

2023

11^{ème}

SÉMINAIRE de CARDIOLOGIE
INTERVENTIONNELLE de TROYES

01 & 02
AVRIL



SALLE DU CONSEIL MUNICIPAL
HOTEL DE VILLE de TROYES



IRM ET MALADIE CORONAIRE

Aurélie MARCHAIS

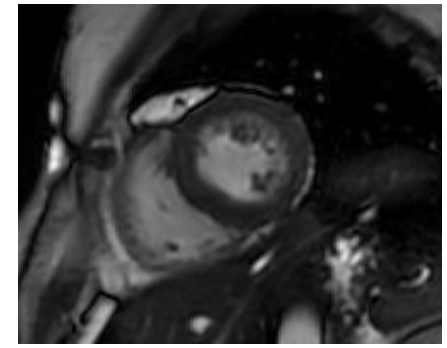
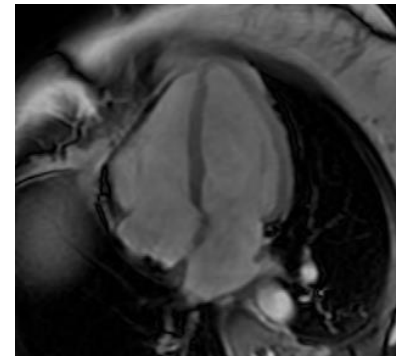
Cardiologie

Centre Hospitalier de Troyes

Déclaration de conflits d'intérêts

- Pas de conflit d'intérêt

IRM CARDIAQUE



- Outil devenu indispensable dans la prise en charge des patients porteurs de cardiopathies notamment ischémiques

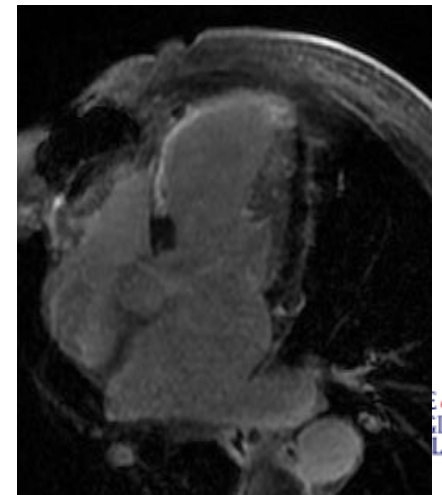
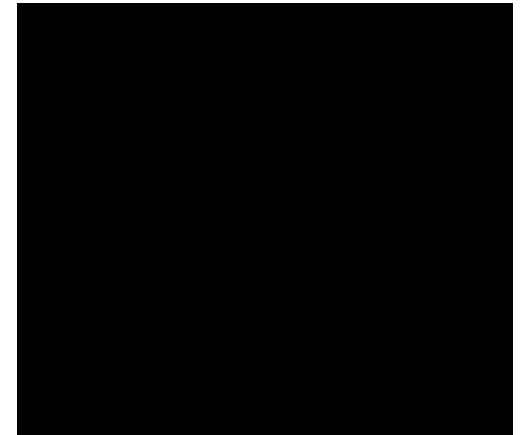
1 Fonctions VG VD, complications post SCA

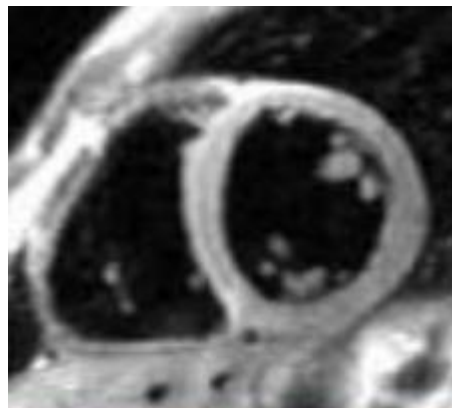
2 Détection ischémie

3 Viabilité

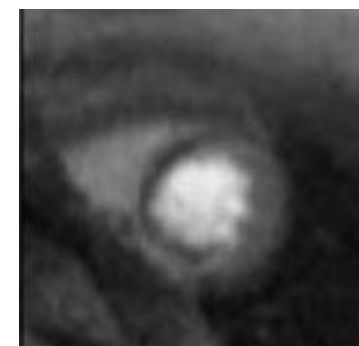
4 MINOCA

- Limites : disponibilité, claustrophobie, boitier...





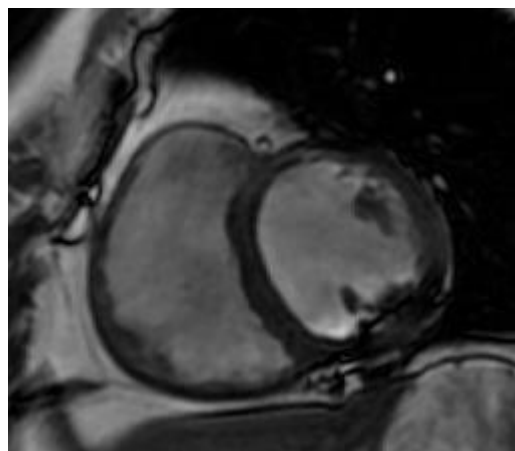
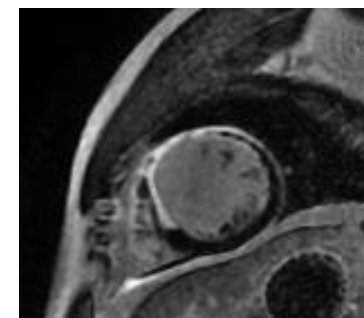
Anatomie



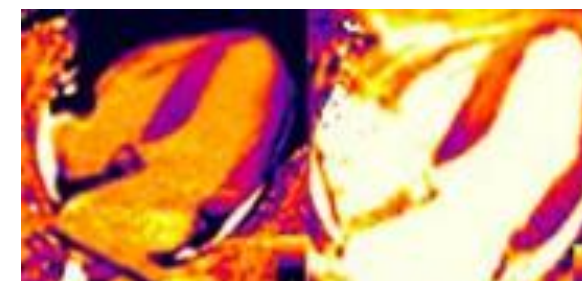
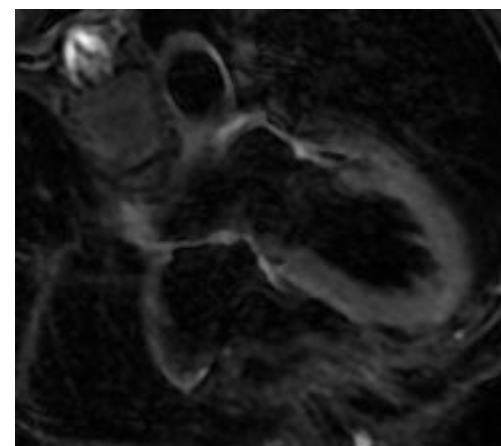
Perfusion
+/- Stress



Caractérisation tissulaire LGE



Fonction



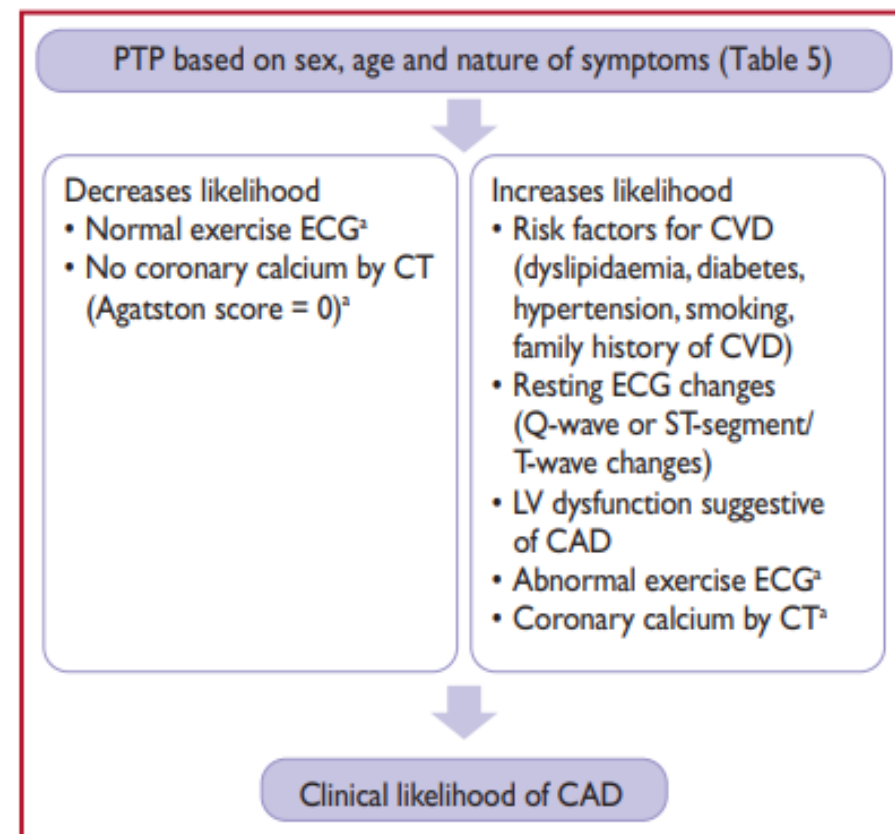
MALADIE CORONAIRE CHRONIQUE

Table 5 Pre-test probabilities of obstructive coronary artery disease in 15 815 symptomatic patients according to sex, and the nature of symptoms in a pooled analysis⁶⁴ of contemporary data^{7,8,62}

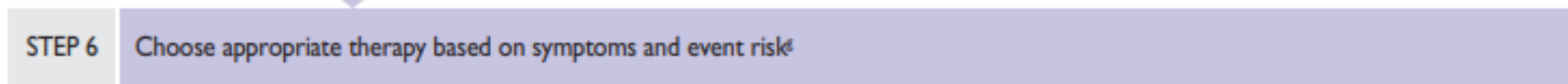
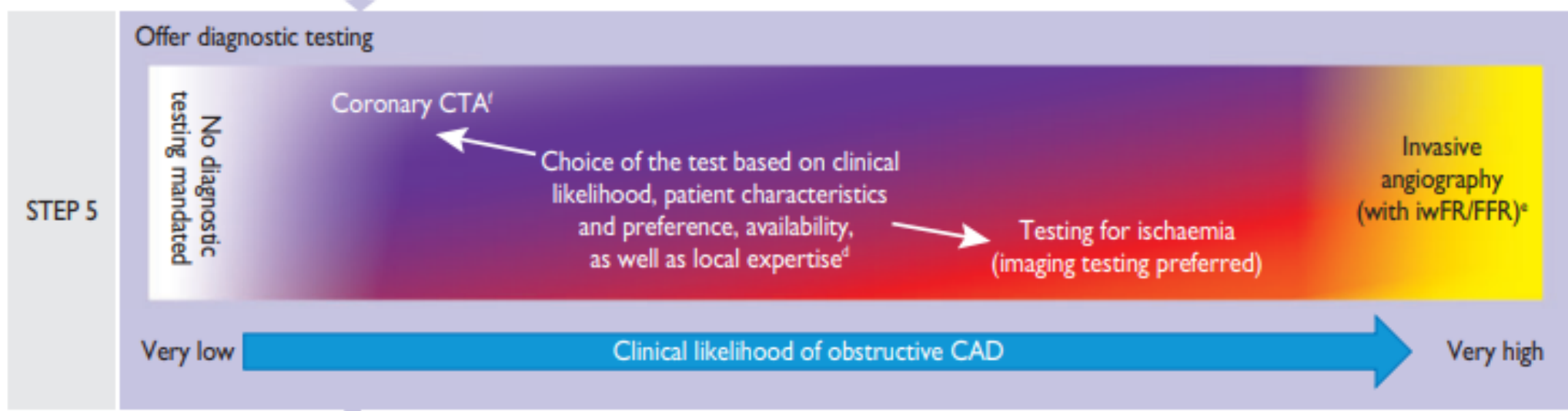
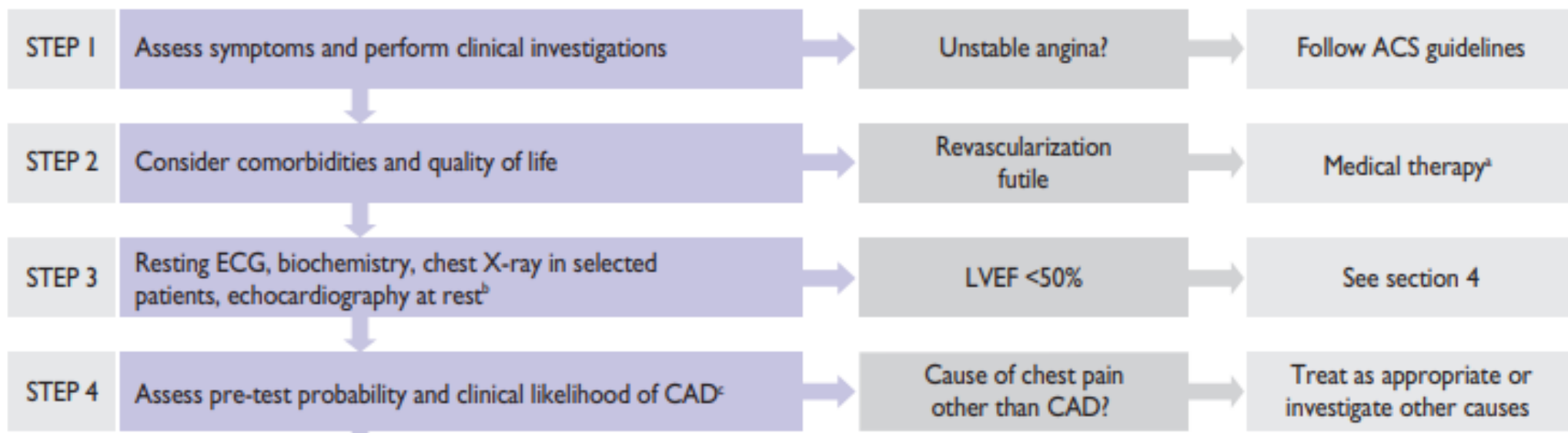
Age	Typical		Atypical		Non-anginal		Dyspnoea ^a	
	Men	Women	Men	Women	Men	Women	Men	Women
30–39	3%	5%	4%	3%	1%	1%	0%	3%
40–49	22%	10%	10%	6%	3%	2%	12%	3%
50–59	32%	13%	17%	6%	11%	3%	20%	9%
60–69	44%	16%	26%	11%	22%	6%	27%	14%
70+	52%	27%	34%	19%	24%	10%	32%	12%

CAD = coronary artery disease; PTP = pre-test probability.

^aIn addition to the classic Diamond and Forrester classes,⁵⁹ patients with dyspnoea only or dyspnoea as the primary symptom are included. The regions shaded dark denote the groups in which non-invasive testing is most beneficial (PTP >15%). The regions shaded light green denote the groups with PTPs of CAD between 5–15%, in testing for diagnosis may be considered after assessing the overall clinical likelihood based on the modifiers of PTPs presented in Figure 3.



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Use of diagnostic imaging tests in the initial diagnostic management of symptomatic patients with suspected coronary artery disease

Recommendations	Class ^a	Level ^b
Non-invasive functional imaging for myocardial ischaemia ^c or coronary CTA is recommended as the initial test to diagnose CAD in symptomatic patients in whom obstructive CAD cannot be excluded by clinical assessment alone. ^{4,5,55,73,78–80}	I	B
It is recommended that selection of the initial non-invasive diagnostic test is done based on the clinical likelihood of CAD and other patient characteristics that influence test performance, ^d local expertise, and the availability of tests.	I	C
Functional imaging for myocardial ischaemia is recommended if coronary CTA has shown CAD of uncertain functional significance or is not diagnostic. ^{4,55,73}	I	B
Invasive coronary angiography is recommended as an alternative test to diagnose CAD in patients with a high clinical likelihood, severe symptoms refractory to medical therapy or typical angina at a low level of exercise, and clinical evaluation that indicates high event risk. Invasive functional assessment must be available and used to evaluate stenoses before revascularization, unless very high grade (>90% diameter stenosis). ^{71,72,74}	I	B
Invasive coronary angiography with the availability of invasive functional evaluation should be considered for confirmation of the diagnosis of CAD in patients with an uncertain diagnosis on non-invasive testing. ^{71,72}	IIa	B
Coronary CTA should be considered as an alternative to invasive angiography if another non-invasive test is equivocal or non-diagnostic.	IIa	C
Coronary CTA is not recommended when extensive coronary calcification, irregular heart rate, significant obesity, inability to cooperate with breath-hold commands, or any other conditions make obtaining good image quality unlikely.	III	C
Coronary calcium detection by CT is not recommended to identify individuals with obstructive CAD.	III	C

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CAD = coronary artery disease; CT = computed tomography; CTA = computed tomography angiography.

^aClass of recommendation.

^bLevel of evidence

^cStress echocardiography, stress cardiac magnetic resonance, single-photon emission CT, or positron emission tomography.

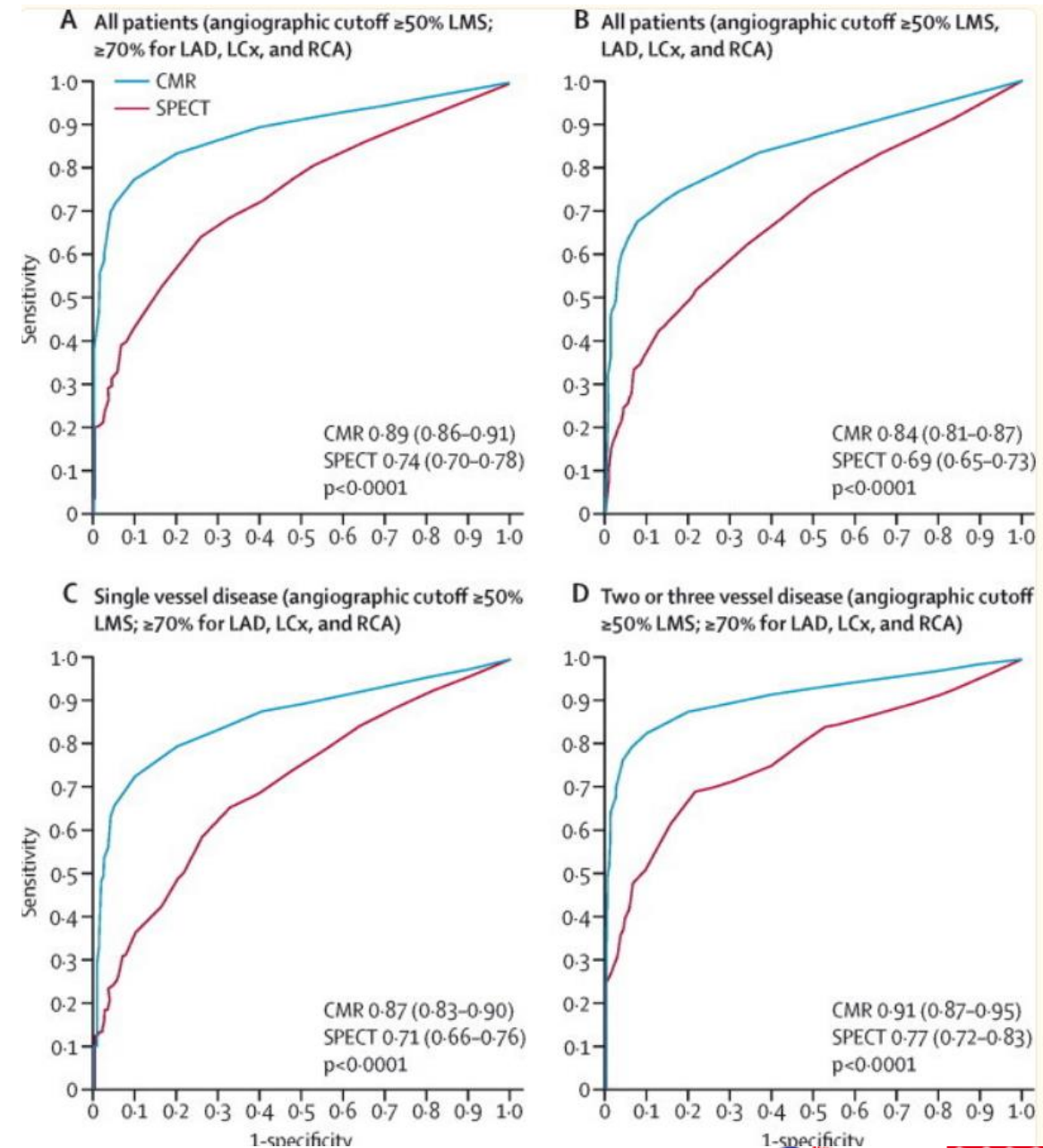
^dCharacteristics determining ability to exercise, likelihood of good image quality, expected radiation exposure, and risks or contraindications.

IRM de Stress

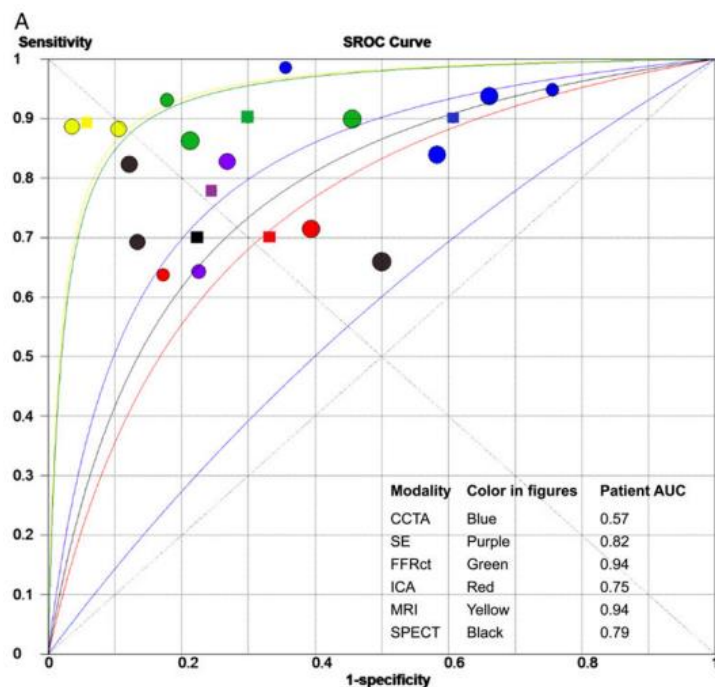
- 752 patients
- Référence : Coronarographie

- IRM
 - Se : 86,5% (95% CI 81,8-90,1) $p < 0,0001$
 - Sp : 83,4% (79,5-86,7) $p = 0,916$

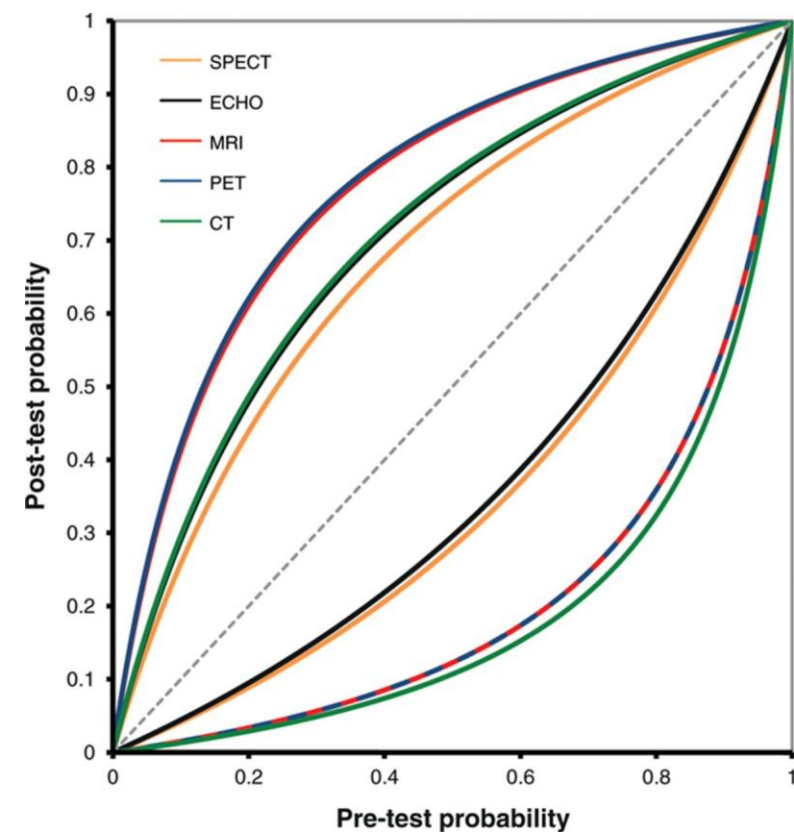
- Scinti
 - Se : 66,5% (95% CI 60,4-72,1)
 - Sp : 82,6% (78,5-86,1)



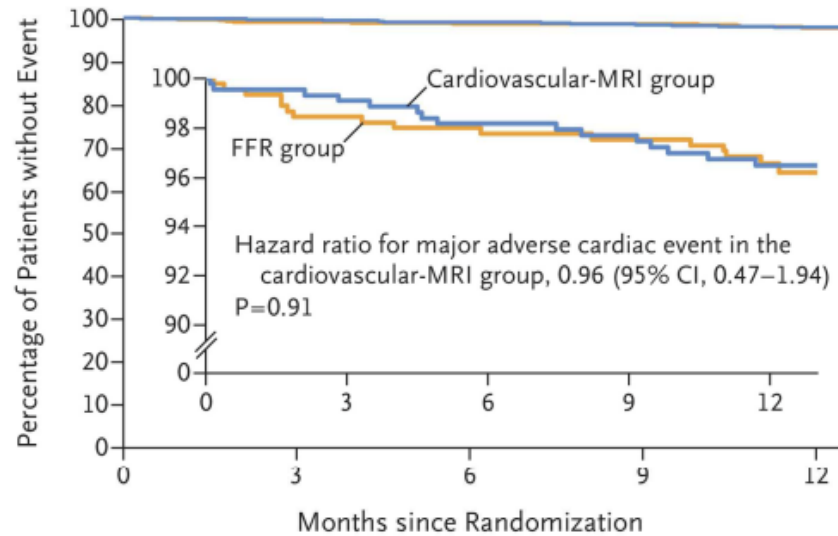
IRM de Stress / FFR



Métaanalyses 1696 patients
IRM le plus spécifique et sensible pour le
diagnostic de coronaropathie
Danad et Al Eur Hear J 2017



Métaanalyse
Tahx et Al Cardiovasc Imaging 2015



No. at Risk	0	3	6	9	12
Cardiovascular-MRI group	449	433	423	413	340
FFR group	461	442	431	424	338

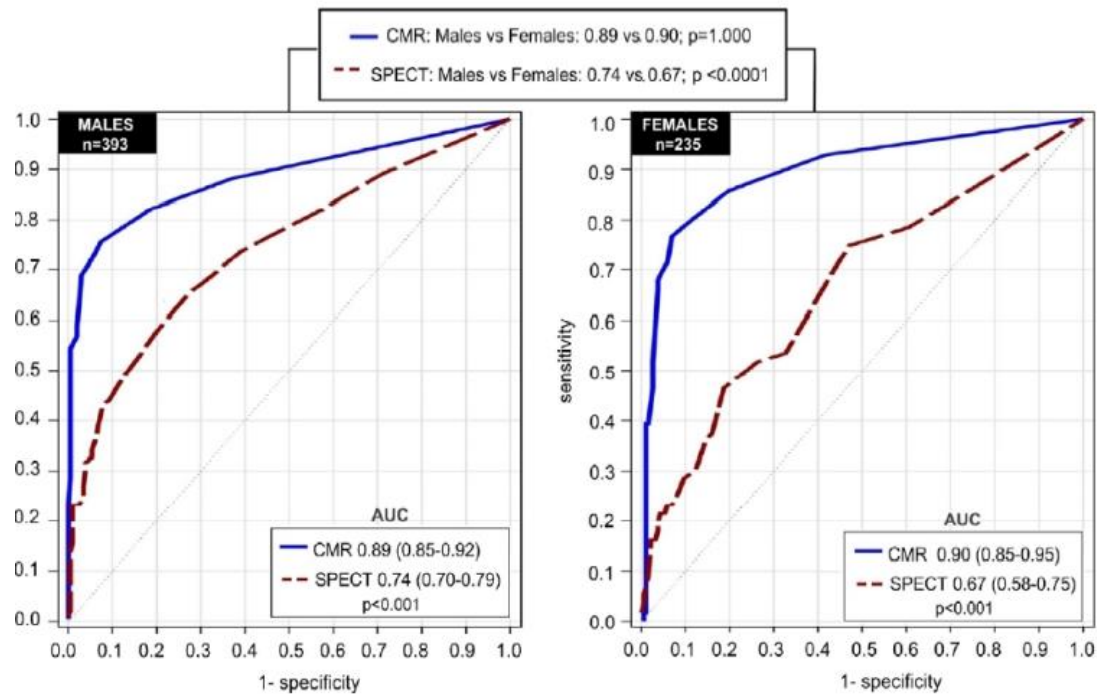
MR-INFORM

918 patients avec angor typique et FFR ou test d'effort positif

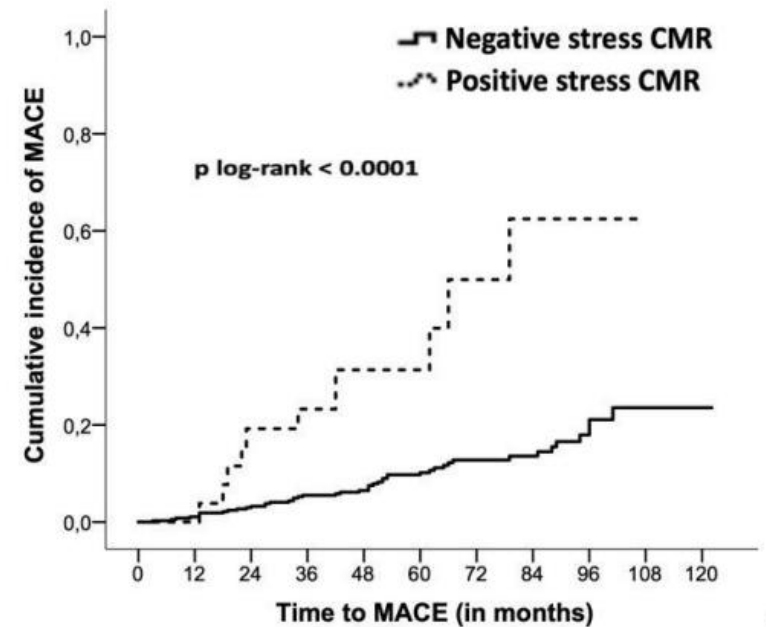
- IRM de stress donne un taux moindre de revascularisation que la FFR avec un taux d'événements cardiaques similaires à 12 mois
- Seuil FFR

Nagel et Al NEJM 2019

Populations particulières



444 patients avec IMC > 40 kg/m²



	IRM		Scinti	
	Femmes	Hommes	Femmes	Hommes
Sensibilité	89	86	51	71
Spécificité	84	83	84	81

Greenwod et Al Circulation 2014

Kinnel M et Al JACC CV Img 2019

Associé aux séquences de réhaussement tardif

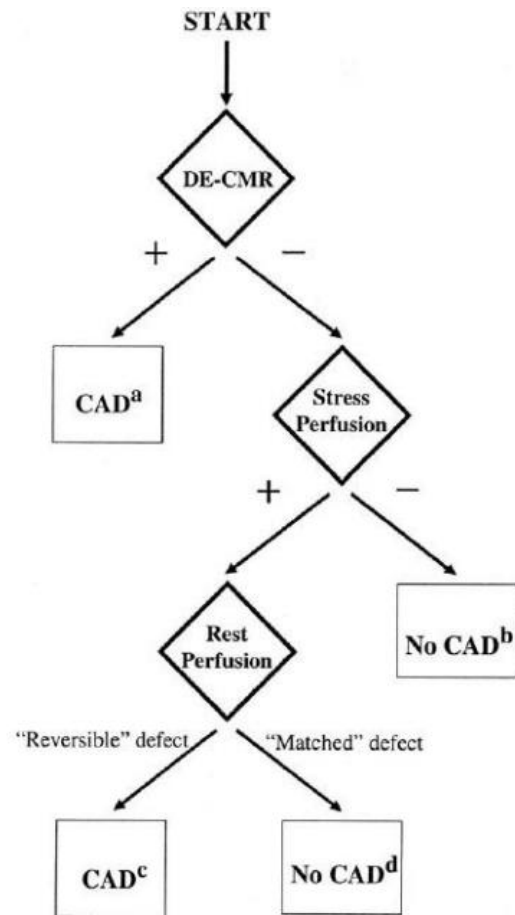


Table 2. Diagnostic Performance of the Interpretation Algorithm According to the Severity of Coronary Stenosis

	Sensitivity	Specificity	Accuracy
Coronary Stenosis $\geq 70\%$ or Left Main $\geq 50\%$			
Interpretation algorithm	89% (33/37)	87% (48/55)*	88% (81/92)*
Individual techniques			
Perfusion (stress/rest)	84% (31/37)	58% (32/55)	68% (63/92)
Cine (rest)	49% (18/37)	73% (40/55)	63% (58/92)
DE-CMR	49% (18/37)	98% (54/55)	78% (72/92)

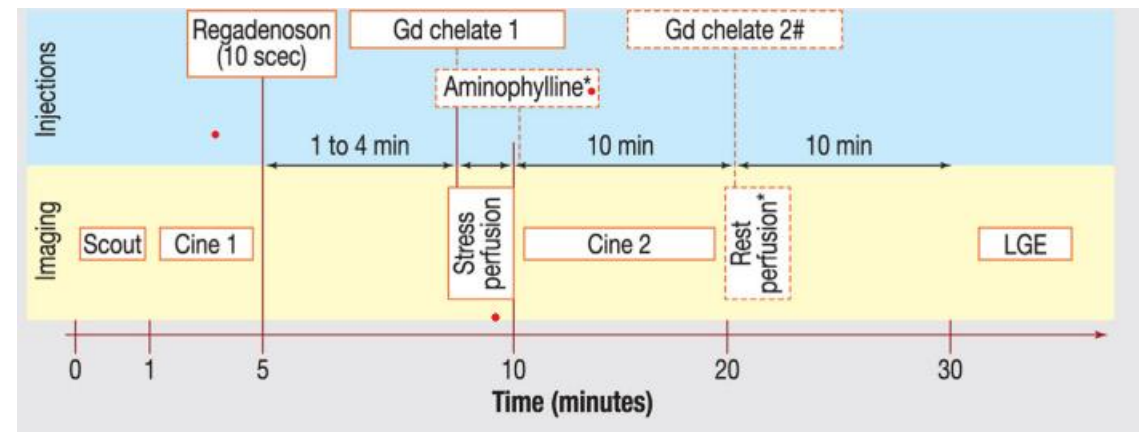
Klem et al, JACC 2006;47:1630-8

Agents vasodilatateurs

- Dypiridamole
- Adénosine
- **Régadenoson +++** injection 400ug dose unique IVL 10sec puis rinçage sérum physiologique

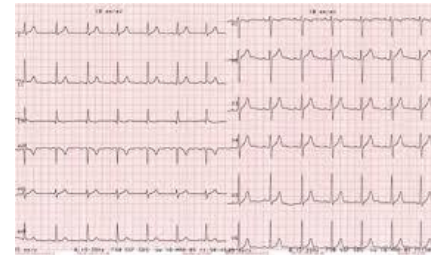


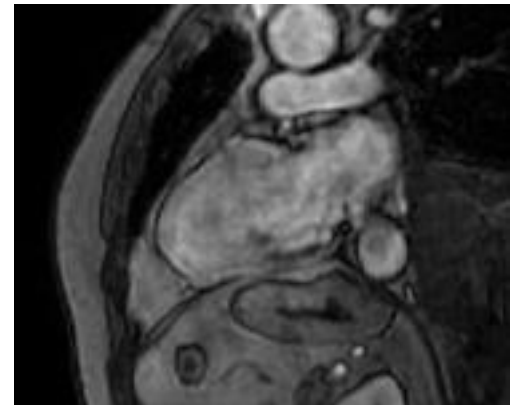
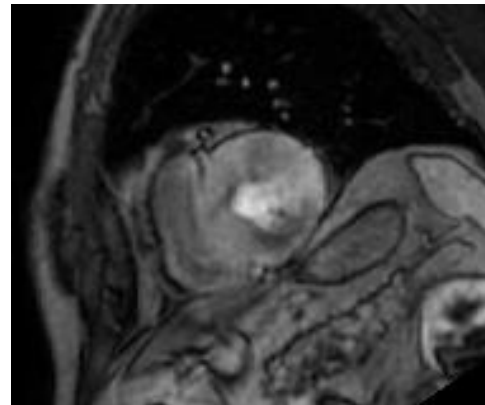
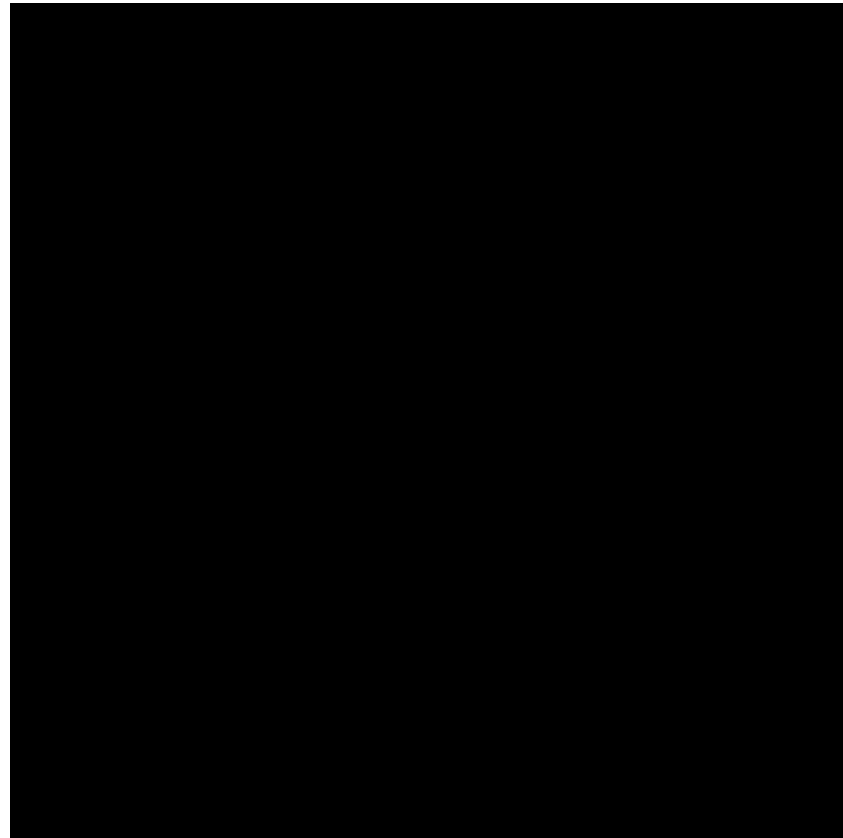
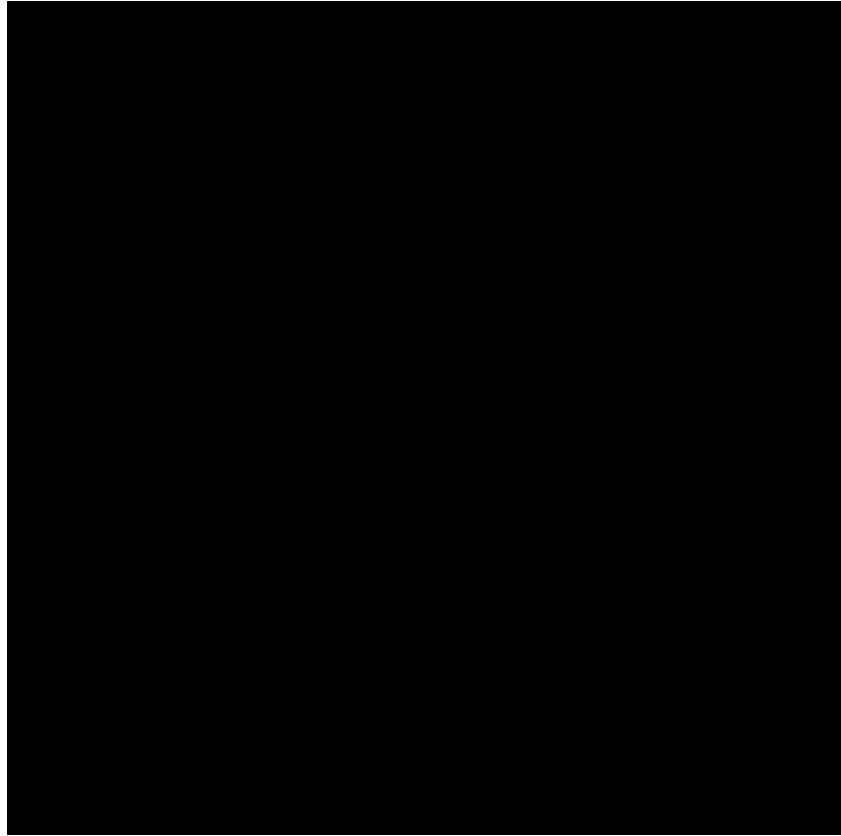
- BPCO, asthme
- BAV 2 et 3
- TDR non contrôlés
- Hypotension artérielle
- SCA
- Obstruction intra VG



Préparation patient

- Patient informé
- Pas de bases xanthiques dans les 12h avant examen
 - chocolat, café, thé avant l'examen
- ECG pré et post test
- Chariot d'urgence à proximité
- Surveillance scopée , TA, contact avec la patient
- Centre avec unité de soins intensifs cardiologie

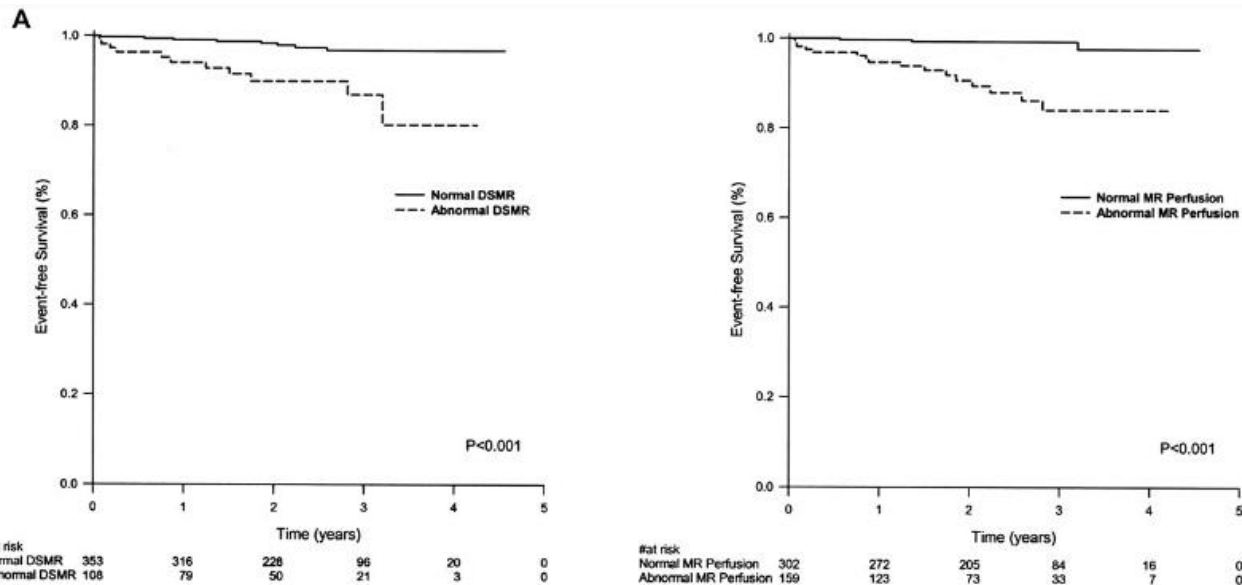




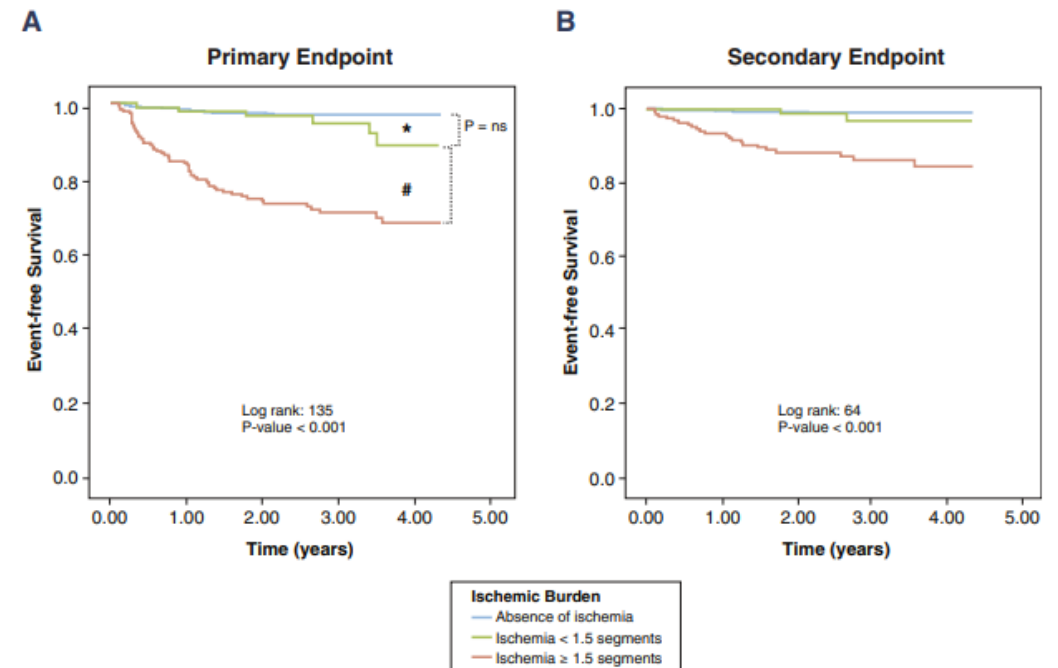
Valeur pronostique de l'IRM de Stress

516 patients
Moins de 1% d'événement à 2 ans si IRM de stress négative

1024 patients
Sévérité ischémie corrélée avec les événements CV



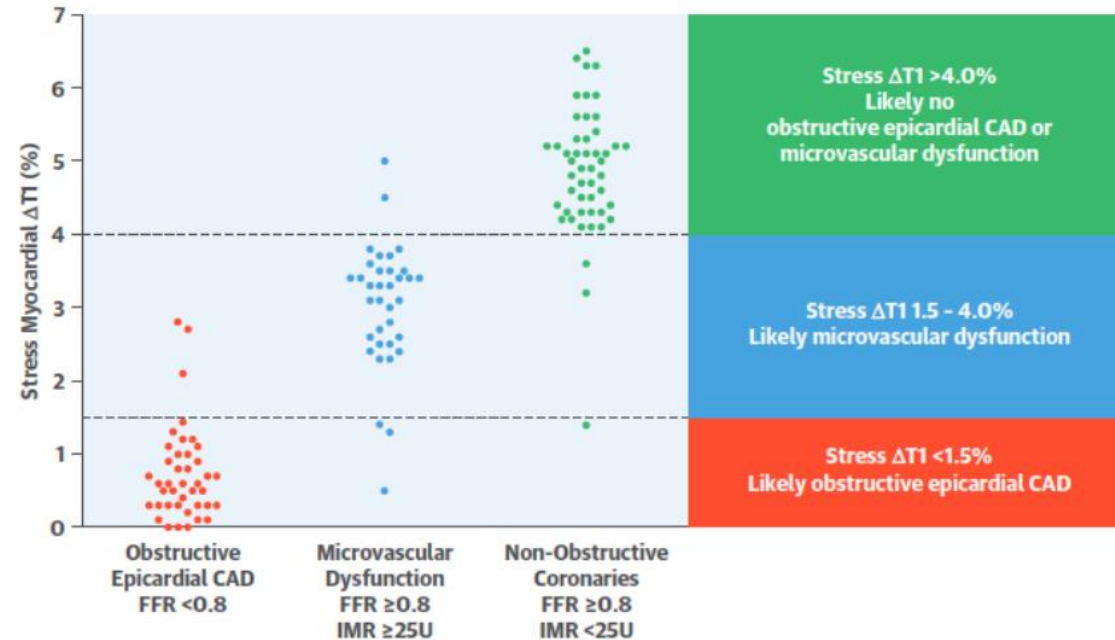
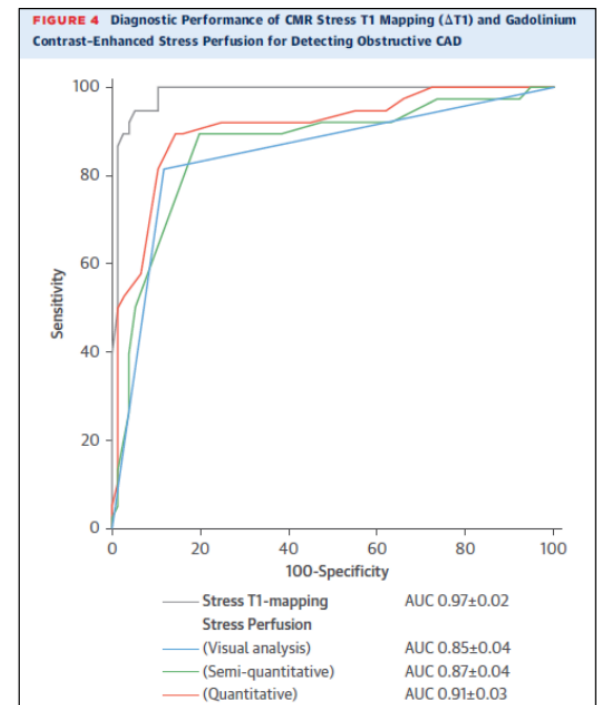
Jahnke et al Circulation 2007



Vicenti et al
JACC Cardiovasc Imaging 2017

Perspectives

- Stress T1 mapping , evaluation delta T1
- Absence d'augmentation du T1 sous stress
- Sténose epicardique
- Obstruction microvasculaire
- Sans injection de gadolinium

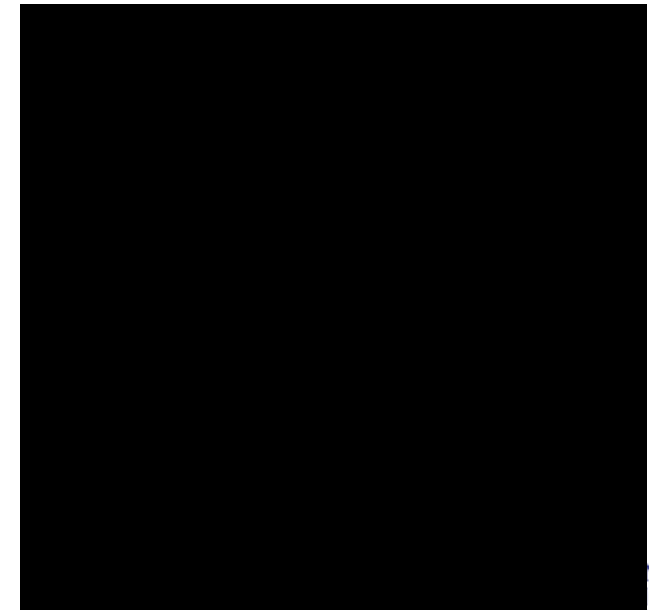
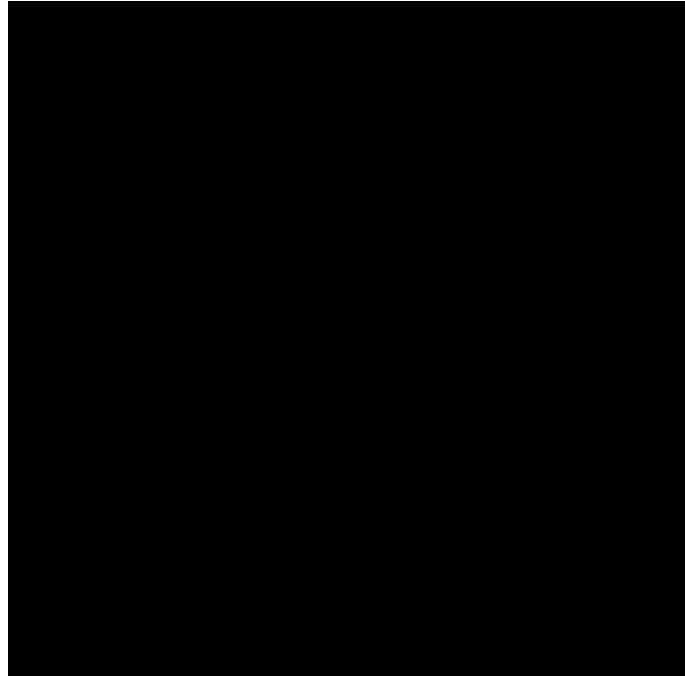
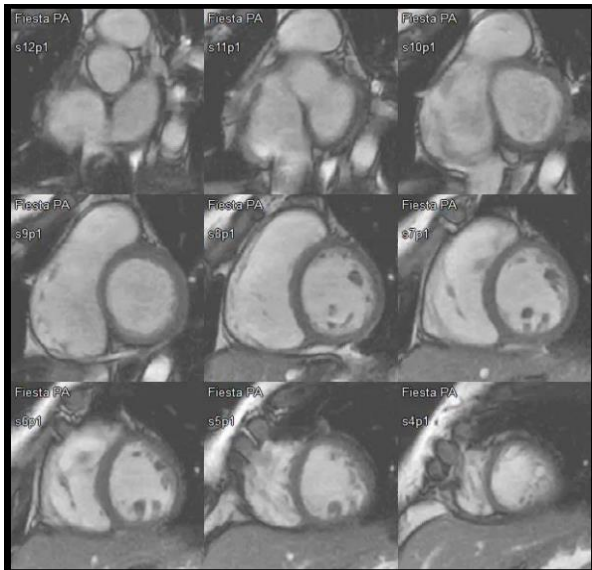


Liu et al JACC 2016

SCA

Fonction VG, cinétique

- Volume Télè D, Télè S
- FEVG FEVD
- Masse
- Epaisseur Myocardique
- Cinétique



Thrombus

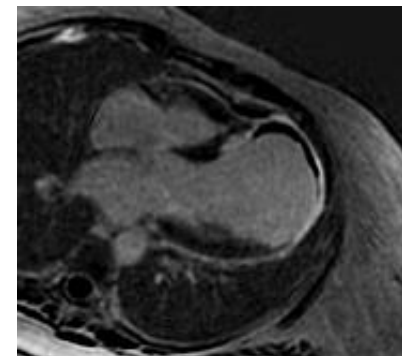
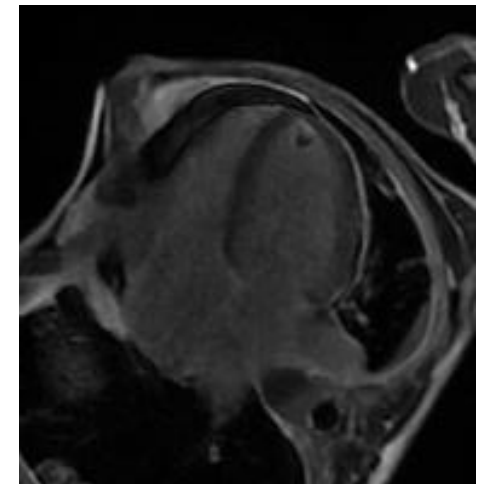
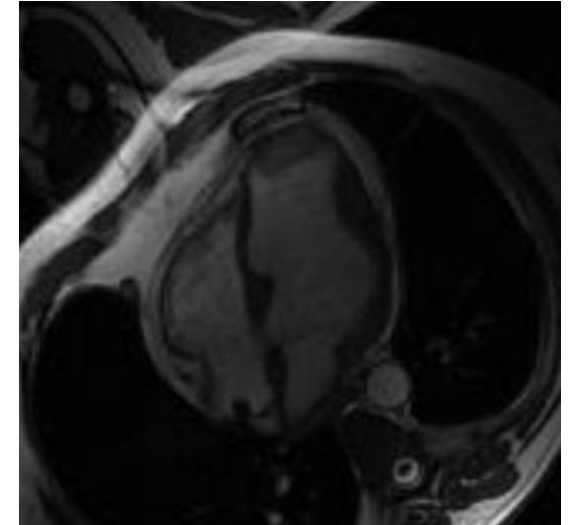
- Détection IRM

sensibilité 88% et spécificité 99%
vs 23% et 96% en ETT

Srichai MB et al, AM Heart J 2006

	Sensibilité	Spécificité
ETT	23	96
ETO	40	96
Echo de contraste	61	99

Weinsaft et al JACC Img 2009



Thrombus

- Incidence SCA ST+ 6,3%
- SCA ST + antérieur 12,2%
- SCA ST+ antérieur et FE < 50% 19,2%

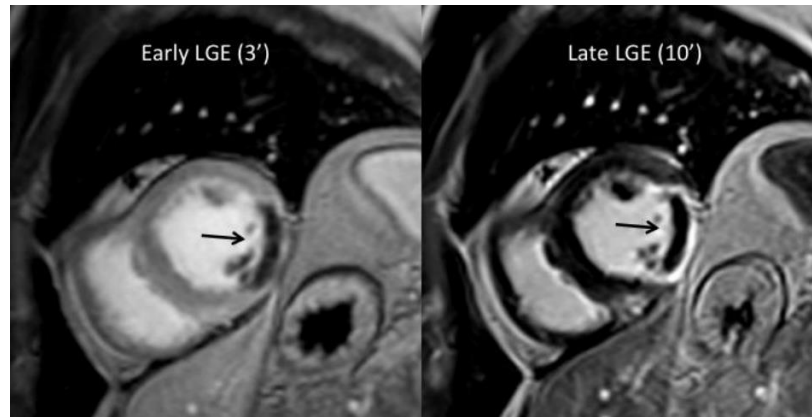
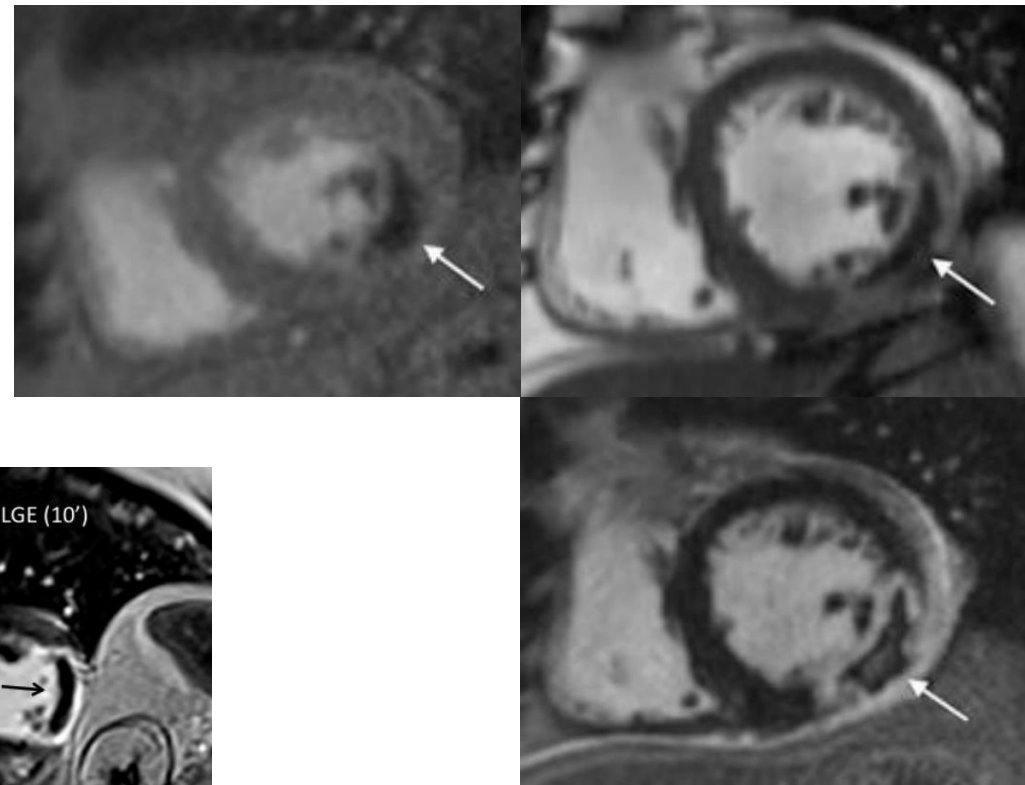
Bulluck H et al J Cardiovasc Magn Reson 2018

- Facteurs favorisants : taille infarctus, obstruction microvasculaire, absence d'angioplastie, territoire antérieur

Poss et al Circ cardiovasc imaging 2015

No reflow 50-60% STEMI

- Absence de viabilité si persistant
- Valeur pronostique



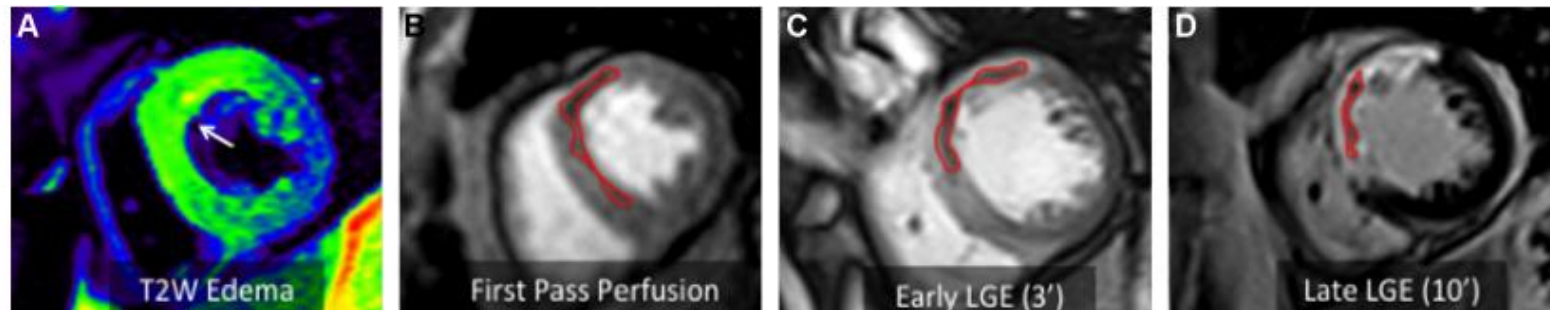
60% STEMI

Augmente la taille de l'infarctus (+40%)

Remodelage VG

Risque rythmique, IC et MS

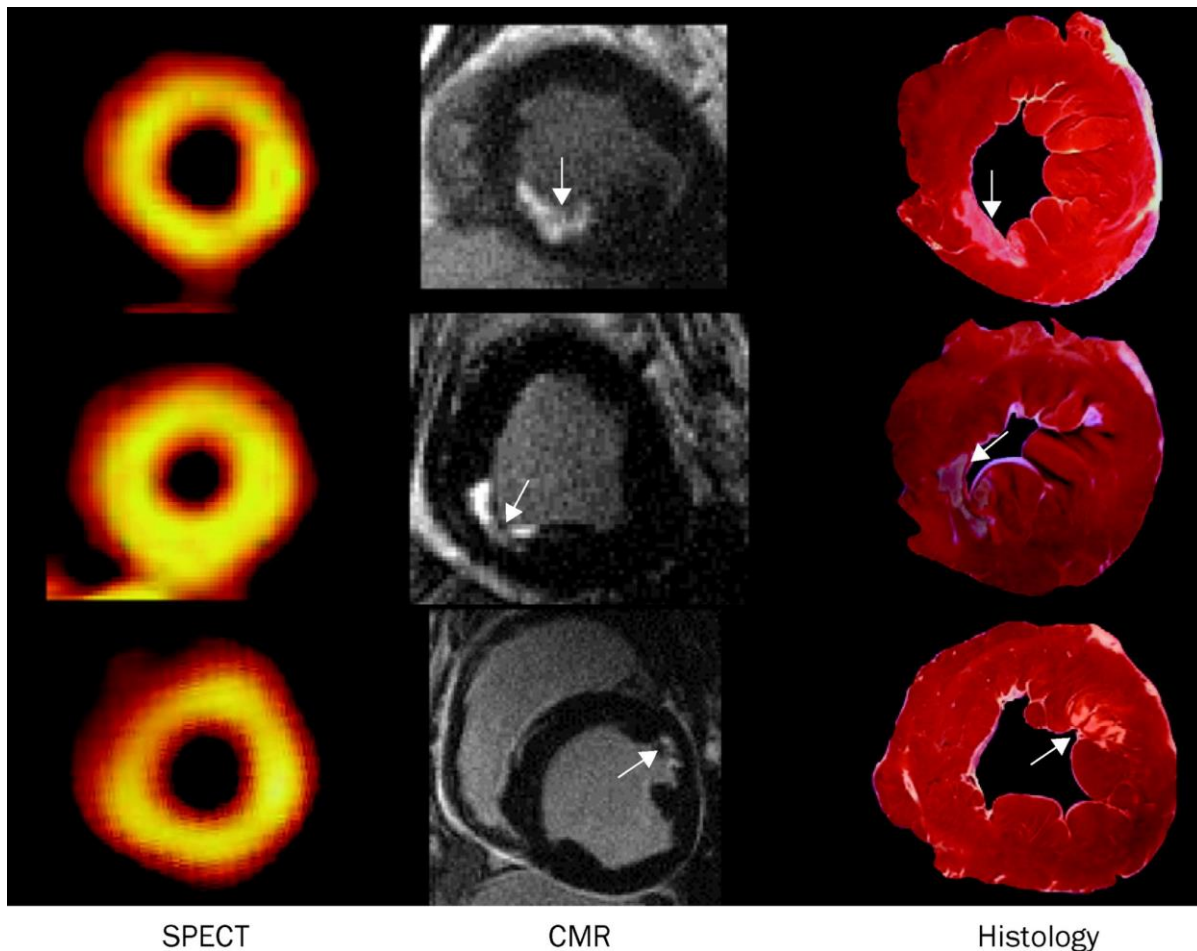
Bouleti et Al 2015 ACVD



VIABILITE

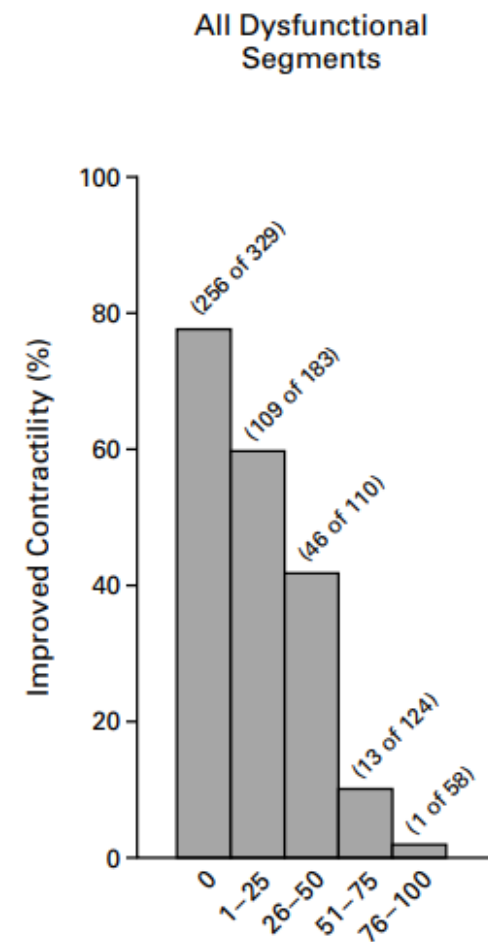
Analyse du réhaussement tardif post gadolinium

Détection séquelle de petite taille

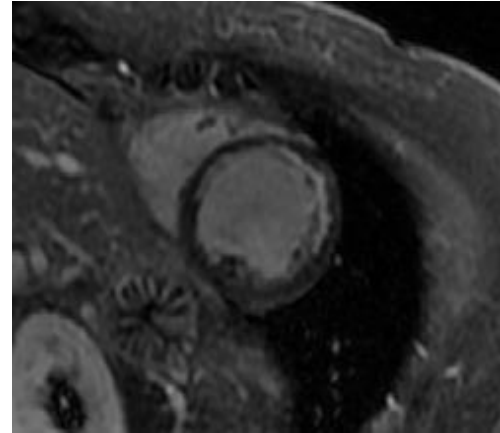
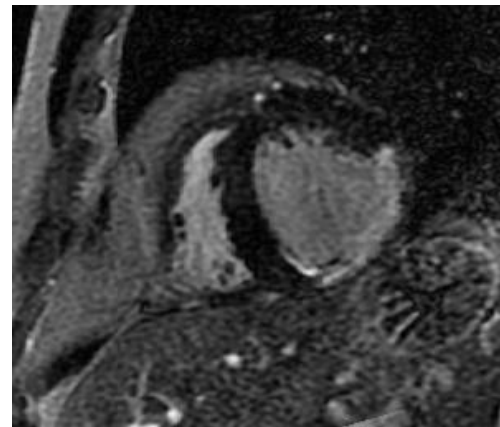
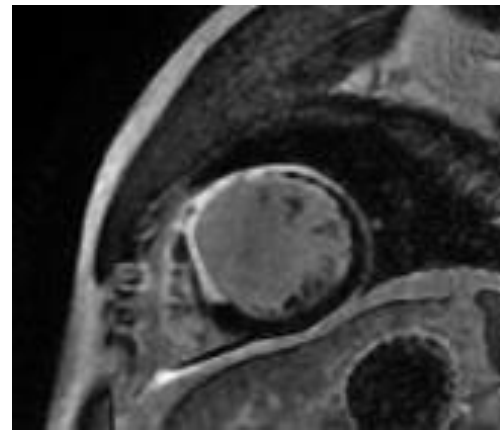
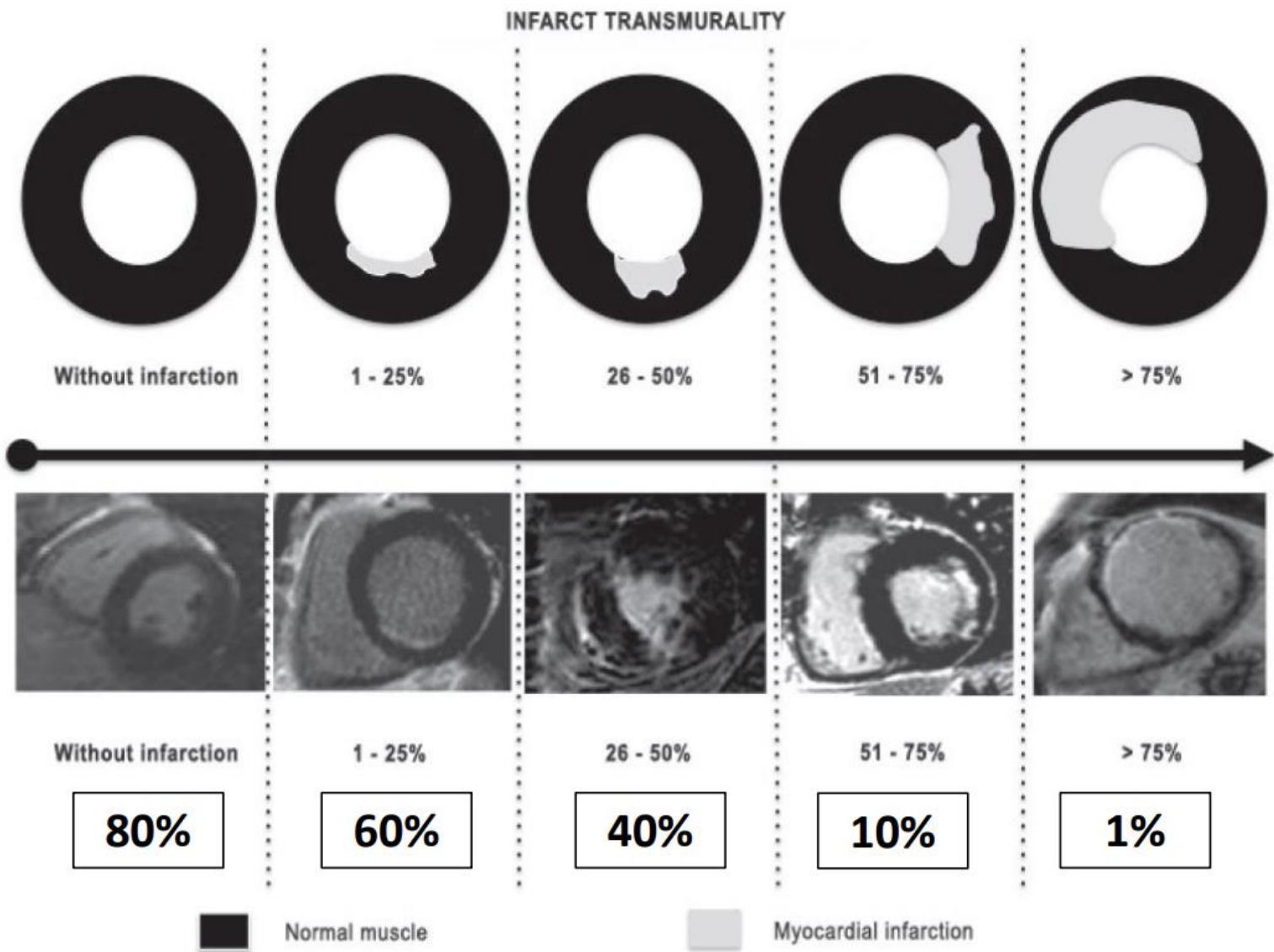


Wagner et al Lancet 2003

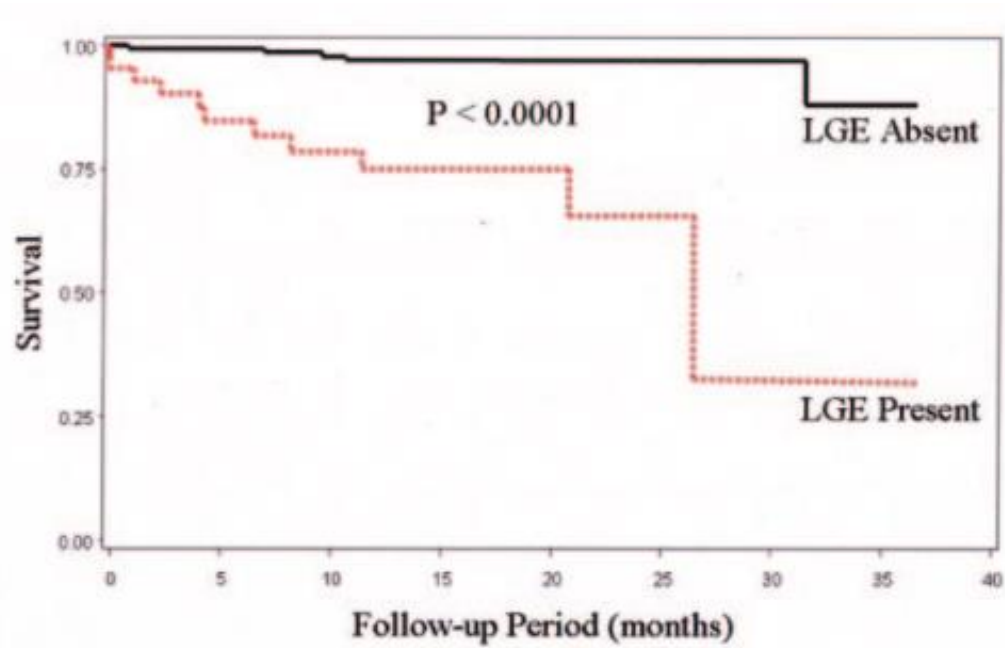
LGE > 75% non viable
 LGE < 25% viable



Kim et al NEJM 2000



Valeur pronostique du rehaussement tardif

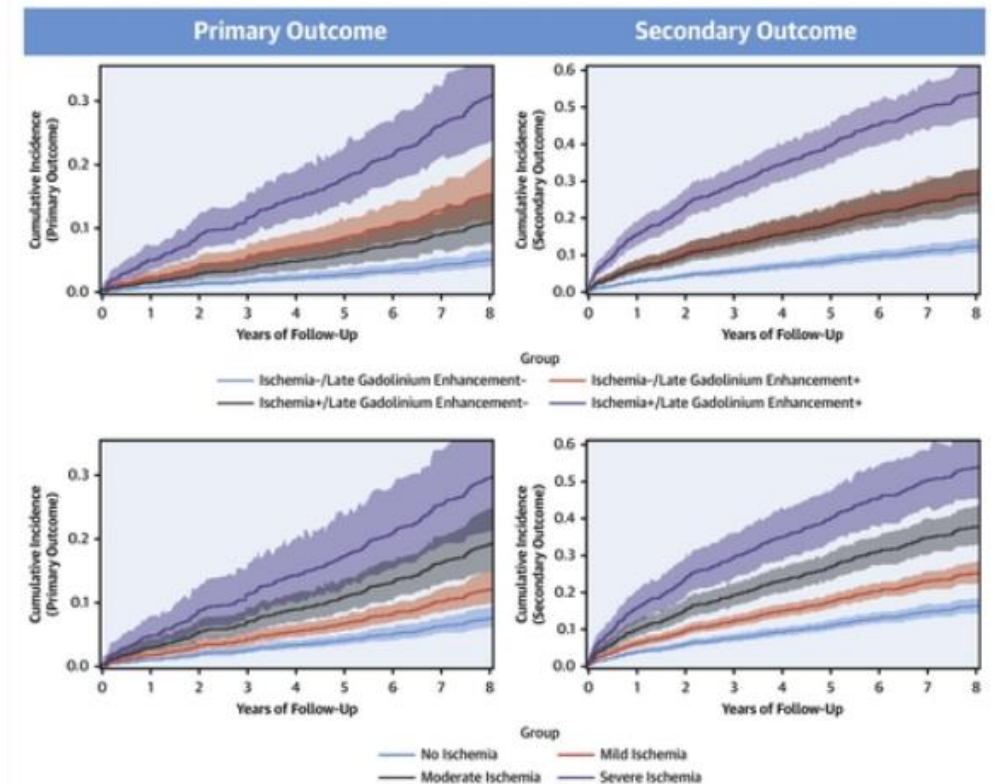


Kwong et al Circulation 2006

Etude multicentrique n= 2349

Critère principal = décès CV et MI non fatal

Critère secondaire = critère composite décès CV MI IC angor instable CABG



Kwong, R.Y. et al. J Am Coll Cardiol. 2019;74(14):1741-55.

Détection zone infarctie et zone grise periinfarctus prédictrice d'événement rythmique

Roes et Al Circ Cardiovasc Imaging 2009

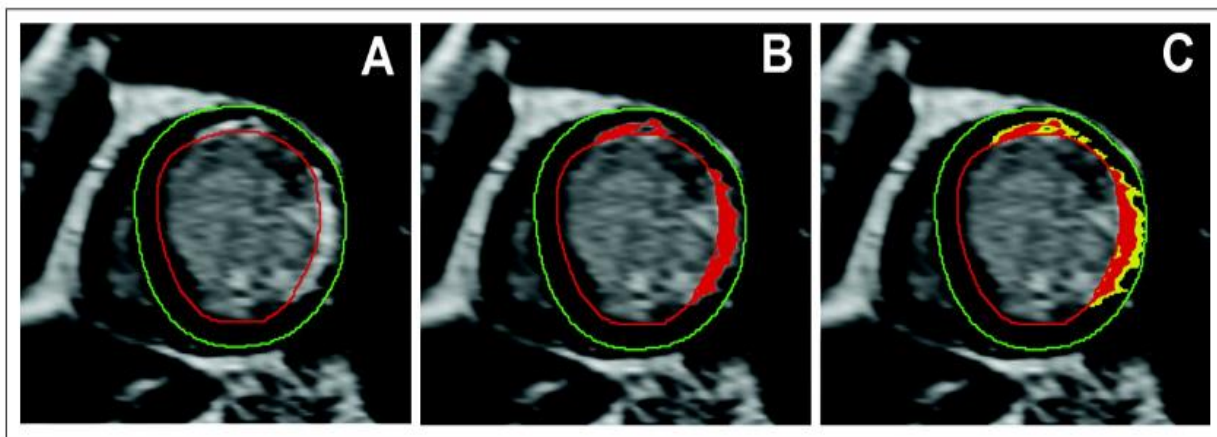
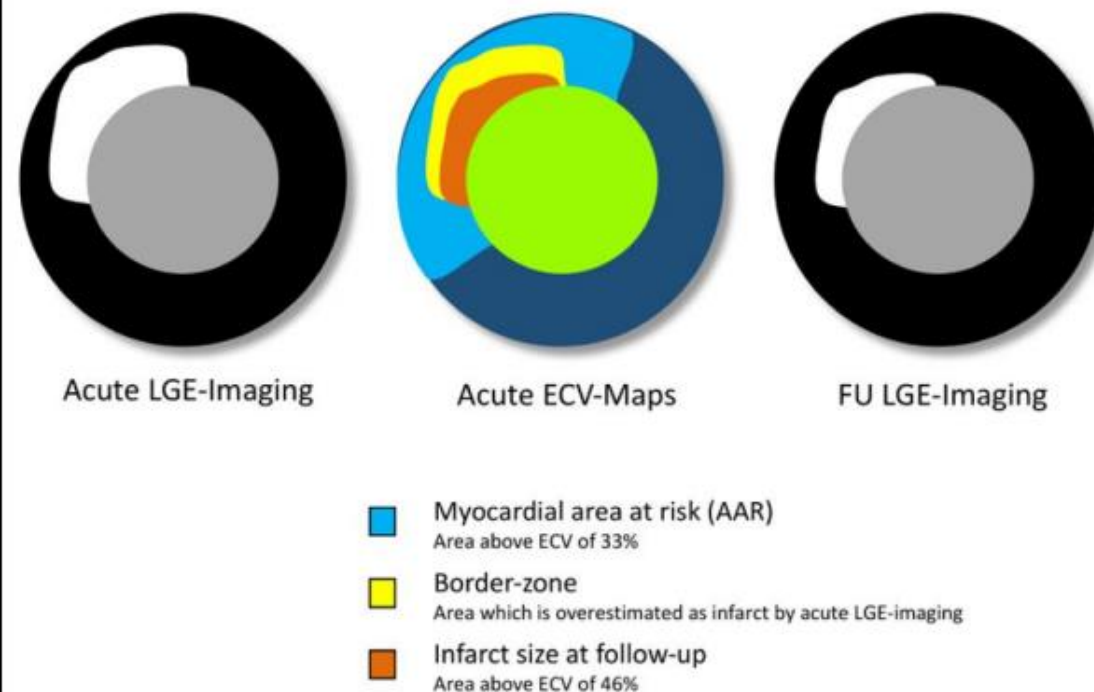
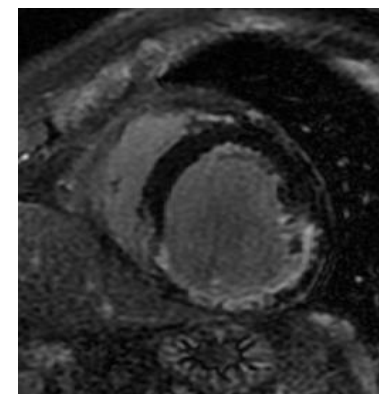
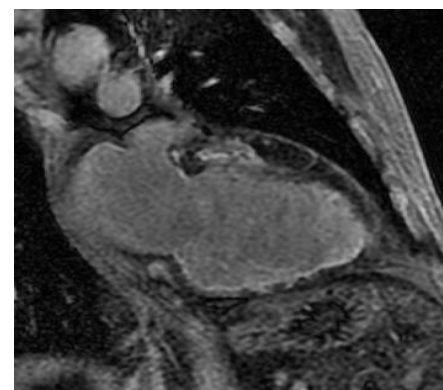
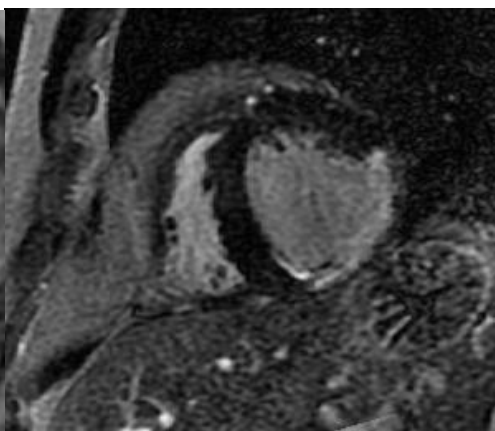
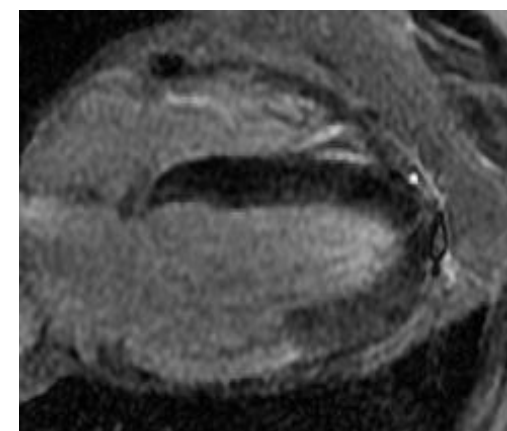
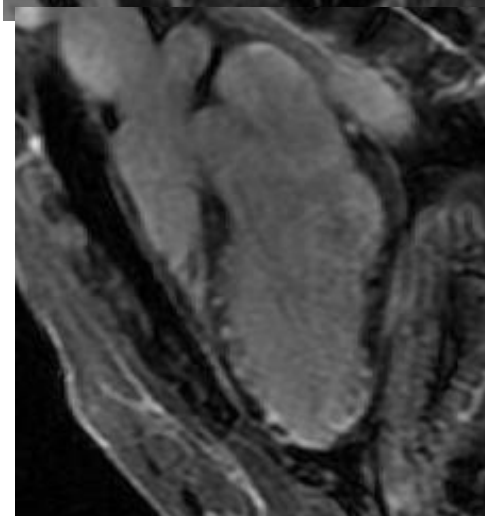
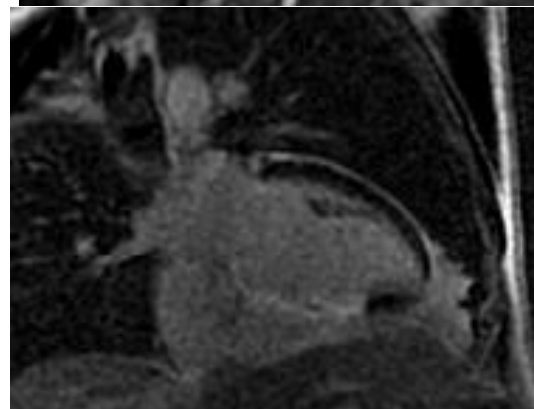
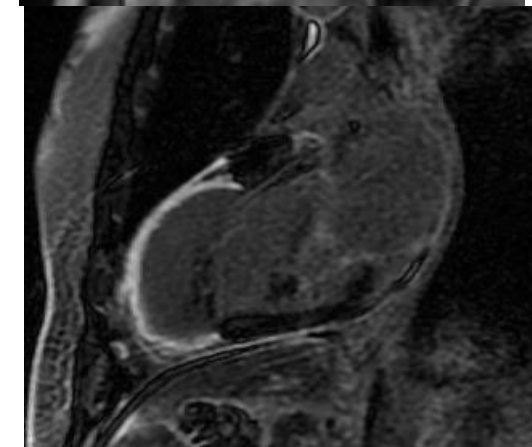
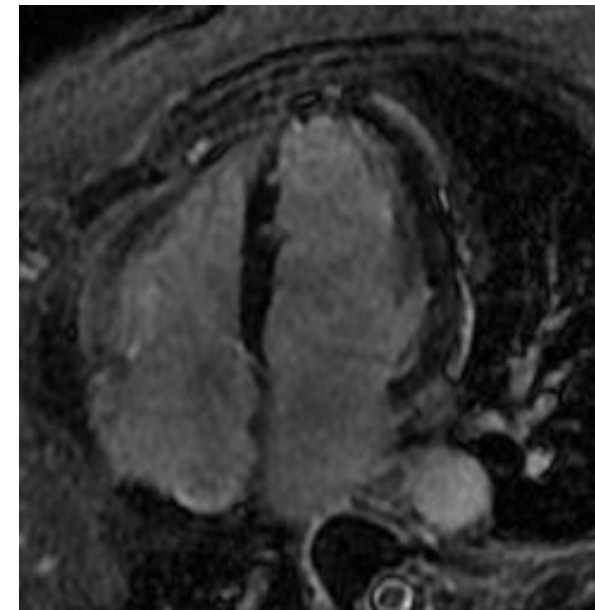
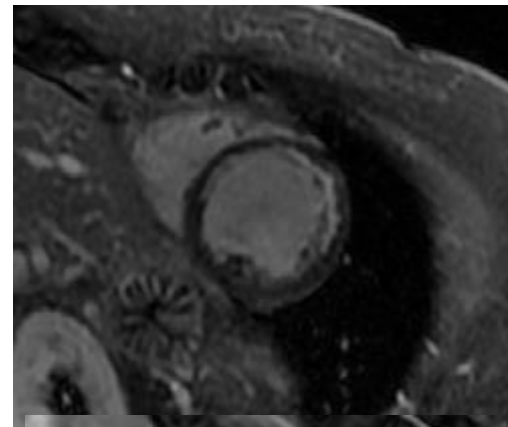
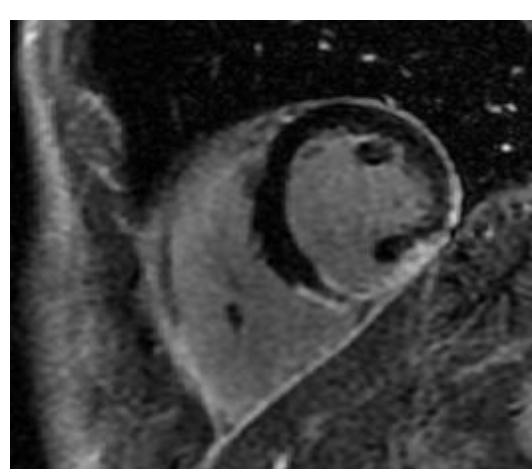
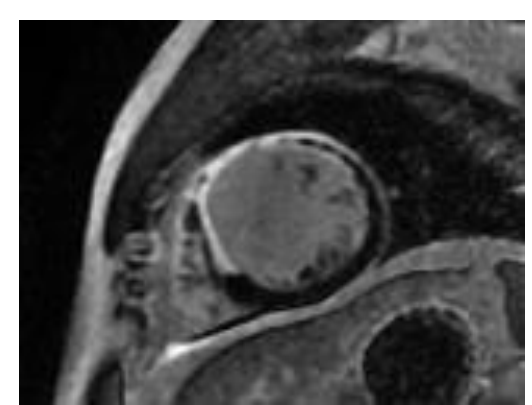


Figure 1. Assessment of the infarct gray zone: Short-axis contrast-enhanced MRI of a patient with a previous MI. A, Endocardial (red) and epicardial (green) borders were outlined manually. Subsequently, the maximum signal intensity (SI) within the infarct region was determined. B, The infarct core was defined as myocardium with SI $\geq 50\%$ of the maximum SI (red area). C, The infarct gray zone was defined as myocardium with SI $\geq 35\%$ but with SI $< 50\%$ of the maximum SI (yellow area). Summation of the infarct core and infarct gray zone yielded the total infarct size (red plus yellow area).

T1 Mapping Zone à risque evaluation ECV



Garg et Al Circ Img 2017



MINOCA

Infarctus du myocarde sans obstruction coronaire

Intérêt diagnostique de l'IRM



Souffrance myocardique

Tako Tsubo

Myocardite

Cardiopathie amyloïde CMH

Origine systémique : sepsis , EP....



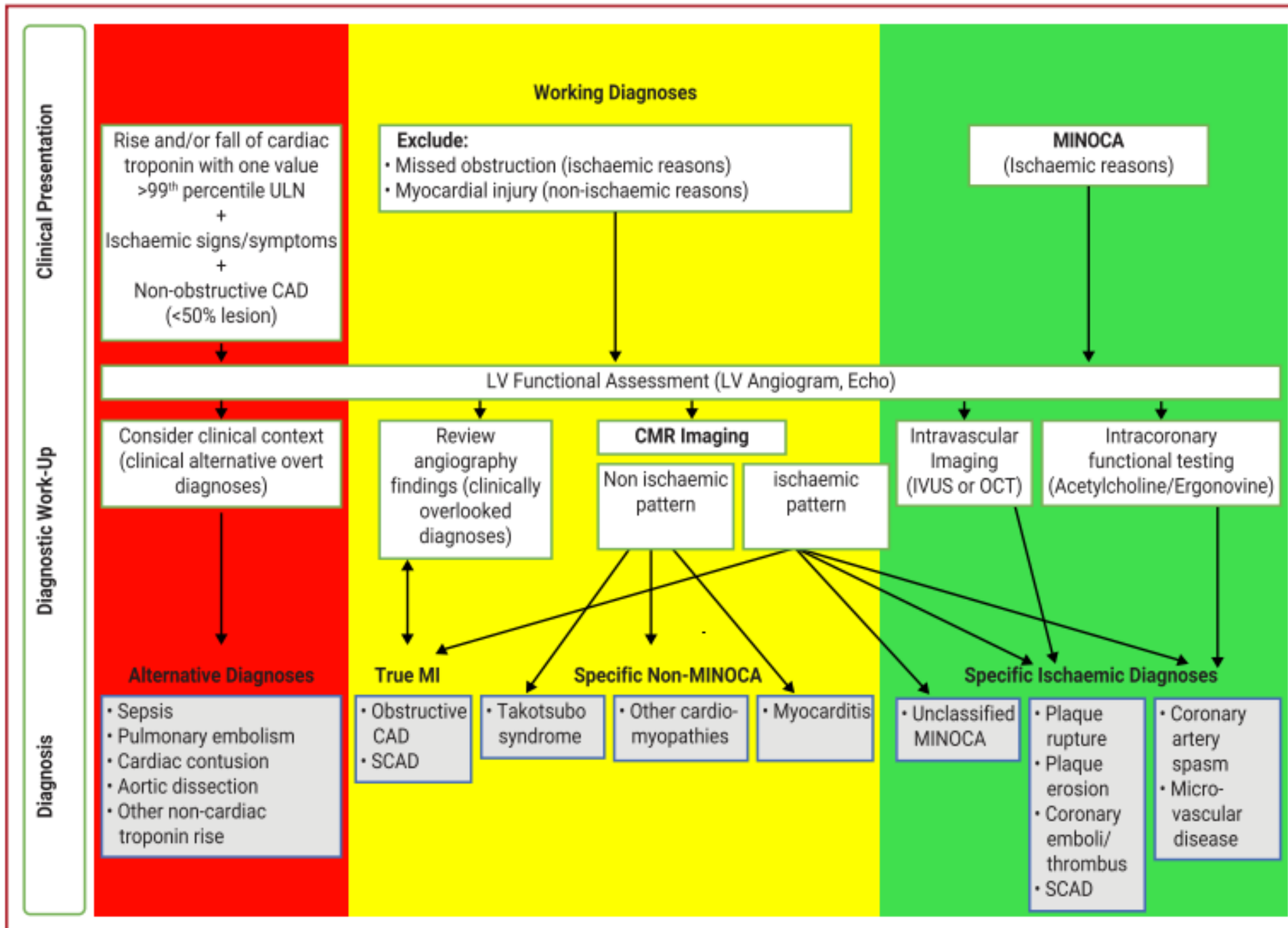
Ischémie myocardique

Spasmes

Embols coronaires

Rupture de plaque

Imagerie endocoronaire+++



ESC 2020

Recommendations for myocardial infarction with non-obstructive coronary arteries

Recommendations	Class ^a	Level ^b
In all patients with an initial working diagnosis of MINOCA, it is recommended to follow a diagnostic algorithm to differentiate true MINOCA from alternative diagnoses.	I	C
It is recommended to perform CMR in all MINOCA patients without an obvious underlying cause. ³⁷⁰	I	B
It is recommended to manage patients with an initial diagnosis of MINOCA and a final established underlying cause according to the disease-specific guidelines.	I	C
Patients with a final diagnosis of MINOCA of unknown cause may be treated according to secondary prevention guidelines for atherosclerotic disease.	IIb	C

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CMR = cardiac magnetic resonance; MINOCA = myocardial infarction with non-obstructive coronary arteries.

^aClass of recommendation.

^bLevel of evidence.

	Clné	T2	T2 Mapping	Réhaussement tardif
Infarctus	Segmentaire	Œdème (récent)	Augmenté	Sous endocardique
Myocardite	+/-segmentaire	Œdème (récent)	Augmenté	Sous épicardique Intra mural
Tako Tsubo	Hypokinesie apicale	Œdème	Augmenté	Non

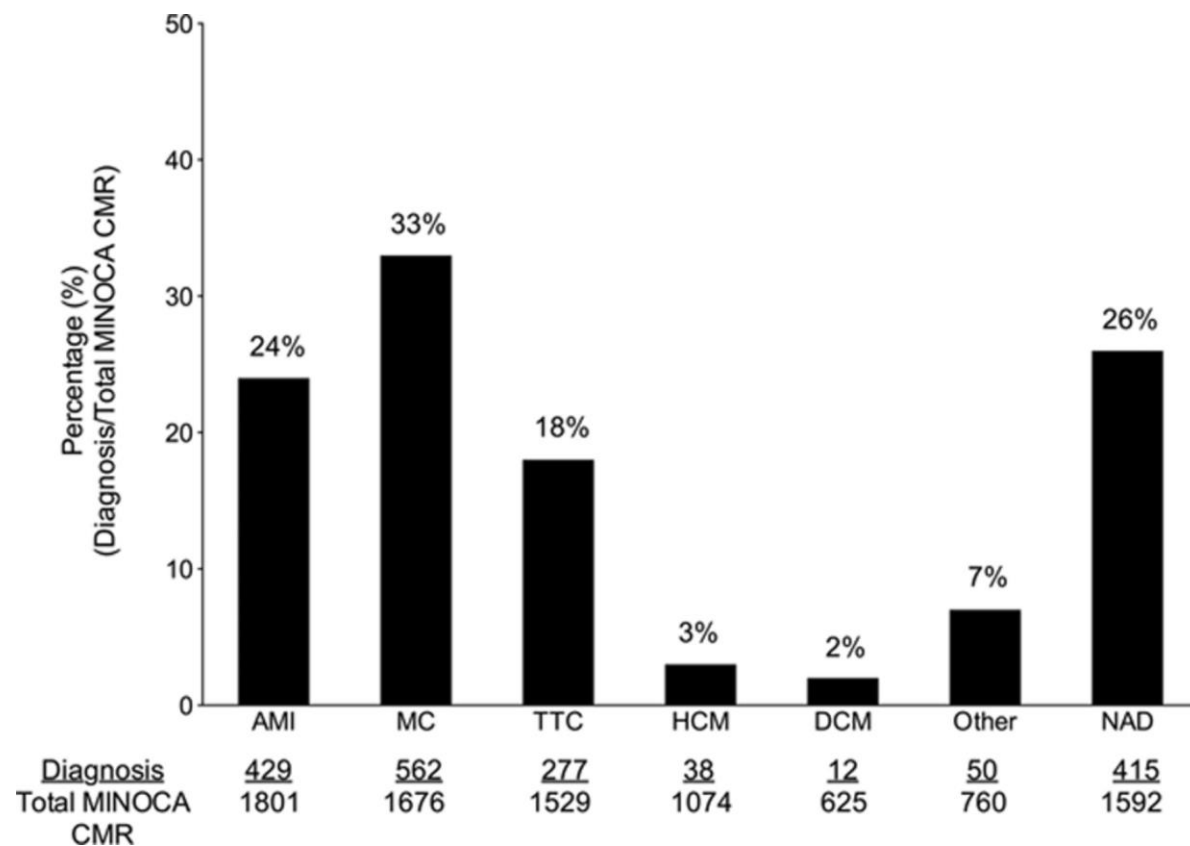
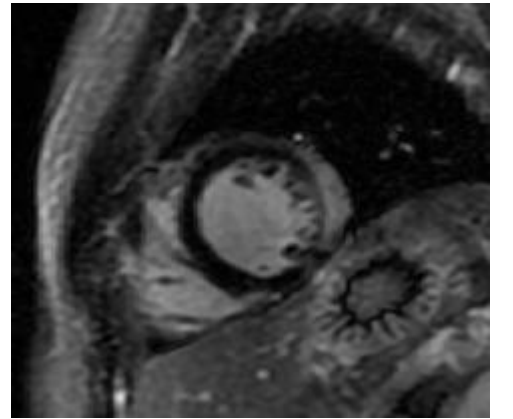
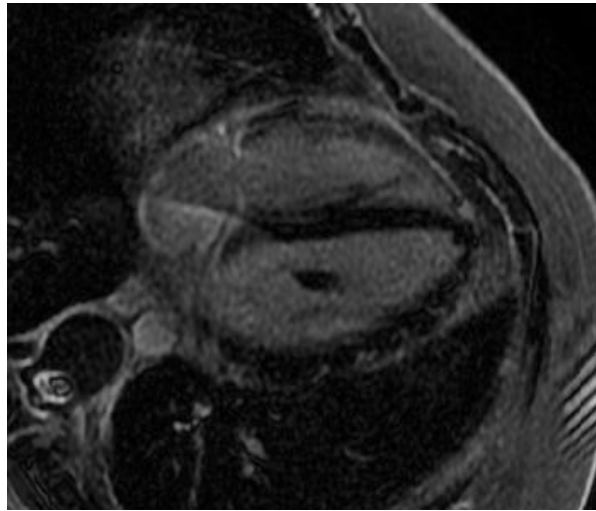
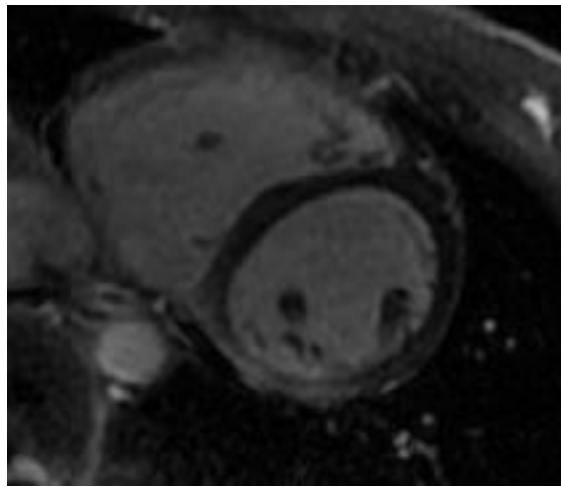
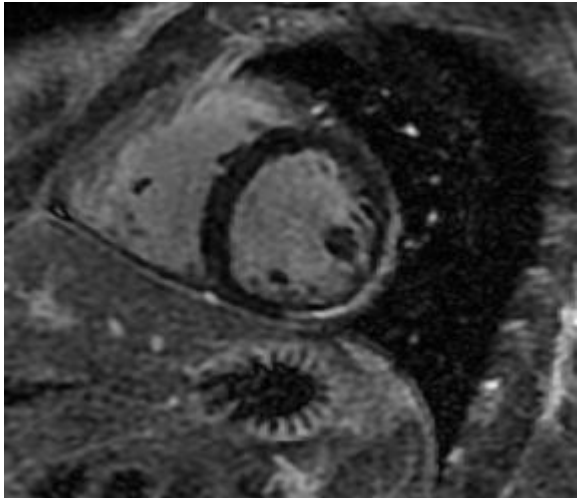
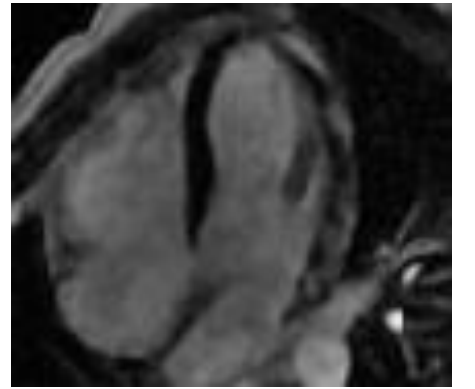
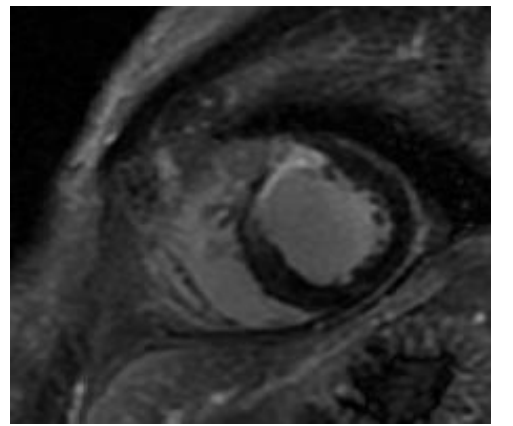
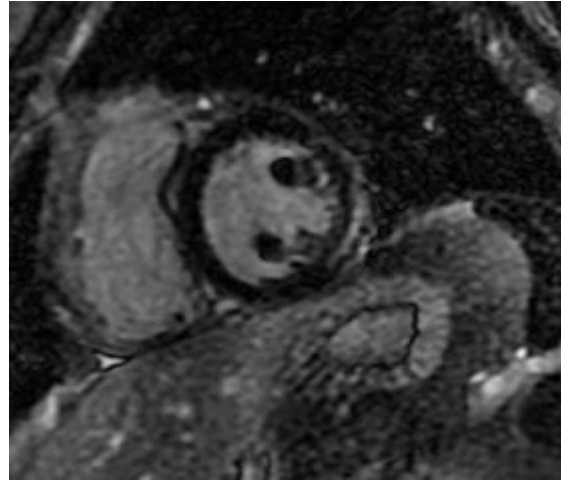
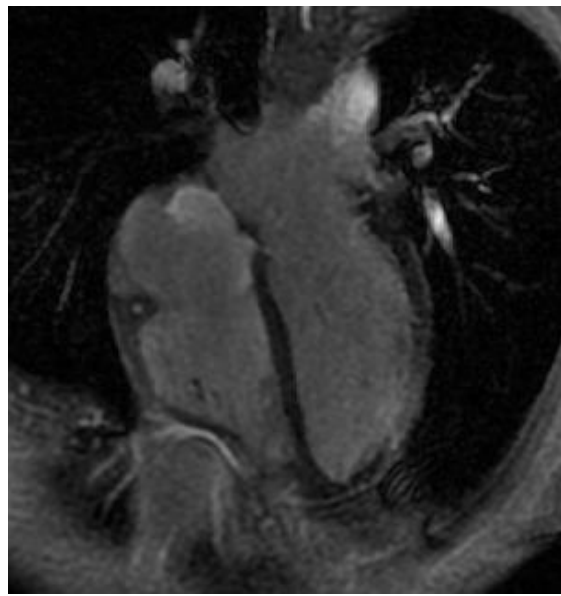
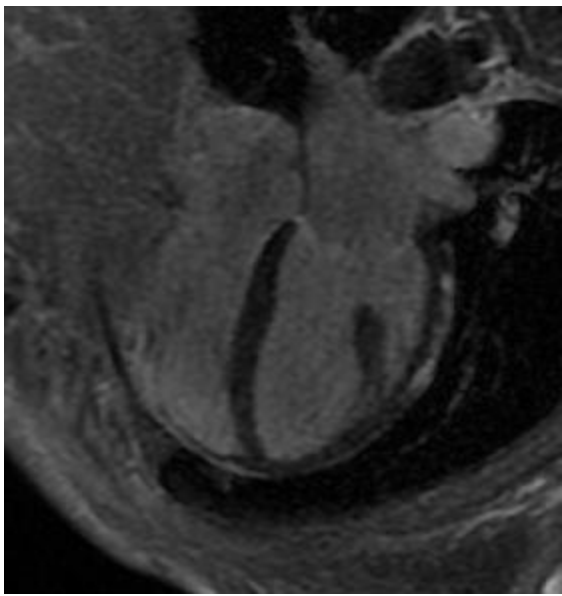


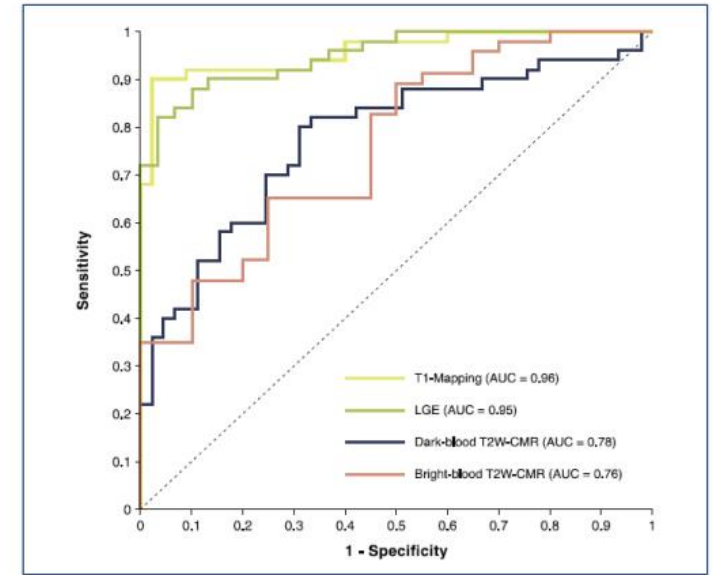
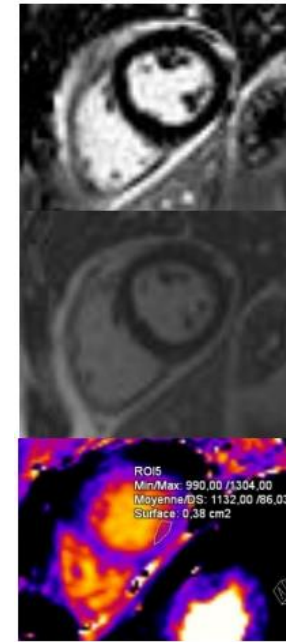
Figure 4. Cardiac magnetic resonance (CMR) imaging findings in patients with myocardial infarction with nonobstructive coronary arteries (MINOCA). Bar graph of published studies showing the diagnostic significance of CMR imaging in MINOCA patients. Data presented as percentage (%). AMI indicates acute myocardial infarction; MC, Myocarditis; TTC, Tako-tsubo cardiomyopathy; DCM, dilated cardiomyopathy; HCM, hypertrophic cardiomyopathy; and NAD, diagnosis not available.

Pasupathy S et al Circulation 2015

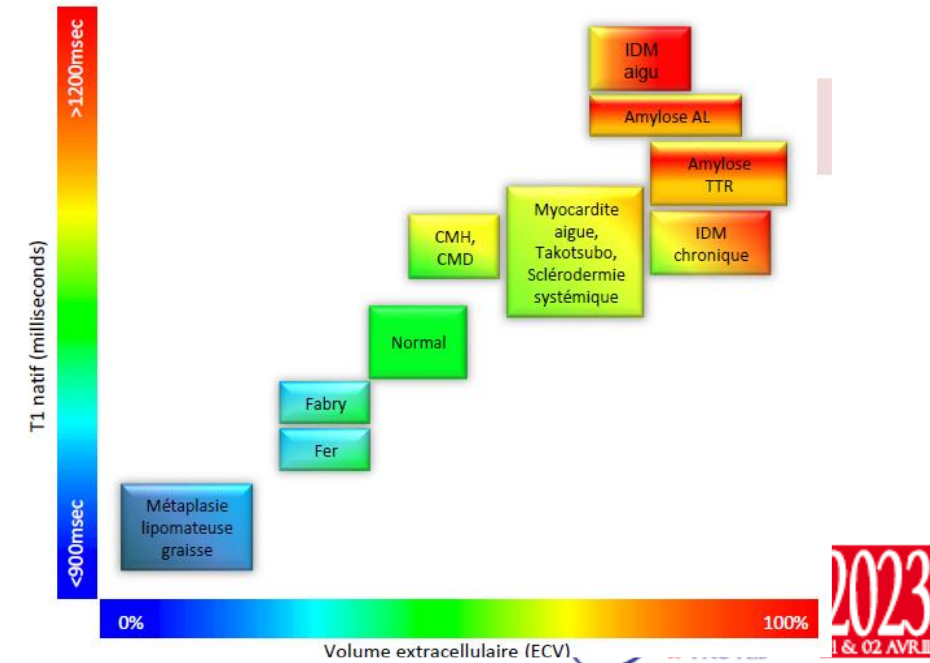
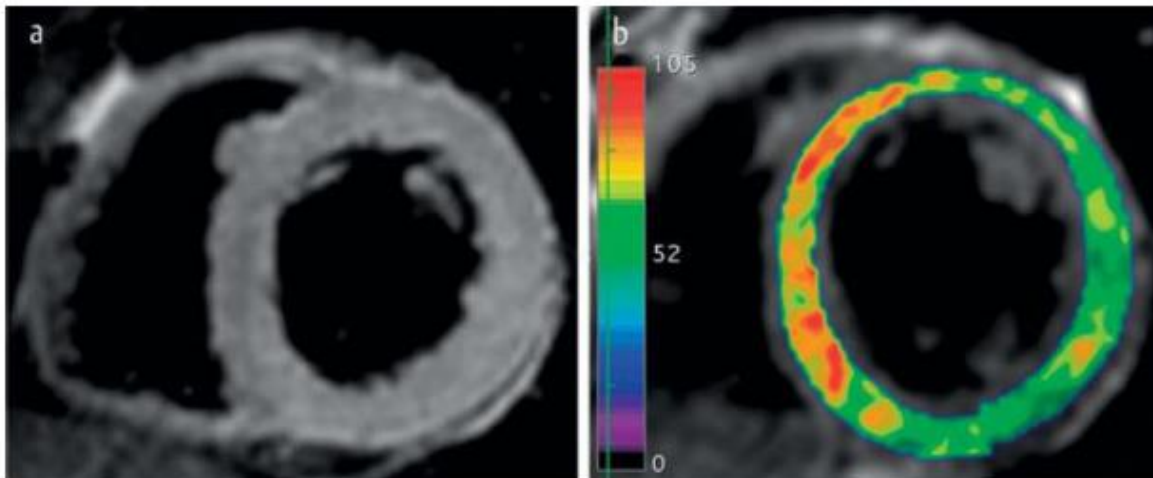


Séquences mapping

- T1 pré gadolinium
- T2 évaluation œdème intra myocardique
- T1 post gadolinium et ECV



Ferreira et al J Am Cardiol Img 2013



IRM cardiaque

- Maladie coronaire chronique : diagnostic et suivi du coronarien, évaluation FEVG
- Viabilité
- SCA : Thrombus
- Minoca

