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# Actualités en imagerie cardiaque en 2014 CORO-SCANNER

Amicale des Cardiologues de la Côte d'Azur

*Mardi 3 Décembre 2013*

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Conflits d'intérêt pour cette présentation

**AUCUN**

# CORO-TDM en 10 POINTS

1. CALCIUM
2. STENOSE
3. PLAQUE
4. TAVI
5. URGENCES
6. VEINEUX
7. FONCTION
8. PERFUSION
9. FFR
10. RAYONS

**QCM** à la demande



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1.

# SCORE CALCIQUE

# QCM choix simple: le score calcique

*Une réponse fausse*

- A. Permet de stratifier le risque coronaire
- B. Est indiqué chez les sujets à risque intermédiaire
- C. Est peu irradiant: 2 mSv
- D. Nécessite une faible injection de PCI (iode)
- E. Un score calcique  $> 400$  peut faire pratiquer un test d'ischémie

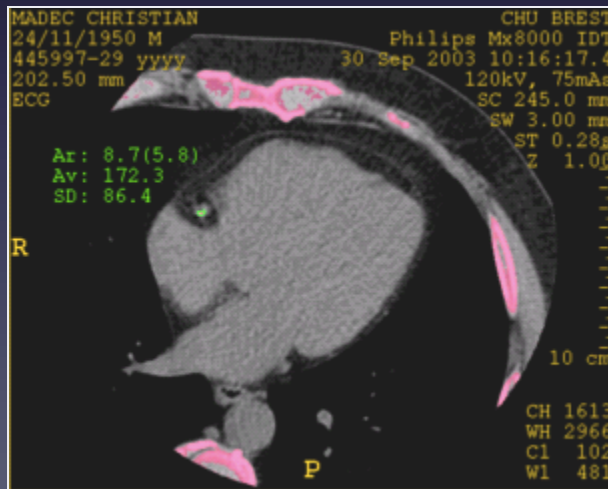
# Score Calcique

Collimation 32 0.6 mm  
 section acquisition 64 0.6 mm  
 gantry rotation time, 330 msec  
 pitch 0.2–0.39  
 tube current, 80 mAs per rotation  
 tube voltage, 120 kV.

- $Ca^{2+}$  = composant de l'athérosclérose coronaire (hors IR)
- Pixel > 130 HU et surface > 1mm<sup>2</sup>=  $Ca^{2+}$
- Score corrélé à l'importance de l'athérosclérose coronaire
- Mais non aux % sténose; CAS=0 n'exclue pas des sténoses...

0,5-2 msV

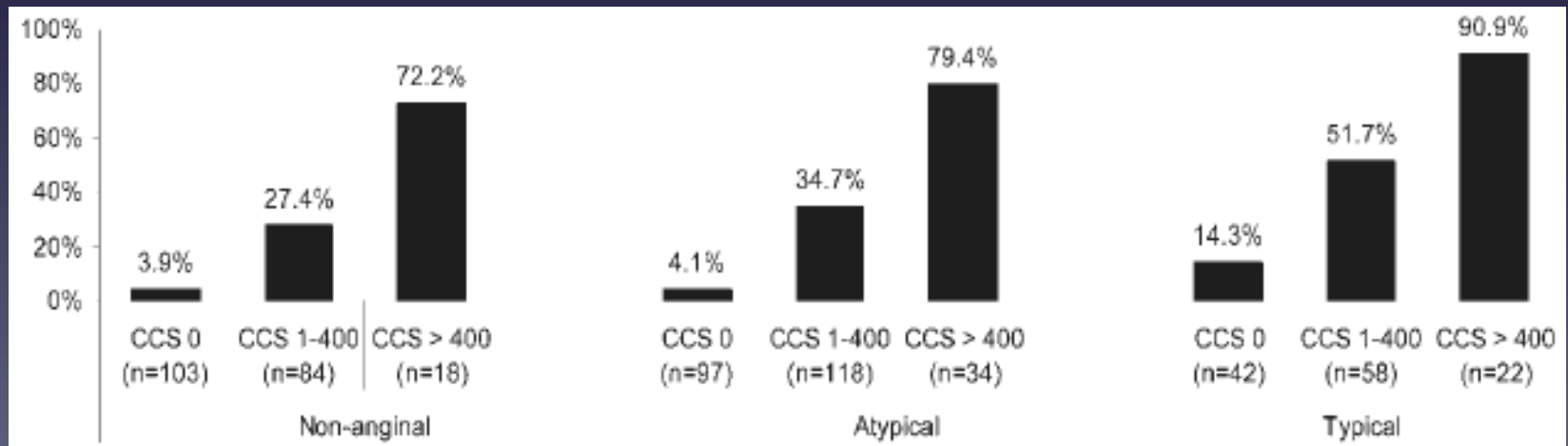
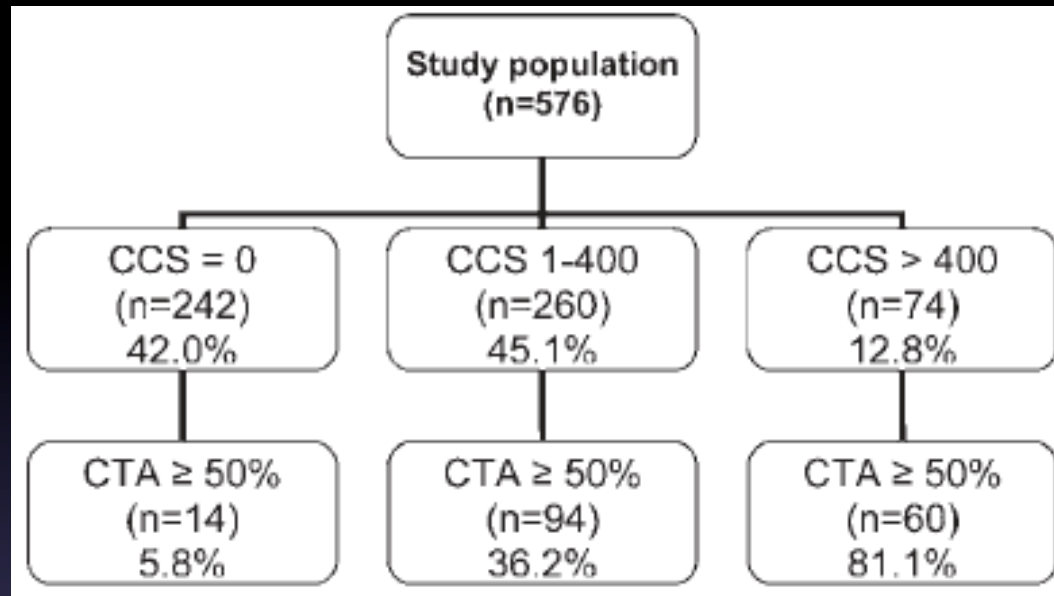
RECONSTRUCTION  
 Coupes de 3mm  
 Sans overlap  
 60% RR



Threshold = 130 HU  
(83.6 mg/cm<sup>2</sup> CaHA)

Artery	Number of Lesions (1)	Volume [mm <sup>3</sup> ] (3)	Equiv. Mass [mg CaHA] (4)	Calcium Score (2)
LM	0	0.0	0.00	0.0
LAD	2	18.7	2.85	19.1
CX	0	0.0	0.00	0.0
RCA	2	1185.9	244.90	1431.8
Total	4	1204.6	247.75	1450.9

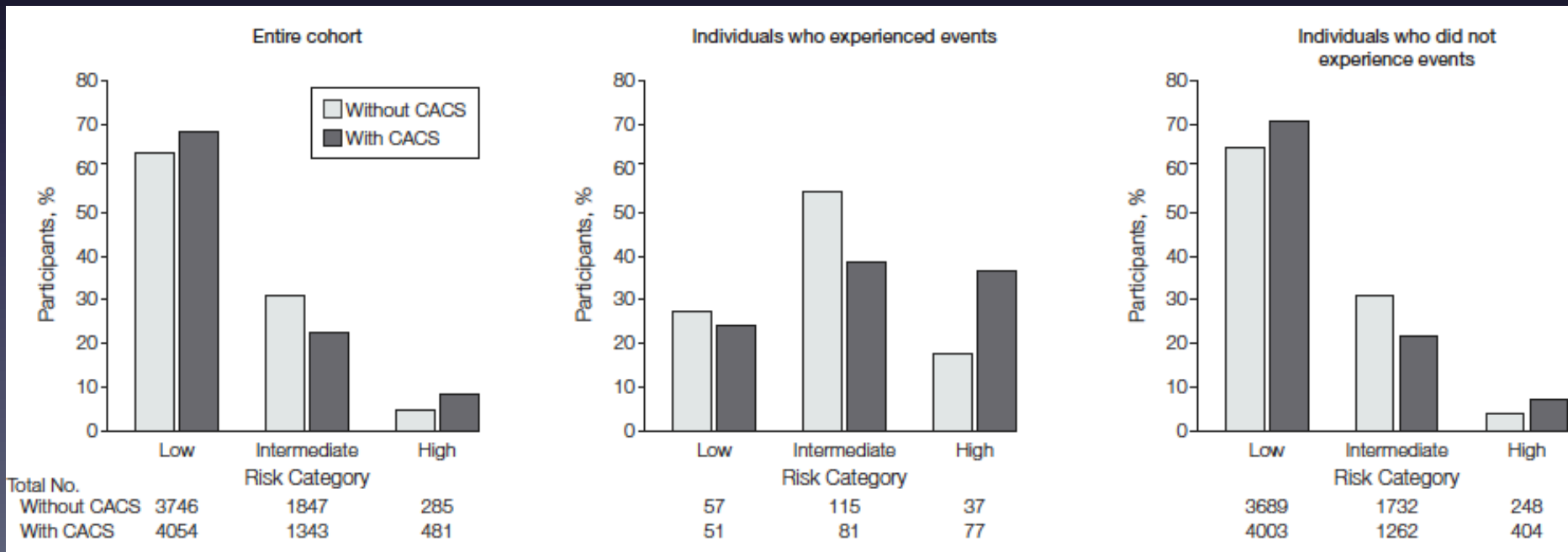
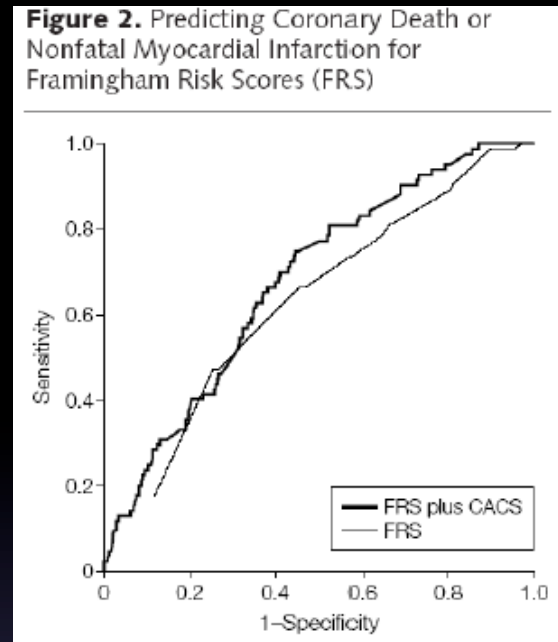
# Score calcique et probabilité clinique



# Score Calcique et re-classification du risque

CAS > 400  
OR 7-10 de MACE  
30% NIR : reclassification du risque  
Indépendant des résultats du SPECT

<http://www.newportbodyscan.com/CACrisk.htm>



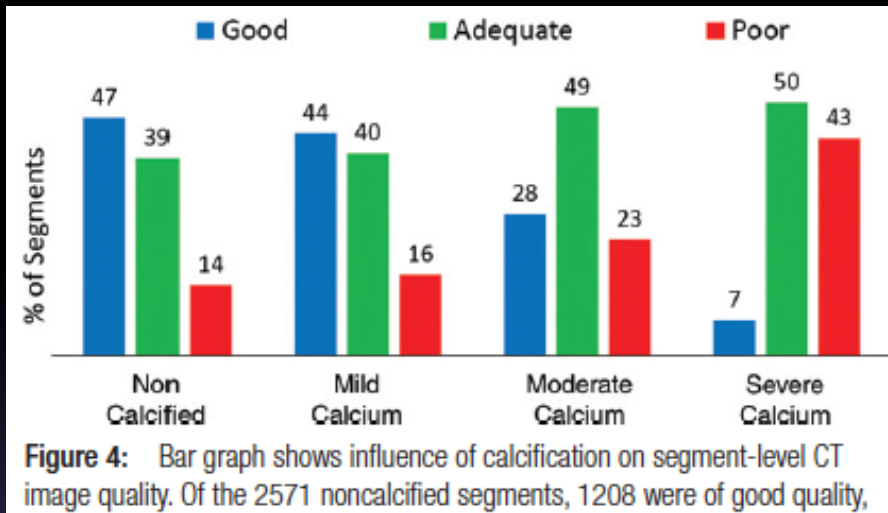


# Score calcique et recommandations ESC 2013

## Table 21 Testing in asymptomatic patients at risk for stable coronary artery disease

Recommendations	Class <sup>a</sup>	Level <sup>b</sup>
In asymptomatic adults with hypertension or diabetes a resting ECG should be considered for CV risk assessment.	IIa	C
In asymptomatic adults at intermediate risk (see SCORE for definition of intermediate risk - <a href="http://www.heartscore.org">www.heartscore.org</a> ) measurement of carotid intima-media thickness with screening for atherosclerotic plaques by carotid ultrasound, measurement of ankle-brachial index or measurement of coronary calcium using CT should be considered for CV risk assessment.	IIa	B
In asymptomatic adults with diabetes, 40 years of age and older, measurement of coronary calcium using CT may be considered for CV risk assessment.	IIb	B
In asymptomatic adults without hypertension or diabetes a resting ECG may be considered.	IIb	C
In intermediate-risk asymptomatic adults (see SCORE for definition of intermediate risk - <a href="http://www.heartscore.org">www.heartscore.org</a> ), (including sedentary adults considering starting a vigorous exercise programme), an exercise ECG may be considered for CV risk assessment particularly when attention is paid to non-ECG markers such as exercise capacity.	IIb	B
In asymptomatic adults with diabetes or asymptomatic adults with a strong family history of CAD or when previous risk assessment testing suggests high risk of CAD, such as a coronary artery calcium score of 400 or greater stress imaging tests (MPI, stress echocardiography, perfusion CMR) may be considered for advanced CV risk assessment.	IIb	C
In low- or intermediate-risk (based on SCORE) asymptomatic adults stress imaging tests are not indicated for further CV risk assessment.	III	C

# CALCIUM et CoroTDM



CoroTDM 64 barrettes

*gantry rotation speed = 330 msec*  
*isotropic spatial resolution = 0.4 mm<sup>3</sup>*

## The Effect of Segment Calcification on the Diagnostic Accuracy of Multidetector CT Angiography versus CCA

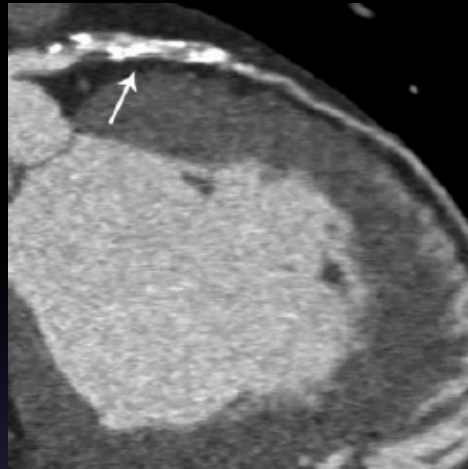
Parameter	Noncalcified (n = 2571)	Mild Calcium (n = 1099)	Moderate Calcium (n = 503)	Severe Calcium (n = 338)
Prevalence (%)	5.4 (139/2571)	15.0 (163/1099)	27.0 (138/503)	43.0 (145/338)
Sensitivity (%)	43.9 (61/139) [35.5, 52.5]	60.1 (98/163) [52.2, 67.7]	70.3 (97/138) [61.9, 77.8]	81.4 (118/145) [74.1, 87.4]
Specificity (%)	98.7 (2401/2432) [98.2, 99.1]	93.9 (879/936) [92.2, 95.4]	83.6 (305/365) [79.4, 87.2]	71.0 (137/193) [64.0, 77.3]
Positive predictive value (%)	66.3 (61/92) [55.7, 75.8]	63.2 (98/155) [55.1, 70.8]	61.8 (97/157) [53.7, 69.4]	67.8 (118/174) [60.3, 74.7]
Negative predictive value (%)	96.9 (2401/2479) [96.1, 97.5]	93.1 (879/944) [91.3, 94.6]	88.2 (305/346) [84.3, 91.4]	83.5 (137/164) [77.0, 88.9]
AUC	0.86 [0.82, 0.90]	0.85 [0.81, 0.89]	0.82 [0.78, 0.87]	0.81 [0.76, 0.85]
Positive likelihood ratio	34.4 [23.1, 51.2]	9.9 [7.5, 13.1]	4.3 [3.3, 5.5]	2.8 [2.2, 3.5]
Negative likelihood ratio	0.57 [0.49, 0.66]	0.43 [0.35, 0.51]	0.36 [0.27, 0.46]	0.26 [0.18, 0.37]

# Score calcique et CoroTDM

Scanner bi-tube

temporal resolution = 83 msec

independent of FC and eliminates the need for dual-segment reconstruction algorithms



**Diagnostic Accuracy according to Calcification**

Calcium Score (Agatston units)	Sensitivity (%)	Specificity (%)	Positive Predictive Value (%)	Negative Predictive Value (%)	Accuracy (%)	Image Quality*	No. of Nondiagnostic Segments <sup>†</sup>
≤100	82 (14/17)	99 (343/347)	78 (14/18)	99 (343/346)	98 (357/364)	1.6 ± 0.6	1
>100 to ≤400	82 (31/38)	95 (238/251)	70 (31/44)	97 (238/245)	93 (269/289)	2.0 ± 0.4	7
>400	93 (187/201)	84 (316/375)	76 (187/246)	96 (316/330)	87 (503/576)	2.5 ± 0.5	92

Calcification = seul facteur limitant la fiabilité diagnostique (FC et variabilité: NS)  
(P .001)



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2.

Diagnostic de Coronaropathie stable

**PERFORMANCE COROTDM**

# QCM choix simple: **coroTDM** et coronaropathie

*Une réponse fausse*

- A. A la meilleure sensibilité / autres tests diagnostique
- B. A la meilleure spécificité/ autres tests diagnostique
- C. A la meilleure VPN/ autres tests diagnostique
- D. Permet d'éliminer une coronaropathie chez les patients à risque faible/ intermédiaire
- E. Ne doit pas être pratiqué chez les coronariens revascularisés
- F. Ne doit pas être pratiqué chez les sujets asymptomatiques

# Comparaison des performances diagnostiques

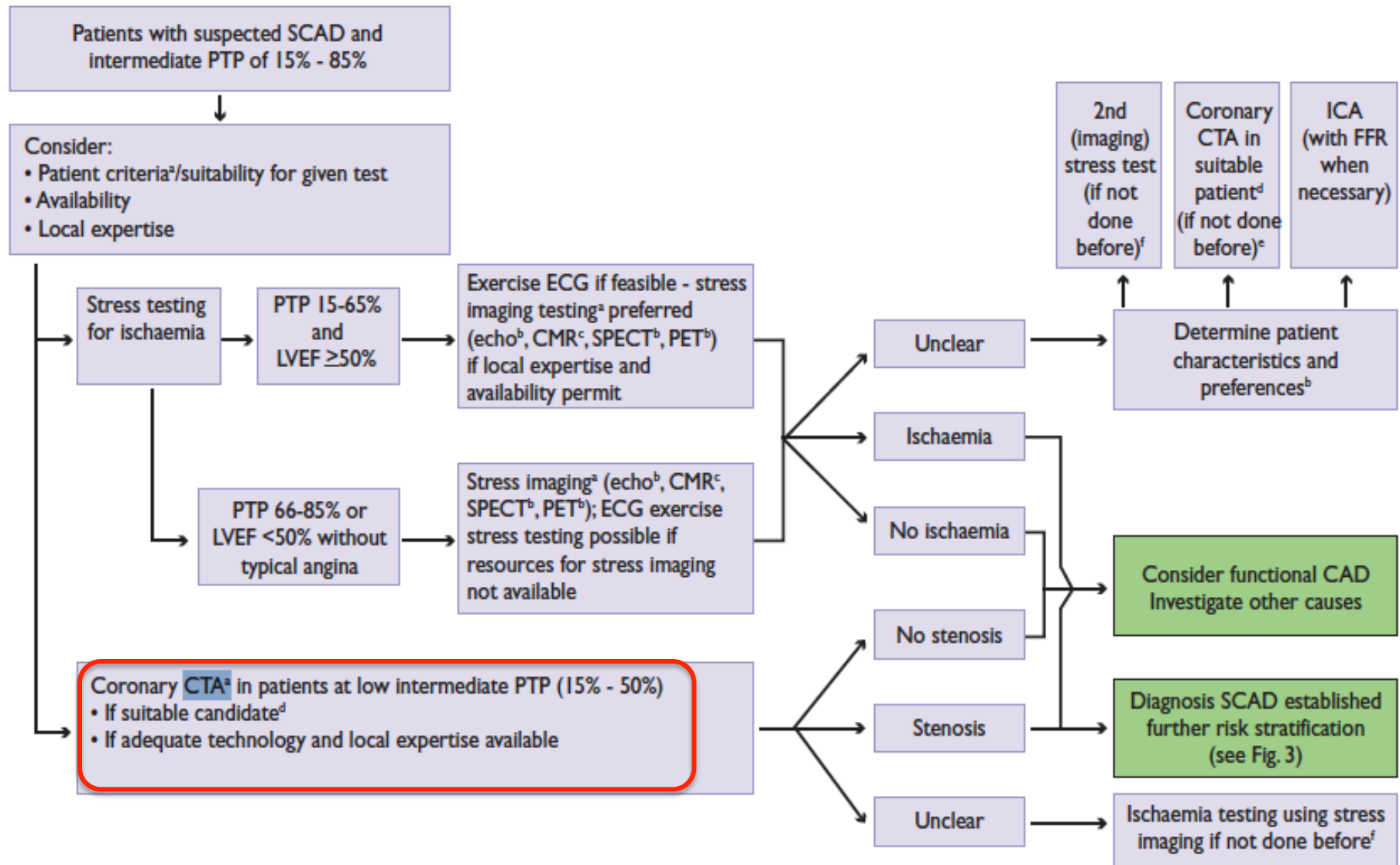
	Diagnosis of CAD	
	Sensitivity (%)	Specificity (%)
Exercise ECG <sup>a, 91, 94, 95</sup>	45–50	85–90
Exercise stress echocardiography <sup>96</sup>	80–85	80–88
Exercise stress SPECT <sup>96,99</sup>	73–92	63–87
Dobutamine stress echocardiography <sup>96</sup>	79–83	82–86
Dobutamine stress MRI <sup>b,100</sup>	79–88	81–91
Vasodilator stress echocardiography <sup>96</sup>	72–79	92–95
Vasodilator stress SPECT <sup>96, 99</sup>	90–91	75–84
Vasodilator stress MRI <sup>b,98, 100-102</sup>	67–94	61–85
<b>Coronary CTA<sup>c,103-105</sup></b>	<b>95–99</b>	<b>64–83</b>
Vasodilator stress PET <sup>97, 99, 106</sup>	81–97	74–91

*Prévalence de coronaropathie dans la population étudiée*

*Intermédiaire à élevée*

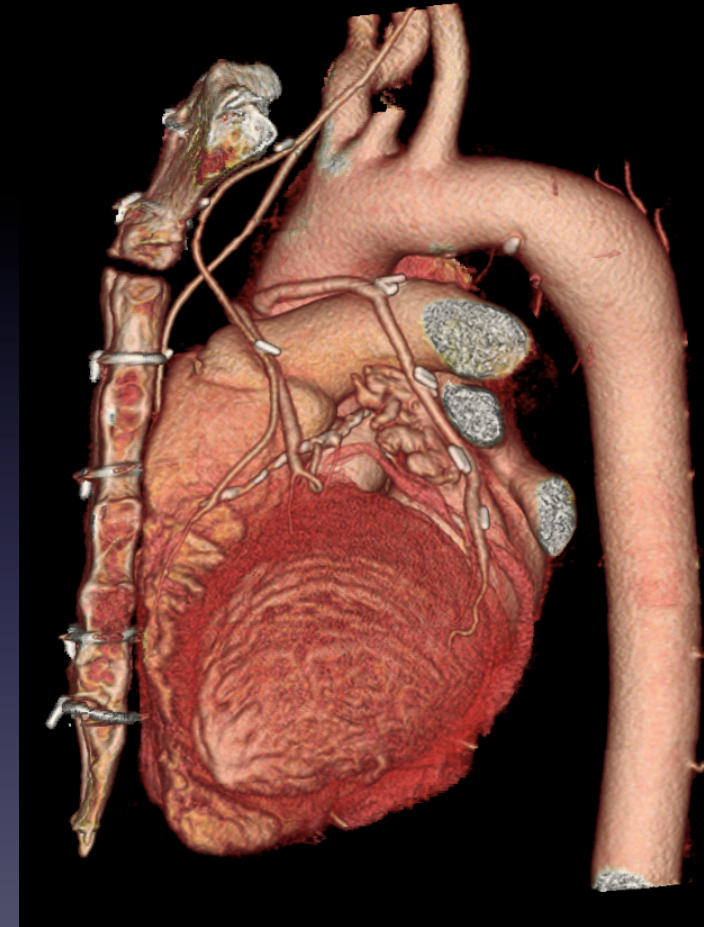
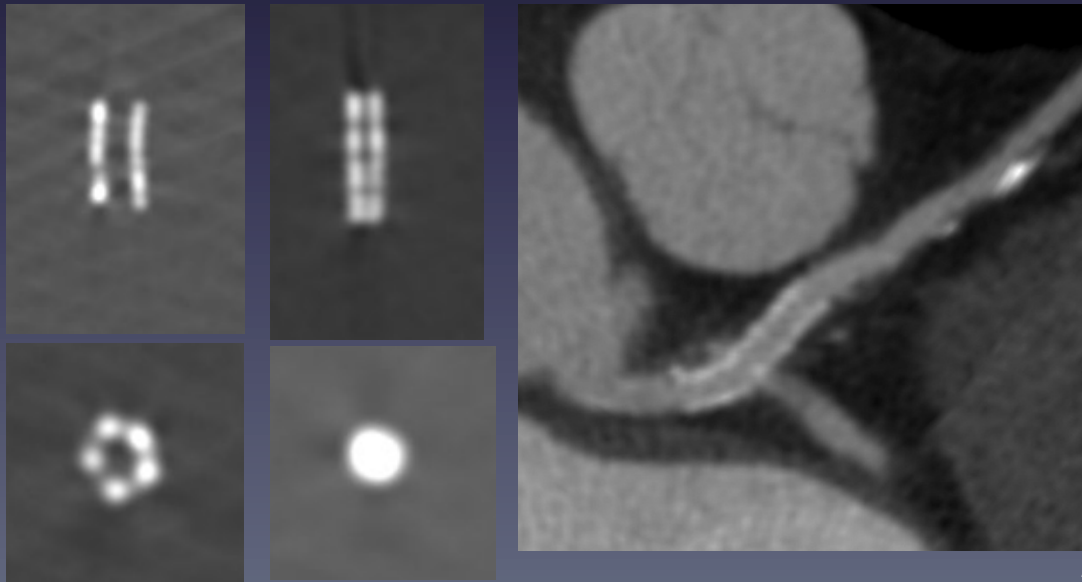
*Faible à Intermédiaire*

# Probabilité Clinique pré-test



# CTA chez le coronarien ?

- NON: Se=85%, Spe=90% si ATCD SCA, PCI\*
- Stents: artéfacts, sauf TC (>3,2mm 64 bar)
- Pontages: perméabilité++,
  - avant chirurgie redux (trajet)
  - pb: anastomoses distales -





# CTA *et* recommandations ESC 2013

## e 16 Use of coronary computed tomography angiography for the diagnosis of stable coronary artery disease

Recommendations	Class <sup>a</sup>	Level <sup>b</sup>
Coronary CTA should be considered as an <u>alternative to stress imaging techniques</u> for ruling out SCAD in patients within the <u>lower range of intermediate PTP for SCAD in whom good image quality can be expected.</u>	IIa	C
Coronary CTA should be considered in patients within the lower range of intermediate PTP for SCAD <u>after a non conclusive exercise ECG or stress imaging test</u> or who have contraindications to stress testing in order to avoid otherwise necessary invasive coronary angiography if fully diagnostic image quality of coronary CTA can be expected.	IIa	C
Coronary calcium detection by CT is not recommended to identify individuals with coronary artery stenosis.	III	C
Coronary CTA is <u>not recommended in patients with prior coronary revascularization.</u>	III	C
Coronary CTA is <u>not recommended as a 'screening' test</u> in asymptomatic individuals without clinical suspicion of coronary artery disease.	III	C

### *Sélection des patients – consensus \**

- Apnée possible (8-15 sec)
- BMI < 40kg/m<sup>2</sup>
- CAS < 400
- Rythme sinusal
- FC ≤ 65 bpm (idéalement 60: BB po ou IV, ivabradine)

3.

CTA – coronarien stable

# STRATIFICATION DU RISQUE

# QCM choix simple: **coroTDM-Stratification du risque**

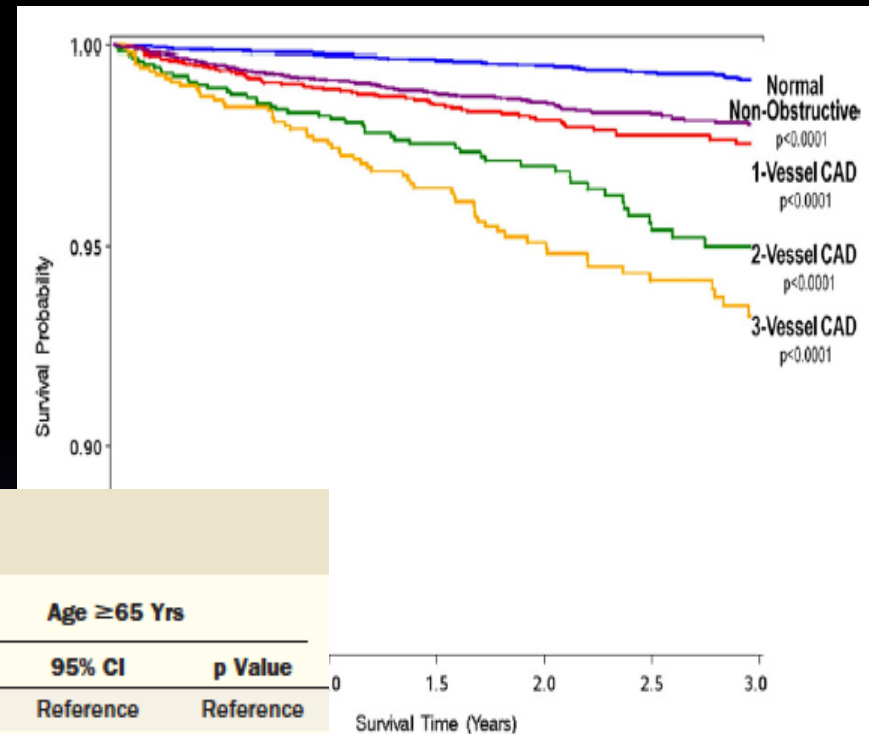
*Une réponse fausse*

- A. Le nombre d'artères pathologiques est pronostique
- B. L'analyse de plaque est possible
- C. Une plaque à risque est hypodense (core lipidique)
- D. Une plaque calcifiée est à haut risque de SCA**
- E. Le remodelage négatif est de meilleur pronostic

# STRATIFICATION DU RISQUE

## NOMBRE d'artères atteintes

24 775 patients; Suivi 2,3 +/- 1,1 ans  
coroTDM ≥ 64 barrettes



**Table 6** Adjusted Hazard Ratios for All-Cause Mortality for Patients <65 Versus ≥65 Years of Age

Variable	Age <65 Yrs			Age ≥65 Yrs		
	HR	95% CI	p Value	HR	95% CI	p Value
Normal	1	Reference	Reference	1	Reference	Reference
Nonobstructive	1.57	0.98-2.51	0.0594	1.63	1.08-2.47	0.0212
1-vessel disease	2.12	1.22-3.69	0.0080	1.96	1.25-3.07	0.0036
2-vessel disease	4.00	2.16-7.40	<0.0001	2.46	1.51-4.02	0.0003
3-vessel disease or left main disease	6.19	3.43-11.2	<0.0001	3.10	1.95-4.92	<0.0001

**Table 7** Adjusted Hazard Ratios for All-Cause Mortality for Female Versus Male Patients

CAD Severity	Female			Male		
	HR	95% CI	p Value	HR	95% CI	p Value
Normal	1.00	Reference	Reference	1	Reference	Reference
Nonobstructive	1.67	1.10-2.54	0.0160	1.52	0.97-2.40	0.0689
1-vessel disease	1.83	1.11-3.01	0.0176	2.05	1.25-3.35	0.0043
2-vessel disease	2.88	1.63-5.07	0.0003	2.81	1.65-4.77	0.0001
3-vessel/left main disease	4.21	2.47-7.18	<0.0001	3.27	1.96-5.45	<0.0001

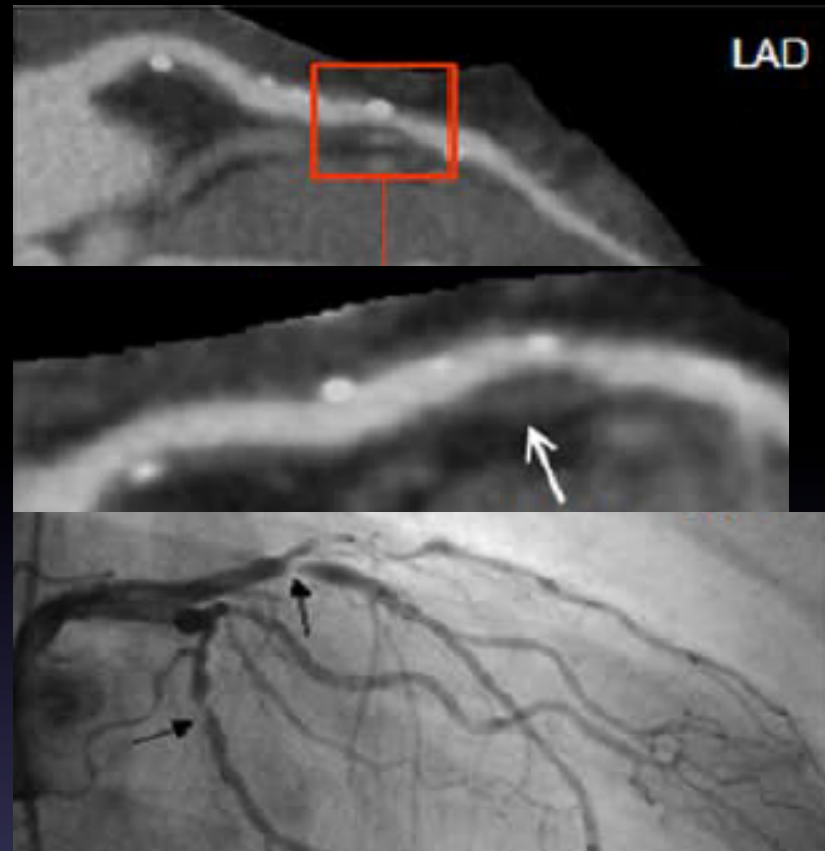
# STRATIFICATION DU RISQUE PLAQUE

- Absente: décès = 0,22-0,28% / an
- Plaque sans sténose: taux < 0,5% / an

## Type de plaque:

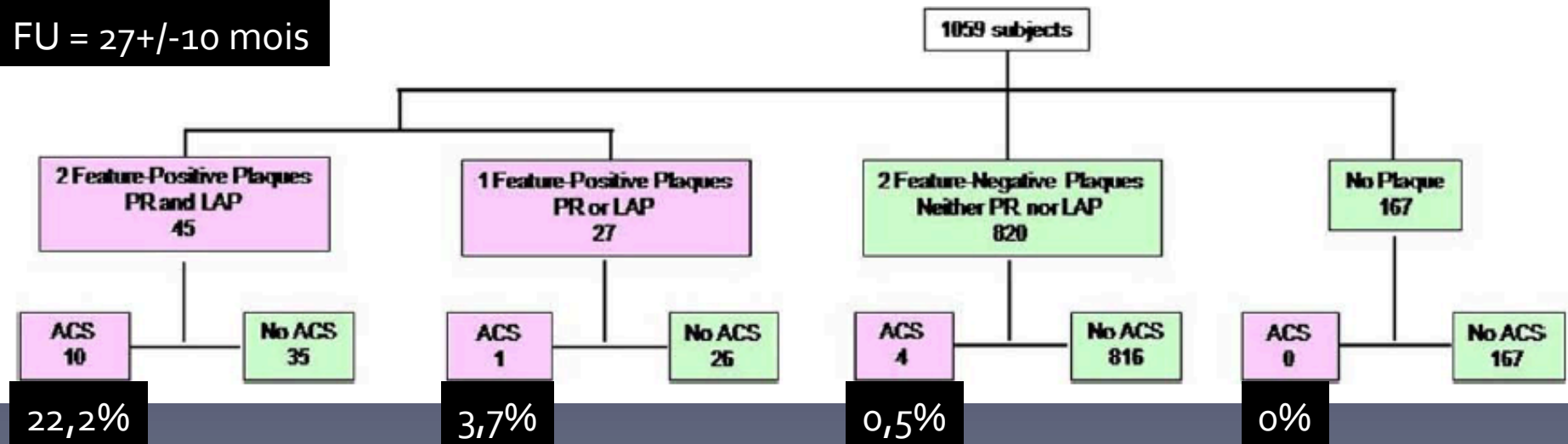
MOLLES <30HU: core lipidique (IVUS)  
 30-150 HU: chape fibreuse

REMODELAGE POSITIF >10% diamètre segment réf



Motoyama S; J Am Coll Cardiol 2009;54:49-57.

FU = 27 +/- 10 mois



# CARACTÉRISATION DE LA PLAQUE

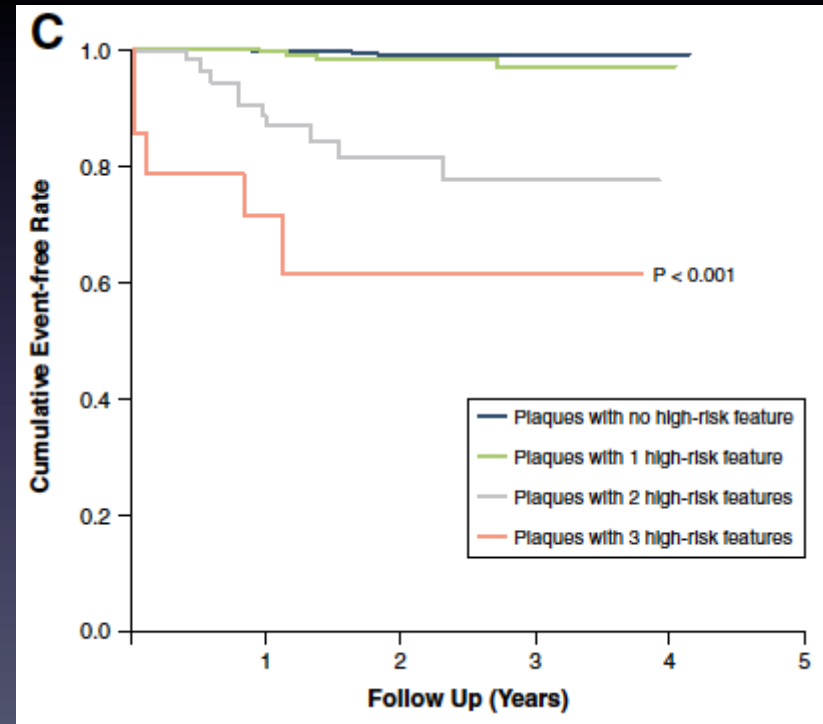
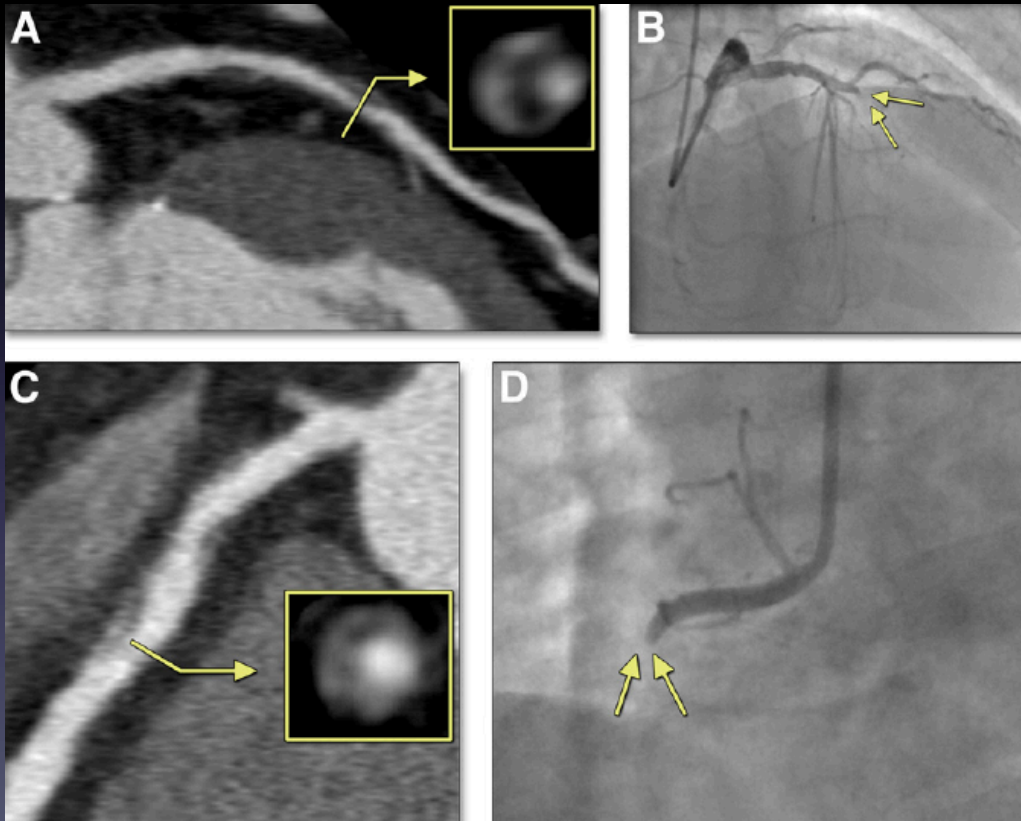
*et prédiction du risque de SCA*

Low Attenuation  $<30\text{HU}$

Positive Remodeling  $>1.1$

Napkin-ring sign:

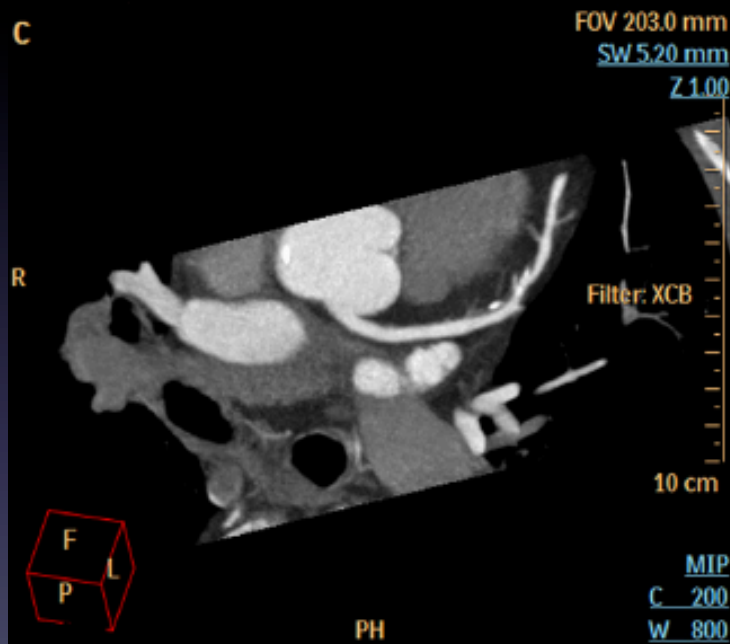
*Ring*  $>$  *adjacent* + *atténuation*  $<130\text{HU}$



# PRONOSTIQUE: quantification de plaque

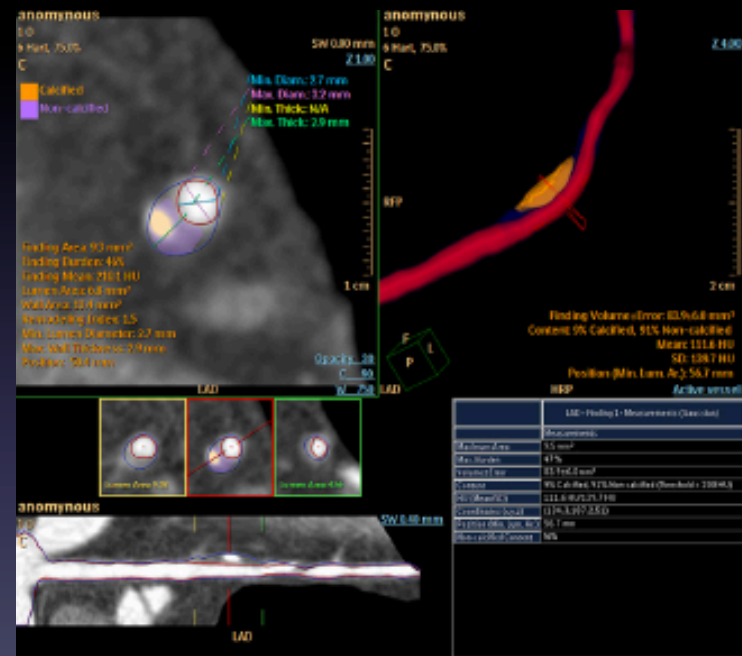
Brilliance 64, Philips Healthcare  
Dual source CT scanner Siemens Definition

1650 patients, suivi 26+/-10 mois  
Algorithme Comprehensive Cardiac Analysis



Lecture conventionnelle

Calcium score  
≥50% stenosis  
Segment stenosis score  
Non-calcified plaque content



Algorithme semi-automatique

Plaque volume  
Plaque burden  
Plaque area  
Plaque non-calcified percentage  
Plaque attenuation  
Plaque remodeling

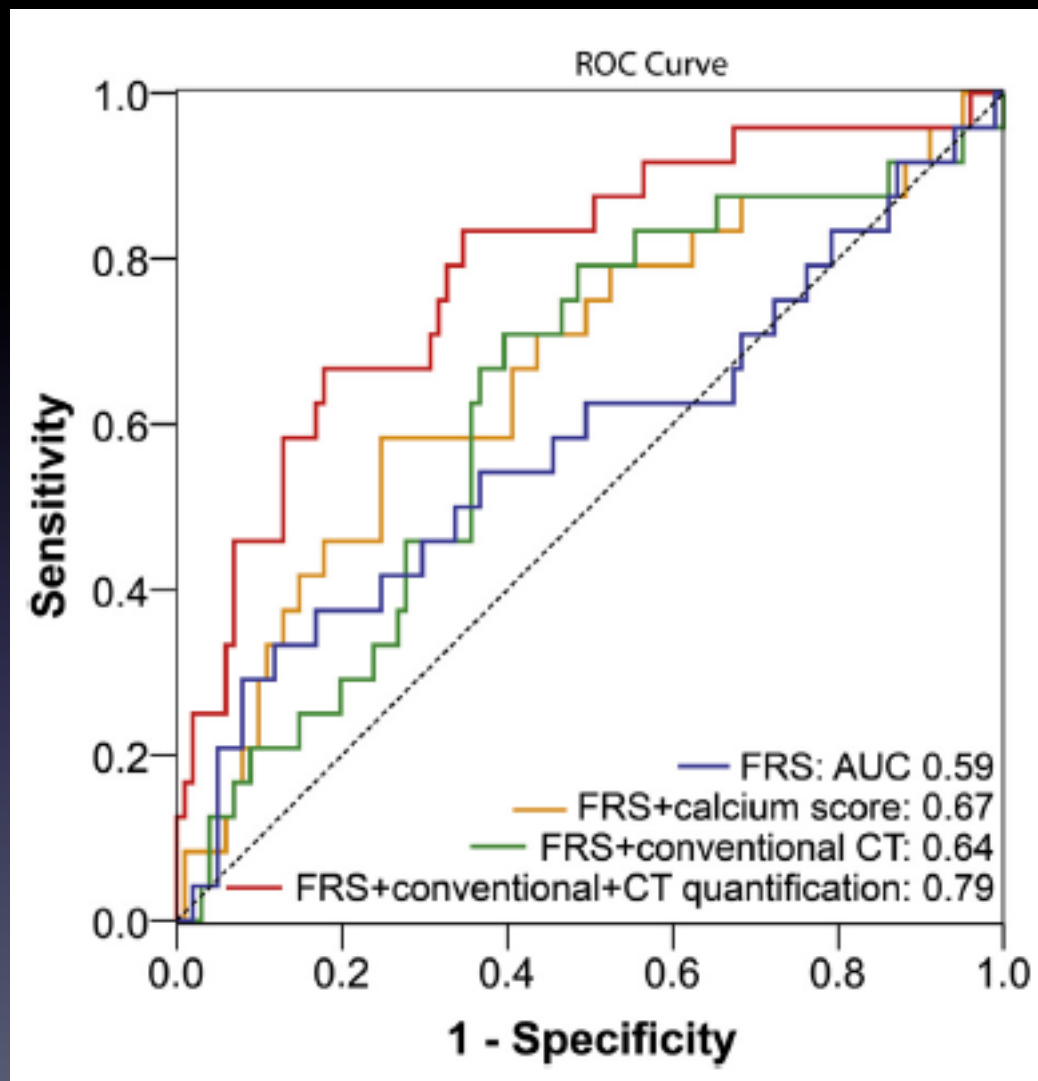
# PRONOSTIQUE

## Quantif. de plaque

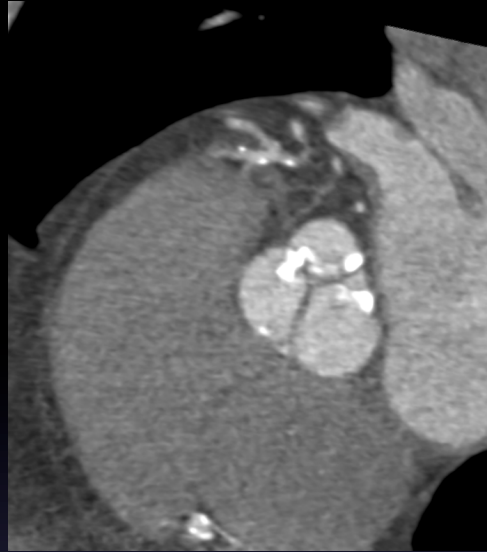
Table 3

Difference in Semiautomatically Quantified Plaque Characteristics Between Culprit Lesions and Nonculprit Plaques Within Patients Who Had ACS (n = 24)

	Culprit Plaques (n = 24)	Nonculprit Plaques (n = 74)	p Value
Plaque total volume, mm <sup>3</sup>	25.4 (7.3-69.6)	9.5 (1.9-43.8)	0.04
Plaque noncalcified volume, mm <sup>3</sup>	3.4 (0-18.8)	0 (0-5.4)	0.005
Plaque burden, %	39.0 (24.5-56.0)	29.0 (12.0-39.3)	0.02
Plaque area, mm <sup>2</sup>	5.0 (2.4-8.6)	3.3 (0.9-5.9)	0.04
Plaque attenuation, HU	287 (195-543)	468 (323-557)	0.04
Plaque remodeling index	1.3 (1.2-1.5)	1.2 (1.0-1.4)	0.06







## 4. TAVI

### Objectifs

- Sizing aortique: paramètres anatomiques - IAO
- Comorbidités – IR: limitation iode

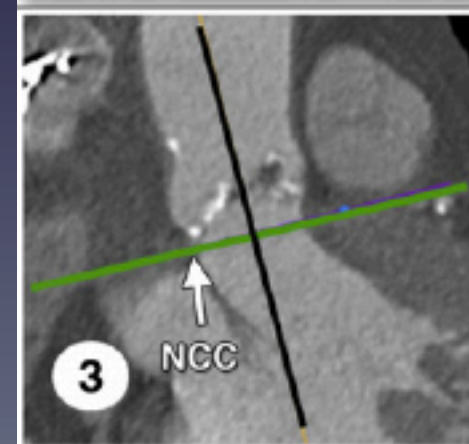
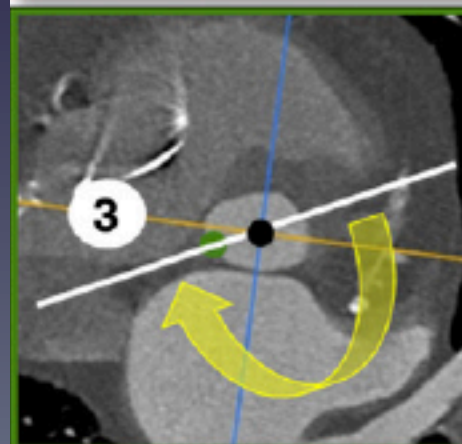
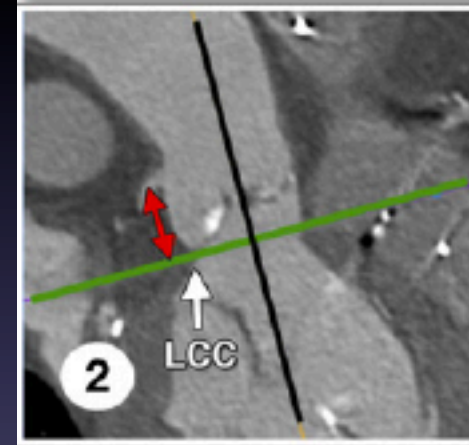
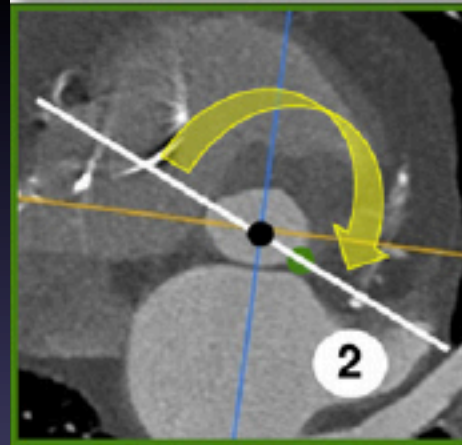
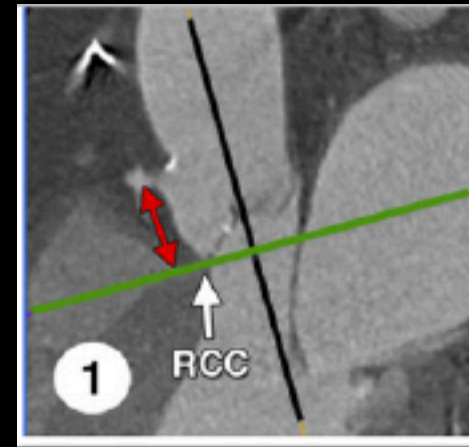
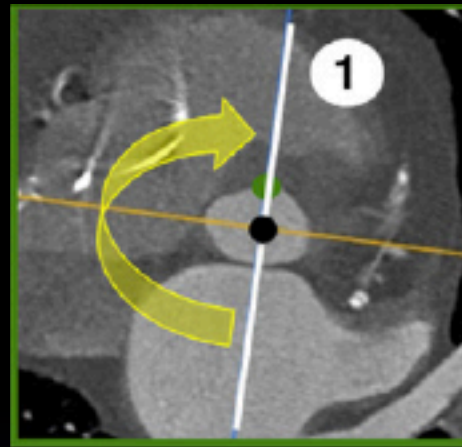
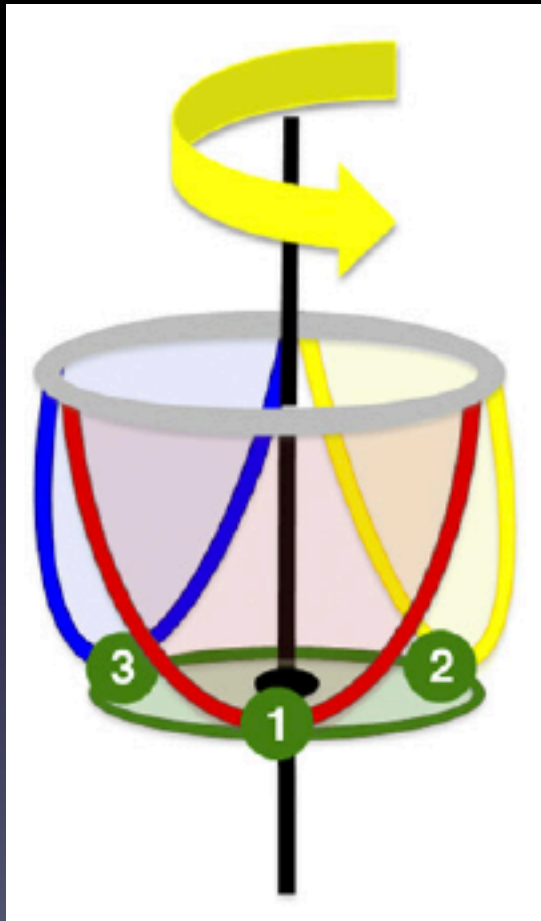
## QCM choix simple: **coroTDM-TAVI**

*Une réponse fausse (pas complètement vraie !)*

- A. Le scanner avec gating cardiaque est un examen complet avant TAVI
- B. Il permet de mesurer la taille de l'anneau
- C. Il permet de choisir la bonne prothèse
- D. Il permet d'analyser les coronaires**
- E. Il est prédictif d'IAO post procédure

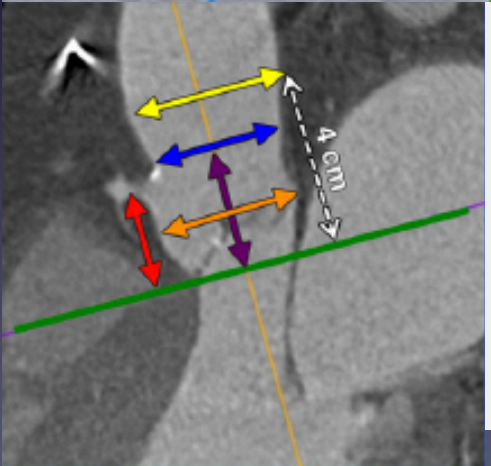
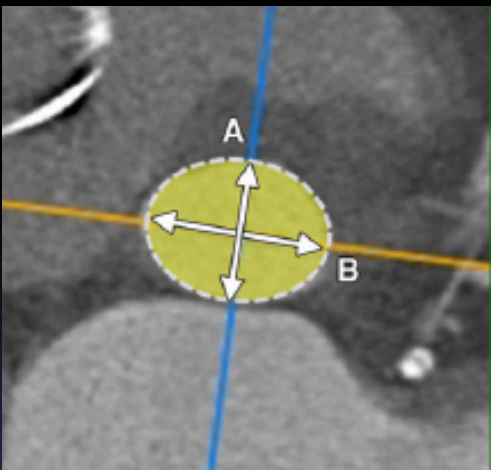
# MSCT et TAVI

≥64 barrettes, résolution spatiale 0,5mm  
Gating ECG, reconstruction toute phase



# MSCT et TAVI

## Choix de la prothèse



$\frac{A + B}{2}$  = Mean Diameter

= Area

= Perimeter

= Sinus Width

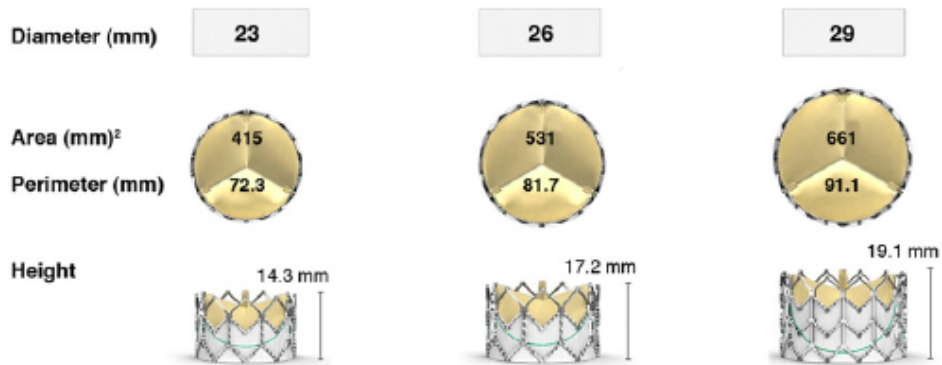
= Diameter of the Sinotubular Junction

= AsAo Width in 4 cm Distance from Annulus

= Sinus Height

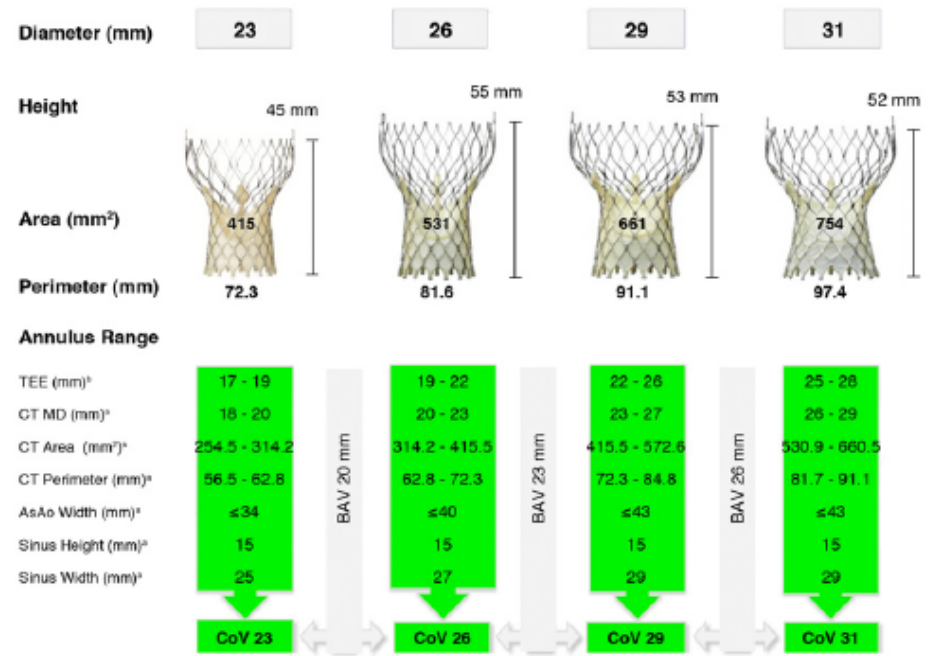
= Distance to Coronaries

Mesure automatique de l'angulation



Annulus Range	TEE (mm) <sup>a</sup>	CT MD (mm) <sup>b</sup>	CT Area (mm <sup>2</sup> ) <sup>b</sup>	CT Perimeter (mm) <sup>b</sup>	Distance Coronaries (mm) <sup>c</sup>	Prosthesis
23	18 - 21	19 - 22	300 - 380	60.0 - 69.0	10	SXT 23
26	22 - 24	23 - 25	415 - 490	72.0 - 78.5	10	SXT 26
29	25 - 27	26 - 28	530 - 620	81.5 - 88.0	11	SXT 29

BAV 23 mm (between 23 and 26), BAV 25 mm (between 26 and 29)



# MSCT preTAVI: sizing et risque d'IAO

Exemple de la Edward Sapien XT

Taux d'IAO >2 : 7.6%

Taux d'Iao minimum si oversizing >25% ( $r = -0.236$ ,  $p < 0.02$ )

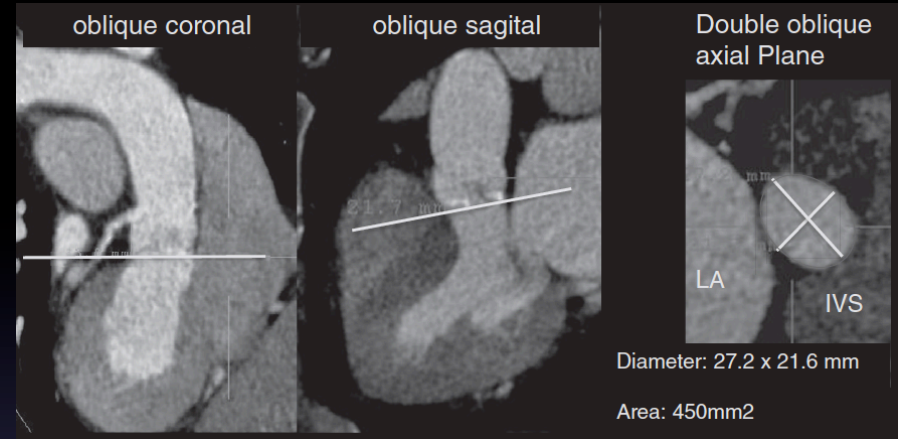
Plus fort taux d'IAO si ratio <15% (0% vs. 15.8%,  $p < 0.02$ )

PM: 5.3% si oversizing <15% vs 16.7% si >25% ( $p < 0.23$ )

Meilleur compromis: ratio prothèse/anneau optimal:

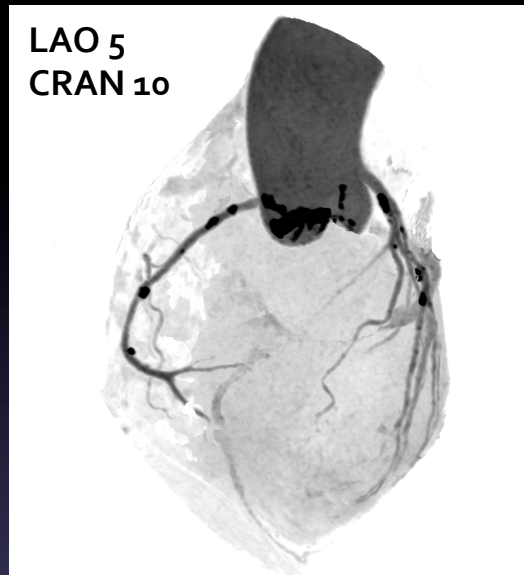
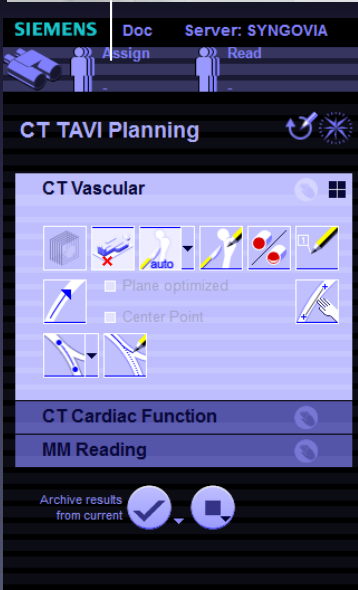
15-25% sur la surface et

7-12% sur la diamètre



# TAVI procedures et MSCT

Diamètres iliaques  
Calcifications  
Anneau aortique  
Distance anneau-ostias



LAO 5  
CRAN 10

Spatial resolution: 0.33 mm  
Pitch: 3.4  
Rotation time: 0.28 s  
Temporal resolution: 75 ms  
Tube voltage: 120 kV  
**Dose: 4.3 mSv**



Scan time: 1.37 s  
Scan length: 587 mm  
**CA dose: 40 ml**

\* CA: Contrast agent  
Courtesy S. Gauß, University of Erlangen-Nürnberg, Erlangen, Germany

**Diamètre et position / anneau: prédictifs IAO $\geq$ 2 post TAVI**

# CoroTDM préopératoire de RAC

## Calcification aortiques associées à

- un CAS plus élevé
- un sur-risque d'évènements coronaires: HR=1.72
- une surmortalité: HR=2.51

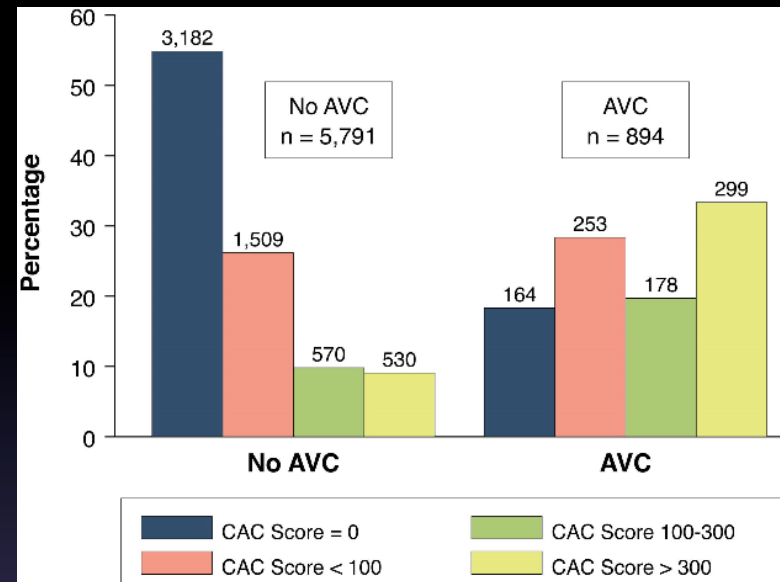
**Table 6** Management of coronary artery disease in patients with valvular heart disease

	Class <sup>a</sup>	Level <sup>b</sup>
<b>Diagnosis of coronary artery disease</b>		
Coronary angiography <sup>c</sup> is recommended before valve surgery in patients with severe valvular heart disease and any of the following: <ul style="list-style-type: none"> <li>• history of coronary artery disease</li> <li>• suspected myocardial ischaemia<sup>d</sup></li> <li>• left ventricular systolic dysfunction</li> <li>• in men aged over 40 years and postmenopausal women</li> <li>• ≥1 cardiovascular risk factor.</li> </ul>	I	C

<sup>a</sup>Level of evidence.

<sup>c</sup>Multi-slice computed tomography may be used to exclude coronary artery disease in patients who are at low risk of atherosclerosis.

<sup>d</sup>Chest pain, abnormal non-invasive testing



Préopératoire de RAC, vs coro:

Se = 80%

Spe = 86%

VPN= 75%

Agreement coefficient =0.64

Jakami et al; [Arch Cardiovasc Dis](#). 2012 Aug-Sep;105(8-9):424-31  
 Owens et al; [JACC Cardiovasc Imaging](#). 2012 Jun;5(6):619-25  
 Cornily et al; [Arch Cardiovasc Dis](#). 2010 Mar;103(3):170-5  
 European Heart Journal (2012) 33, 2451–2496

5.

Urgences – douleur thoracique

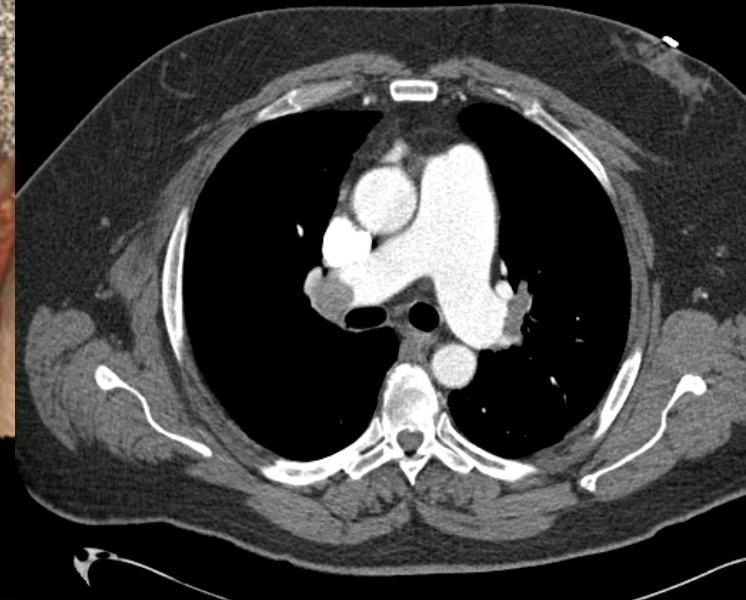
**TRIPLE RULED OUT**



# TRO: application

<100ml produit iodé  
5-9 mSv

DT = 11% des motifs de consultation au SAU  
TRO: Se et Spe = TDM dédié (coronaires / AP/ Aorte)  
Evite d' autre examens dans 75% des cas  
Coût / efficacité favorable



## Sélection des patients++:

Probabilité d' ACS faible/intermédiaire, peu de calcification, pas de stent ni CABG  
Apnée 15 sec, FC < 80 bpm régulière, créat

# Irradiation liée aux examens cardiaques

Examination	Effective dose (mSv)	Equivalent n. of chest x-rays
<b>CONVENTIONAL RADIOLOGY</b>		
♣ Chest x ray (single postero-anterior)	0.02	1
<b>NUCLEAR MEDICINE</b>		
♣ Tc-99 m tetrafosmin cardiac rest-stress (10 mCi+30 mCi)*	10.6	530
♣ Tc-99 m sestamibi cardiac 1-day rest-stress (10 mCi+30 mCi)*	12	600
♣ Tc-99 m sestamibi cardiac 2-day stress-rest (30 mCi+30 mCi)*	17.5	775
♣ Tl-201 cardiac stress and reinjection (3.0 mCi+1.0 mCi)*	25	1500
♣ Dual isotope cardiac (3.0 mCi Tl201 + 30 mCi Tc-99 m)*	27	1600
<b>64-Slice CARDIAC COMPUTED TOMOGRAPHY</b>		
♣ ECG pulsing, no aorta**	9	450
♣ No ECG pulsing, yes aorta**	29	1450
<b>INTERVENTIONAL RADIOLOGY</b>		
♣ Conventional rhythm device***	1.4	70
♣ Cardiac resynchronization device***	5.5	275
♣ Cerebral angiography ***	1.6–10.6	80–530
♣ Coronary angiography ***	3.1–10.6	155–555
♣ Abdomen angiography ***	6–23	300–1150
♣ Peripheral angiography***	2.7–14	135–700
♣ Coronary angioplasty ***	6.8–28.9	340–1445
♣ Peripheral angioplasty***	10–12	500–600
♣ Radiofrequency ablation***	17–25	850–1250
♣ Valvuloplasty***	29	1450



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6.

Rythmologie

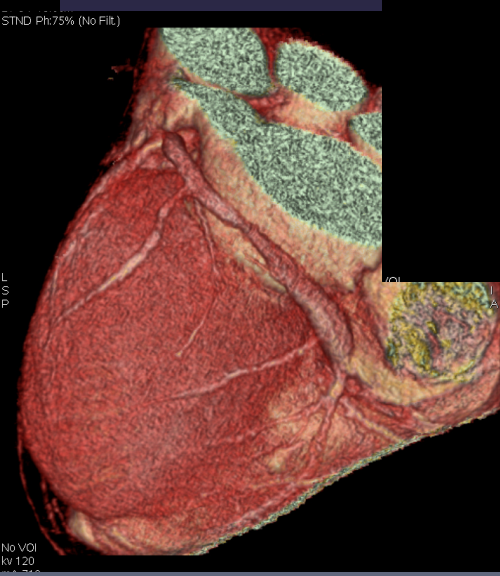
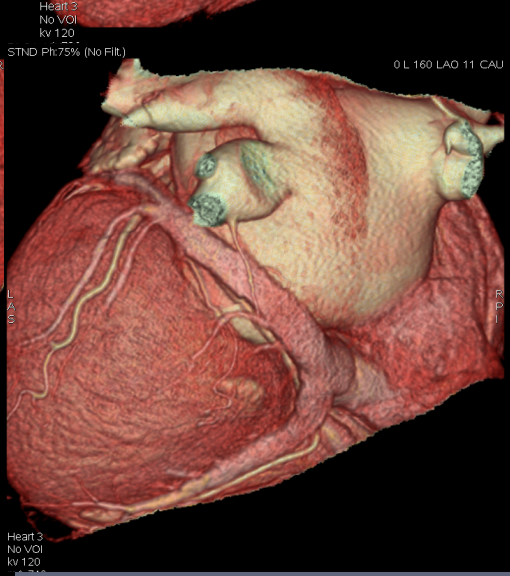
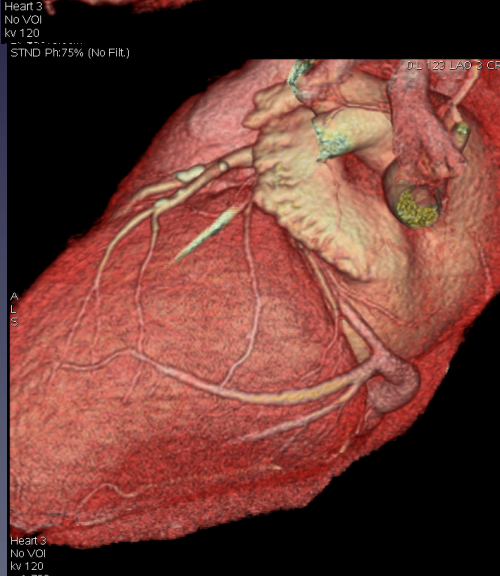
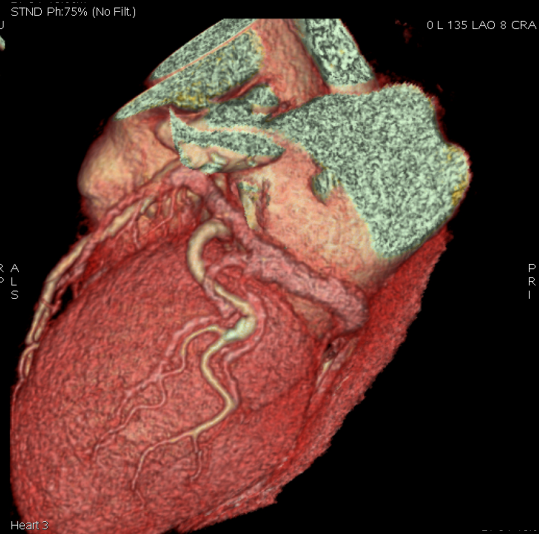
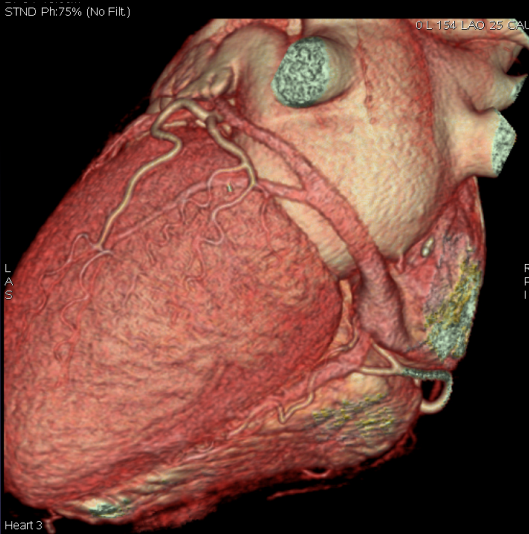
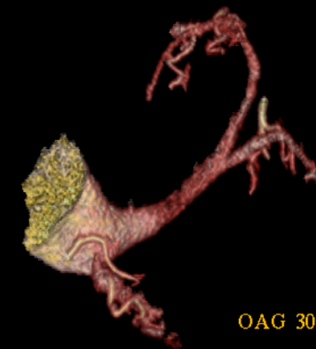
**VEINEUX**

# Système veineux coronaire

## Variations anatomique



kv 120  
fMA 738  
Rot 0.25s/CH 8.0mm/rot

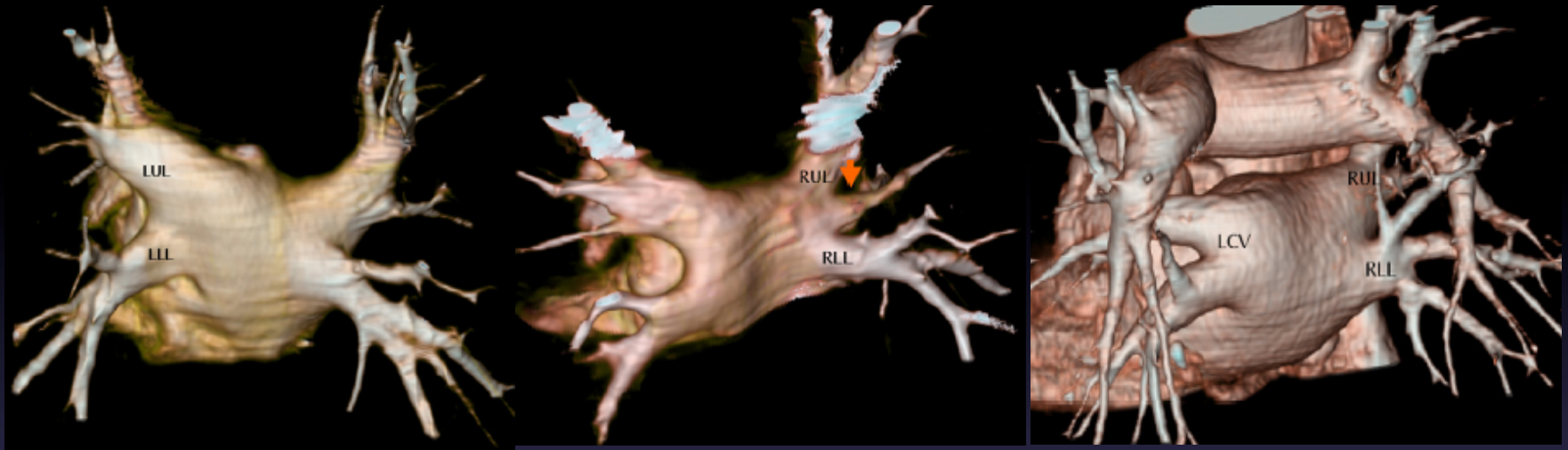


Heart 3  
No VOI  
kv 120

Heart 3  
No VOI  
kv 120

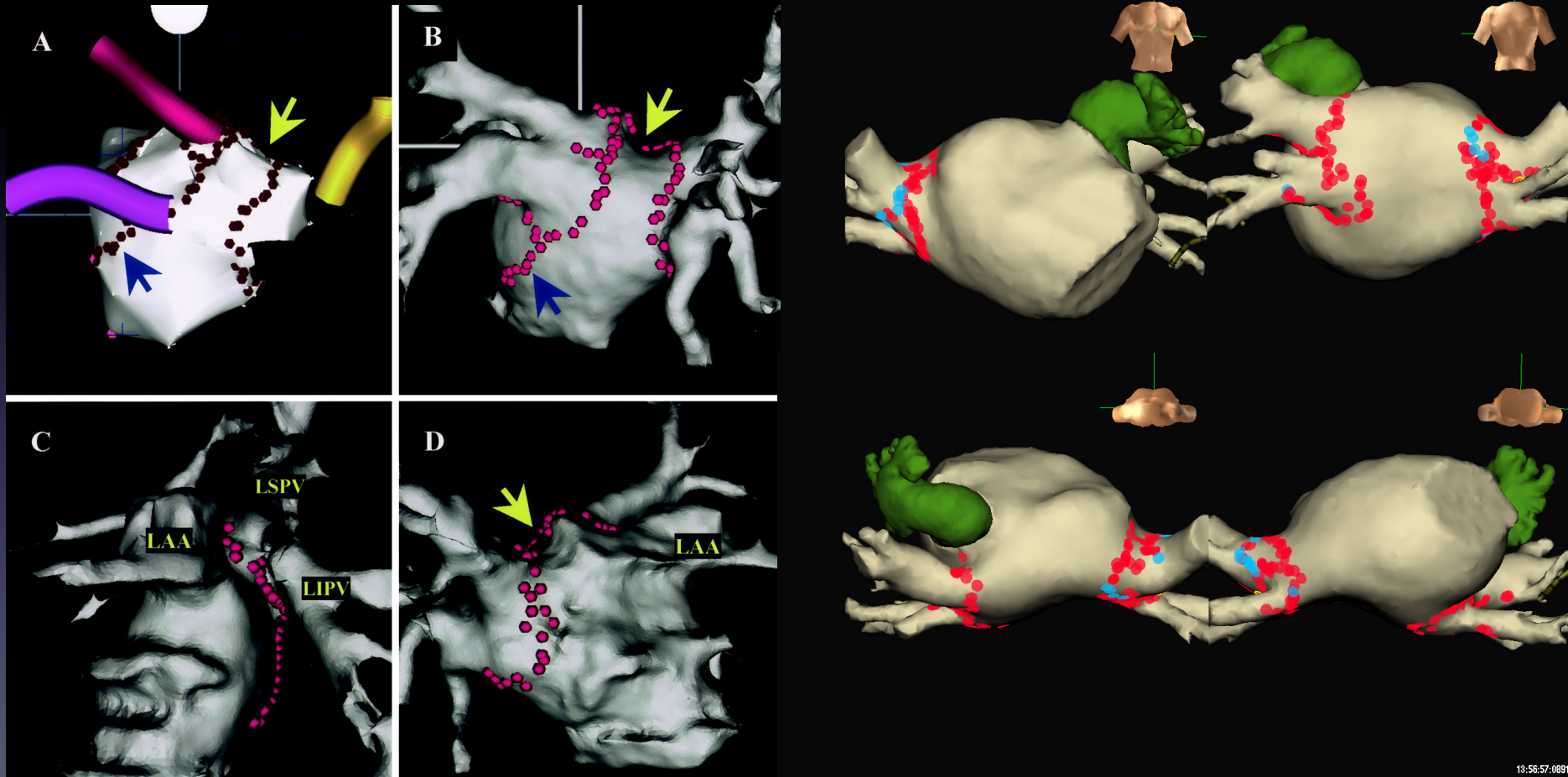
No VOI  
kv 120

# Système veineux pulmonaire



# FUSION

Scanner /cartographie magnétique (Cordis®)



13:58:57:0891



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7.

Analyse fonctionnelle

**FONCTION**

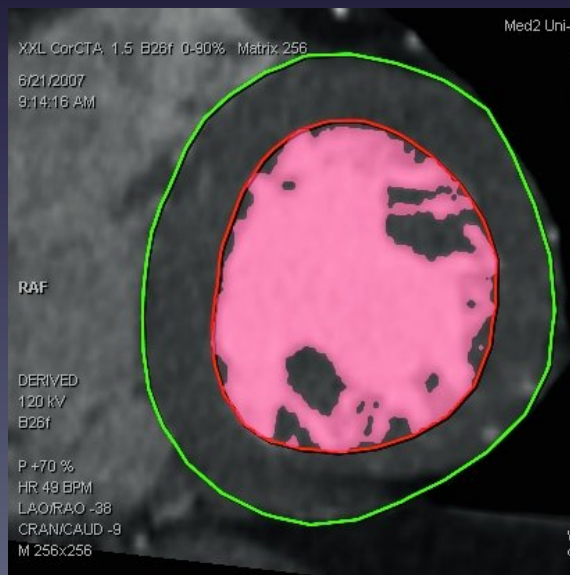
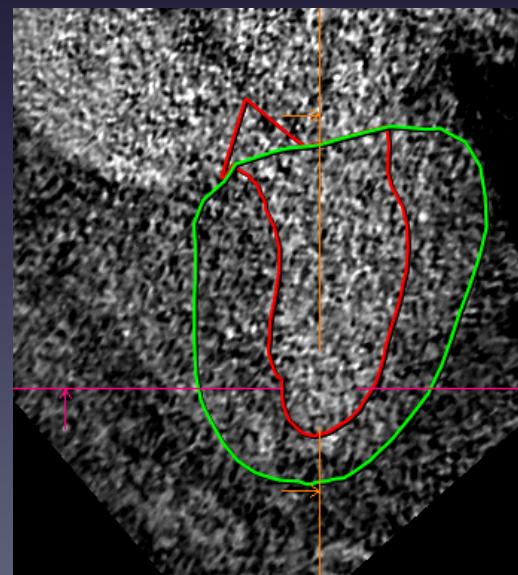
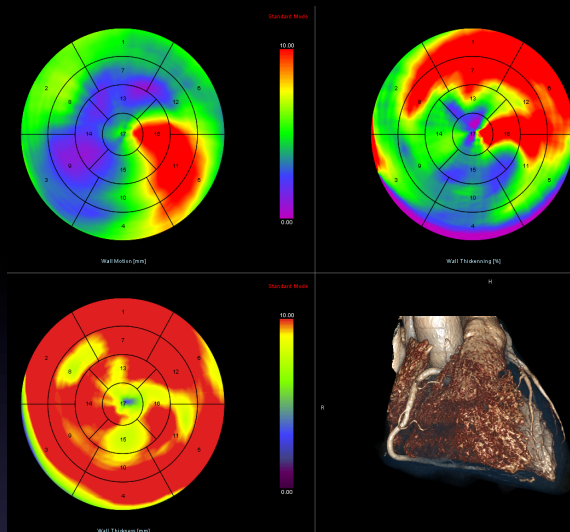
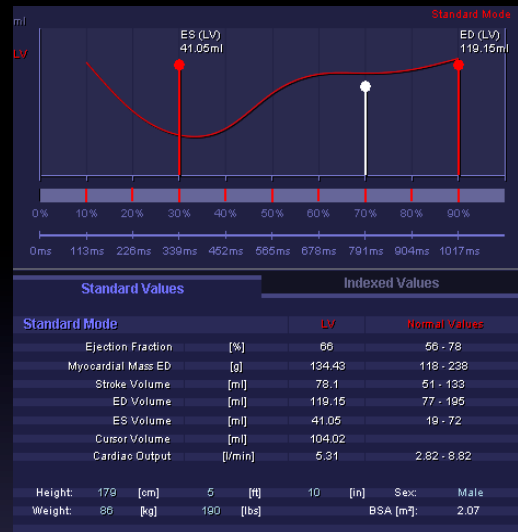
# QCM choix simple: **coroTDM: fonction, perfusion**

*Une réponse fausse*

- A. La fonction VG globale en coroTDM est fiable
- B. La fonction VG segmentaire est fiable à 90%
- C. La perfusion en coroTDM est analysable comme en IRM
- D. Le scanner de stress est un examen standardisé**
- E. La FFR est réalisable en coroTDM



# FEVG FEVD - MSCT



- Fonction / 10% RR
- Coupes 2mm
- Détection automatique contours
- Volumes, diamètres, fonction, masse
- Fonction régionale: épaissement systolique, segmentation 17 AHA
- Gating prospectif, modulation de dose (- 40%)

# Corrélation fonction CT/IRM

## TDM Bi-tube Dual Energy

**TABLE 1: Global and Time-Dependent Left Ventricular Functional Parameters Assessed by Dual-Source CT and MRI**

Functional Parameter	Dual-Source CT	MRI	$p^a$	Pearson's $r$ ( $p$ ) <sup>b</sup>
EDV (mL)	148.6 ± 55.2	146.4 ± 56.6	0.042	0.98 (< 0.0001)
ESV (mL)	70.5 ± 35.2	69.1 ± 35.8	0.18	0.99 (< 0.0001)
SV (mL)	79.8 ± 26.7	77.3 ± 27.6	0.35	0.96 (< 0.0001)
EF (%)	54.1 ± 10.4	54.8 ± 11.1	0.24	0.95 (< 0.0001)
PER (mL/s)	415.9 ± 123.2	398.6 ± 115.6	0.12	0.79 (< 0.0001)
PFR (mL/s)	416.1 ± 171.3	389.2 ± 182.9	0.069	0.84 (< 0.0001)
Time to PER (ms)	129.3 ± 28.2	121.6 ± 37.5	0.18	0.68 (0.001)
Time to PFR from ES (ms)	167.7 ± 29.1	156.7 ± 34.0	0.32	0.64 (0.0026)

Note—Data are ± SD. EDV = end-diastolic volume, ESV = end-systolic volume, SV = stroke volume, EF = ejection fraction, PER = peak ejection rate, PFR = peak filling rate, ES = end-systole.

<sup>a</sup>For differences between imaging techniques,  $p$  was obtained by paired Student's  $t$  test.

<sup>b</sup>Pearson's  $r$  and the corresponding  $p$  quantify the magnitude of correlation.

# Fonction régionale MSCT - ETT

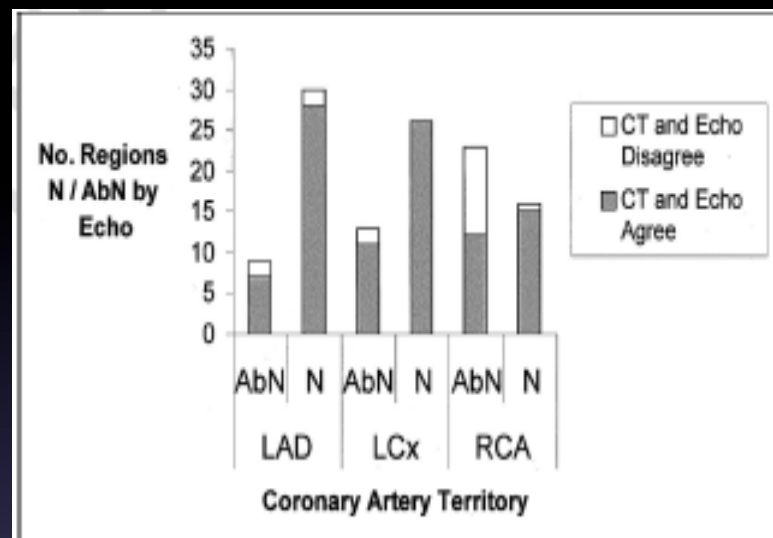
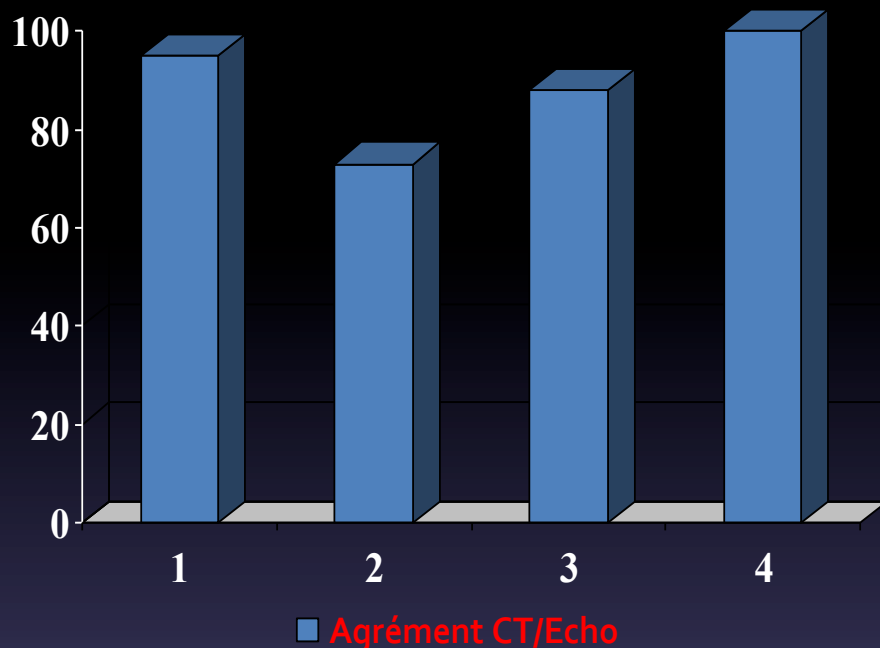


Table 4  
MDCT assessment of segmental function versus echocardiography as the gold standard (normal or abnormal)

Segment	No. of Segments	Sensitivity	Specificity	Positive Predictive Value	Negative Predictive Value	Accuracy
16-segment approach	616	66% (103/155)	96% (443/461)	85% (103/121)	89% (443/495)	89% (546/616)
3-segment approach						
All segments	117	67% (30/45)	96% (69/72)	90% (30/33)	82% (69/84)	85% (99/117)
Left anterior descending segments	39	78% (7/9)	93% (28/30)	78% (7/9)	93% (28/30)	90% (35/39)
Left circumflex segments	39	85% (11/13)	100% (26/26)	100% (11/11)	93% (26/28)	95% (37/39)
Right coronary segments	39	52% (12/23)	94% (15/16)	92% (12/13)	58% (15/26)	69% (27/39)



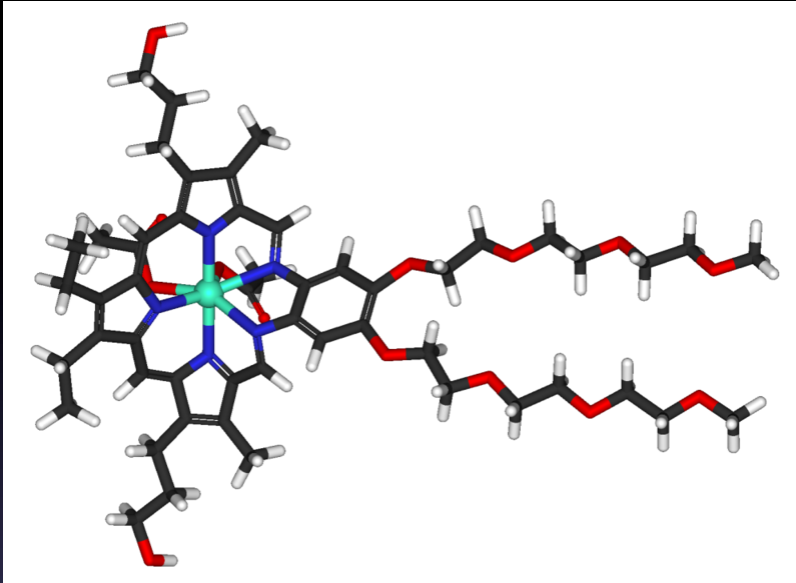
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8.

Analyse fonctionnelle

# PERFUSION

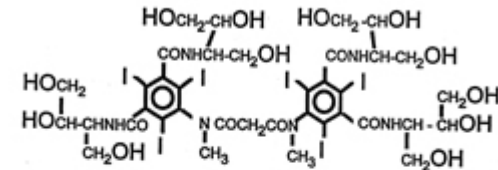
# Perfusion en Scanner



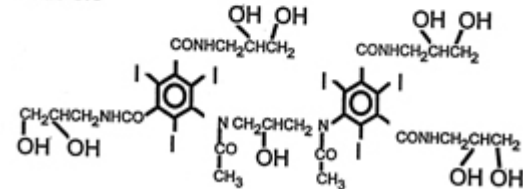
**Gadolinium**

Iotrolan  
ratio 6.0

Iotrolan  
ratio 6.0



Iodixanol  
ratio 6.0



**PCNI**

Mêmes caractéristiques biologiques, mêmes poids moléculaire, diffusion extracellulaire  
Mêmes propriétés pour évaluer la perfusion myocardique.

Sémiologie MSCT = IRM

1° passage: perfusion, passage tardif, réhaussement tardif

# PERFUSION MSCT

-Gating prospectif avec modulation de dose

-1<sup>o</sup> passage post injection PCI (100-140cc)

Collimation 64\*0.625mm, 120 Kv

12mSv

Hypodensité 20HU < myocarde adjacent

-Defect tardif: 5-10min après

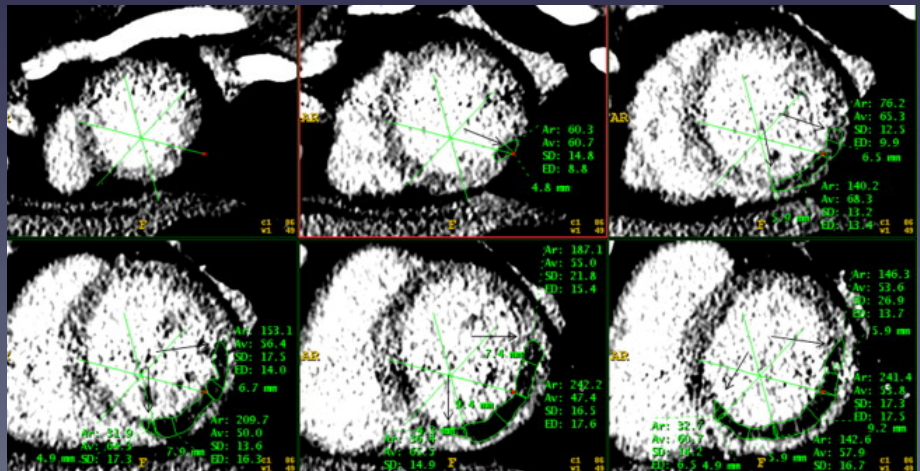
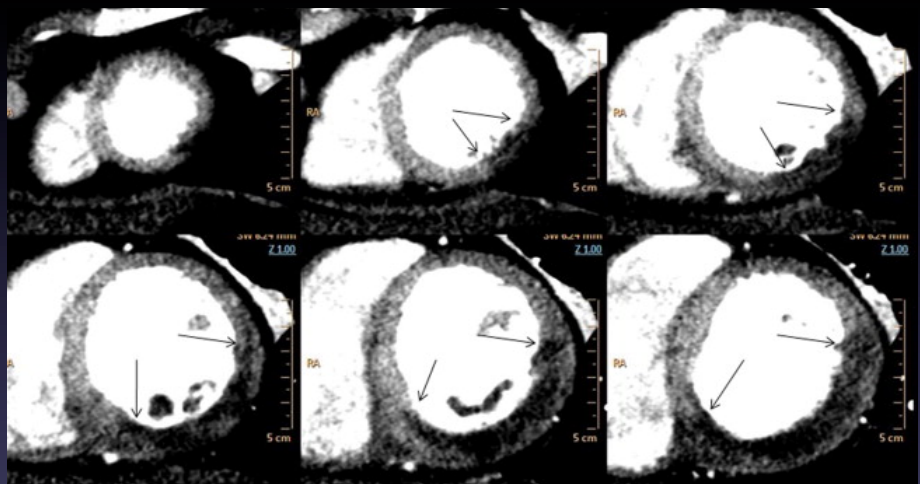
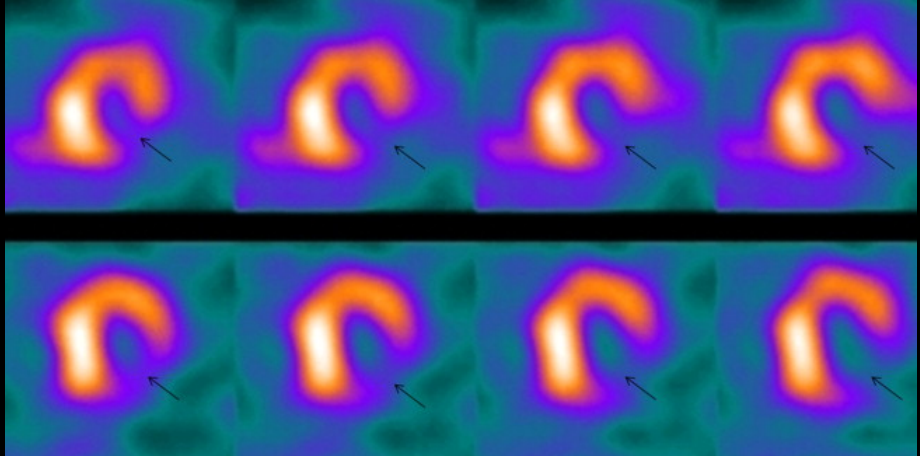
Collimation 32\*1.25mm, 80kV

1.5 mSv

Réhaussement tardif 20HU > myocarde adjacent

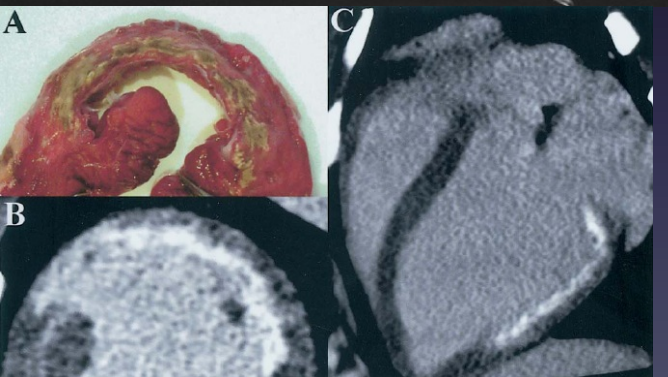
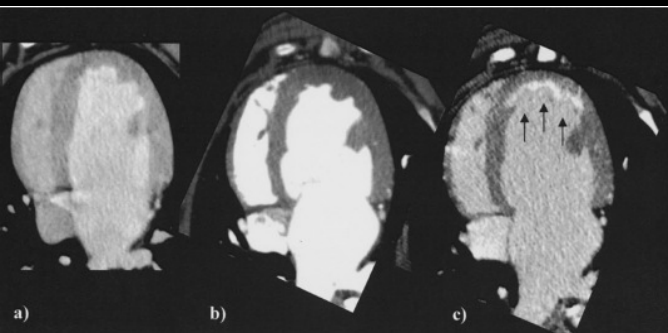
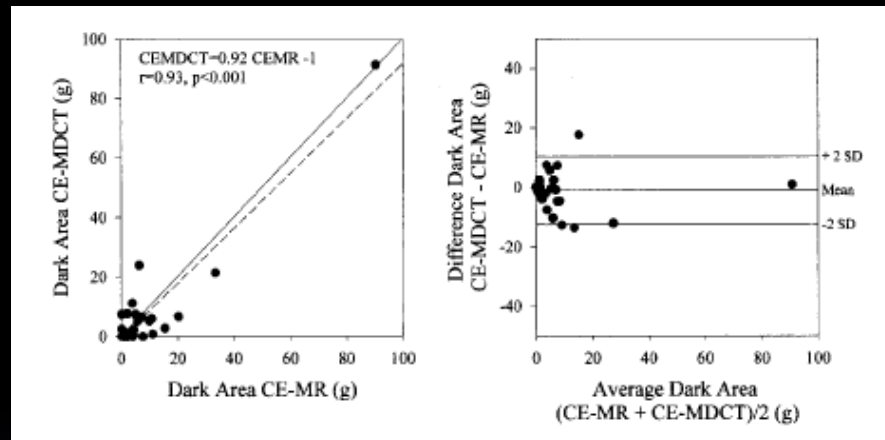
Reconstruction coupes axiales 5mm base-apex

Planimétrie, phases 0-75%, ES

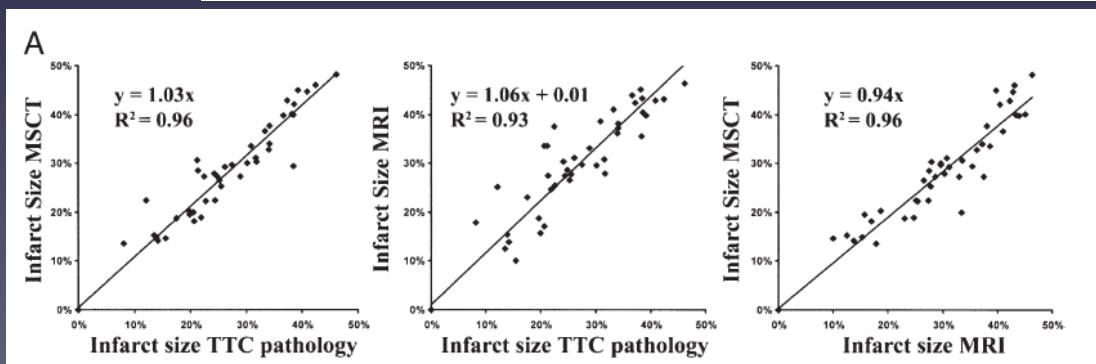
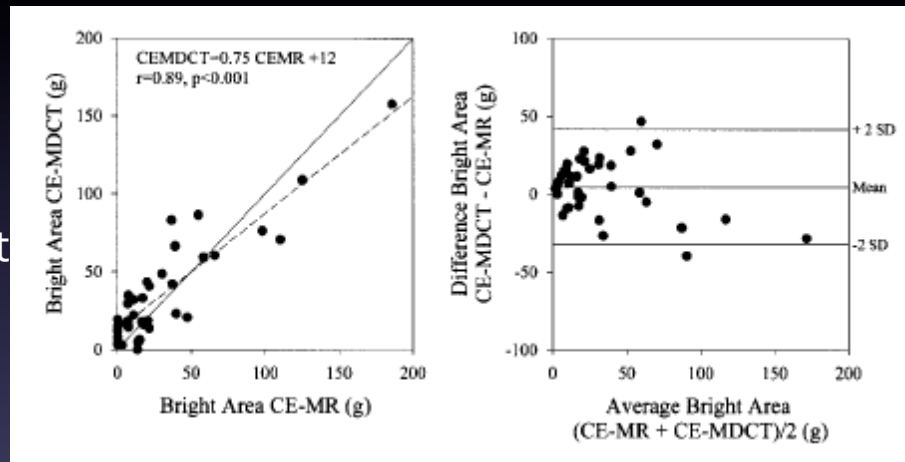


# PERFUSION MSCT vs IRM

1° passage



Réhaussement tardif

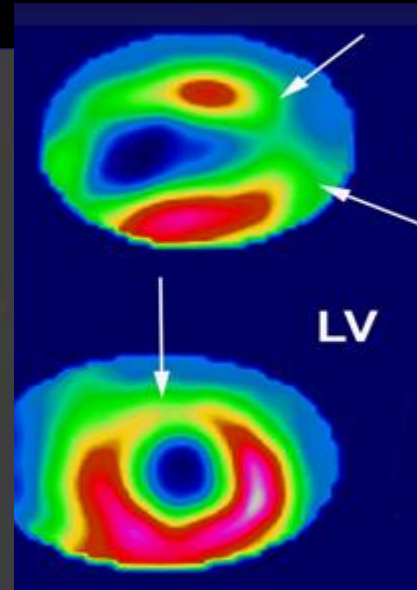
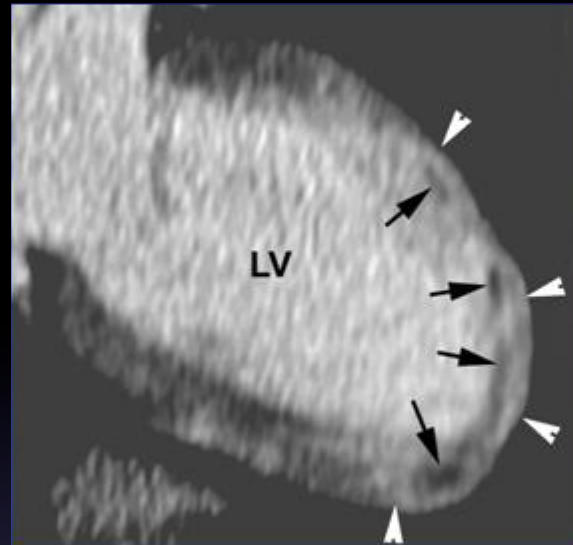


Taille de l' infarctus, modèle animal

# NO REFLOW MSCT

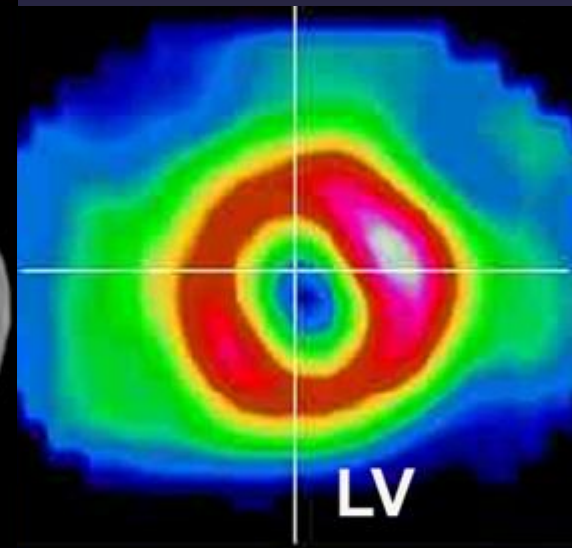
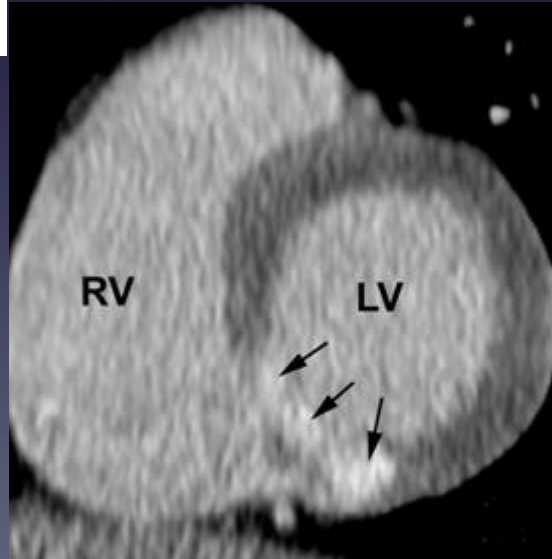
## Pronostique

Hypodensité persistante sur temps tardif  
/ Séquelle scintigraphique à distance



**Sensibilité 78%**    **Spécificité 91%**

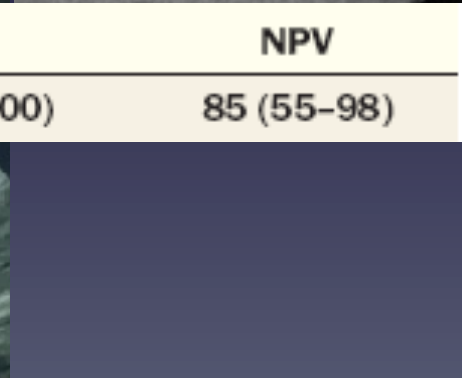
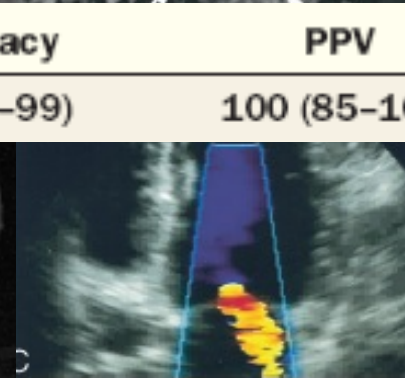
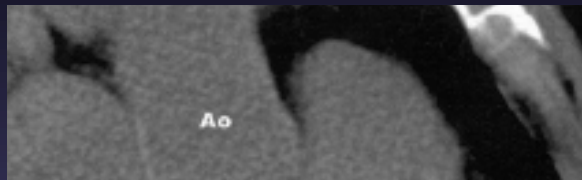
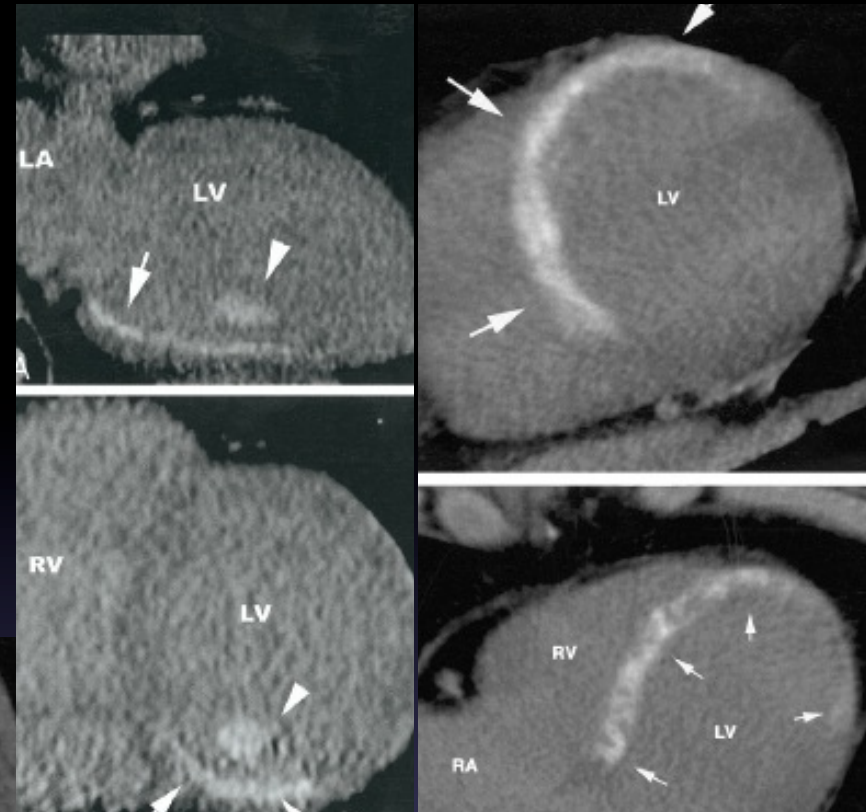
Pas d'hypodensité persistante  
au temps tardif  
/ Pas de séquelle d'infarctus



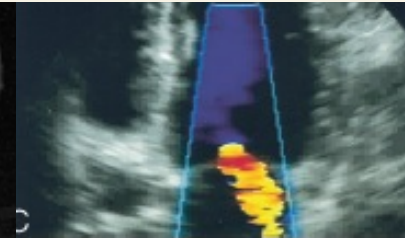
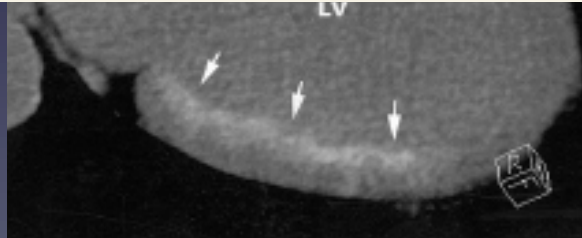


# TRANSMURALITE ET VIABILITE

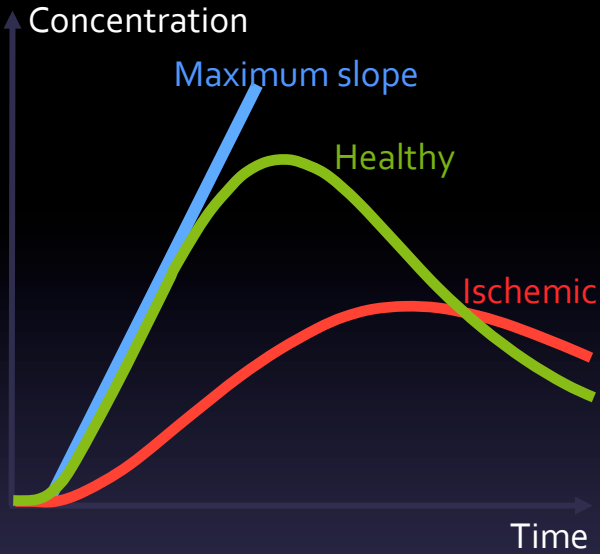
MSCT 64 barrettes 24+/- 11min post coro  
 SANS réinjection de PCI  
 Sous endo <50% épaisseur myocardique  
 Prédiction viabilité écho de stress 4sem



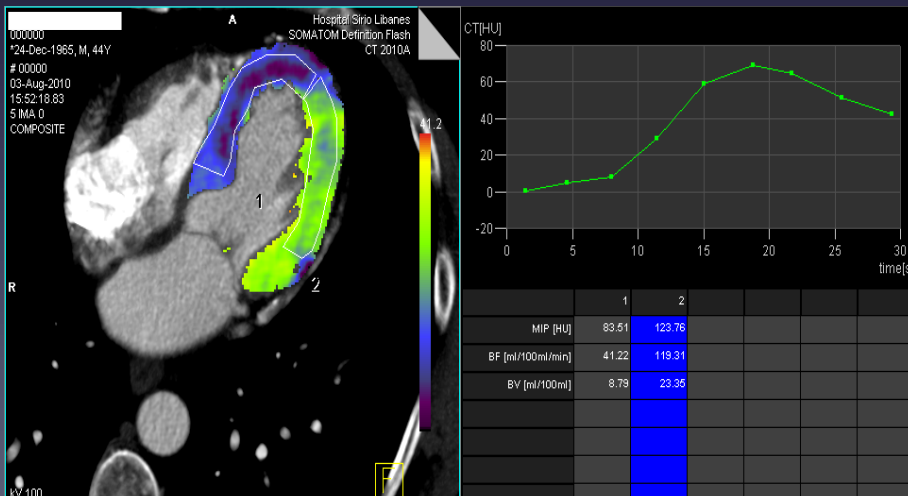
Sensitivity	Specificity	Accuracy	PPV	NPV
92 (74-99)	100 (72-100)	94 (81-99)	100 (85-100)	85 (55-98)



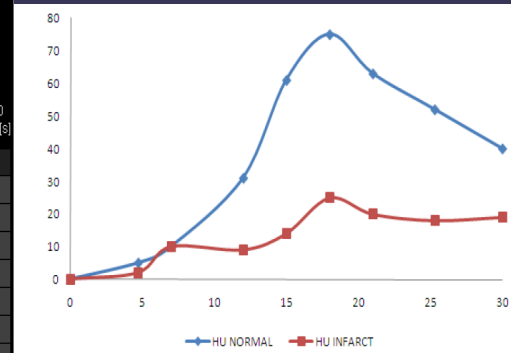
# PERFUSION ET **SCANNER CARDIAQUE DE STRESS ?**



- Enregistrement de la prise de contraste myocardique pendant 30 sec
- Flux myocardique: pente maximale de la courbe d'atténuation
- Dose : 9.2 – 9.6 mSv<sup>2,3</sup> (CT) vs. 10 – 20 mSv<sup>3-5</sup> (SPECT)



Flux myocarde ischémique: **41 cc/ 100 cc/ min**  
 Flux myocarde sain: **119 cc/ 100 cc/ min**

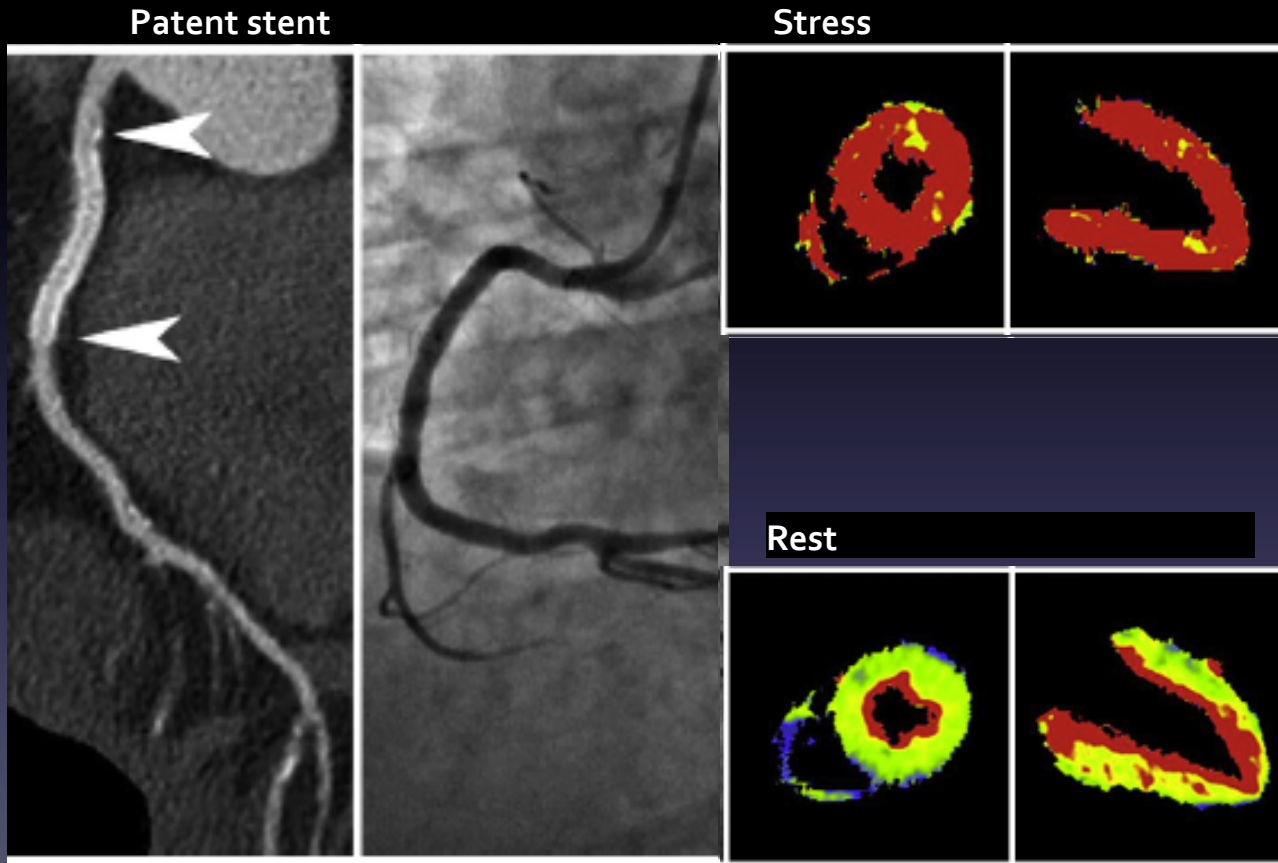


Rotation time: 0.28 s  
 Temporal resolution: 75 ms  
 Tube voltage: 100 kV  
 Prospectively triggered scans for 30 s  
 Dose: 9.98 mSv

3: Ho et al., JACC 3 (8), 2010  
 2: Bamberg et al., EurRad 20, 2010

5: Earls et al., Radiology, 2008  
 4: Thompson, Journal of Nuclear Cardiology, 2006

# Exemple **MSCT PERFUSION STRESS**



FLUX zone ischémique:  
**118 cc/ 100 cc/ min**

FLUX myocarde sain:  
**112 cc/ 100 cc/ min**

Rotation time: 0.28 s  
Temporal resolution: 75 ms  
Tube voltage: 100 kV  
Prospectively triggered scans  
for 30 s



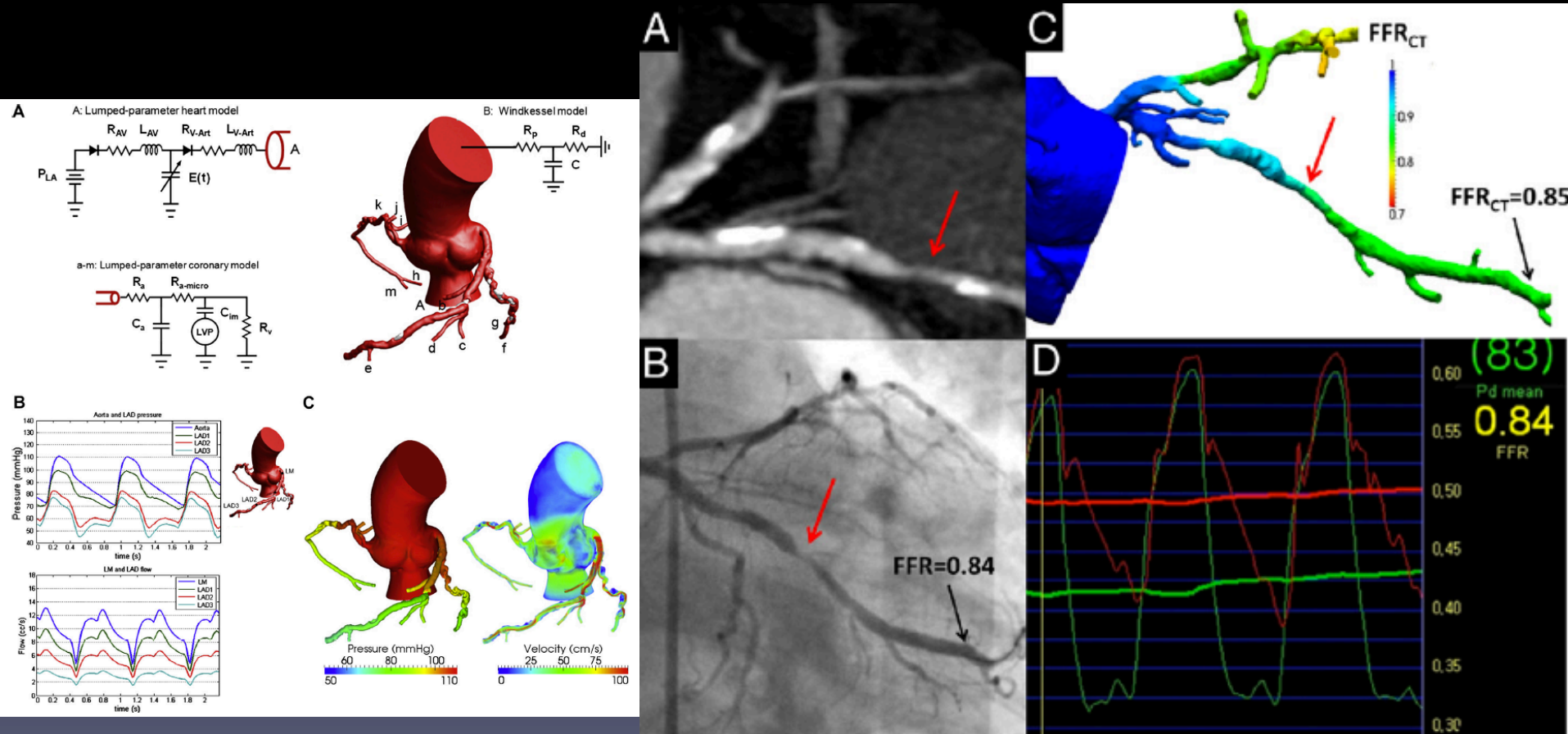
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9.

Analyse fonctionnelle

**FFR CTA**

# FFR CTA – modélisation mathématique; dynamique des fluides

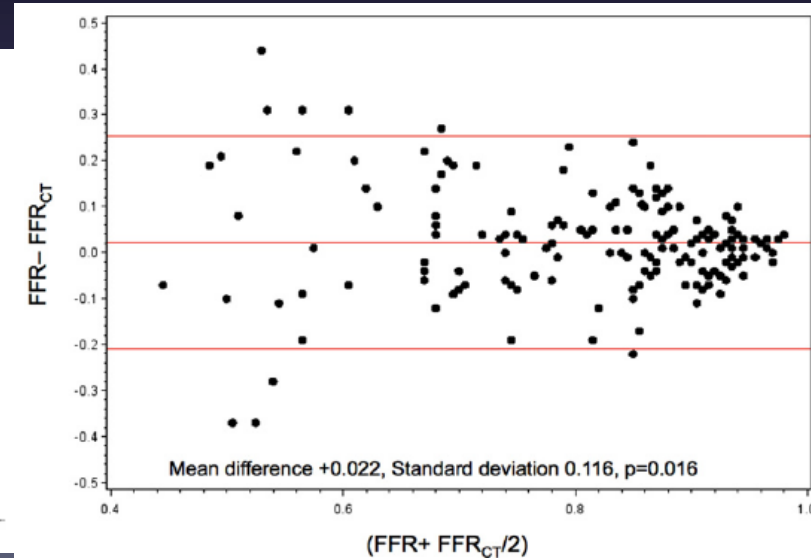
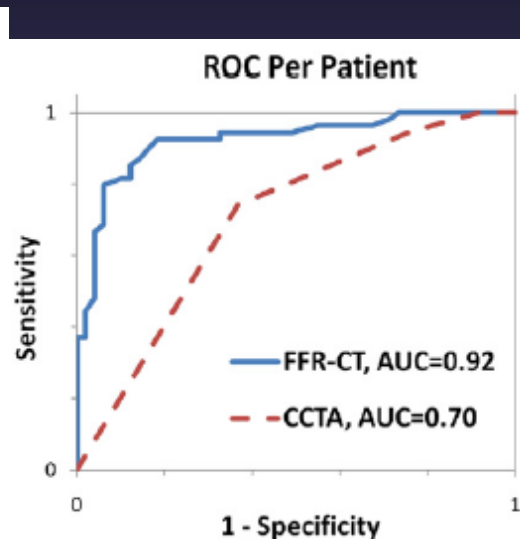
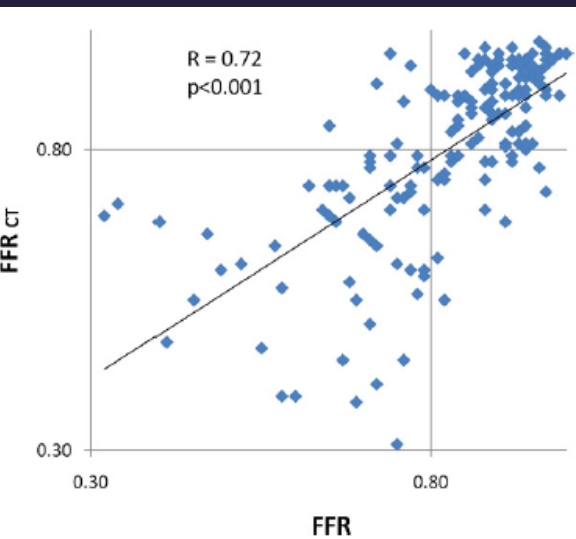


# DISCOVER FLOW

103 pts, CTA, QCA, FFR

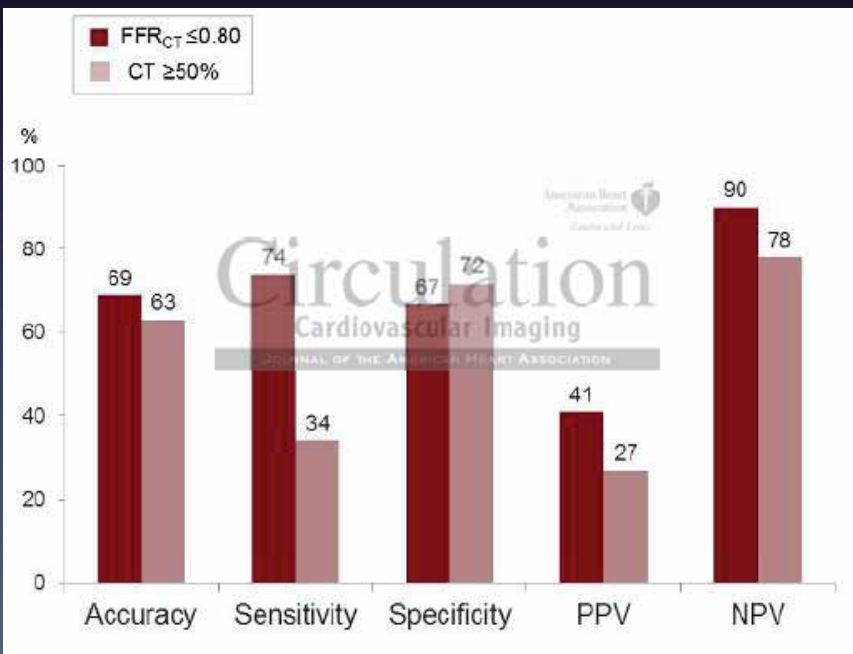
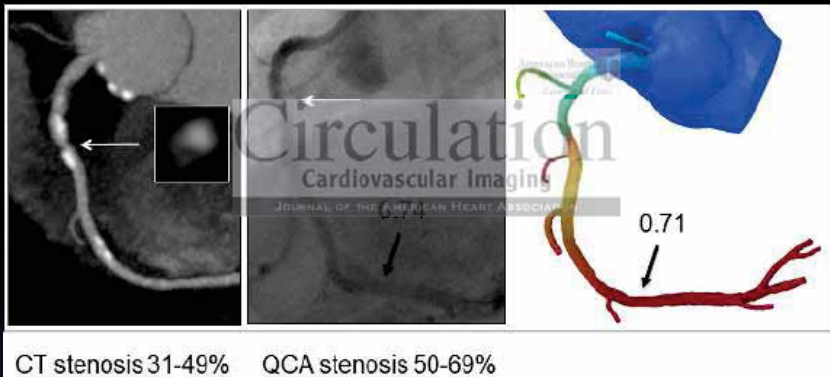
**Table 2** Diagnostic Performance of FFR<sub>CT</sub> and CCTA on a Per-Vessel and -Patient Basis

Measure	Per-Vessel		Per-Patient	
	FFR <sub>CT</sub> ≤ 0.80 (95% CI)	CCTA Stenosis ≥ 50% (95% CI)	FFR <sub>CT</sub> ≤ 0.80 (95% CI)	CCTA Stenosis ≥ 50% (95% CI)
Accuracy	84.3 (77.7–90.0)	58.5 (50.4–66.2)	87.4 (79.4–93.1)	61.2 (51.1–70.6)
Sensitivity	87.9 (76.7–95.0)	91.4 (81.0–97.1)	92.6 (82.1–97.9)	94.4 (84.6–98.8)
Specificity	82.2 (73.3–89.1)	39.6 (30.0–49.8)	81.6 (68.0–91.2)	24.5 (13.3–38.9)
PPV	73.9 (61.9–83.7)	46.5 (37.1–56.1)	84.7 (73.0–92.8)	58.0 (47.0–68.4)
NPV	92.2 (84.6–96.8)	88.9 (75.9–96.3)	90.9 (78.3–97.5)	80.0 (51.9–95.7)
LR (+)	4.94 (3.54–6.89)	1.51 (1.33–1.73)	5.03 (3.34–7.59)	1.25 (1.11–1.41)
LR (–)	0.147 (0.097–0.224)	0.22 (0.127–0.370)	0.091 (0.046–0.181)	0.229 (0.097–0.541)

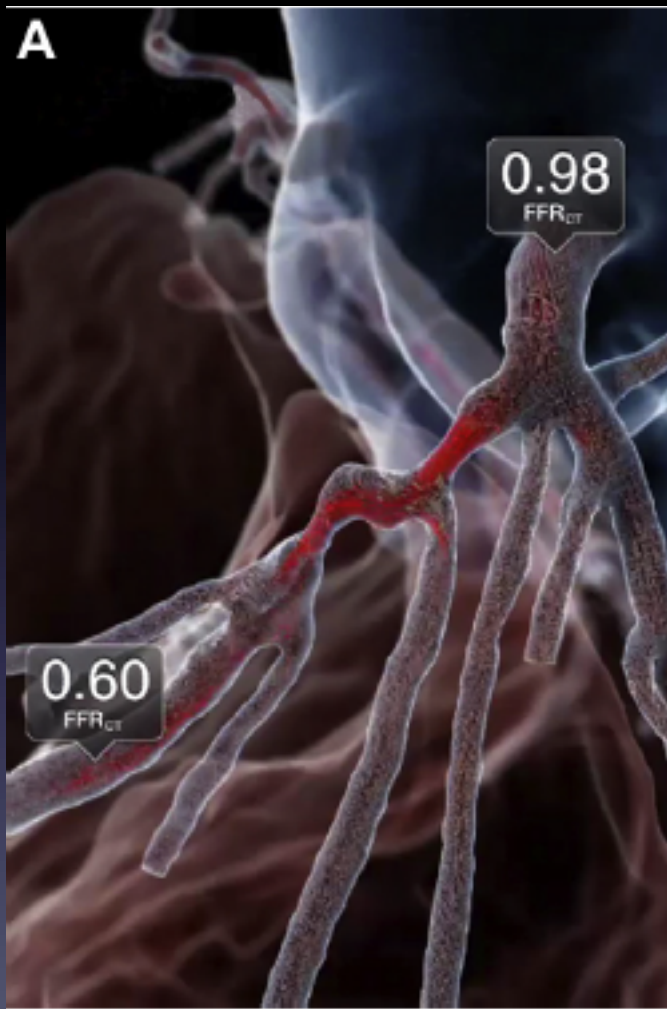


# DE FACTO

252 pts, 150 vaisseaux sténose 30-69%: FFR<sub>CTA</sub>, QCA, FFR, ≥64 bar



FFR <sub>CT</sub>	Pretest likelihood <70% (n=51)		Pretest likelihood ≥70% (n=31)	
	Estimate, % (95% CI)	No. of patients in group	Estimate, % (95% CI)	No. of patients in group
Accuracy	75 (60-86)	51	71 (52-86)	31
Sensitivity	78 (52-94)	18	89 (52-100)	9
Specificity	73 (55-87)	33	64 (41-83)	22
PPV	61 (39-80)	23	50 (25-75)	16
NPV	86 (67-96)	28	93 (68-100)	15
AUC	0.75 (0.63-0.88)	-	0.76 (0.61-0.91)	-
<b>CT stenosis</b>				
Accuracy	59 (44-72)	51	48 (30-67)	51
Sensitivity	44 (22-69)	18	22 (3-60)	9
Specificity	67 (48-82)	33	59 (36-79)	22
PPV	42 (20-67)	19	18 (2-52)	11
NPV	69 (50-84)	32	65 (41-85)	20
AUC	0.56 (0.41-0.70)	-	0.41 (0.23-0.59)	-







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10.

Sécurité

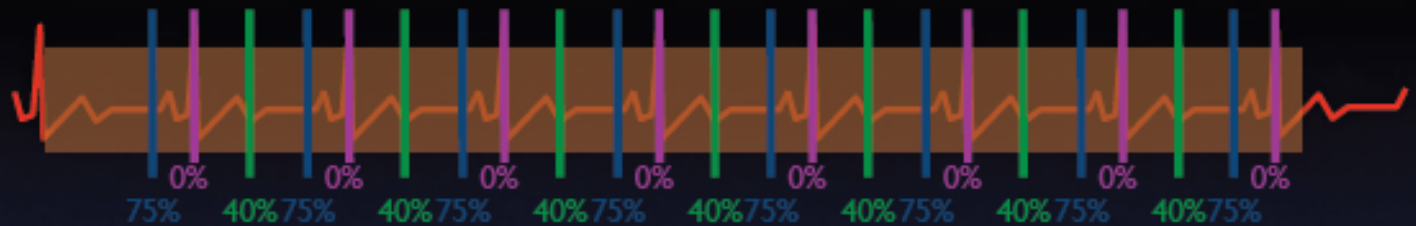
# RADIOPROTECTION

# Evolutions RX et évolutions techniques

Coronarographie diagnostique: 3 –10 mSv

- Retrospective Spiral (Reference mode)

**8-16 mSv**



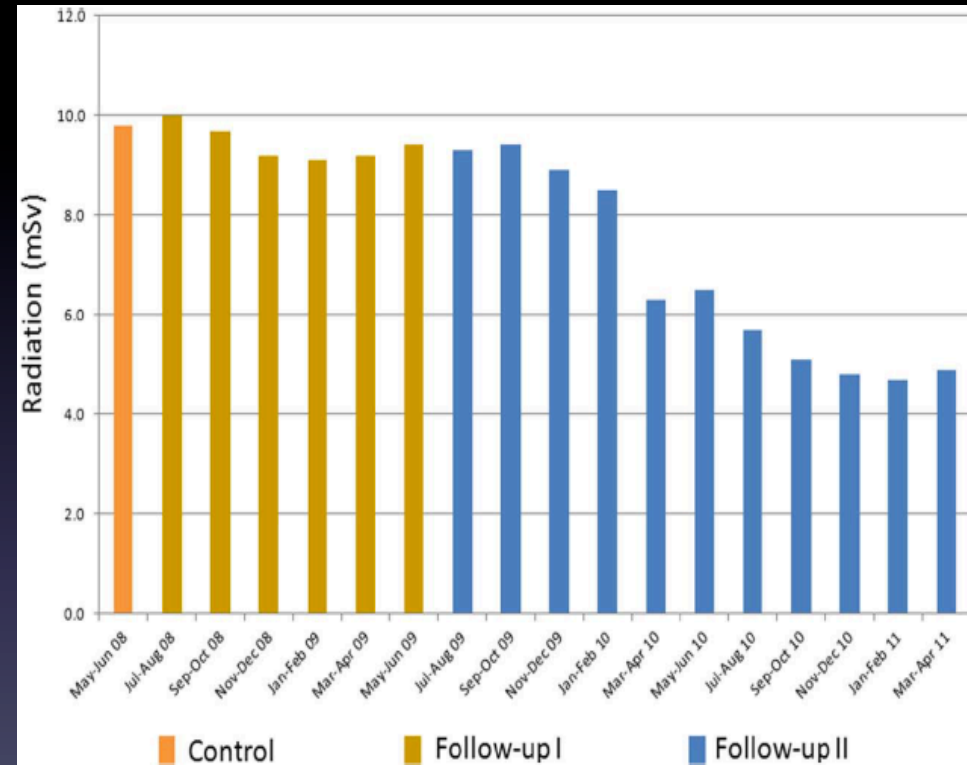
# Objectifs de réduction de dose: optimisation des protocoles

Facteurs associés à une dose <10 mSv:

- Voltage du tube 100 kV (vs 120 kV)  
(odds ratio 3.12): - 40%,
- Gating prospectif (OR 2.236)
- BMI <30 kg/m<sup>2</sup> (OR 1.731),
- Femme (OR 1.092)

*Autres:*

- Fenêtre d'acquisition réduite: 1.8mSv
- Dual Source CT (acquisition du volume cardiaque en 300 msec): **0.56 mSv !**



coroTDM

**ETUDES EN ATTENTE**

# PROMISE Trial Design

Symptoms suspicious for significant CAD,  
Requiring non-emergent noninvasive testing



**Randomization**

**Coronary Computed Tomographic Angiography for Selective Cardiac Catheterization (CONSERVE)**

**This study is currently recruiting participants.**

*Verified September 2013 by MDDX LLC*

**Sponsor:**

MDDX LLC

**Collaborator:**

GE Healthcare

**Information provided**

MDDX LLC

ClinicalTrials.gov Identifier:

NCT01810198

First received: February 22, 2013

A prospective, randomized controlled multicenter trial to determine the clinical and cost effectiveness of a "selective catheterization" strategy versus a "direct catheterization" strategy for stable patients with suspected but without known CAD and clinical indication for non-emergent invasive coronary angiography.

Primary endpoint of non-inferiority for rates of major adverse cardiac events (MACE)

**Subsequent testing/mgmt per care team + guideline care**  
**Average f/u 30 months**



**1° = 30 mo death, MI, Complications, UA hosp**

**2° = MACE components, Costs, QOL**

**Safety: Radiation exposure**





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Actualités en imagerie cardiaque en 2014

CORO-SCANNER

**CONCLUSION**

# CONCLUSION



- 1. Exclusion coronaropathie / VPN
- 2. Stratification du risque coronaire:
  - Score calcique
  - Analyse de plaque
- 3. TAVI: préparatoire, réduction des IAO
- 4. TRO: DT aux urgences
- 5. Rythmologie: veines coronaires et pulmonaires, fusion
- 6. Fonction VG / VD
- 7. Perfusion: repos et stress
- 8. FFR CTA
- 9. Amélioration efficacité diagnostique et sécurité clinique: RX, iode

SEPTEMBER 5, 2005

www.time.com AOL Keyword: TIME

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COOL NEW SEARCH ENGINES

# TIME

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**HEART  
ATTACK**  
BEFORE IT  
HAPPENS

Amazingly detailed new  
**HEART SCANS** help doctors  
spot trouble without  
surgery. How technology  
could save your life



Mike Fackelmann, 50,  
holds a scan of his  
heart, which revealed  
a major blockage of a  
coronary artery (arrow)