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Société Algérienne de Médecine
Nucléaire et d'Imagerie Moléculaire



2ÈME CONGRÈS ANNUEL DE LA **SAMNIM** – 2026

VENDREDI 25 SEPTEMBRE

HÔTEL SOFITEL, ALGER



ACTUALITES EN SPECT-CT MYOCARDIQUE DE PERFUSION

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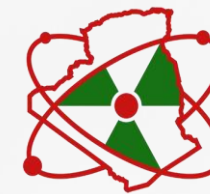
IMAGERIES DU SYNDROME CORONARIEN

- Prévalence pré-test et choix du test (ESC 2024)
- Apports du score Ca à la SPECT ?
- CTA/CORO et ischémie

RESERVE CORONAIRE : principe et applications

- Coronaropathies 3-tronculaires
- INOCA
- Réduction du sinus coronaire
- Amylose aTTR

PREVALENCE DU SCC



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Modèle de Diamond et Forrester

p(DT/vie) = 20-40%
F > H
Aux urgences :
SCA < 10% des DT

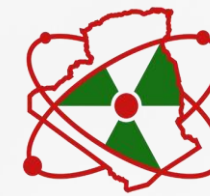
	Typical angina		Atypical angina		Non-anginal pain	
Age	Men	Women	Men	Women	Men	Women
30-39	59	28	29	10	18	5
40-49	69	37	38	14	25	8
50-59	77	47	49	20	34	12
60-69	84	58	59	28	44	17
70-79	89	68	69	37	54	24
>80	93	76	78	47	65	32

- **White boxes:**
PTP <15%. No further testing.
- **Blue boxes:**
PTP 15-65%. May need Exercise EKG or non-invasive imaging.
- **Orange boxes:**
PTP 66-85%. Should have a non-invasive imaging.
- **Red boxes:**
PTP >85%. Assume CAD is present.

Prévalence . 10 ⁵	1990	2023	Ecart
Europe de l'ouest	1950	1480	-24 %
Algérie	4843	3566	-26 %

GA Diamond & JS Forrester. Analysis of probability as an aid in the clinical diagnosis of CAD. N Engl J Med 1979;300:1350-8. Institute for Health Metrics and Evaluation. Global Burden of Disease (GBD) study, age-standardized prevalence rate (per 100 000) for Ischemic Heart Disease
ESC Atlas of Cardiology - M Gulati et al. 2021 J Cardio Comput Tomo. 2022;16(1):54-122 - C Vrints et al. 2024 Eur Heart J. 2024; 45:3415-3537

PREVALENCE DU SCC



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1 Symptom score (0–3 points)

Chest pain characteristics		Symptom score
Type and location	Constricting discomfort located retrosternally or in neck, jaw, shoulder or arm (1 point)	Main symptom either: Chest pain (0–3 points) or Dyspnoea (2 points)
Aggravated by	Physical or emotional stress (1 point)	
Relieved by	Rest or nitrates within 5 min (1 point)	
Dyspnoea characteristics		
Shortness of breath and/or trouble catching breath aggravated by physical exertion (2 points)		

2 Number of risk factors for CAD (0–5): Family history, smoking, dyslipidaemia, hypertension and diabetes

3 Estimate the Risk Factor-weighted Clinical Likelihood (RF-CL) of obstructive CAD

	Symptom score 0–1 point					2 points					3 points				
	Women		Men			Women		Men			Women		Men		
Number of risk factors	0–1	2–3	4–5	0–1	2–3	4–5	0–1	2–3	4–5	0–1	2–3	4–5	0–1	2–3	4–5
Age 30–39	0	1	2	1	2	5	0	1	3	2	4	8	2	5	10
Age 40–49	1	1	3	2	4	8	1	2	5	3	6	12	4	7	12
Age 50–59	1	2	5	4	7	12	2	3	7	6	11	17	6	10	15
Age 60–69	2	4	7	8	12	17	3	6	11	12	17	25	10	14	19
Age 70–80	4	7	11	15	19	24	6	10	16	22	27	34	16	19	23

Clinical likelihood: ● Very low ● Low ● Moderate



Adjust clinical likelihood based on abnormal clinical findings

(Class I)

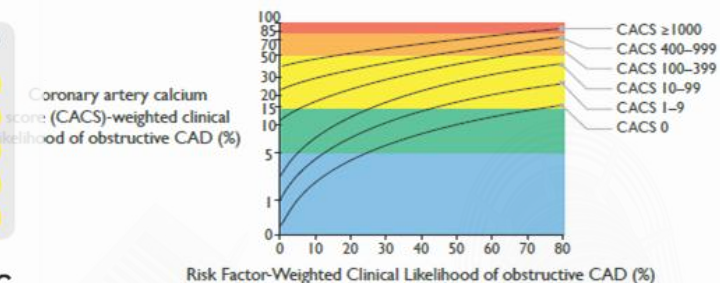
4

- Resting ECG changes (Q-wave or ST-segment/T-wave changes)
- Exercise ECG with abnormal findings
- LV dysfunction (severe or segmental)
- Ventricular arrhythmia
- Peripheral artery disease
- Coronary calcification on pre-existing chest CT

Consider reclassification of low RF-CL (>5–15%) using CACS to identify very low (≤5%) CACS-CL

(Class IIa)

5



C Vrints et al. 2024 ESC Guidelines for the management of chronic coronary syndromes. Eur Heart J. 2024; 45:3415-3537
S Winther et al. Incorporating coronary calcification into pre-test assessment of the likelihood of CAD. JACC 2020;76:2421-32



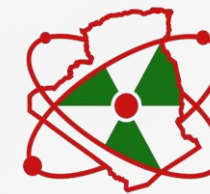
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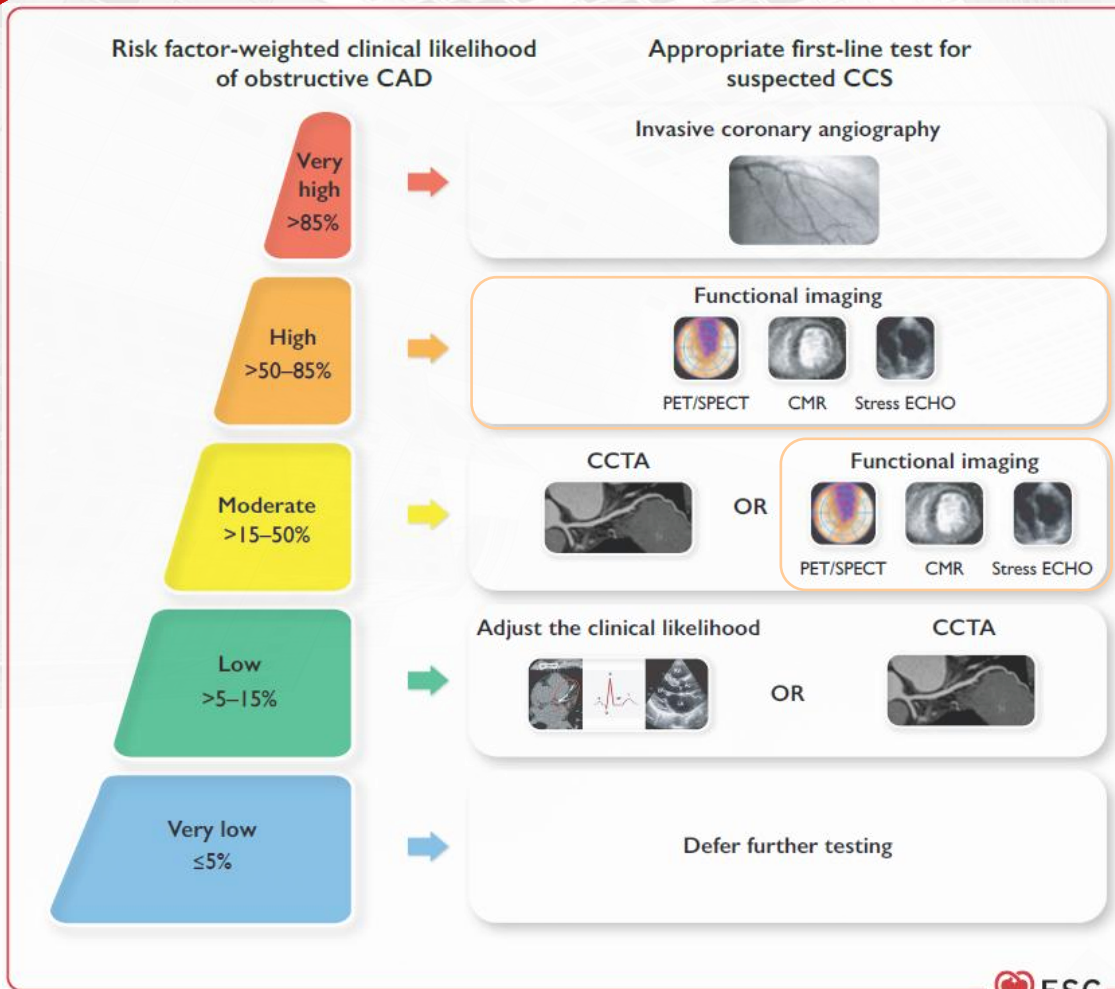
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DIAGNOSTIC DU SCC



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😊 CCTA ⇒ sténose, plaques à haut risque, SC
Dic ≠ (péricardite, dissection Ao, Ep, pneumopathie...).

☹ tachy-arythmie, iode, dosimétrie/seins >> Sc Ca

? CCTA +/- ⇔ +/- ischémie

C Vrints et al. 2024 ESC Guidelines for the management of chronic coronary syndromes. Eur Heart J. 2024; 45:3415-3537 - S Winther et al. Incorporating coronary calcification into pre-test assessment of the likelihood of CAD. JACC 2020;76:2421-32 - R Hachamovitch et al. Circulation 2003; 107(23): 2900-2907 - SD Fihn et al JACC 2012;60(24): e44-e164 - J Knuuti et al. Eur Heart J 2020; 41(3):407-477.



CTA/CORO normale

⇒ ~~ischémie~~ ?

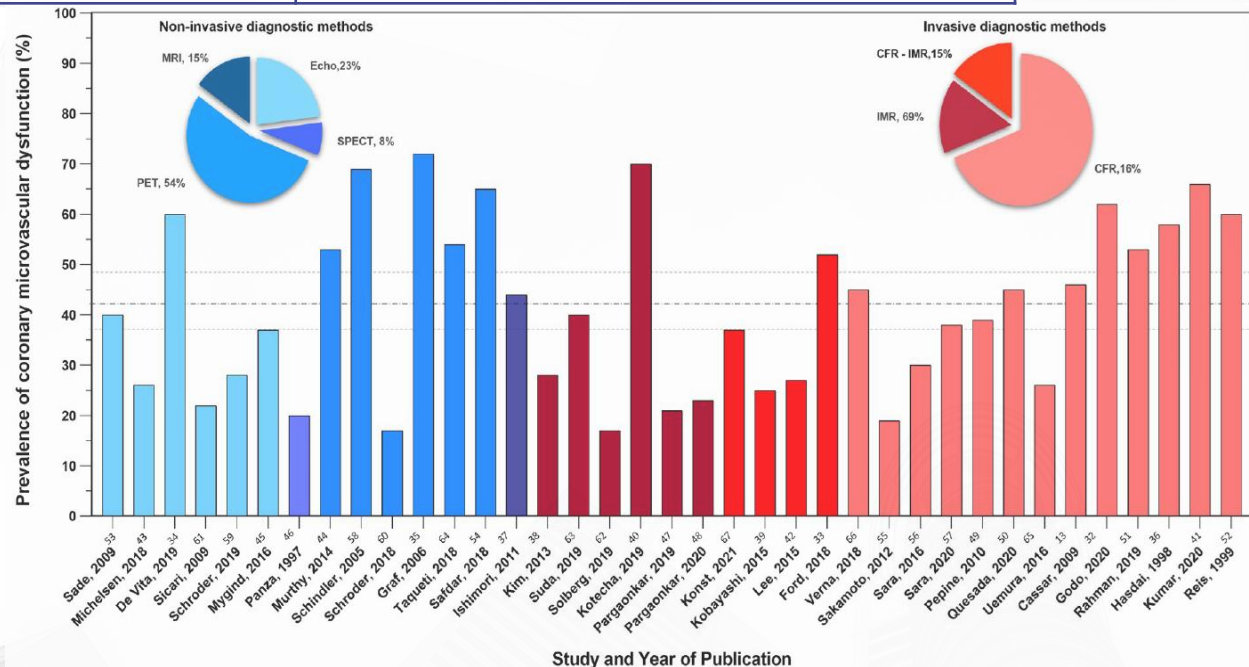


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56 études / 14 427 angor sans coronaropathie obstructive	
37 / 7212 : ? Microangiopathie (Doppler, thermodil. $\equiv$ PET)	24 / 6553 : ? Vasospasme Test à l'acétylcholine (methergin)
59 ans, 61% F, 66% HTA, 22% DNID, 19% tabac	60 ans, 39% F 21% DNID, 32% tabac
P = 41% [36,47] ; F > H	P = 49% [43,56] ; F = H

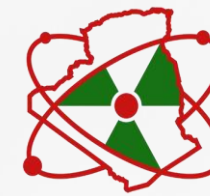
Risque de FN dans les
microangiopathies/vasospasme

- En CCTA
- en SPECT standard



Niya Mileva et al. Prevalence of
Coronary Microvascular Disease
and Coronary Vasospasm in Patients
With Nonobstructive Coronary Artery
Disease: Systematic Review and
Meta-Analysis.
J Am Heart Assoc. 2022 Apr 5;11(7)

CCTA pathologique ⇒ Ischémie ?



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Patients undergoing coronary CTA for suspected CAD (n=758) ; $\emptyset > 50\%$



62% de CCTA-
(Registre ACC : 40 % Coro -)

PET perfusion imaging due
to suspected obstructive
stenosis (n=286) = 38%

111 ischémies = 15% de 758 = 39% des CCTA+



Normal stress MBF
in all territories
(n=175)
= 61% des CCTA+



Reduced MBF
in 1 territory
(n=32)
11% des CCTA+



Reduced MBF
in 2 territories
(n=33)
11% des CCTA+



Reduced MBF
in 3 territories
(n=46)
16% des CCTA+

6% des patients explorés
41% des 111 ischémies

MBF > 80% du MBF_{max}



Heterogeneous
reduction
(n=33)



Balanced
reduction
(n=13)

28% des 46 tritronculaires
12% des 111 ischémies

Risque de FN en SPECT standard

61 % FP du CCTA :
CCTA+ $\nrightarrow$ ischémie

61 ans
H 43%
Tabac 32%
DNID 16%
HTA 55%
LDL 59%
ATCD F 44%
Angor T 20%
Angor aT 65%
Sc Ca 28

Teemu Maaniity et al. Extensive and balanced reduction of myocardial blood flow in patients with suspected obstructive coronary artery disease: ^{15}O -water PET study. Int J Cardiol. 2021 Sep 1:338:1-7.

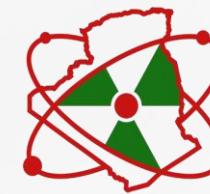


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CT-AC et SCORE Ca

Intérêts du SC/CTAC+SPECT :

- Correction d'atténuation
- Incidentalomes
- Graisse épocardique ?
- $AS = \sum_{d>130} UH S_{Ca}(mm^2) \cdot INT \left(\frac{d(UH<500)}{100} \right)$
 - ECV<1%/an à TSM N:
 - 10 ans si AS < 400;
 - 4 ans si AS ∈ [400,999];
 - 0 si AS > 1000 (6% ECV@1 an)
 - ∅ TSM_{repos} si stress et AS N
 - ∅ statines si AS = 0

Table 1

Agreement Between VECAC and AS in 492 Patients With 2 Readers per Patient, 3 centres

apnée/gated AS	VECAC sur CT-AC faible dose, non synchronisé, sans apnée					
	0	1-9	10-99	100-399	400-999	1,000+
0	323	14	11	2	0	0
1-9	46	8	8	0	0	0
10-99	37	13	100	24	2	0
100-399	5	4	57	73	33	2
400-999	0	0	1	44	62	19
1,000+	1	0	1	5	33	56

93 % correct à ± 1 classe
Place de l'IA ?

Table 4

Agreement Between Readers in 492 Patients

Reader 1	Reader 2					
	0	1-9	10-99	100-399	400-999	1,000+
0	183	12	13	1	0	0
1-9	5	3	7	0	0	0
10-99	12	7	48	26	4	0
100-399	2	2	13	31	27	0
400-999	1	0	0	15	29	18
1,000+	0	0	0	0	7	26

Einstein AJ et al. J Am Coll Cardiol,
2010;56:1914-21

Malek Nayfeh et al. Semin Nucl Med 2024 ; 54

Naya et al. JACC 2013;61(20)



COMMENT EVITER LES FN ?

PROBA PRE-TEST

- FRCV, angor, écho...

EE (+/- C/E)

- METs, TA ↓, ECG

SPECT-CT/AC

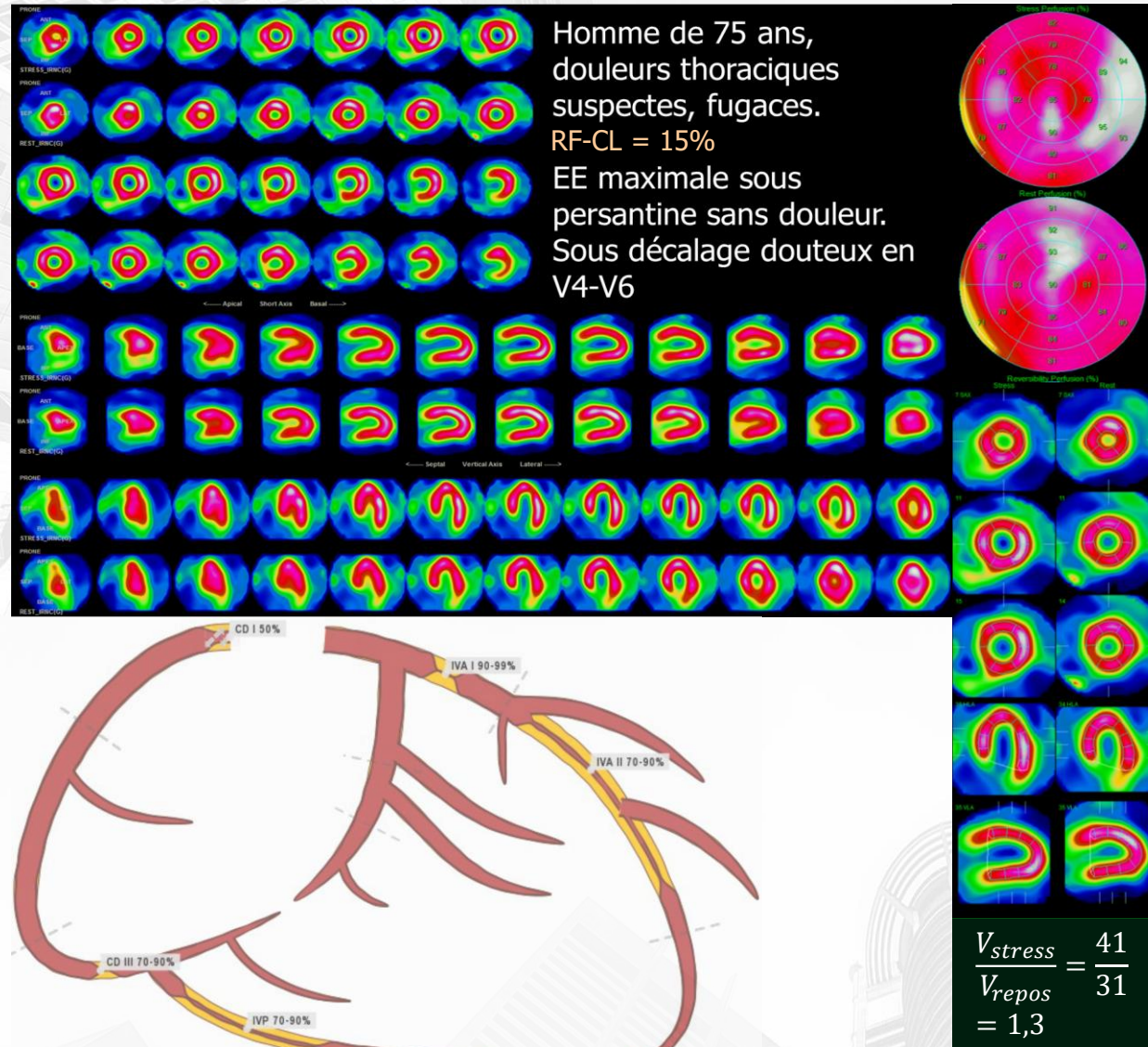
- *SCORE CALCIQUE*
- $\frac{V_{stress}}{V_{repos}} > 1,2$ (ISE)
- *I / S / H / N*
- *Dilatation VG*
- $FE_{stress} < FE_{repos}$



Réserve coronaire



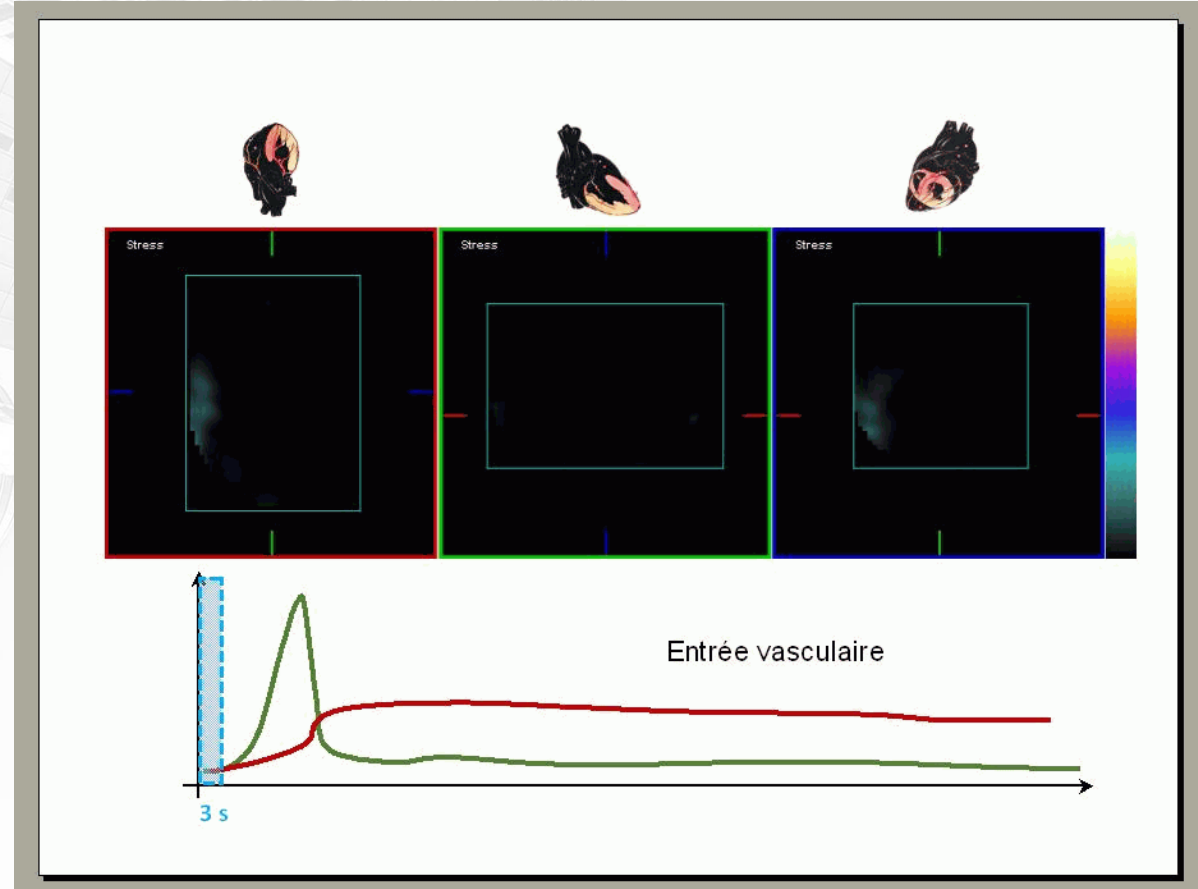
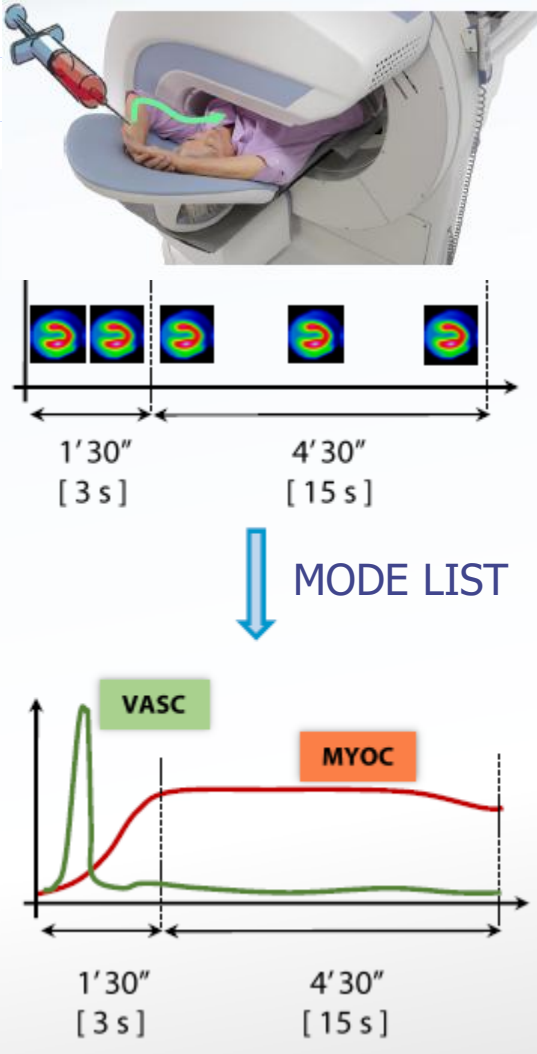
Coronarographie



SPECT DYNAMIQUE



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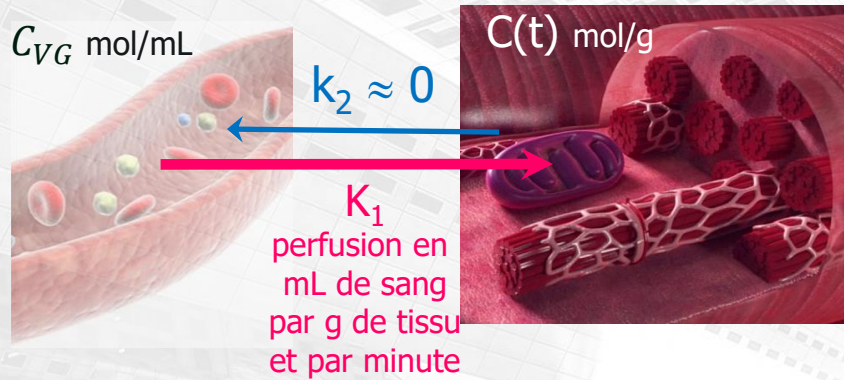
1 mCi Tc-TF 5 mCi Tc-TF 0,56 mg/kg DIP 18 mCi Tc-TF

centrage Repos List 5' 4' Stress List 5'

RESERVE CORONAIRE

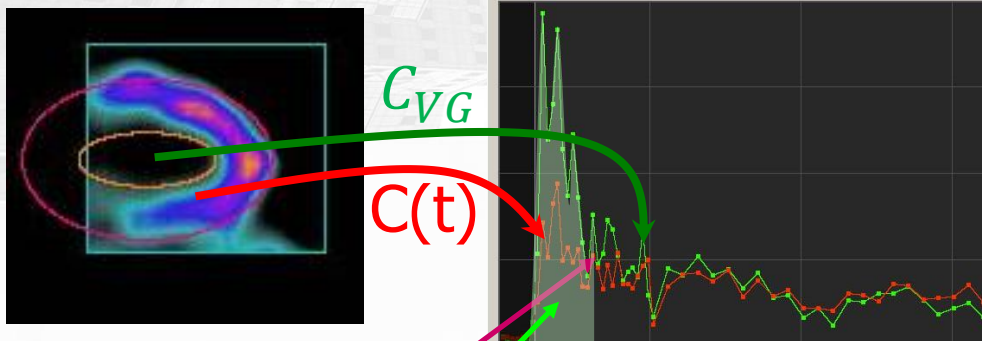


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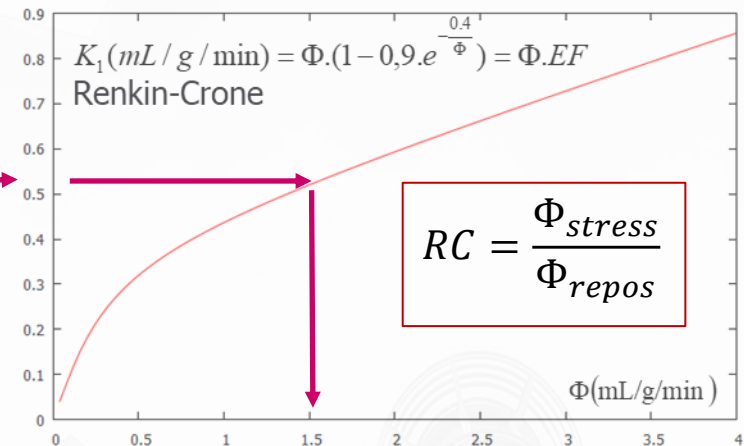


$$\frac{dC(t)}{dt} = K_1 \cdot C_{VG}(t) \Rightarrow \int_0^t \frac{dC(t)}{dt} dt = K_1 \cdot \int_0^t C_{VG}(t) \cdot dt$$

$$C(t) = K_1 \cdot \int_0^t C_{VG}(t) \cdot dt$$



$$K_1 = \frac{C(t)}{ASC(t)} \approx \frac{\bar{C}_{Myoc\ plateau}}{ASC_{Pic\ vascu}}$$



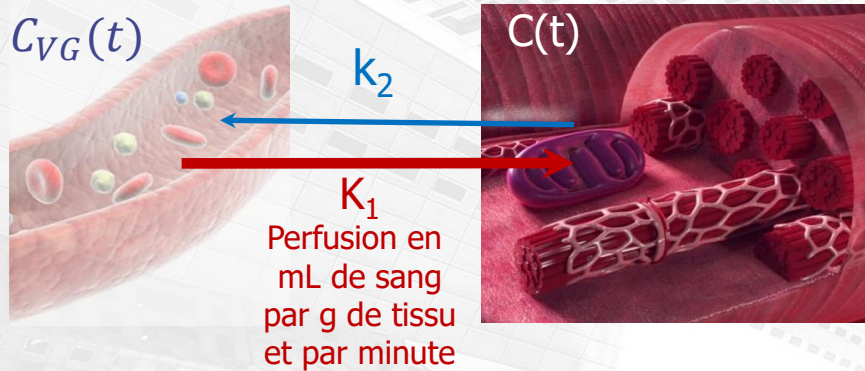
(correction EVP et contamination P→C)

JA Leppo Circ Res. 1989; 65:632-9

MODELE DE SHRESTA



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$$\frac{dC(t)}{dt} = K_1 \cdot C_{VG}(t) - k_2 C(t)$$

$$\Rightarrow C(t) = K_1 \cdot e^{-k_2 \cdot t} \int_0^t C_{VG}(u) \cdot e^{k_2 \cdot u} du$$

Initialisation de K_1 et k_2

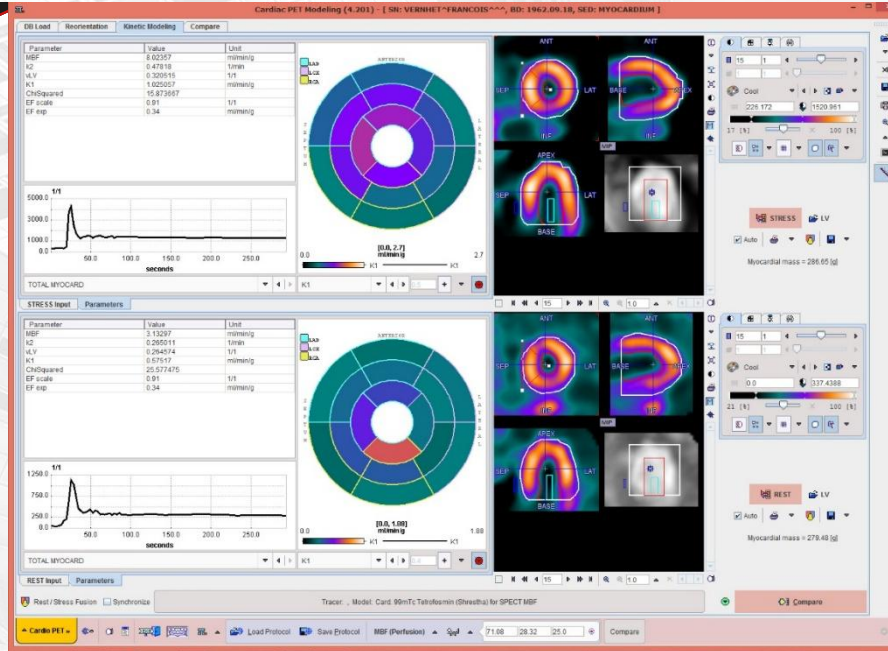
$$C_{Mod\grave{e}le}(t) = (1 - f_{VG} - f_{VD}) \cdot C(t) + f_{VG} \cdot C_{VG}(t) + f_{VD} \cdot C_{VD}(t)$$

$$(K_1, k_2) = Argmin \chi^2 = \sum_i \frac{1}{\sigma_i^2} [C_{SPECT}(t_i) - C_{Mod\grave{e}le}(t_i)]$$

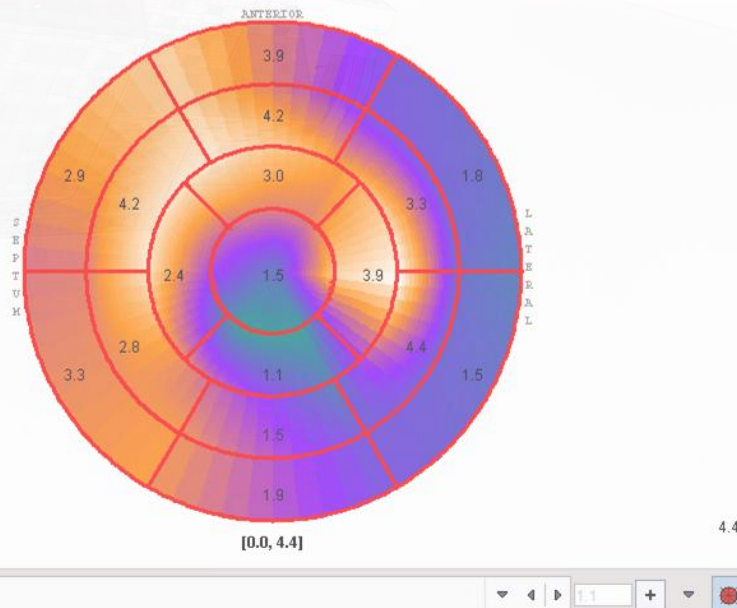
$$K_1 = MBF \cdot \left(1 - 0,91 \cdot e^{-\frac{0,34}{MBF}}\right) \Rightarrow RC \stackrel{\text{def}}{=} \frac{MBF_{stress}}{MBF_{repos}}$$

Shrestha U, et al. Measurement of absolute myocardial blood flow in humans using dynamic cardiac SPECT and (99m)Tc-tetrofosmin: Method and validation. J Nucl Cardiol 2017, 24(1):268-277.

EN PRATIQUE



$N > 2$



Segment [1/1]	Value	%
1. basal anterior	3.88446	88.21
2. basal anterosseptal	2.902009	65.9
3. basal inferosseptal	3.299700	74.93
3. basal inferosseptal	1.892456	42.98
5. basal inferolateral	1.461196	33.18
6. basal anterolateral	1.791929	40.69
7. mid anterior	4.178699	94.89
8. mid anterosseptal	4.169406	94.68
9. mid inferosseptal	2.837374	64.43
9. mid inferosseptal	1.481905	33.65
11. mid inferolateral	4.403579	100.0
12. mid anterolateral	3.333418	75.7
13. apical anterior	3.016674	68.5
14. apical septal	2.413306	54.8
15. apical inferior	1.099946	24.98
16. apical lateral	3.943216	89.55
17. apex	1.518129	34.47

$$K_1 = \Phi \cdot (1 - 0,91 \cdot e^{-\frac{0,34}{\Phi}}) = \Phi \cdot EF$$

^{99m}Tc -TF NM 530 CZT

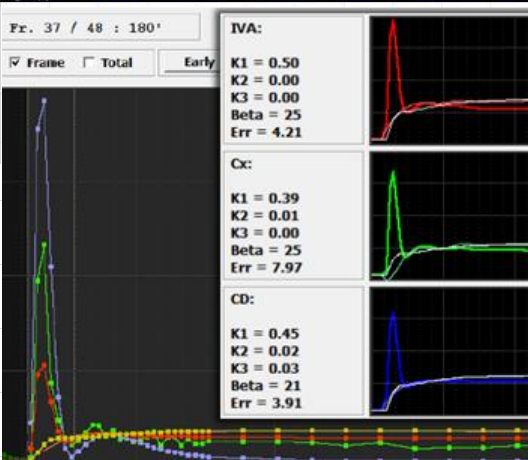
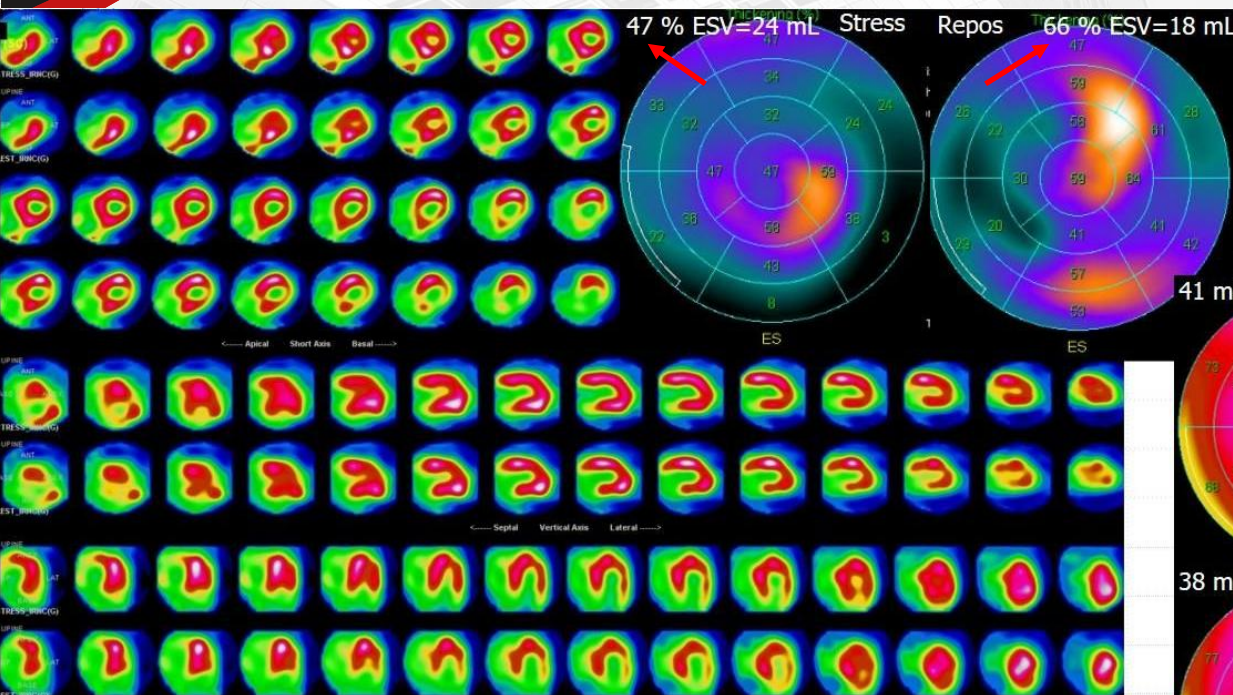
Shrestha U, Sciammarella M, Alhassen F, Yeghiazarians Y, Ellin J, Verdin E, Boyle A, Seo Y, Botvinick EH, Gullberg GT: J Nucl Cardiol 2017, 24(1):268-277.

MULTI-TRONCULAIRE



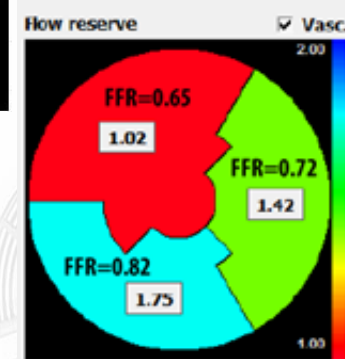
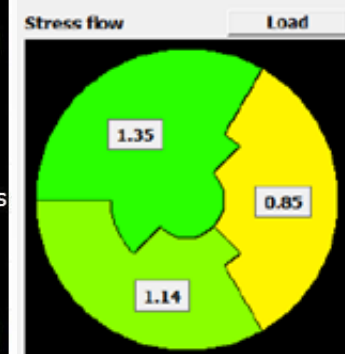
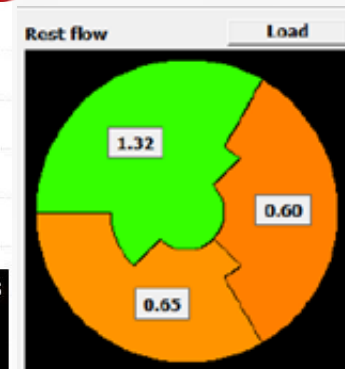
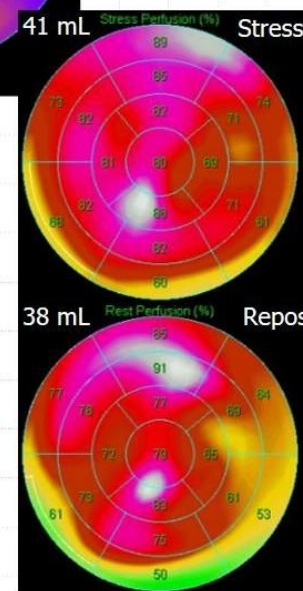
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Surveillance d'un stent sur CD1

⇒ coronarographie:
80 % IVA 2
80 % IVA 3
95 % Mg

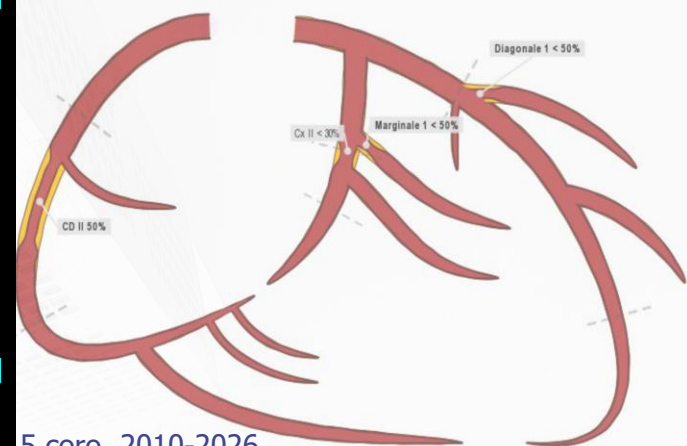
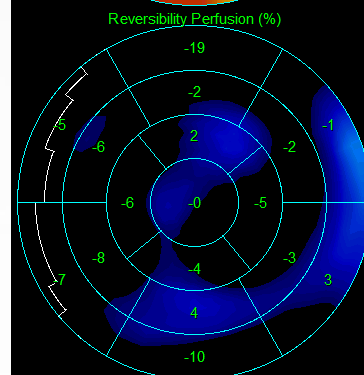
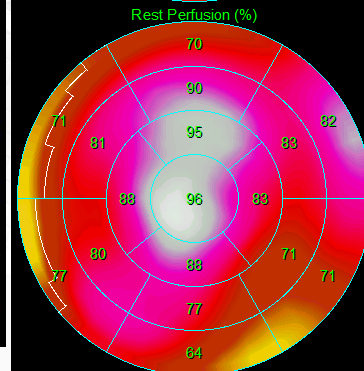
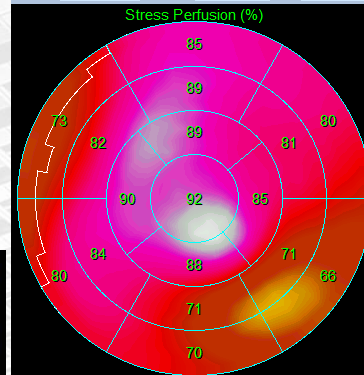
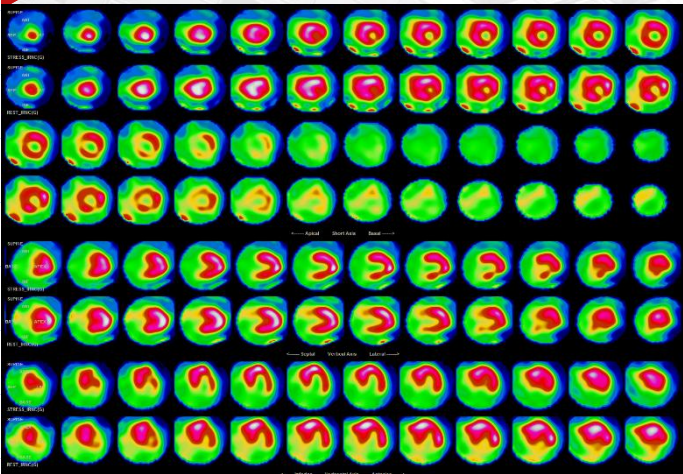


INOCA

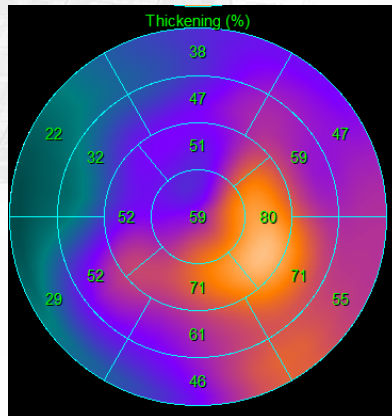
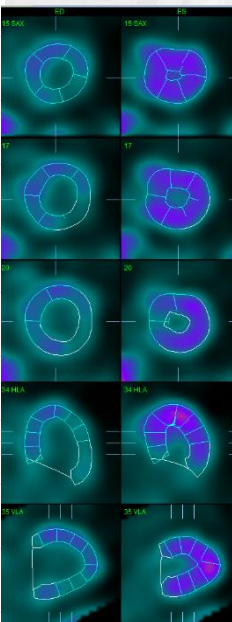
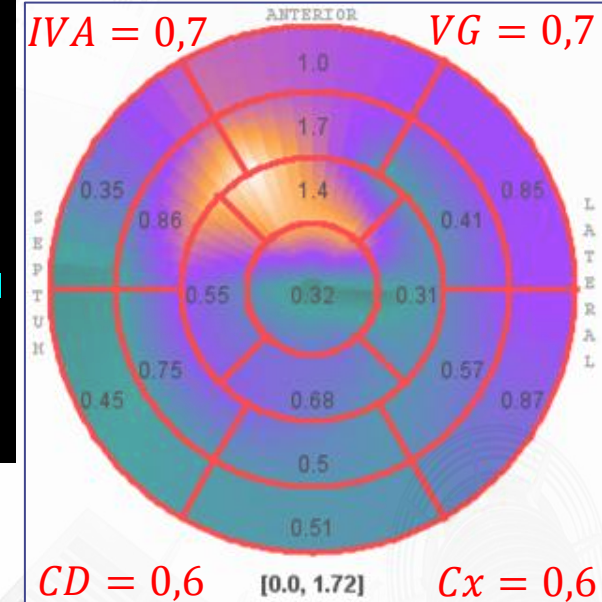


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5 coro. 2010-2026



F, 73 ans, angor
LDL, HTA, Tabac, Hérédité
RF-CL = 11%

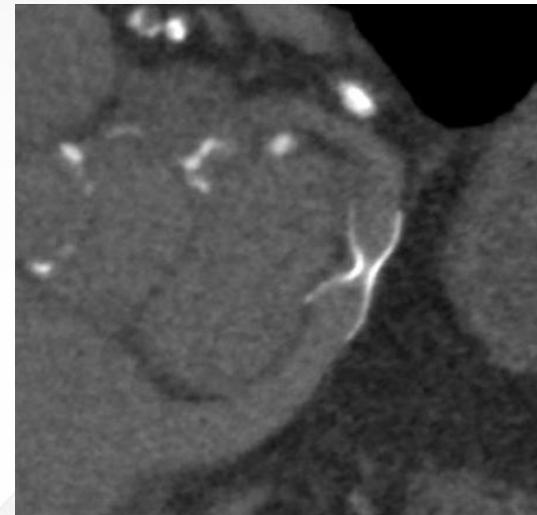
$$\frac{V_{stress}}{V_{repos}} = \frac{22}{33} < 1$$

SSS = 1 ; SRS = 1

ES normal ; FE = 77 %

VTD = 47 mL VTS = 11 mL

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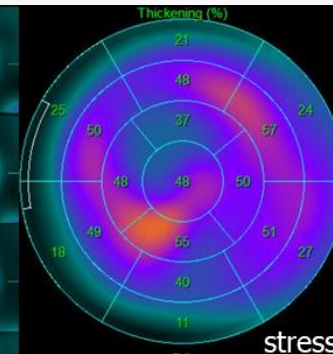
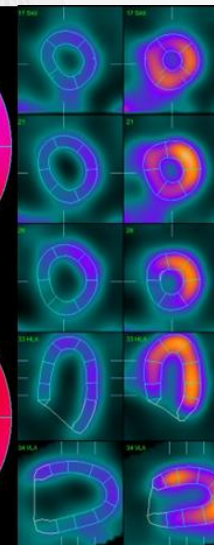
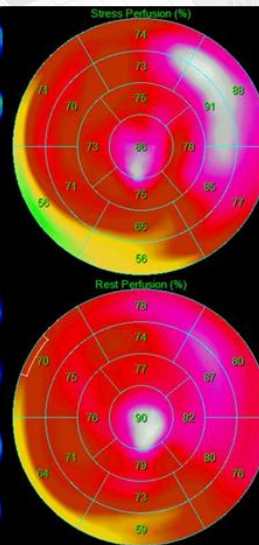
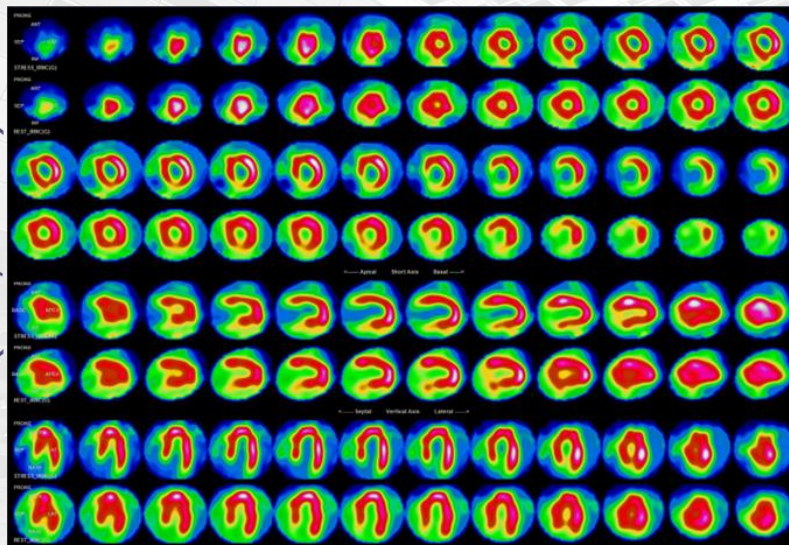

$$\frac{dC(t)}{dt} = \Phi_{cap \rightarrow myocyte} = D \frac{S}{e} \cdot (P_{cap} - P_{myocyte})$$


REDUCTION DU SINUS CORONAIRE



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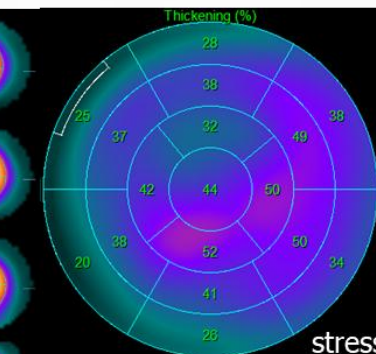
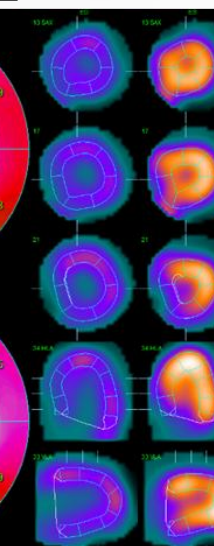
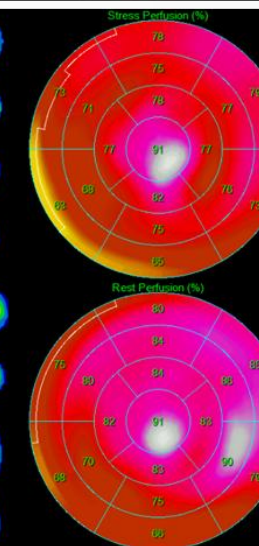
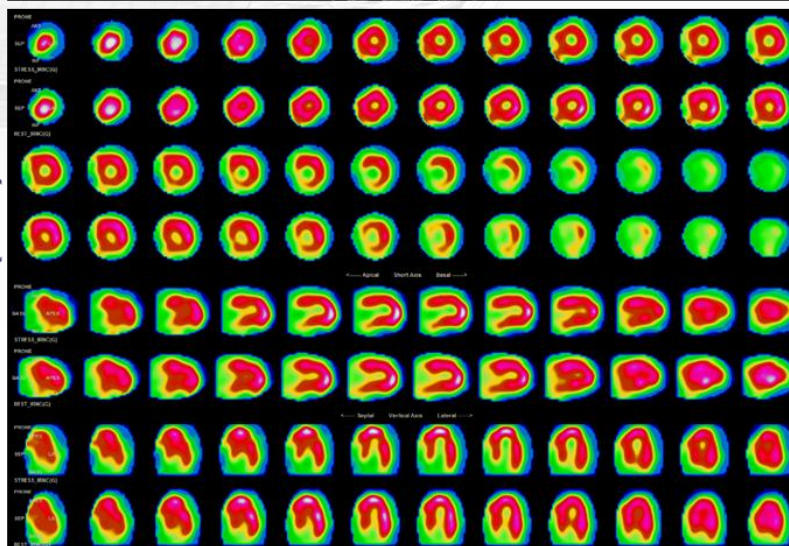
AVANT (EE -, Coro N)



$$\frac{V_{stress}}{V_{repos}} = \frac{68}{56} = 1,2$$

SSS = 3 ; SRS = 2
ES normal
VTD = 94 mL VTS = 31 mL
FE = 66 %

APRES (EE -)



$$\frac{V_{stress}}{V_{repos}} = \frac{50}{59} < 1$$

SSS = 3 ; SRS = 2
ES normal
VTD = 90 mL VTS = 38 mL
FE = 58 %



REDUCTION DU SINUS CORONAIRE



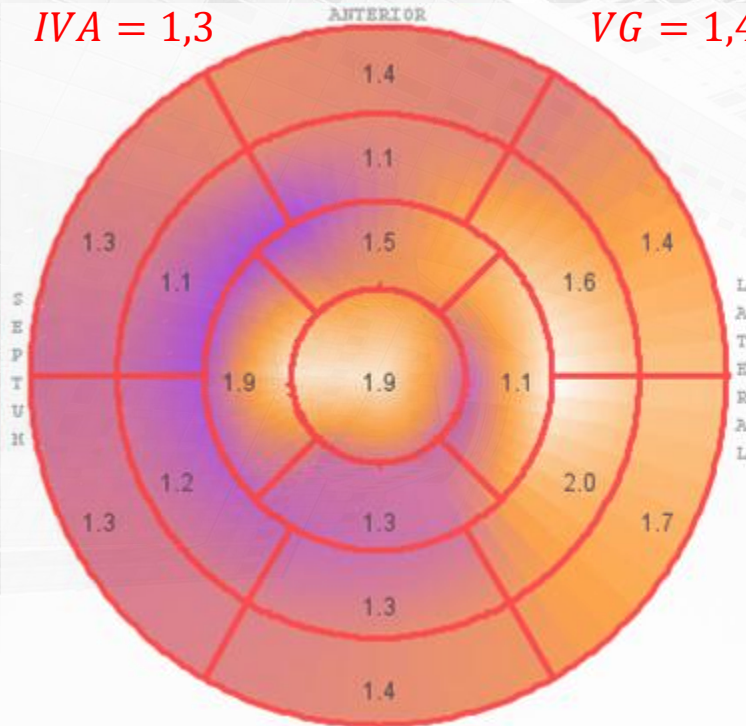
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$IVA = 1,3$

$VG = 1,4$

$IVA = 1,6$

$VG = 1,5$

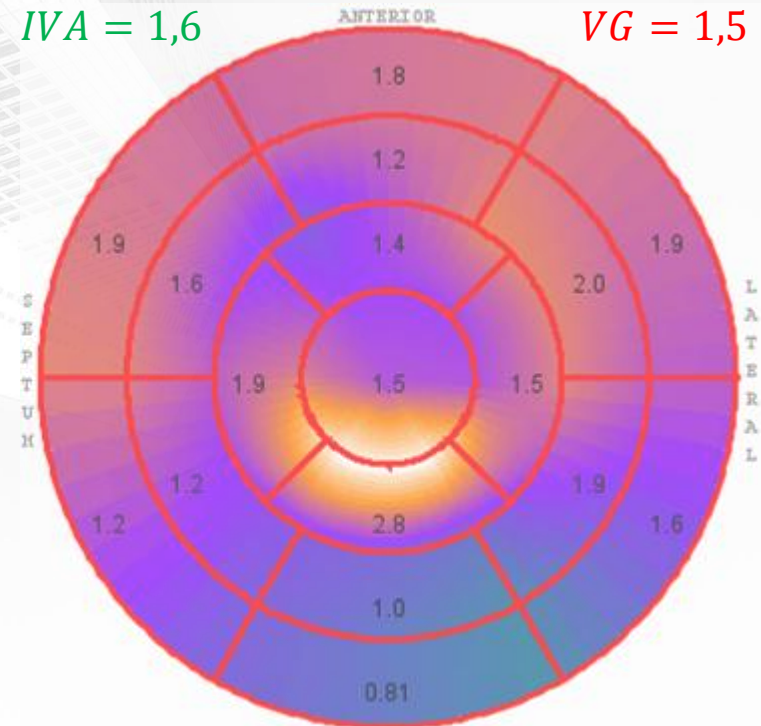


$CD = 1,3$

$[0,0, 2,0]$

$Cx = 1,5$

AVANT



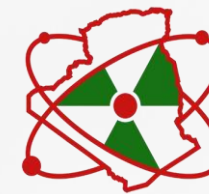
$CD = 1,5$

$[0,0, 2,81]$

$Cx = 1,8$

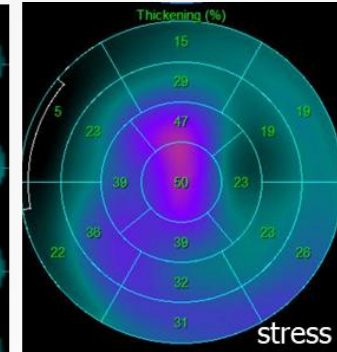
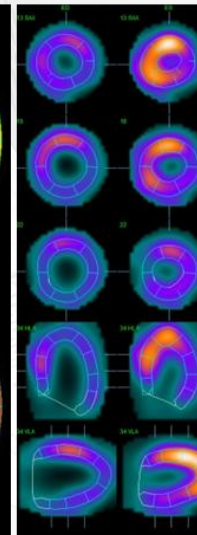
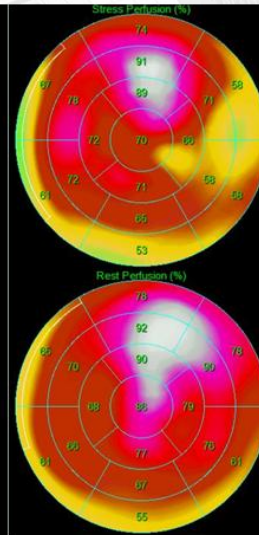
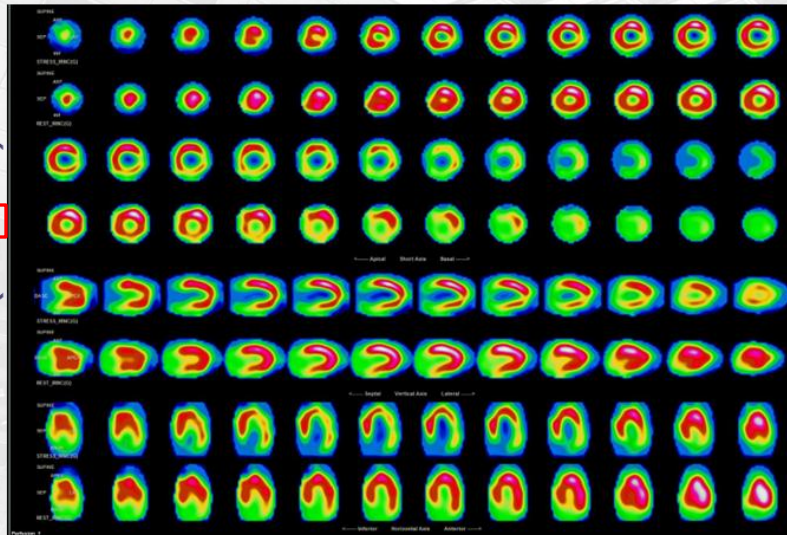
APRES

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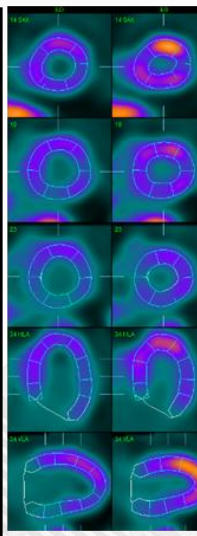
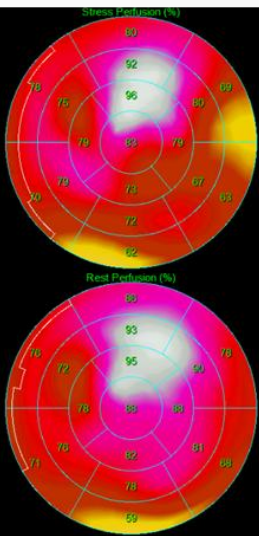
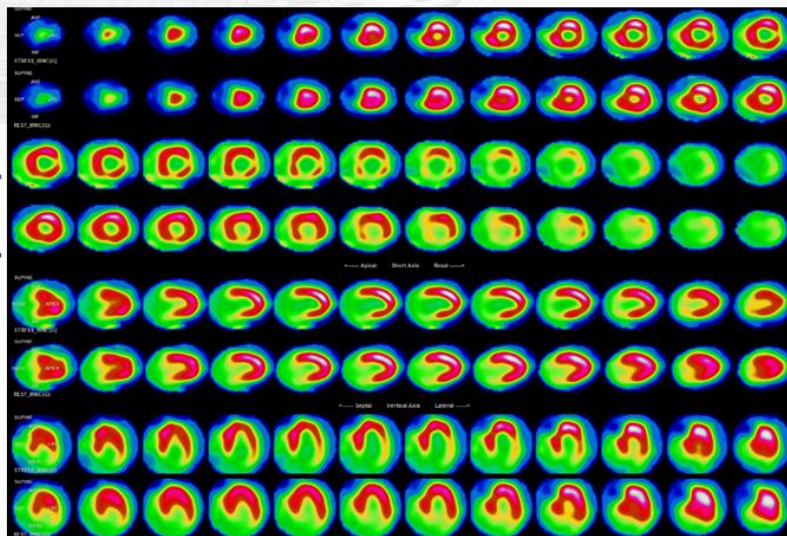
AVANT (EE + Ci)



$$\frac{V_{\text{stress}}}{V_{\text{repos}}} = \frac{71}{52} = 1,4$$

SSS = 8 ; SRS = 6
ES normal
VTD = 104 mL VTS = 50 mL
FE = 52 %

APRES (EE -)



$$\frac{V_{\text{stress}}}{V_{\text{repos}}} = \frac{49}{46} = 1,1$$

SSS = 4 ; SRS = 2
ES normal
VTD = 89 mL VTS = 49 mL
FE = 44 %



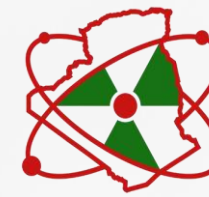
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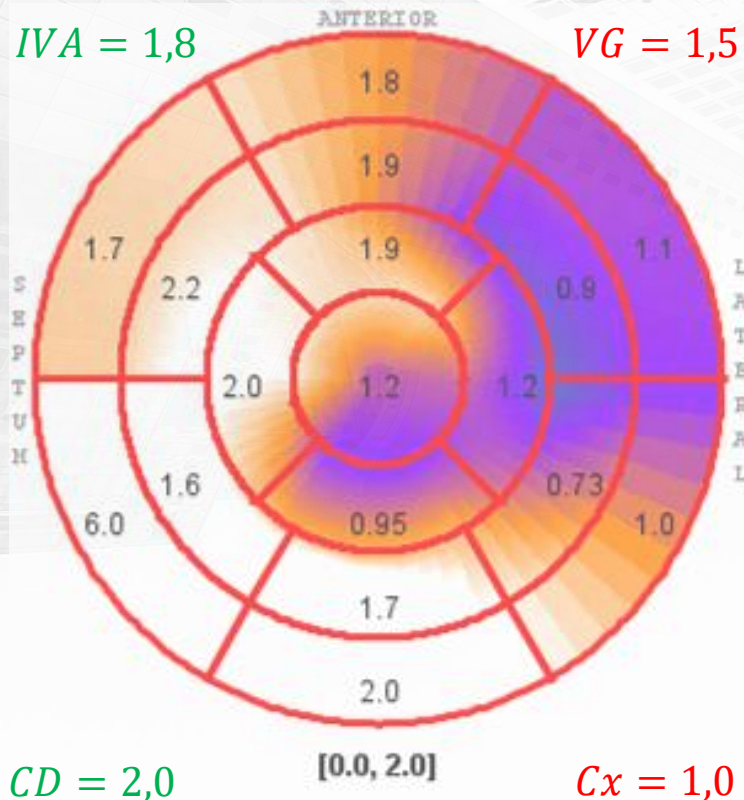
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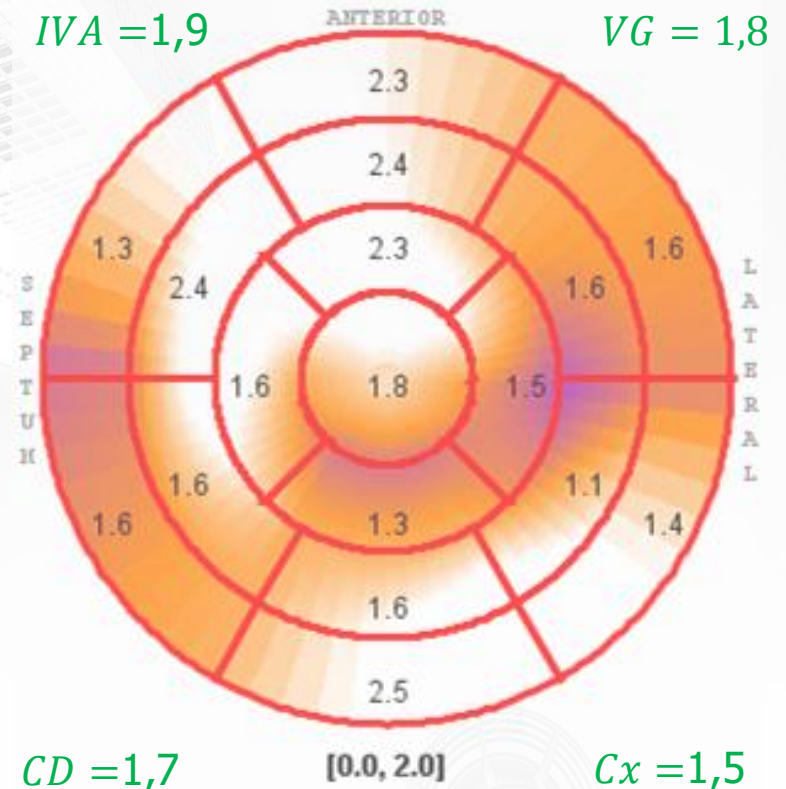
REDUCTION DU SINUS CORONAIRE



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AVANT



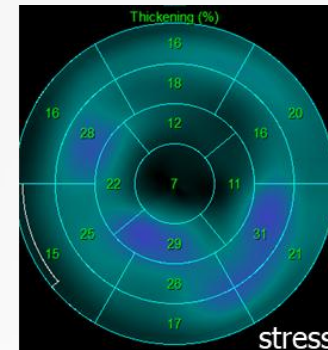
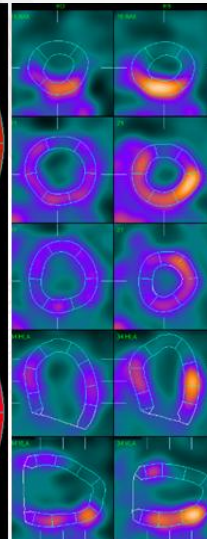
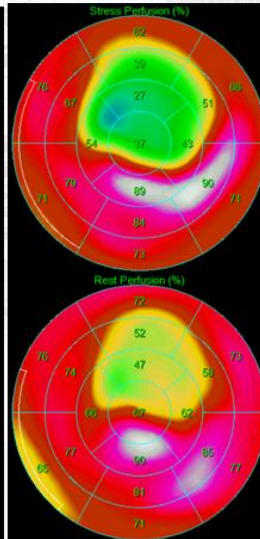
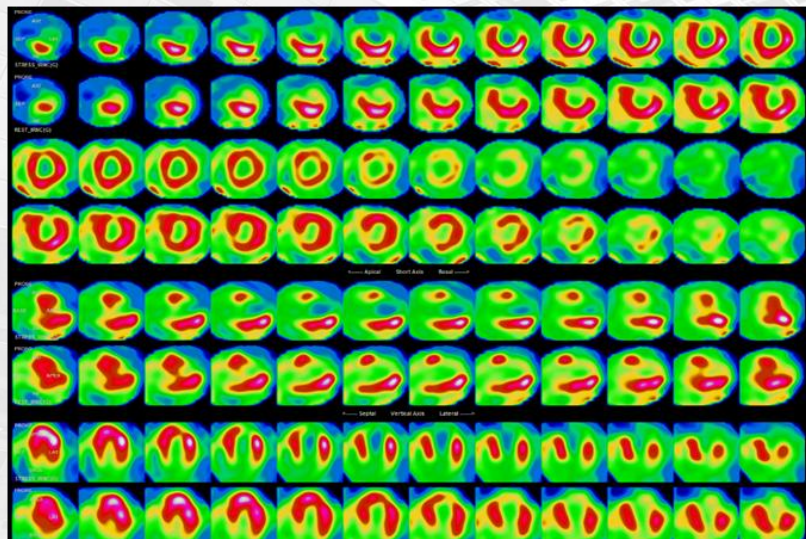
APRES

REDUCTION DU SINUS CORONAIRE



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AVANT (EE-)



$$\frac{V_{stress}}{V_{repos}} = \frac{93}{84} = 1,1$$

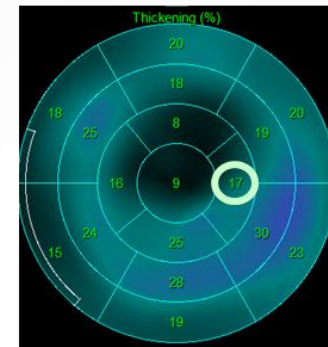
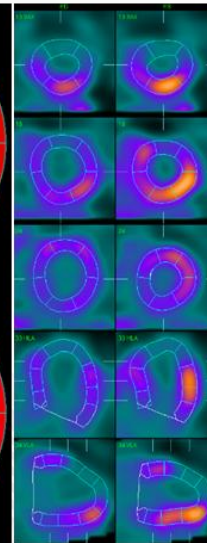
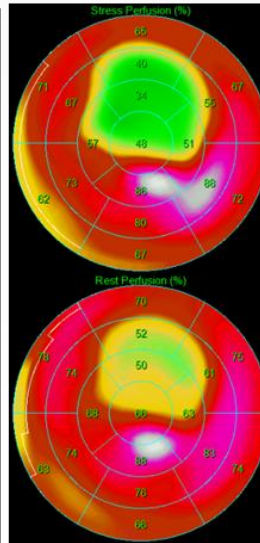
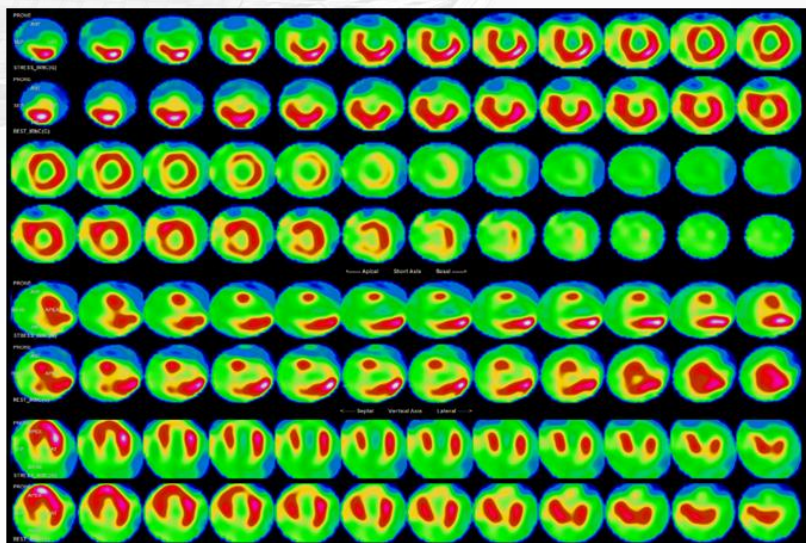
$$SSS = 16 ; SRS = 8$$

$$ES(S,R) \downarrow \text{en } 13,16,17$$

$$VTD = 130 \text{ mL} \quad VTS = 74 \text{ mL}$$

$$FE = 43 \%$$

APRES (EE-)



$$\frac{V_{stress}}{V_{repos}} = \frac{95}{88} = 1,1$$

$$SSS = 14 ; SRS = 8$$

$$ES(S,R) \downarrow \text{en } 13,17$$

$$VTD = 111 \text{ mL} \quad VTS = 64 \text{ mL}$$

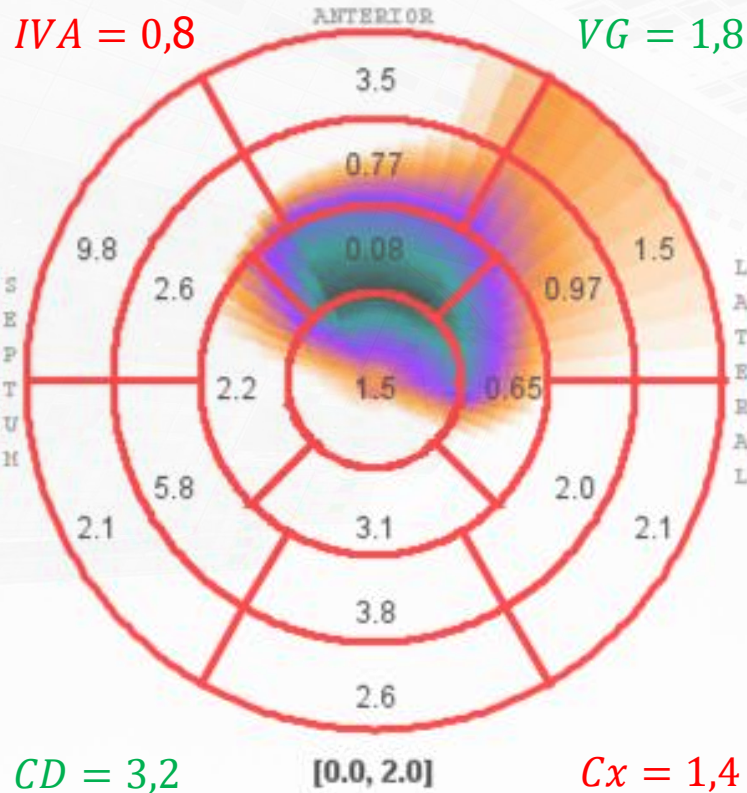
$$FE = 42 \%$$



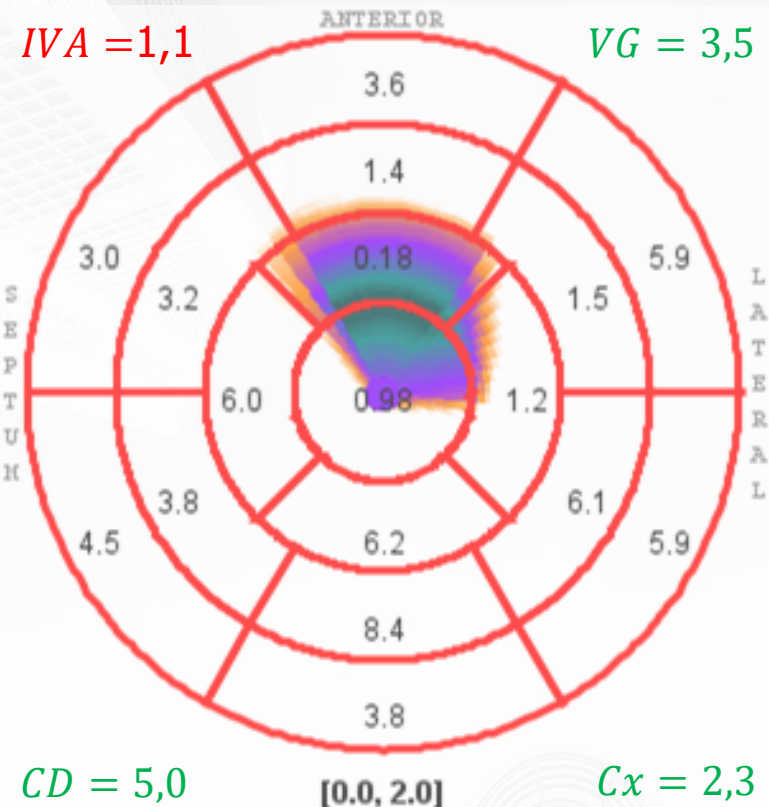
REDUCTION DU SINUS CORONAIRE



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AVANT



APRES

AMYLOSE aTTR



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- 41 H + 3 F amyloses aTTR, Perugini 2 ou 3 (52%), 17 % mutées
39% de SPECT anormales E et/ou R (16% = 7 ischémies)
52% de RC < 2 dont 57 % à perfusion E/R homogène

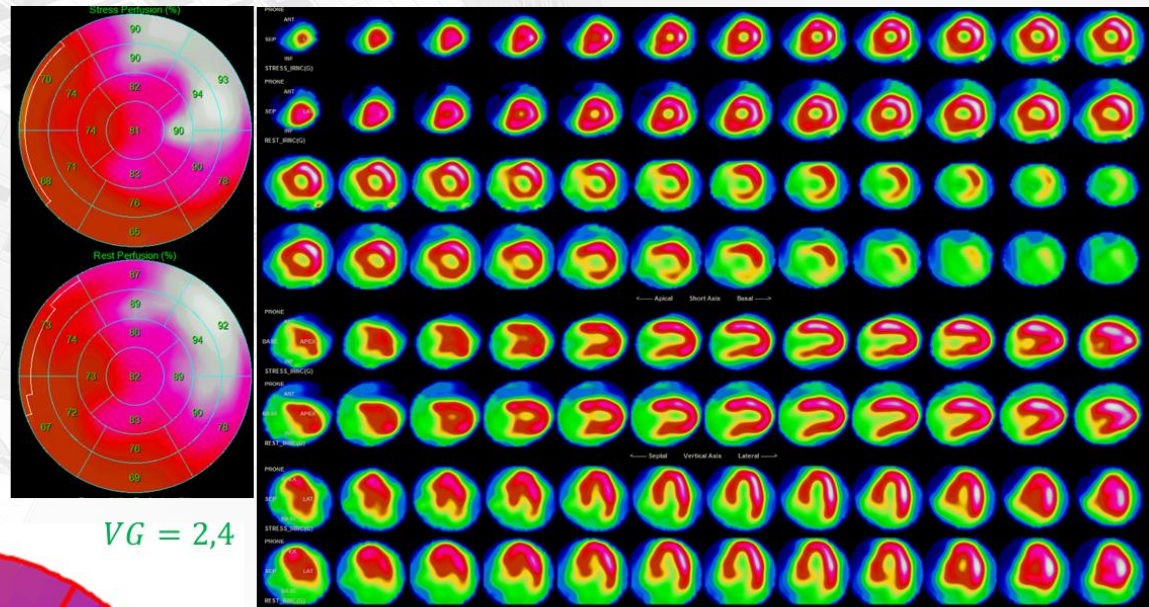
% (N)	SPECT normale	SPECT anormale	
RC $\geq$ 2	32% (14)	16% (7)	48% (21)
RC < 2	29% (13)	23% (10)	52% (23)
	61% (27)	39% (17)	100% (44)

- La RC corrélée avec le délai diagnostic - instauration du TAFAMIDIS
- La RC est indépendante du grade de Perugini, du DFG, $\pm$ NT-pro BNP ?

aTTR (tafamidis au Dic)

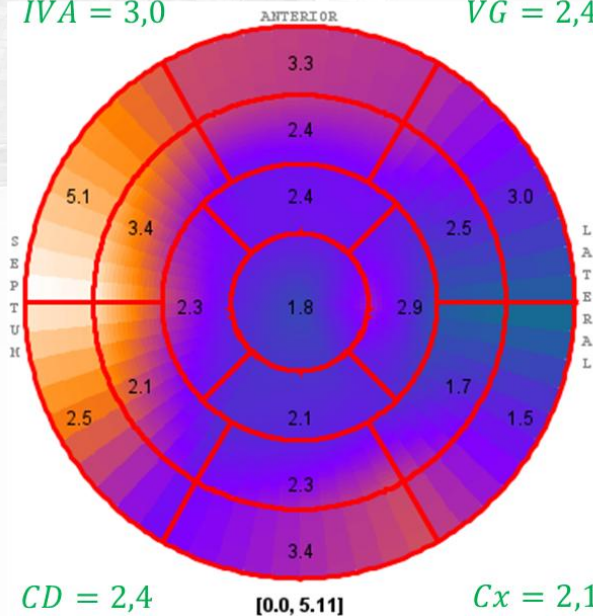


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IVA = 3,0

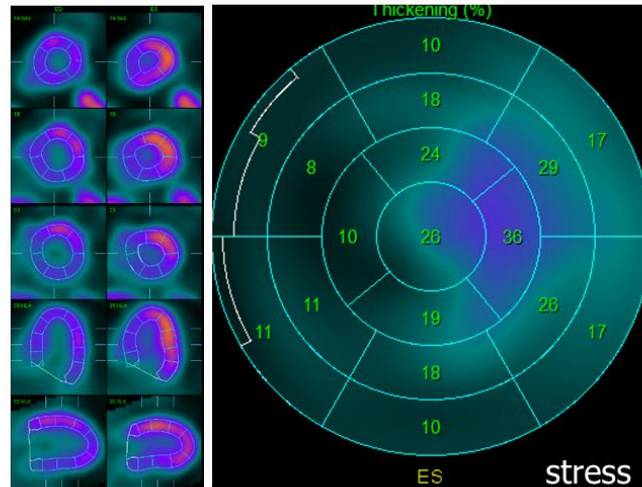
VG = 2,4



CD = 2,4

[0,0, 5,11]

Cx = 2,1

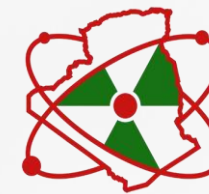


$$\frac{V_{stress}}{V_{repos}} = \frac{49}{89} < 1$$

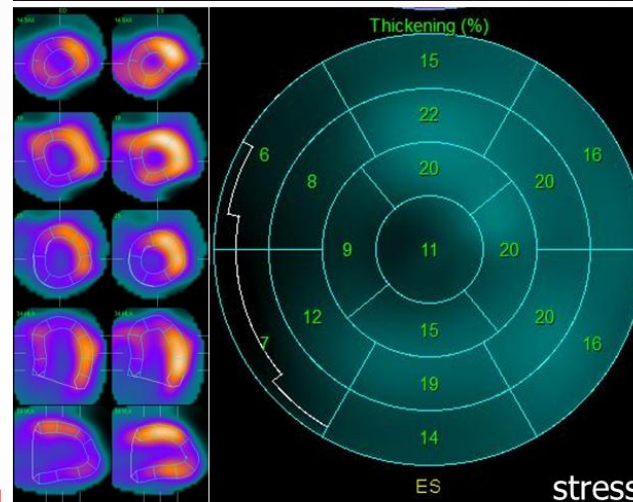
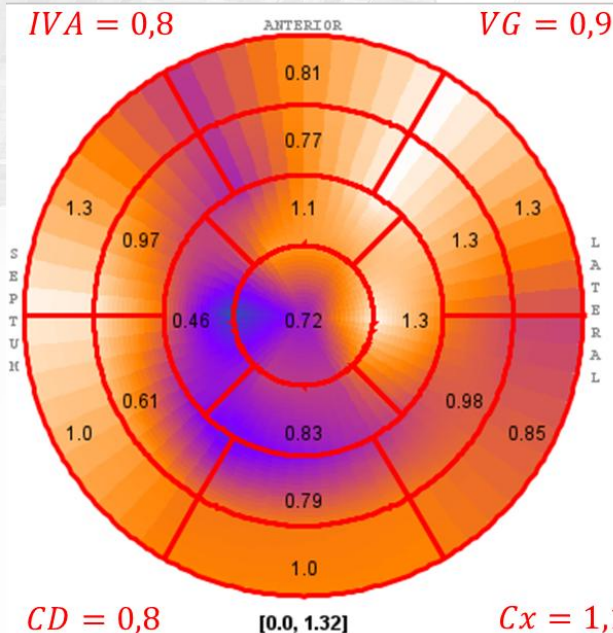
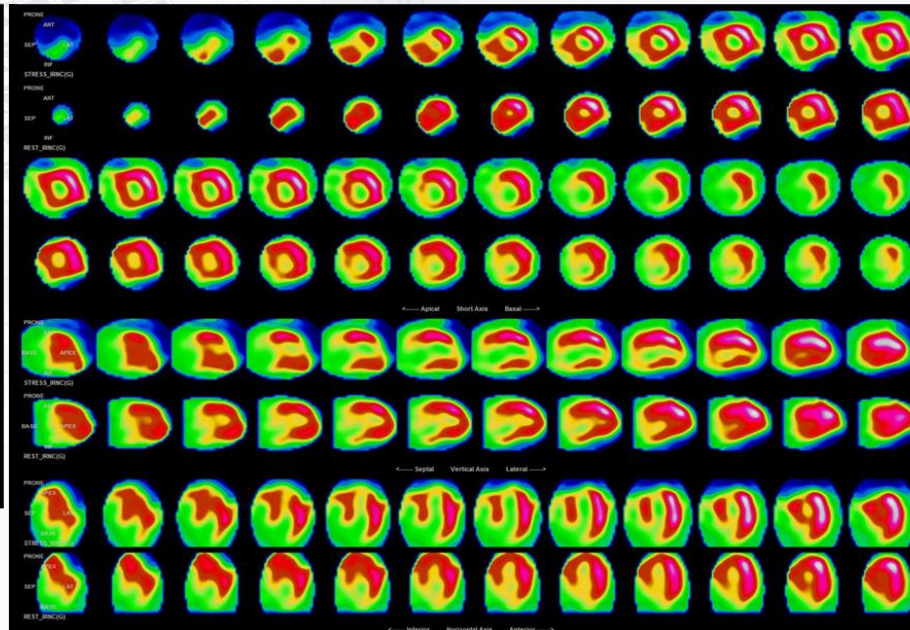
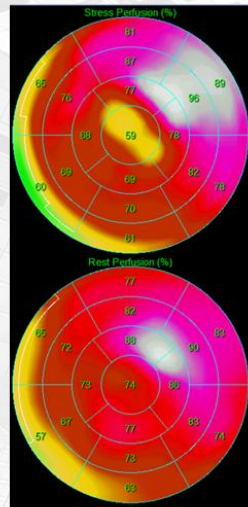
$$SSS = SRS = 2$$

ES normal
VTD = 71 mL
VTS = 42 mL
FE = 41 %

aTTR (tafamidis à M54)



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$$\frac{V_{stress}}{V_{repos}} = \frac{77}{82} < 1$$

$$SSS = 7$$

$$SRS = 4$$

$ES(repos)N$
 $ES(stress) \downarrow$
en 14,17
 $VTD = 89 \text{ mL}$
 $VTS = 58 \text{ mL}$
 $FE = 35 \%$

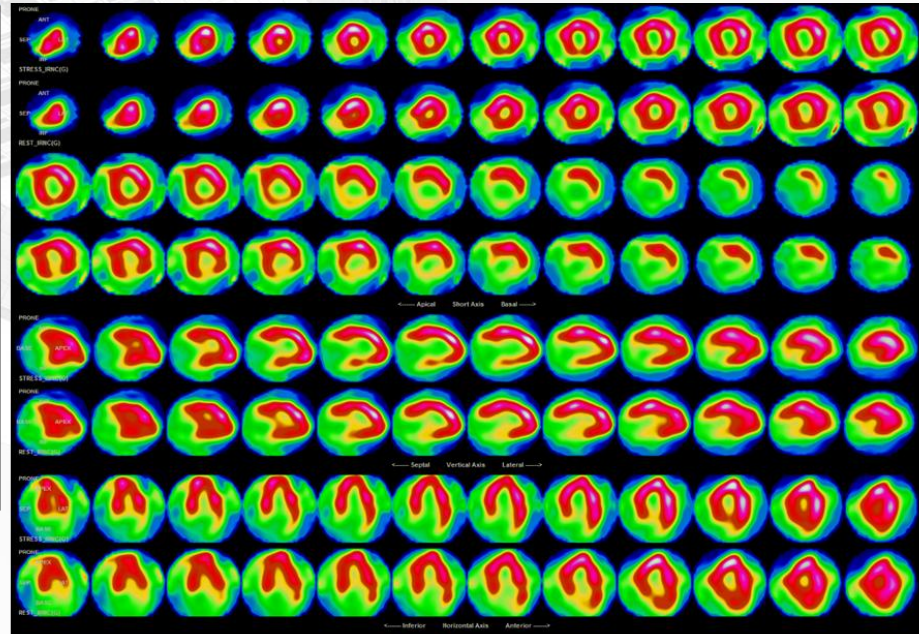
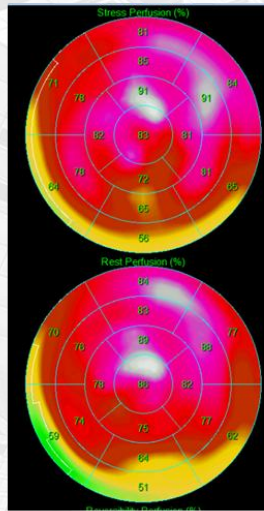


aTTR DIFFUSE



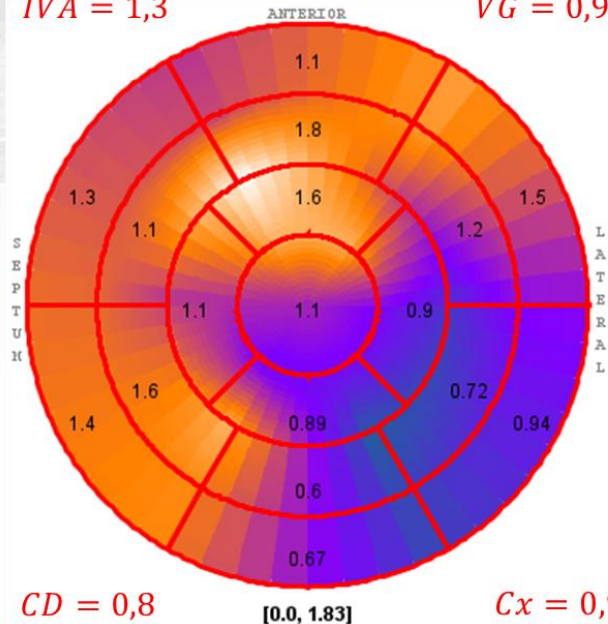
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IVA = 1,3

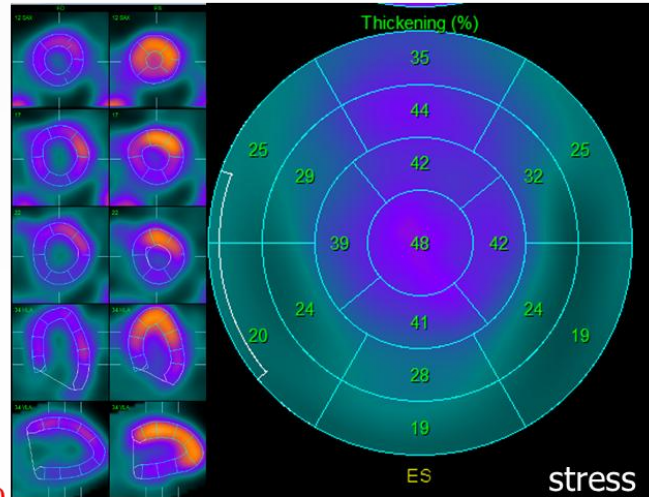
VG = 0,9



CD = 0,8

[0,0, 1,83]

Cx = 0,9



$$\frac{V_{stress}}{V_{repos}} = \frac{77}{76} = 1$$

$$SSS = SRS = 4$$

ES normal
VTD = 91 mL
VTS = 37 mL
FE = 59 %



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Merci

