with
intermediate
/high risks for
future
CAD events

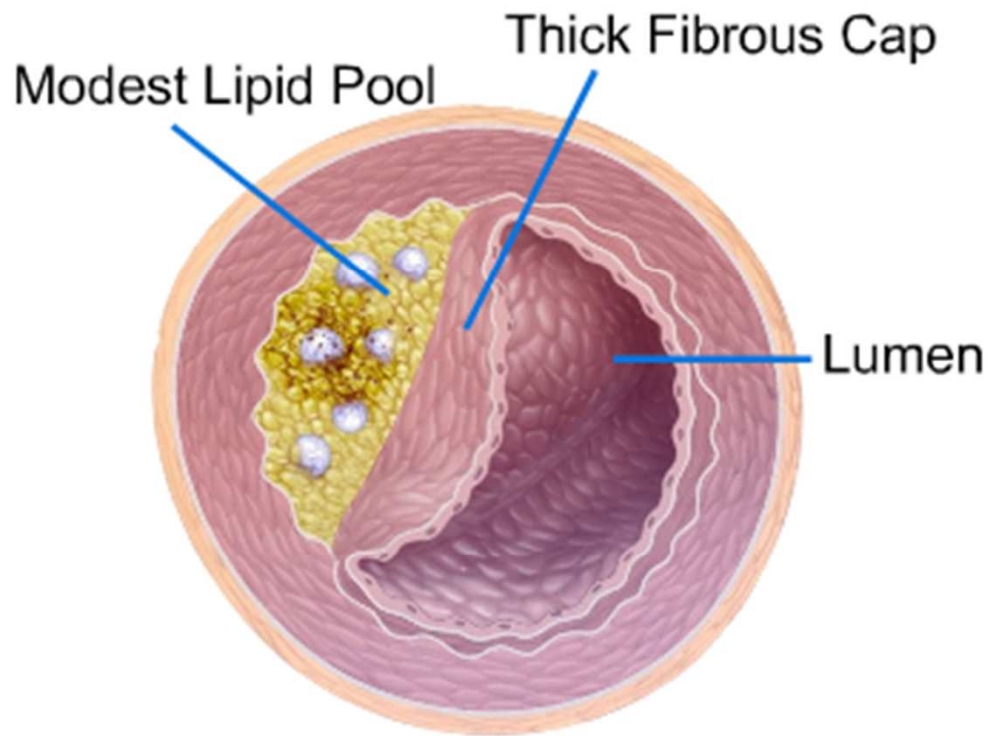
Am J Kidney Dis. 2011 Sep 22. [Epub ahead of print]

Progression of Coronary Artery Calcification and Thoracic Aorta Calcification in Kidney Transplant Recipients.

Maréchal C, Coche E, Goffin E, Dragean A, Schlieper G, Nguyen P, Floege J, Kanaan N, Devuyst O, Jadoul M.

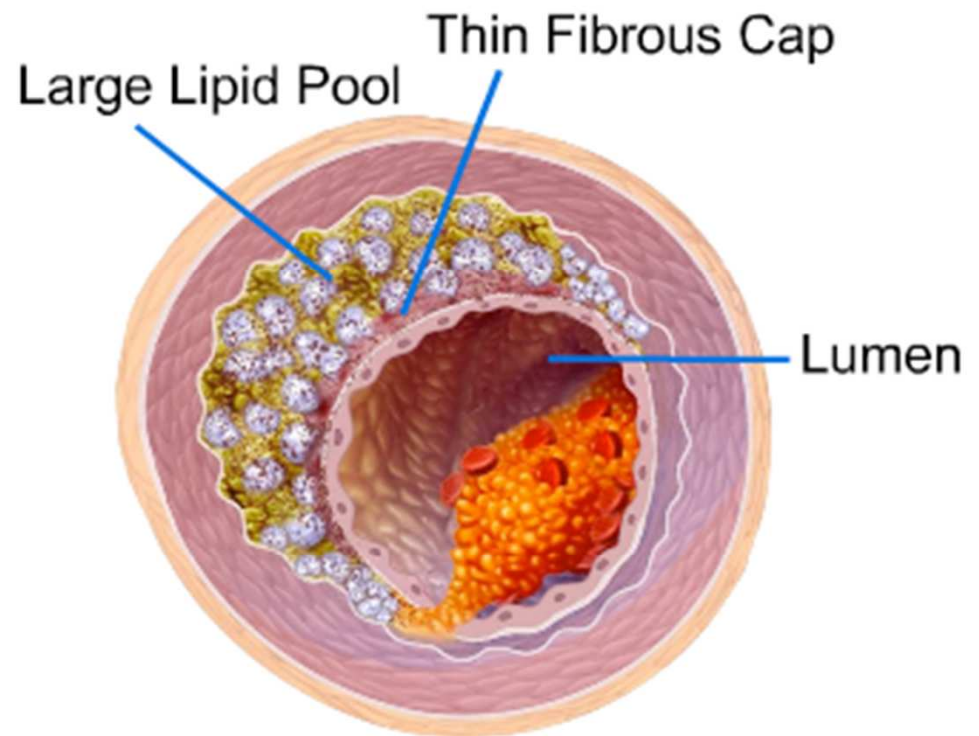
Division of Nephrology, Cliniques Universitaires Saint-Luc, Université catholique de Louvain Medical School, Brussels, Belgium.

Characteristics of a stable versus ruptured plaque



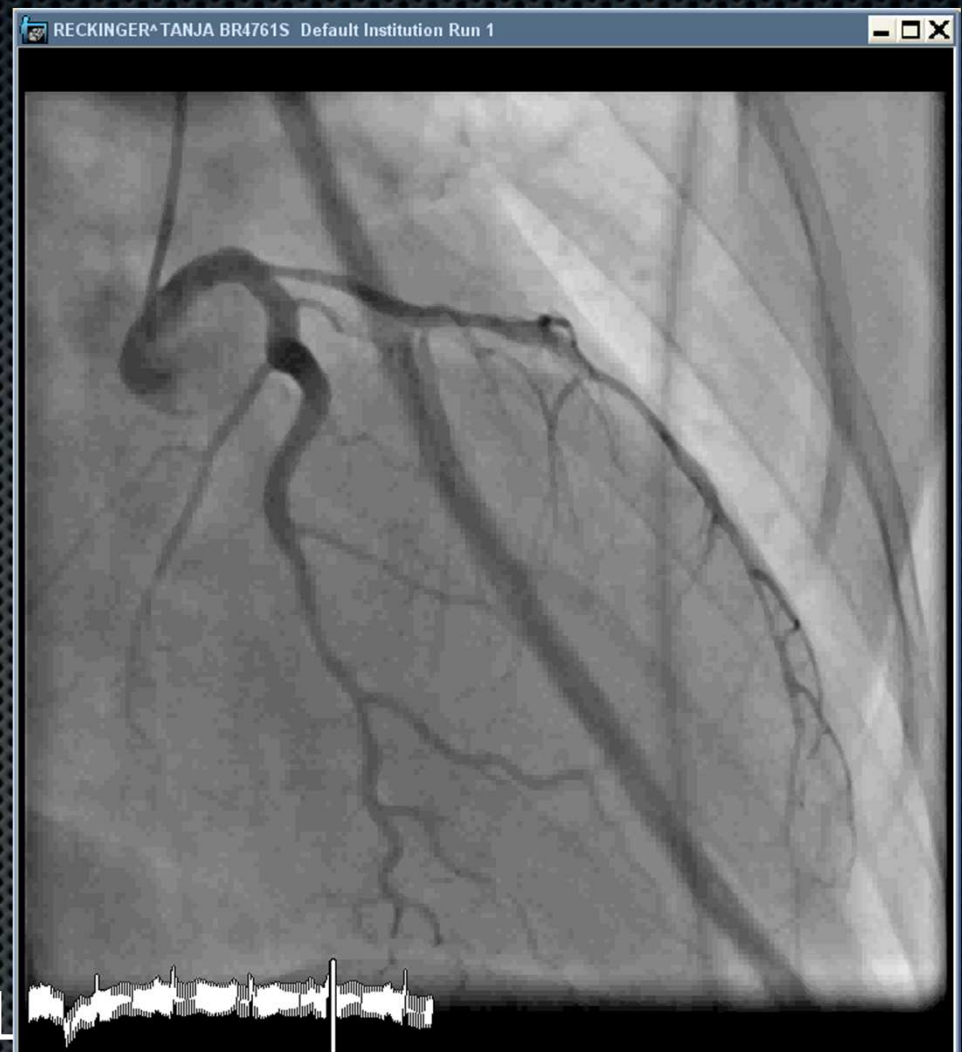
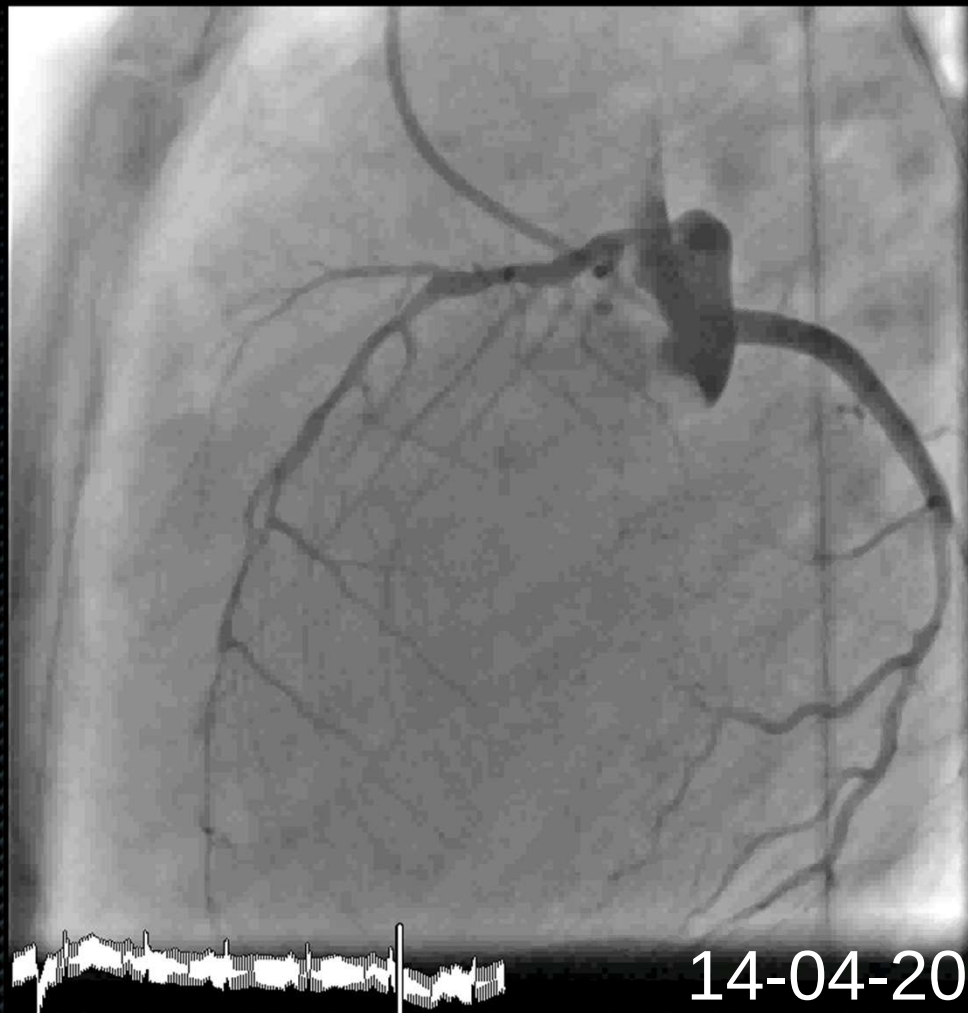
Stable Plaque

- ✓ May have significant stenosis
- ✓ Thick fibrous cap / high collagen content
- ✓ Modest lipid pool
- ✓ Few inflammatory cells



Ruptured Plaque

- ✓ May have minimal stenosis
- ✓ Thin fibrous cap / low collagen content
- ✓ Large lipid pool
- ✓ Many inflammatory cells



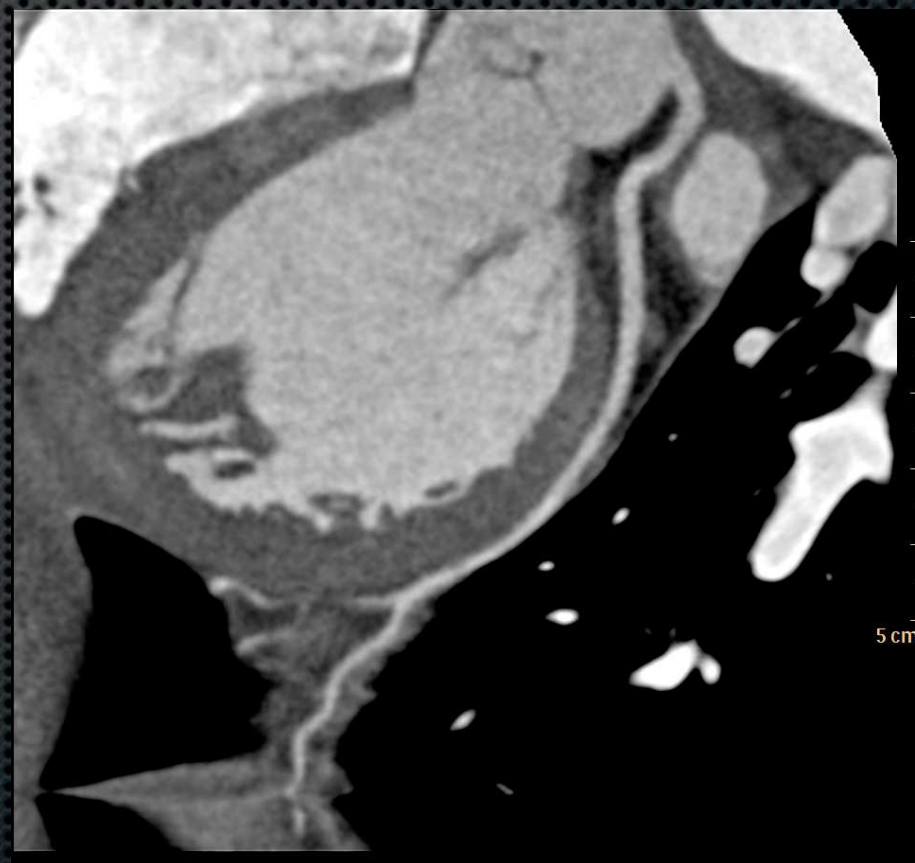
39-year-old woman admitted for major cardiac failure (Ejection fraction: 46%)
Aortic assistance (counterpulsation)
Past Medical History; headaches treated by Methergine
1 month post partum (Tocolysis, methylergometrine)

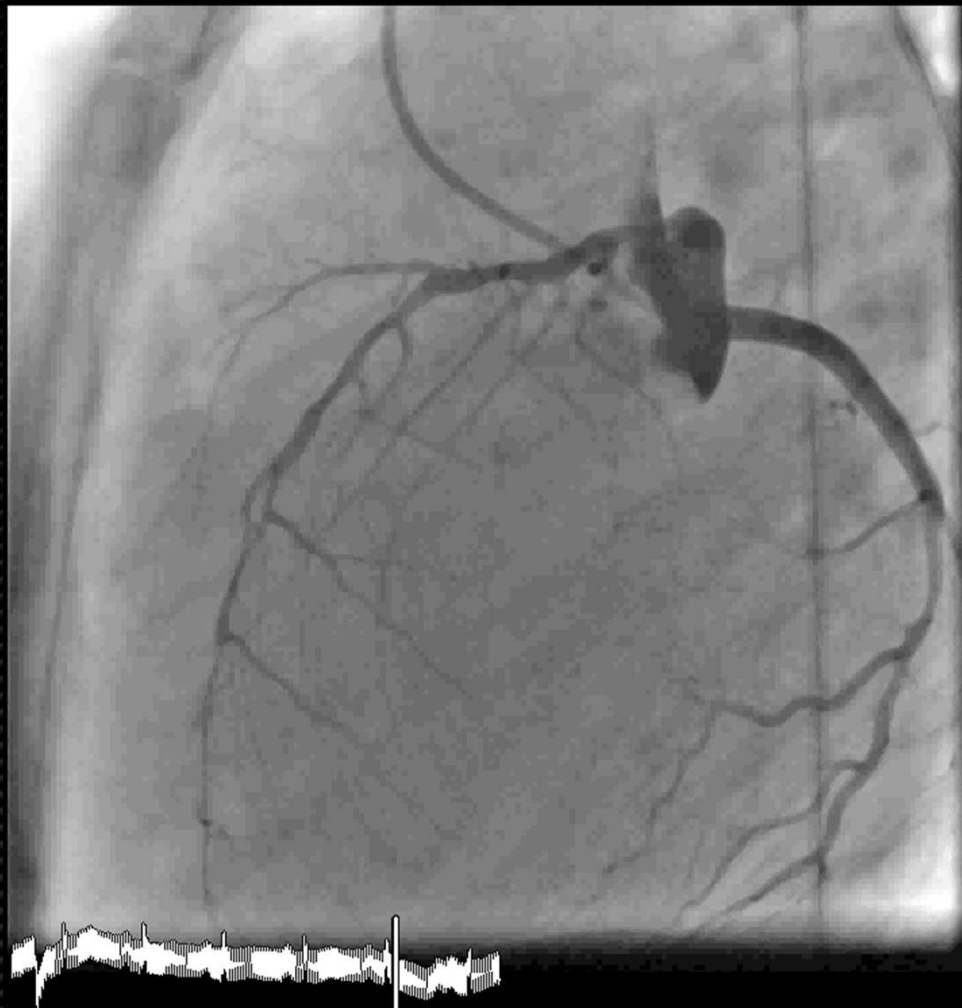


RCA

LAD

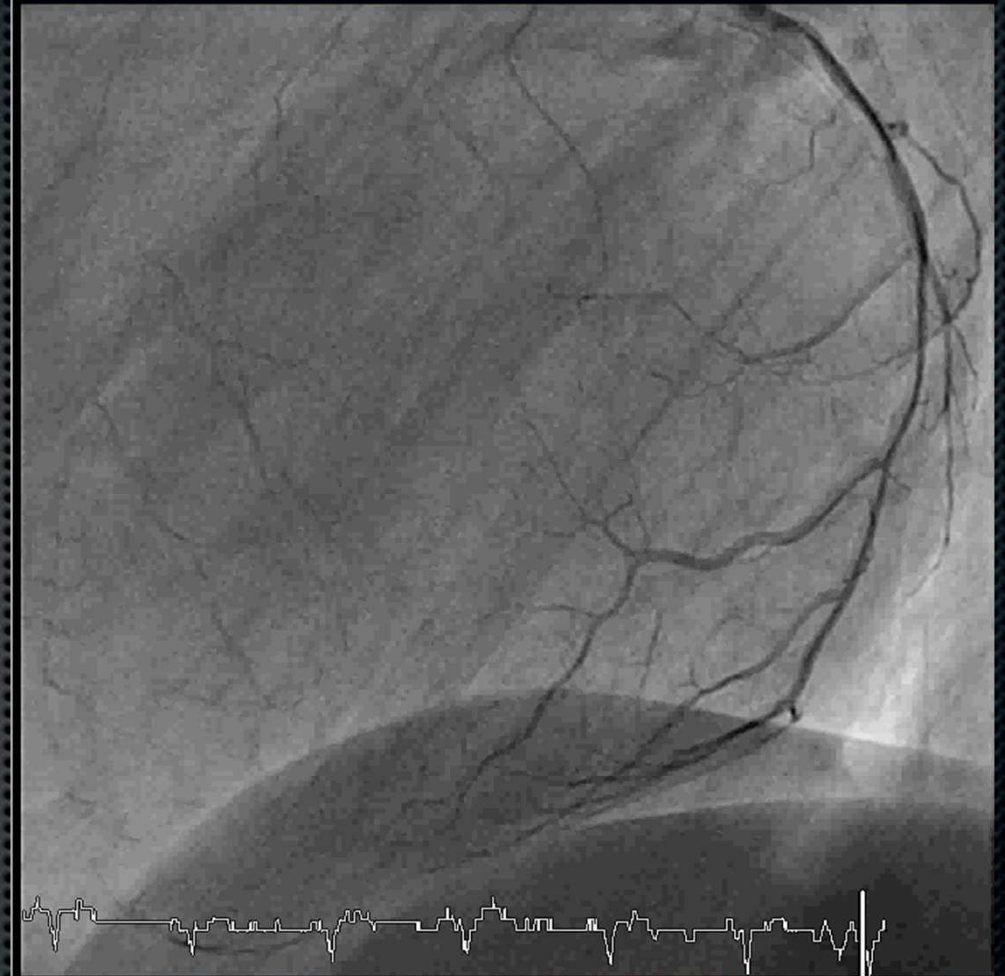
04-2011





14-04-2011

Baseline angiography



05-11-2011

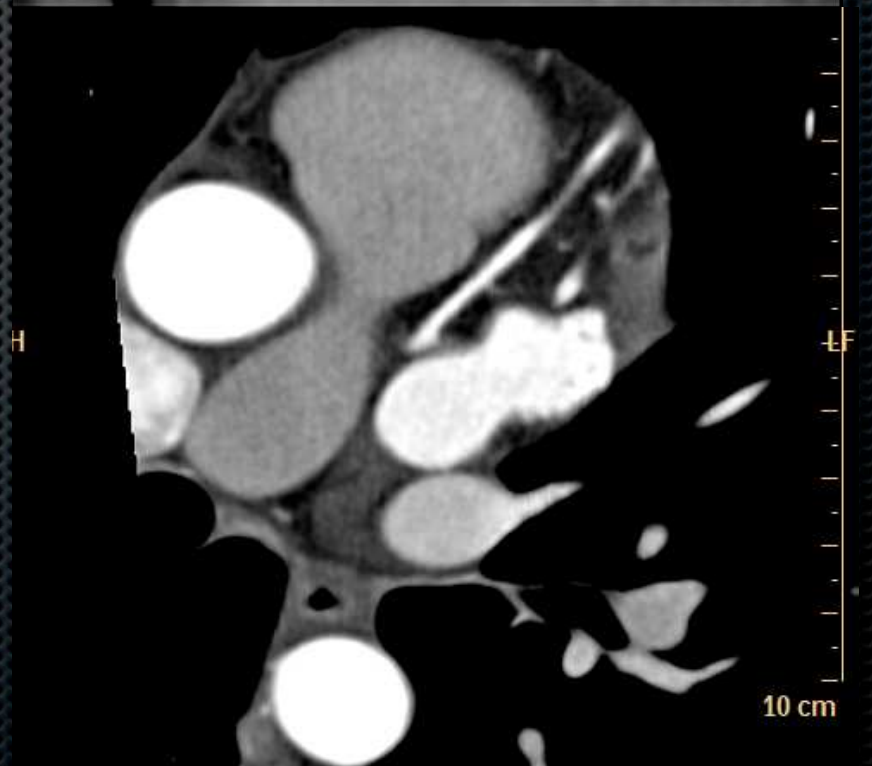
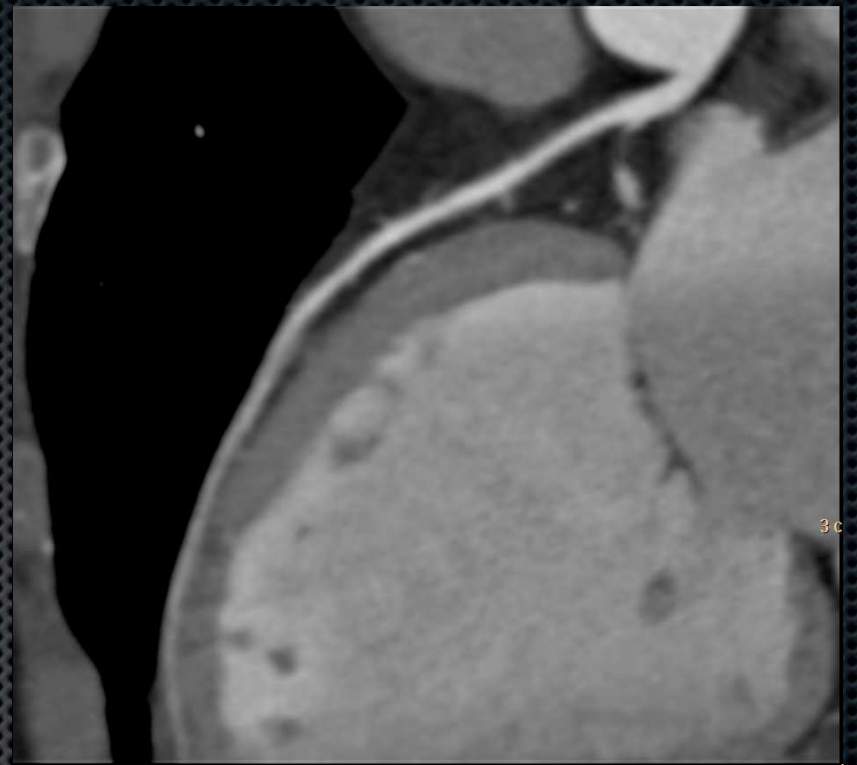
After corticosteroid
treatment

Baseline MDCT



After corticosteroid treatment







Biopsy: no vasculitis

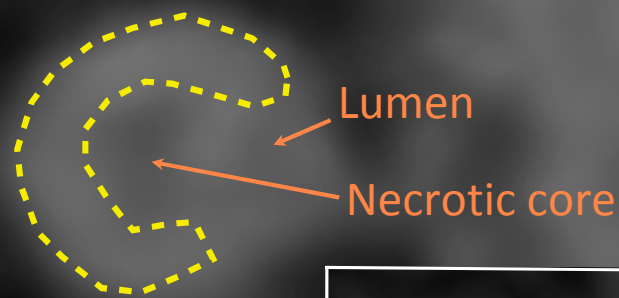
MDCT aorta: no evidence of other vascular diseases

Plaque Pattern Analysis

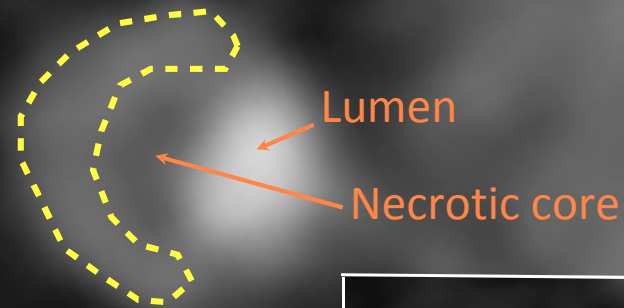
Mapping

non-contrast CT

A

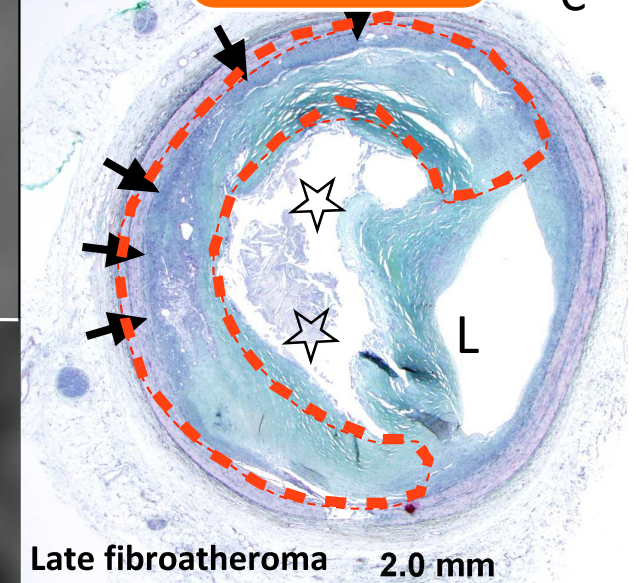


contrast enhanced CT

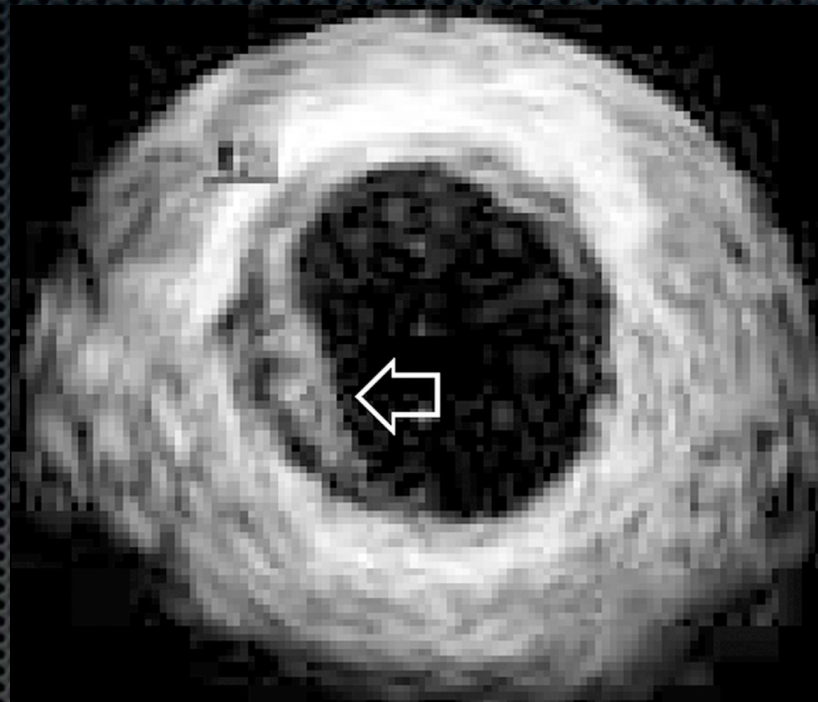
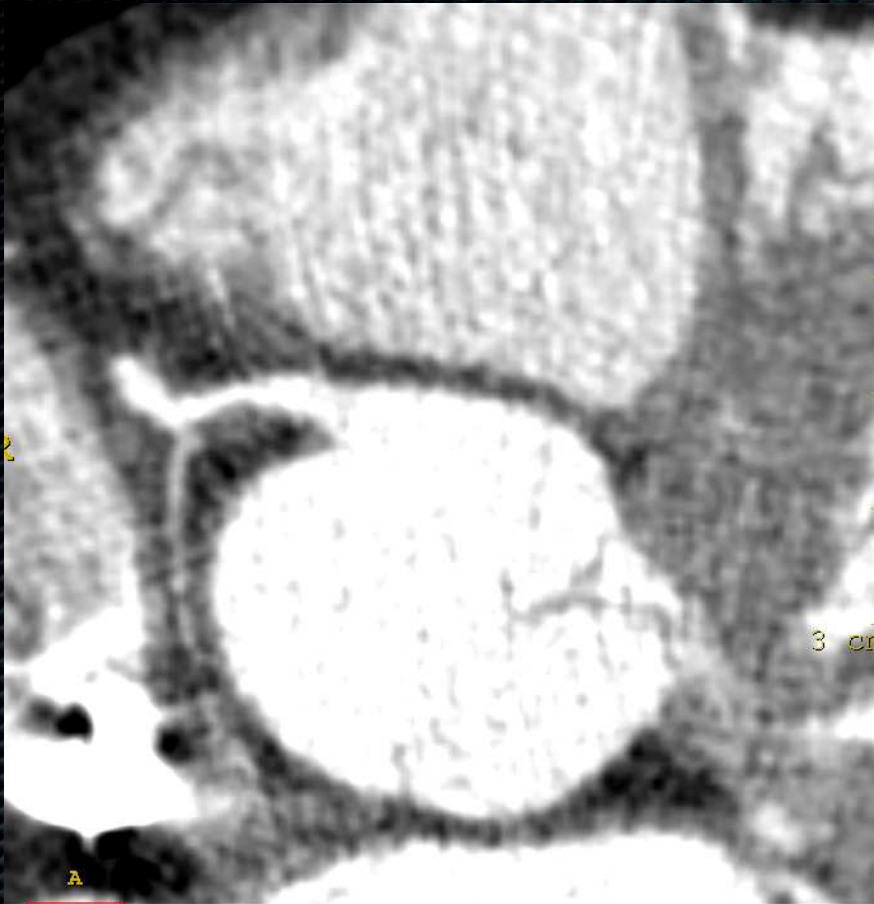


histology

C



“The Napkin-ring sign in CCTA images is associated with high risk plaque features.”



$r = 0,91$

- MDCT is able to detect and quantify atherosclerotic plaque
- Further improvement in CT resolution is necessary for more reliable assessment of very small and distal coronary plaques

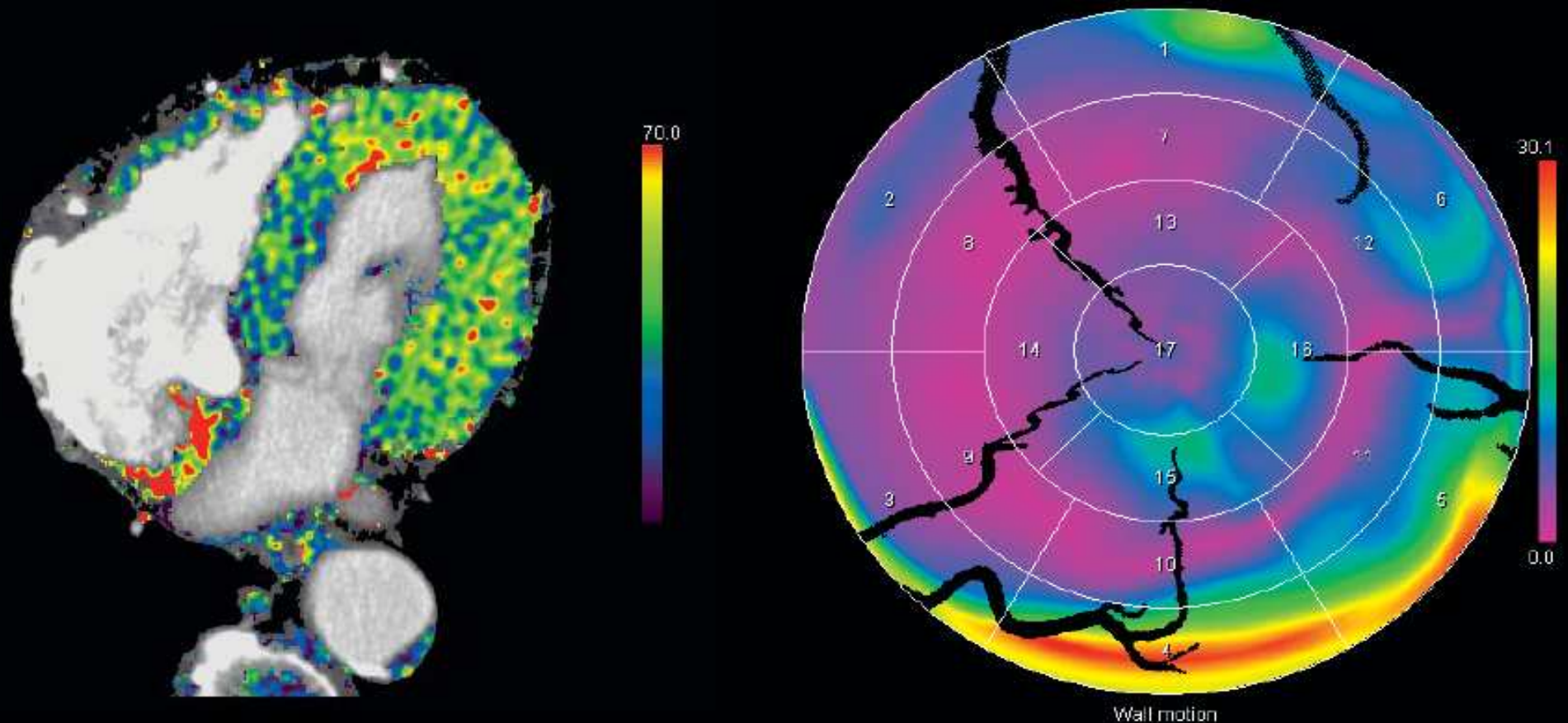
Papadopoulou SL, et al. Detection and quantification of coronary atherosclerotic plaque by 64-slice multidetector CT: a systematic head-to-head comparison with intravascular ultrasound. *Atherosclerosis* (2011);219:163-170

	Lumen	Vessel	Wall
Area	6.2 mm ²	17.8 mm ²	11.5 mm ²
Max. Diam./Thickness	3.0 mm	4.7 mm	2.3 mm
Min. Diam./Thickness	2.1 mm	4.2 mm	0.2 mm
Effective Diam.	2.8 mm	4.8 mm	
Eccentricity	0.29	0.11	0.93
HU (Mean/STD)	406.2 HU/118.6 ...	393.8 HU/247.3 ...	387.2 HU/2...
Burden			65 %
Position	23.3 mm		

CT viability and perfusion

- Assessment of myocardial viability and myocardial perfusion plays a critical role in CAD evaluation and management (prognostic indicator)
- 91% sensitivity, 79% specificity, 83% accuracy for the CT detection of myocardial infarct
- Good correlation between dual energy CT and SPECT nuclear myocardial perfusion imaging to detect decrease in myocardial blood supply

Myocardial Perfusion



From Siemens: Dual Flash MDCT

Additional value of dipyridamole stress myocardial perfusion by 64-row computed tomography in patients with coronary stents.

Magalhães TA, Cury RC, Pereira AC, Moreira Vde M, Lemos PA, Kalil-Filho R, Rochitte CE.

Abstract

BACKGROUND: Coronary computed tomography angiography (CTA) is a well-established diagnostic tool for coronary artery disease (CAD). However, coronary segments with prior stent implantation visualized with CTA may have limited evaluation and reduced accuracy.

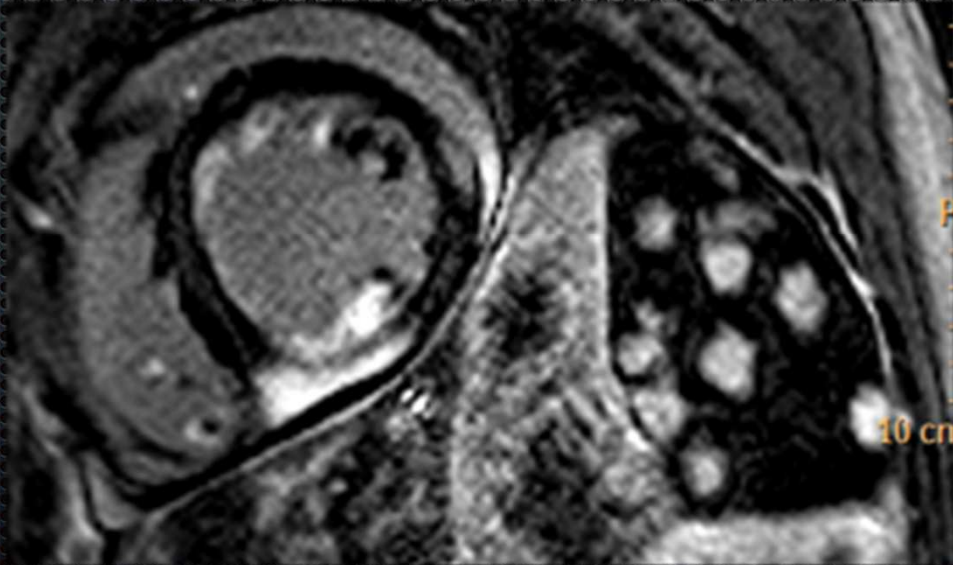
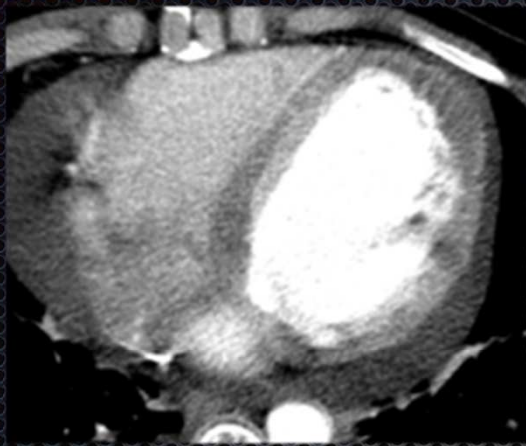
OBJECTIVE: We assessed the incremental value of stress myocardial CT perfusion (CTP) over anatomical assessment by coronary CTA alone in patients with stents, using quantitative invasive coronary angiography ($\geq 50\%$) as reference.

METHODS: Forty-six patients (56.9 ± 7.2 years; 28 men) referred to invasive coronary angiography were evaluated, combining coronary CTA and dipyridamole stress myocardial CTP with 64 detector-row CT. Coronary CTA was evaluated for $\geq 50\%$ coronary stenosis, and myocardial CTP was used to potentially reclassify coronary territories, including those with stents and poorly evaluated stents because of artifacts.

RESULTS: We evaluated 138 coronary territories, 62 with ≥ 1 stent. From these, 21 (34%) territories had adequately evaluated stents, 28 (45%) had limitedly evaluated stents still allowing diagnosis, and 13 (21%) had inadequately evaluated stents (no luminal assessment possible). Sensitivity, specificity, positive predictive value, negative predictive value and accuracy for coronary CTA in stent territories were, respectively, 85%, 77%, 87%, 74%, and 81%, and the combined use of coronary CTA and myocardial CTP were 88%, 95%, 97%, 81%, and 91% ($P = 0.0292$). In territories with impaired stent evaluation (limited or inadequate), the diagnostic performance of coronary CTA alone was 83%, 72%, 79%, 76% and 77%, and combined with myocardial CTP were 87%, 94%, 95%, 85%, and 91% ($P = 0.036$).

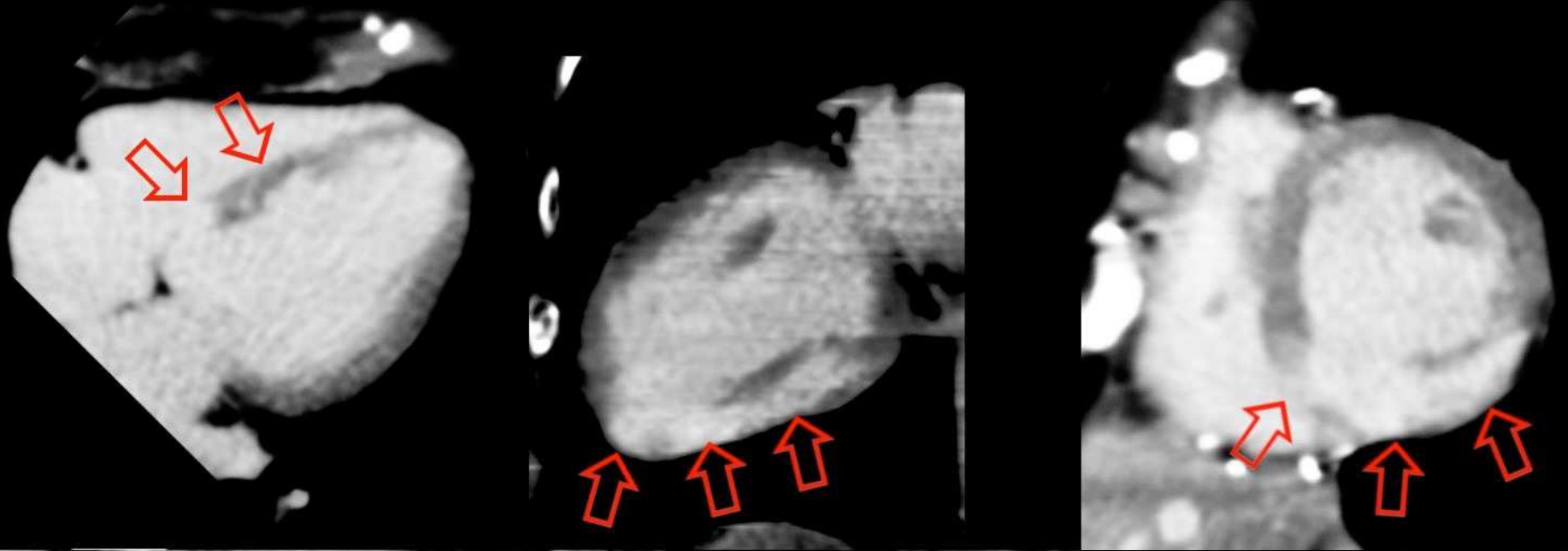
CONCLUSION: The combined evaluation of coronary CTA and stress myocardial CTP improved the diagnostic accuracy for the detection of significant obstructive CAD in patients with stents.

Cardiac Sarcoidosis



Cardiac Viability: late enhancement

CT



MR



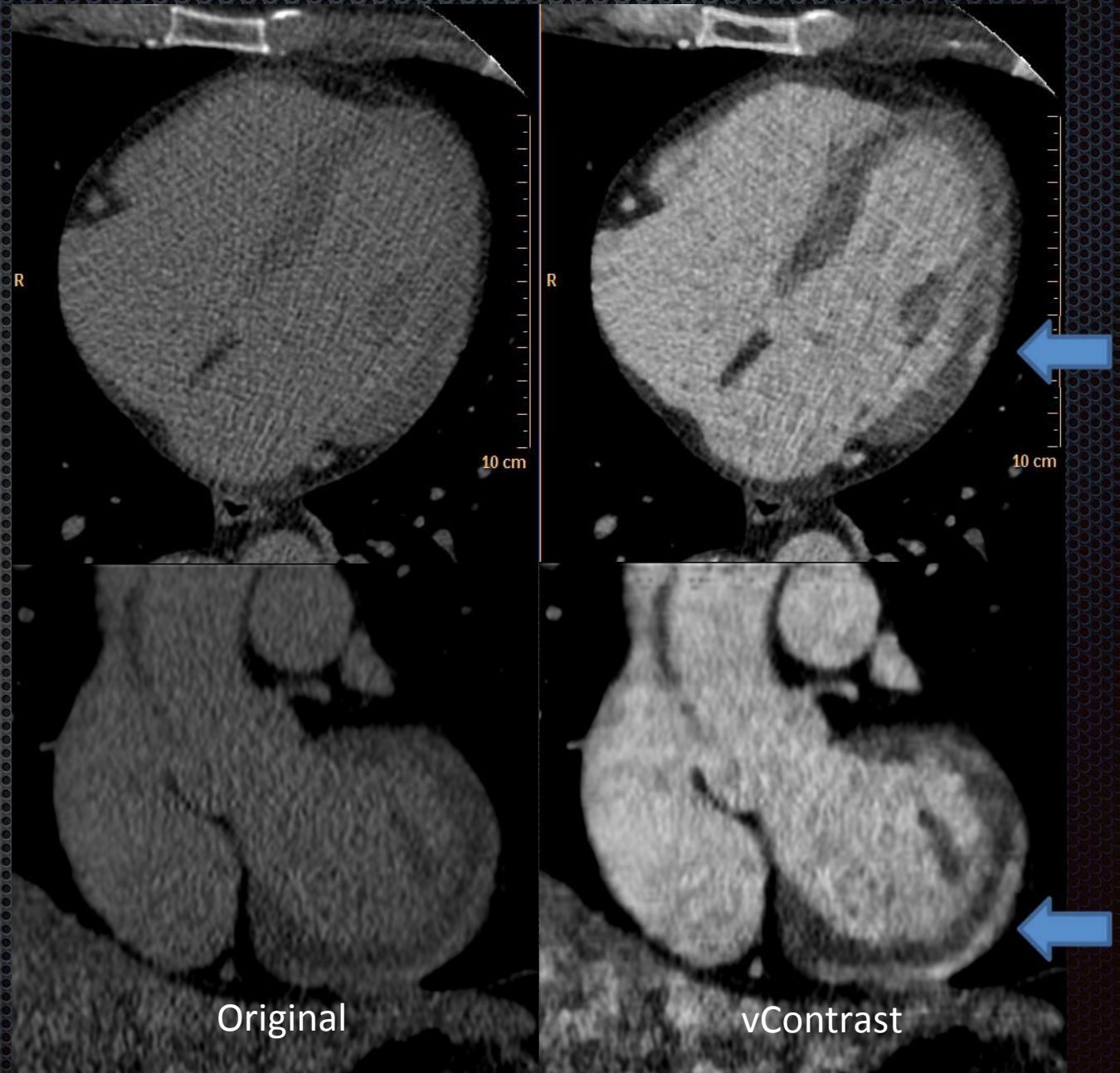
MI: 11 months

Cardiac Viability: vContrast

Cardiac CT: Viability Assessment



Late Myocardial Enhancement



Original

vContrast

➡ Non viable tissue

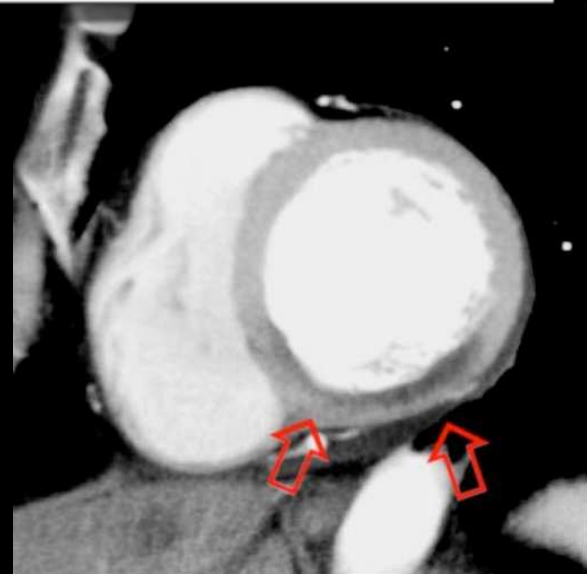
Image Courtesy, Prof. Douek, CHU L.Pradel, Lyon

Cardiac Viability: late enhancement

CT



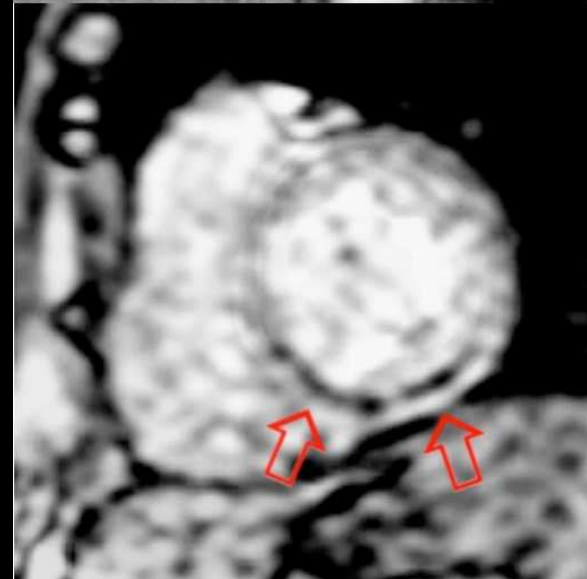
CT



MR



MR



Gerber et al. Circulation. 2006 Feb 14;113(6):823-33.

Characterization of acute and chronic myocardial infarcts by multidetector computed tomography: comparison with contrast-enhanced magnetic resonance.

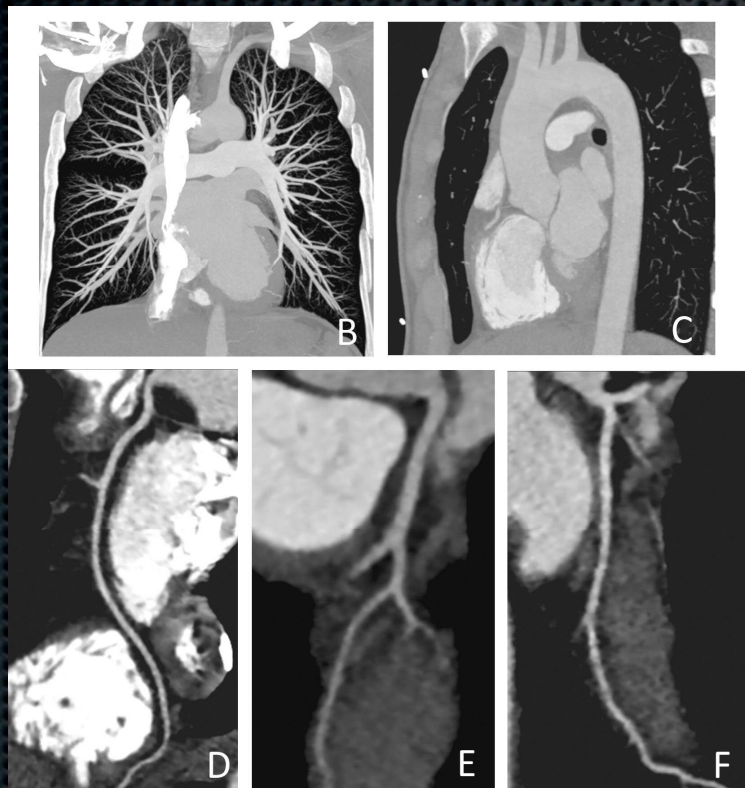
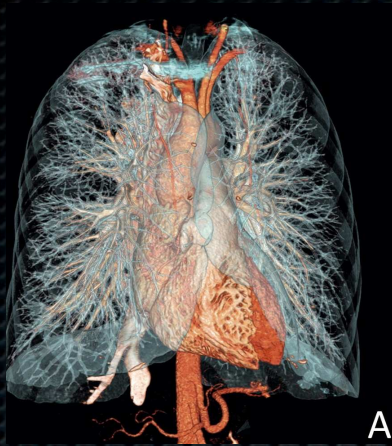
Acute Myocardial infarct: 10 days

Acute Myocardial infarct: 2 days

Integrated cardio-thoracic imaging

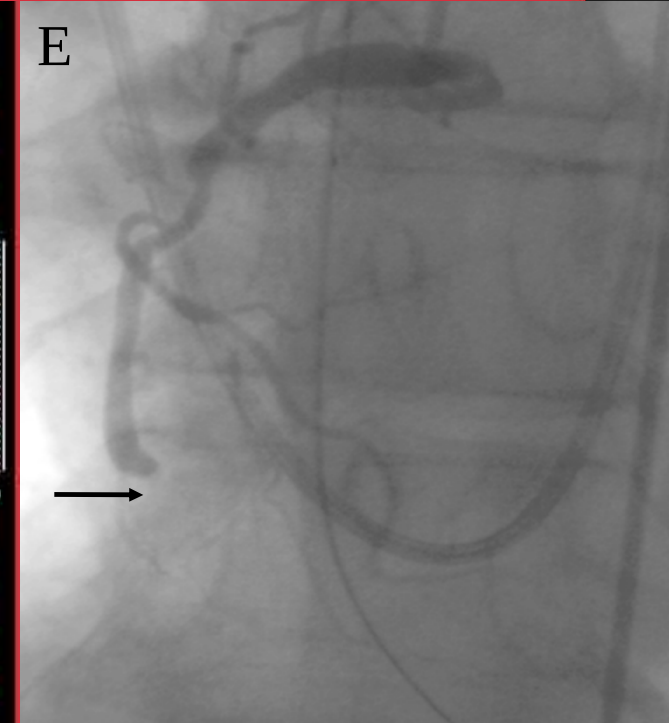
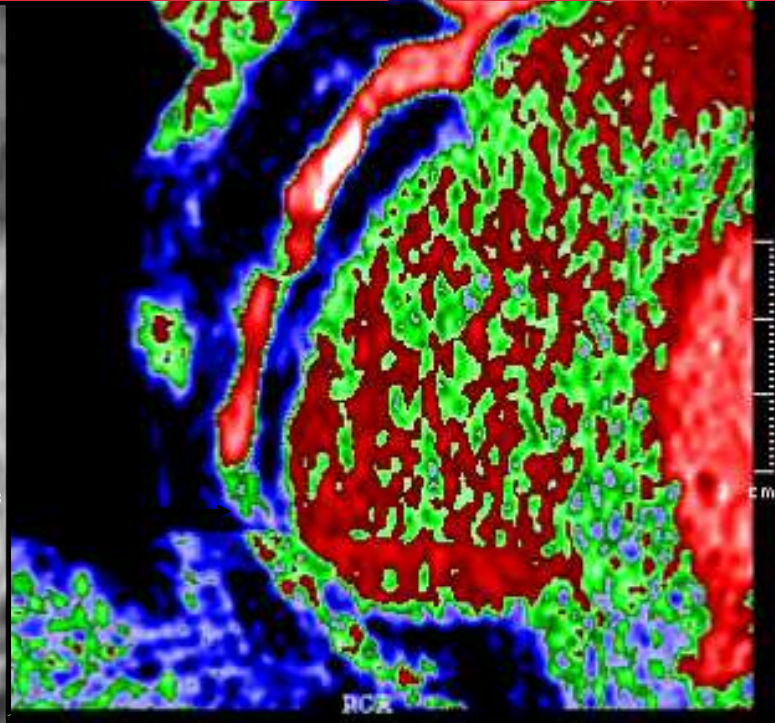
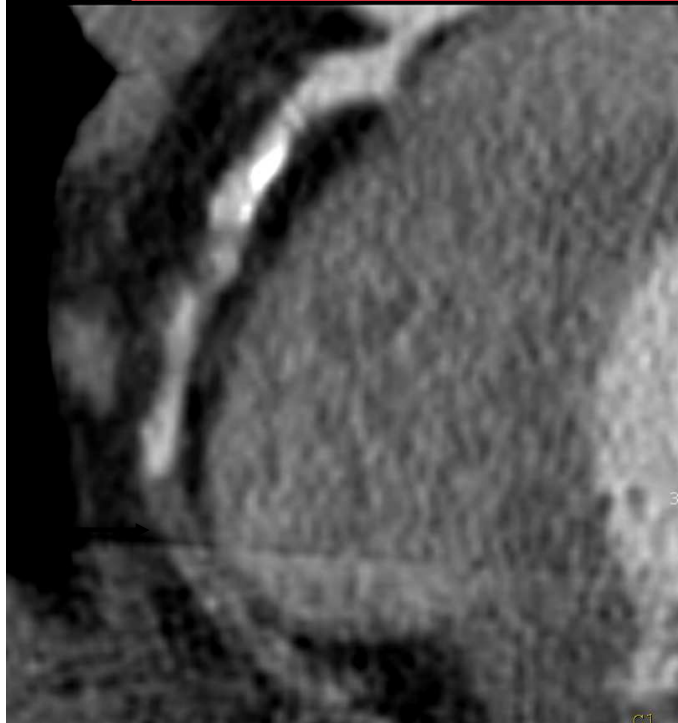
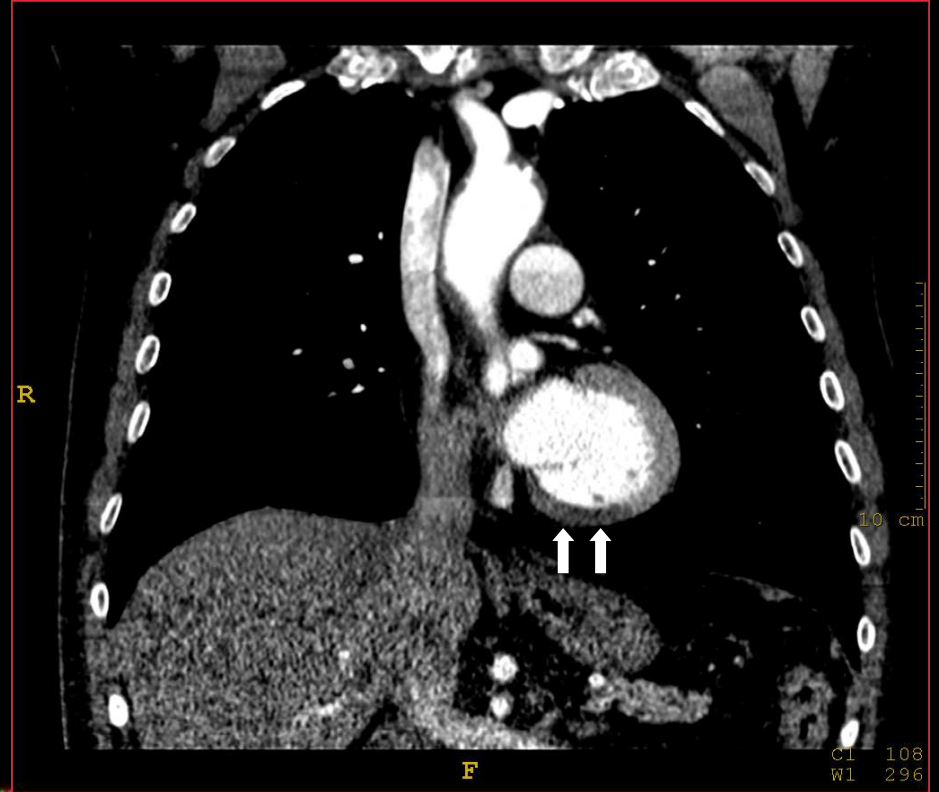
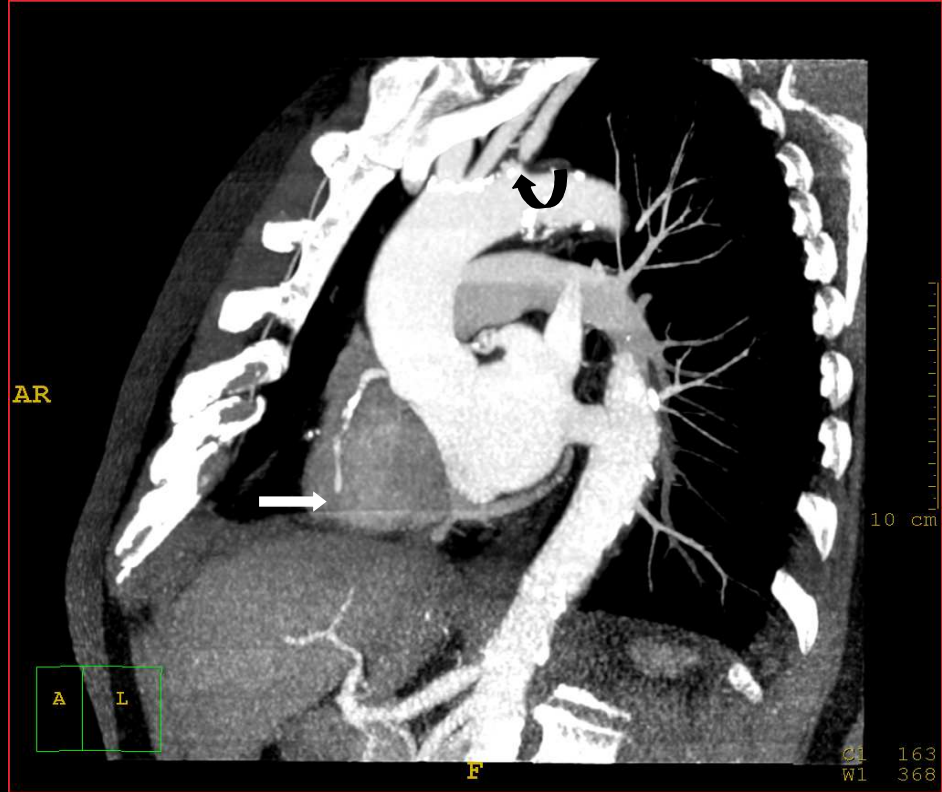
- The heart is between the lungs
- Strong interaction between those 2 structures
- Assessment of underlying respiratory disease and cardiac function from the same data set was achievable in 92% of patients with ECG-gated 64-slice MDCT
- Triple rule out protocol

High pitch dual spiral

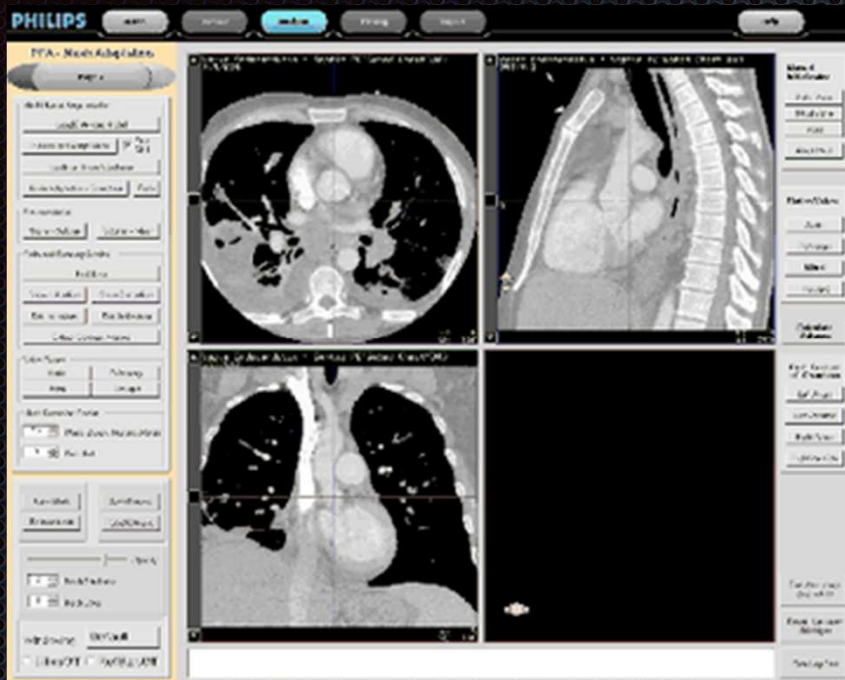


- o Dual –source CT : Somatom Definition Flash (Forchheim, Germany)
- o 2 x 100 kV- 2 x 120 kV (BMI>30)
- o 370 mAs-320 mAs (BMI>30)
- o Pitch: 3.8/ECG synchronization
- o 53 patients with chest pain
- o Scan time: 0.8 ± 0.1 sec
- o 3.8% of coronary arteries non analysable
- o radiation dose: 3.8 ± 0.1 mSv
- o Treshold for protocol: 65 bpm

Bamberg F, et al. Diagnostic image quality of a comprehensive high pitch dual-spiral cardiothoracic CT protocol in patients with undifferentiated acute chest pain. Eur J.Radiol. (in press)

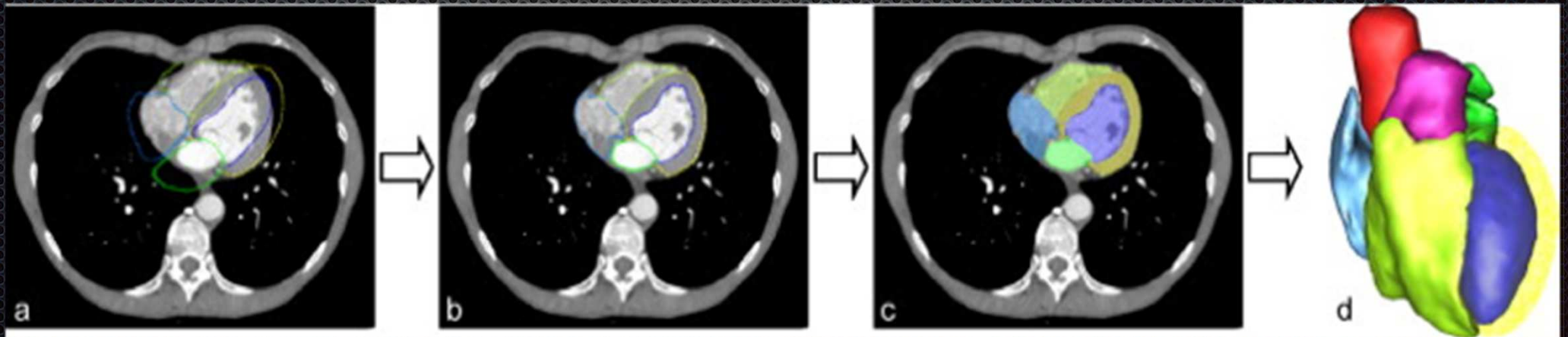


Cardiac Function

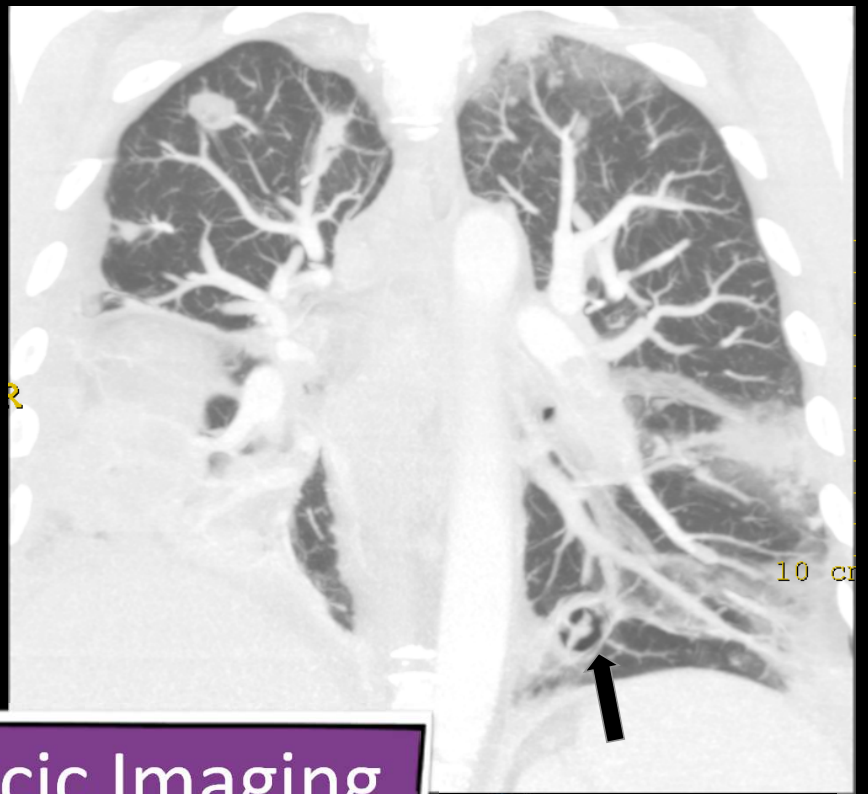
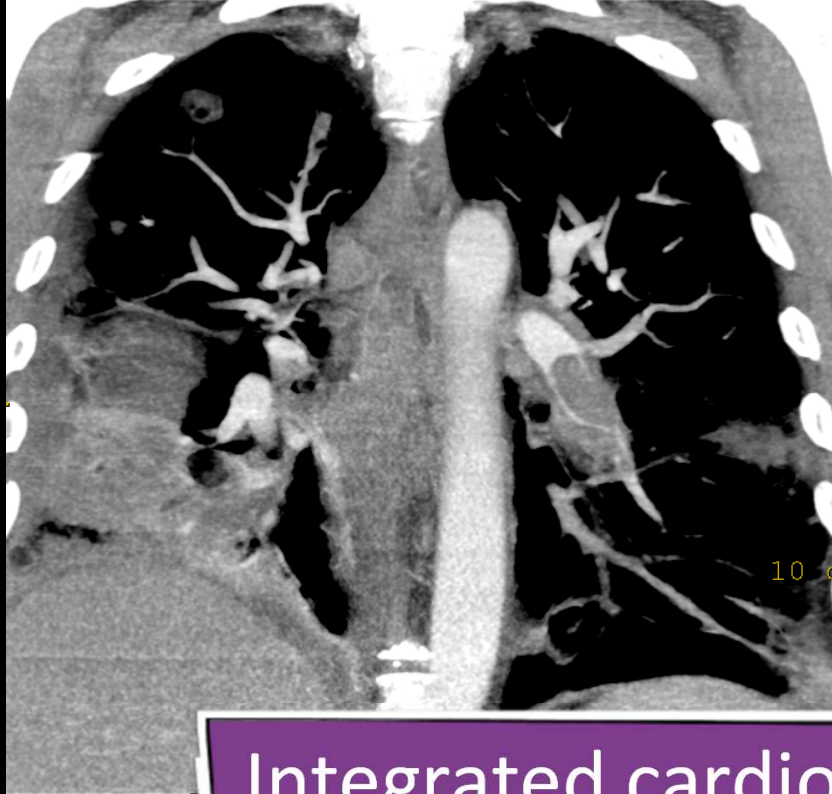


30 seconds for each phase

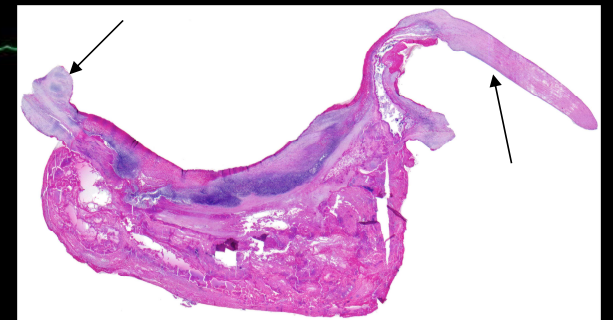
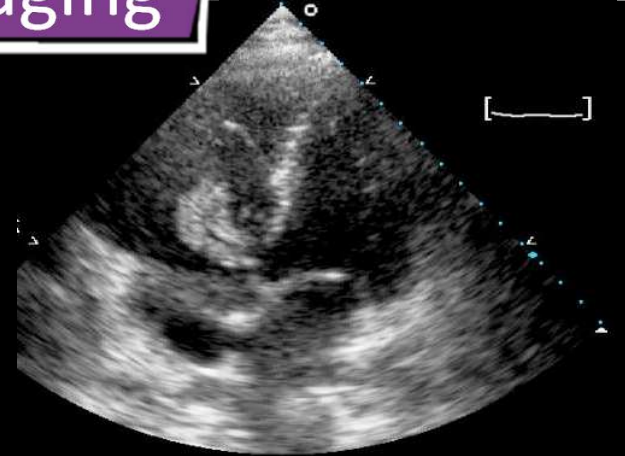
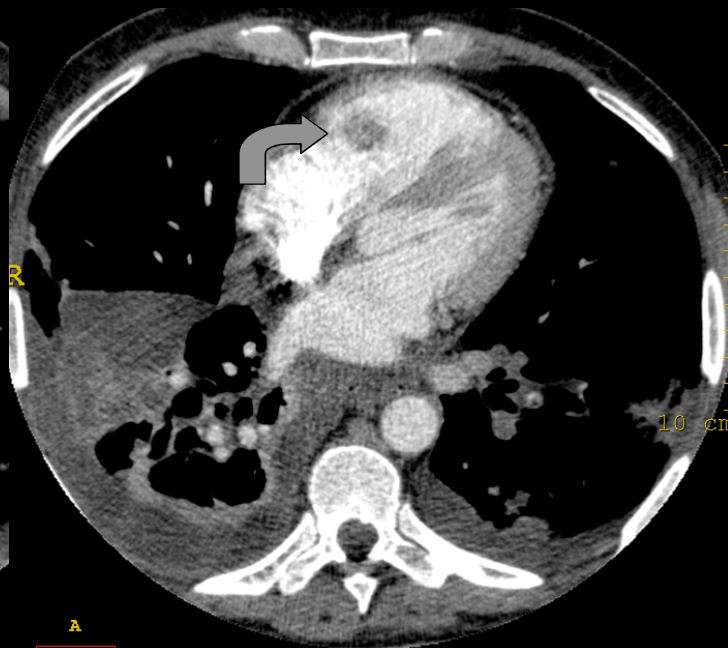
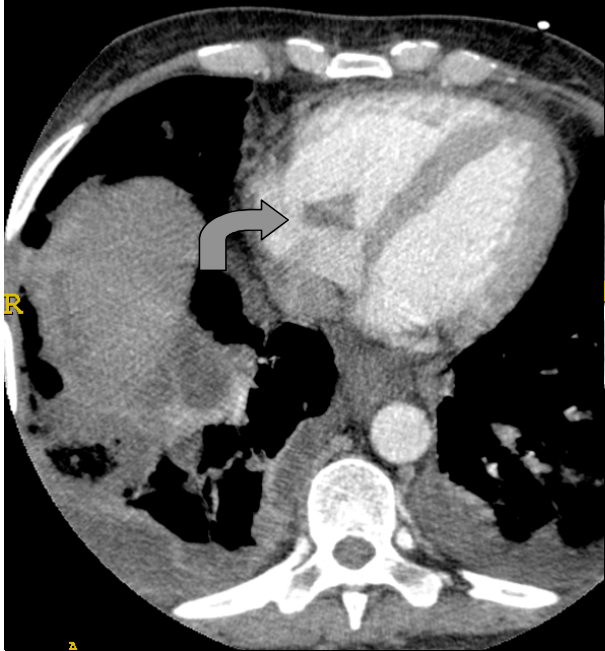
Very good concordance with semi-manual contouring



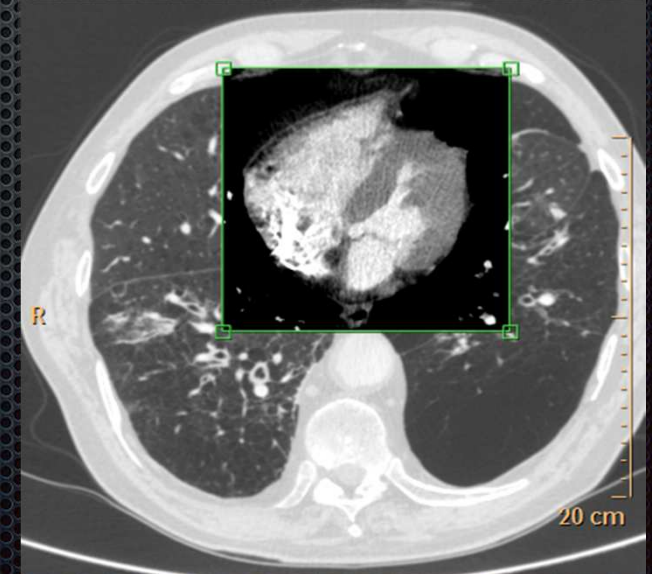
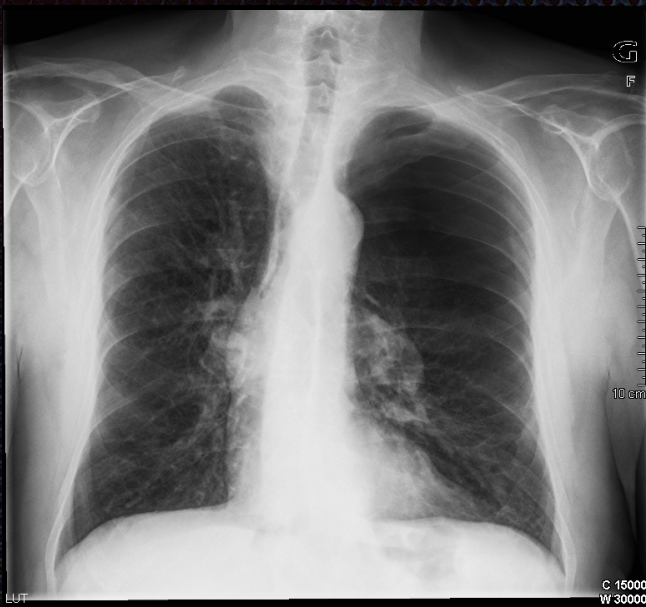
Coche E, et al. Quantitative right and left ventricular functional analysis during gated whole-chest MDCT: a feasibility study comparing automatic segmentation to semi-manual contouring. Eur J Radiol (2009) June 18. [Epub ahead of print]



Integrated cardio-thoracic Imaging

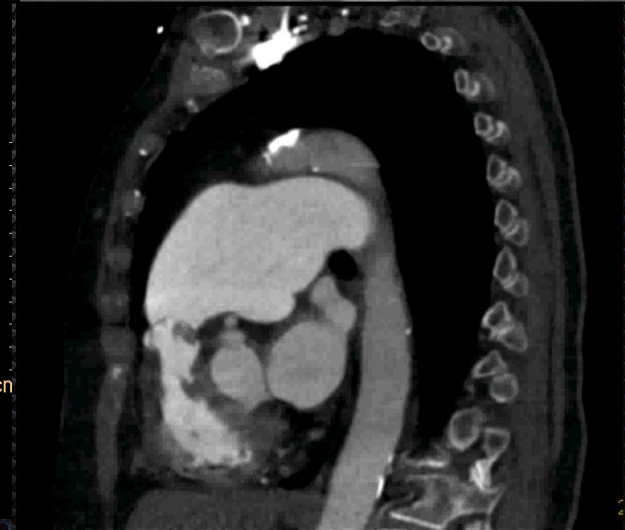
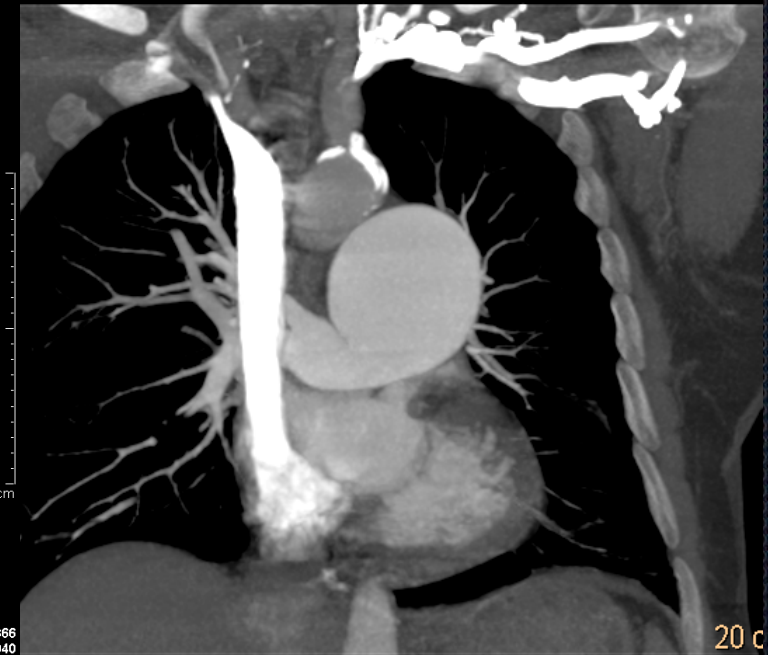
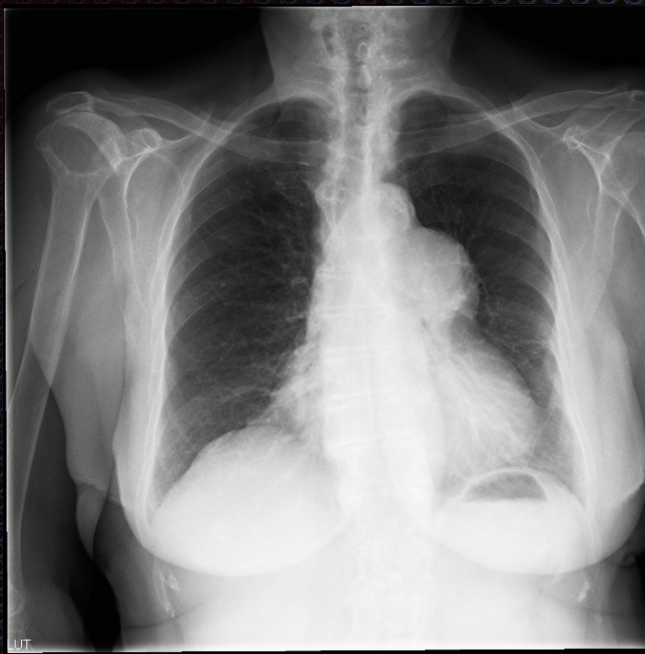


Integrated cardio-thoracic Imaging



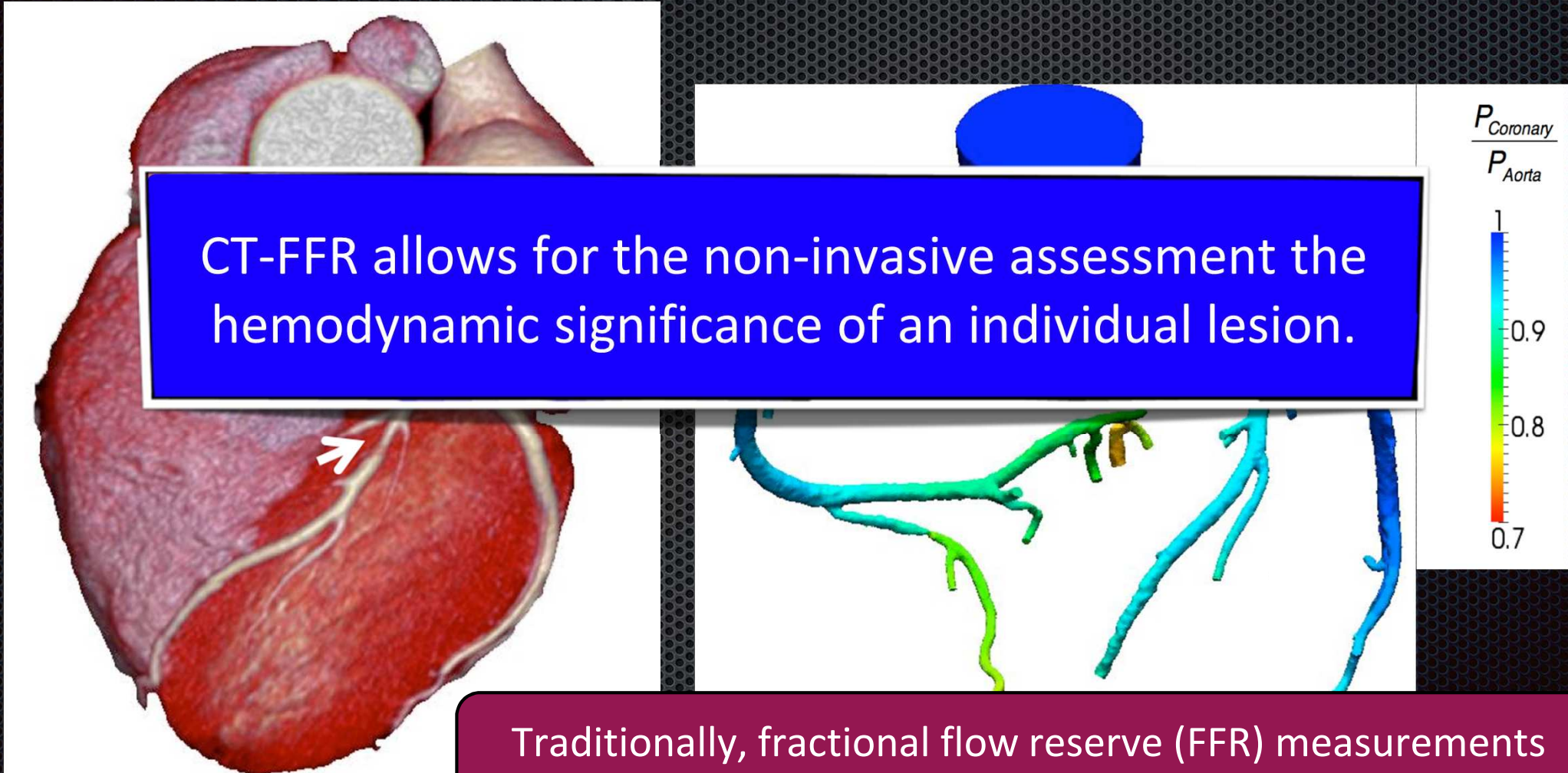
71-year old man, COPD stade IV. Preoperative evaluation reduction surgery

Integrated cardio-thoracic Imaging



77-year old woman-Preoperative work-up
Known HTAP-RV Ejection fraction: 70%

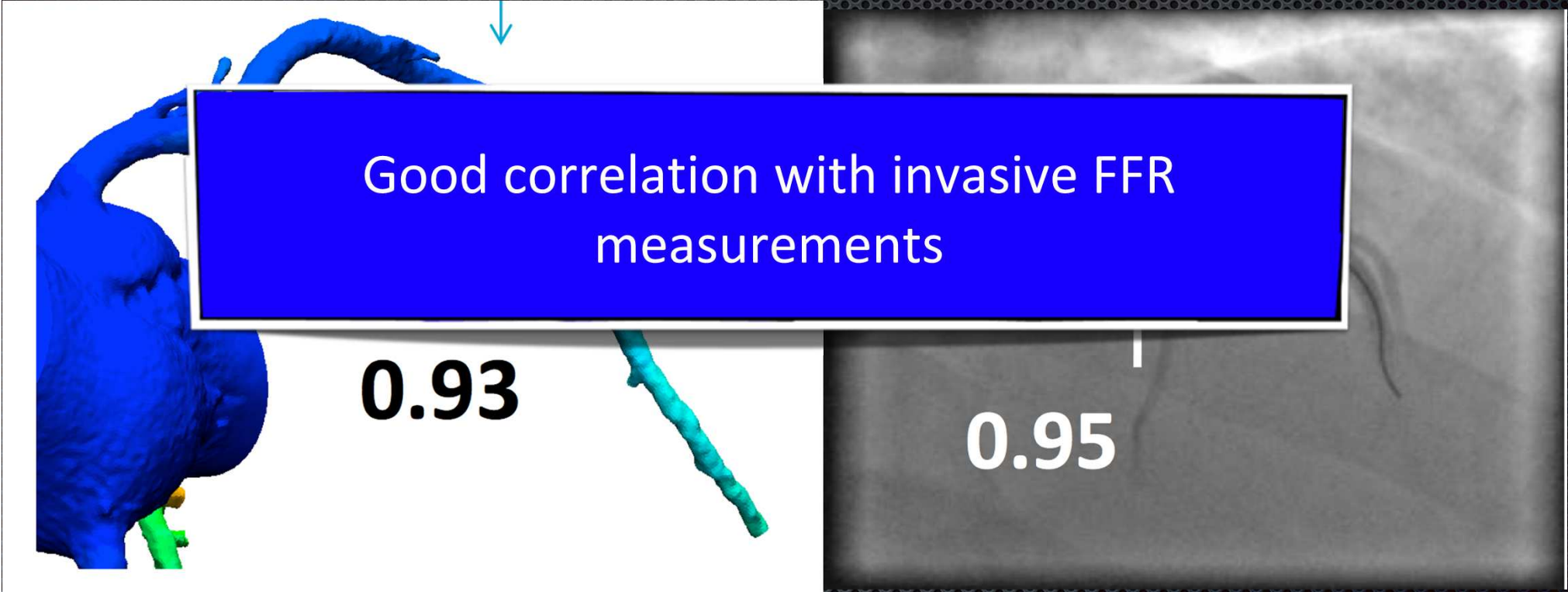
CT Fractional Flow Reserve



CT-FFR allows for the non-invasive assessment the hemodynamic significance of an individual lesion.

Traditionally, fractional flow reserve (FFR) measurements have been performed during invasive coronary angiography.

CT Fractional Flow Reserve



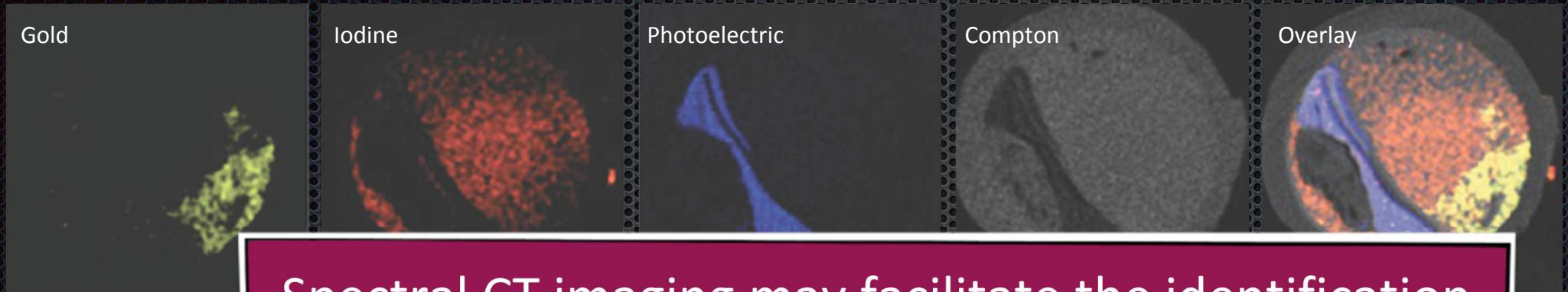
Good correlation with invasive FFR
measurements

0.93

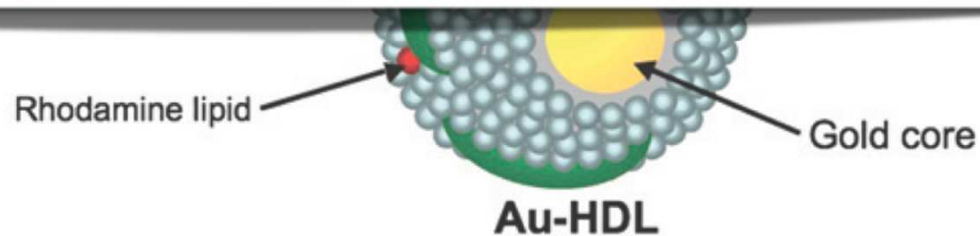
0.95

FFR is defined by the ratio of maximum blood flow in a diseased artery to blood flow in the hypothetical case that the artery is normal.

Multicolor CT



Spectral CT imaging may facilitate the identification of vulnerable plaque through molecular imaging and improved tissue differentiation.



Schematic illustration of macrophage-targeted gold core nanoparticle Au-HDL

Endothelial Shear Stress

Mapping

Low ESS is a critical determinant not only of plaque formation and growth, but also of the transition of a developing plaque to a rupture-prone phenotype.

Curved multiplanar reconstruction

Velocity vectors showing flow patterns

Endothelial shear stress vascular profiling of a coronary tree

Conclusions

- Non invasive assessment of coronary arteries and cardiac structures with MDCT is possible in a short acquisition time and a minimal amount of radiation dose
- Additional informations such as myocardial viability, FFR, plaque composition will provide the functional repercussions of the anatomical lesions with potential consequences on the patient's outcome
- Integrated cardio-thoracic Imaging represents an interesting approach to understand the heart and lungs interactions and need to be optimized