28 Mars 2019
AMCAR
Casablanca

# Evaluer un myocarde avant revascularisation: quels examens pour quels patients?

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مصحة الإختصاصات الشفاء
Clinique des Spécialités Achifaa

ESC European Society of Cardiology
European Heart Journal (2018) 00, 1–96
doi:10.1093/eurheartj/ehy394



# 2018 ESC/EACTS Guidelines on myocardial revascularization

## Table of contents

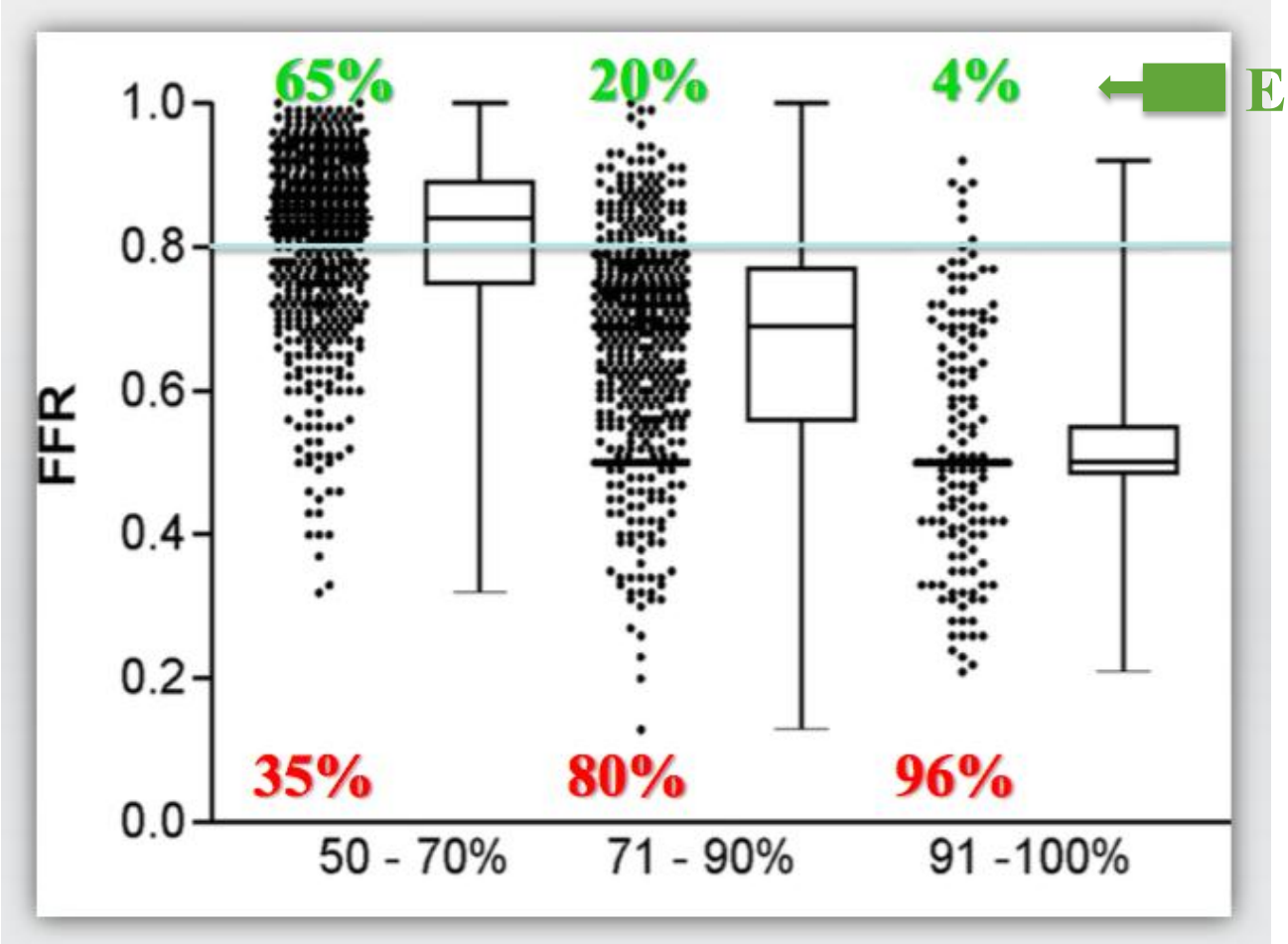
# Deux axes porteurs

- FFR (IA)
- CMR ou IRM Cardiaque (IIb-B)
- CT-FFR ou CT Spectral

ESC European Society of Cardiology European Heart Journal (2018) 00, 1–96 doi:10.1093/eurheartj/ehy394 ESC/EACTS GUIDELINES

2018 ESC/EACTS Guidelines on myocardial revascularization

# L'œil du cardiologue est faillible

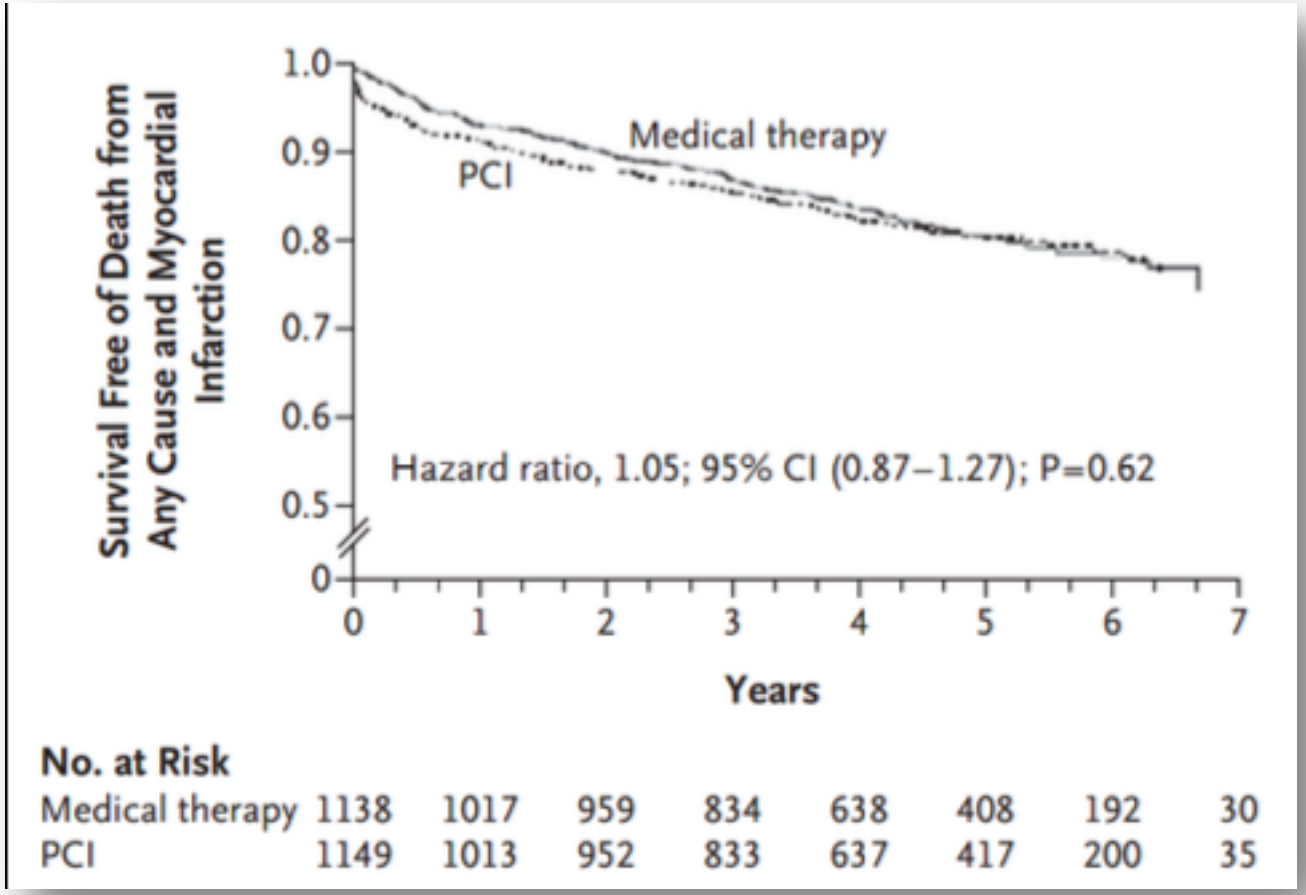



FAME, Circulation 2010; 122:2545-50

# Anatomic Lesion Severity is Insufficient to Guide PCI

## 2287 pts >70% stenosis & ischemia or >80% stenosis

## randomized to PCI or medical therapy

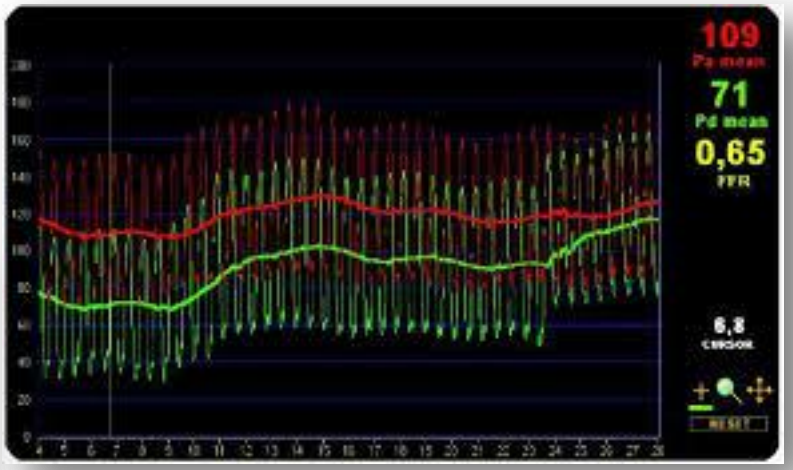



Boden WE et al, COURAGE, NEJM 2007;356:1503-1516

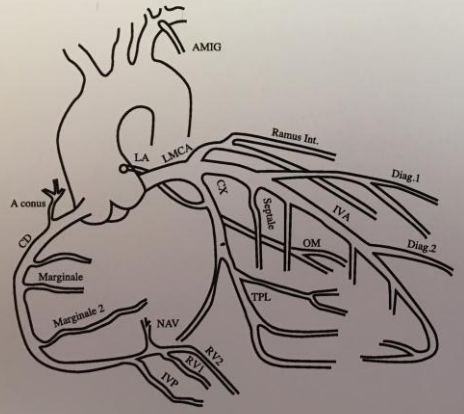
# Tests d'ischémie

- Test invasifs :
  - FFR,
  - En cours d'évaluation: iFR, QFR
- Test non invasif:
  - Echo de stress, Echo d'effort
  - Imagerie de perfusion (Scinti, IRM)
- Test hybride
  - CT de perfusion (Spectral), CT-FFR

# FFR


❑ Indication du doppler coronaire :
❑ Lésion coronarienne :
❑ TC ❑ IVA ❑ OM ❑ CX ❑ CD ❑ Diagonale ❑ PL




**Conclusion :**

**Résultats des index Pd/PA**

1. ..... Pd/dA
2. ..... Pd/dA
3. ..... Pd/PA
4. ..... Pd/PA

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# Les recommandations nous disent

- De procéder par FFR quand :
  - Un test d'ischémie non invasif n'a pu être réalisé chez un patient **stable**
  - Une revascularisation est décidée chez un **multitronculaire**

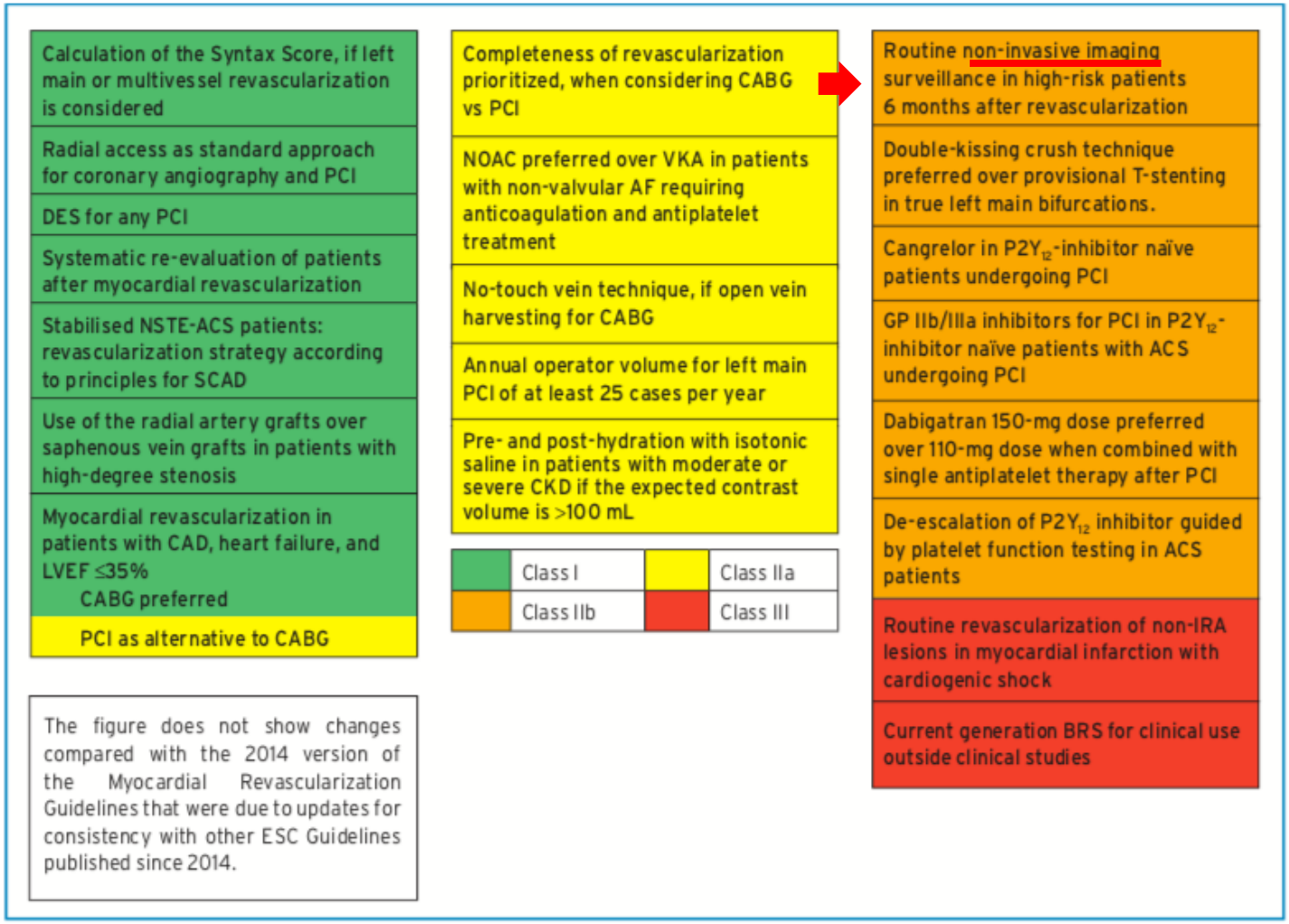
**Recommendations for the clinical value of intracoronary diagnostic techniques**

| Recommendations | Class[a] | Level[b] | Ref.[c] |
|---|---|---|---|
| FFR to identify haemodynamically relevant coronary lesion(s) in stable patients when evidence of ischaemia is not available. | I | A | 50,51,713 |
| FFR-guided PCI in patients with multivessel disease. | IIa | B | 54 |
| IVUS in selected patients to optimize stent implantation. | IIa | B | 702,703,706 |
| IVUS to assess severity and optimize treatment of unprotected left main lesions. | IIa | B | 705 |
| IVUS or OCT to assess mechanisms of stent failure. | IIa | C | |
| OCT in selected patients to optimize stent implantation. | IIb | C | |

[a]Class of recommendation.
[b]Level of evidence.
[c]Reference(s).
FFR = fractional flow reserve; IVUS = intravascular ultrasound; OCT = optical coherence tomography. PCI = percutaneous coronary intervention.

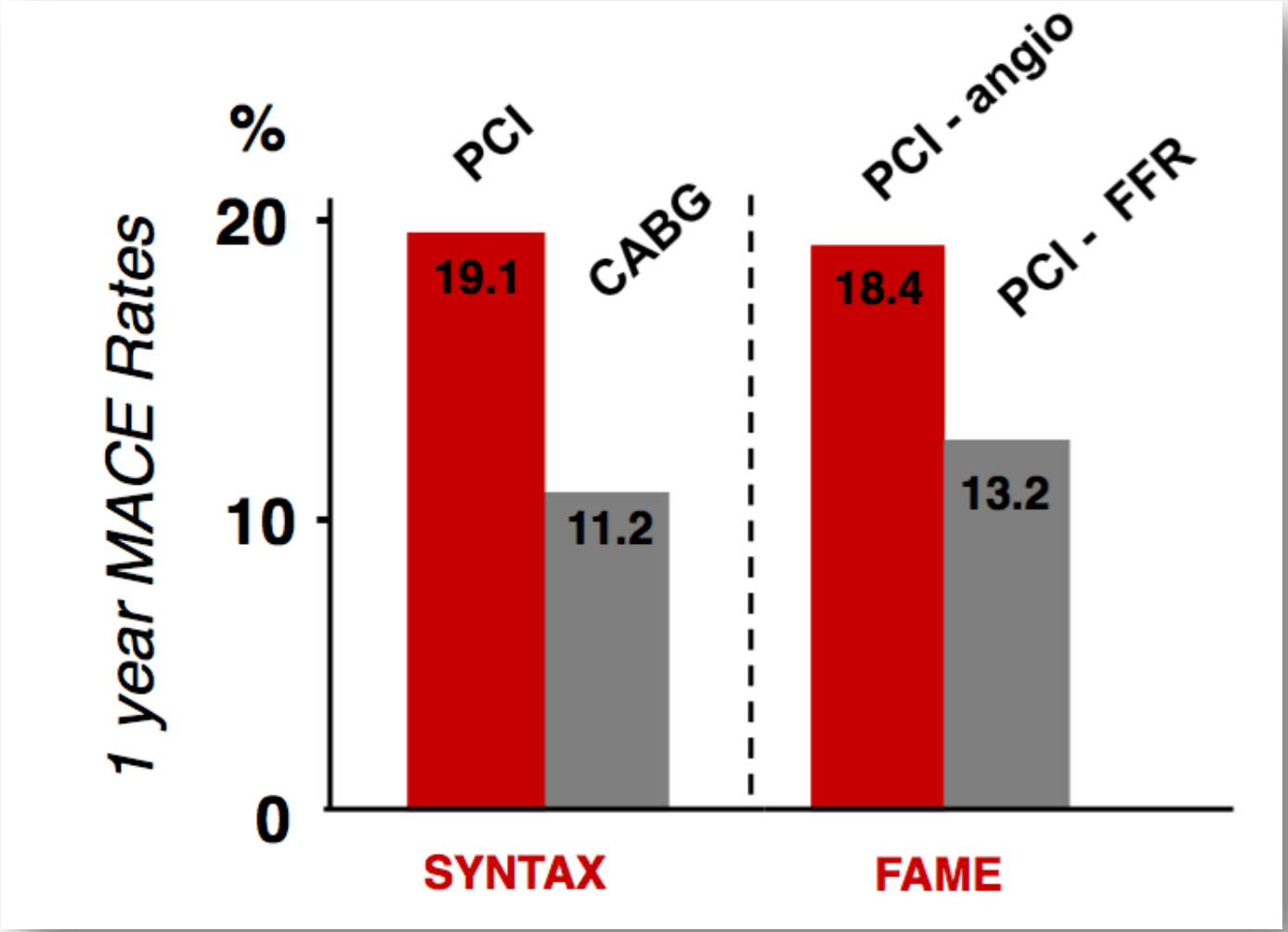
European Heart Journal
doi:10.1093/eurheartj/ehu278

## 2.1 What is new in the 2018 Guidelines?




ACS = acute coronary syndromes; AF = atrial fibrillation; BRS = bioresorbable scaffolds; CABG = coronary artery bypass grafting; CAD = coronary artery disease; CKD = chronic kidney disease; DES = drug-eluting stents; FFR = fractional flow reserve; GP = glycoprotein; IRA = infarct-related artery; LVEF = left ventricular ejection fraction; NOAC = non-vitamin K oral anticoagulants; NSTEMI = non-ST-elevation; PCI = percutaneous coronary intervention; SCAD = stable coronary artery disease; VKA = vitamin K antagonists.

# Implication de FAME




FAME, Circulation 2010; 122:2545-50

# FUnctional Testing Underlying REvascularization
# The FUTURE trial

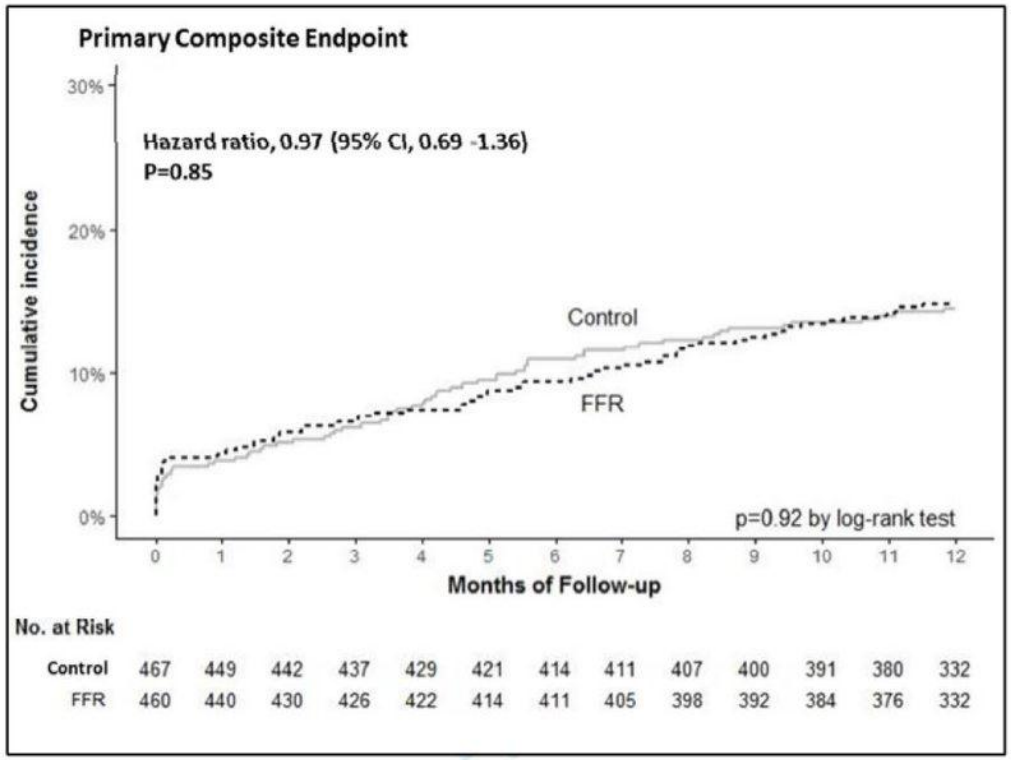
Gilles Rioufol, François Roubille, Thibault Perret, Pascal Motreff, Denis Angoulvant, Yves Cottin, Ludovic Meunier,Nathan Mewton, Michel Ovize, Gérard Finet, on behalf of the FUTURE trial investigators, France

NCT01881555

ESC Congress
Munich 2018

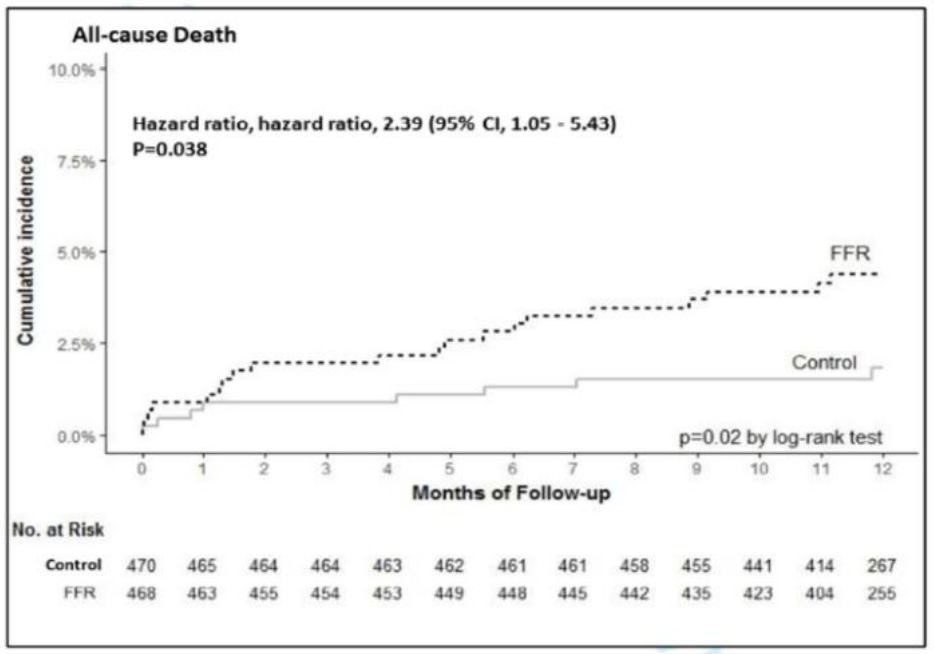

FUTURE trial : Treatment strategy in multivessel coronary disease patients based on Fractional F...
Centre Stage
FUTURE Study Hypothesis
All cause mortality + Myocardial infarction
+ Repeat revascularization + Stroke
Gilles RIOUFOL
(Bron - FR)
ESC 365
Ask a question
MOBILE APP
MODERATOR

# Primary endpoint (death – MI – revasc – stroke) at one year - ITT



**Recruitement stop at n=938 patients after DSMB recommendation**

**All-cause death at one year - safety analysis**



## All-cause mortality: exploratory analysis only in death cases

| | Control group | FFR group | P-value |
|---|---|---|---|
| **Characteristics of deaths** | | | |
| n | 7 | 17 | |
| Cardiovascular death (n,%) | 5/7 (71) | 12/17 (71) | |
| Diabetes (%) | 4/7 (57) | 10/17 (59) | |
| ACS (%) | 3/7 (43) | 7/17 (41) | |
| LVEF | 43±16 | 42±13 | |
| SYNTAX score | 16±7 | 24±10 | |
| Three-vx disease (%) | 1/7 (14) | 14/17 (82) | |
| **All-cause death analysis** | | | |
| SYNTAX score ≤32 (n, %) | 7/433 (1.6) | 13/436 (3.0) | 0.18 |
| SYNTAX score >32 (n, %) | 0/29 (0) | 4/23 (17.4) | 0.02 |
| OMT (n, %) | 0/43 (0) | 3/78 (3.9) | 0.20 |
| PCI (%) | 7/369 (1.9) | 13/328 (4.0) | 0.10 |
| CABG (%) | 0/55 (0) | 1/54 (1.9) | 0.31 |

## Conclusions

**Place of FFR for treatment strategy decision in multivx-disease?**

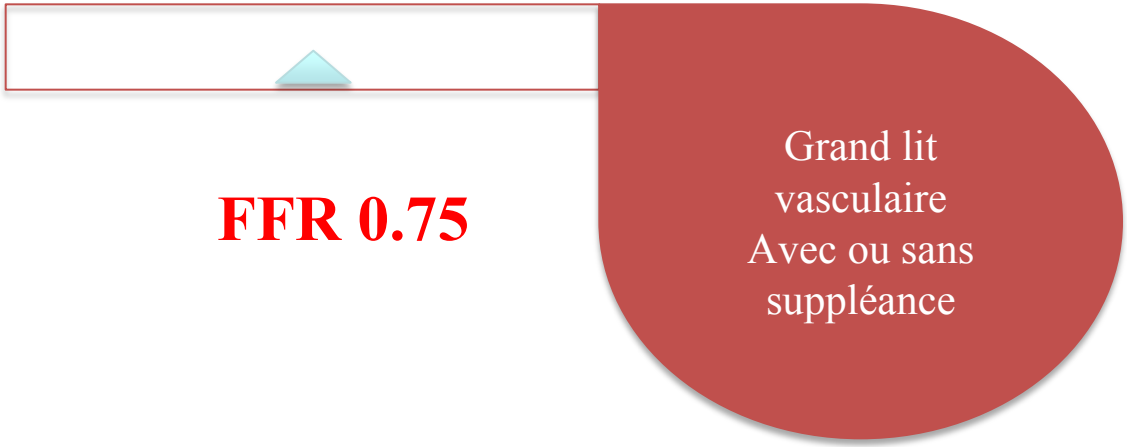

- FFR based strategy decreases the rate of revascularization largely dominated by PCI
- Treatment decision based on FFR in all-comer multivessel-disease patients did not demonstrate any improvement in the primary endpoint at one year.
- The FUTURE trial was prematurely halted because of an excess of all-cause mortality in the FFR group.
- Hypothesis to explain this excess of mortality:
  - Lower than expected rate of CABG in multivessel disease patients
  - high rate of PCI in severe patients with Syntax Score >32,
  - high rate of ad hoc PCI

# Comprendre la réserve coronaire fonctionnelle (FFR)

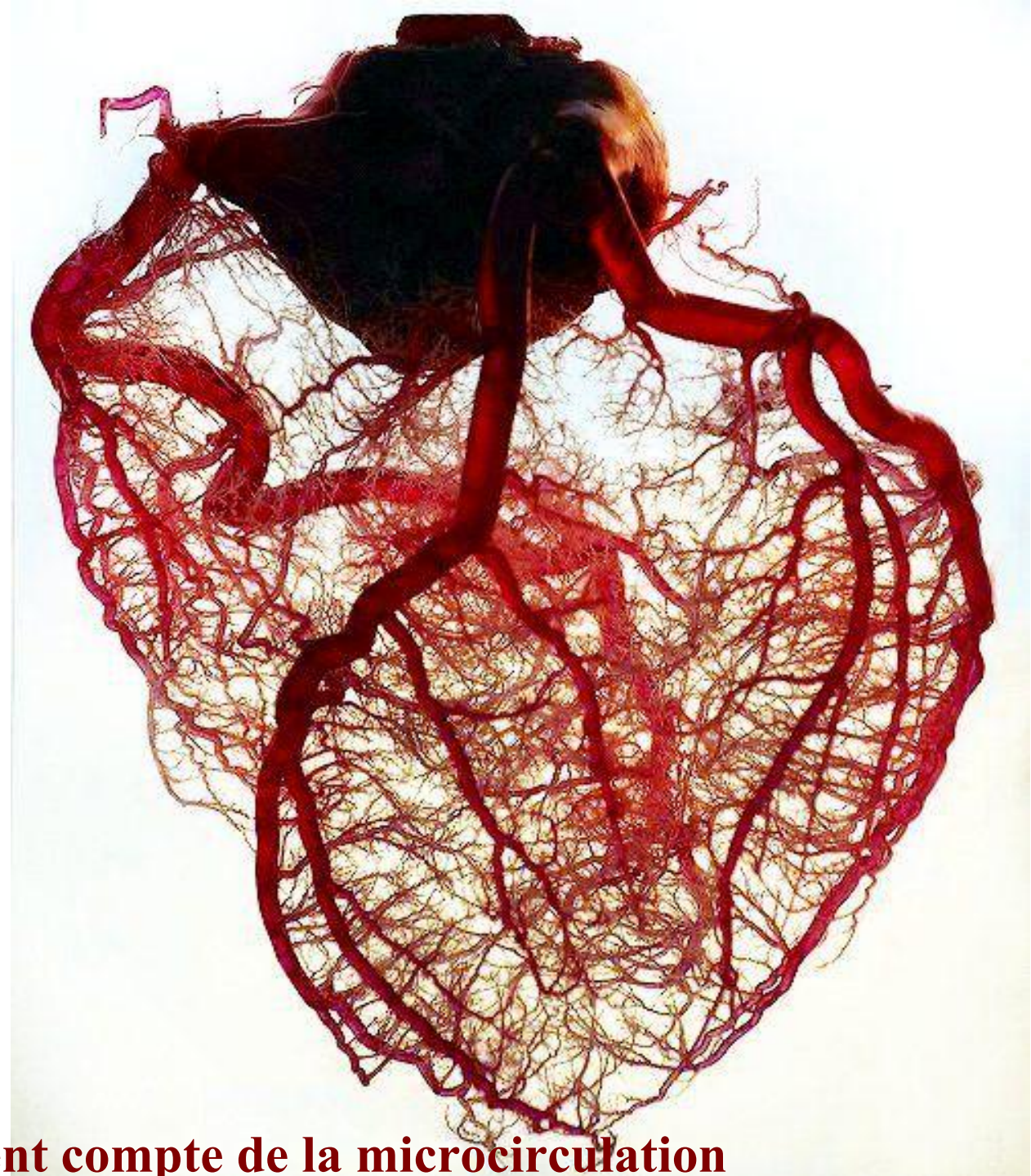
Sténose 75%


**FFR 0.83**

Sténose 50%




**FFR 0.75**



**La FFR tient compte de la microcirculation**

# Pronostic selon la masse ischémiée!!!

**Indications for revascularization in patients with stable angina or silent ischaemia**

| Extent of CAD (anatomical and/or functional) | | Class[a] | Level[b] |
|---|---|---|---|
| For prognosis | Left main disease with stenosis >50%.[c] [68–71] | I | A |
| | Proximal LAD stenosis >50%.[c] [62,68,70,72] | I | A |
| | Two- or three-vessel disease with stenosis >50% with impaired LV function (LVEF ≤35%).[c] [61,62,68,70,73–83] | I | A |
| | Large area of ischaemia detected by functional testing (>10% LV) or abnormal invasive FFR.[d] [24,59,84–90] | I | B |
| | Single remaining patent coronary artery with stenosis >50%.[c] | I | C |
| For symptoms | Haemodynamically significant coronary stenosis[c] in the presence of limiting angina or angina equivalent, with insufficient response to optimized medical therapy.[e] [24,63,91–97] | I | A |

© ESC 2018

CAD = coronary artery disease; FFR = fractional flow reserve; iwFR = instantaneous wave-free ratio; LAD = left anterior descending coronary artery; LV = left ventricular; LVEF = left ventricular ejection fraction.

[a]Class of recommendation.

[b]Level of evidence.

[c]With documented ischaemia or a haemodynamically relevant lesion defined by FFR ≤0.80 or iwFR ≤0.89 (see section 3.2.1.1), or >90% stenosis in a major coronary vessel.

[d]Based on FFR <0.75 indicating a prognostically relevant lesion (see section 3.2.1.1).

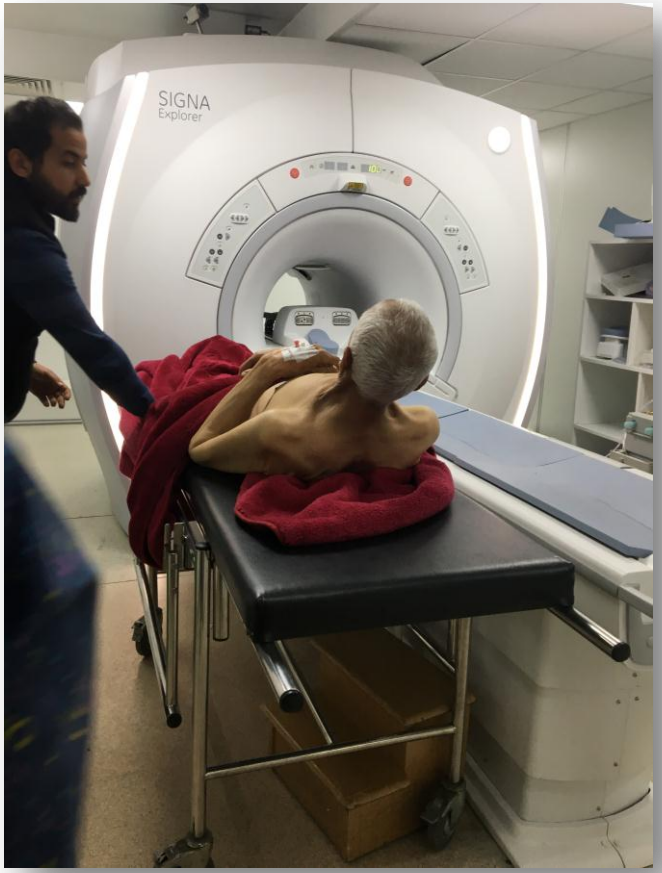
[e]In consideration of patient compliance and wishes in relation to the intensity of anti-anginal therapy.

ESC European Society of Cardiology European Heart Journal (2018) 00, 1–96 doi:10.1093/eurheartj/ehy394

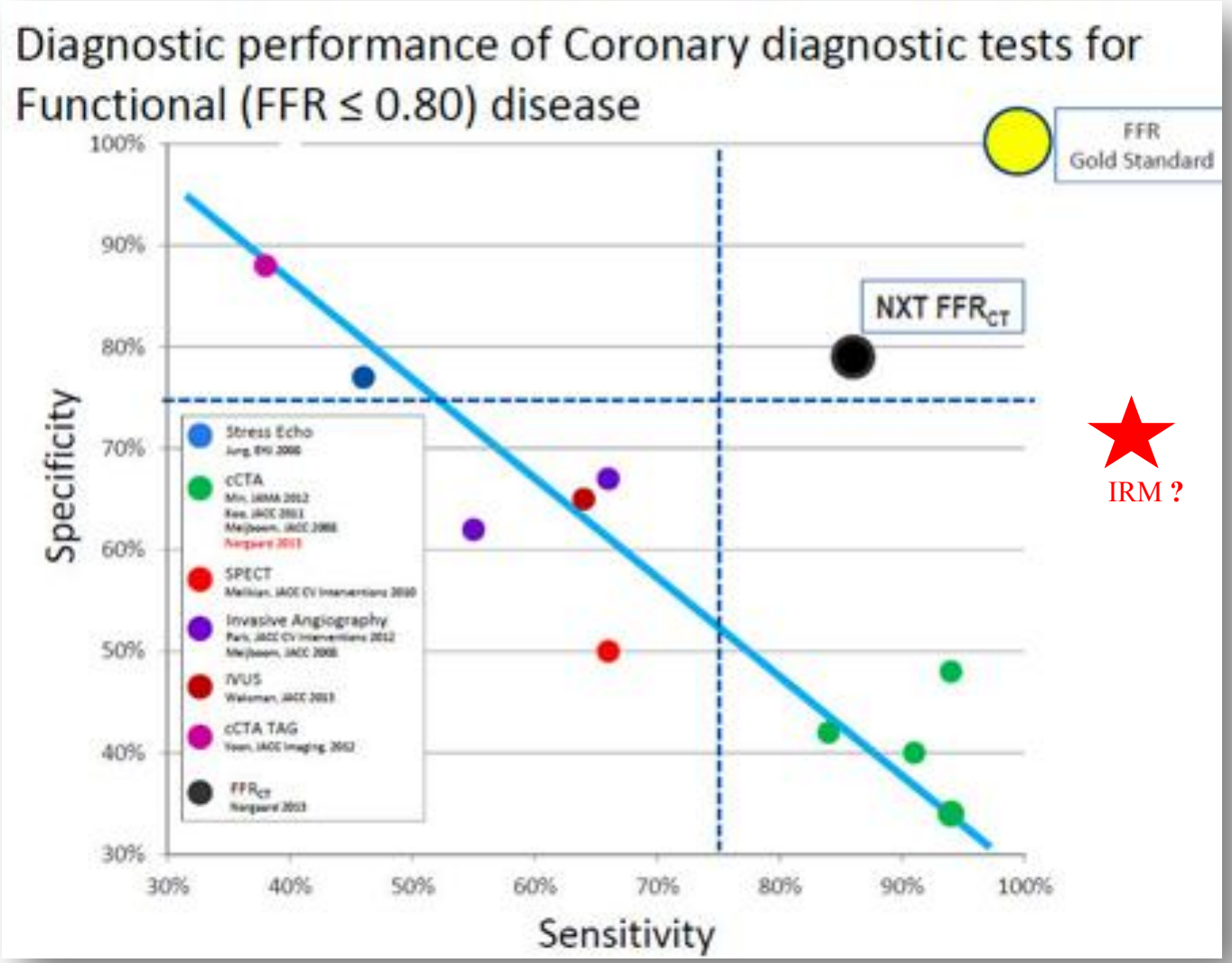
ESC/EACTS GUIDELINES

**2018 ESC/EACTS Guidelines on myocardial revascularization**

# IRM




# Les tests fonctionnels dans la vrai vie




Heat FlowNXT Er, TCT 2013,
(Multicentric study : usage d'un soft qui réduit la radiation à 1mSv)

## 3.1 Non-invasive diagnostic tools

### 3.1.1 Assessment of myocardial ischaemia

Non-invasive diagnostic assessment of patients with CAD being considered for myocardial revascularization comprises the assessment of ischaemia and the evaluation of viability in patients with regional wall motion abnormalities or reduced ejection fraction (EF).

Functional testing to assess ischaemia is critical for the assessment of stable patients with CAD. Documentation of ischaemia using functional testing before elective invasive procedures for CAD is the pre-

patients presenting with acute coronary syndrome (ACS). Because of the low sensitivity of exercise electrocardiogram (ECG) testing in the assessment of patients with symptoms of angina, non-invasive imaging is recommended as the first-line test.[1] Detection of a large area of

undergo revascularization (see section 5).

In patients undergoing coronary computed tomography (CT), both CT-derived fractional flow reserve (CT-FFR) and CT perfusion represent possible approaches to evaluate lesion-specific ischaemia. Although the evidence for both is limited at present, there are considerably more data from clinical investigations of CT-FFR. A number of trials have shown that correlation between CT-derived FFR and invasive FFR is high.[2,3] The non-randomized PLATFORM (Prospective LongitudinAl Trial of FFRct: Outcome and Resource Impacts) study showed that in patients referred for invasive angiography due to chest pain (predominantly atypical angina) and intermediate pre-test probability of CAD, assessment with CT and CT-FFR reduced the number of patients with subsequently normal invasive coronary angiograms compared with standard care.[4] Currently, clinical trial data with CT-FFR are insufficient to make a recommendation for its use in clinical practice.

PET (FDG-PET) or standard care.[6] The primary outcome of cardiac death, myocardial infarction (MI), or recurrent hospital stay for cardiac cause at 1 year was not improved in the group managed by FDG-PET [relative risk (RR) 0.82, 95% confidence interval (CI) 0.59–1.14, $P = 0.16$], though the rate of compliance with the treatment recommended by FDG-PET was variable.

The viability substudy of the STICH (Surgical Treatment for Ischemic Heart Failure) trial found viable myocardium in 487/601 patients (81%) and none in 114 (19%).[9] There was a significant association between myocardial viability and outcome by univariate analy-

lack of correlation between

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t when selecting the optimal

**ive imaging in patients with coronary artery disease and heart failure with reduced ejection fraction**

| Recommendations | Class[a] | Level[b] |
|---|---|---|
| Non-invasive stress imaging (CMR, stress echocardiography, SPECT, or PET) may be considered for the assessment of myocardial ischaemia and viability in patients with HF and CAD (considered suitable for coronary revascularization) before the decision on revascularization.[9–11] | IIb | B |



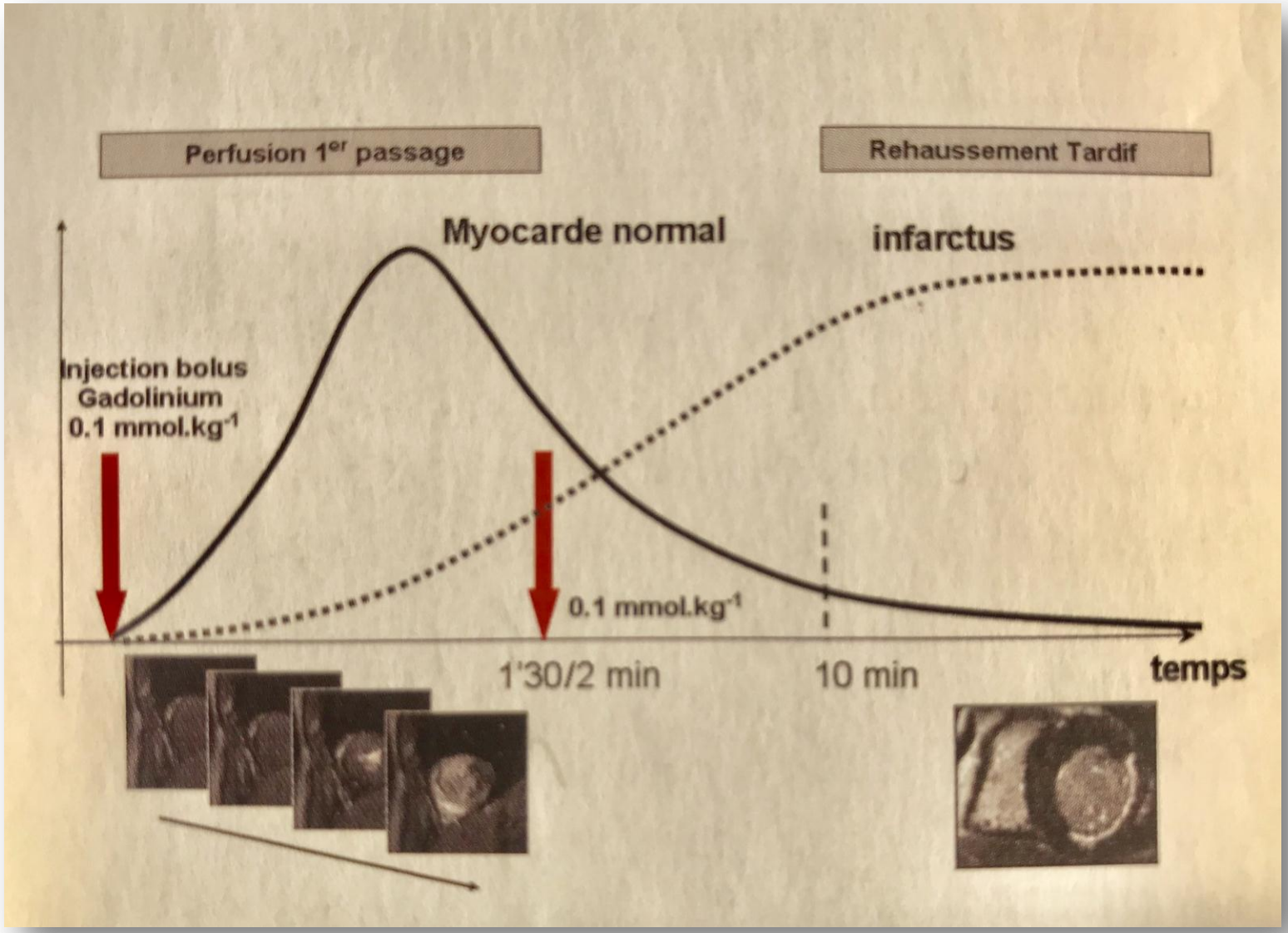
CAD = coronary artery disease; CMR = cardiac magnetic resonance; HF = heart failure; PET = positron emission tomography; SPECT = single-photon emission computed tomography.
[a]Class of recommendation.
[b]Level of evidence.

### 3.1.2 Assessment of myocardial viability in patients with

# Principales séquences employées en post-infarctus: séquences sensibles à **l'oedème**

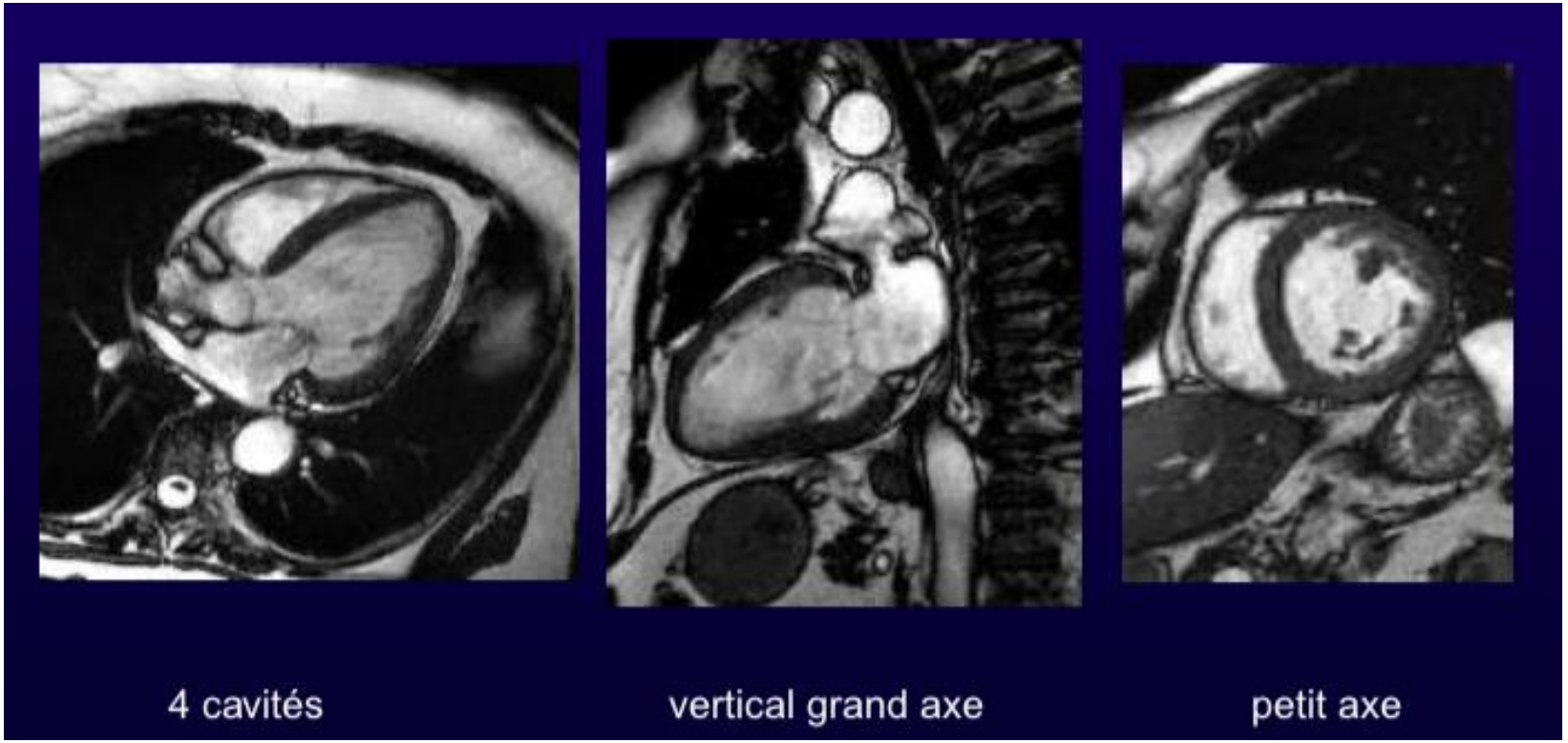
- TSE T2, STIR
- Séquence fonctionnelles
- Séquence sen SSFP (Fiesta, Balanced FFE, Truefisp)
- Ciné-TAG
- Perfusion de premier passage
- Séquence en écho de gradient en sauturation-récupération
- Réhaussement tardif
- EG (2D ou 3D) avec IR (T1 scouting ou PSIR)

# Principes



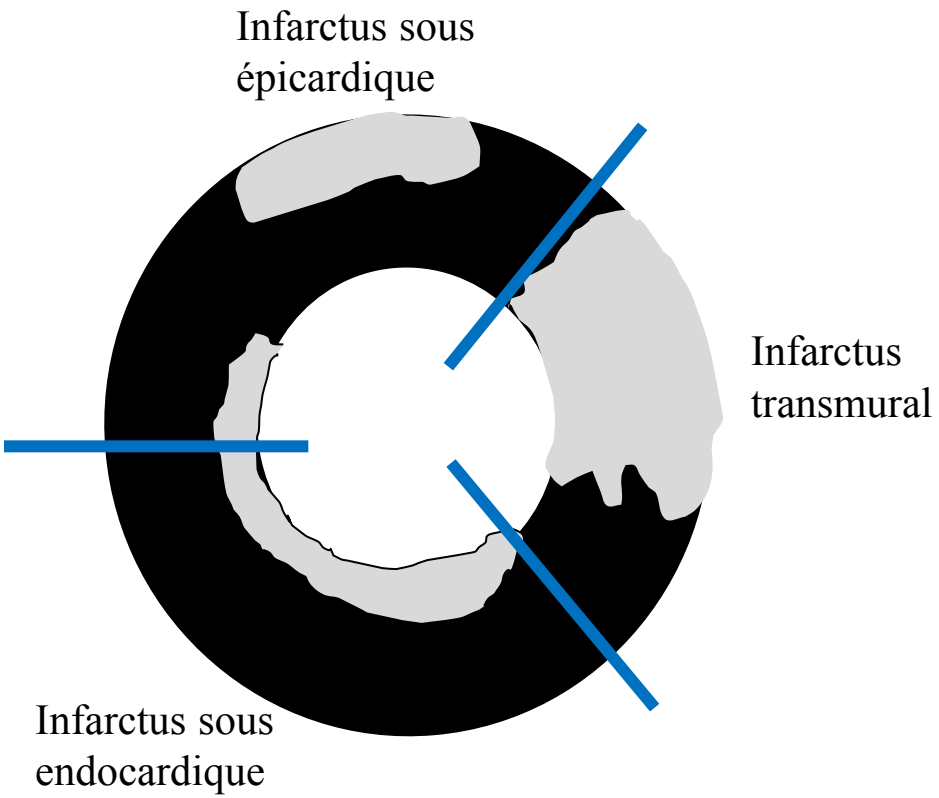

*In Imagerie Cardiaque: Scanner et IRM, G. Vignaux; p 117*

# Evaluation de la fonction VG

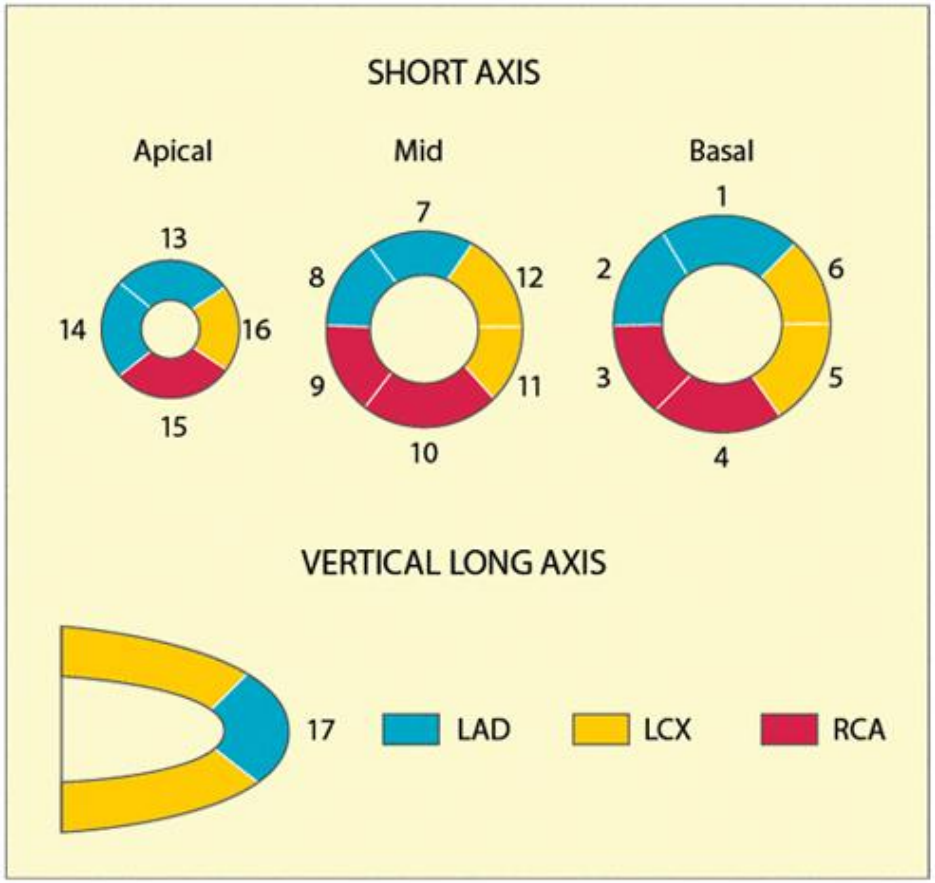


# Sémiologie de l'ischémie

## Systématisée et cohérente



# Segmentation du VG

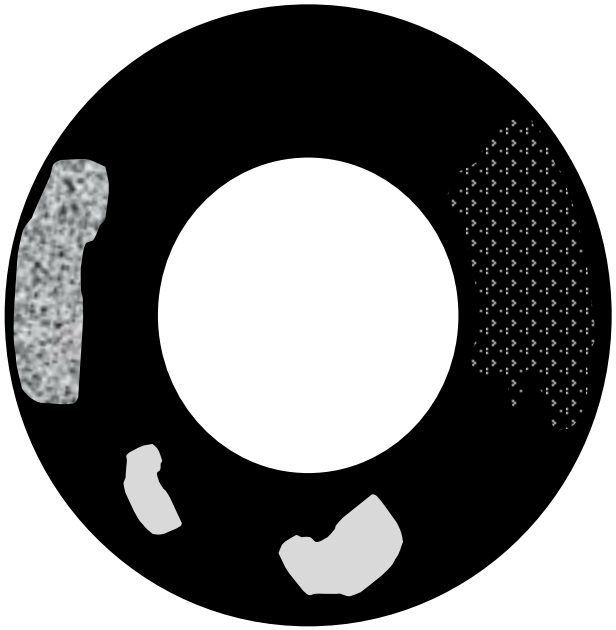



*Strandardized Myocardial Segmentation, Cerqueira et al, Circulation 2002, 105;539-42*

# Suite…

## Non systématisée et éparce

Infarctus localisé, myocardite, sarcoïdose



Patchy : fibrose interstitielle, sarcoïdose, myocardite

Focal: Hypertrophie, CMD, HTAP

# Relaxométrie

Détermination des valeurs absolues de
T1, T2 et T2*, en ms

•*Révolution conceptuelle en quantifiant les caractéristiques tissulaires absolues* et non pas seulement des contrastes relatifs

*(Nagel et al JACC CV Imaging 2013, 6(7), 837-8)*

•**T1 relaxation longitudinale**, basé sur inversion-récupération
- domaine très dynamique actuellement mais non stabilisé car - manque de standardisation

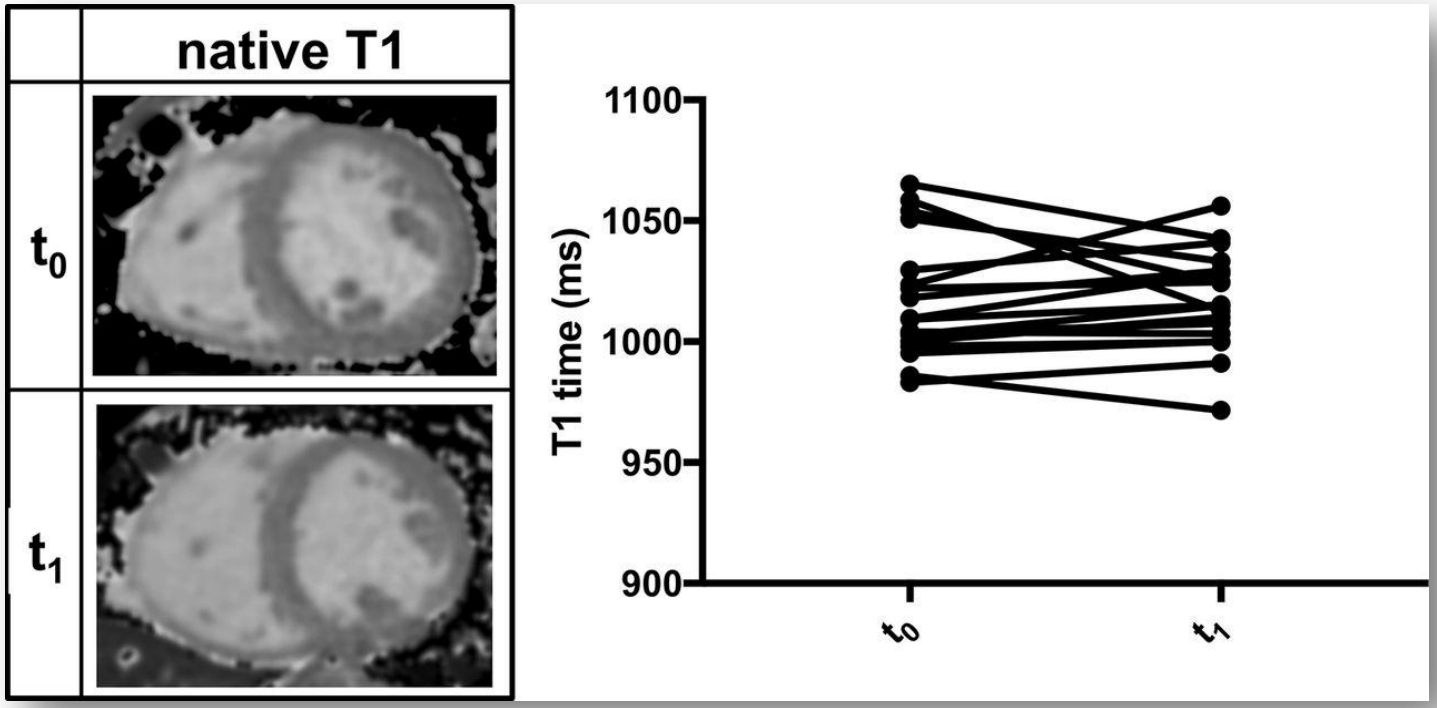
- T1 natif de l'ordre de 1000 ms à 1,5 T et (+25% à 3T)
- T1 post-contraste vers 300-400 ms→calcul ECV (≈27%)

*(Kawel-Boehm et al JCMR 2015, 17:29)*

•**T2 relaxation transversale**, basé sur écho de spin ou T2-Prep - moins étudié et semble moins discriminant (oedème surtout)

•**T2* relaxation transversale en écho de gradient multi-échos** - validé pour estimation de la charge en fer des tissus

# T1 Achifae est en cours….



# Résumé

- VGTD H < 100 ml/m² F < 90 ml/m²
- VDTVD H< 110 ml/m² F < 100 ml/m²
- FEVG > 55% FEVD > 50%
- MVG H < 90 g/m² F < 80 g/m²
- OG < 28 cm² OD < 29 cm²

- Vérifier la cohérence pour les flux +++
- T1 ≈ 1000 ms à 1.5T, T2 ≈ 50 ms, T2* ≈ 35 ms

- Savoir que la précision n'est que de ≈15-20%

Courtoisie : Philippe Germain Chu-Strasbourg et Loic Boussel, Chu-Lyon

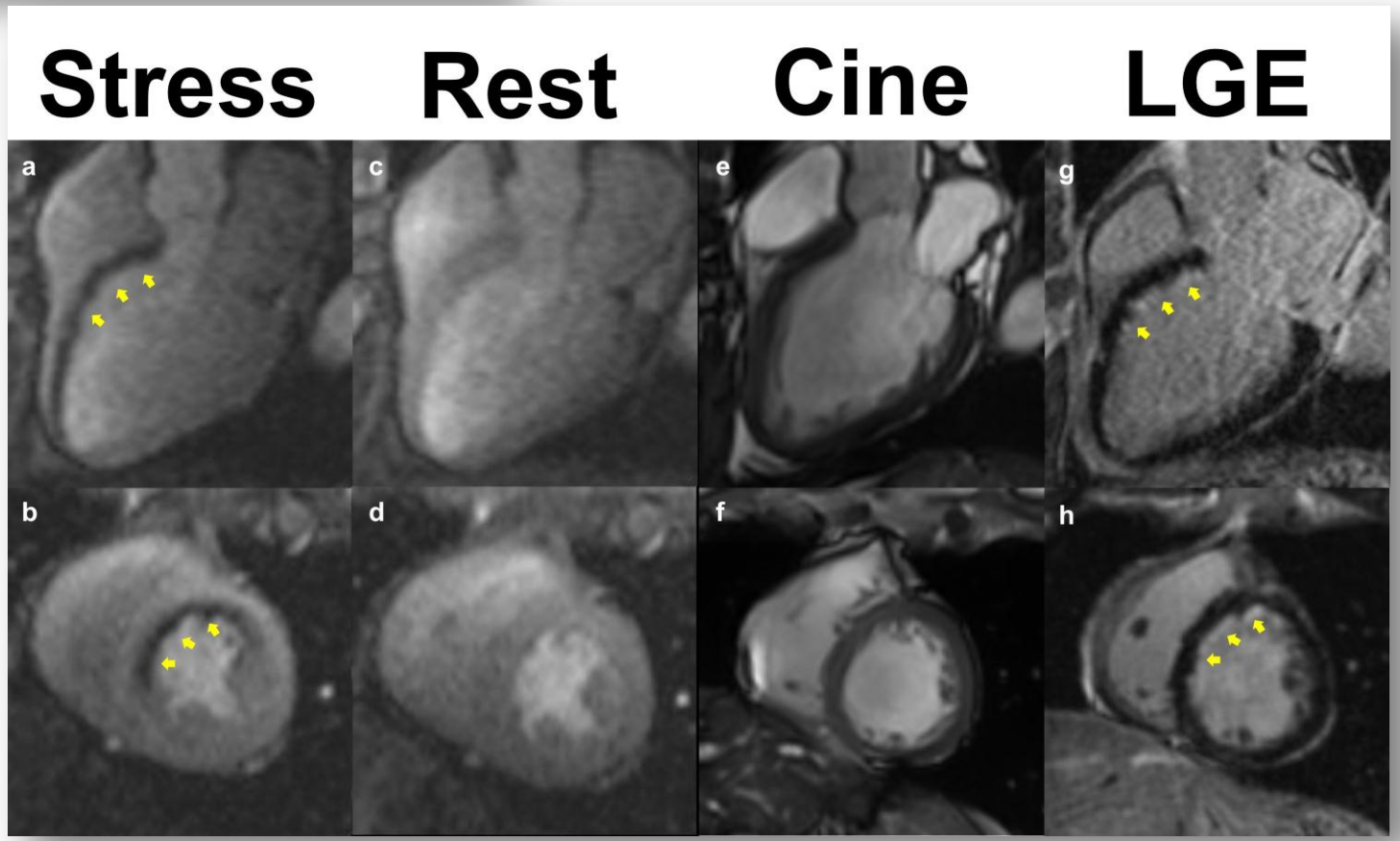
AMERICAN COLLEGE of CARDIOLOGY

Clinical Topics | Latest In Cardiology | Education and Meetings

## Is Stress CMR Ready for Prime Time?

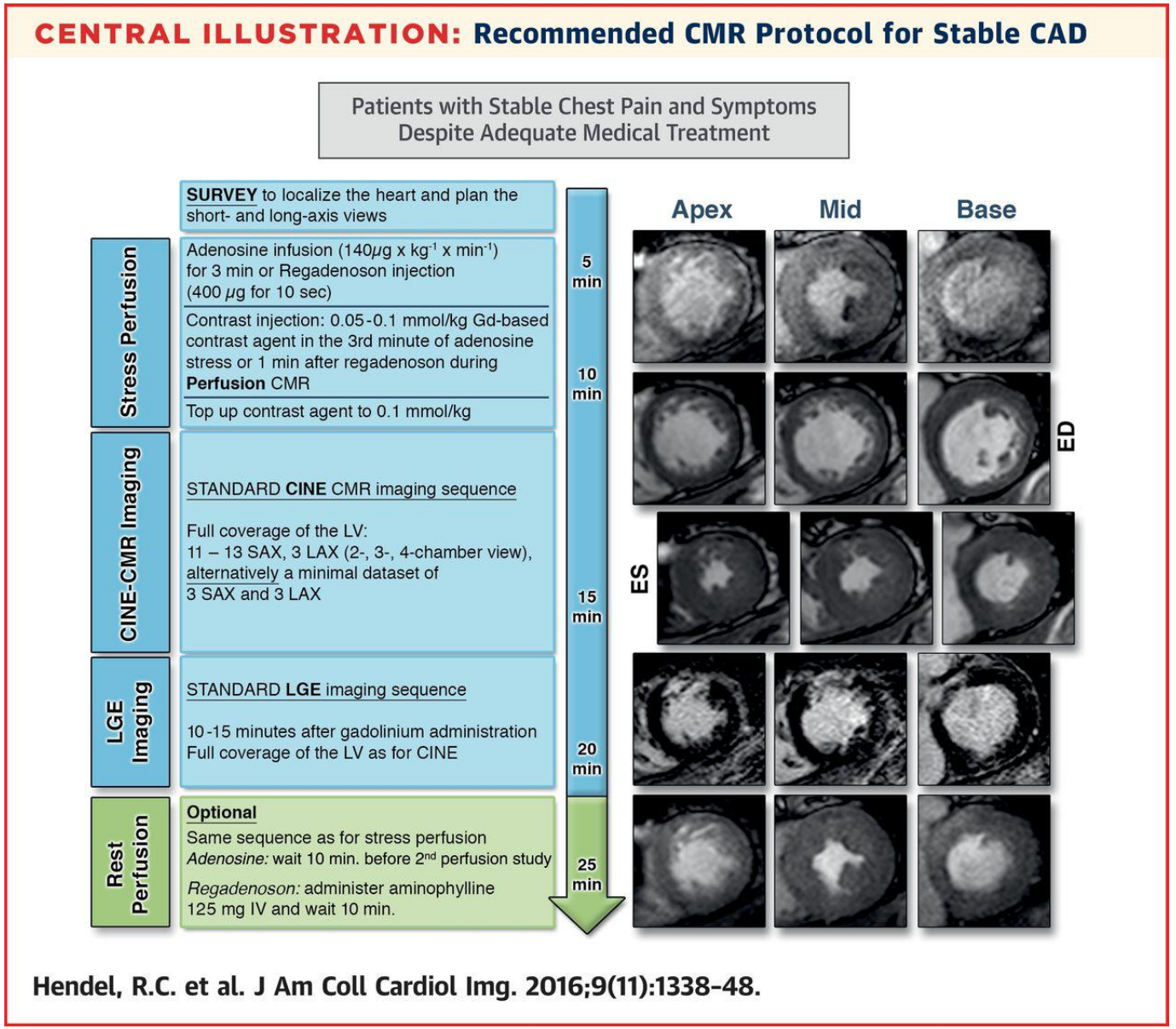
Dec 08, 2017 | Dr. Arif Jivan, MD, PhD ; Daniel C. Lee, MD, FACC

Expert Analysis




Hyperhémie Repos Ciné Réhaussement tardif

# IRM de Stress



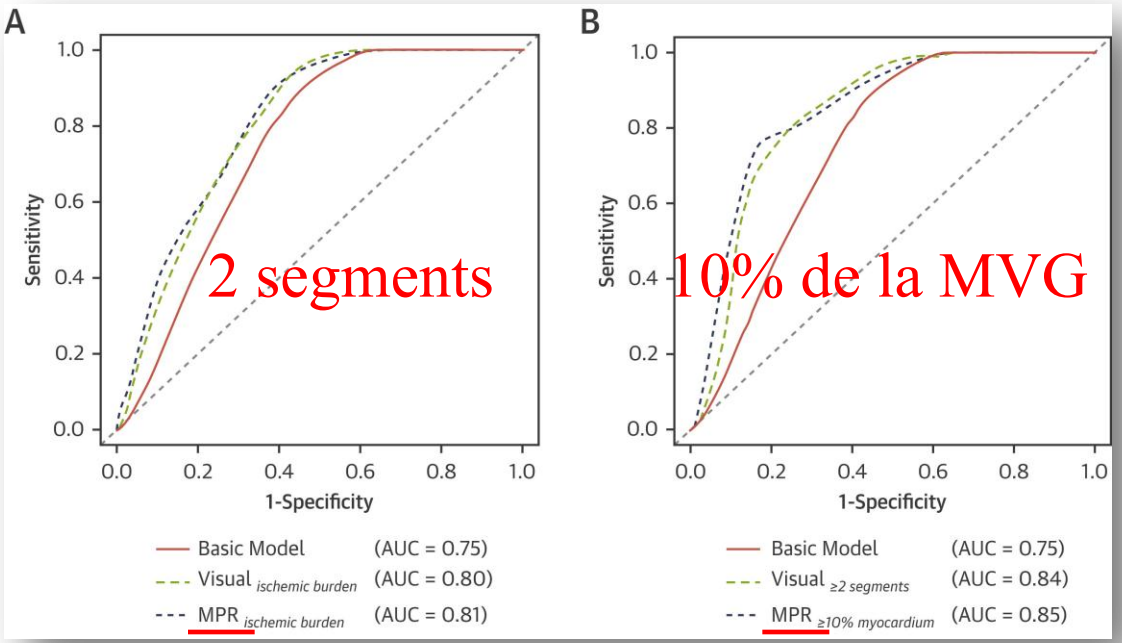

Hendel, R.C. et al. J Am Coll Cardiol Img. 2016;9(11):1338-48.

JACC: CARDIOVASCULAR IMAGING


VOL. 11, NO. 5, 2018

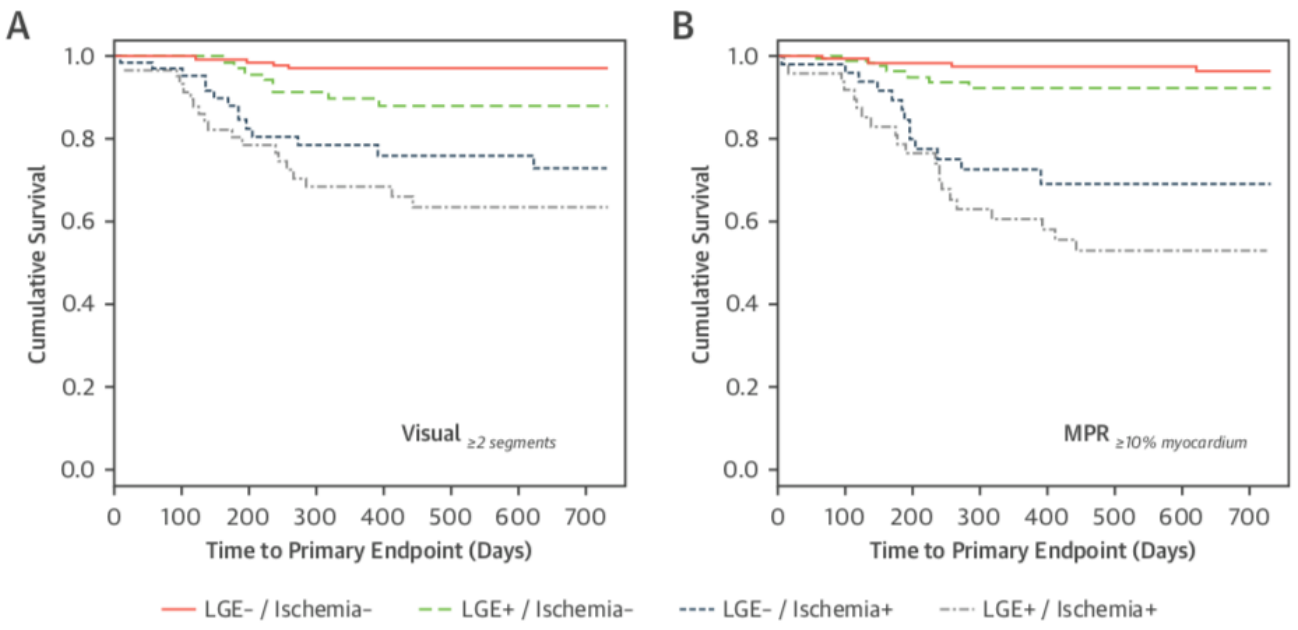
# Prognostic Value of Quantitative Stress Perfusion Cardiac Magnetic Resonance

Eva C. Sammut, MD, PhD,[a,b] Adriana D.M. Villa, MD, PhD,[a] Gabriella Di Giovine, MD,[a] Luke Dancy, MD,[c] Filippo Bosio, BSc,[a] Thomas Gibbs, BSc, MBBS,[a] Swarna Jeyabraba, BSc, MBBS,[a] Susanne Schwenke, PhD,[d] Steven E. Williams, MD, PhD,[a] Michael Marber, MD, PhD,[e] Khaled Alfakih, MD, PhD,[a] Tevfik F. Ismail, MD, PhD,[a] Reza Razavi, MD,[a] Amedeo Chiribiri, MD, PhD[a]



# Le réhaussement tardif (LGE) & la survie

**FIGURE 3** Event-Free Survival Separated According to the Presence of Significant Visual or Quantitative Ischemic Burden and LGE




Kaplan-Meier curves illustrating survival in patients stratified according to late gadolinium enhancement (LGE) and **(A)** dichotomized visual and **(B)** quantitative ischemic burden. Abbreviation as in Figure 1.

## 3.1 Non-invasive diagnostic tools

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[a]Class of recommendation.
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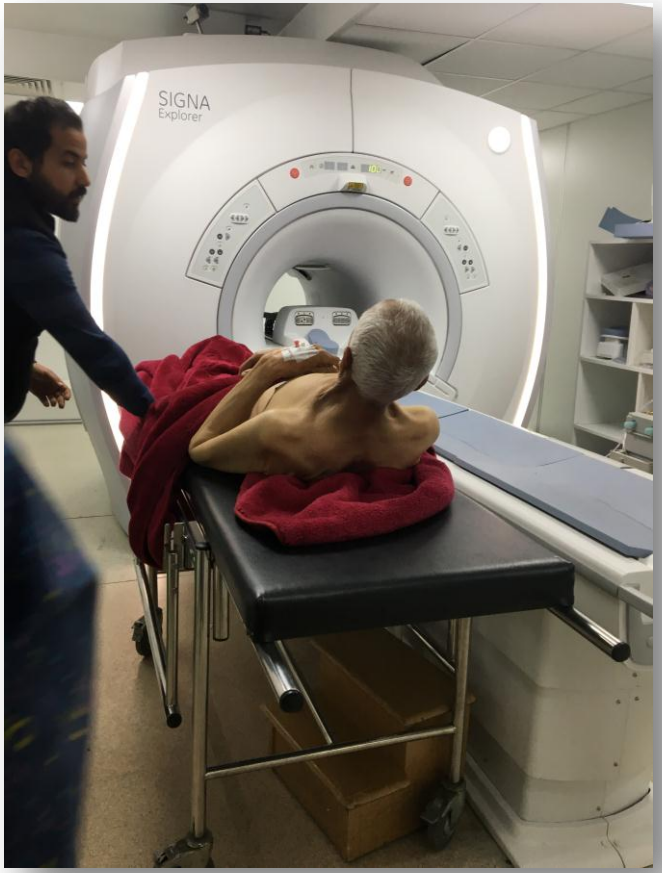
### 3.1.2 Assessment of myocardial viability in patients with

# IRM 1.5 Tesla

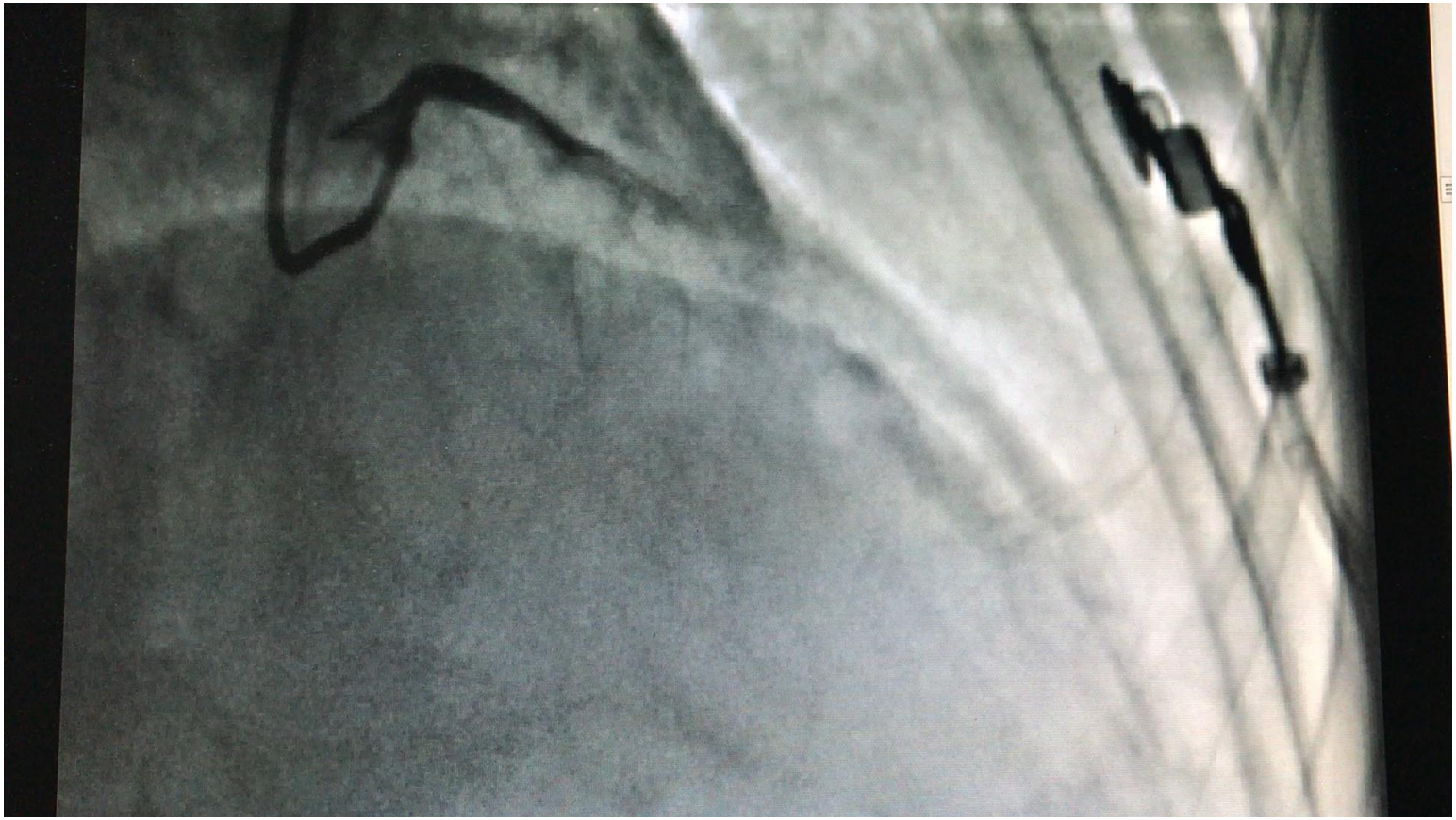




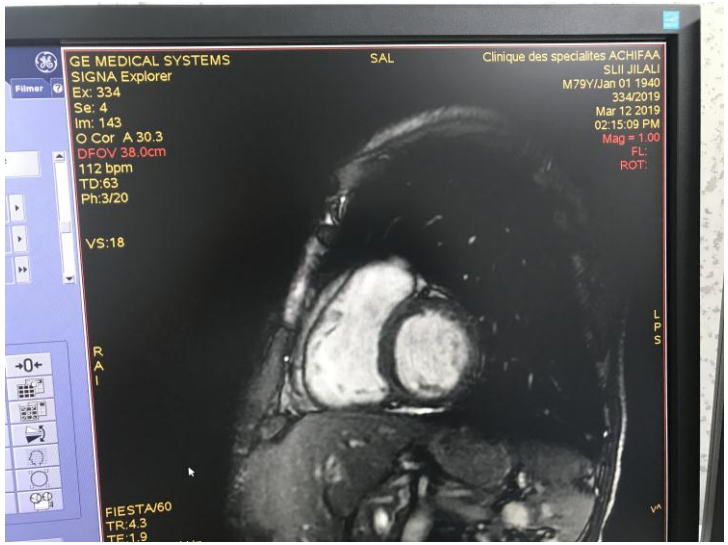
SCHILLER
MENU
SpO2

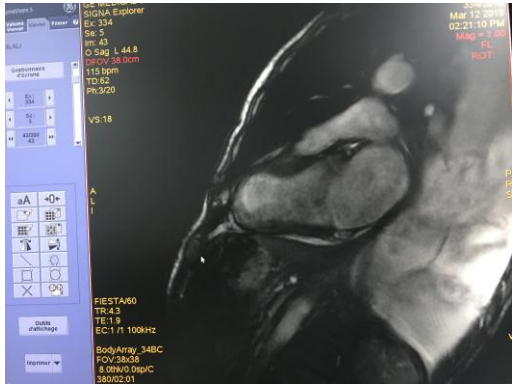

PUISSANT
SYRINGE
Gadovist
1,0 mmol/ml

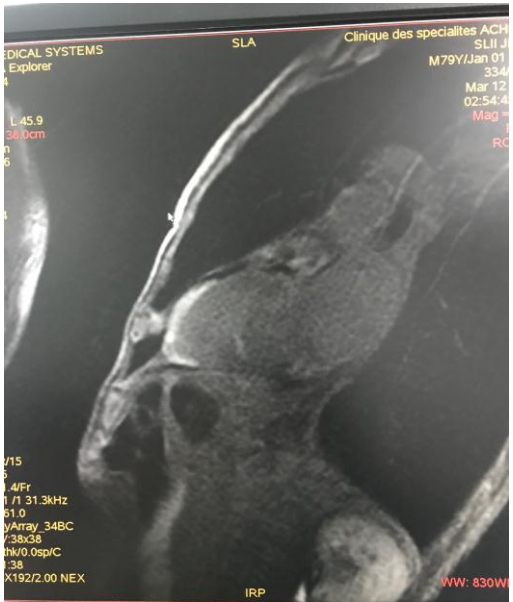
H 78 ans, IC NYHA2-3,
FE 28% et hypokinésie apicale, 2 stents sur l'IVA

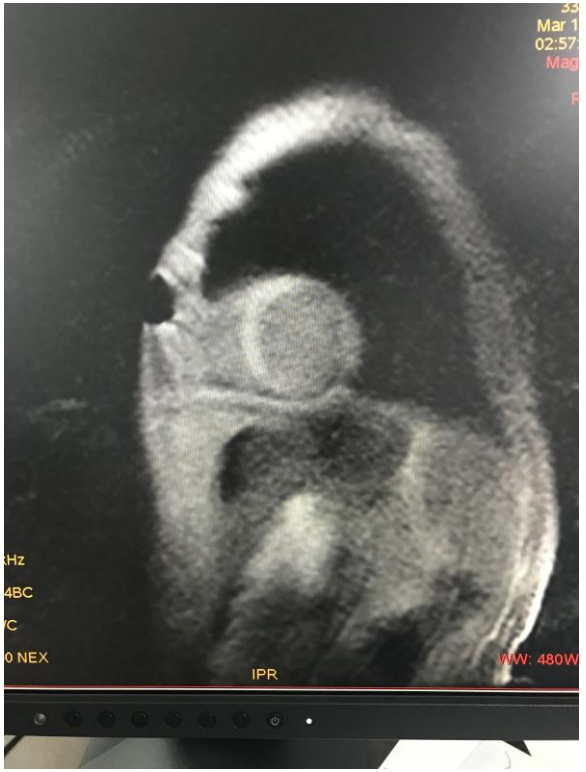


# IRM avec injection de gadolinium sans Stress
# Recherche du réhaussement tardif



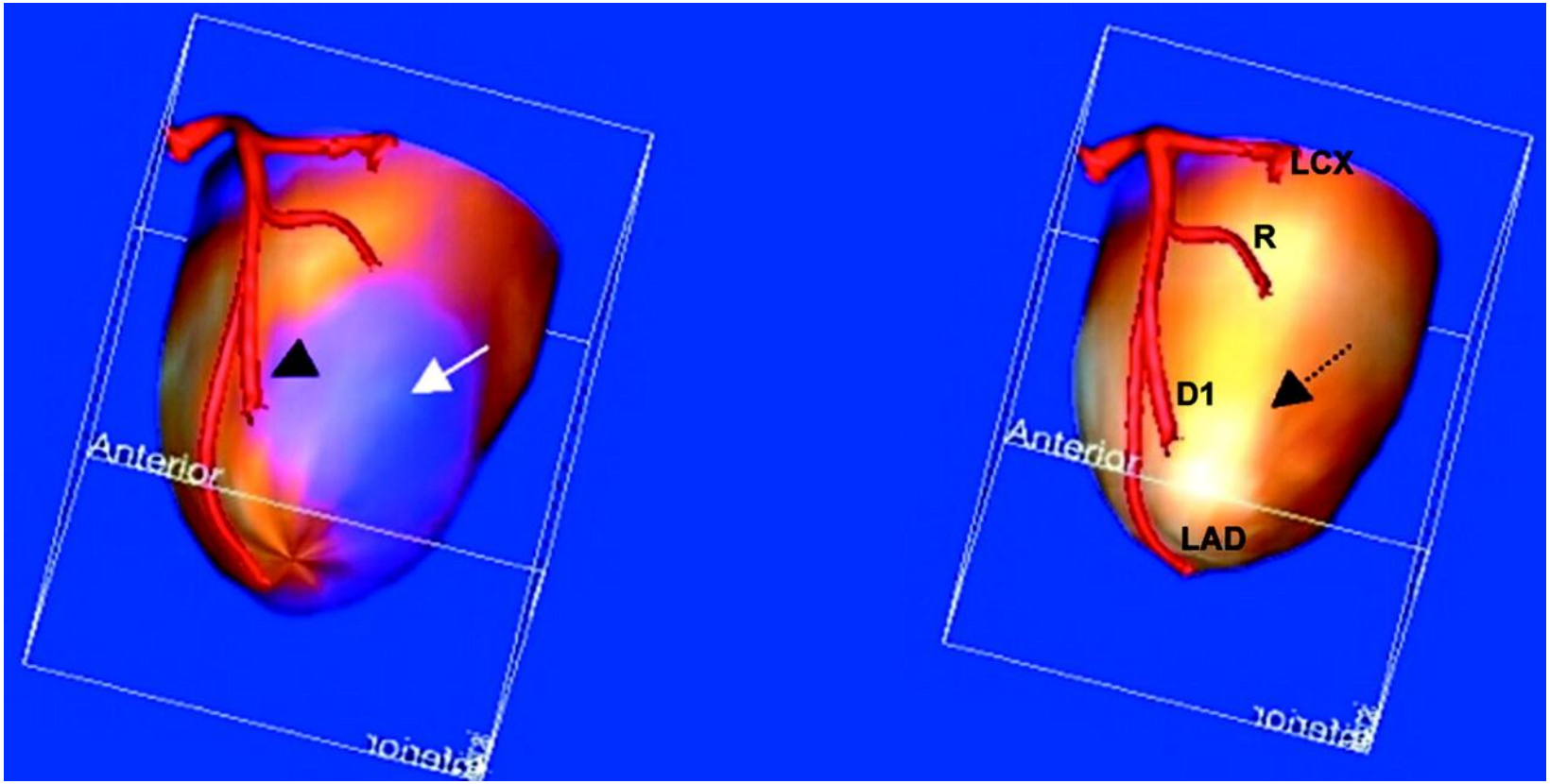



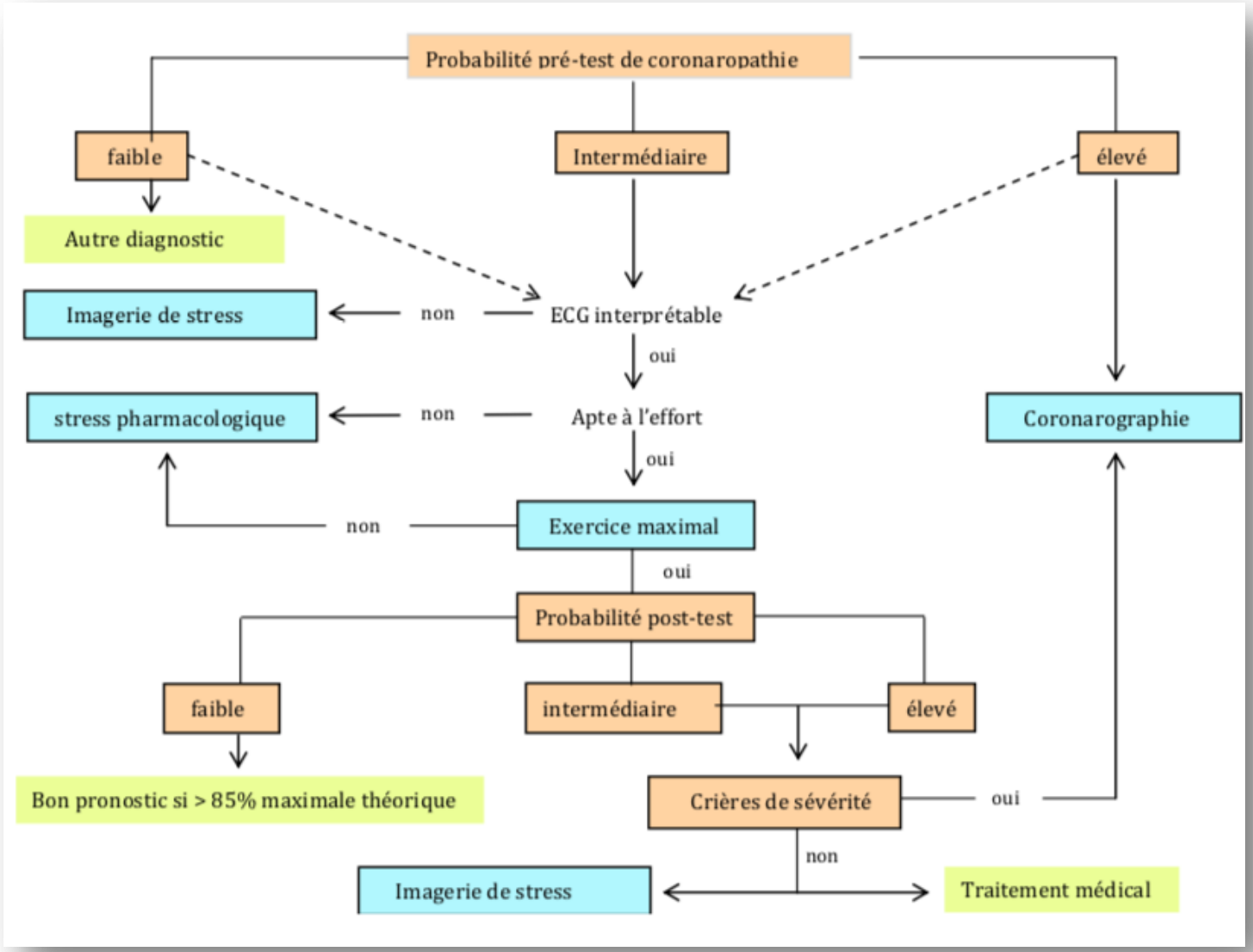



# Conclusion

- La FFR demeure le gold standard…
- L'imagerie de perfusion (IRM) prend de la place et risque de détrôner les tests fonctionnels invasifs voire non invasifs
- Le scanner spectral risque de bouleverser l'approche puisqu'il pourra combiner l'imagerie anatomique et l'analyse fonctionnelle tissulaire (perfusion)

# Techniques hybrides






*Recommandations de la SFC pour les épreuves d'effort. Dany Marcadet et al, 13 mars 2018*

**Tableau 4 Niveaux de risque cardiovasculaire, adaptées selon [5]**

| | |
|---|---|
| Risque très élevé | Maladie cardiovasculaire documentée (antécédent d'IDM, SCA, revascularisation coronarienne ou artérielle, AVC/AIT, anévrisme de l'aorte ou MAP)<br>Imagerie d'un maladie cardiovasculaire, comme une plaque importante (angiographie coronaire ou échographie carotidienne)<br>Diabète avec atteinte d'organes cibles (protéinurie) ou avec un facteur de risque cardiovasculaire majeur<br>Insuffisance rénale sévère (DFG < 30 mL/min/1.73m$^2$)<br>SCORE ≥ 10% |
| Risque élevé | Facteur de risque cardiovasculaire unique très élevé<br>Autres patients diabétiques (sauf sujet jeune avec diabète de type I sans facteur de risque cardiovasculaire majeur)<br>Insuffisance rénale modérée (DFG = 30-59 mL/min/1.73m$^2$)<br>SCORE ≥ 5% et < 10% |
| Risque modéré | SCORE ≥ 1% et < 5% |
| Risque faible | SCORE < 1% |

SCA: syndrome coronarien aigu; IDM: infarctus du myocarde; DFG: débit de filtration glomérulaire; MAP: maladie artérielle périphérique; AVC: accident vasculaire cérébral; AIT: accident ischémique transitoire.

*Recommandations de la SFC pour les épreuves d'effort. Dany Marcadet et al, 13 mars 2018*