

EVALUATION DE LA PERFUSION MYOCARDIQUE

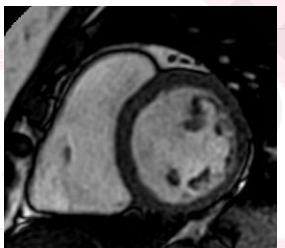
Etude de la Perfusion Myocardique en IRM

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AZARINE Arshid
Groupe Hospitalier Paris Saint-Joseph

IRM : un Examen Fonctionnel Multi-paramétrique

FONCTION

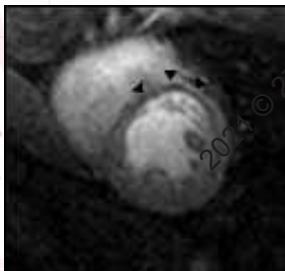


Ciné

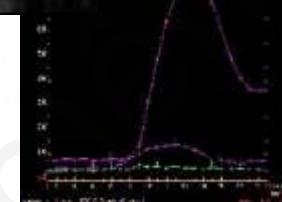


Tagging

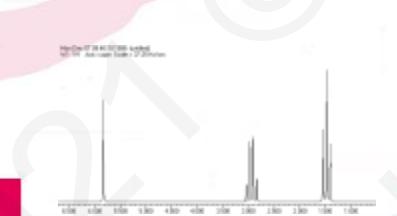
PERFUSION



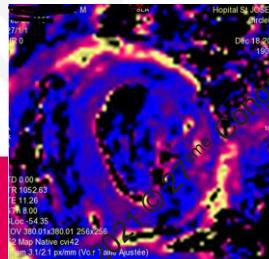
200 © 2010



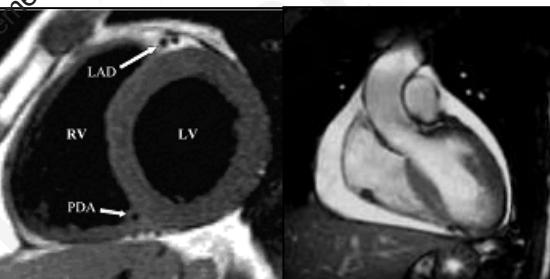
SPECTROSCOPIE



Cartographie T1 et T2



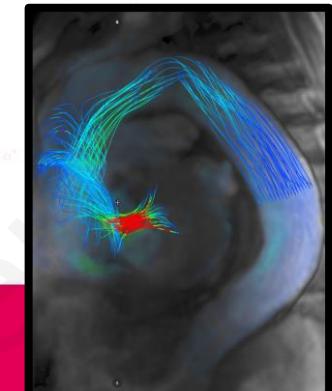
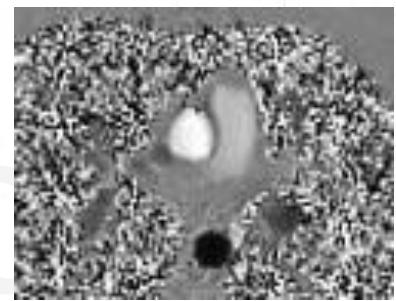
ANATOMIE



ANGIOGRAPHIE



FLUXOMÉTRIE



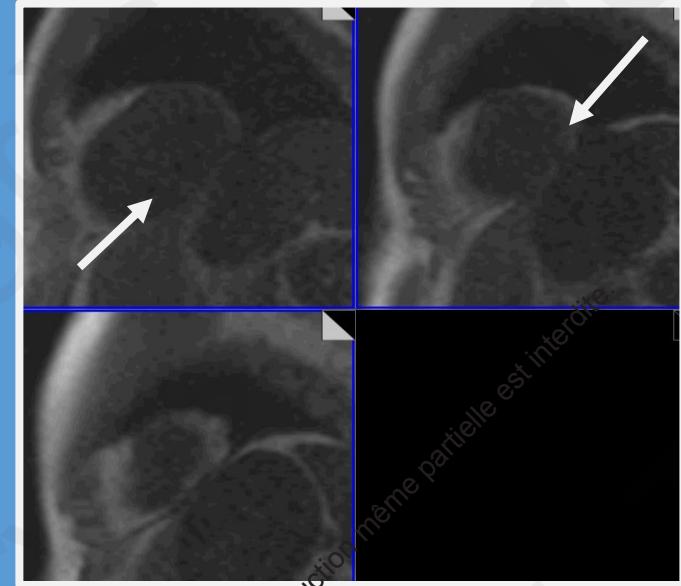
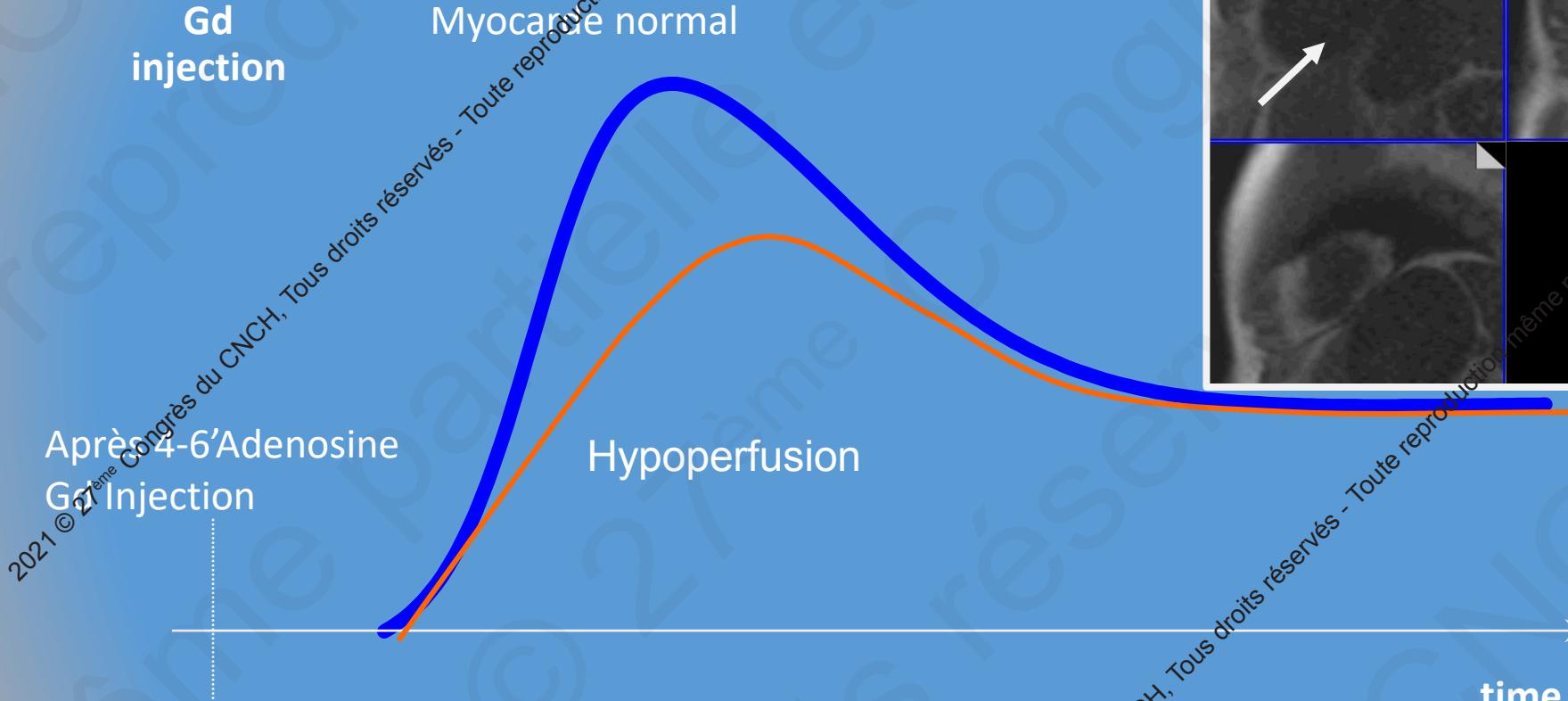
=>VIABILITÉ



Caractérisation Tissulaire

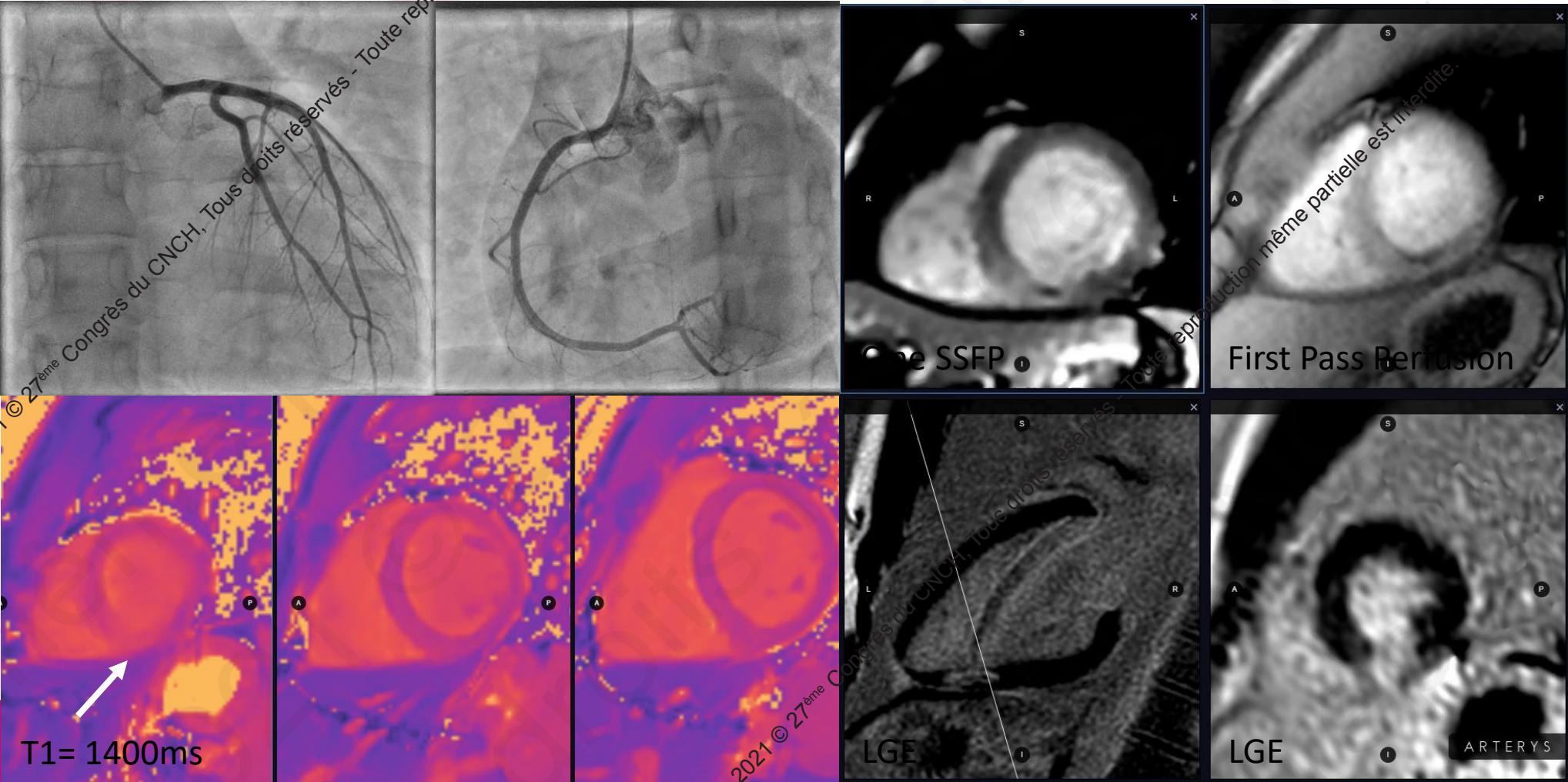
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IRM de Perfusion Myocardique

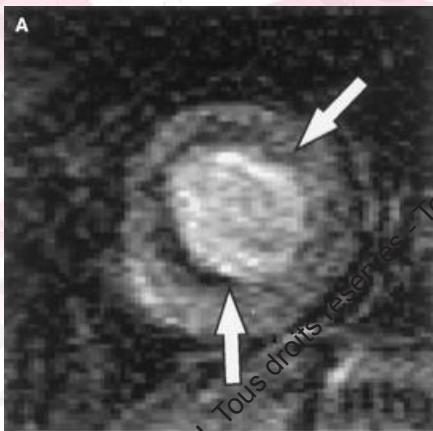


L'interprétation est qualitative: basé sur une différence de signal d'une région hypoperfusée par rapport à la zone adjacente normopérfusée

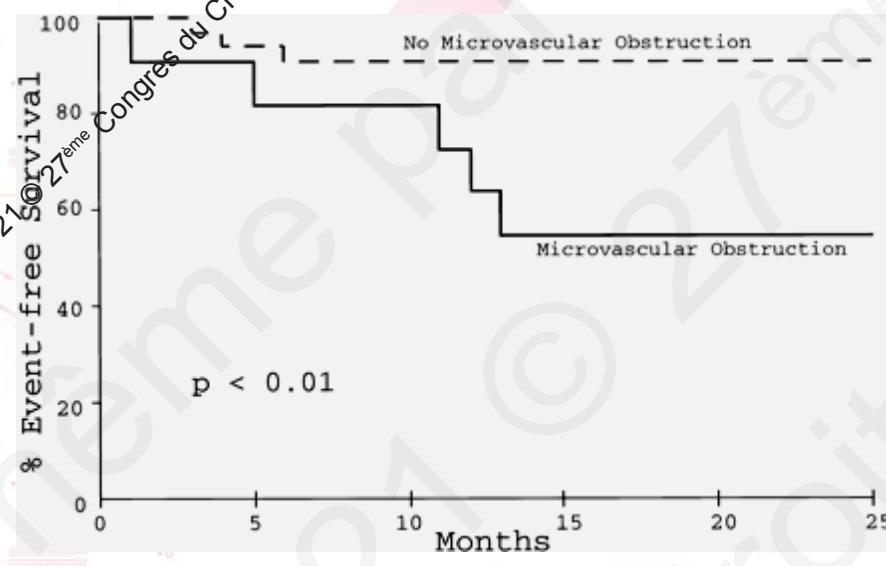
Perfusion de Repos: dans SCA
H 21 ans, SCA ST-élévation troponine à 4900.
Cannabis quotidien dont le jour de la douleur thoracique. CRP normale. Pas de contexte viral.



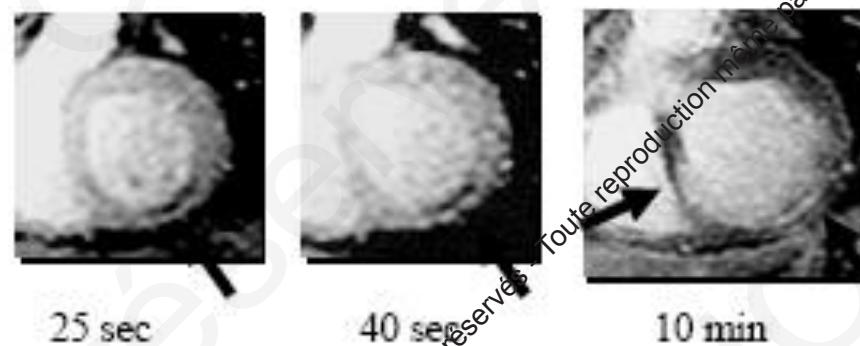
Perfusion de Repos: No Reflow? distal microcirculation Obstruction?



Ischémie longue durée
Aspect de no reflow
Obstruction
de la microcirculation distale



KC Wu, Circulation 1998; 97:765-772

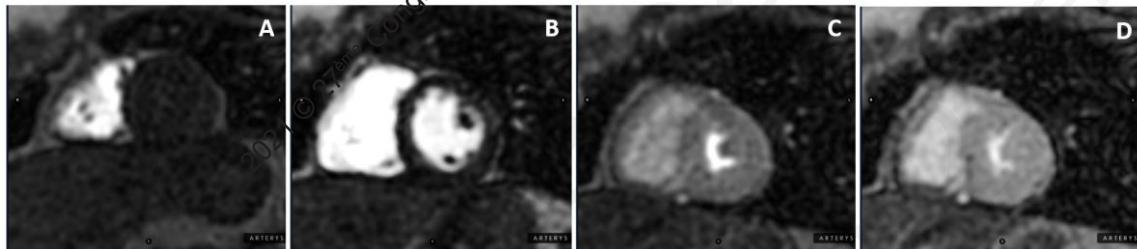


De mauvais pronostic

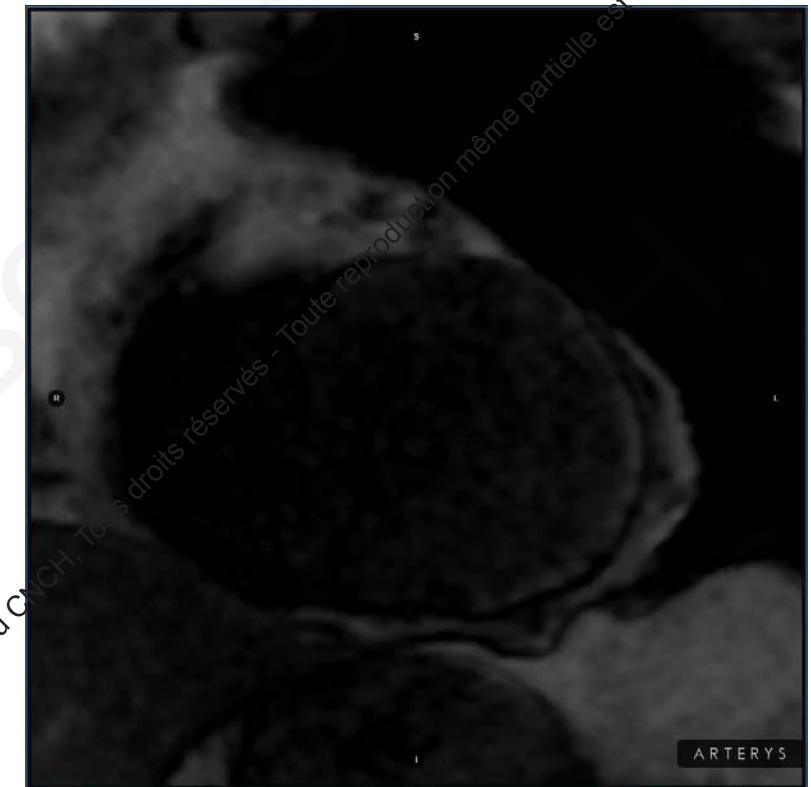
Stress Agent	Dose & infusion rate	Mechanism of action	Half-life	Comment
Dipyridamole	0,56 - 0,86 mg/kg 4 minutes infusion	Inhibition of adenosine reuptake	30 minutes	0,5-2 euros Attention Asthme! © 2021 Congrès du CNCH. Tous droits réservés - Toute reproduction même partielle est interdite.
Adenosine	140-210 mg/kg/min 3-5 minutes infusion	Activation of A ₁₋₃ receptors	<10 seconds	SE Amagnétique Attention Asthme! © 2021 Congrès du CNCH. Tous droits réservés - Toute reproduction même partielle est interdite.
Adenosine 5'-trophosphate (ATP)	160 mg/kg/min 3-5 minutes infusion	Same as adenosine	Same as Adenosine	SE Amagnétique Attention Asthme! © 2021 Congrès du CNCH. Tous droits réservés - Toute reproduction même partielle est interdite.
Regadenoson	0,4mg single bolus	Activation of A _{2A} receptor	2 – 4 minutes	120 euros

IRM de Perfusion sous Stress

Normale



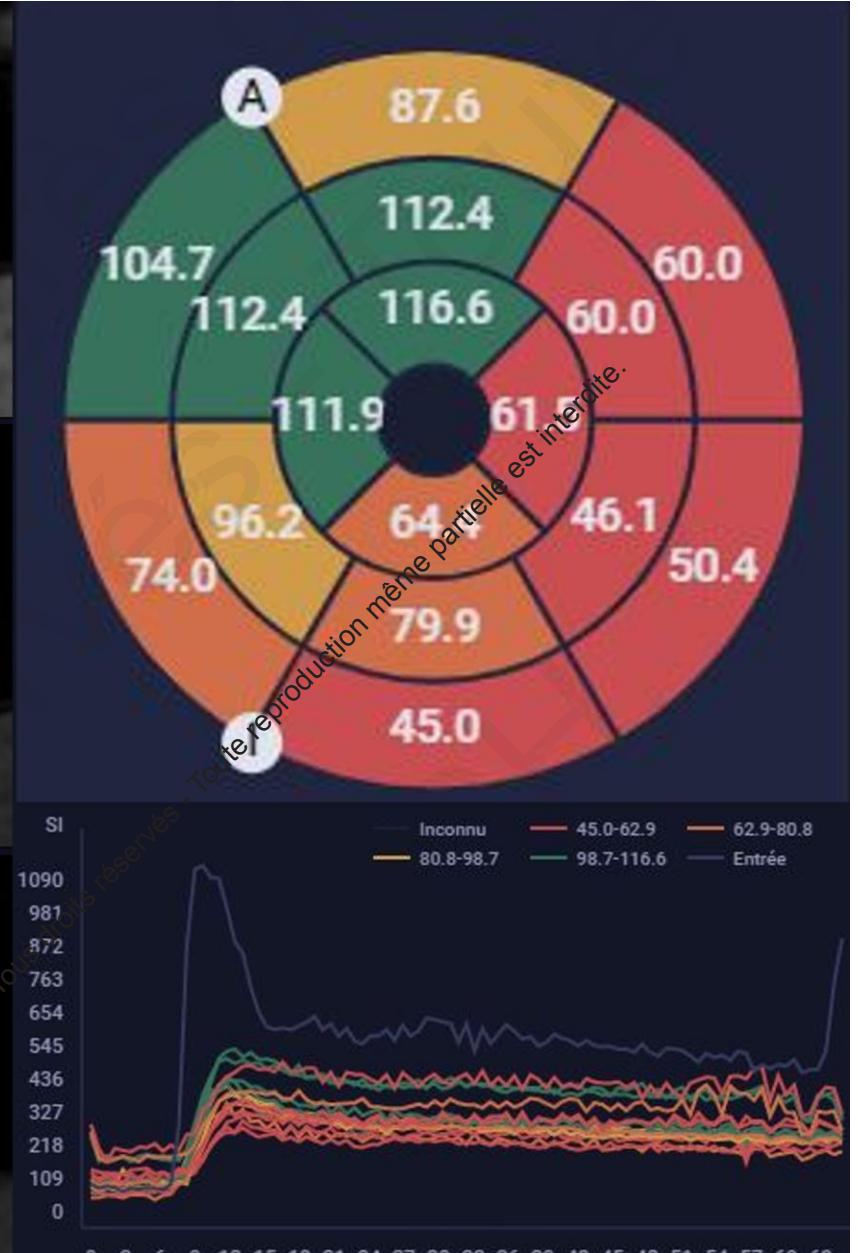
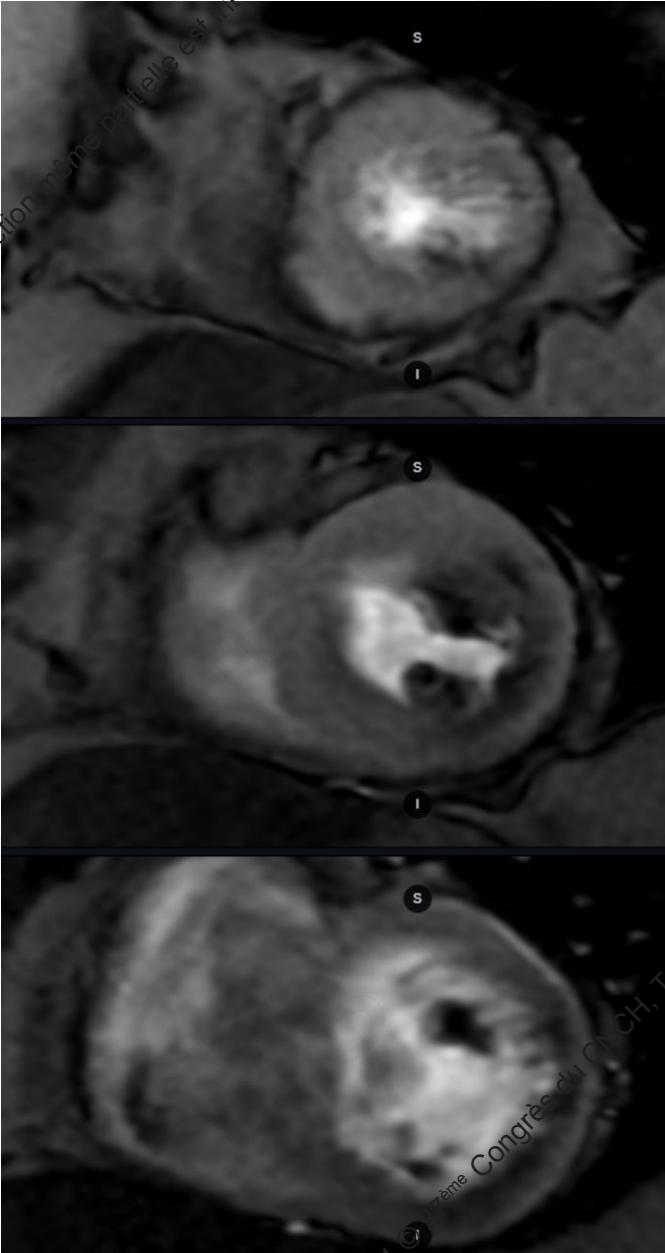
Ischémie



Retard de Perfusion ≥ 2 segments/16 = Test Positif!

Perfusion Myocardique en IRM de Stress

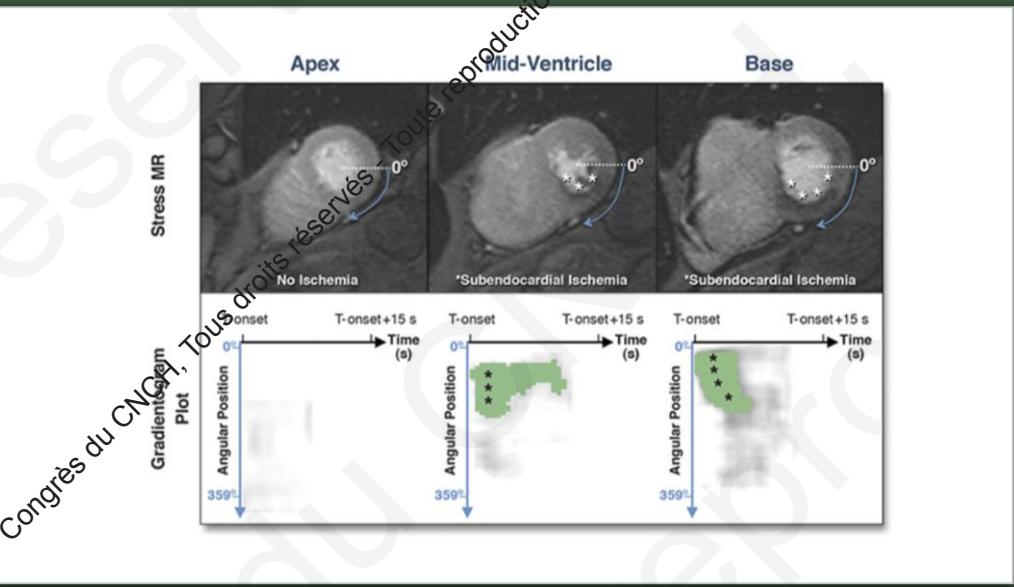
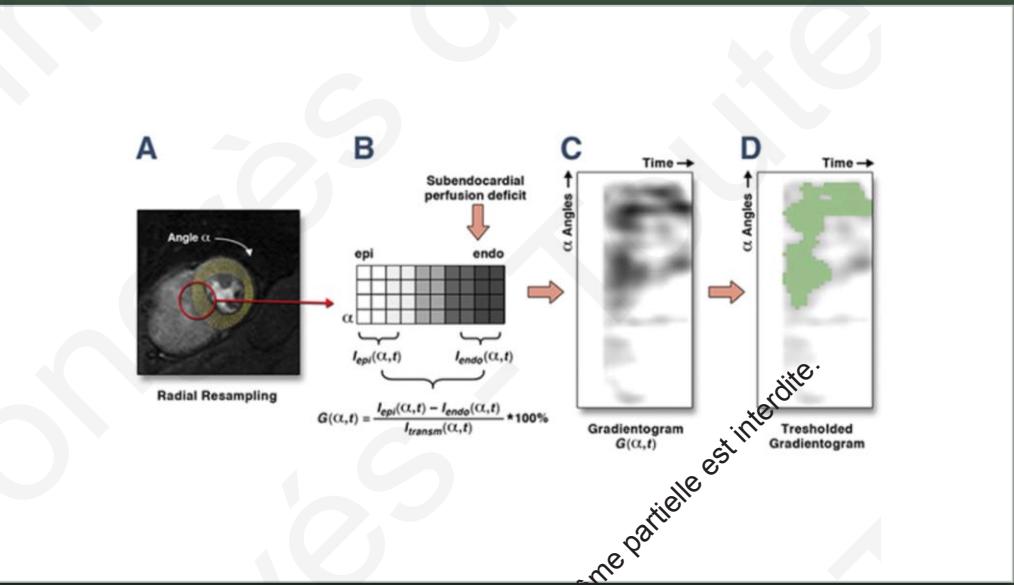
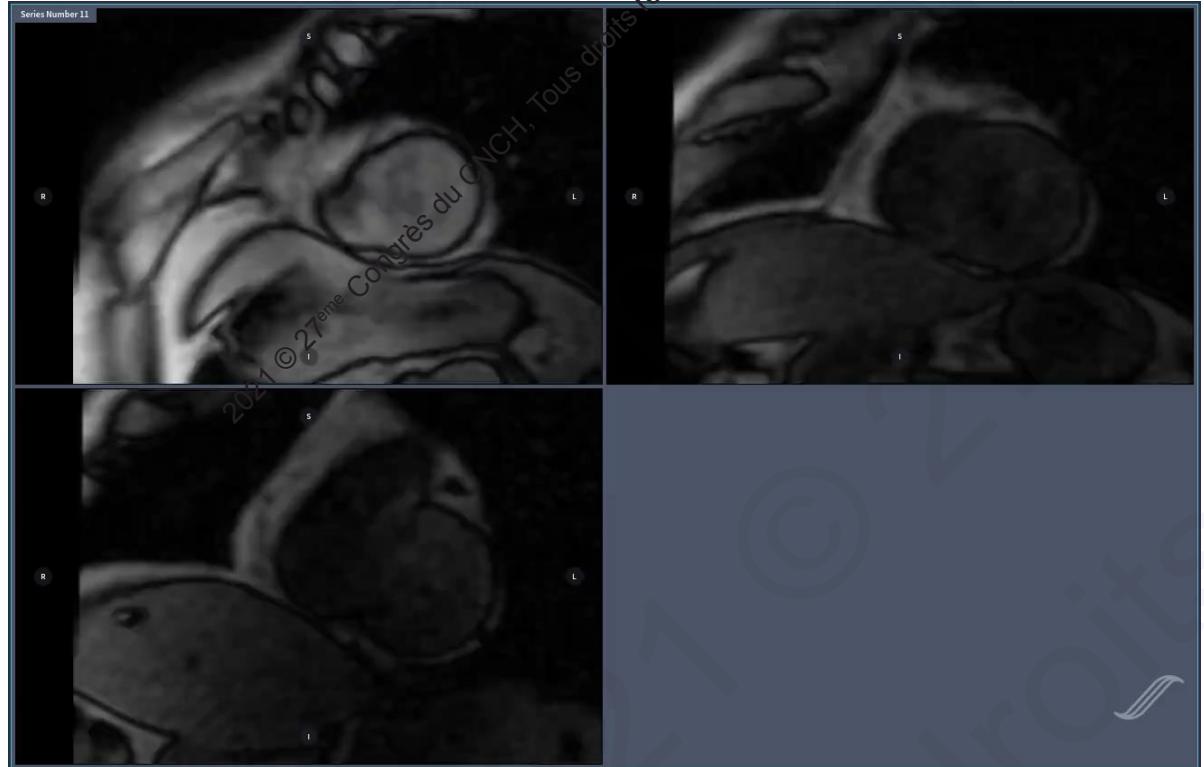
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Perfusion Quantitative « fiable »? WIP

Protocole d'acquisition et Post-traitement Complexes!

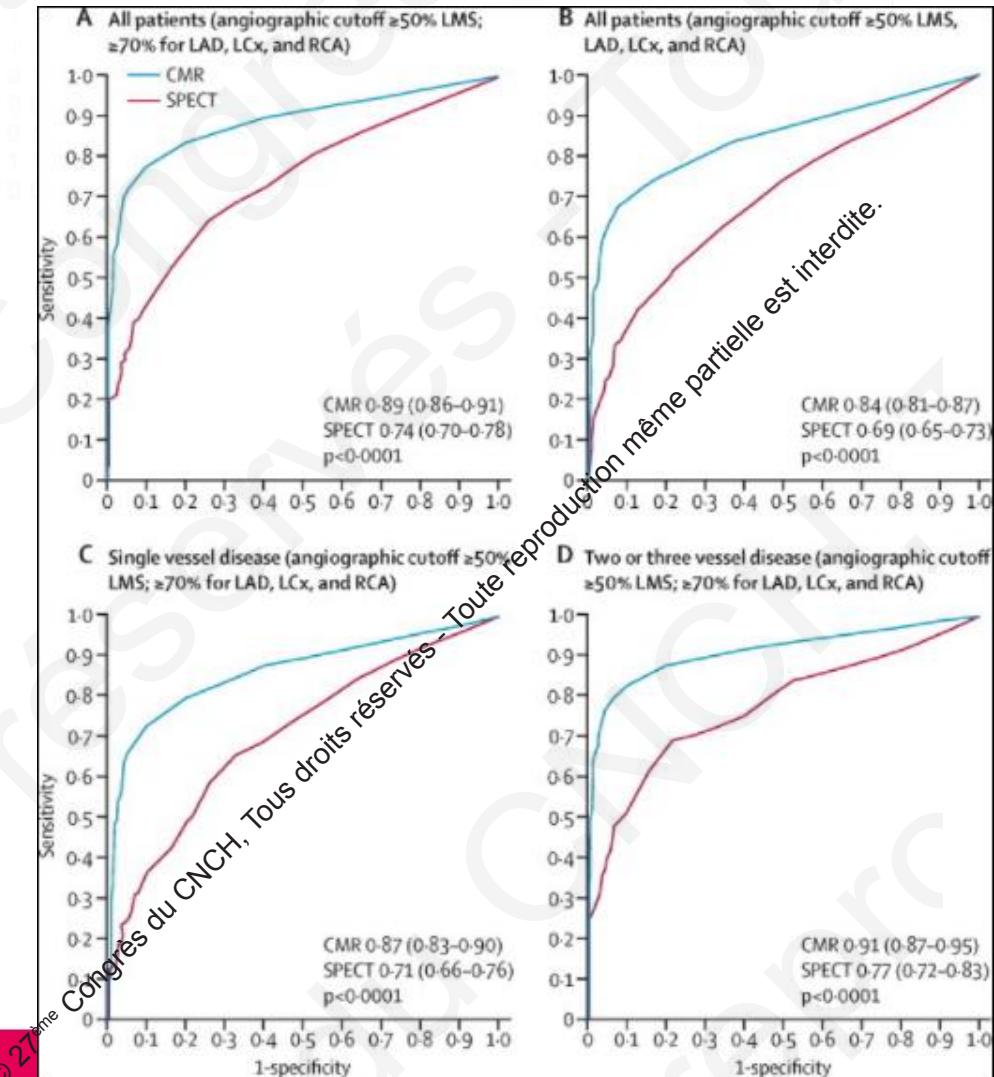
Perfusion Quantitative meilleure pour lésions tri-troncs



CE-MARC : Stress Perfusion Performances

CMR > SPECT

- 752 patients, prospective, CMR, SPECT, angiography
- Se (86,5%) & NPV (90,5%) of CMR > SPECT (66,5% & 79,1%) ($p<0.0001$)
- Gender Equality with Stress CMR!
 - Lower sensitivity in women of SPECT: 51%
 - Versus Stress CMR 89%



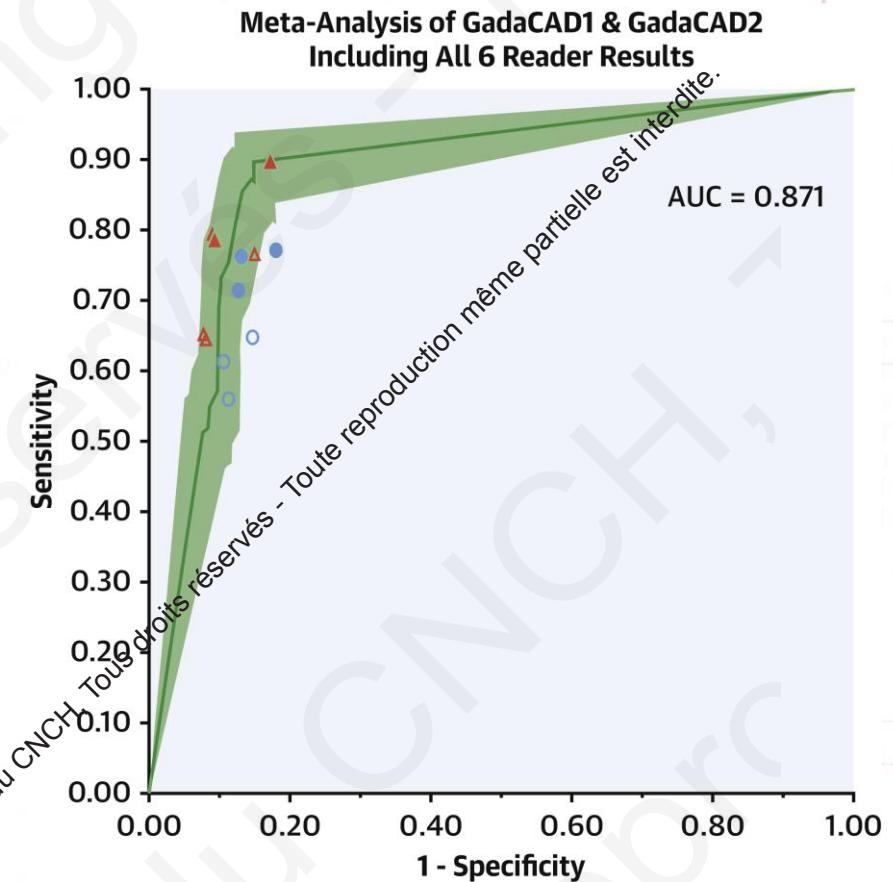
Greenwood JP et al. (CE-MARC): Lancet. 2012

GadaCad: Gadobutro-Enhanced CMR to detect Coronary Artery Disease Trial

	Sensibilité	Spécificité
Single vessel	79%	87%
Multi-vessel	87%	73%

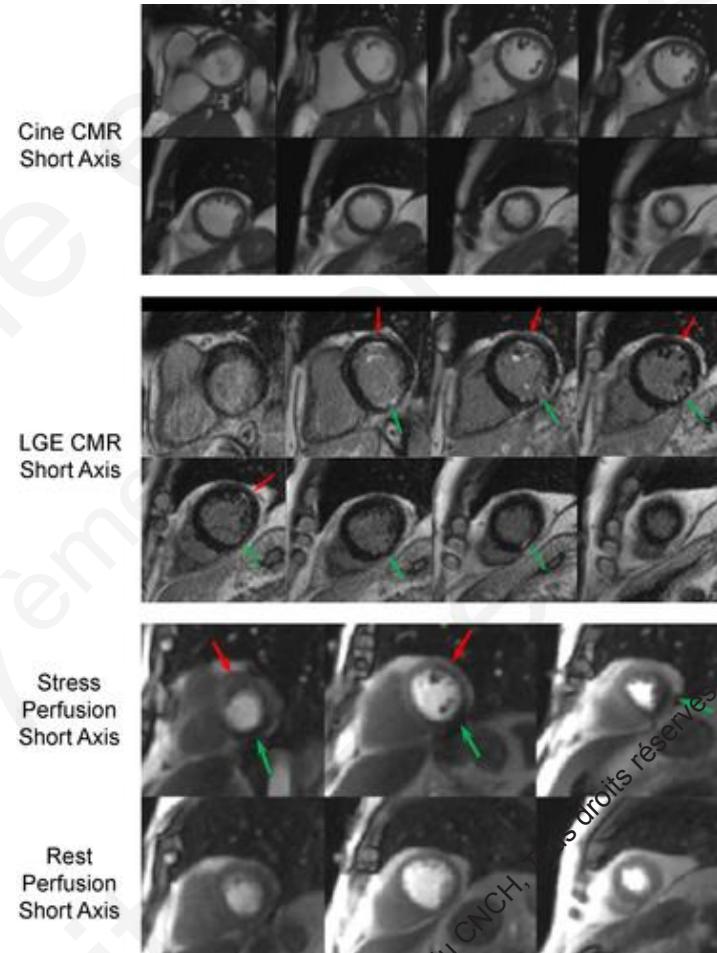
ARAI et al. *J Am Coll Cardiol.* 2020 Sep, 76 (13) 1536–1547

• Stress Perfusion CMR Vs QCA stenosis >70%



Protocole IRM de Stress: Perfusion+Fonction+Nécrose

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ARAI et al. J Am Coll Cardiol. 2020 Sep, 76
(13) 1536–1547

CMR Image Acquisition

Cine short axis

Rest Real-Cine x 3

Vasodilator Stress
Adenosine or
Regadenoson

Stress Real-Cine

Stress Perfusion
0.05 mmol/kg
gadobutrol

Cine long axis

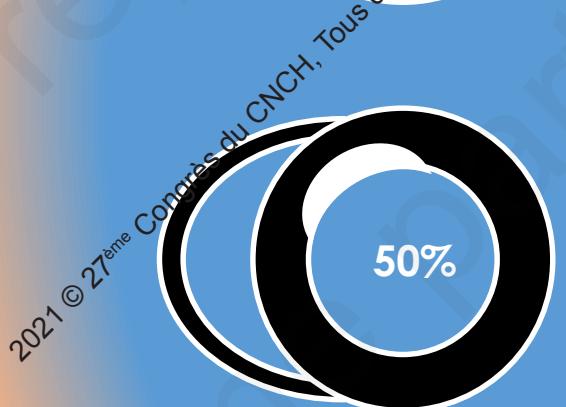
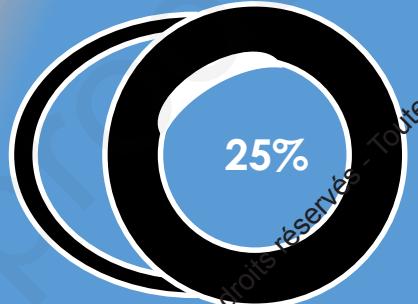
Rest Perfusion
0.05 mmol/kg
gadobutrol

Single Shot LGE
Magnitude reconstruction &
Phase sensitive reconstruction

High resolution LGE
Magnitude reconstruction &
Phase sensitive reconstruction

Delayed enhancement

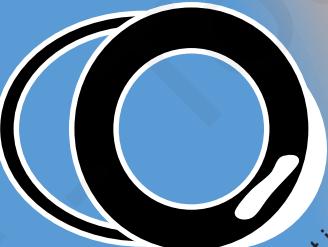
ischemic patterns



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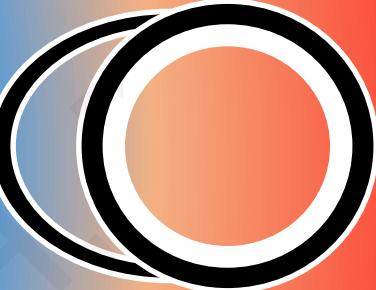
non ischemic patterns

Myocarditis

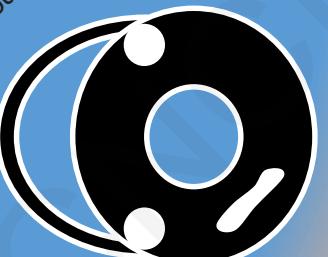


Inflammatory/Infiltrative

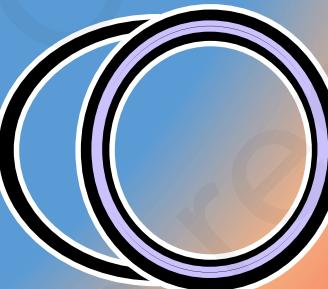
Sarcoïdosis
Scleroderma
FABRY disease
Amyloidosis(diffuse)



HCM



DCM -CHF



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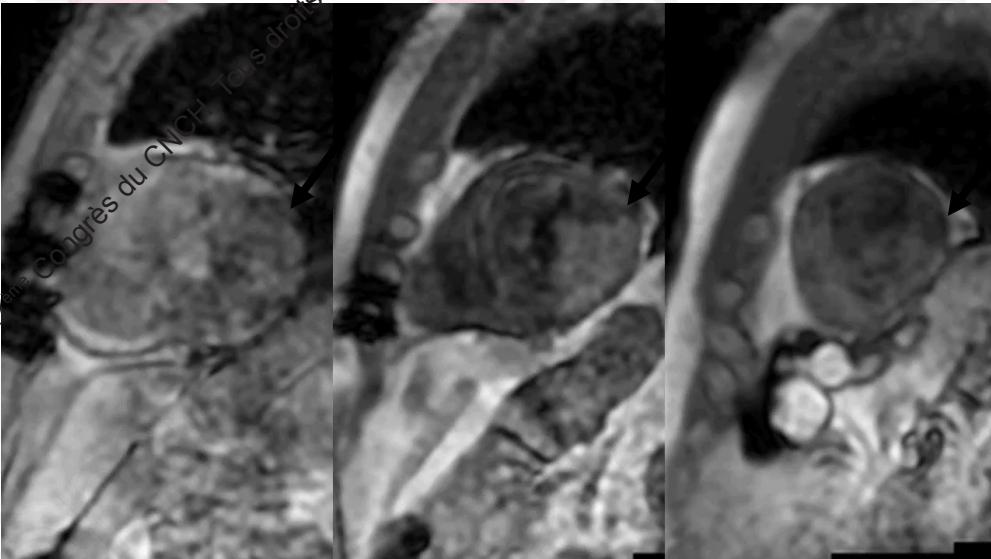
Hypoperfusion confrontée au rehaussement tardif : Ischémie Versus Nécrose

Ischémie DT chez un homme de 72 ans, triple pontage

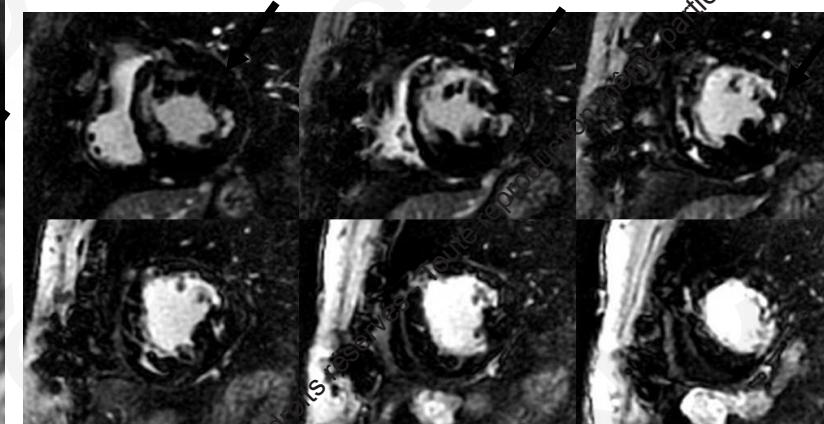
Nécrose ASA > 50% avec « No Reflow »

Viabilité en antéro- latérale

Hypokinésie + Rehaussement <50% + Ischémie = viabilité



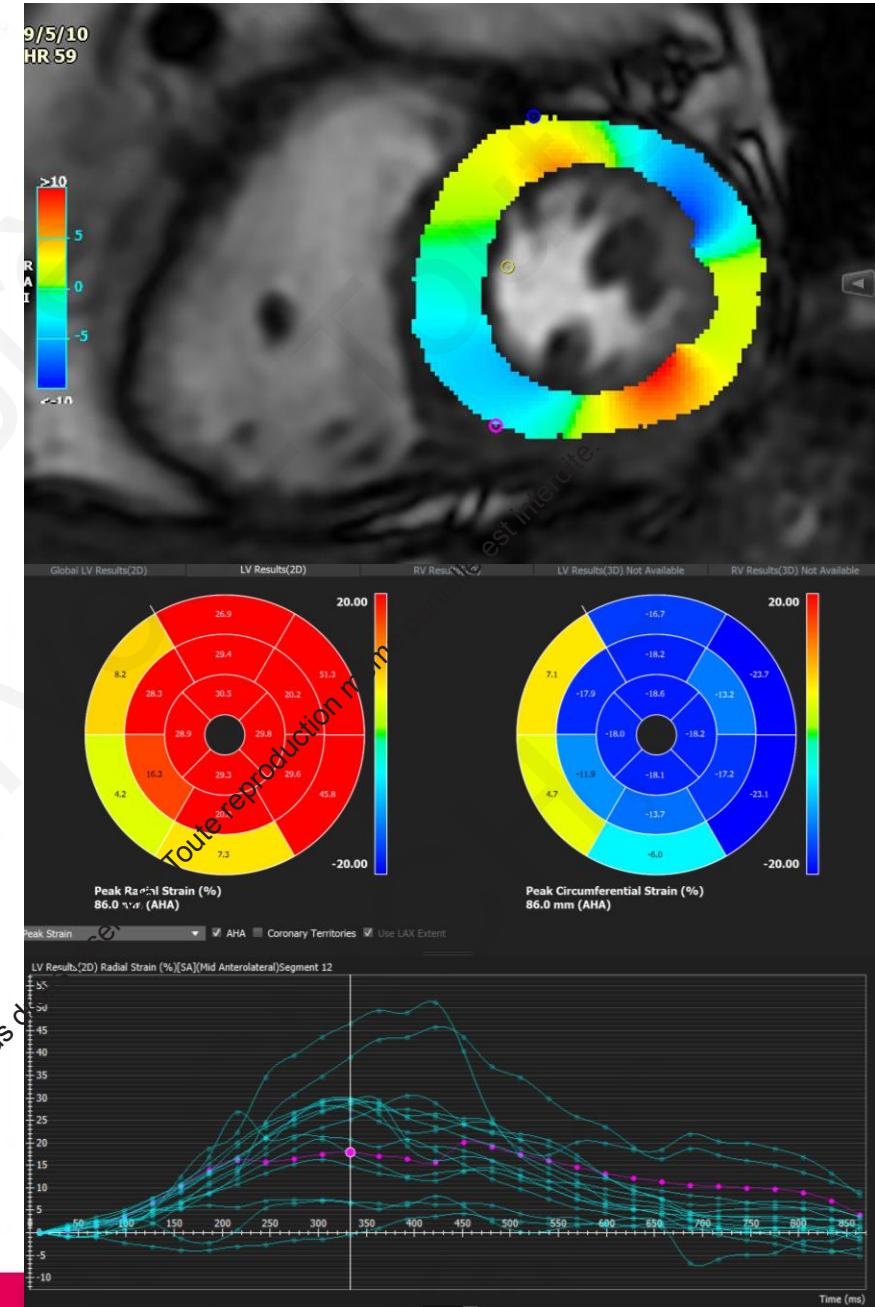
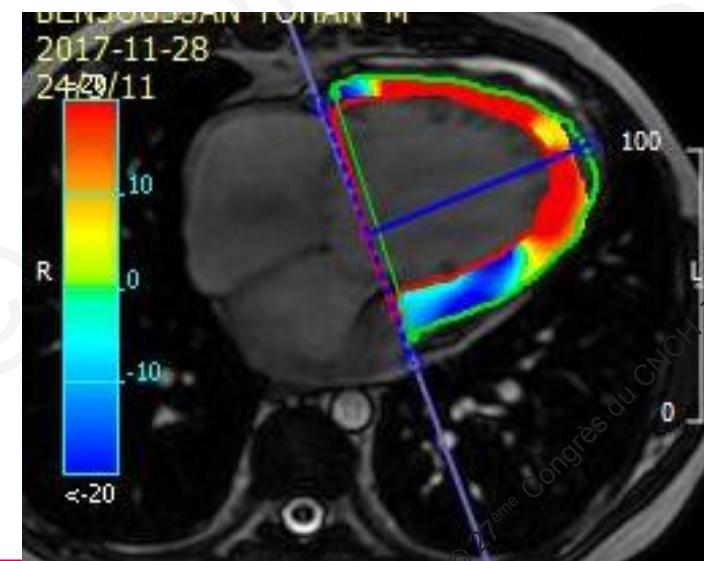
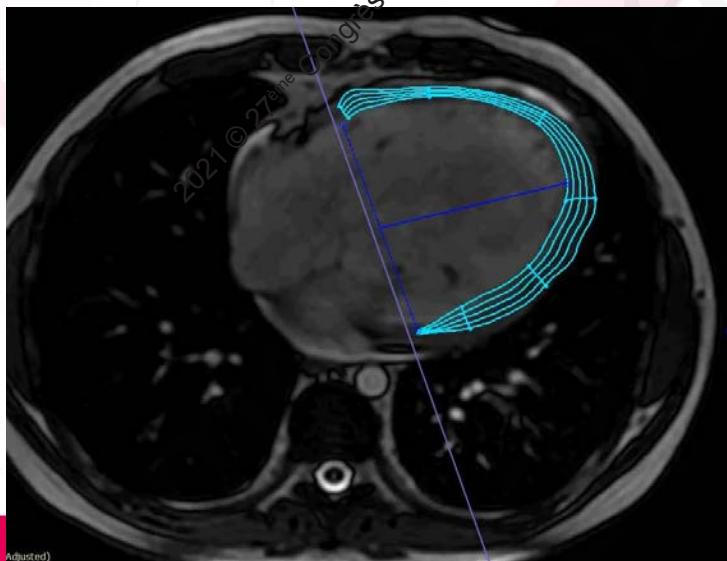
MR Stress test: retard de perfusion dans une zone viable
Occlusion bras en Y AMIG sur une diagonale



IRM cardiaque =
Identification optimale des zones de nécrose
(Rehaussement tardif) et des zones d'obstruction de
la microcirculation distale

Baisse Strain Au pic du stress

- Strain sur ciné Fonction après la perfusion
- Marqueur indépendant d'événement majeur dans les atteintes microvasculaires (greffon cardiaque)



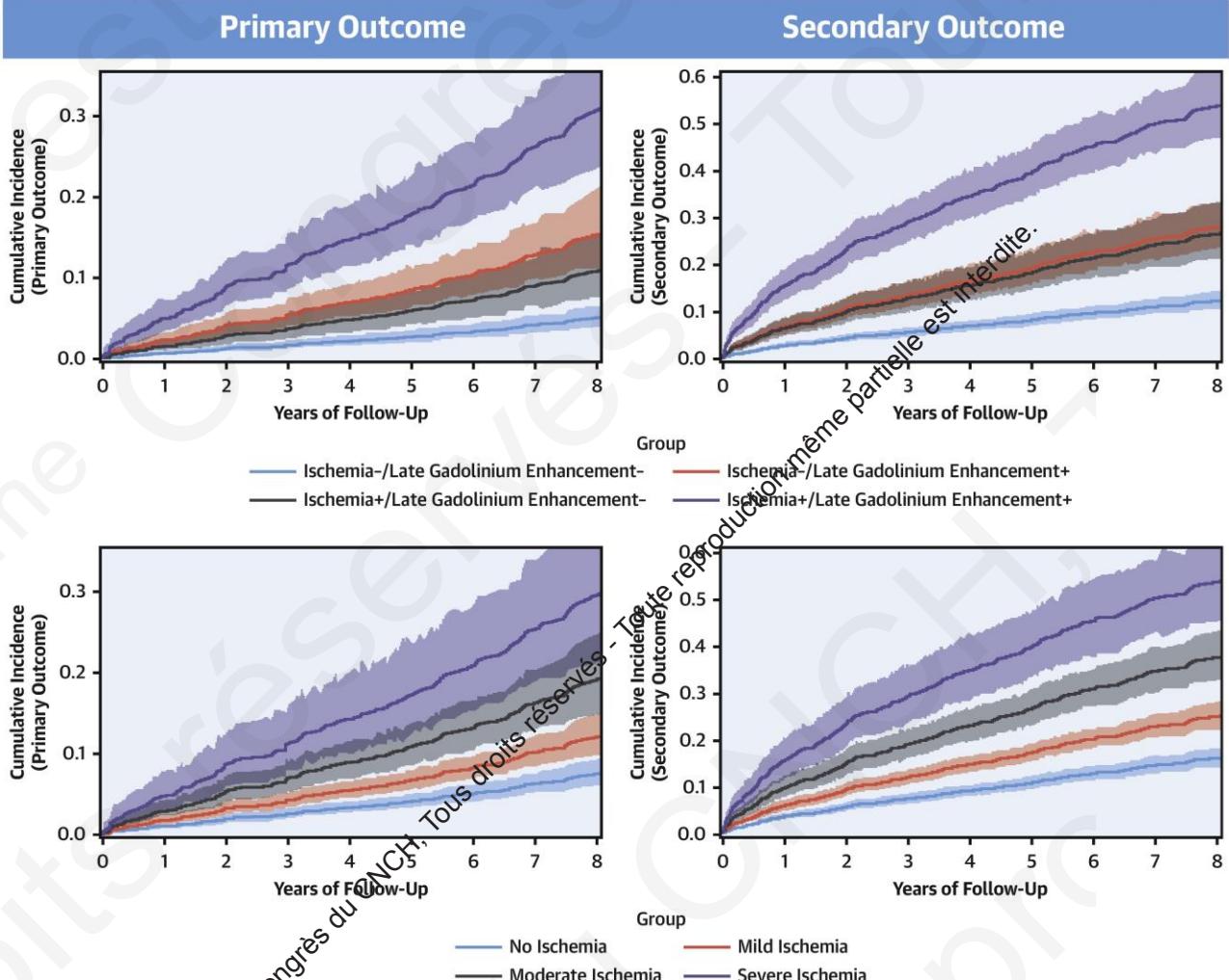
Valeur Pronostique de l'IRM de Stress

SPINS: Stress Perfusion Imaging in the US

IRM de Stress ≤ 0 + Absence de
rehaussement tardif = Bon
pronostic à 5,5 ans!

« Patients without ischemia
(stress perfusion) or necrosis
(LGE) on Stress CMR had 99,3%
event-free rate over a 5,5-year
follow-up! »

CENTRAL ILLUSTRATION: Stress Cardiac Magnetic Resonance Imaging Registry for Prognosis and Costs in the United States



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

Valeur pronostic de l'IRM cardiaque de stress en prévention primaire chez des patients à risque intermédiaire/élevé

Pezel et al. J Cardiovasc Magn Reson (2021) 23:43
https://doi.org/10.1186/s12968-021-00737-0

Journal of Cardiovascular
Magnetic Resonance

RESEARCH

Open Access

Long-term prognostic value of stress perfusion cardiovascular magnetic resonance in patients without known coronary artery disease

Théo Pezel^{1,2}, Thierry Unterseeh¹, Marine Kinnel¹, Thomas Hovasse¹, Francesca Sanguineti¹, Solenn Toupin³, Stéphane Champagne¹, Philippe Garot¹ and Jérôme Garot^{1*} 

Abstract

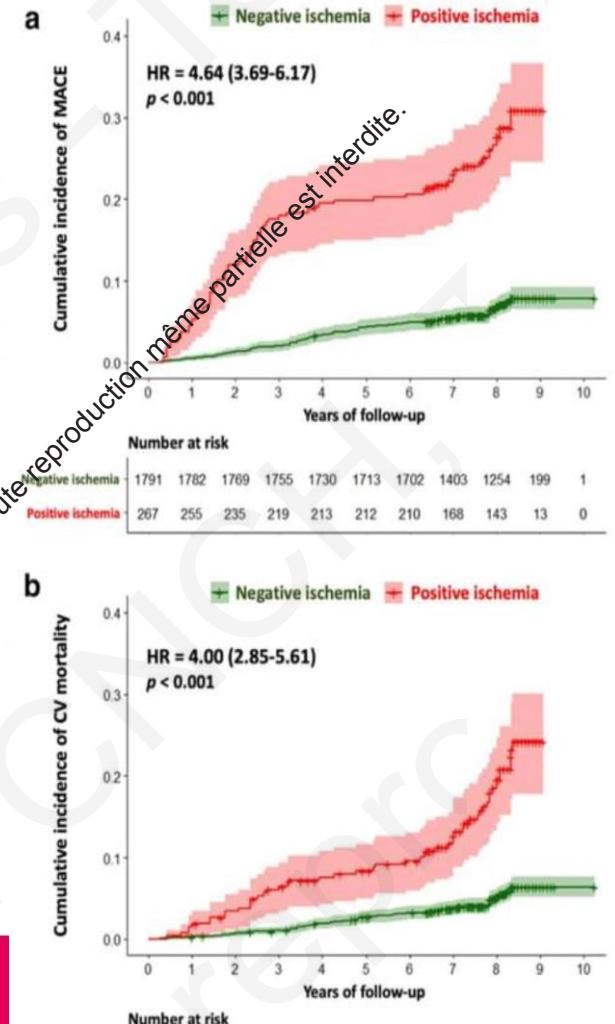
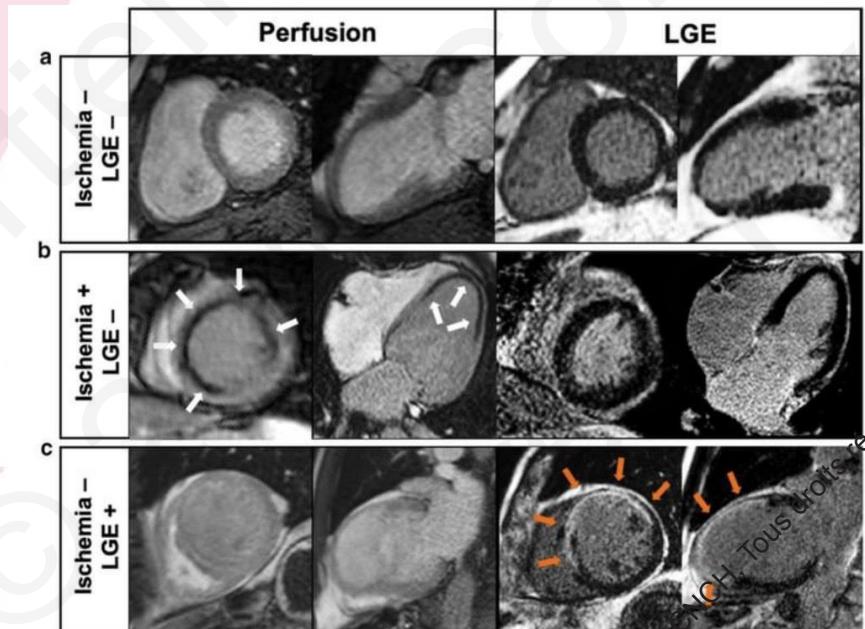
Background: To assess the incremental long-term prognostic value of vasodilator stress perfusion cardiovascular magnetic resonance (CMR) in patients without known coronary artery disease (CAD).

Methods: Between 2010 and 2011, consecutive patients with cardiovascular risk factors without known CAD referred for stress CMR were followed for the occurrence of major adverse cardiac events (MACE), defined by cardiovascular mortality or recurrent non-fatal myocardial infarction (MI). Uni- and multivariable Cox regressions were performed to determine the prognostic value of ischemia and unrecognized MI defined by sub-endocardial or transmural late gadolinium enhancement (LGE).

Results: Among 2,295 patients without known CAD, 2,058 (89.7%) (71.2 ± 12.5 years; 37.5% males) completed the follow-up (median [IQR]: 8.3 [7.3–8.7] years), and 203 had MACE (9.9%). Using Kaplan–Meier analysis, ischemia and unrecognized MI were associated with MACE (hazard ratio, HR: 4.64 95% CI: 3.69–6.17 and HR: 2.88; 95% CI: 2.08–3.99, respectively; both $p < 0.001$). In multivariable stepwise Cox regression, ischemia and unrecognized MI were independent predictors of MACE (HR = 3.71; 95% CI 2.73–5.05, $p < 0.001$ and HR = 1.73; 95% CI 1.22–2.45, $p = 0.002$; respectively) and cardiovascular mortality (HR: 3.13; 95% CI: 2.17–4.51, $p < 0.001$ and HR = 1.73; 95% CI 1.15–2.62, $p = 0.009$; respectively). The addition of ischemia and unrecognized MI led to an improved model discrimination for MACE (change in C statistic from 0.61 to 0.72; NRI = 0.431; IDI = 0.053).

Conclusions: Inducible ischemia and unrecognized MI identified by stress CMR have incremental long term prognostic value for the incidence of MACE in patients without known CAD over traditional risk factors and left ventricular ejection fraction.

Keywords: Cardiovascular magnetic resonance, Stress testing, Ischemia, Unrecognized myocardial infarction, Perfusion

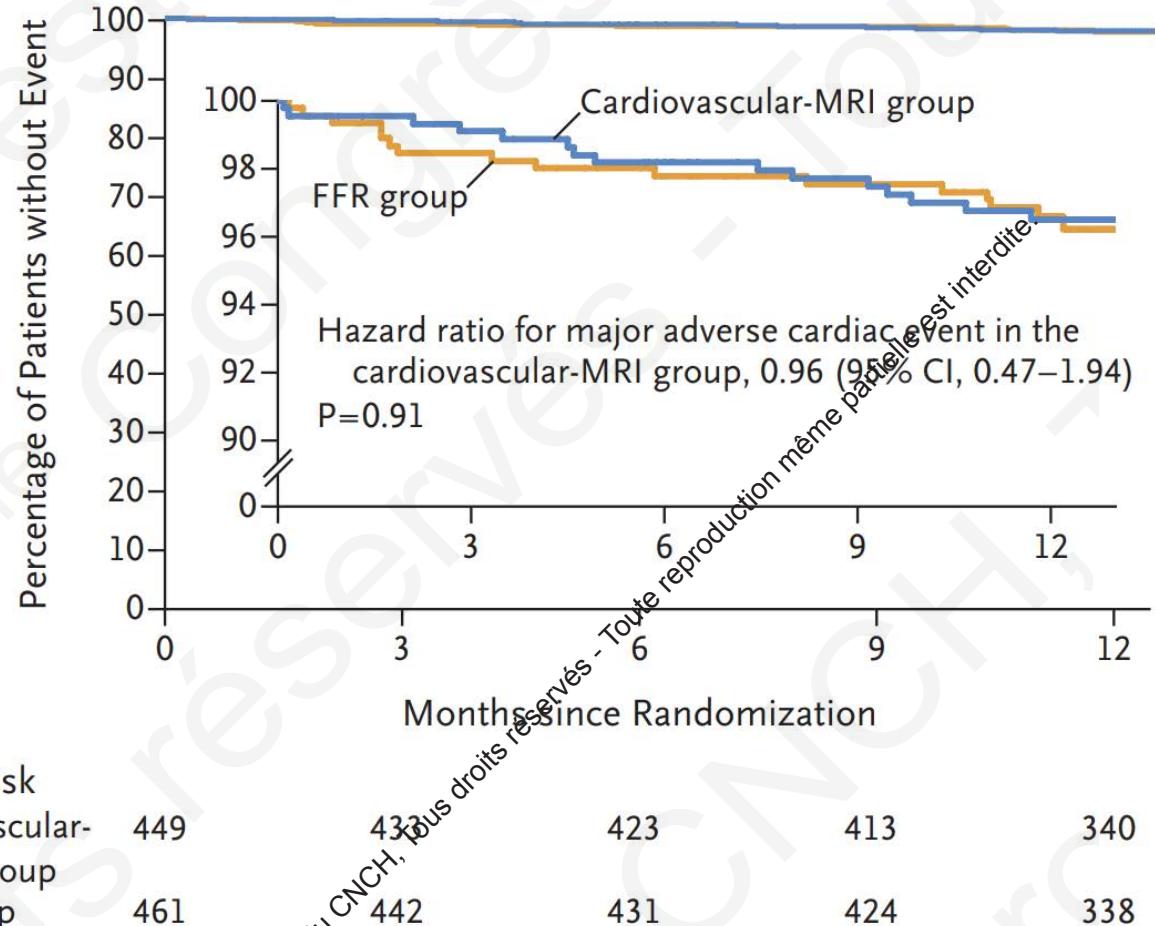


MR-INFORM

Magnetic Resonance
Perfusion or Fractional
Flow Reserve in
Coronary Disease

- Among patients with stable angina and risk factors for coronary artery disease:
 - Stress Perfusion CMR** was associated with a **lower** incidence of coronary **revascularization** than **FFR**
 - CMR was non-inferior to FFR** with respect to major adverse cardiac events (**MACE**)

Nagel et al. New England Journal of Medicine
2020



Inconvénients de l'IRM de stress?

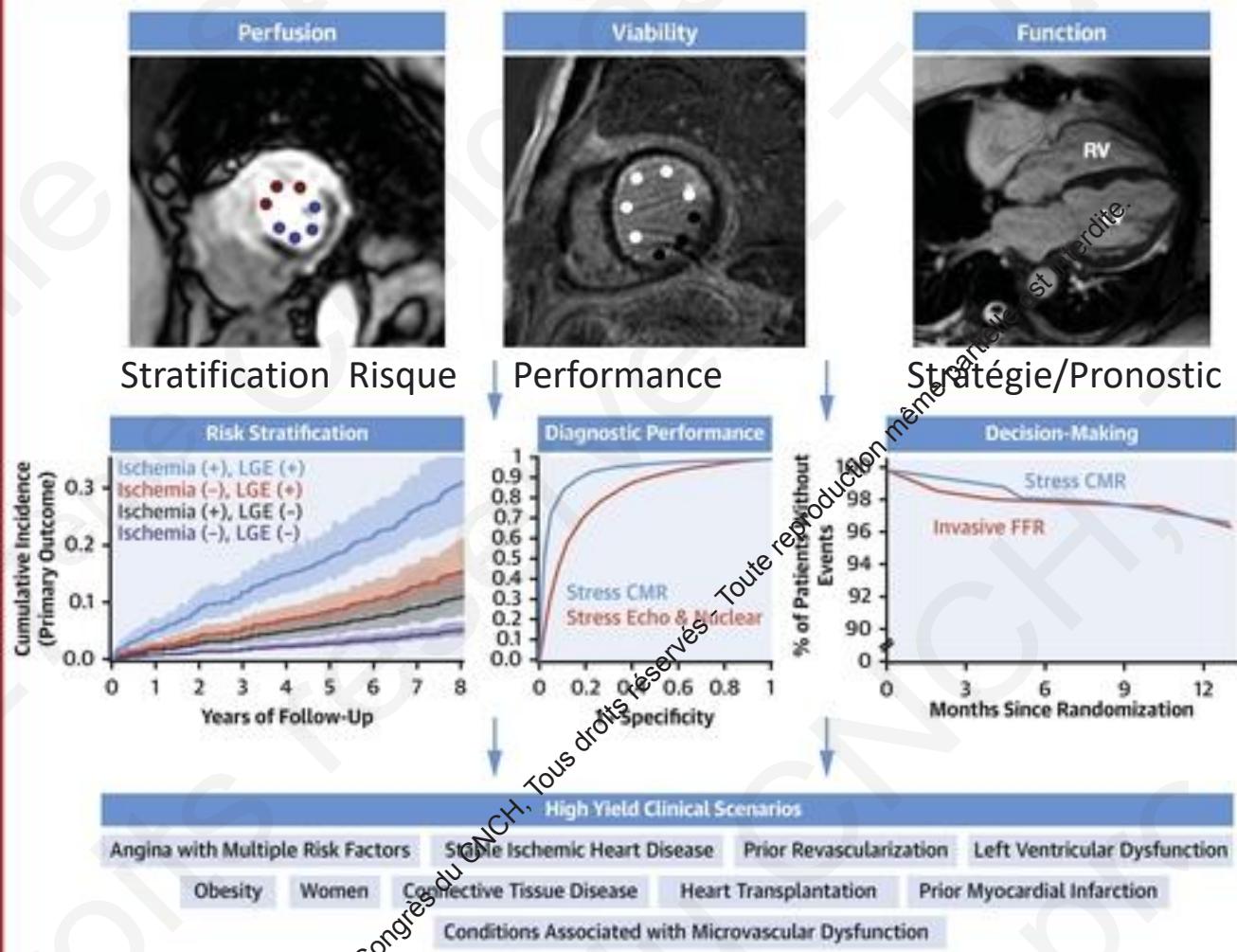
- Disponibilité limitée
- Incapacité d'inclure l'exercice
- La claustrophobie
- Porteurs de dispositifs électroniques cardiaques implantables : procédures de plus en plus facile sauf peut-être défibrillateur sous-cut ou certains reveal: Artéfacts!



Take Home Messages

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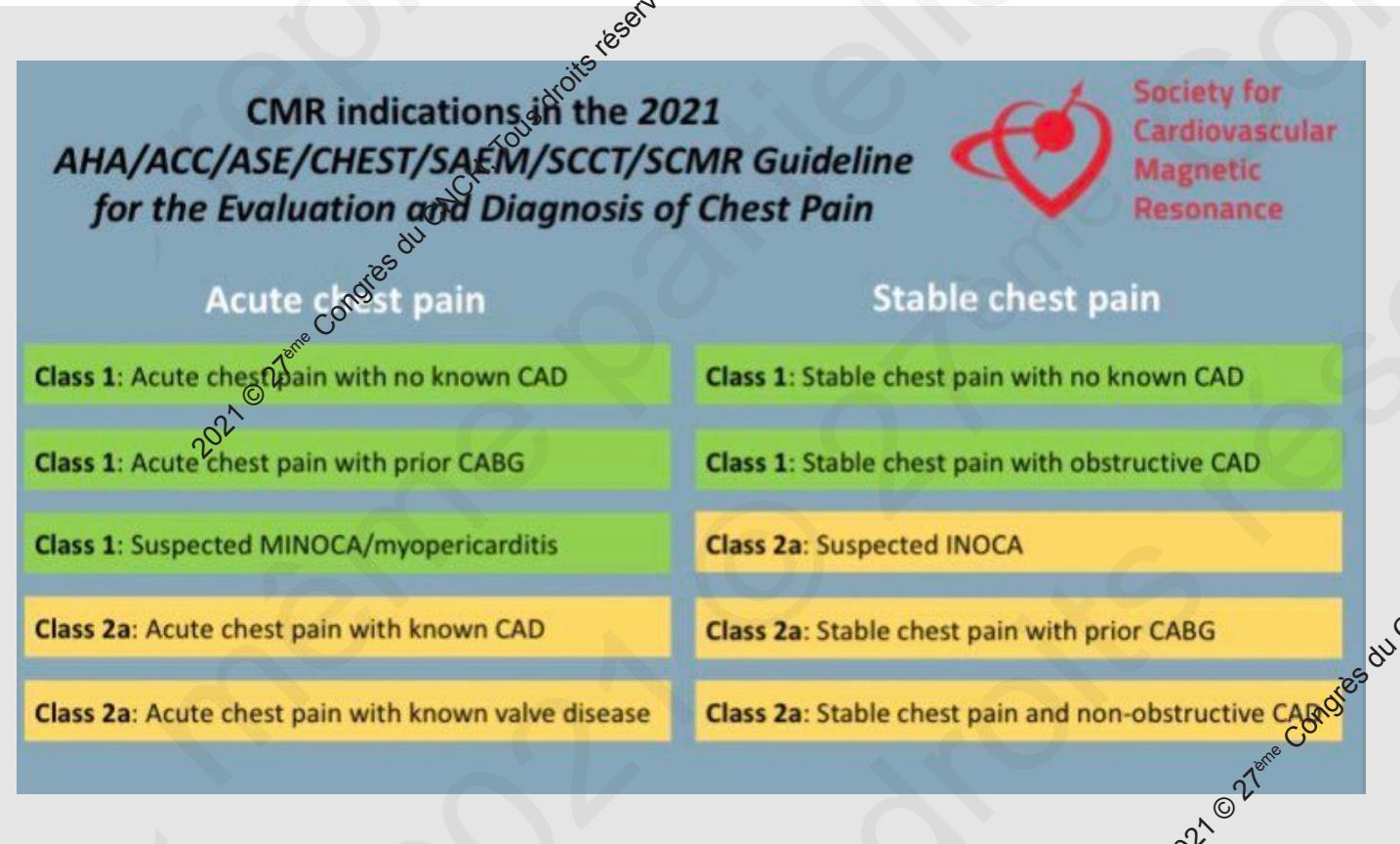
CENTRAL ILLUSTRATION: The Key Elements of A Stress Cardiac Magnetic Resonance Imaging Examination Include Assessment of Ischemia, Viability, and Function



Patel, A.R. et al. J Am Coll Cardiol. 2021;78(16):1655-1668.

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CONCLUSION



- « Cost-effective »
- Non invasive
- Non X-Ray
- Ischémie + viabilité + fonction
- En 2021: enfin validations multiples
- Enfin entrée dans les guidelines
- Populations cibles :
 - Risque intermédiaire à élevé
 - Femmes
 - ATCD revascularisation ou de dysfonction VG

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