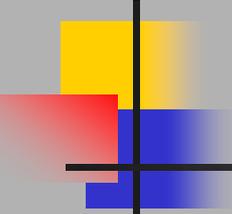


Syndrome coronaire aigu et ses complications: TDM

Christophe CAUSSIN
IMM Paris



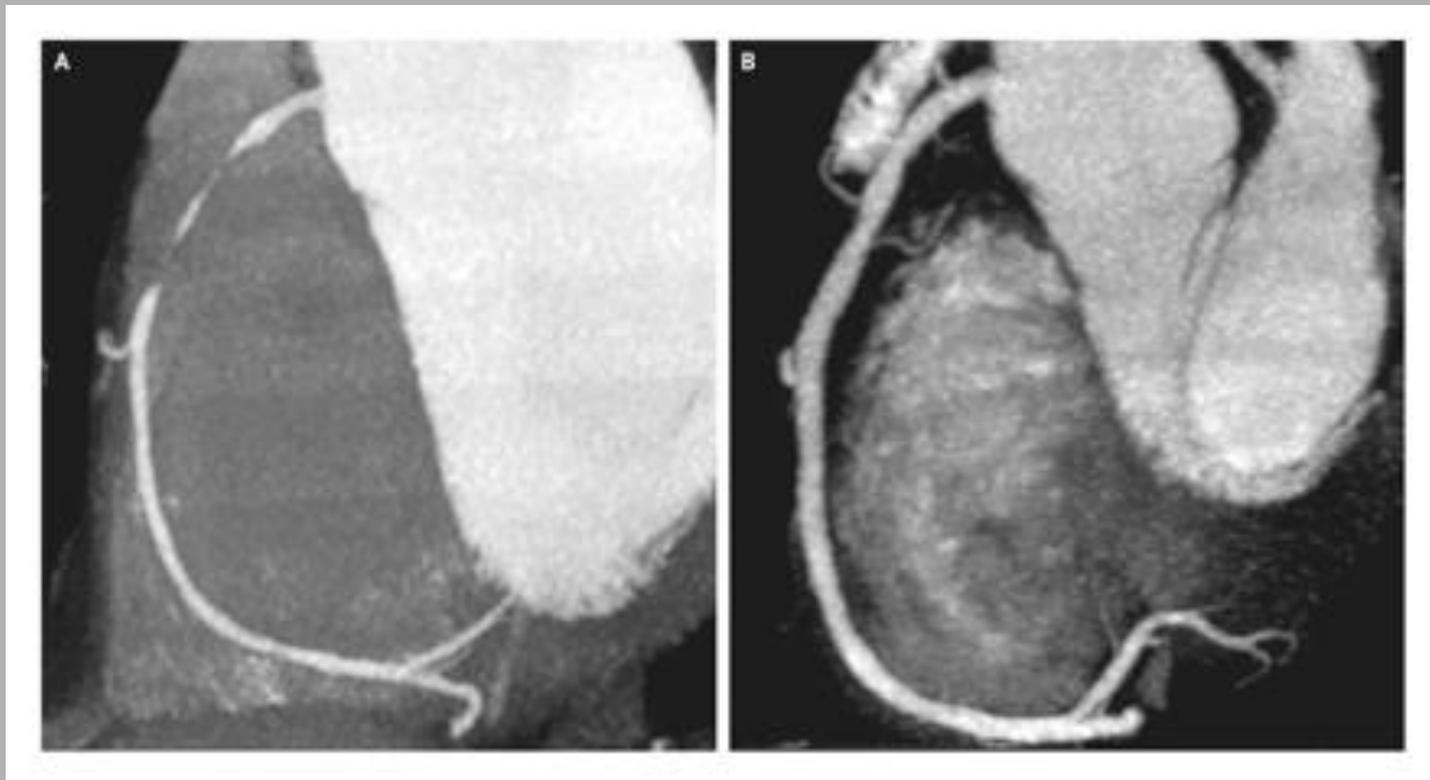
L'INSTITUT
MUTUALISTE
MONTSOURIS



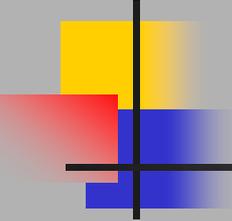
Place du scanner dans le SCA

- Pas d'indication si Syndrome coronaire Avéré
 - Perte de temps
 - Transport dangereux
 - Cumul de produit de contraste
 - Cumul d'irradiation
 - Pas de geste de revascularisation≠coronarographie
 - Pas d'exploration de la vasoconstriction pathologique (Methergin)

Spasme spontané au cours d'un scanner



M. Hamon NEJM 2006

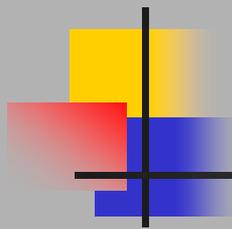


Cas clinique

- Mme H 53 ans
- FDR: Hérité (IDM +DC père à 65ans)
- Douleur atypique non liée à l'effort depuis 1 semaine
- ECG normal
- Troponine négative

Comparaison à la coronarographie

		n	Excl (%)	Sens (%)	Spec (%)	PPV (%)	NPV (%)
4 slice MSCT							
Nieman et al	Lancet 2001	31	27	81	97	81	97
Achenbach et al	Circulation 2001	64	32	85	76	56	94
Knez et al	Am J Cardiol 2001	44	6	78	98	84	96
Vogl et al	Radiology 2001	38	19	75	99	92	98
16 slice MSCT							
Nieman et al	Circulation 2002	58	0	95	86	80	97
Ropers et al	Circulation 2003	77	12	92	93	79	97
Mollet et al	JACC 2004	128	0	92	95	79	98
Paul et al	Arch Mal Cœur 2004	30	10	87	99	82	99
Martuscelli et al	Eur Heart J 2004	91	16	89	98	90	98
Kuettner et al	JACC 2005	72	0	82	98	87	97
64 slice MSCT							
Raff et Al	JACC 2005	70	12	86	95	66	98
Mollet et Al	Circulation 2005	52	2	99	95	76	99
Leshcka etr Al	Eur Heart J 2005	67	0	94	97	76	99
Leber et Al	JACC 2005	59	7	73	97	-	-
Ghostine et Al	JACC 2006	58	0	73	95	91	97



Place du scanner dans le SCA

■ Stratification du risque et probabilité pré test

■ TIMI score

Table 2 TIMI risk score for Unstable Angina and NSTEMI

- Age ≥ 65 years
- History of known CAD (documented prior coronary artery stenosis $>50\%$)
- ≥ 3 conventional cardiac risk factors (age, male sex, family history, hyperlipidemia, diabetes mellitus, smoking, obesity)
- Use of aspirin in the past 7 days
- ST-segment deviation (persistent depression or transient elevation)
- Increased cardiac biomarkers (troponins)
- ≥ 2 anginal events in the preceding 24 h

Chest Pain Score (Geleijnse et al. [17])

Location	
Substernal	+3
Precordial	+2
Neck, jaw, epigastrium	+1
Apical	-1
Radiation	
Either arm	+2
Shoulder, back, neck, jaw	+1
Characteristics	
Crushing, pressing, squeezing	+3
Heaviness, tightness	+2
Sticking, stabbing, pinprick, catching	-1
Severity	
Severe	+2
Moderate	+1
Influenced by	
Nitroglycerin	+1
Stature	-1
Breathing	-1
Associated symptoms	
Dyspnea	+2
Nausea or vomiting	+2
Diaphoresis	+2
History of exertional angina	+3

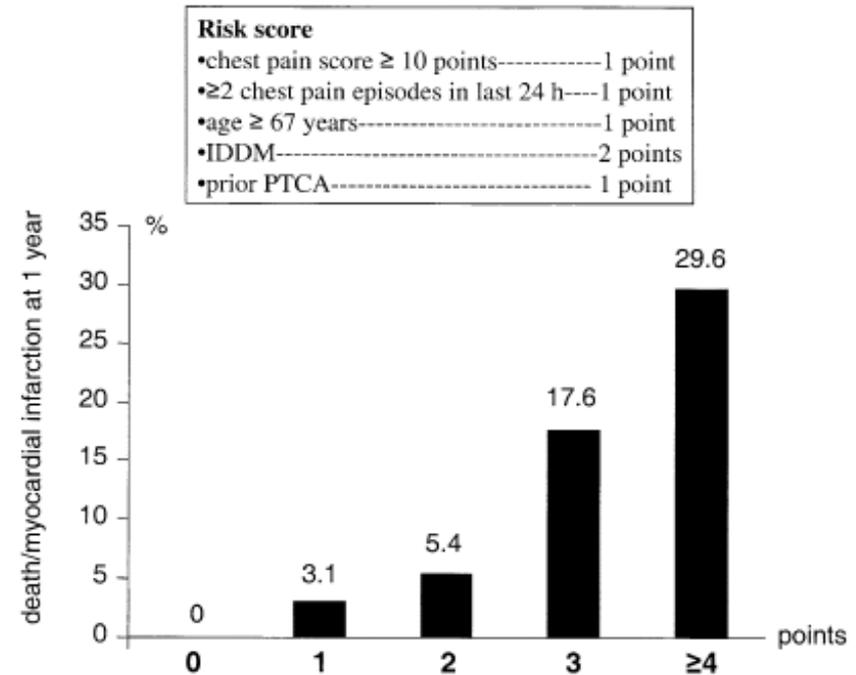


Figure 1. Risk categories according to risk score: very low-risk (0 points, primary end point = 0%), low-risk (1 point, primary end point = 3.1%), intermediate-risk (2 points, primary end point = 5.4%), high-risk (3 points, primary end point = 17.6%), and very high-risk (≥ 4 points, primary end point = 29.6%). The statistical significance for the trend was $p = 0.00001$; the differences between the very low-, low-, and intermediate-risk categories being significant compared to the very high- ($p = 0.0001$, $p = 0.0001$, and $p = 0.0001$, respectively) and high-risk ($p = 0.002$, $p = 0.0001$, $p = 0.0001$, respectively) categories. IDDM = insulin-dependent diabetes mellitus; PTCA = percutaneous transluminal coronary angioplasty.

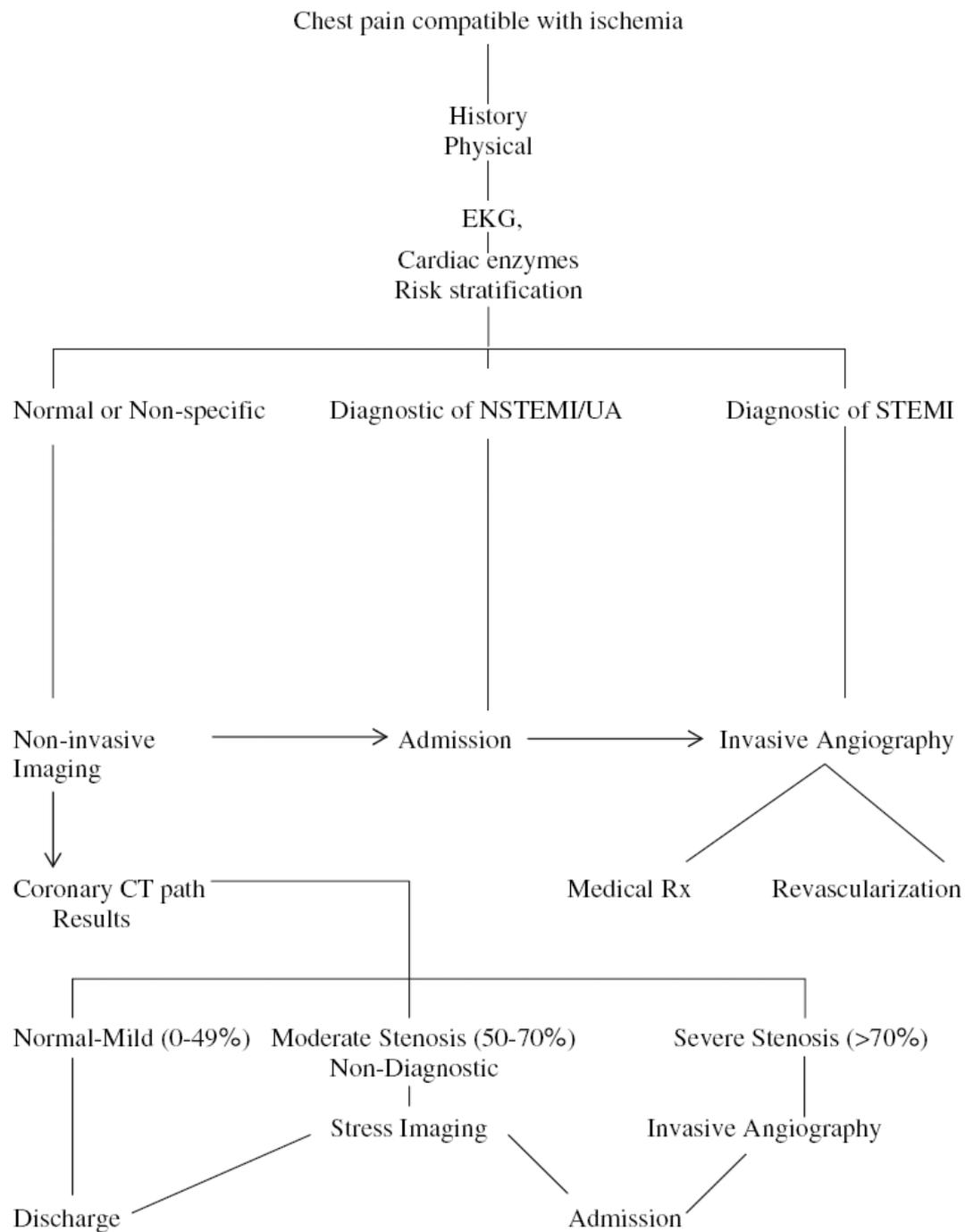
Archives of Cardiovascular Diseases Supplements

Guide de bonnes pratiques
et recommandations en imagerie
cardiaque en coupes

Indications inappropriées

L'utilisation de scanner coronaire n'est pas recommandée dans les situations suivantes.

1. Douleur thoracique aiguë avec modifications ECG et/ou élévation des enzymes cardiaques



Usefulness of 64-Slice Cardiac Computed Tomographic Angiography for Diagnosing Acute Coronary Syndromes and Predicting Clinical Outcome in Emergency Department Patients With Chest Pain of Uncertain Origin

Ronen Rubinshtein, MD; David A. Halon, MB, ChB; Tamar Gaspar, MD; Ronen Jaffe, MD; Basheer Karkabi, MD; Moshe Y. Flugelman, MD; Asia Kogan, MD; Reuma Shapira, MD; Nathan Peled, MD; Basil S. Lewis, MD, FRCP

(Circulation. 2007;115:1762-1768.)

Valeur pronostique CT aux urgences sur les MACE:

VPP d'évènement: 52%

VPN d'évènement: 97% (1 pt/ 35)

ORIGINAL ARTICLE

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

Harold I. Litt, M.D., Ph.D., Constantine Gatsonis, Ph.D., Brad Snyder, M.S.,
Harjit Singh, M.D., Chadwick D. Miller, M.D., Daniel W. Entrikin, M.D.,
James M. Leaming, M.D., Laurence J. Gavin, M.D., Charissa B. Pacella, M.D.,
and Judd E. Hollander, M.D.

This article (10.1056/NEJMoa1201163) was
published on March 26, 2012, at NEJM.org.

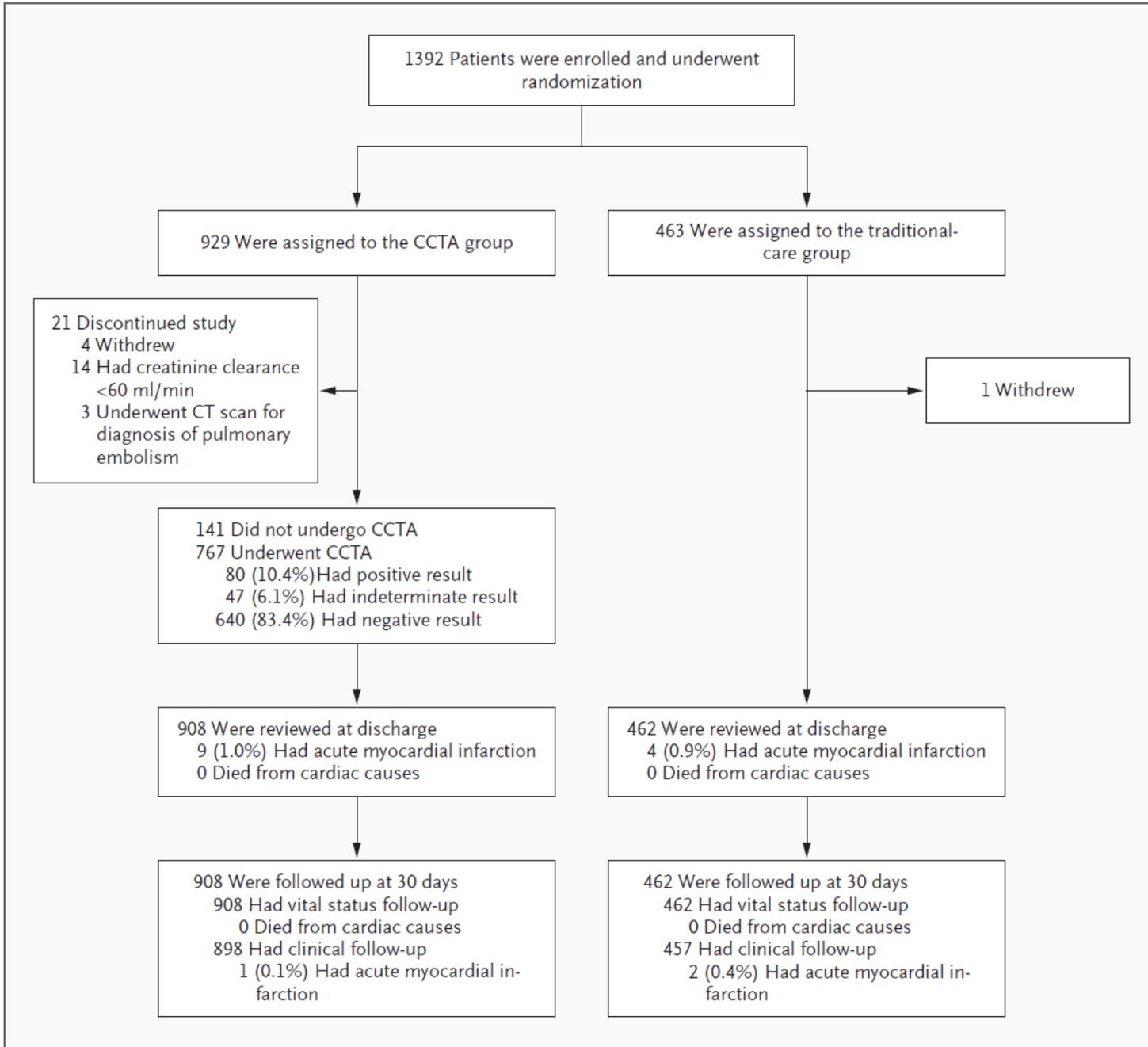


Figure 1. Enrollment, Randomization, Treatment, and Follow-up of the Study Patients.

MDCT in Early Triage of Patients with Acute Chest Pain

AJR 2006; 187:1240-1247

Udo Hoffmann¹
Antonio J. Pena¹
Fabian Moselewski¹
Maros Ferencik¹
Suhny Abbara¹
Ricardo C. Cury¹
Claudia U. Chae²
John T. Nagurney³

5/40 pts avaient un SCA
70% admissions épargnées

to the hospital because of suspected acute cardiac ischemia. Because of restricted funding, study enrollment was limited to only 2 days per week from 9 am to 5 pm during the weekdays. We included patients

Coronary Computed Tomography Angiography for Early Triage of Patients With Acute Chest Pain

The ROMICAT (Rule Out Myocardial Infarction using Computer Assisted Tomography) Trial

Udo Hoffmann, MD, MPH,*† Fabian Bamberg, MD, MPH,*† Claudia U. Chae, MD, MPH,‡
John H. Nichols, BA,* Ian S. Rogers, MD, MBA,* Sujith K. Seneviratne, MBBS,*
Quynh A. Truong, MD,* Ricardo C. Cury, MD,*† Suhny Abbara, MD,*† Michael D. Shapiro, DO,*
Jamaluddin Moloo, MD,* Javed Butler, MD, MPH,* Maros Ferencik, MD, PhD,* Hang Lee, PhD,§
Ik-Kyung Jang, MD, PhD,‡ Blair A. Parry, BA,|| David F. Brown, MD,|| James E. Udelson, MD,¶
Stephan Achenbach, MD,‡ Thomas J. Brady, MD,*† John T. Nagurney, MD, MPH||

Boston, Massachusetts; and Erlangen, Germany

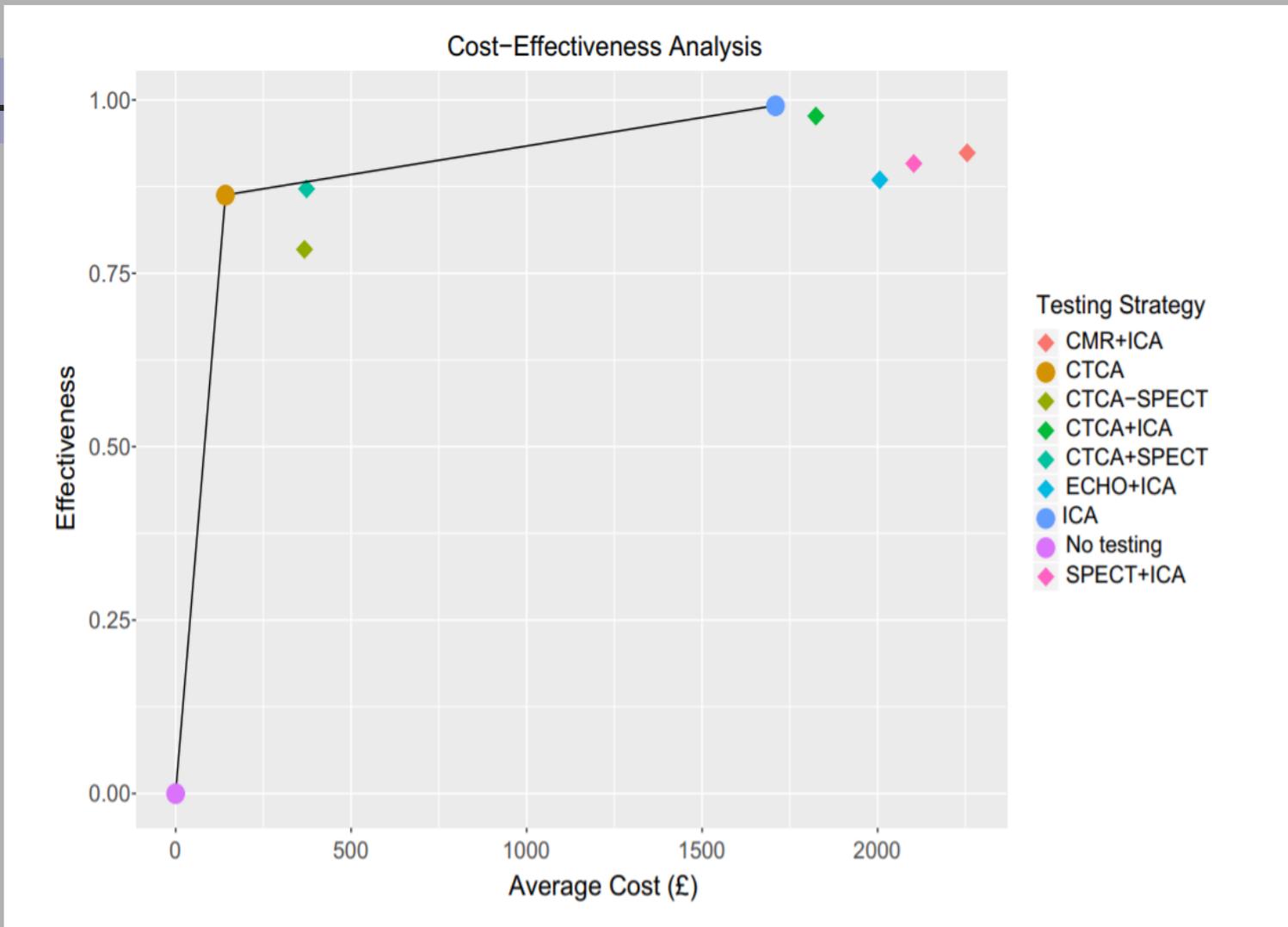
1869 pts éligibles

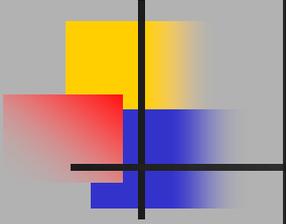
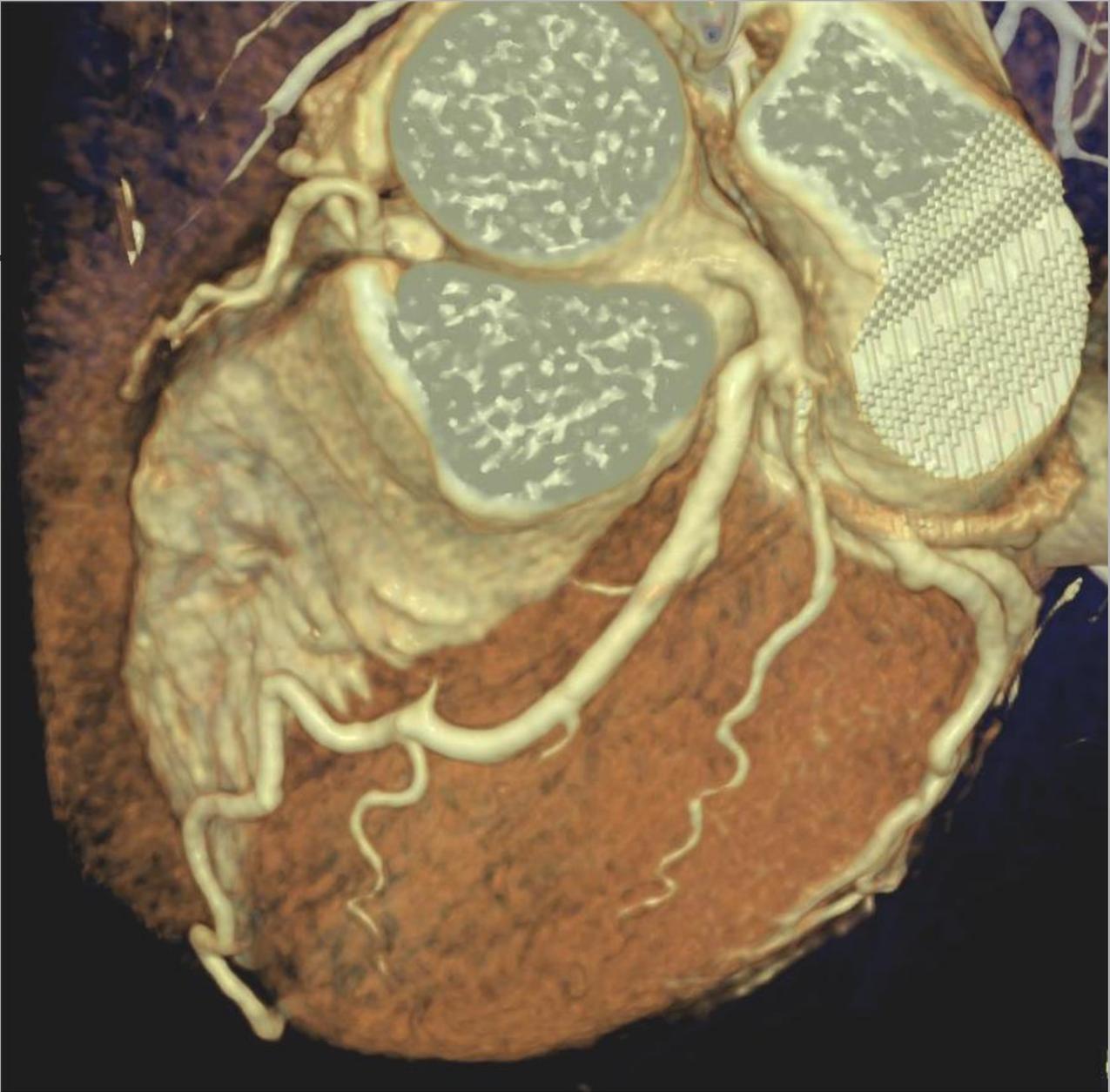
368 inclus

8% (31pts) SCA

50% pas de sténose

Etude cout efficacité des tests non invasifs





Recommendations for diagnosis and risk stratification

Recommendations	Class ^a	Level ^b	Ref ^c
In patients with a suspected NSTEMI-ACS, diagnosis and short-term ischaemic/bleeding risk stratification should be based on a combination of clinical history, symptoms, physical findings, ECG (repeated or continuous ST monitoring), and biomarkers.	I	A	16, 18, 27, 30, 58, 56, 57
ACS patients should be admitted preferably to dedicated chest pain units or coronary care units.	I	C	47
It is recommended to use established risk scores for prognosis and bleeding (e.g. GRACE, CRUSADE).	I	B	50, 83
A 12-lead ECG should be obtained within 10 min after first medical contact and immediately read by an experienced physician. This should be repeated in the case of recurrence of symptoms, and after 6–9 and 24 h, and before hospital discharge.	I	B	17, 18
Additional ECG leads (V_{3R} , V_{4R} , V_7 – V_9) are recommended when routine leads are inconclusive.	I	C	18
Blood has to be drawn promptly for troponin (cardiac troponin T or I) measurement. The result should be available within 60 min. The test should be repeated 6–9 h after initial assessment if the first measurement is not conclusive. Repeat testing after 12–24 h is advised if the clinical condition is still suggestive of ACS.	I	A	27, 30
A rapid rule-out protocol (0 and 3 h) is recommended when highly sensitive troponin tests are available (see <i>Figure 5</i>).	I	B	20, 21, 23
An echocardiogram is recommended for all patients to evaluate regional and global LV function and to rule in or rule out differential diagnoses.	I	C	-
Coronary angiography is indicated in patients in whom the extent of CAD or the culprit lesion has to be determined (see Section 5.4).	I	C	-
Coronary CT angiography should be considered as an alternative to invasive angiography to exclude ACS when there is a low to intermediate likelihood of CAD and when troponin and ECG are inconclusive.	IIa	B	37–41
In patients without recurrence of pain, normal ECG findings, negative troponins tests, and a low risk score, a non-invasive stress test for inducible ischaemia is recommended before deciding on an invasive strategy.	I	A	35, 54, 55

^aClass of recommendation.

^bLevel of evidence.

^cReferences.

ACS = acute coronary syndromes; CAD = coronary artery disease; CRUSADE = Can Rapid risk stratification of Unstable angina patients Suppress ADverse outcomes with Early implementation of the ACC/AHA guidelines; CT = computed tomography; ECG = electrocardiogram; GRACE = Global Registry of Acute Coronary Events; LV = left ventricular; NSTEMI-ACS = non-ST-segment elevation acute coronary syndrome.

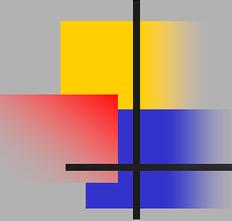
Table 16 Use of coronary computed tomography angiography for the diagnosis of stable coronary artery disease

Recommendations	Class ^a	Level ^b
Coronary CTA should be considered as an alternative to stress imaging techniques for ruling out SCAD in patients within the lower range of intermediate PTP for SCAD in whom good image quality can be expected.	IIa	C
Coronary CTA should be considered in patients within the lower range of intermediate PTP for SCAD after a non conclusive exercise ECG or stress imaging test 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 not recommended in patients with prior coronary revascularization.	III	C
Coronary CTA is not recommended as a 'screening' test in asymptomatic individuals without clinical suspicion of coronary artery disease.	III	C

CTA = computed tomography angiography; ECG = electrocardiogram; PTP = pre-test probability; SCAD = stable coronary artery disease.

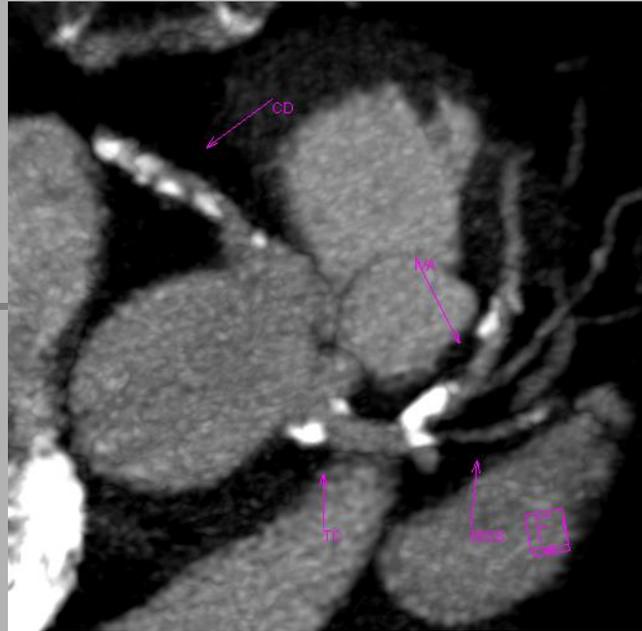
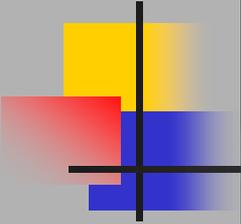
^a Class of recommendation.

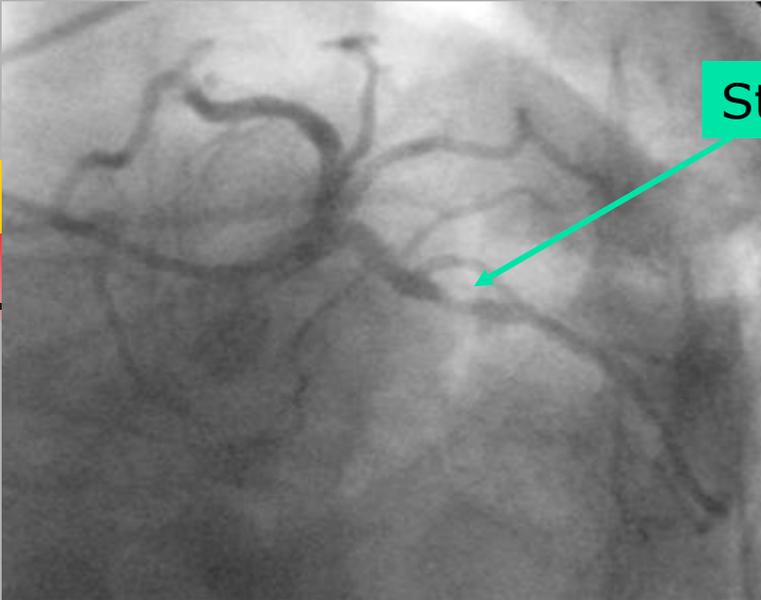
^b Level of evidence.



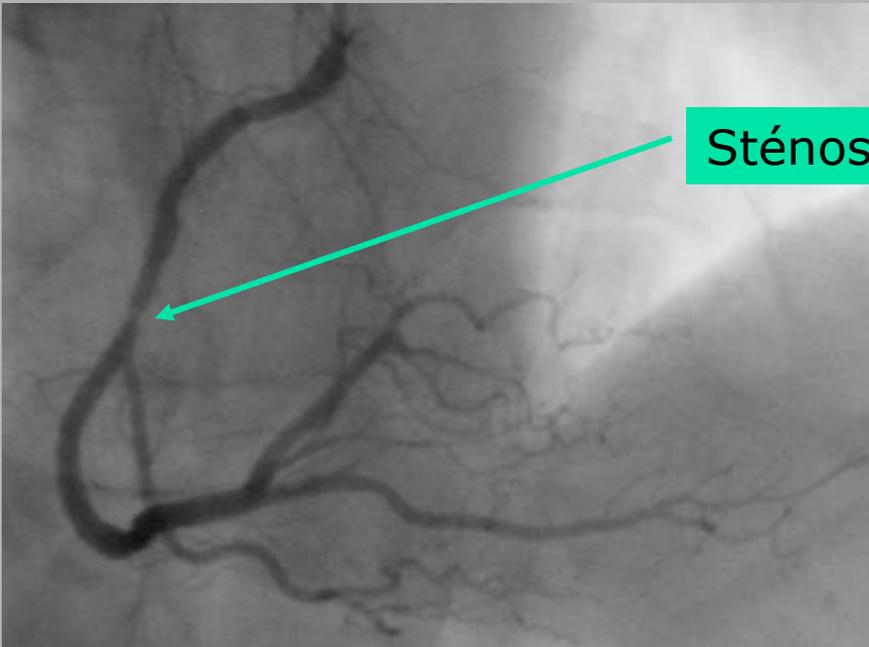
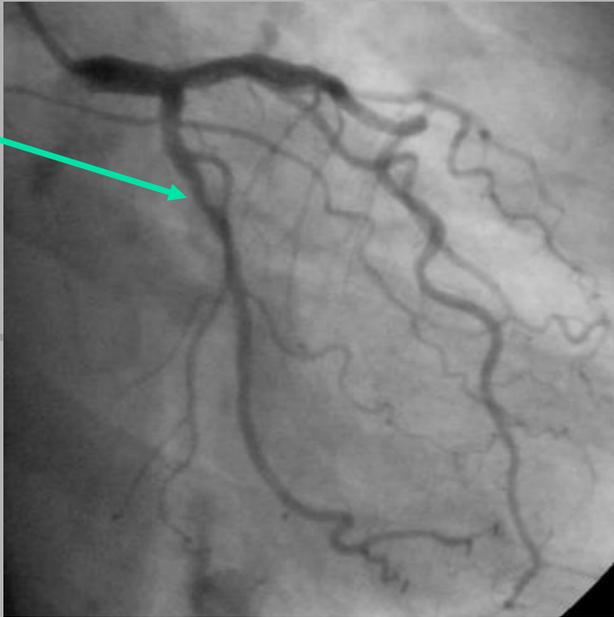
Cas clinique

- Homme 68 ans
- HTA, Hyper CT, Tabac
- Angor d'effort crescendo, douleur spontanée
- ECG: ST raide D2 D3 VF,
- Troponine normale
- Scanner

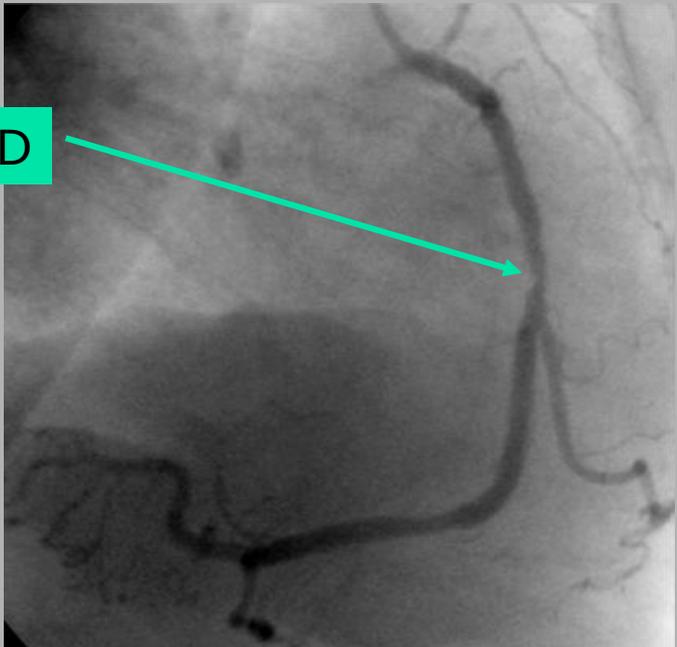


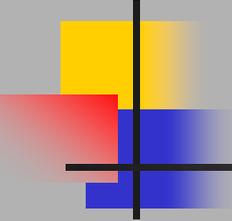


Sténose CX



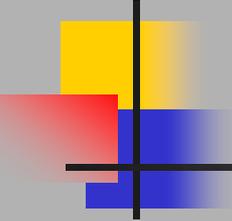
Sténose CD





Notion de rapport de vraisemblance négatif

- $RVN = 1 - (\text{sensibilité} / \text{spécificité}) = 0,05$ pour le coro scanner.
- Probabilité pré test \times $RVN =$ probabilité post test



Probabilité d'un examen pertinent

Cas 1: Probabilité pré test de coronaropathie: 10%,

-> 90% cas examen conclus le dossier

-> Risque d'erreur: $0.1 \times 0.05 = 0.5 \%$

-> 10% d'examen redondant (coro)

Cas 2: Probabilité pré test de coronaropathie: 95%,

-> 5% seul examen

-> Risque d'erreur: $0.95 \times 0.05 = 5 \%$

-> 95% d'examen redondant (coro)

Triple rule out

Bilan douleur thoracique:

Coronaire

EP

Dissection aortique

Pneumopathie

Péricardite



Figure 9: (a) Sagittal and (b) coronal slab MIP images from TRO CT angiogram in 40-year-old man with chest pain and tachycardia show left upper lobe pulmonary embolus extending into an apical segmental branch of left pulmonary artery (arrow). Coronary arteries and aorta were normal.

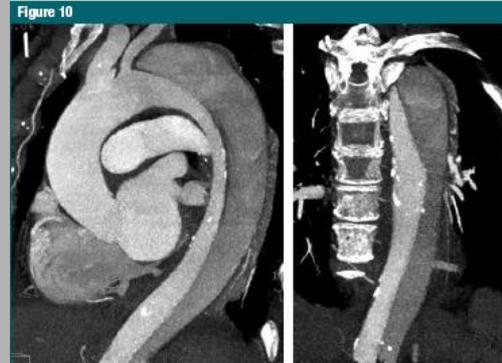


Figure 10: TRO CT angiogram in 70-year-old woman with recent onset of vague chest discomfort. TRO CT demonstrates type B aortic dissection extending from distal aortic arch to descending aorta. (a) Oblique slab MIP image shows entire aortic arch with dissection flap extending into the abdomen. (b) Coronal slab MIP image again demonstrates the dissection with asymmetric enhancement of true and false lumina.

Coronary CT Angiography Protocol

From October 17, 2006, through October 19, 2007, multidetector CT was performed 1 day per week, based on the availability of study personnel, starting at 8:00 AM and ending at 4:00 PM. Any

Meta-Analysis and Systematic Review of the Long-Term Predictive Value of Assessment of Coronary Atherosclerosis by Contrast-Enhanced Coronary Computed Tomography Angiography

Fabian Bamberg, MD, MPH,*† Wieland H. Sommer, MD,† Verena Hoffmann, PhD,‡
Stephan Achenbach, MD,§ Konstantin Nikolaou, MD,† David Conen, MD, MPH,||
Maximilian F. Reiser, MD,† Udo Hoffmann, MD, MPH,* Christoph R. Becker, MD†
Munich and Erlangen, Germany; Boston, Massachusetts; and Basel, Switzerland

(J Am Coll Cardiol 2011;57:2426-36)

Valeur pronostique d'une sténose coronaire

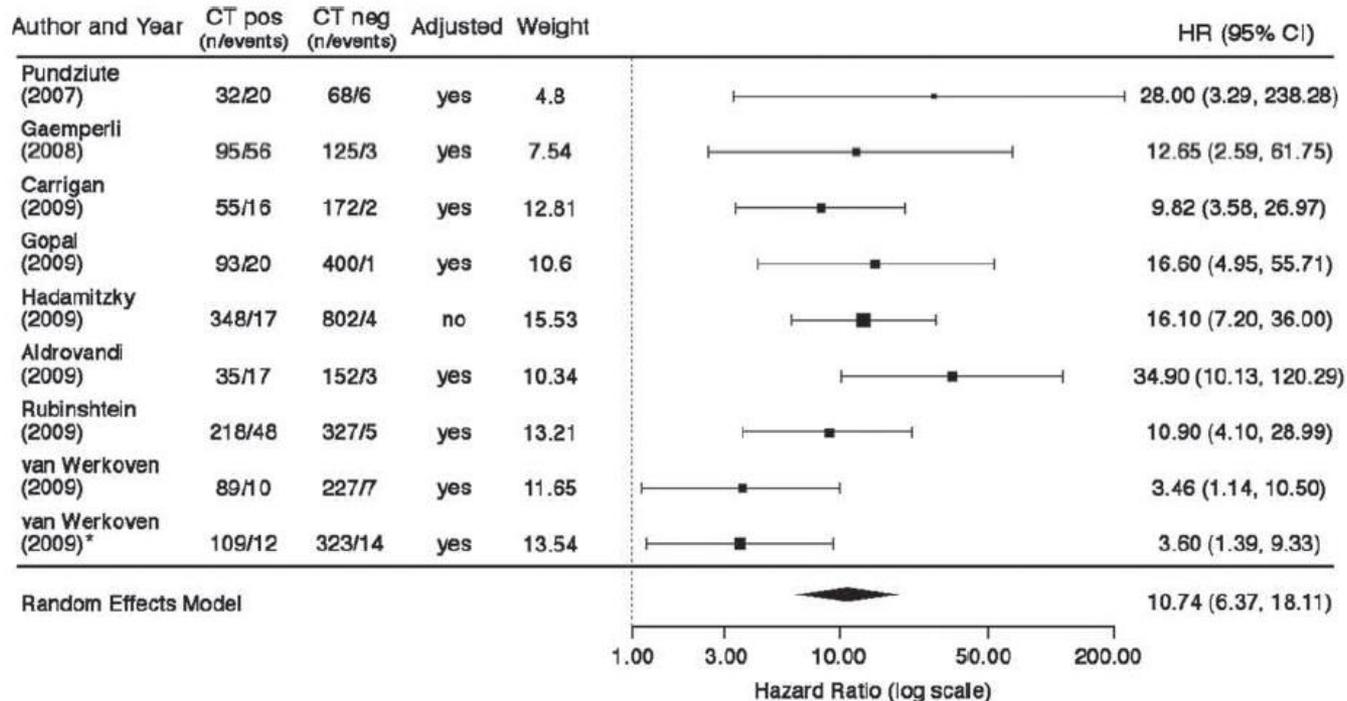
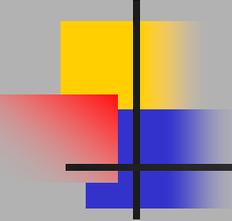


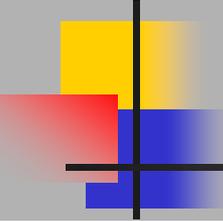
Figure 2 Forest Plot of Single Studies in Analysis for Risk Associated With Significant Coronary Stenosis

“Adjusted” indicates whether multivariate adjustment was performed. **Horizontal lines** represent 95% confidence intervals (CIs). The **rectangles** represent the point estimate, and the size of the rectangle is proportional to the weight given to each study in the meta-analysis. The **diamond** represents the summary estimate (**size of the diamond** = 95% CI). The **dashed vertical line** represents the reference of no increased risk. *In 2009, the same lead author published in *Heart* (12) and the *European Heart Journal* (24). CT = computed tomography; HR = hazard ratio; neg = negative; pos = positive. Figure illustration by Craig Skaggs.

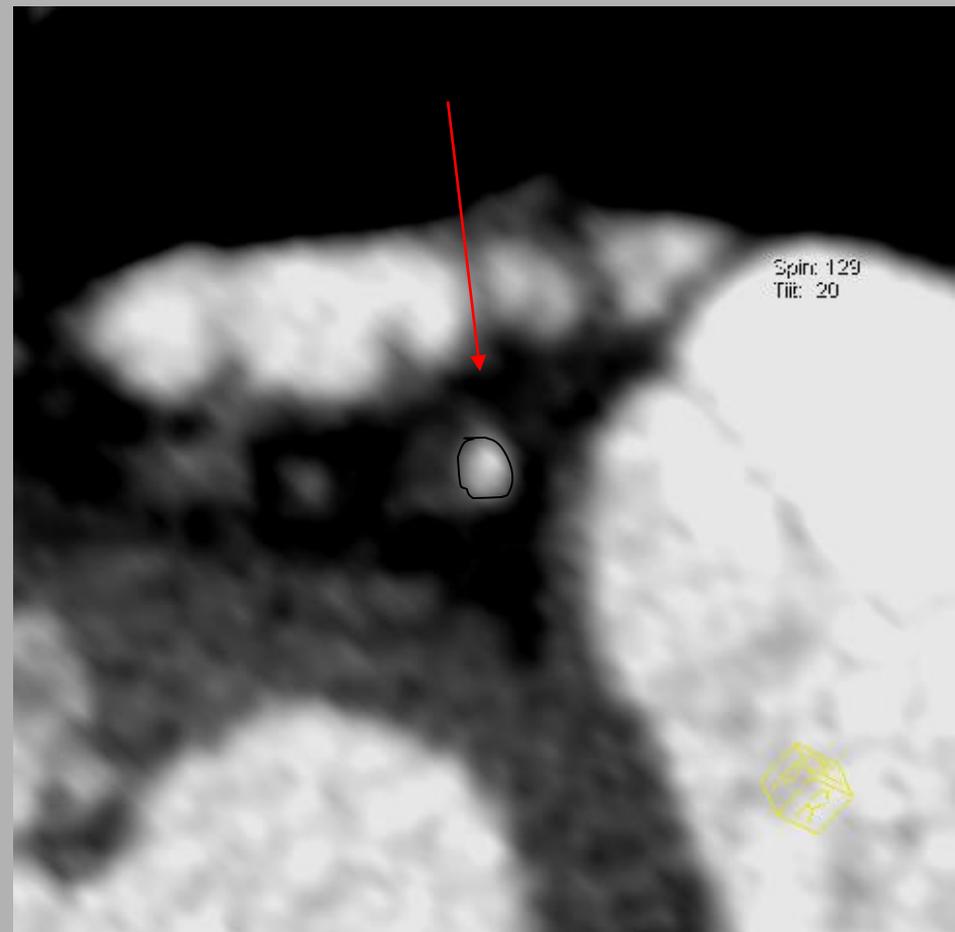


Cas clinique

- Homme 45 ans
- 185 cm 66kg
- Dyslipidémie
- Tabac
- Douleur atypique fluctuante évoluant depuis 72H
- ECG: T ample antéro septal
- Troponine (-)

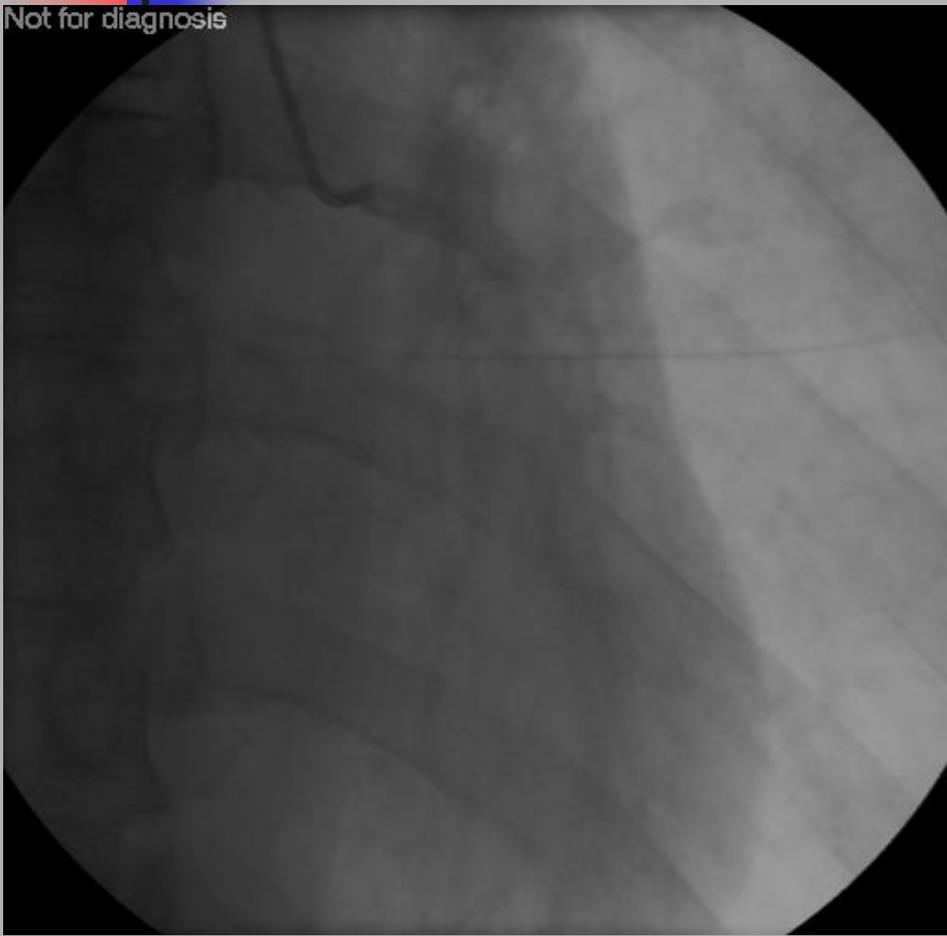


Doute sur un SCA

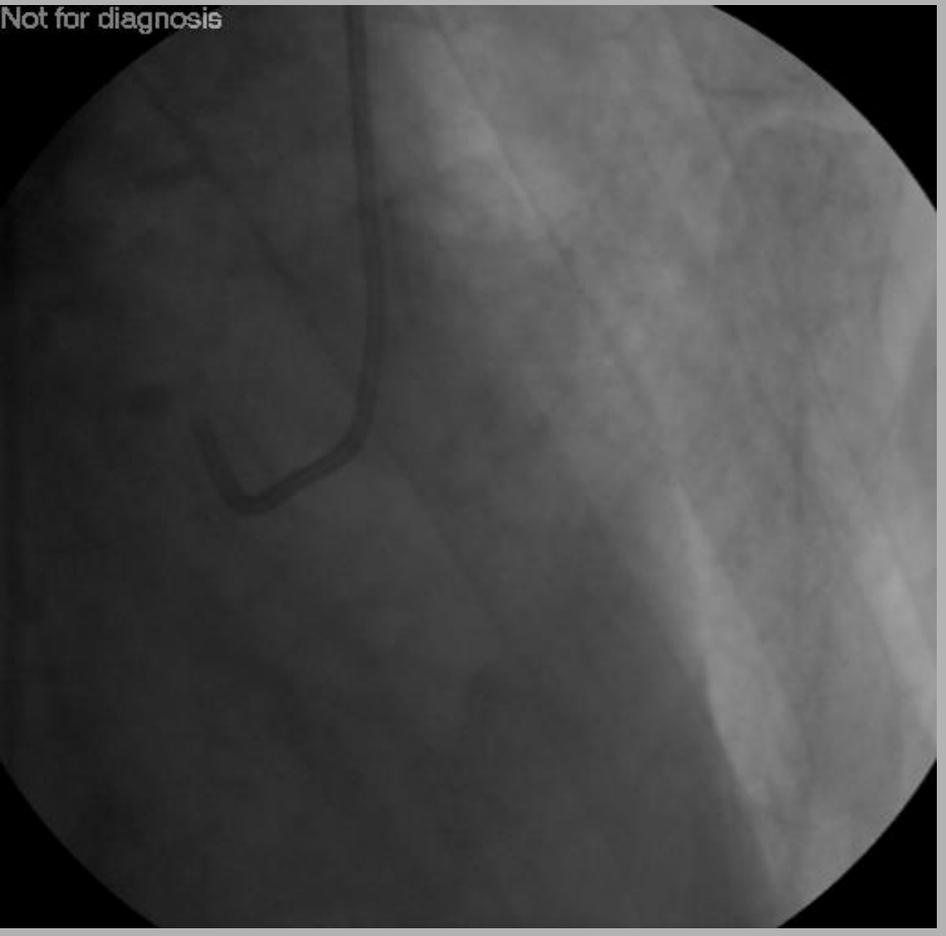


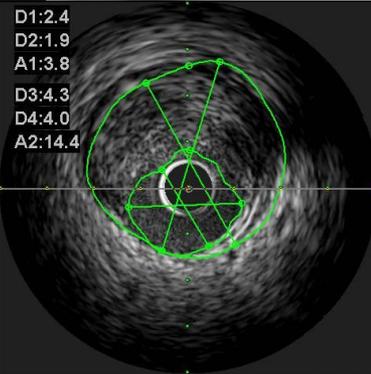
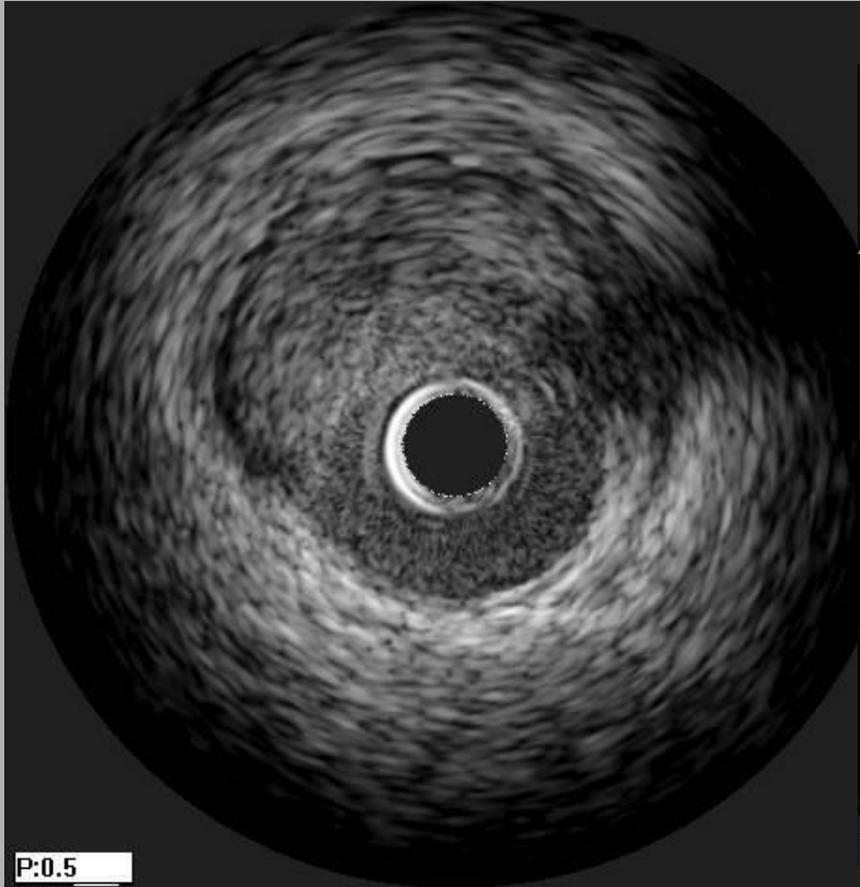
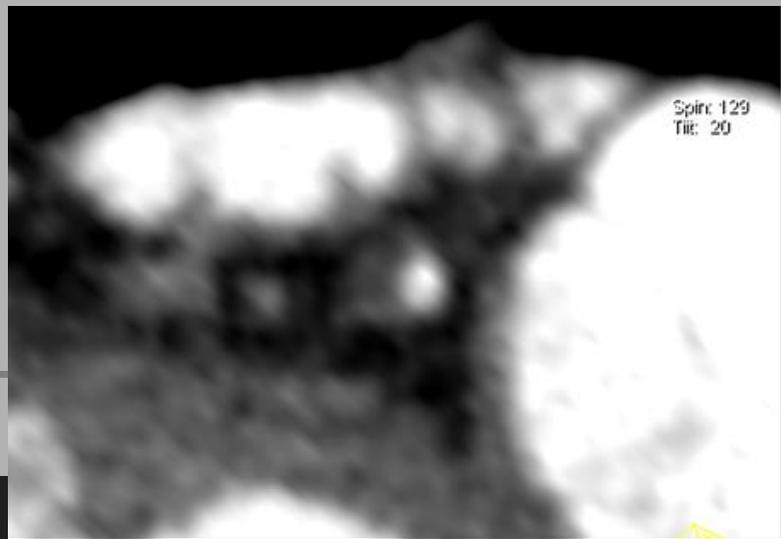
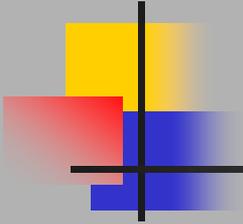


Not for diagnosis



Not for diagnosis





Spine 129
File: 20

10:59:06
08/11/2005
CC MARIE
G A L A X Y
Boston Scientific

052156 050073
Vessel1 Run1

Location:

Distance [mm]

<input checked="" type="checkbox"/> D1: 2.4	Max LD
<input checked="" type="checkbox"/> D2: 1.9	Min LD
<input checked="" type="checkbox"/> D3: 4.3	Max Med-to-Med
<input checked="" type="checkbox"/> D4: 4.0	Min Med-to-Med
<input checked="" type="checkbox"/> D5:	
<input checked="" type="checkbox"/> D6:	

Area [mm²] Circ Diameter [mm]

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<input checked="" type="checkbox"/> A2: 14.4	4.3	Vessel
<input checked="" type="checkbox"/> A3:		

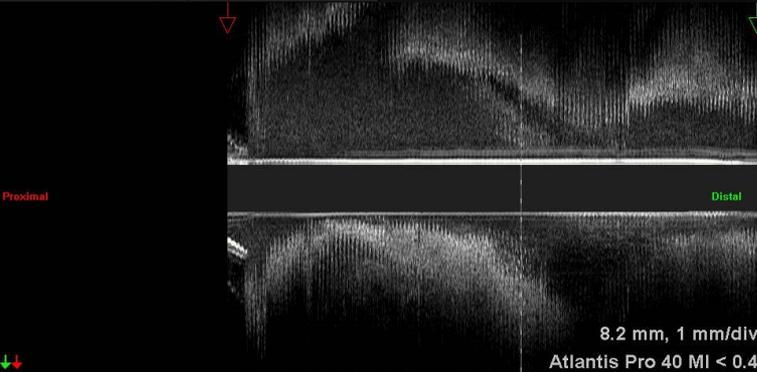
Other Results

% Stenosis: 74.0

Long View Distance [mm]

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<input checked="" type="checkbox"/> L3:	
<input checked="" type="checkbox"/> L4:	

Annotations:



Proximal Distal

8.2 mm, 1 mm/div
Atlantis Pro 40 MI < 0.4

Annotations:

Pre Post Other

Hide Delete All Close

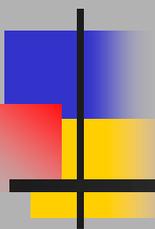
Borders detected.

Run1	Run2
Vessel1	

P:0.5

1215

Navigation icons: play, stop, back, forward, home, power

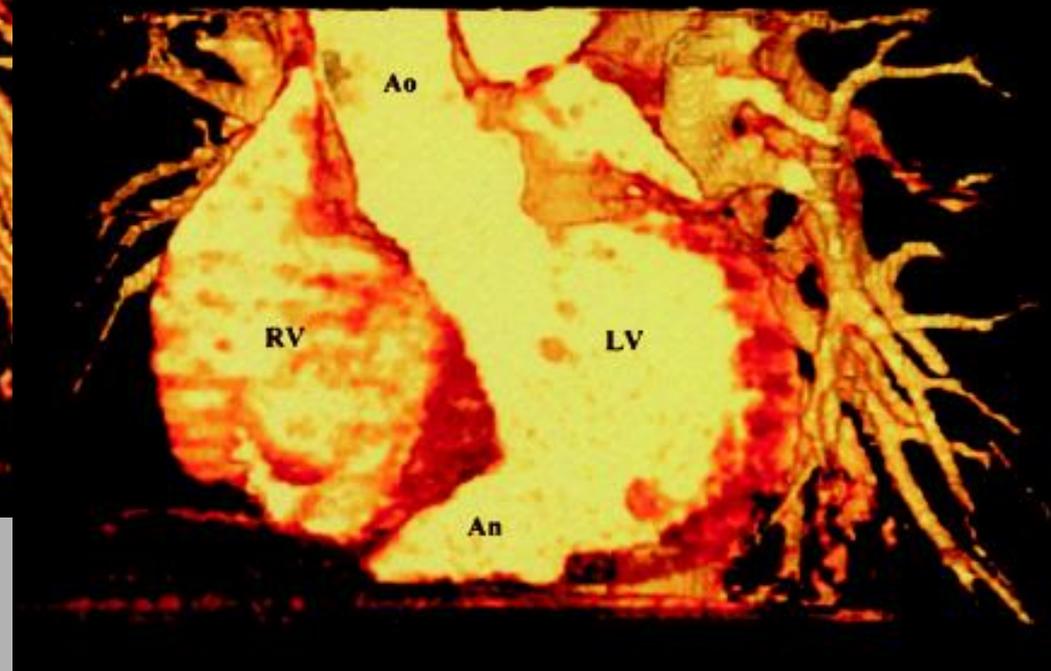
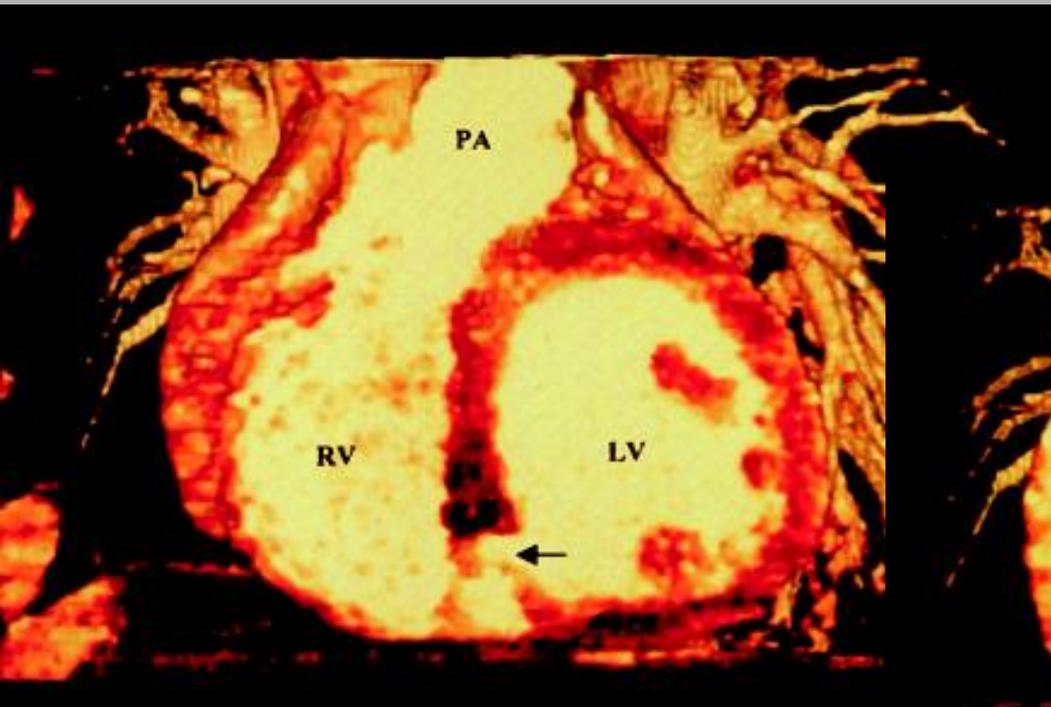


Analyse du myocarde

Images in Cardiovascular Medicine

Multirow Detector Computed Tomography Assessment of Intraseptal Dissection and Ventricular Pseudoaneurysm in Postinfarction Ventricular Septal Defect

Jean-François Paul, MD; Loïc Macé, MD; Christophe Caussin, MD; Abdelhamid Fsihi, MD;
Xavier Berthaux, MD; Philippe Brenot, MD; Claude Angel, MD



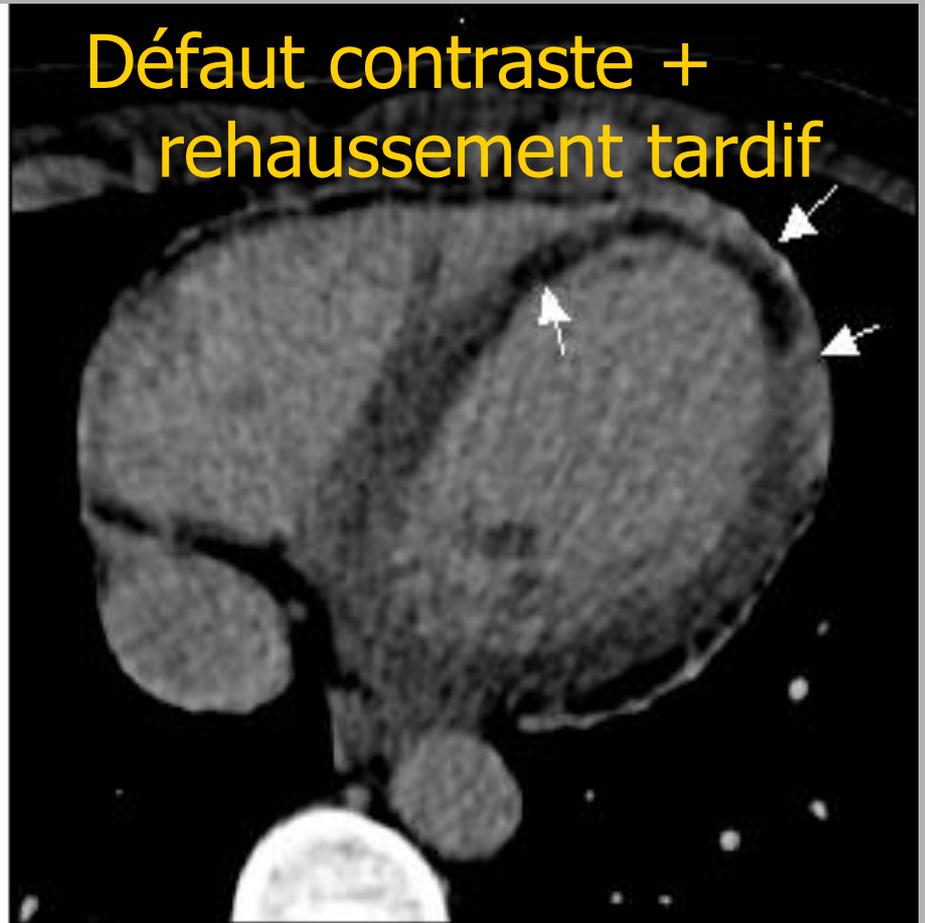
48H post IDM revascularisé

Défaut contraste
précoce

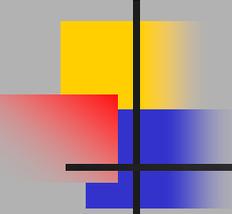


Premier passage

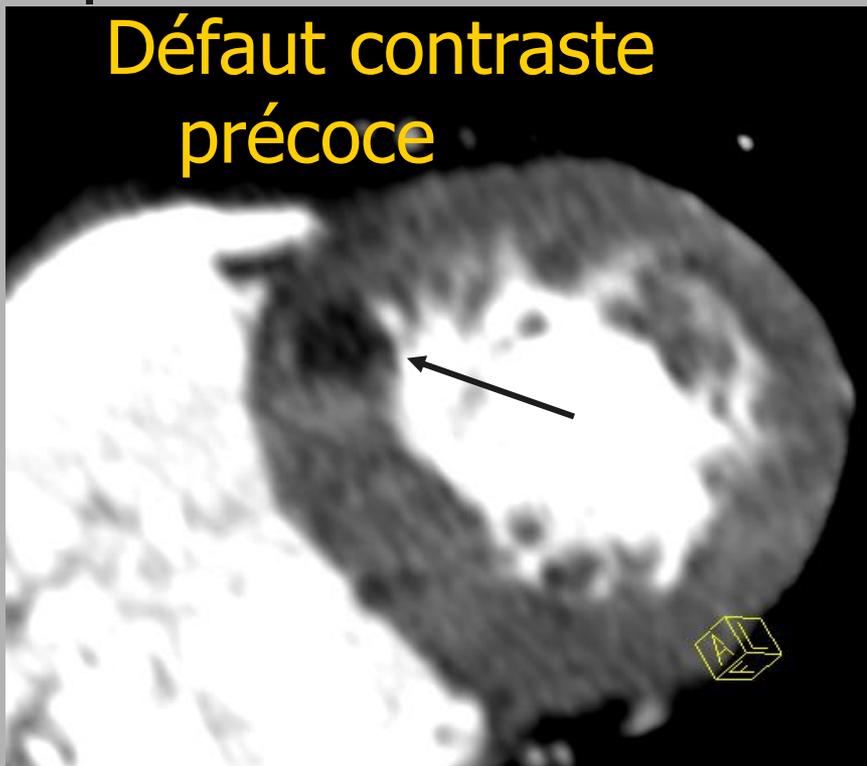
Défaut contraste +
rehaussement tardif



aquisition à 5 min (80kV)

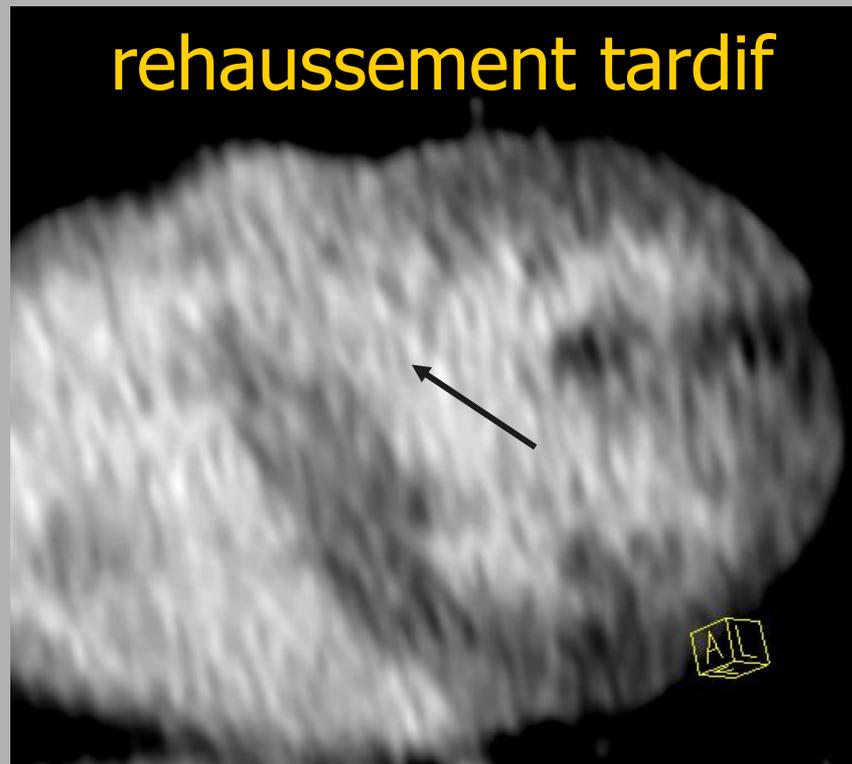


Défaut contraste
précoce



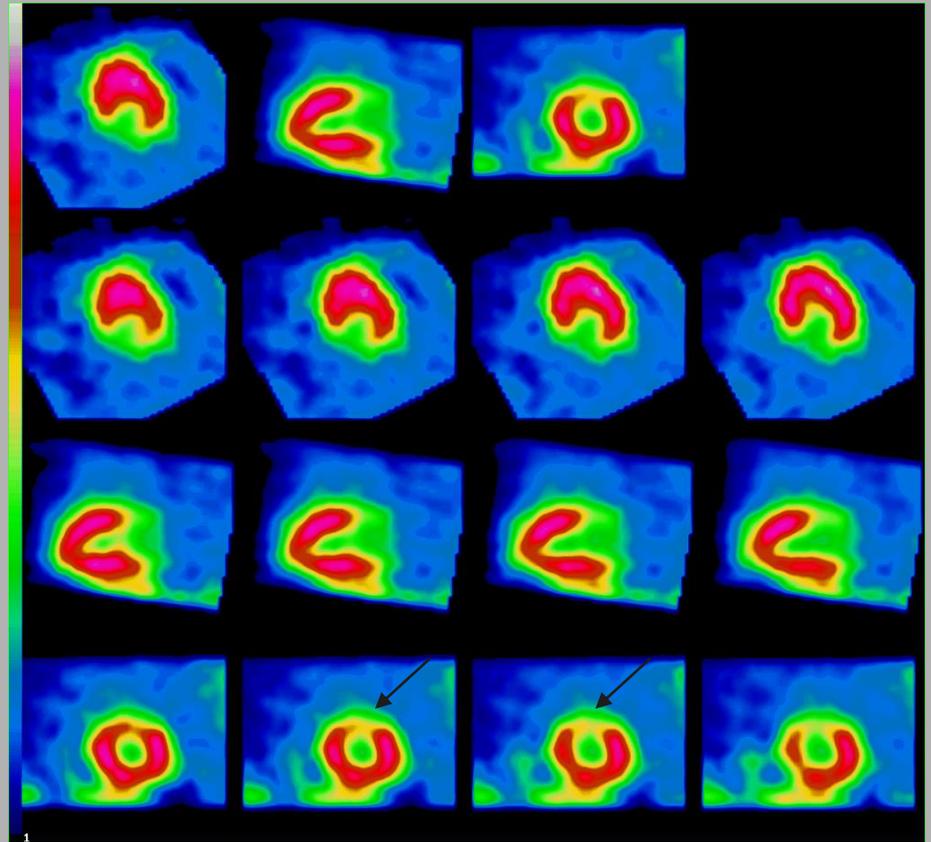
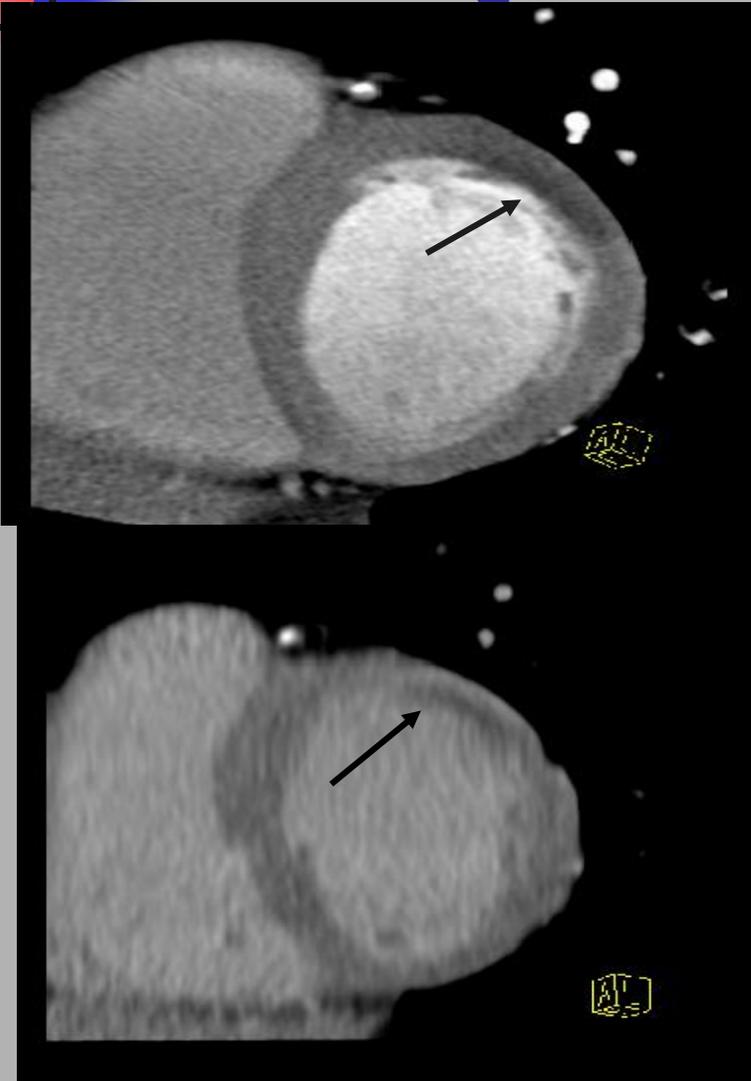
MSCT premier passage

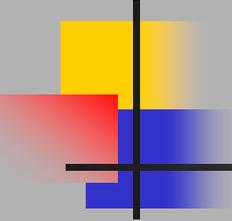
rehaussement tardif



aquisition à 5 min (80kV)

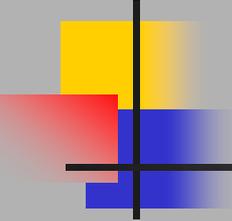
NON Q MI





Comparaison avec la scintigraphie à 6 semaines

- 41 pts avec <12H IDM revascularisé
- CT défaut et rehaussement tardif 3 ± 3 jours post IDM
- 17 segments analysés en aveugle CT et SPECT

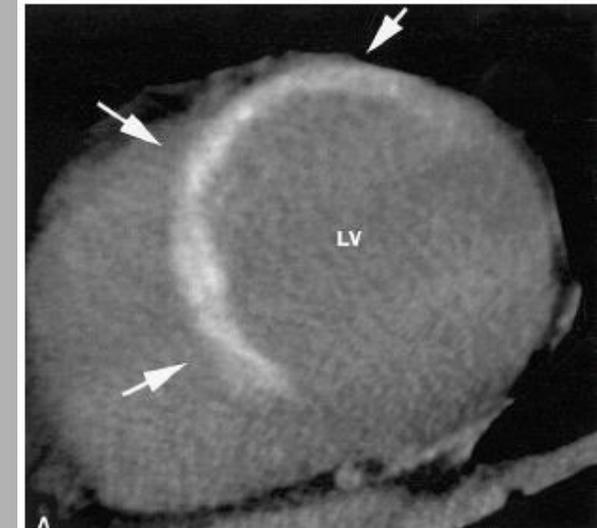
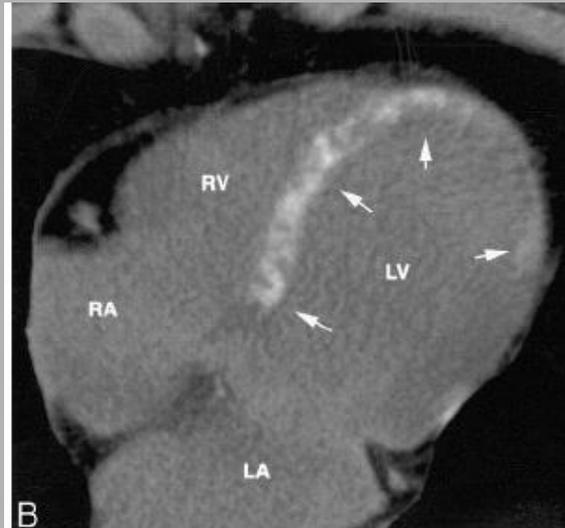


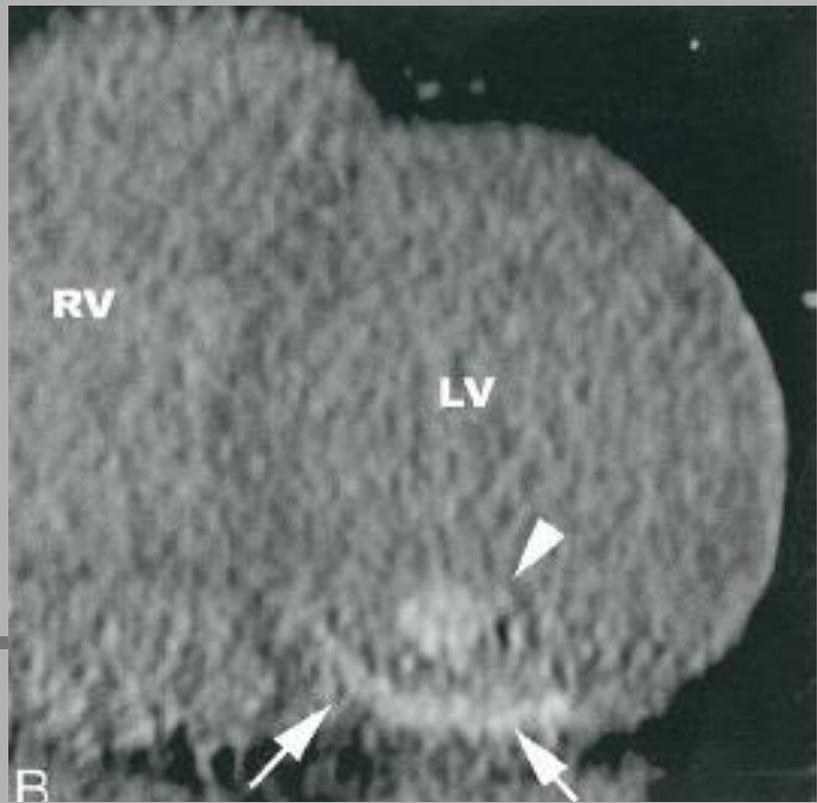
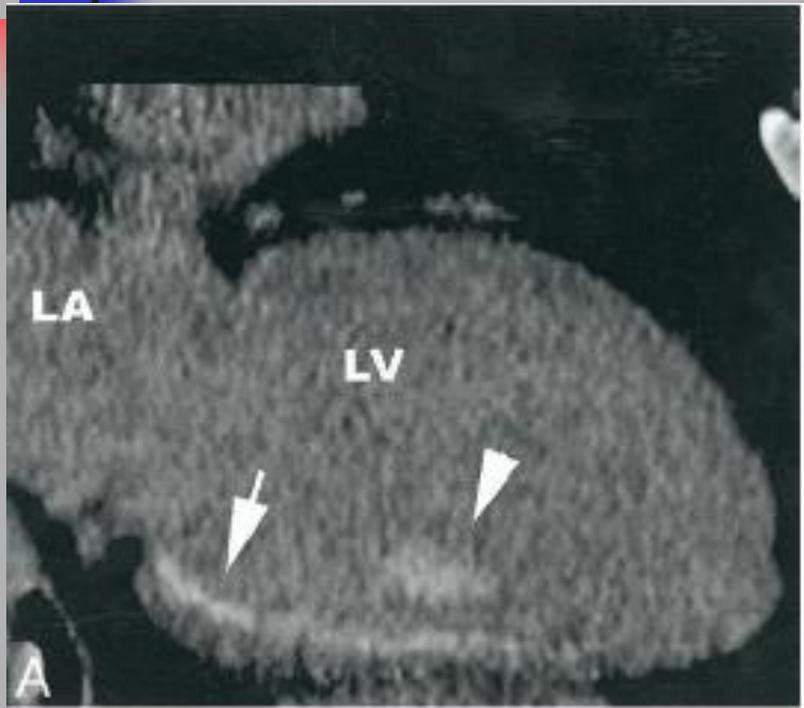
Comparaison avec la scintigraphie à 6 semaines

- Tous les pts ont un rehaussement tardif
- 80% des patients ont un défaut perfusion associé à un réhaussement tardif à 5 min
- Le défaut de perfusion à 5 min au scanner correspond à celui de la scintigraphie (Sens 78%, spe 91%, accuracy 90%).

Analyse myocardique directement après ATC IDM

- Rehaussement tardif (pas de réinjection)
- Imprégnation + longue
- Comparé écho de stress de viabilité à 15 jours





M. Habis et al JACC 2007

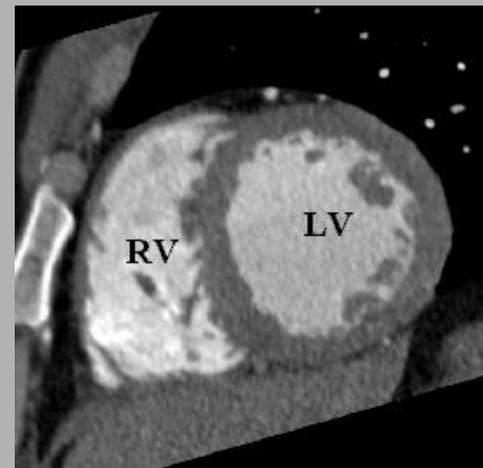
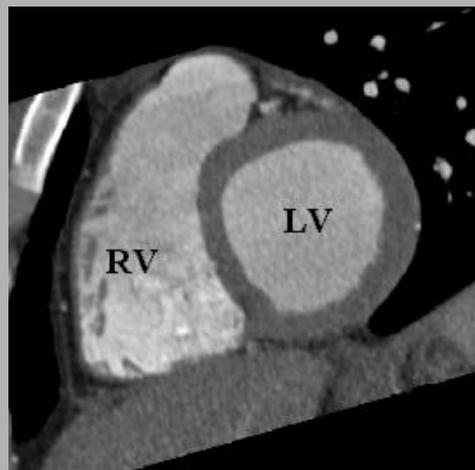
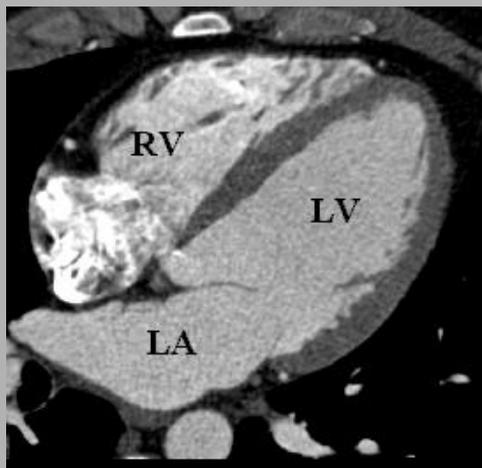
Myocarditis

A

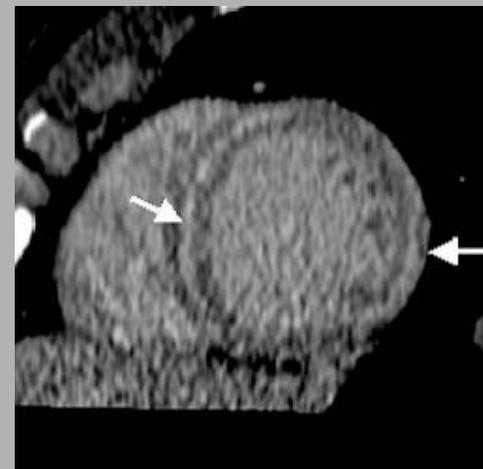
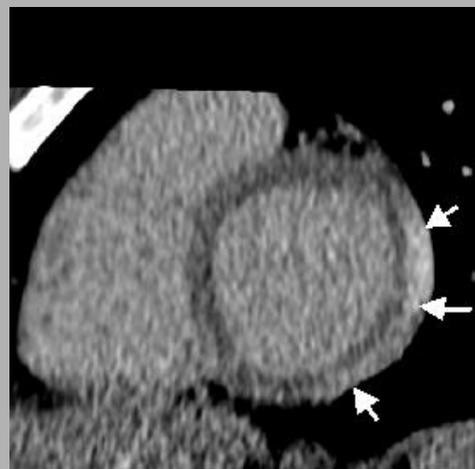
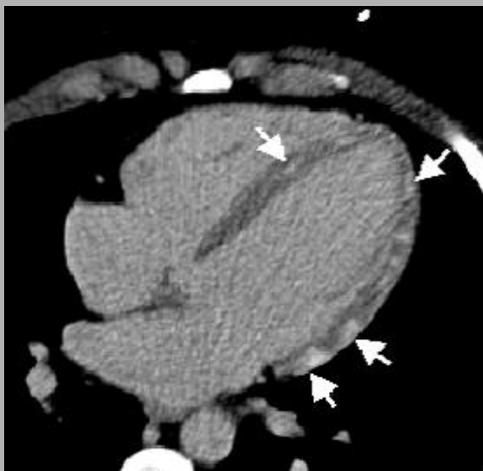
B

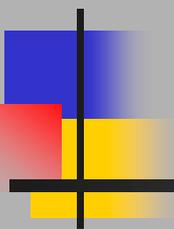
C

1



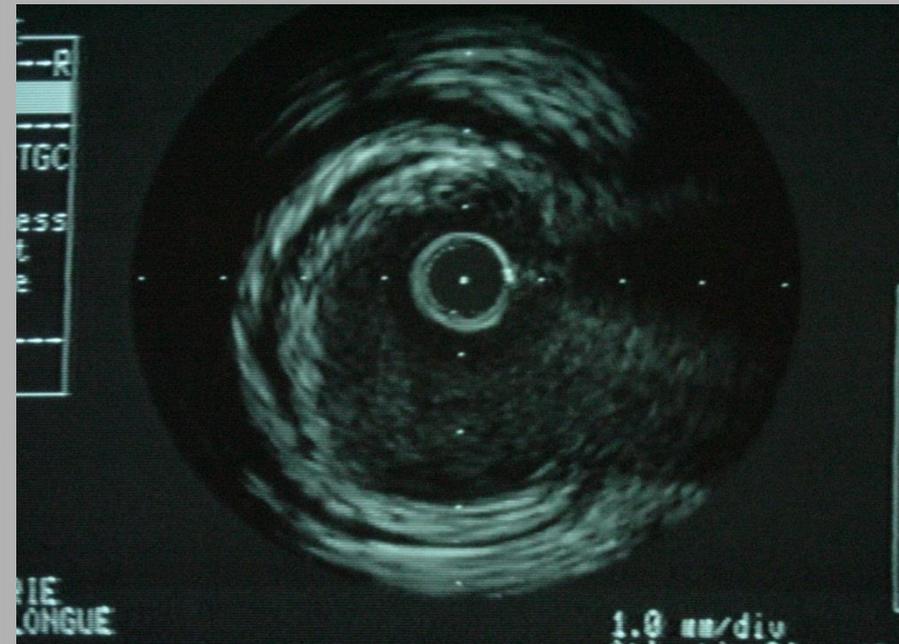
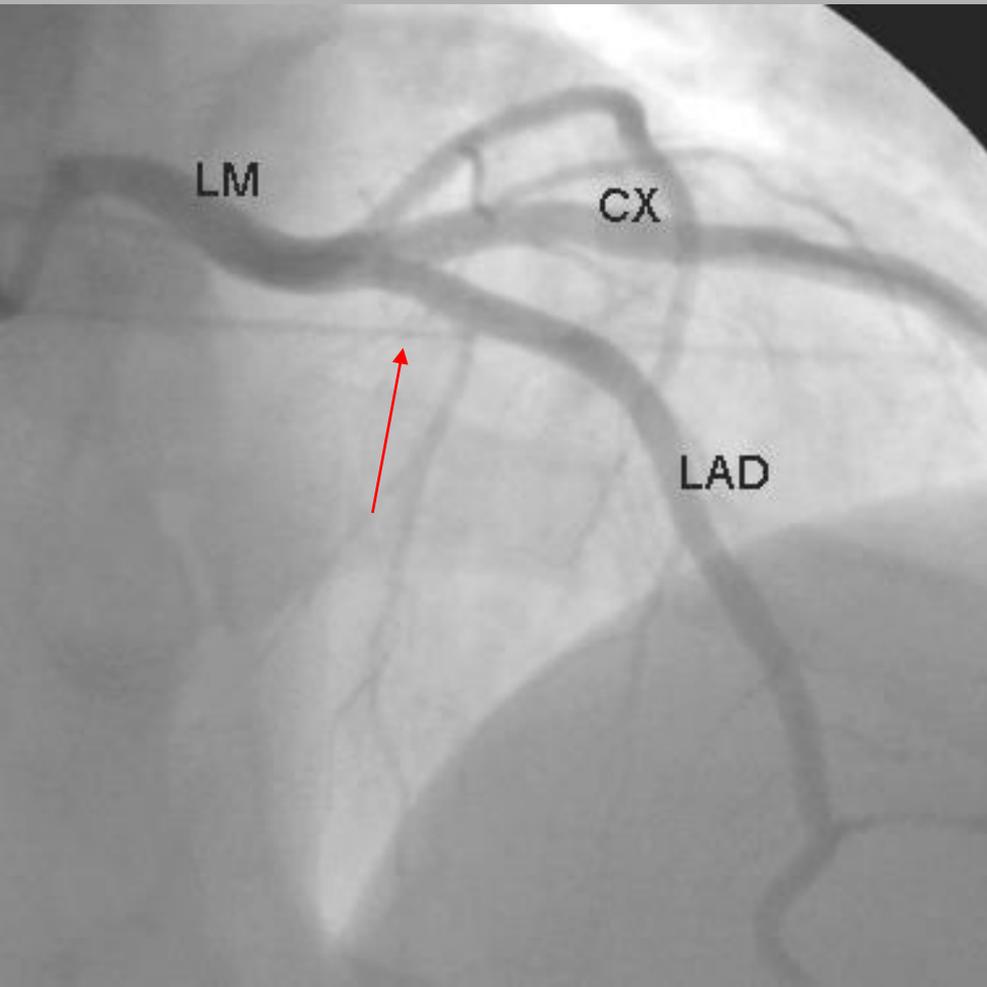
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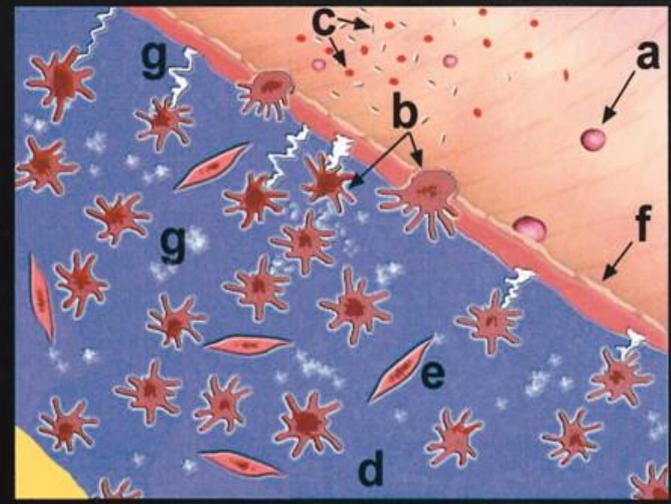


Les plaques coronaires

IDM coronaires « saines »



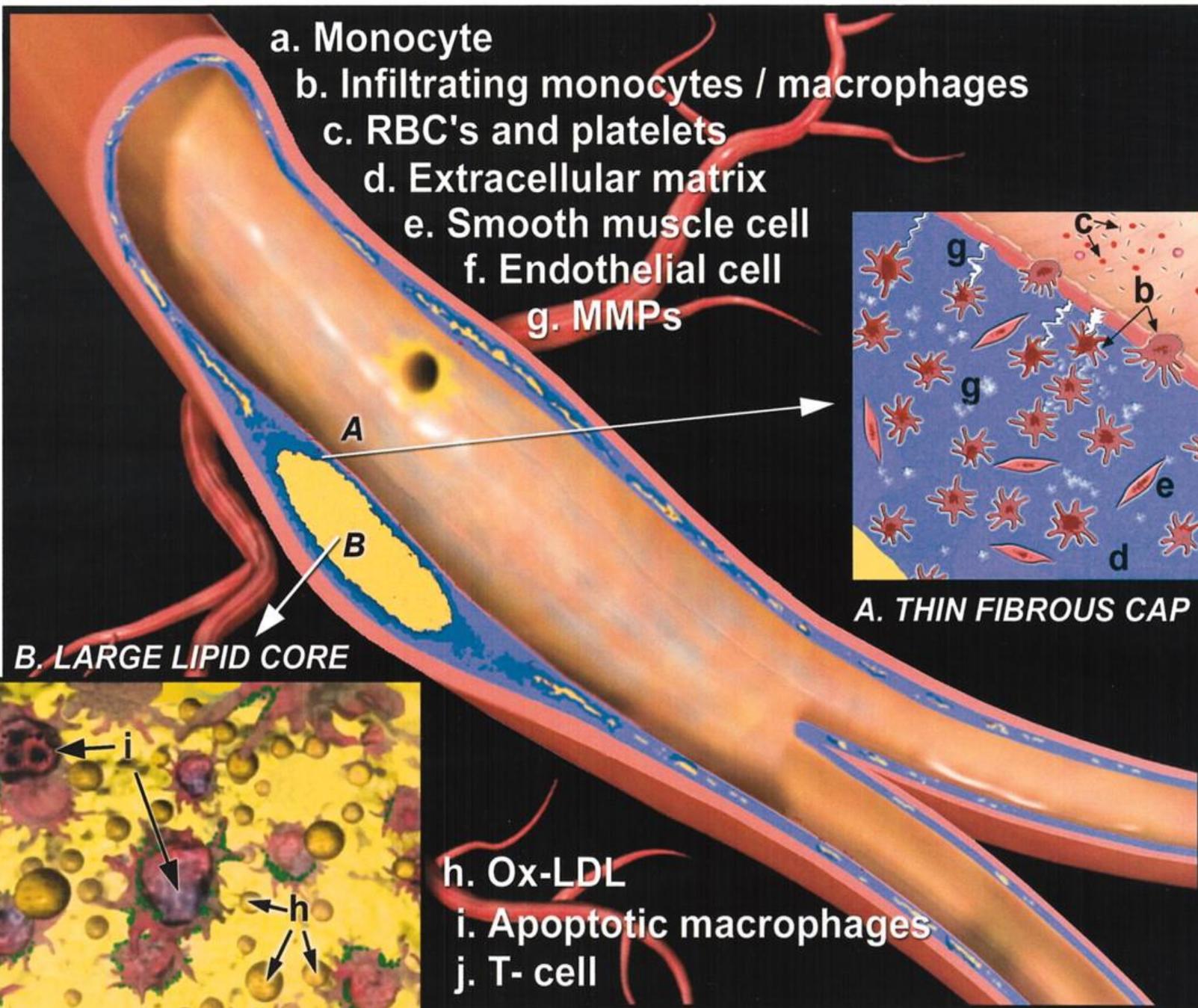
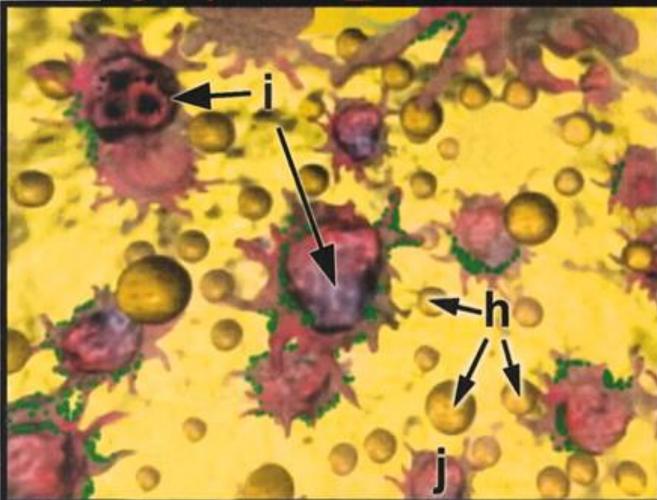
- a. Monocyte
- b. Infiltrating monocytes / macrophages
- c. RBC's and platelets
- d. Extracellular matrix
- e. Smooth muscle cell
- f. Endothelial cell
- g. MMPs

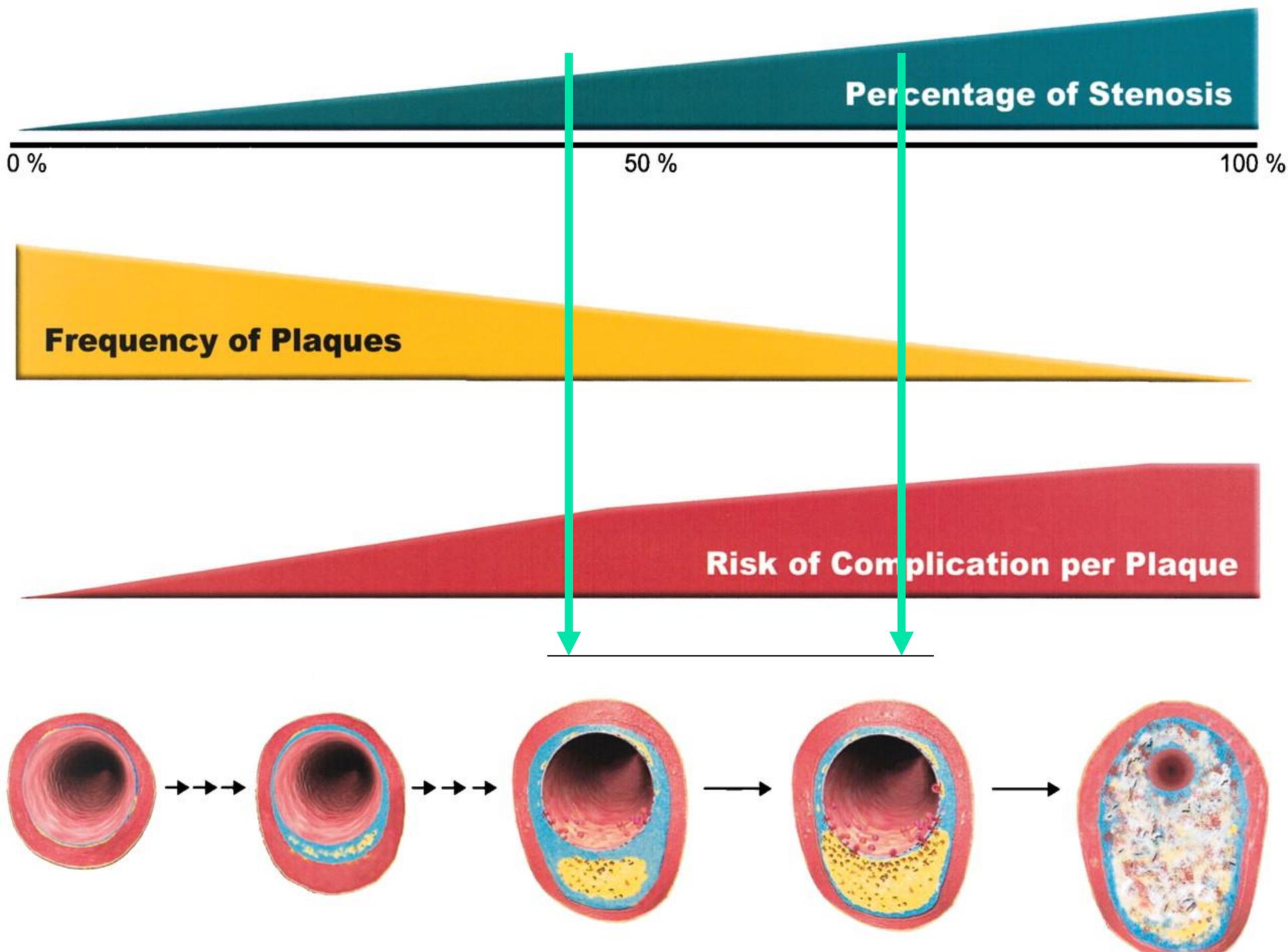


A. THIN FIBROUS CAP

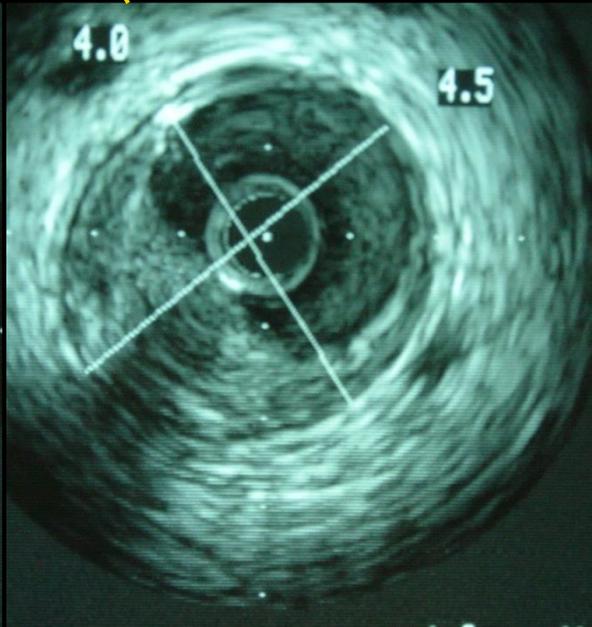
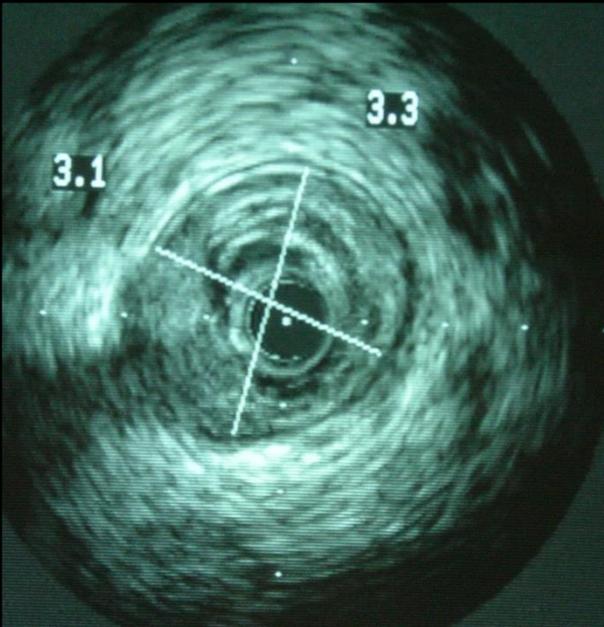
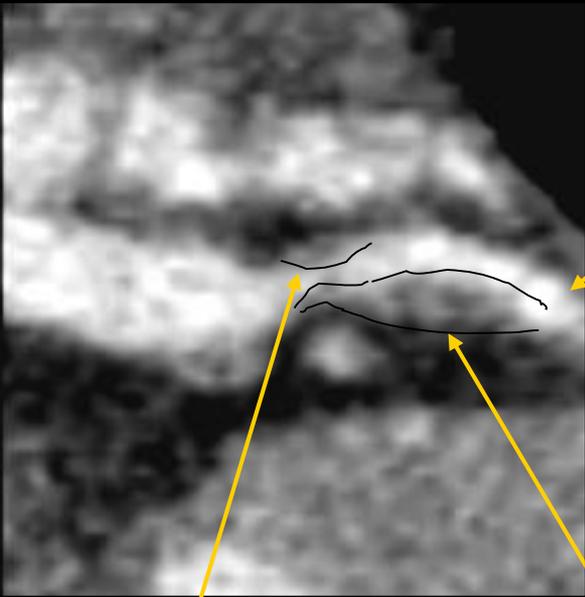
B. LARGE LIPID CORE

- h. Ox-LDL
- i. Apoptotic macrophages
- j. T- cell



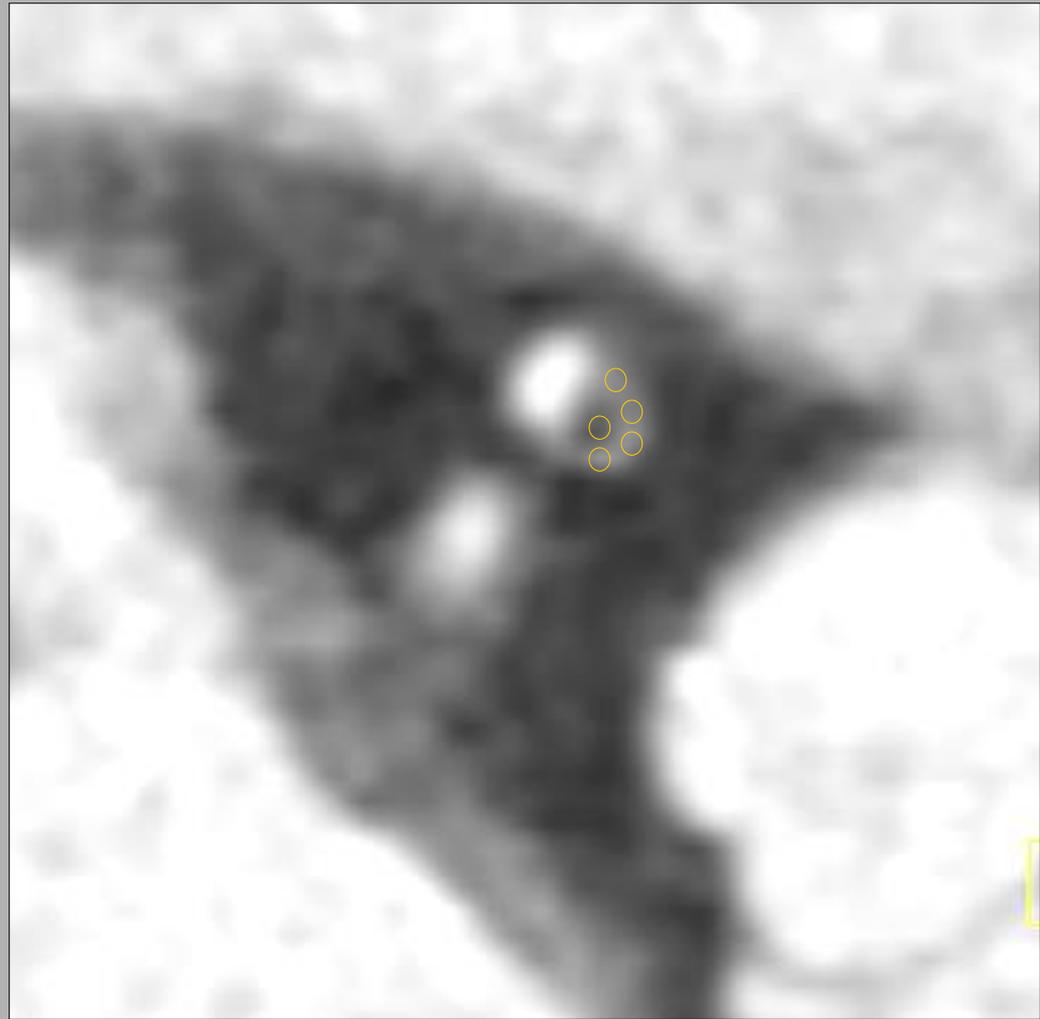


Remodelling

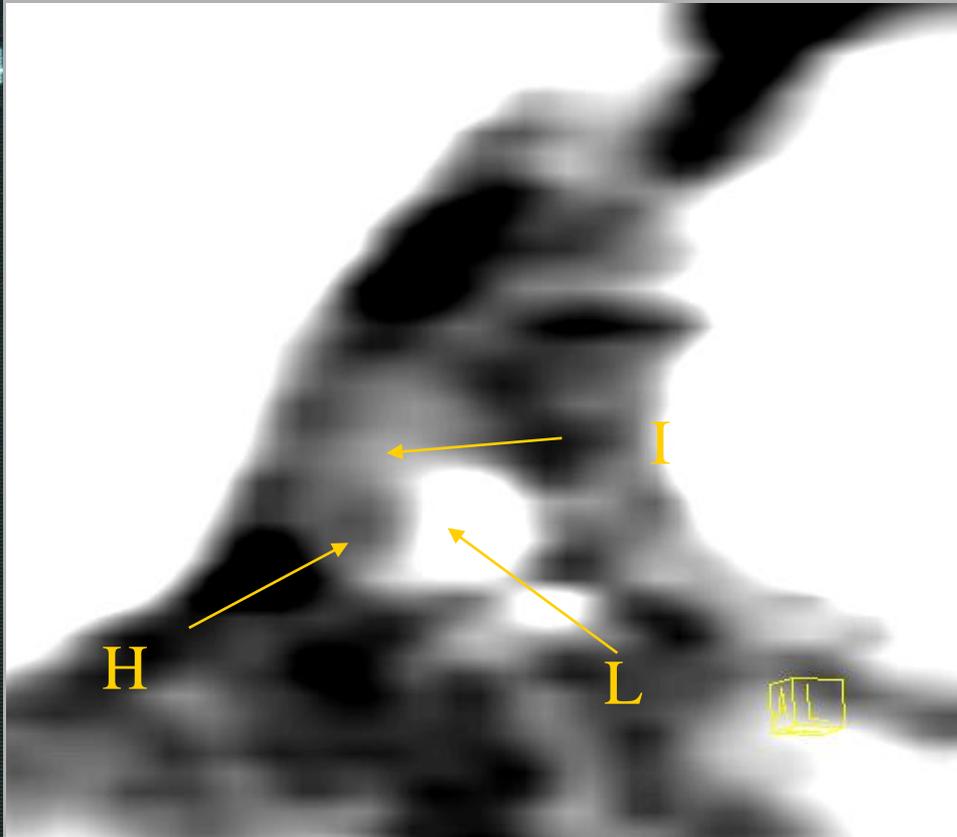
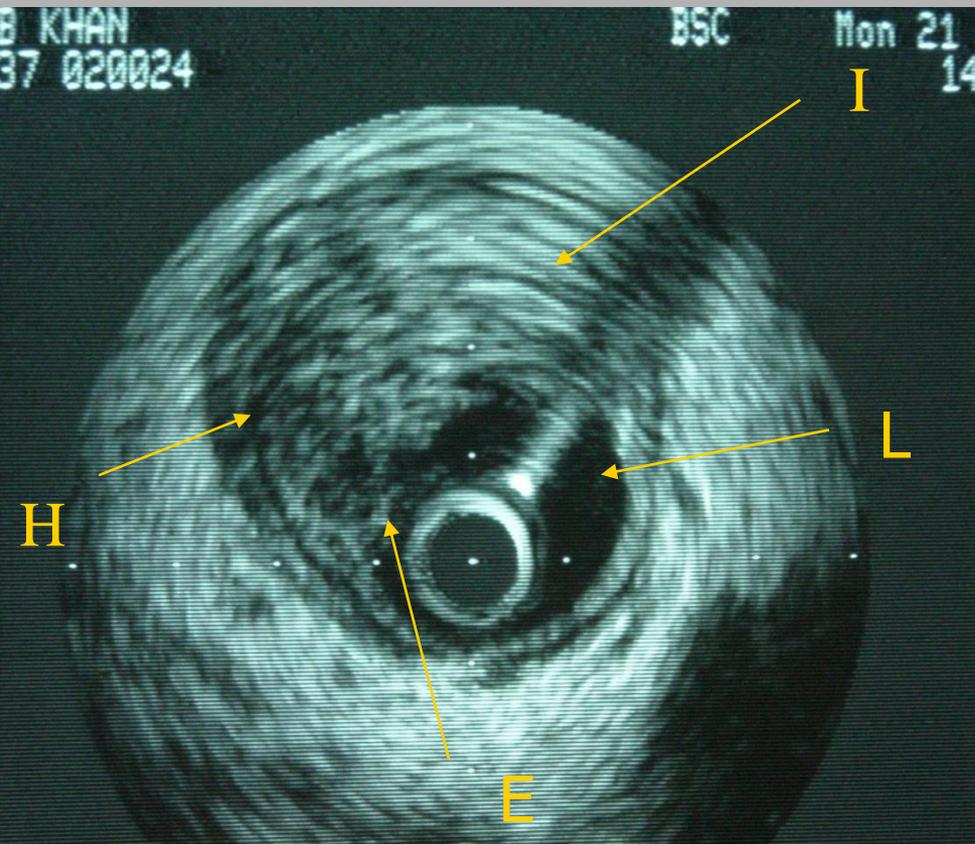


Analyse de la densité des plaques

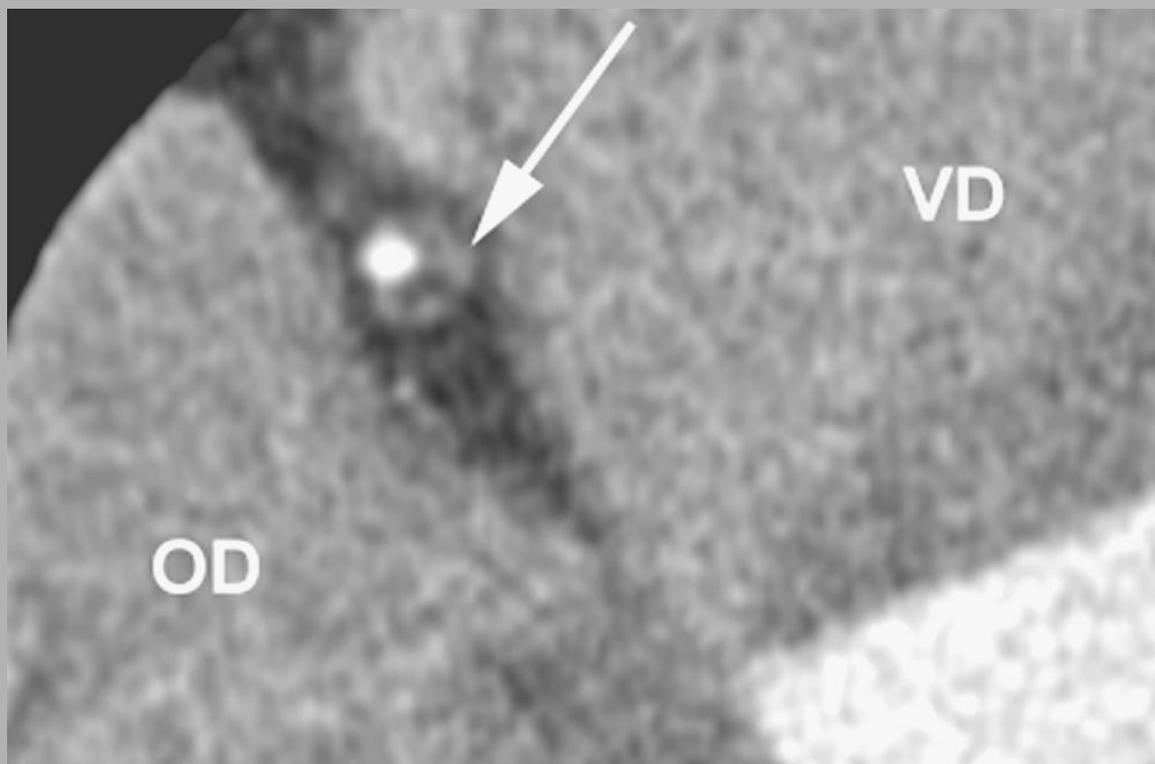
- Section d'artère
- ROI de 5 pixels (1mm^2)
- Prises de densité ponctuelle (5 points par plaque)



Hypodensités

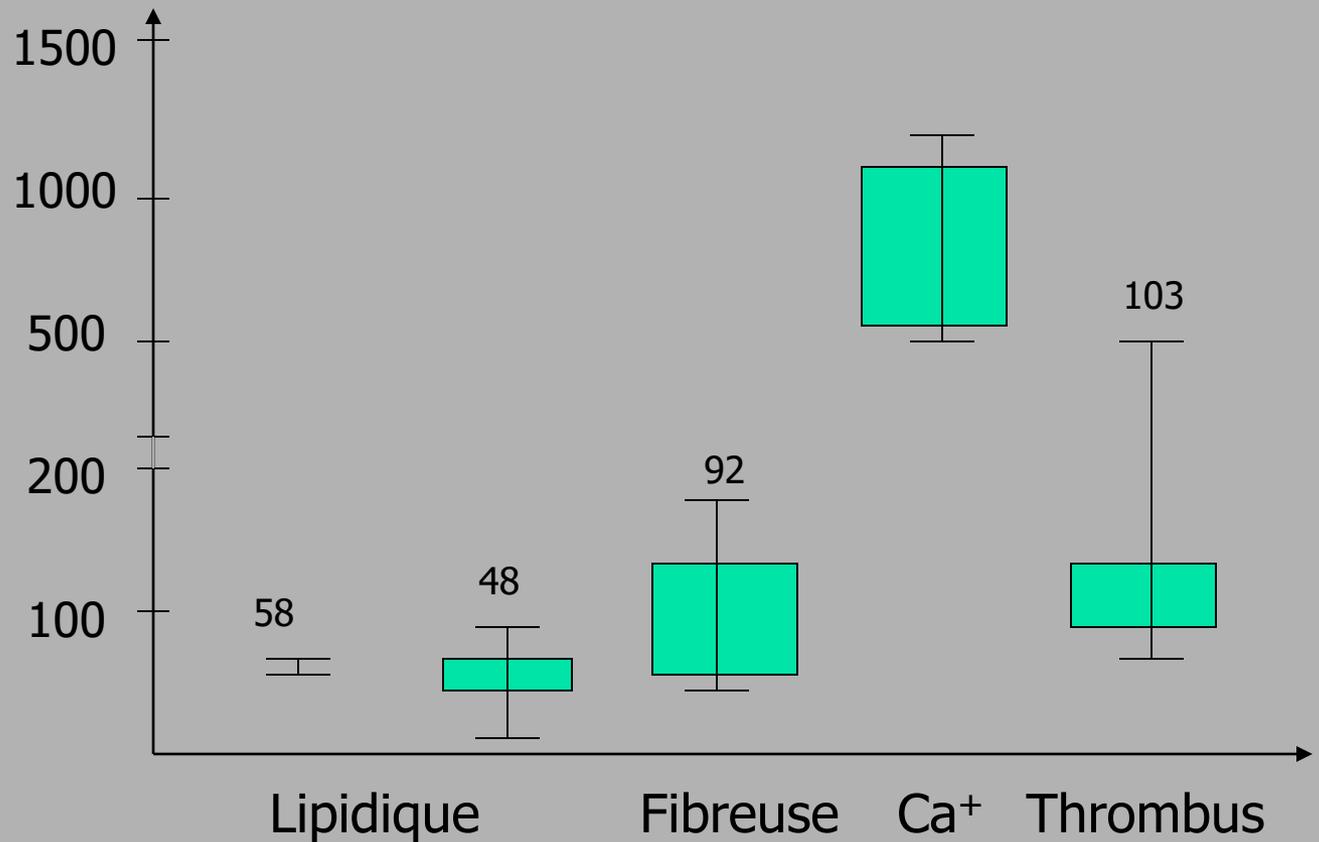


Hypodensité



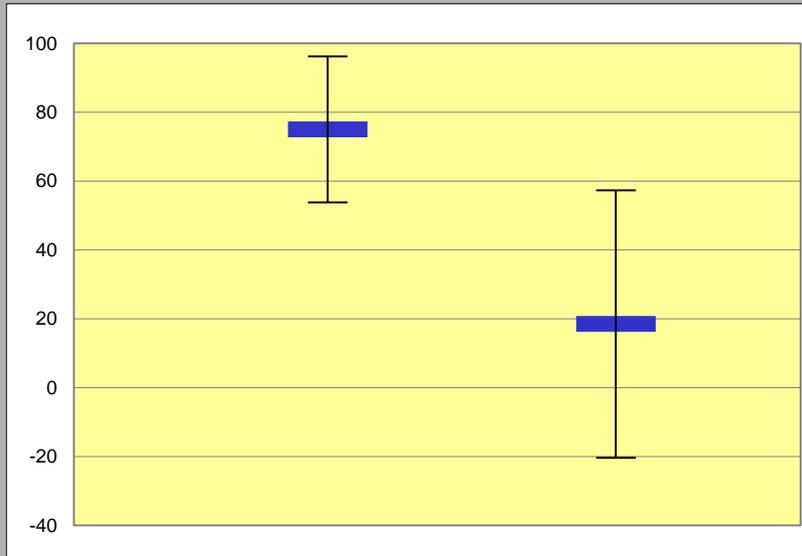
Comparaison à l'histologie

Agent de contraste →



Densité des plaques

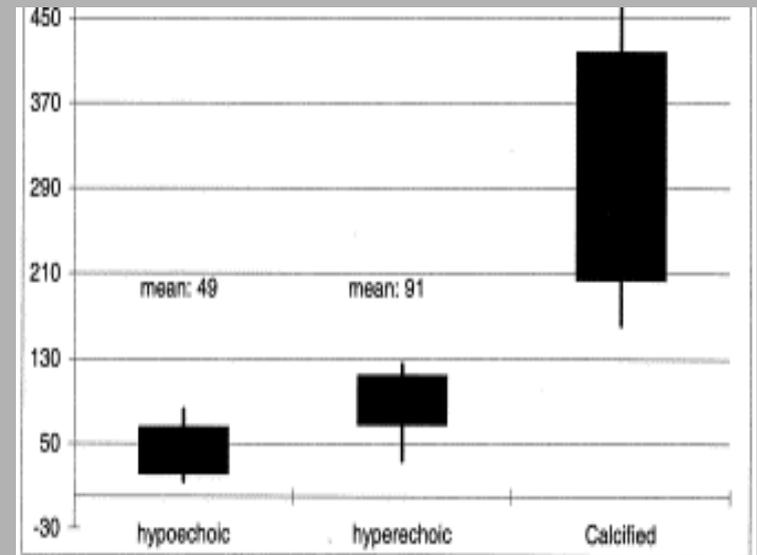
HU



Fibreuses

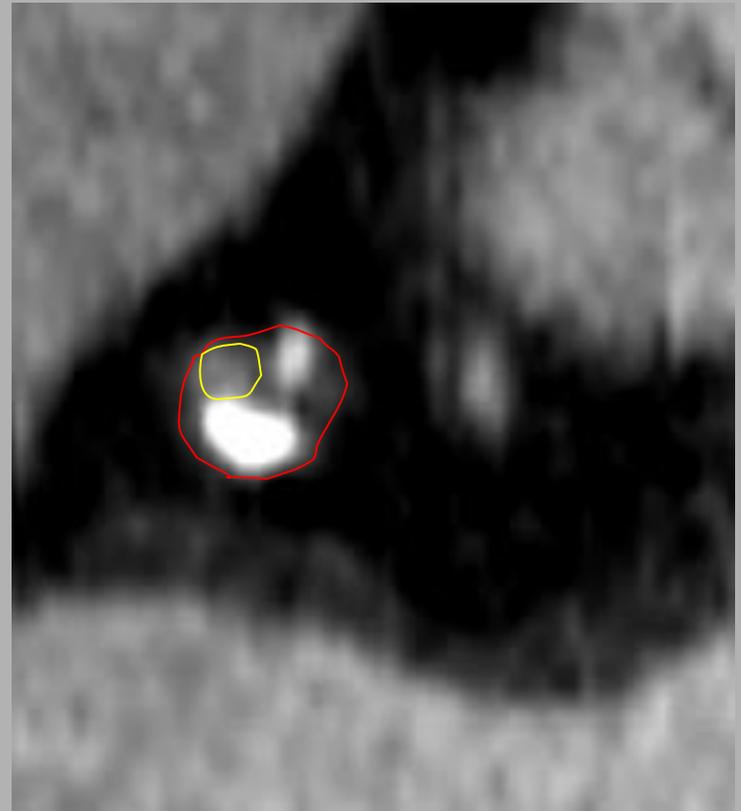
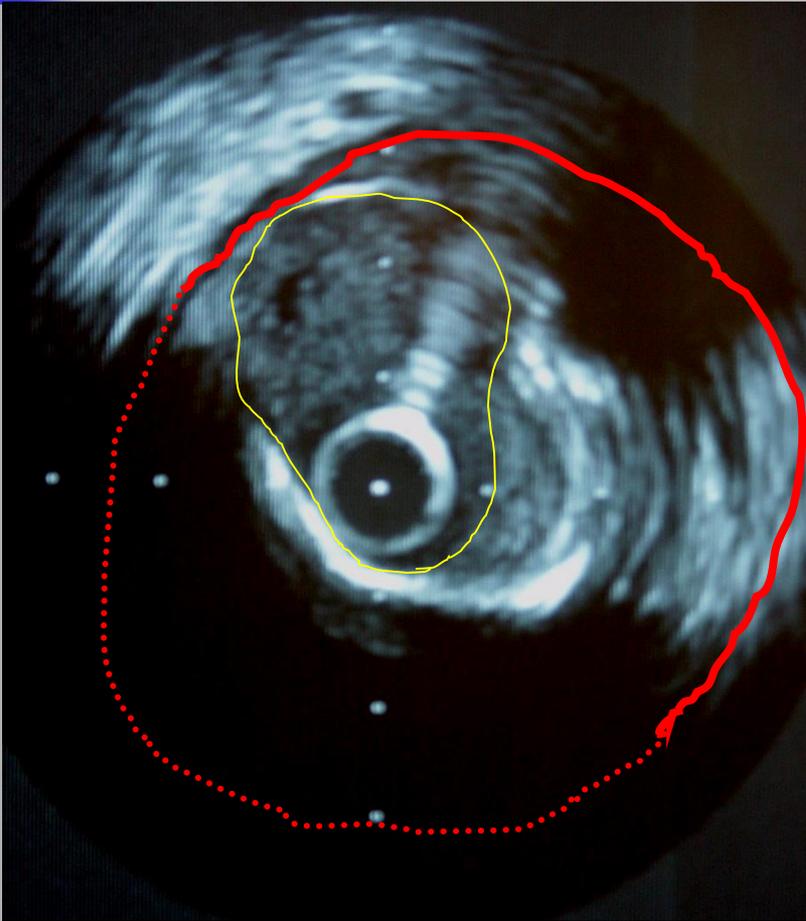
Hypodenses

Caussin et al Am J Cardiol 2004

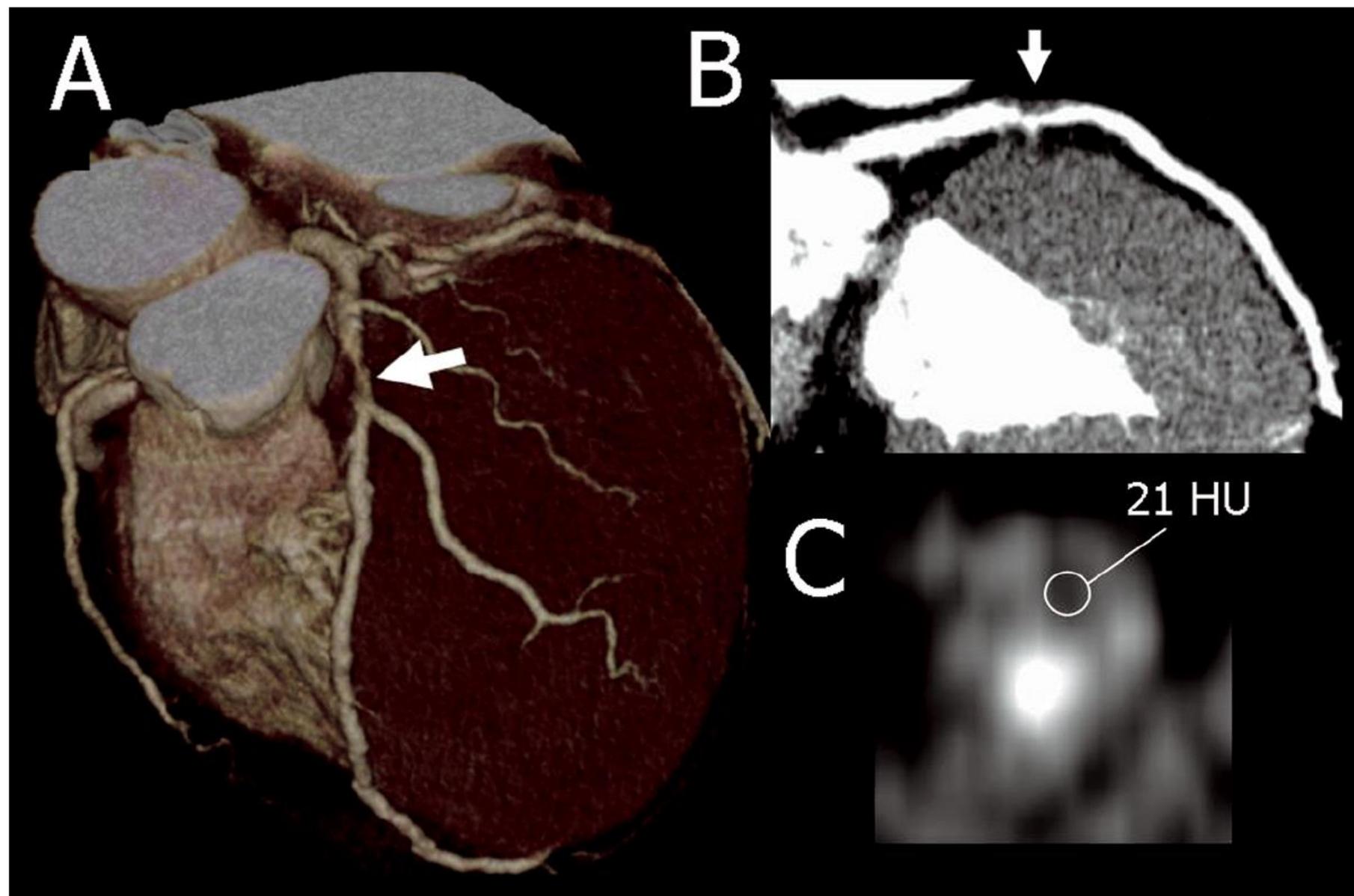


Leber et al JACC 2004

Plaques complexes



Prognostic Value of CT Low-Dense Plaques



Valeur pronostique des plaques hypodenses non obstructives

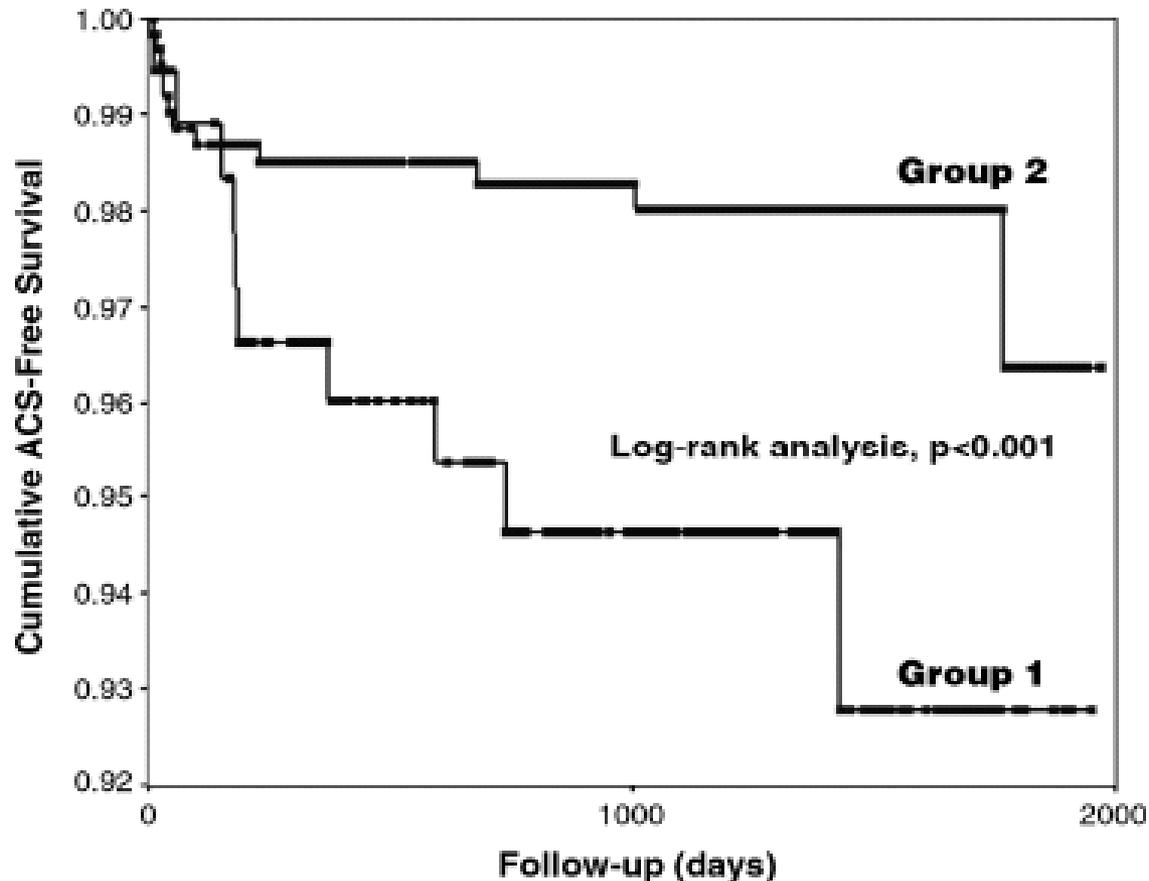
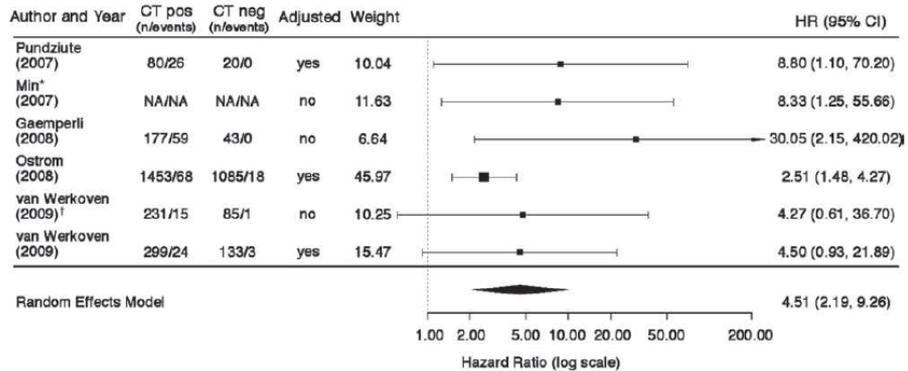


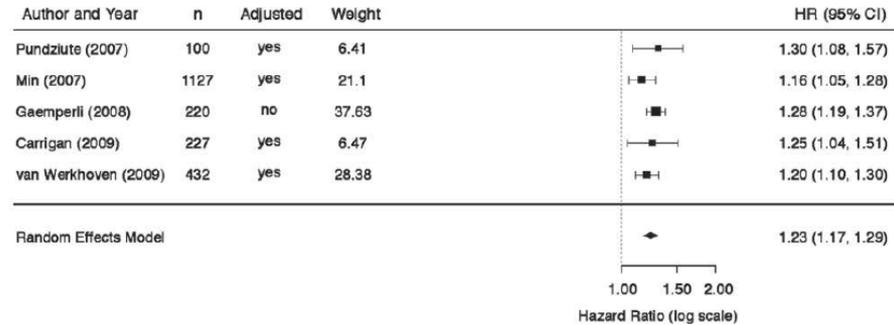
Fig3. ACS-free survival curves for patients with (Group 1) or without (Group 2) CT low-dense plaques. ACS, acute coronary syndrome.

Valeur pronostique d'une plaque

A



B



C

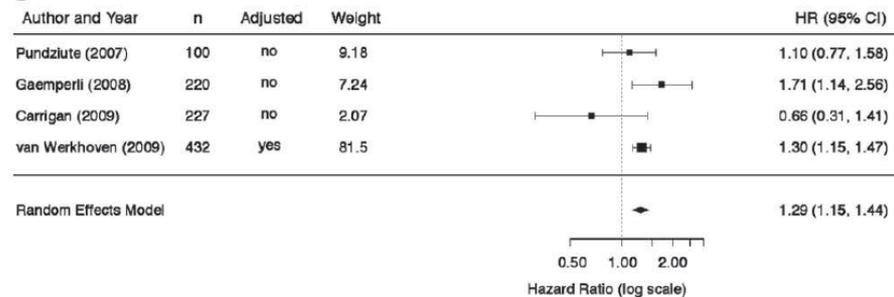
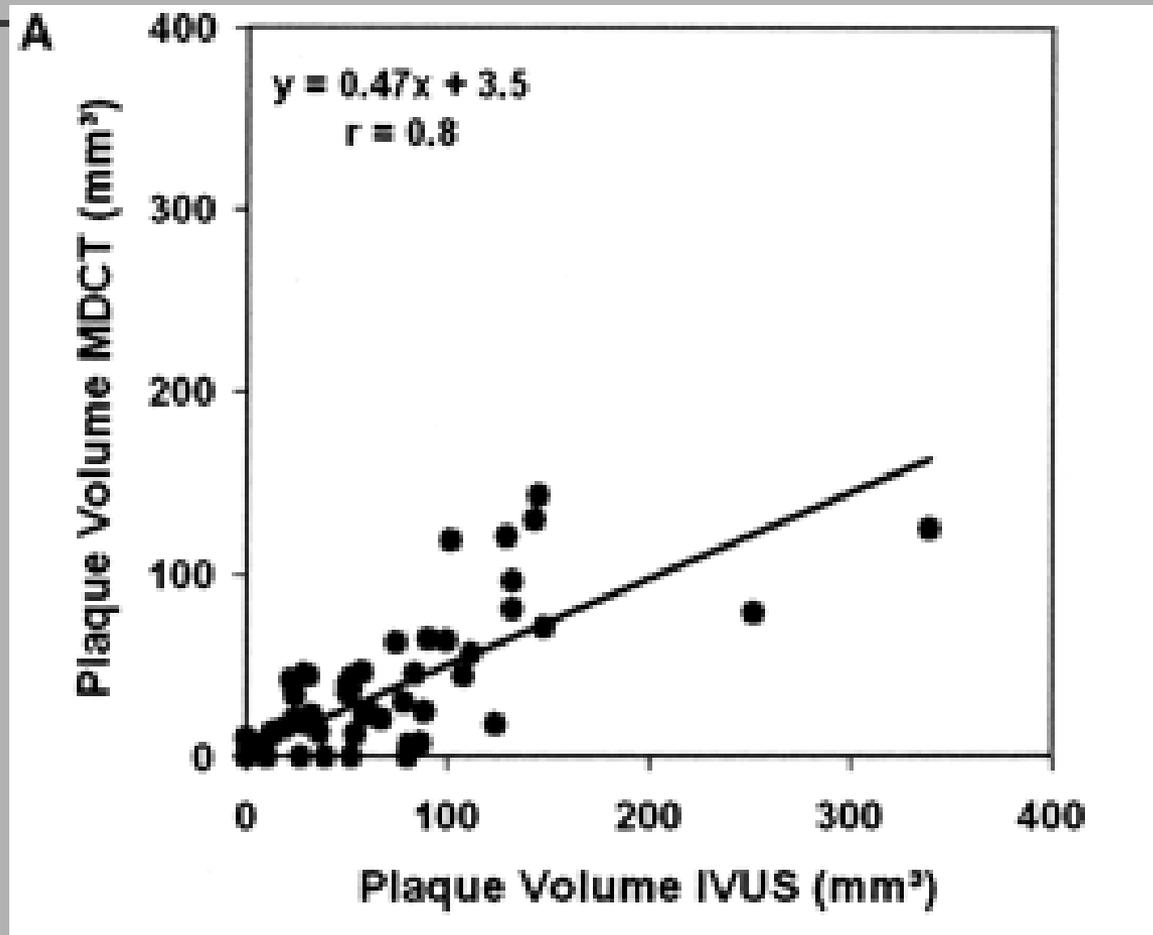


Figure 4 Risk Estimates for the Presence of Plaque, per Segment of Any Plaque, per Segment of Noncalcified Plaque

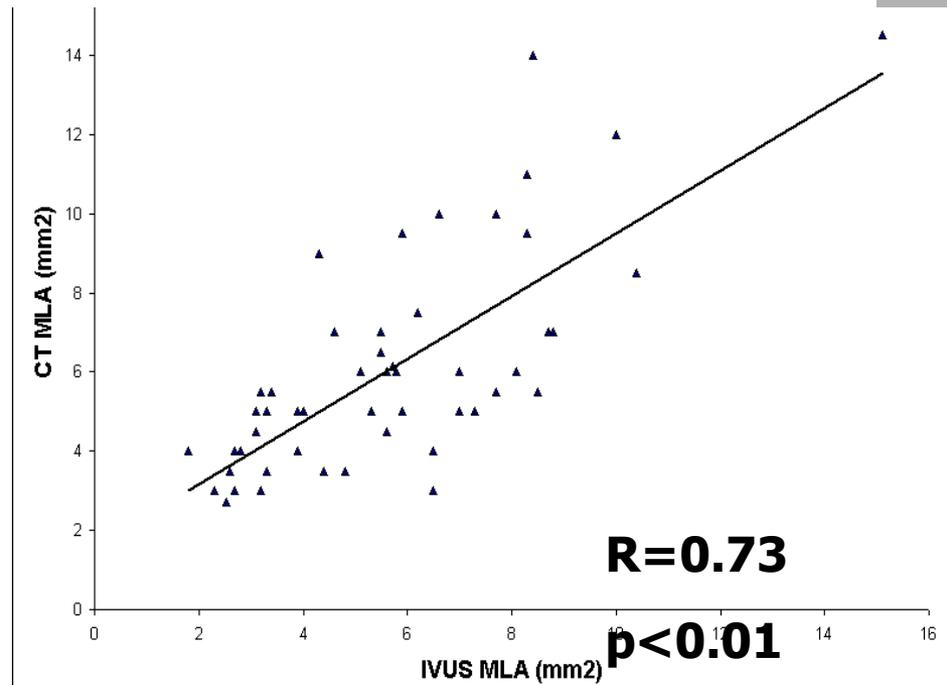
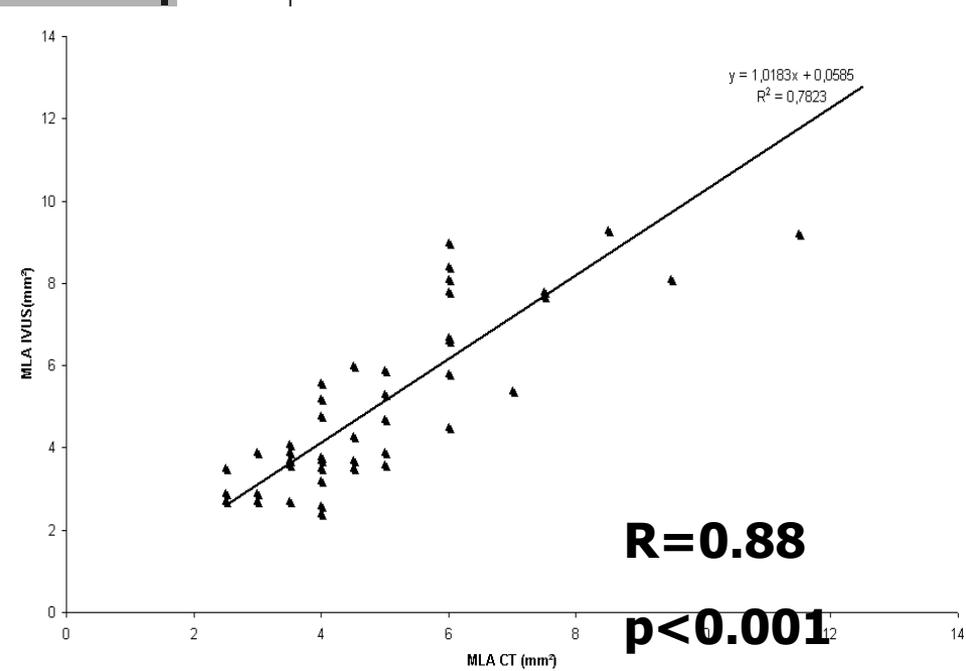
(A) Any atherosclerotic plaque within the coronary artery tree. (B) Each coronary segment containing any atherosclerotic plaque (maximum of 17). (C) Each coronary segment containing noncalcified atherosclerotic plaque. *As derived by the reciprocal. [†]In 2009, the same lead author published in *Heart* (12) and the *European Heart Journal* (24). "Adjusted" indicates whether multivariate adjustment was performed. **Horizontal lines** represent 95% confidence intervals (CIs). The **rectangles** represent the point estimate, and the **size of the rectangle** is proportional to the weight given to each study in the meta-analysis. The **diamond** represents the summary estimate (**size of the diamond** = 95% CI). The **dashed vertical line** represents the reference of no increased risk. Figure by Craig Skaggs. CT = computed tomography; HR = hazard ratio; N/A = not applicable.

Volume de plaque



64 slice CT MLA Correlation with IVUS

14 7



64 slice

+330 ms rotation

+z-flying spot :

0.4 mm

16 slice

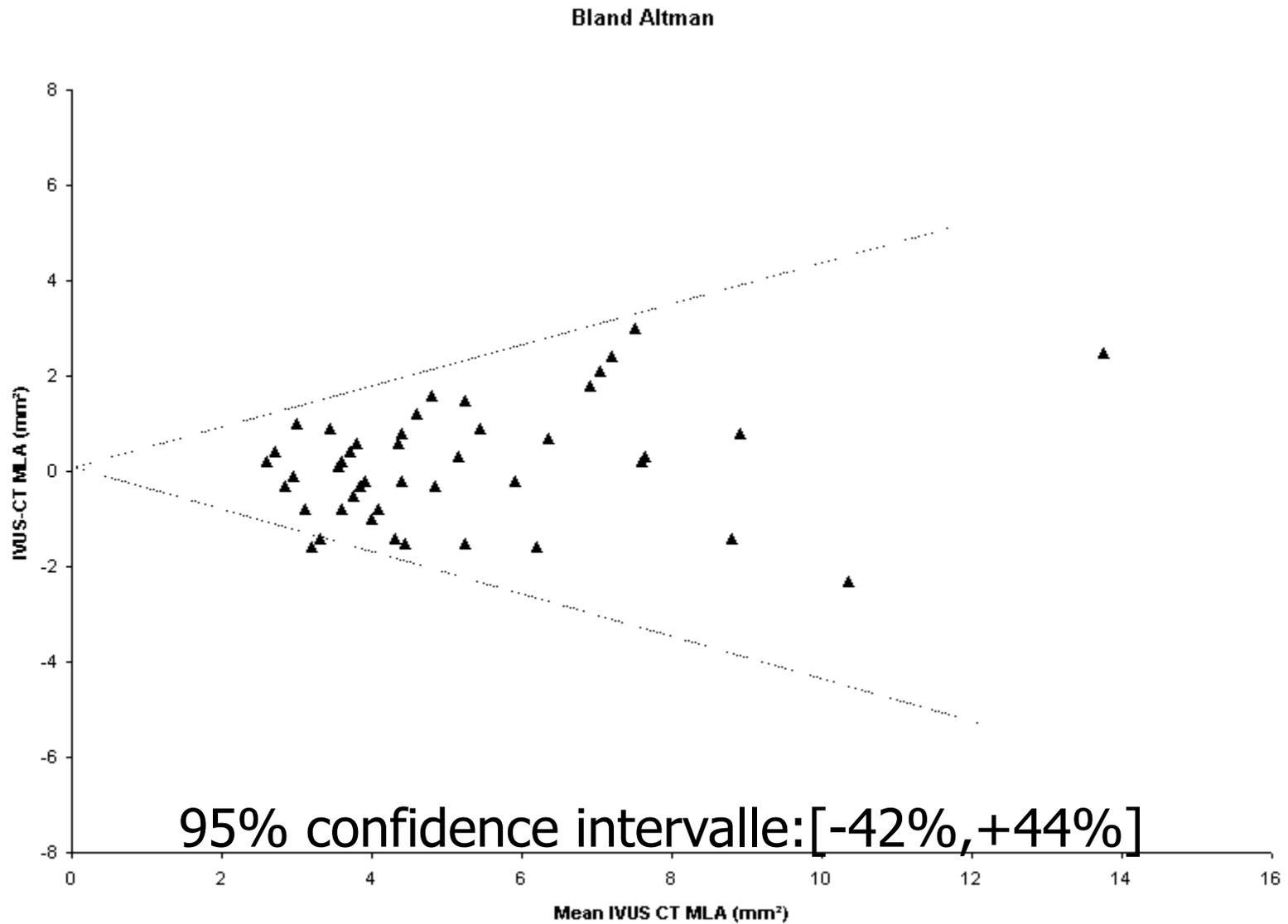
+ 470 ms rotation:

0.75 mm

MLA CT (mm²)

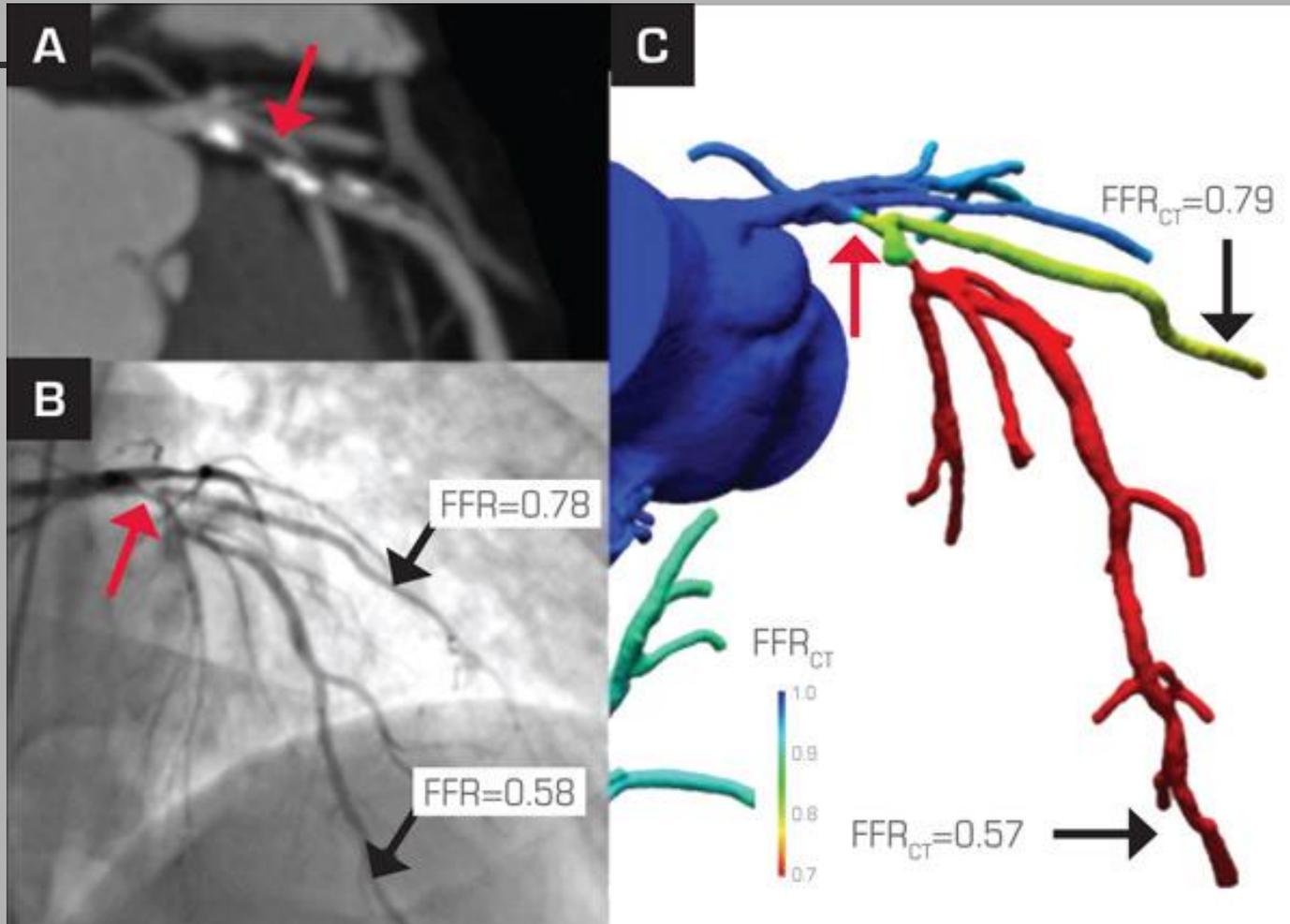
14

Bland-Altman Analysis



Z

FFR-CT



FFR donnée avec un IC 95% \pm 0.2 !!!

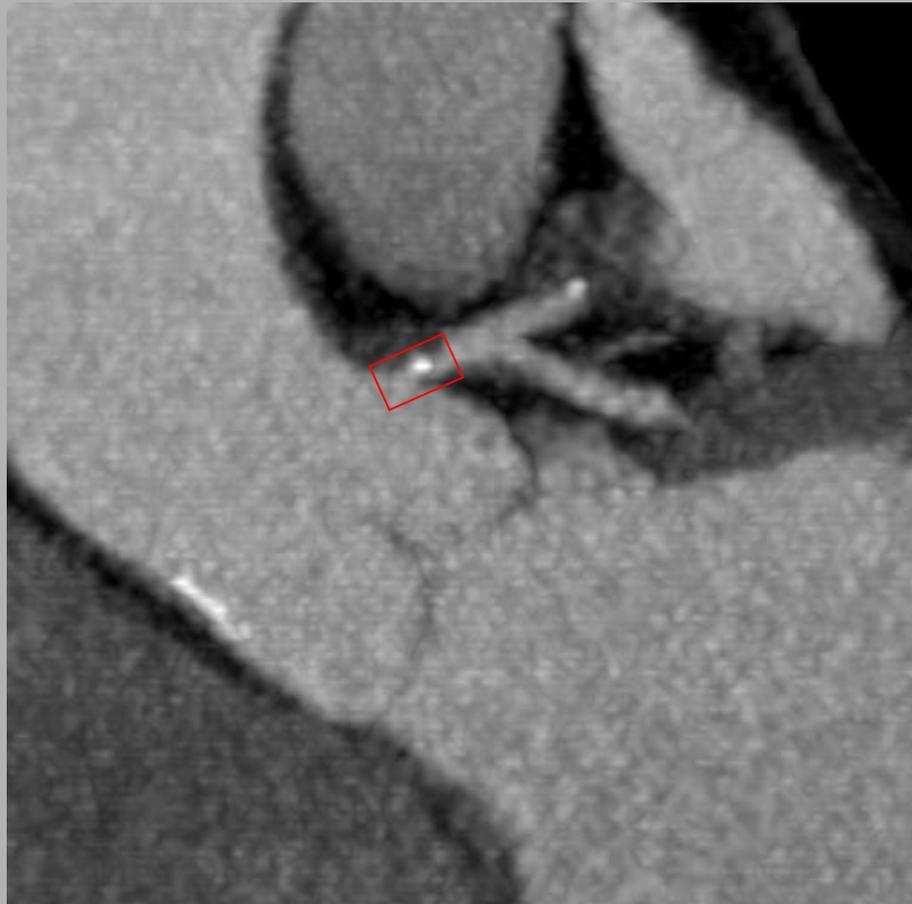
JACC 2011
NEJM 2012

Value of Myocardial Perfusion Assessment With Coronary Computed Tomography Angiography in Patients With Recent Acute-Onset Chest Pain

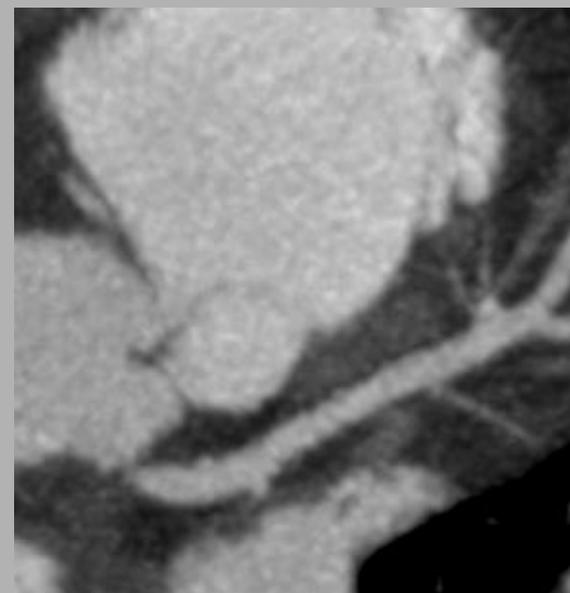
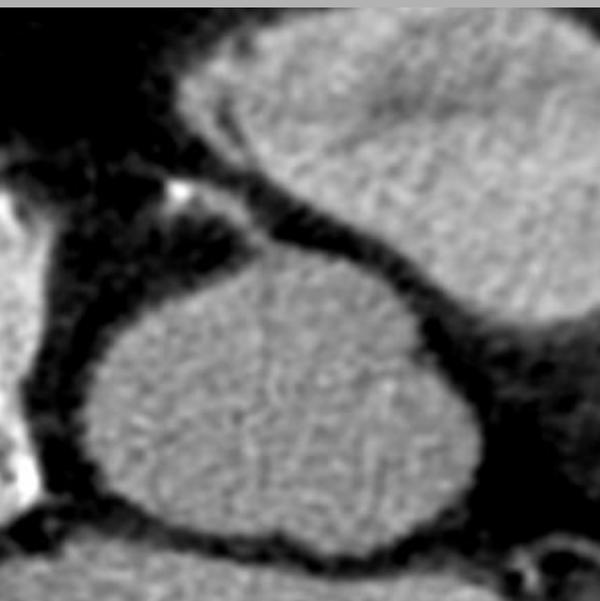
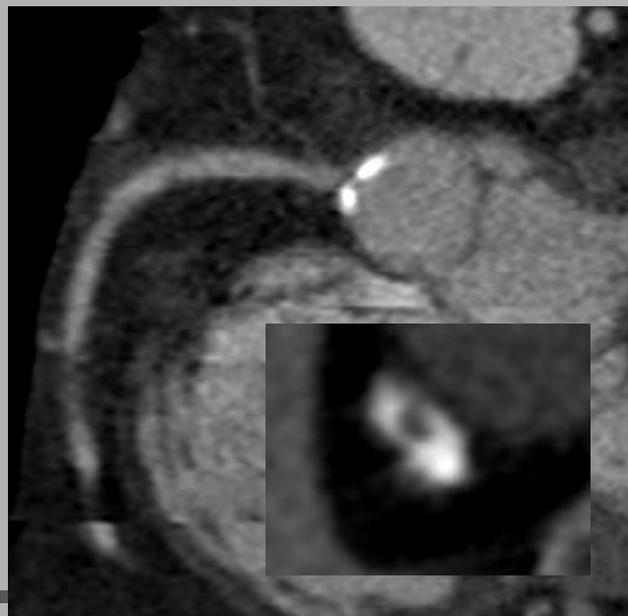


Mathias H. Sørgaard, MD,^a Jesper J. Linde, MD,^a J. Tobias Kühl, MD,^b Henning Kelbæk, MD,^c Jens D. Hove, MD,^d Gitte G. Fornitz, MD,^e Tem B.S. Jørgensen, MD,^e Merete Heitmann, MD,^b Charlotte Kragelund, MD,^f Thomas F. Hansen, MD,^g Jawdat Abdulla, MD,^h Thomas Engstrøm, MD,^a Jan S. Jensen, MD,^g Yaffah T. Wiegandt, BS,^a Dan E. Høfsten, MD,^a Lars V. Køber, MD,^a Klaus F. Kofoed, MD^{a,i}

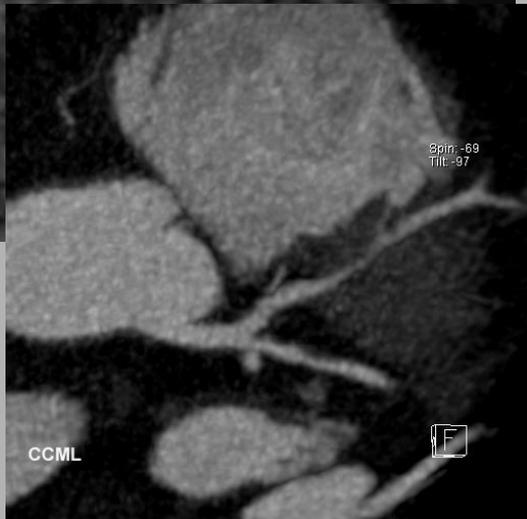
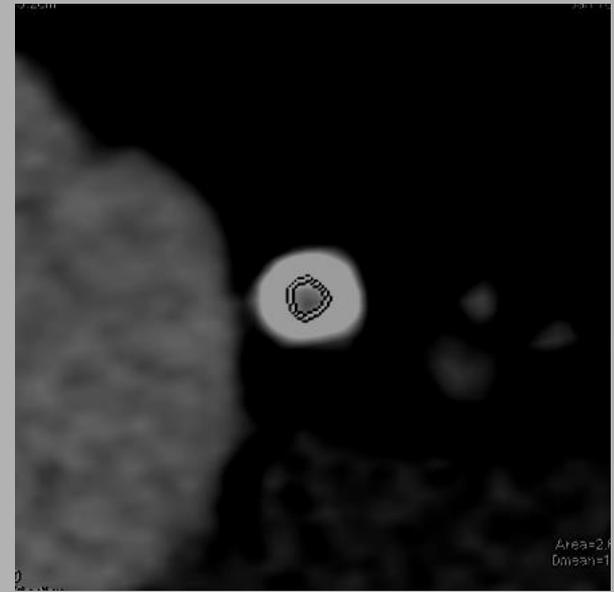
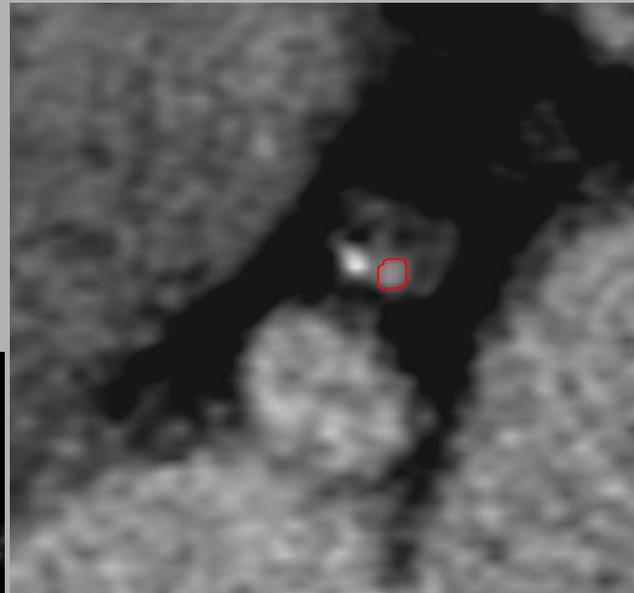
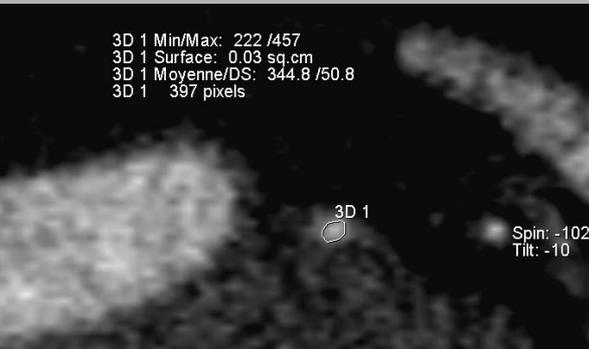
Aide à l'angioplastie

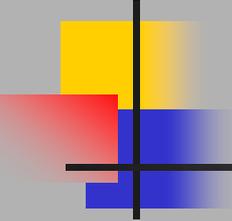


Pesenti-Rossi Eurointervention 2011

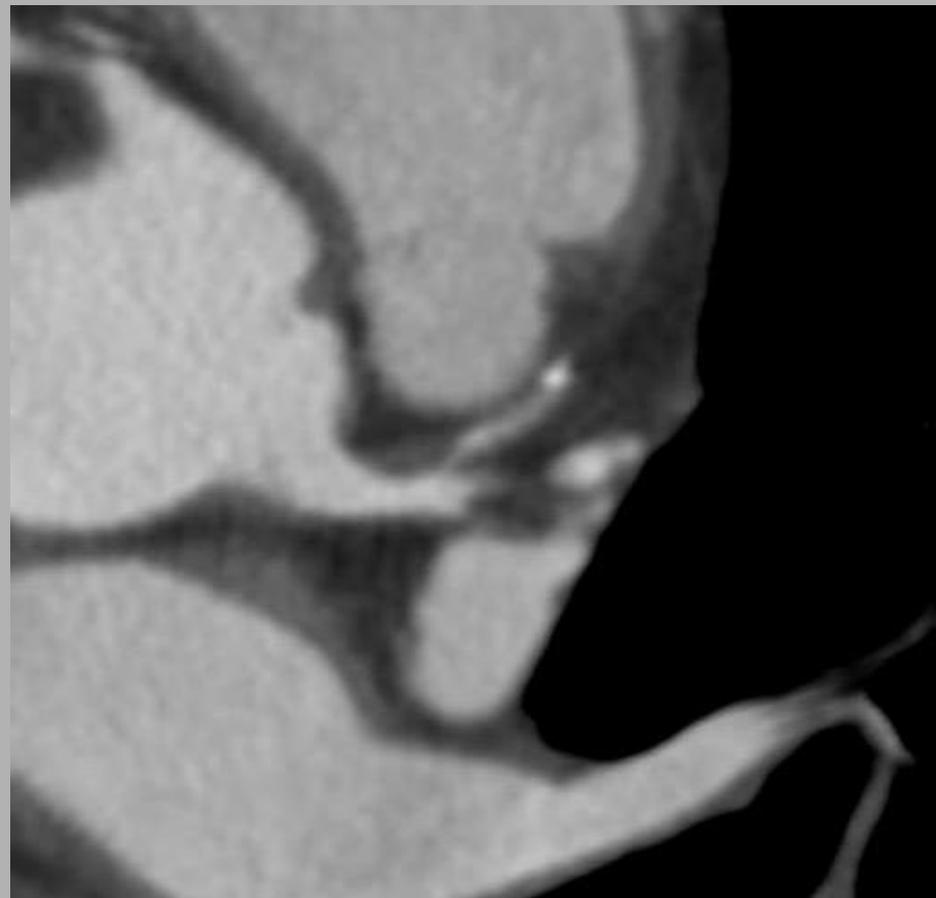
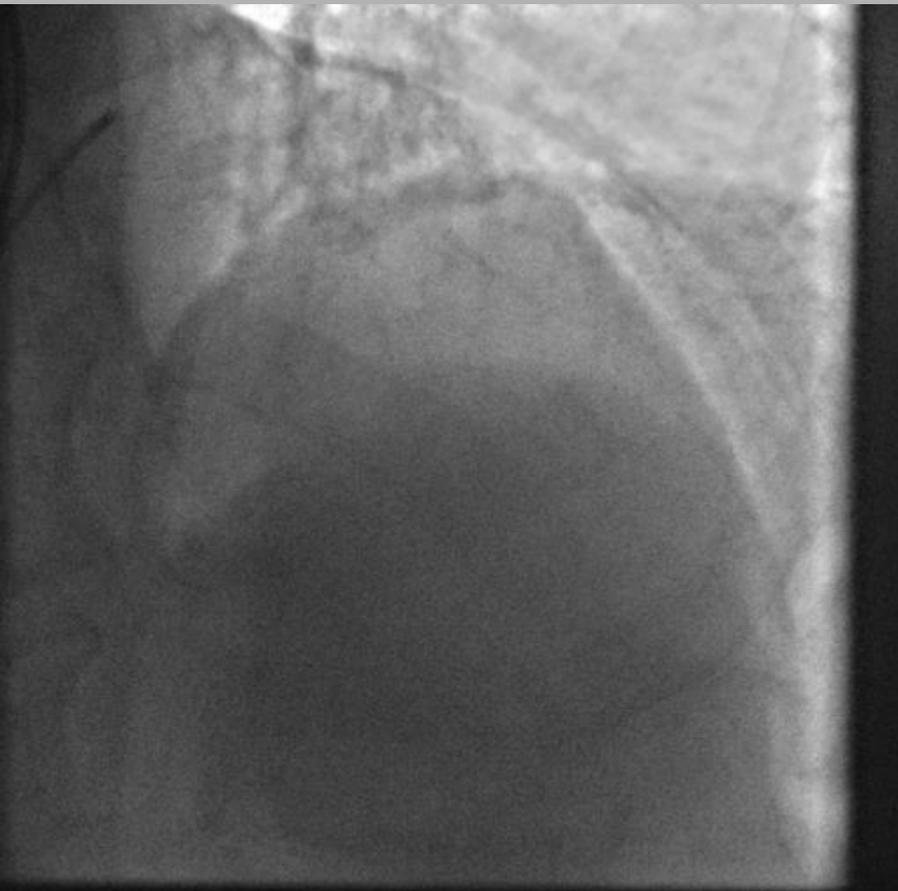


Appréciation des possibilités d'angioplastie

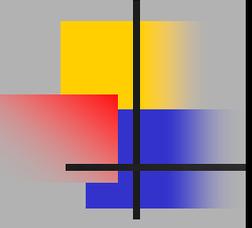


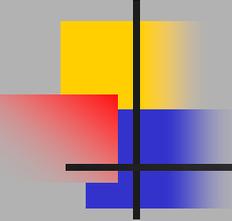


Analyse de la bifurcation



A. Ohanessian





Conclusion

- Pas d'intérêt dans le SCA avéré
- Dg douleur thoracique aiguë
- Complications:
 - CIV, Thrombus, péricarde
 - Etendue de l'IDM, viabilité ->IRM
- Visualisation des plaques
 - Volume, Excentricité, Hypodensités, Remodeling.
- Aide à l'angioplastie