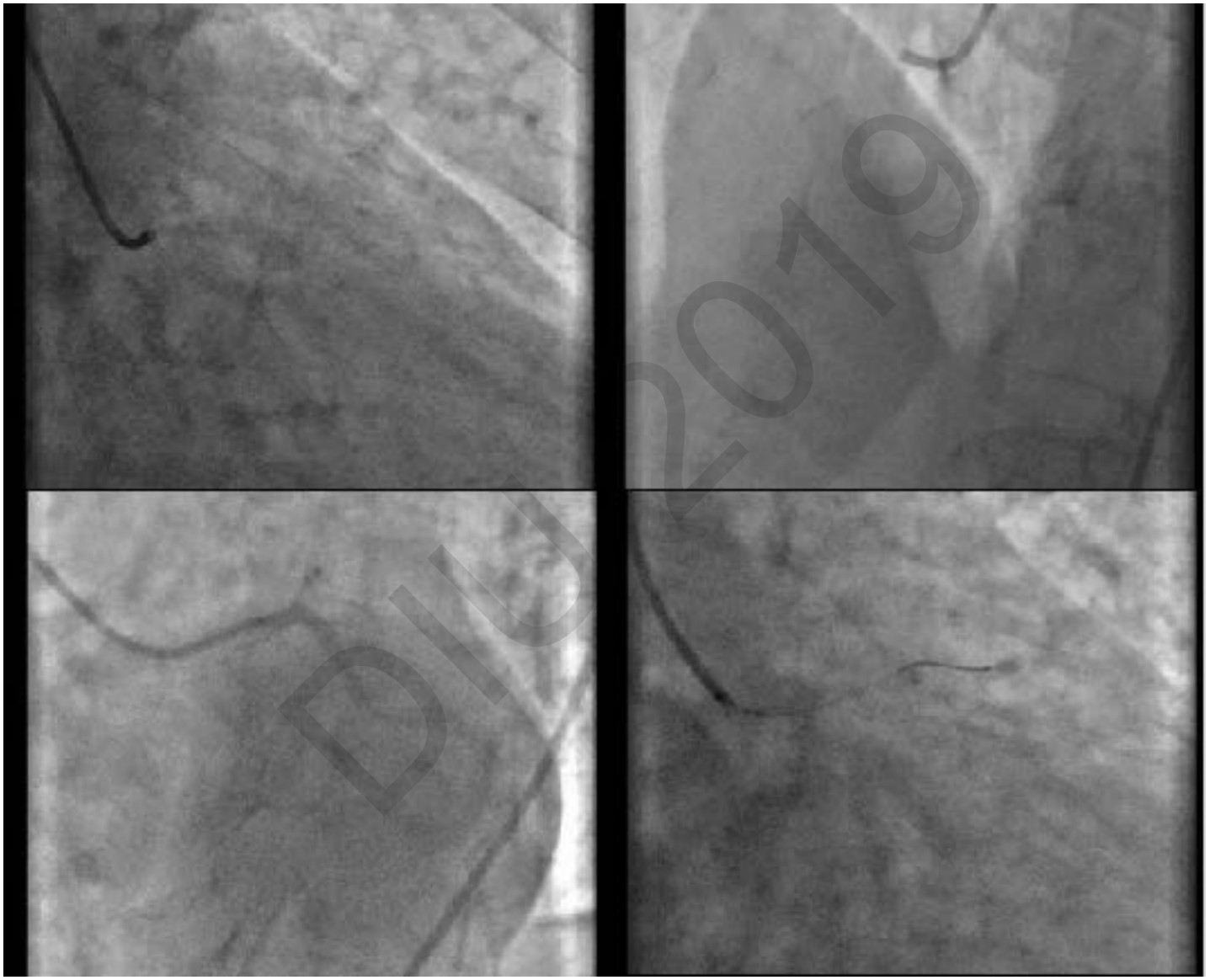
IRM de stress: place dans la détection des cardiopathies ischémiques

Pierre Croisille

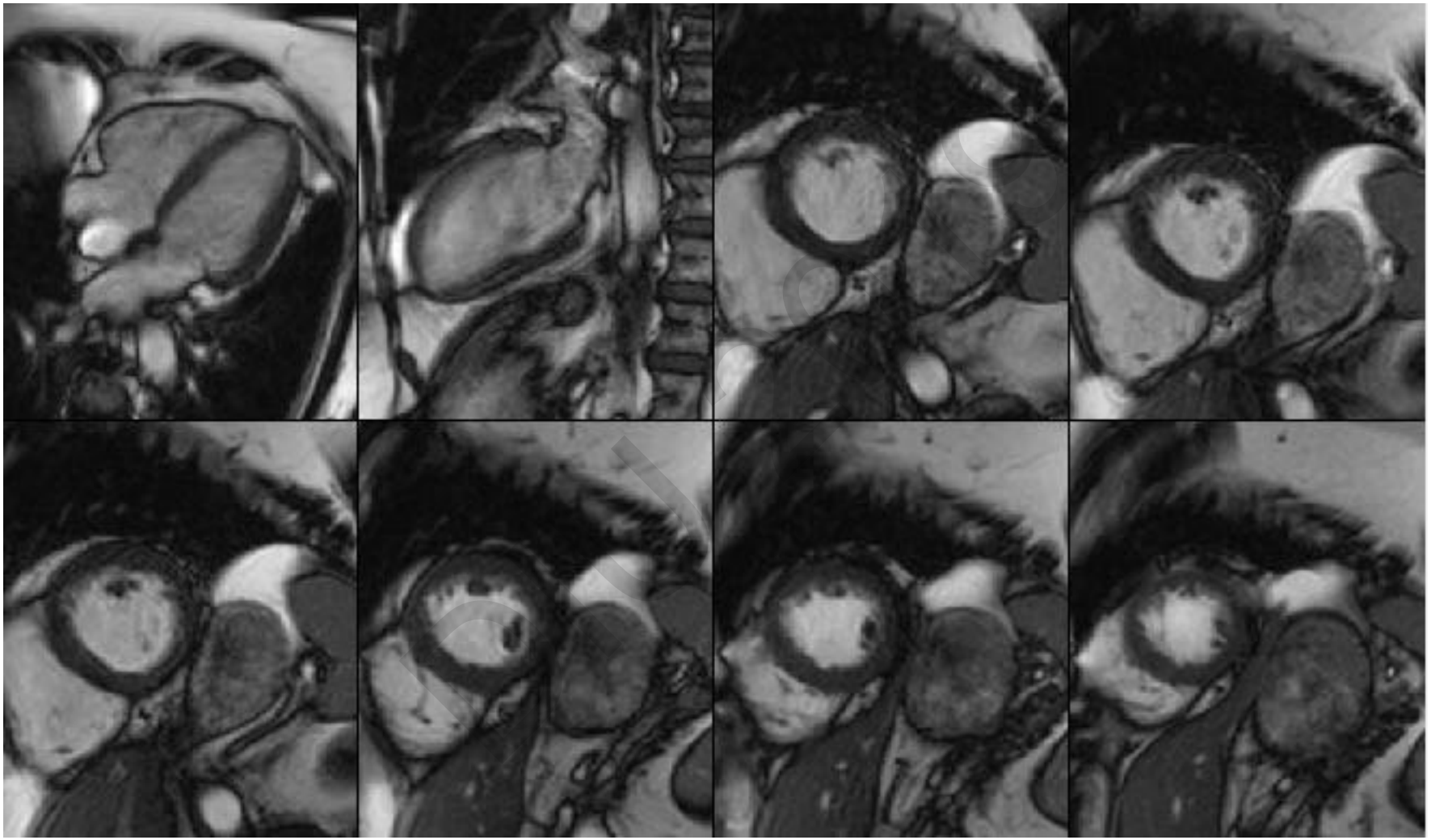
Mrs Dest.

- 71 y.o.female, with hypertension and dyslipidemia
- chest pain @ effort in the last 6 months.
- Treadmill : 100W (95%), with typical chest pain and ST elevation V4-V6.
- coronary angiography ± PTCA

PTCA failure

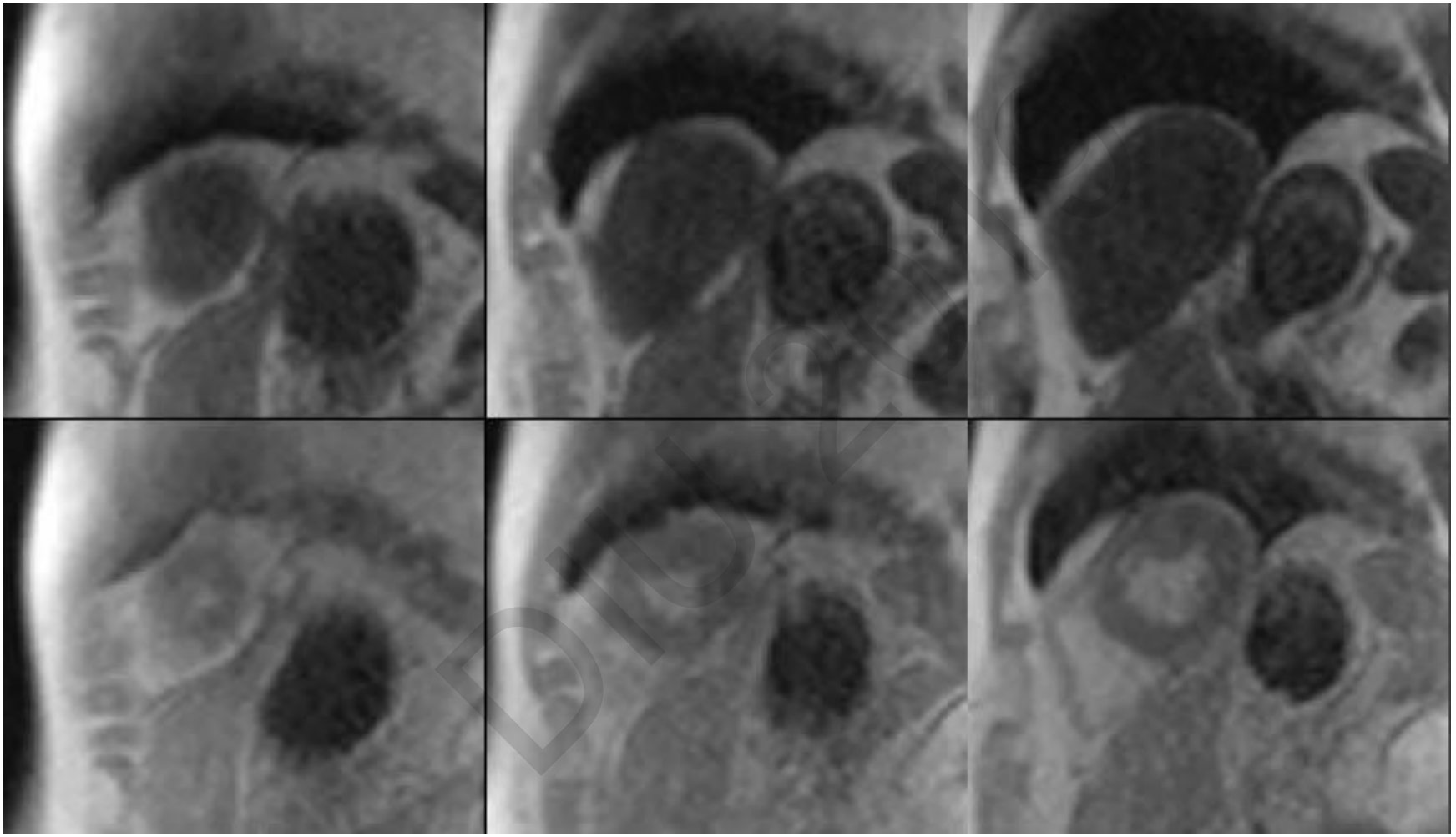


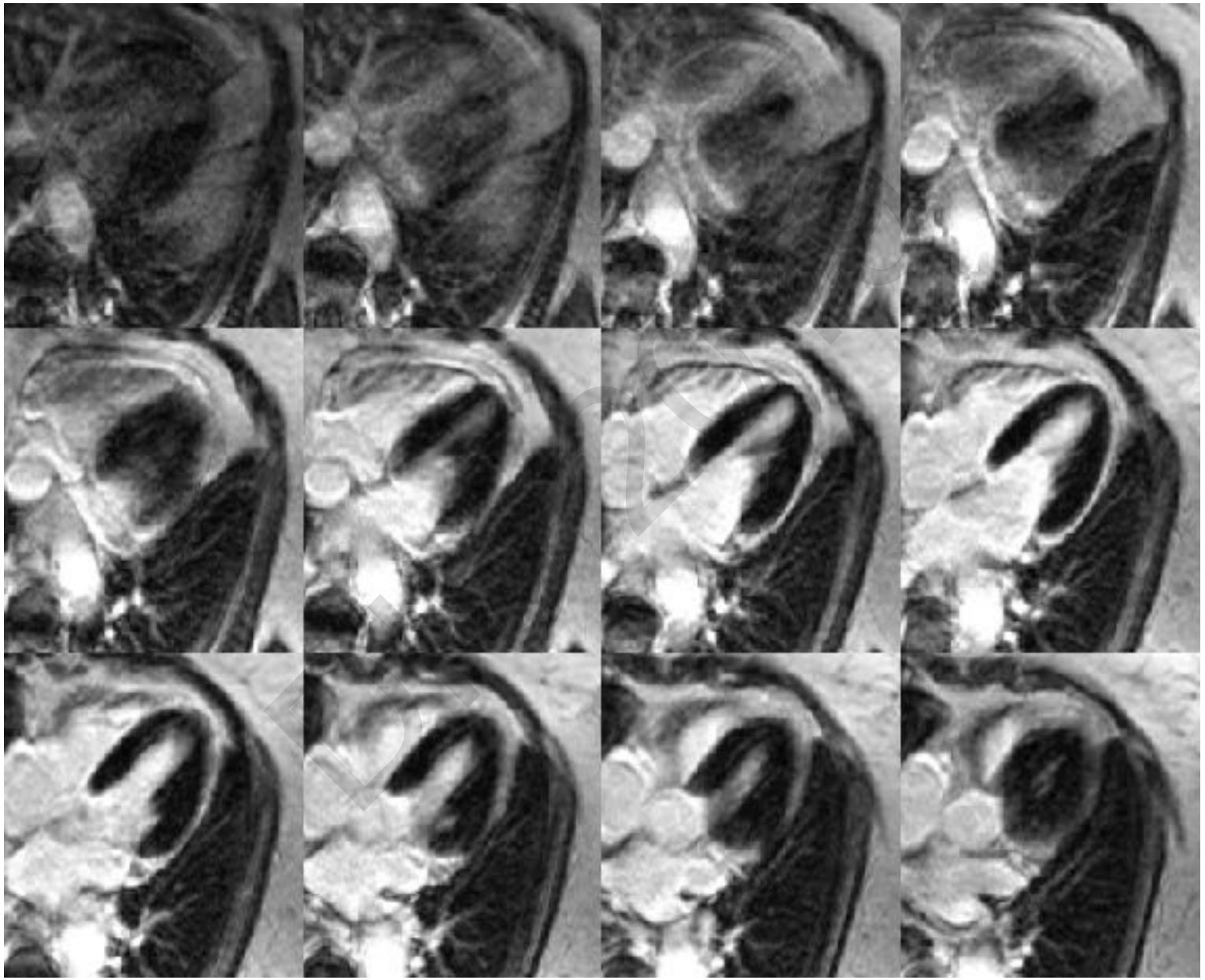
Cine SSFP

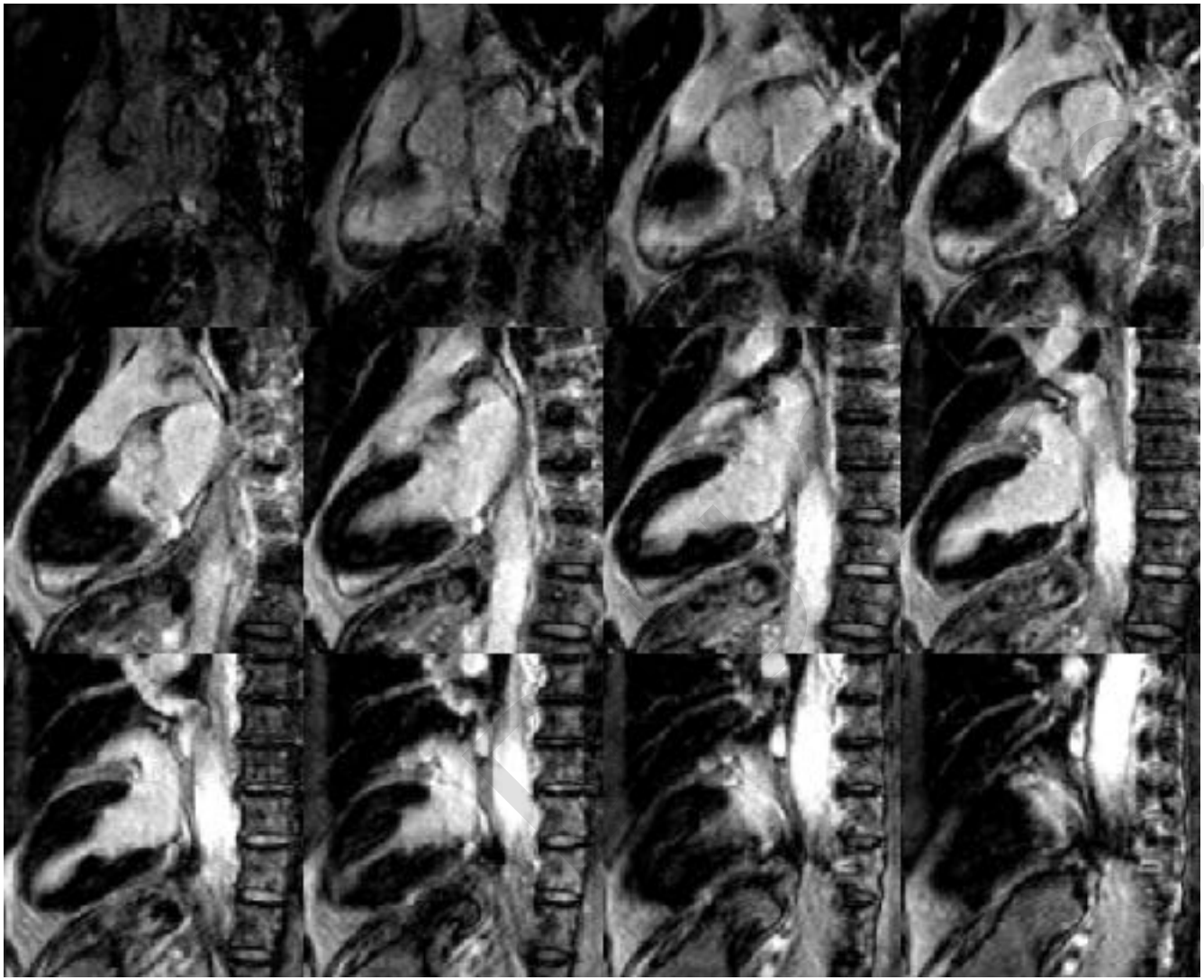


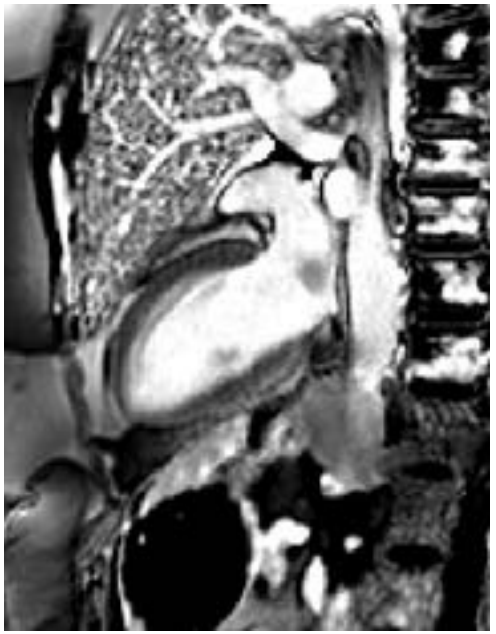
LVEF=71% EDVi=54ml/m^2 ESVi=16ml/m^2

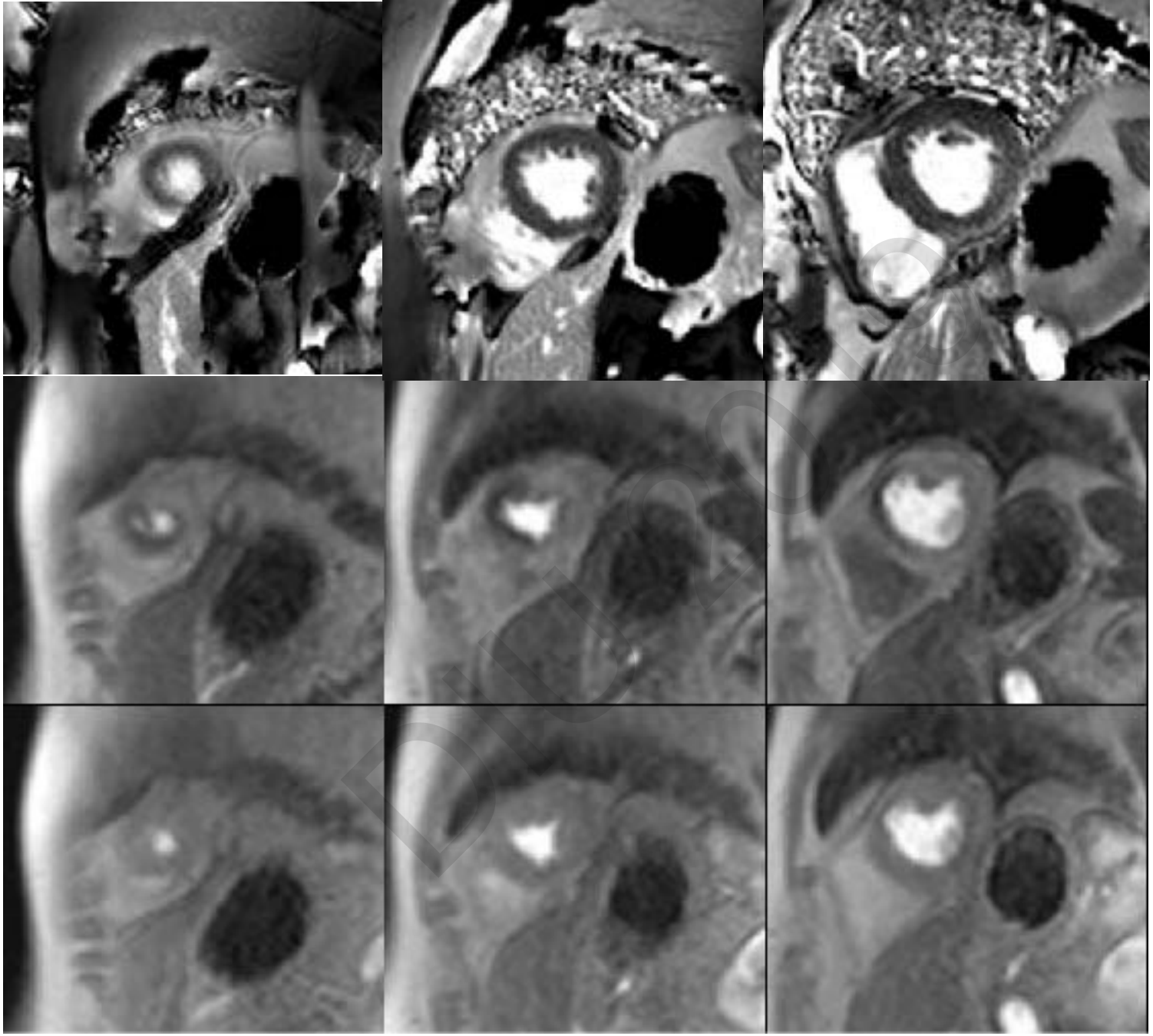
MRI 12/01/11 Stress perfusion (dipyridamole)







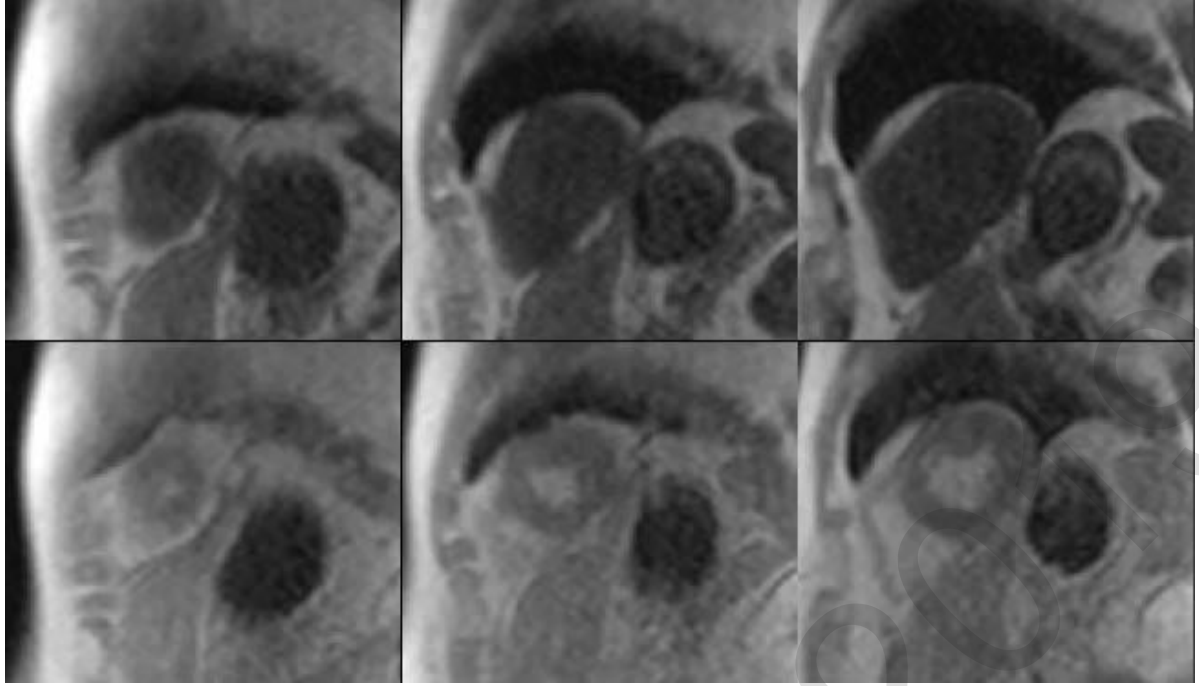




late PSIR

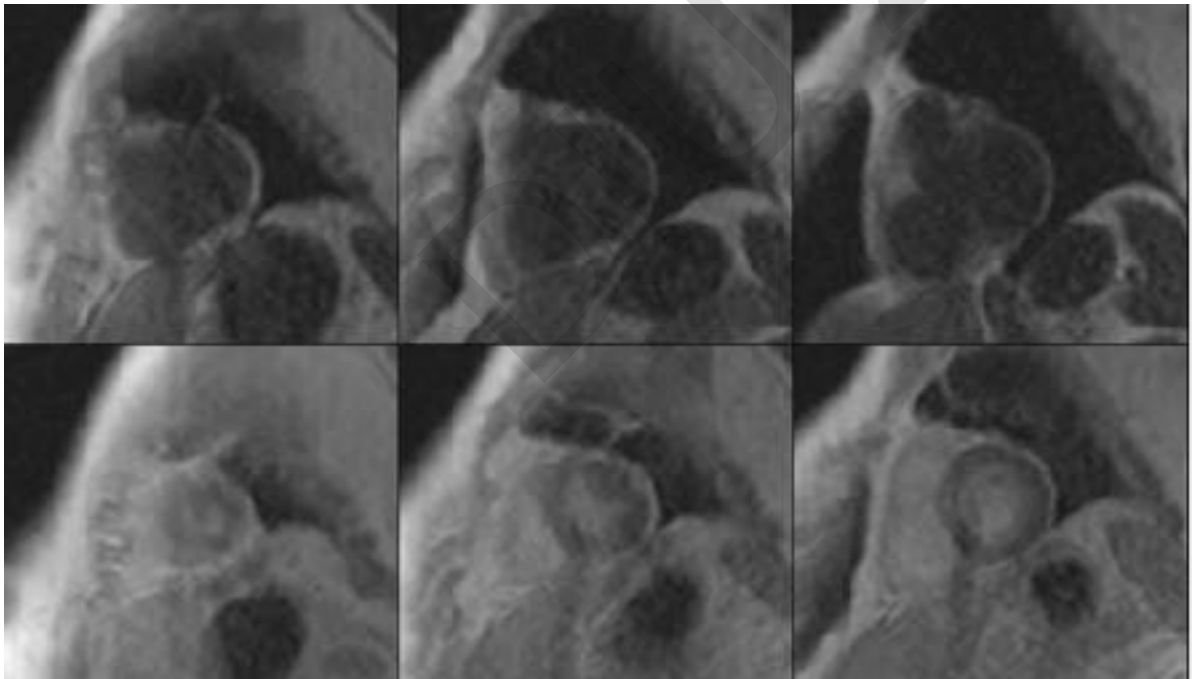
stress

rest



MRI before

total endoscopic coronary artery bypass (TECAB) MG-LAD



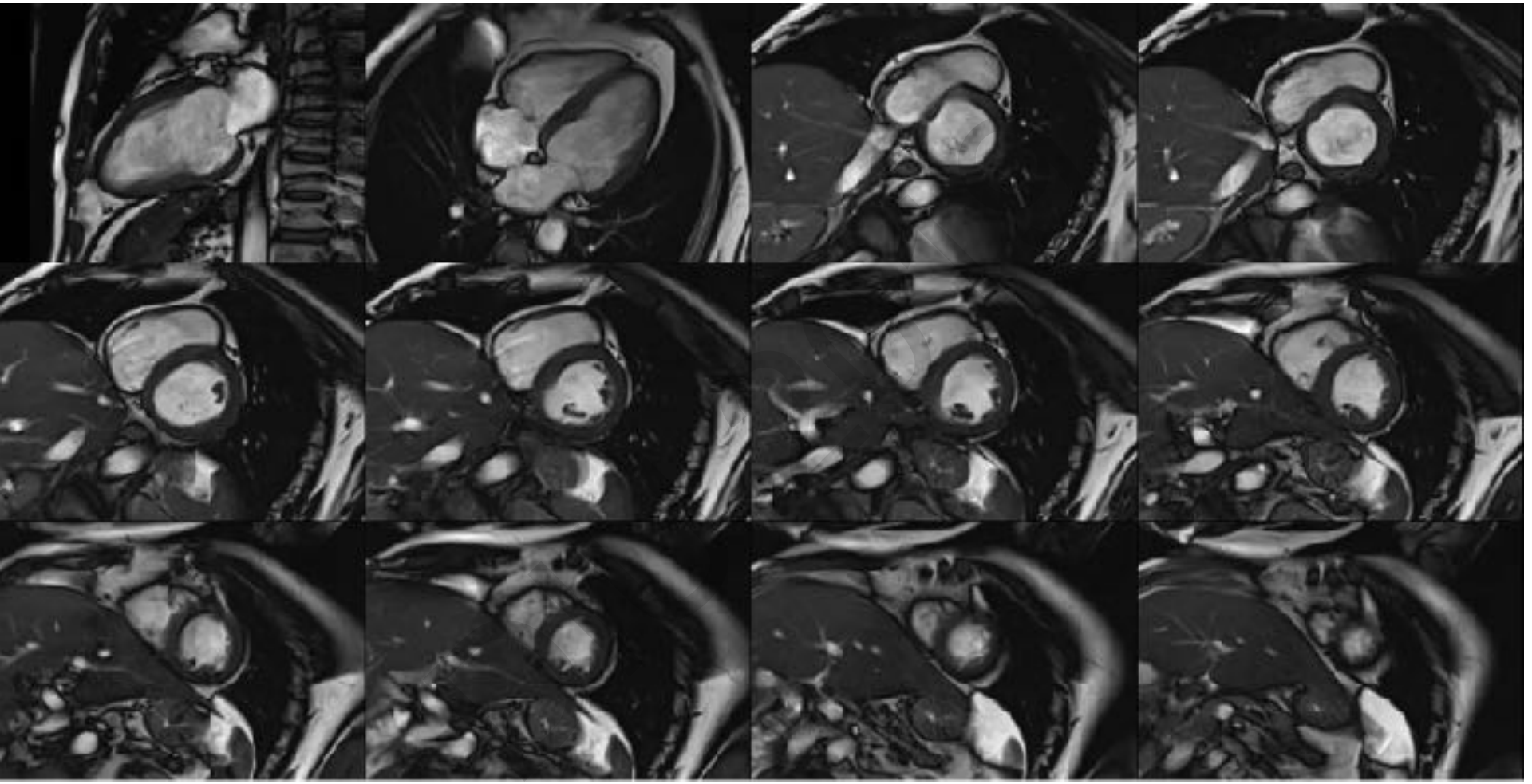
IRM after
3 months

Mr Par. P.

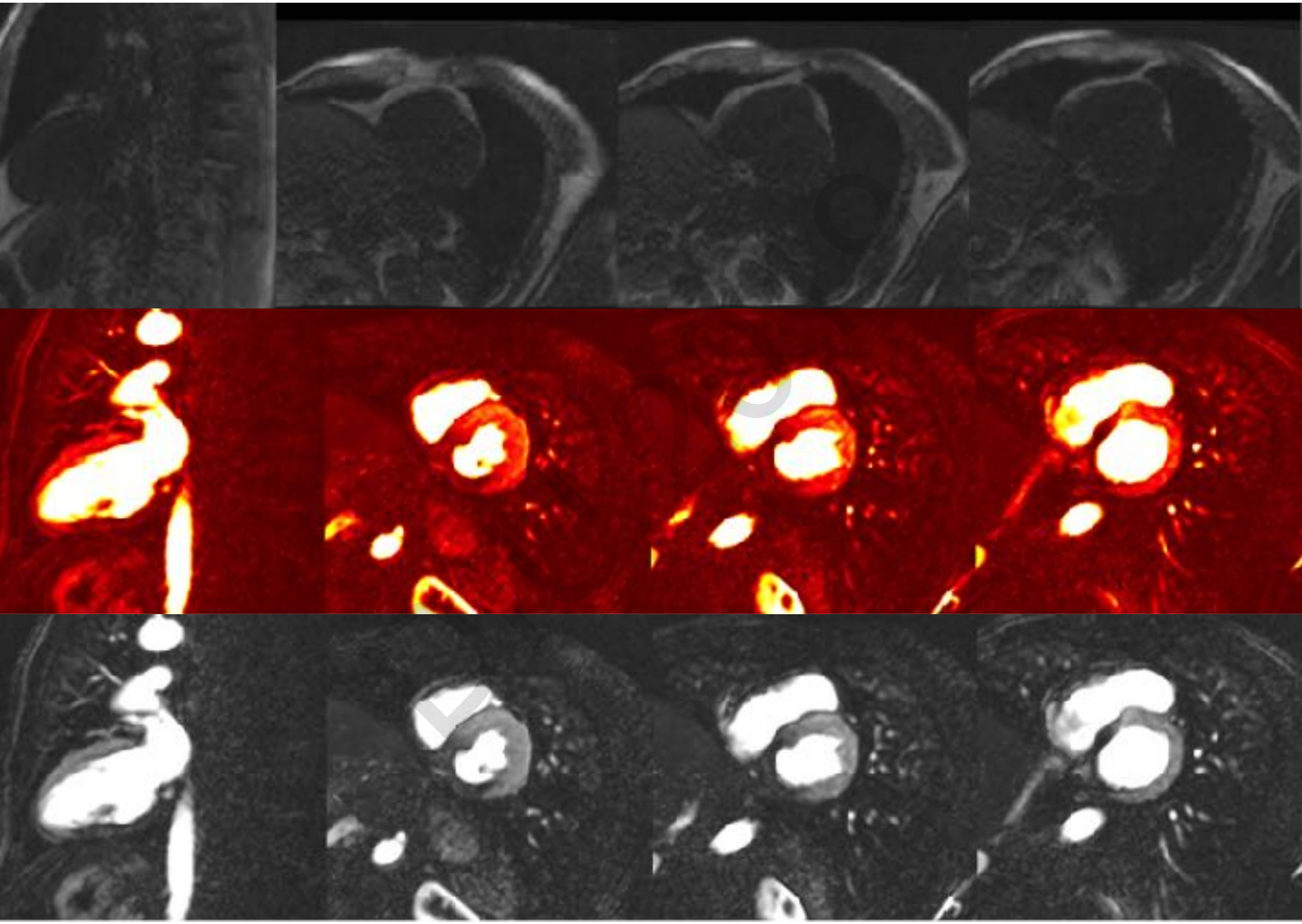
51 ans

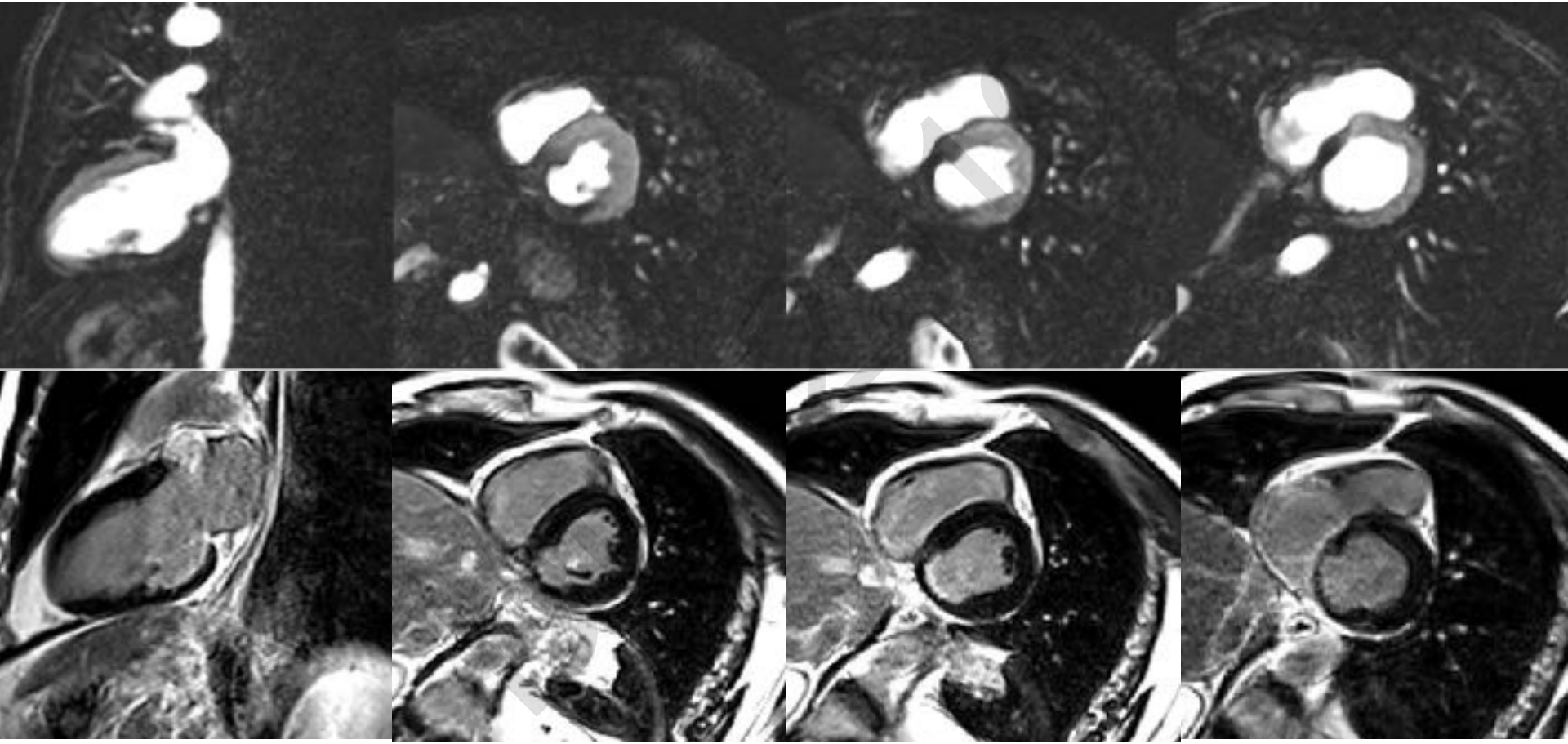
coronarien avéré

douleurs thoraciques à l'effort

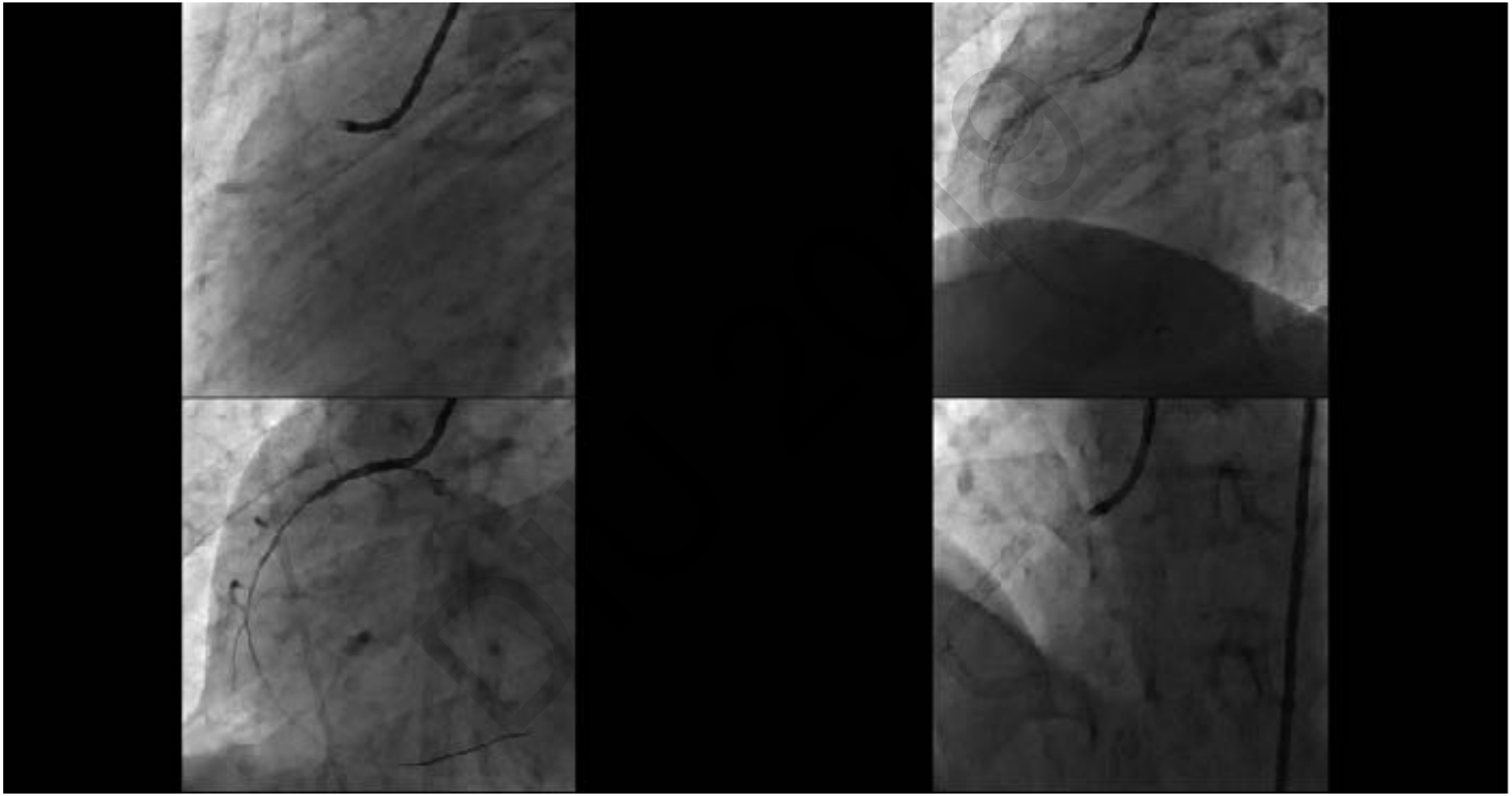


FEVG 49% / VTDi 84ml/m2 / VTSi 43ml/m2

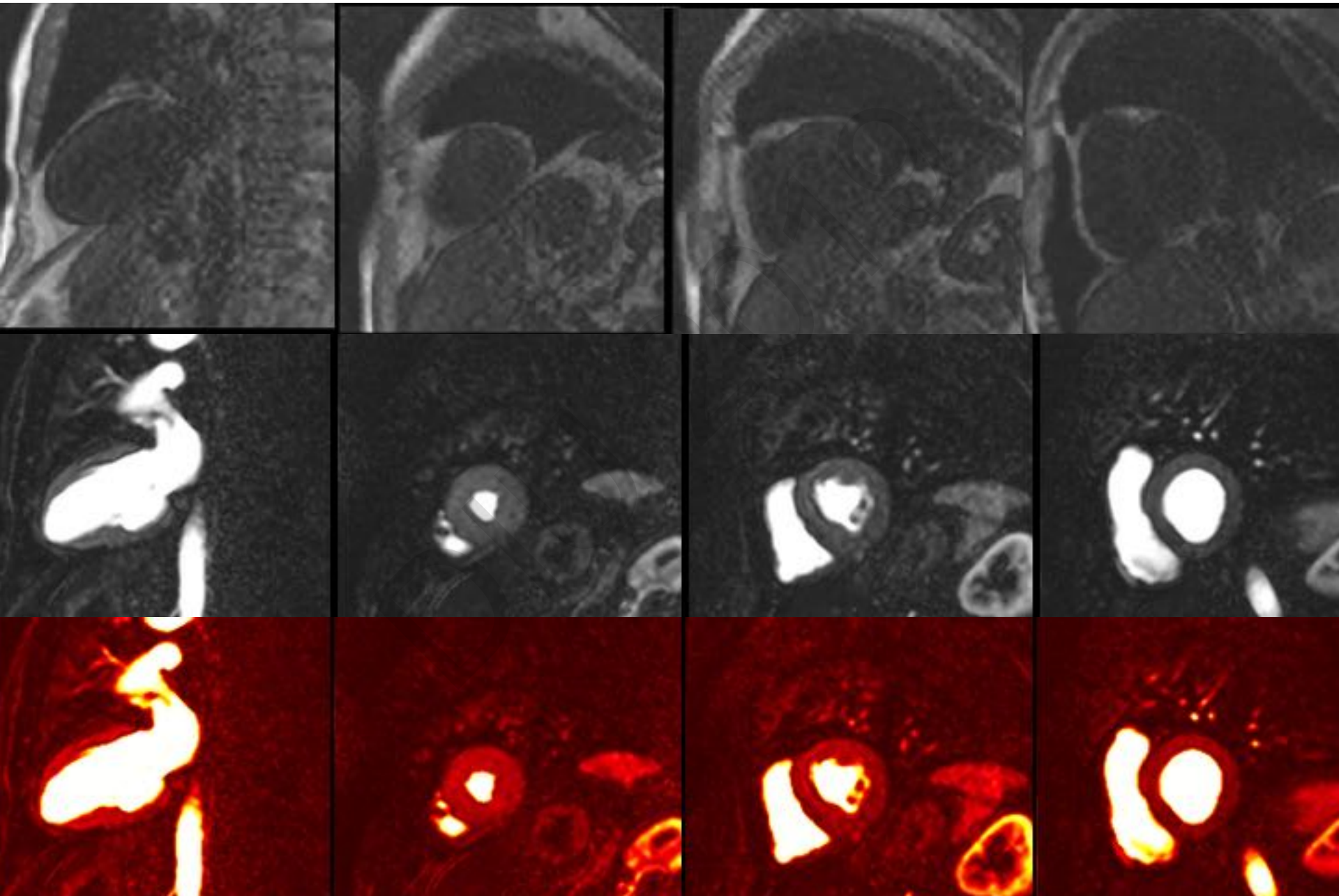




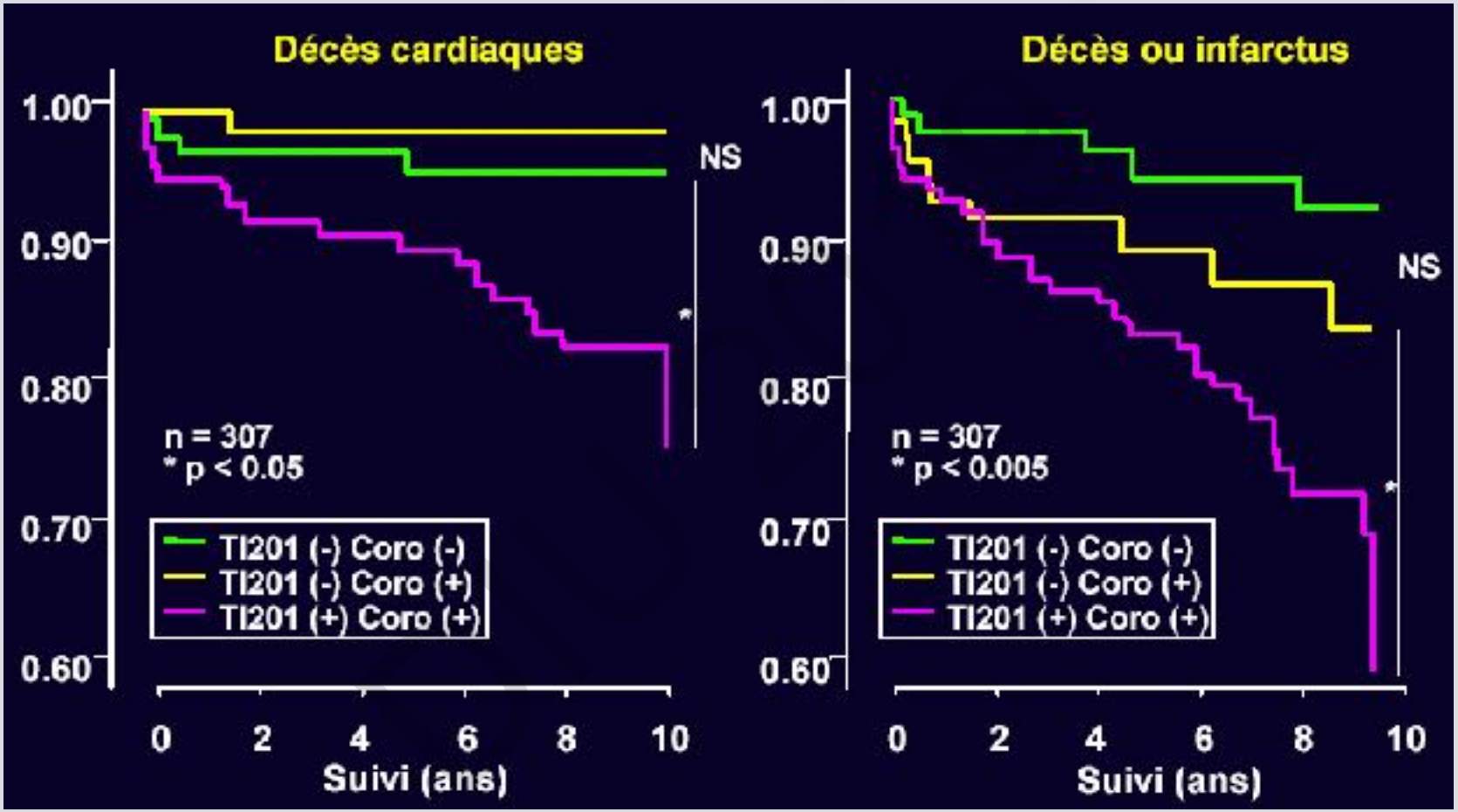
procédure CTO



IRM perfusion J30 post-angioplastie



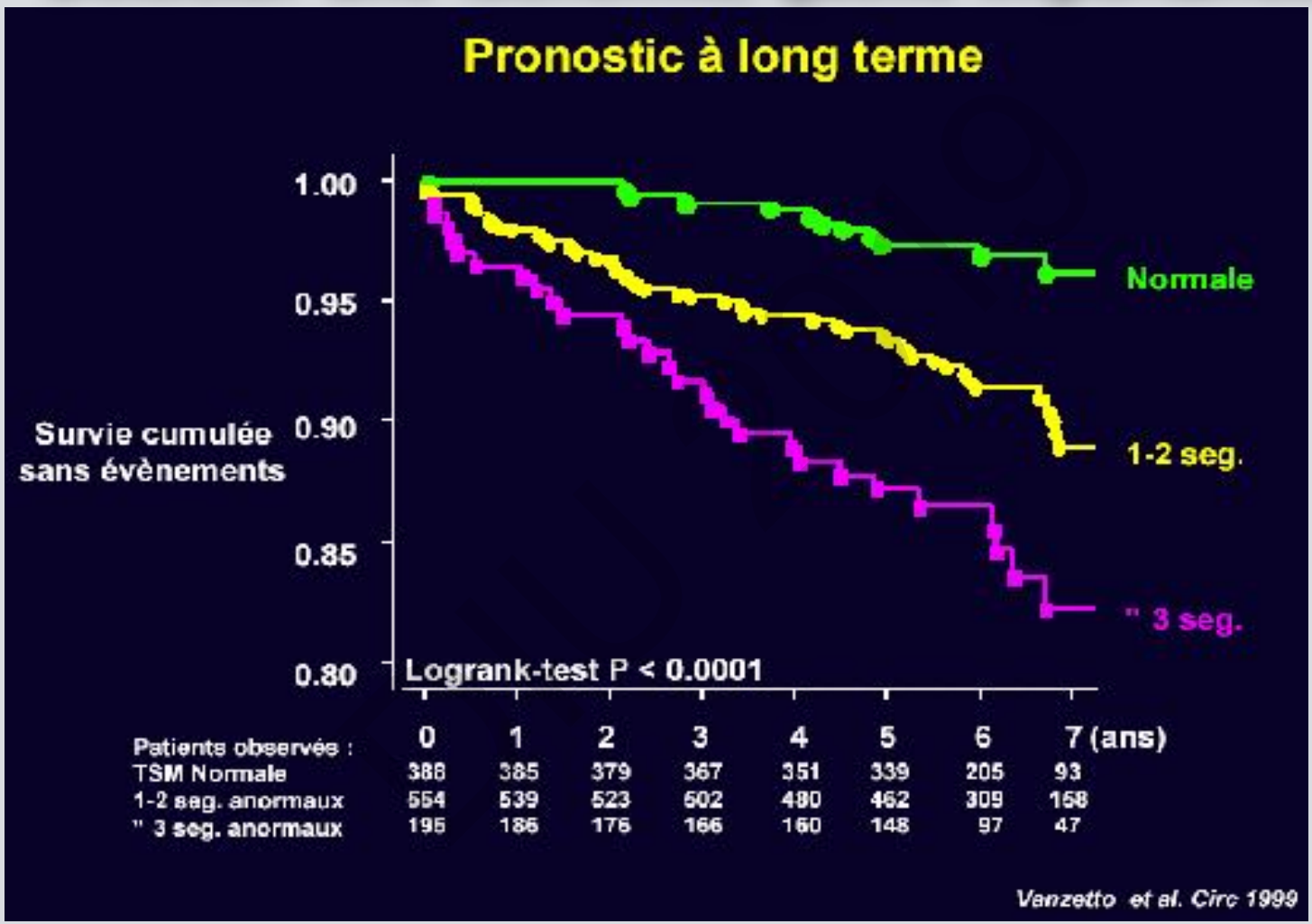
Détecter une ischémie, quelle importance?



c'est la présence d'une ischémie et non la présence de sténoses qui détermine le pronostic

Pavin et al. Eur Heart J 1997

Détecter une ischémie, quelle importance?



valeur pronostique de la sévérité et de l'étendue des anomalies ischémiques

2013 ESC guidelines on the management of stable coronary artery disease

symptomatic patients

Table 13 Clinical pre-test probabilities[a] in patients with stable chest pain symptoms[108]

	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

PPT < 15% : pas d'autre test

PPT de 15 à 65%: ECG ou si disponible imagerie non-invasive pour détection ischémie; considérer le risque/irradiation si jeune

PPT de 65 à 85 %: imagerie non invasive de détection de l'ischémie

PPT > 85%: stratification du risque

2013 ESC guidelines Eur Heart J 2013;34:2949-3003

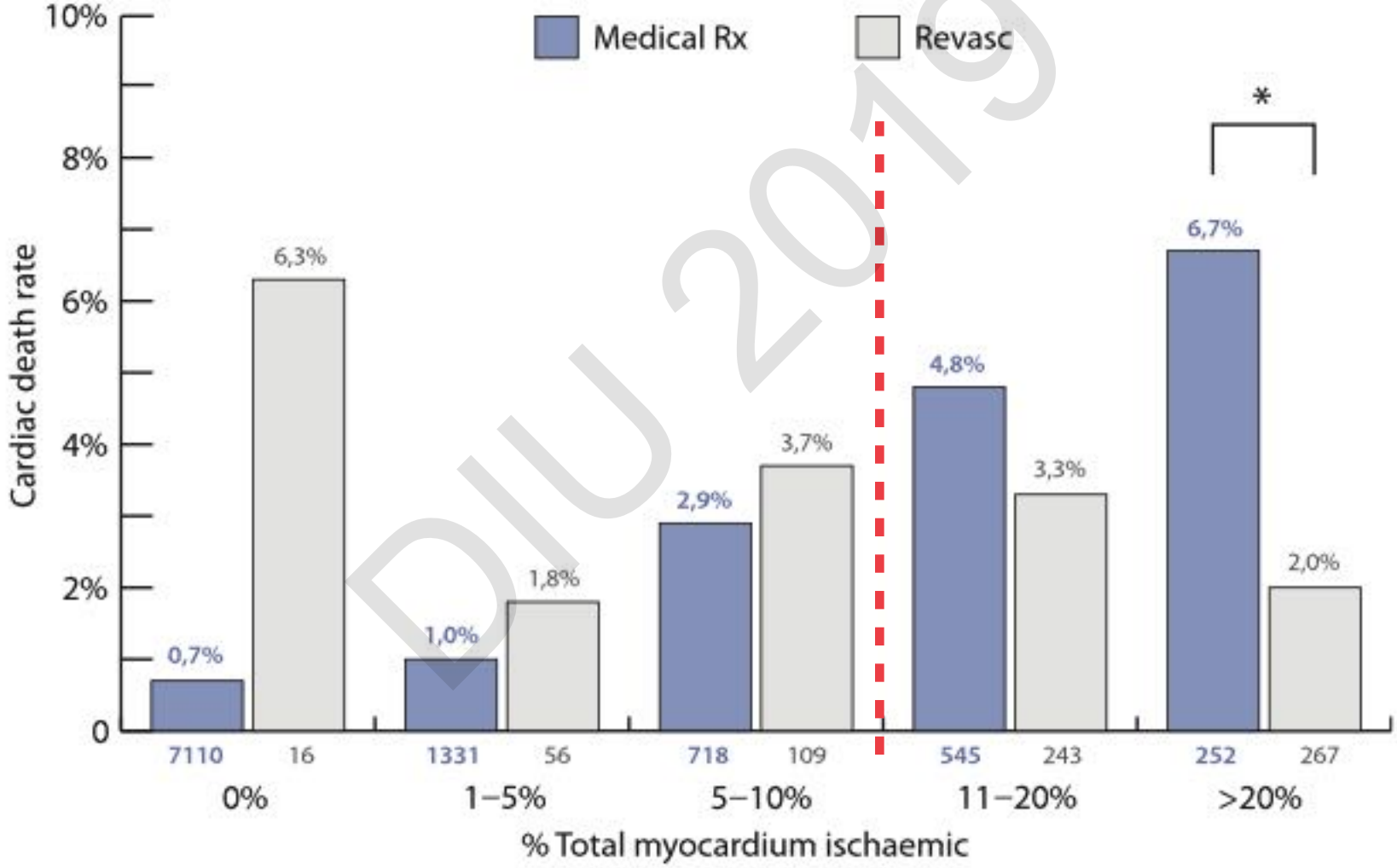
2013 ESC guidelines on the management of stable coronary artery disease

Table 12 Characteristics of tests commonly used to diagnose the presence of coronary artery disease

	Diagnosis of CAD	
	Sensitivity (%)	Specificity (%)
Exercise ECG [a, 91, 94, 95]	45–50	85–90
Exercise stress echocardiography[96]	80 85	80 88
Exercise stress SPECT[95-99]	73–92	63–87
Dobutamine stress echocardiography[96]	79–83	82–86
Dobutamine stress MRI[b,100]	79 88	81 91
Vasodilator stress echocardiography[96]	72–79	92–95
Vasodilator stress SPECT[96, 99]	90–91	75–84
Vasodilator stress MRI[b,98, 100-102]	67–94	61–85
Coronary CTA[c,102, 105]	95–99	64–83
Vasodilator stress PET[97, 99, 106]	81 97	74 91

European Heart Journal 2013; 34: 2949-3003

Relation entre extension de l'ischémie et mortalité d'origine cardiaque traitement medical vs revascularisation



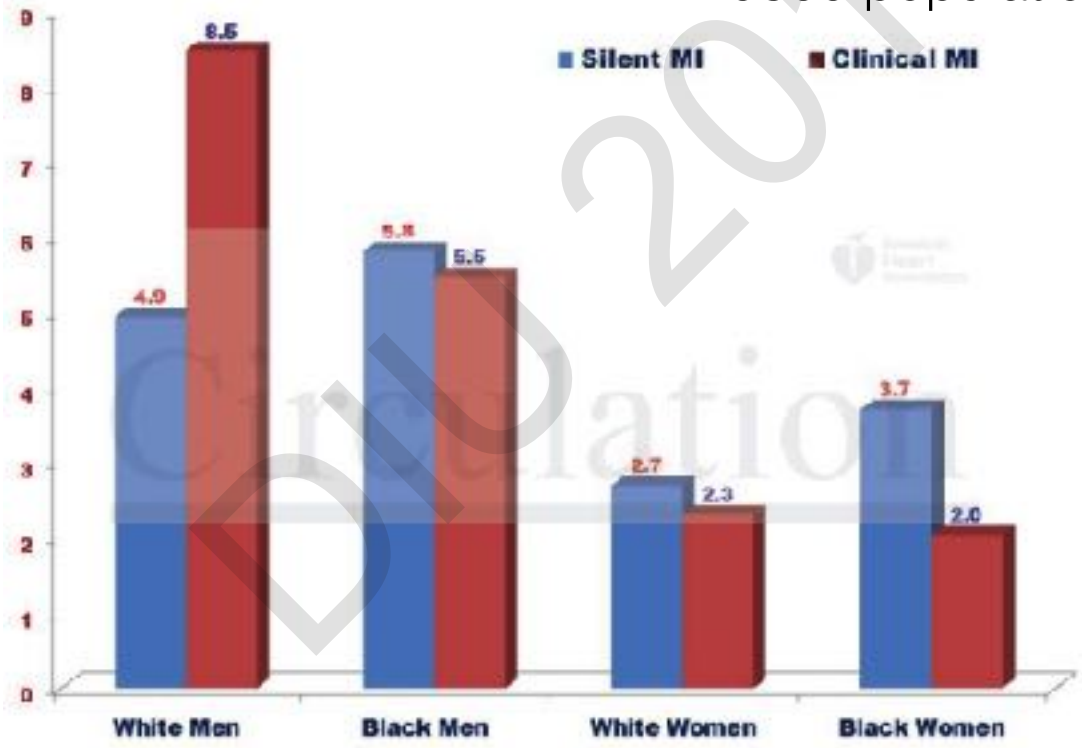
silent myocardial infarction (MI)

Circulation. 2016 May 31;133(22):2141-8. doi: 10.1161/CIRCULATIONAHA.115.021177. Epub 2016 May 16.

Race and Sex Differences in the Incidence and Prognostic Significance of Silent Myocardial Infarction in the Atherosclerosis Risk in Communities (ARIC) Study.

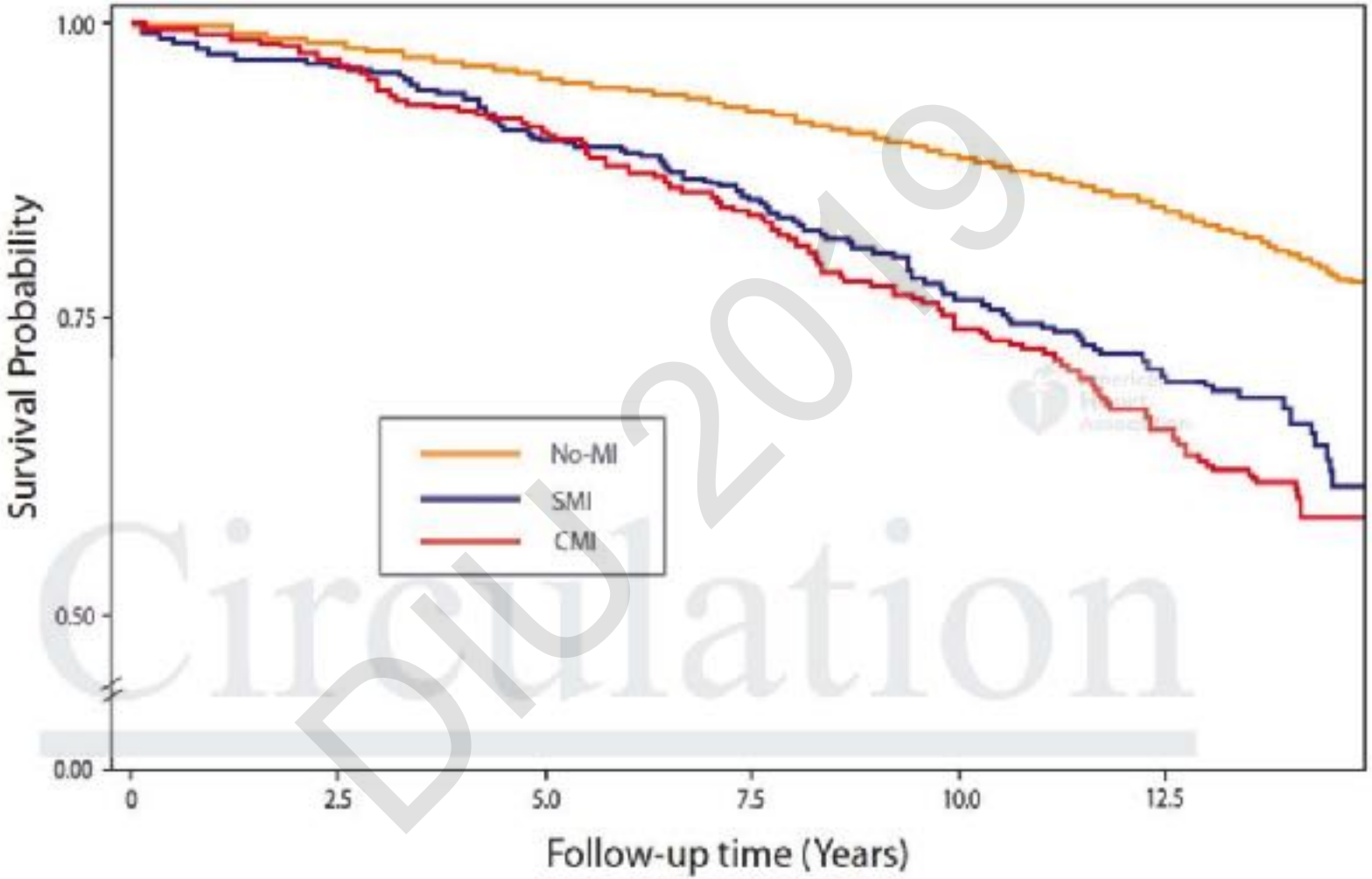
Zhang ZM[1], Rautaharju PM[2], Prineas RJ[2], Rodriguez CJ[2], Loehr L[2], Rosamond WD[2], Kitzman D[2], Couper D[2], Soliman EZ[2].

n=9500 population générale



3.3% Silent MI vs 4.1% clinical MI soit >45%

silent myocardial infarction (MI)



mauvais pronostic similaire si silencieux ou clinique

DEBATE ARTICLE

Screening asymptomatic patients with type 2 diabetes is recommended—Con

Raymond J. Gibbons, MD[a]

DEBATE ARTICLE

Screening asymptomatic patients with type 2 diabetes is recommended: Pro

Mario Petretta, MD,[a] and Alberto Cuocolo, MD[b]

[a] Department of Translational Medical Sciences, University Federico II, Naples, Italy
[b] Department of Advanced Biomedical Sciences, University Federico II, Naples, Italy

Received Nov 25, 2014; accepted Jul 23, 2015
doi:10.1007/s12350-015-0250-0

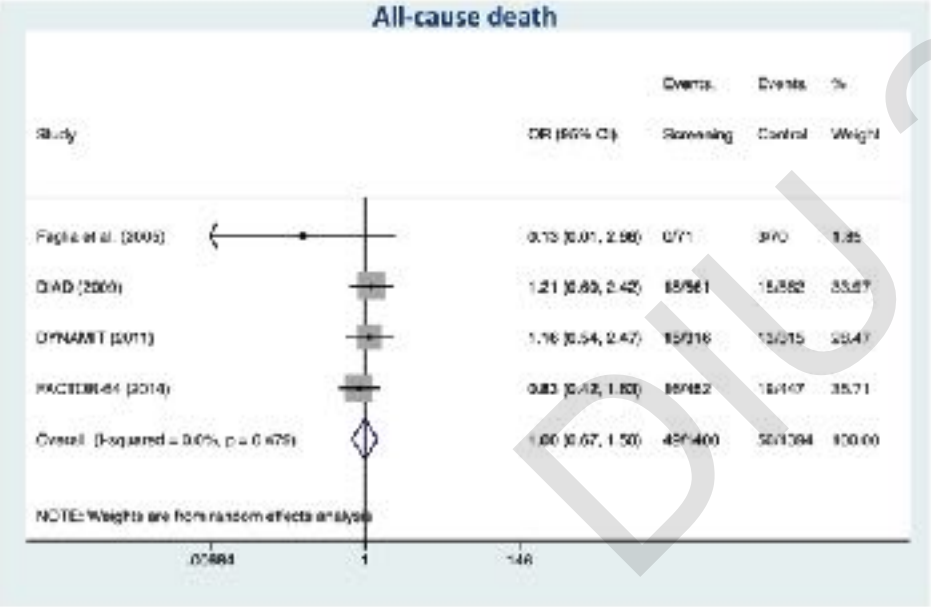
Bauters and Lemesle BMC Cardiovascular Disorders (2016) 16:90
DOI 10.1186/s12872-016-0256-9

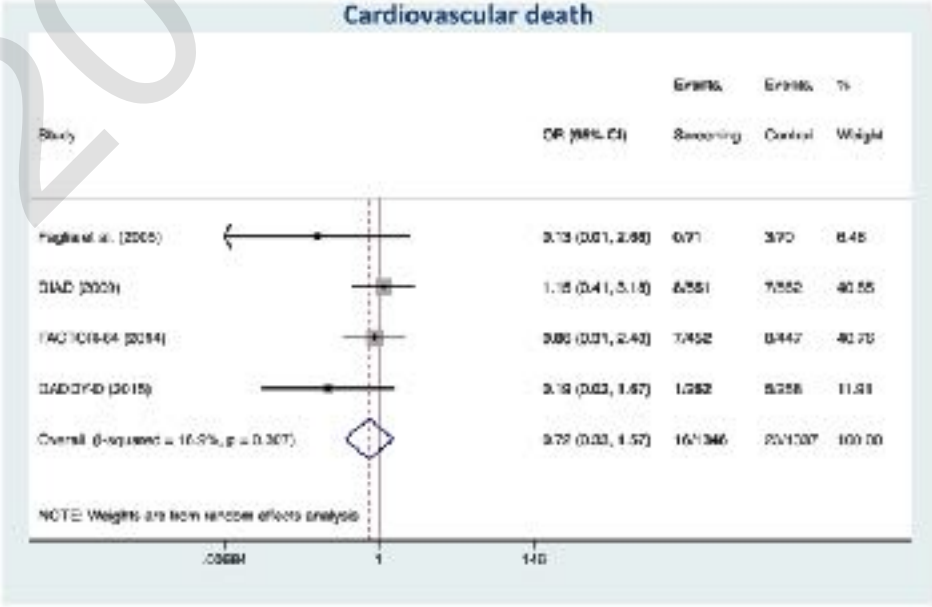
BMC Cardiovascular Disorders

RESEARCH ARTICLE Open Access

Screening for asymptomatic coronary artery disease in patients with diabetes mellitus: A systematic review and meta-analysis of randomized trials

Christophe Bauters[1,2,3,4*] and Gilles Lemesle[1,3,4]





The present analysis shows no evidence for a benefit of screening in term of outcome. The proportion of patients who undergo myocardial revascularization as a consequence of screening is low...

Overall, screening has no detectable impact on the prescription of preventive medications including statins, aspirin and ACE/ARB.

Comment se compare l'IRM de stress (perfusion) par rapport à la méthode de référence scintigraphique?

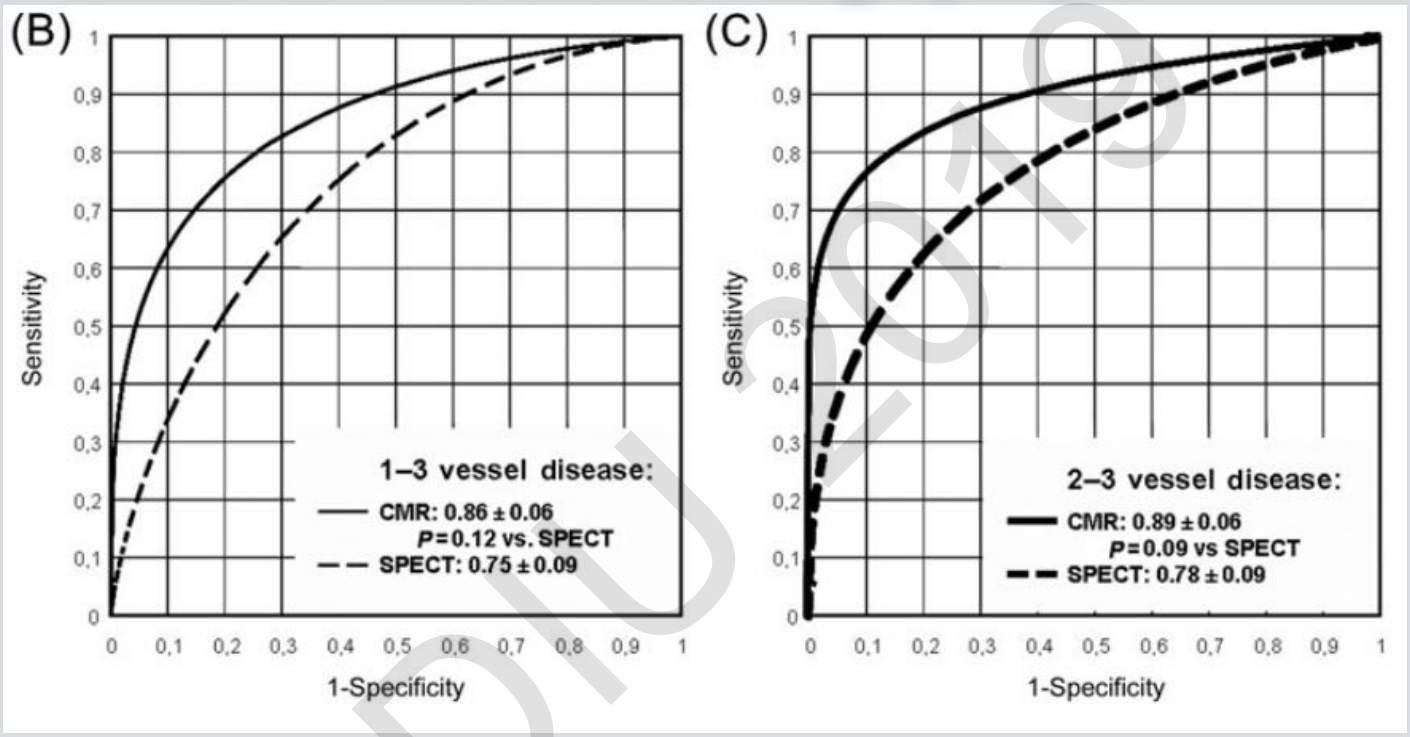
MR-IMPACT: comparison of perfusion-cardiac magnetic resonance with single-photon emission computed tomography for the detection of coronary artery disease in a multicentre, multivendor, randomized trial

Juerg Schwitter[1]*, Christian M. Wacker[2], Albert C. van Rossum[3], Massimo Lombardi[4], Nidal Al-Saadi[5], Hakan Ahlstrom[6], Thorsten Dill[7], Henrik B.W. Larsson[8], Scott D. Flamm[9], Moritz Marquardt[10], and Lars Johansson[6]

- comparaison IRM stress adenosine vs. SPECT pour la détection de la maladie coronarienne
- référence: coronarographie (sténose >50%)
- 18 centres, multivendeurs, 241 patients

European Heart Journal (2008) **29**, 480–489

Comment se compare l'IRM de stress (perfusion) par rapport à la méthode de référence scintigraphique?



L'IRM de stress (perfusion) (0.1 mmol/kg-Gd) a une performance diagnostique >= à la scintigraphie pour la détection de lésions coronariennes

European Heart Journal (2008) **29**, 480–489

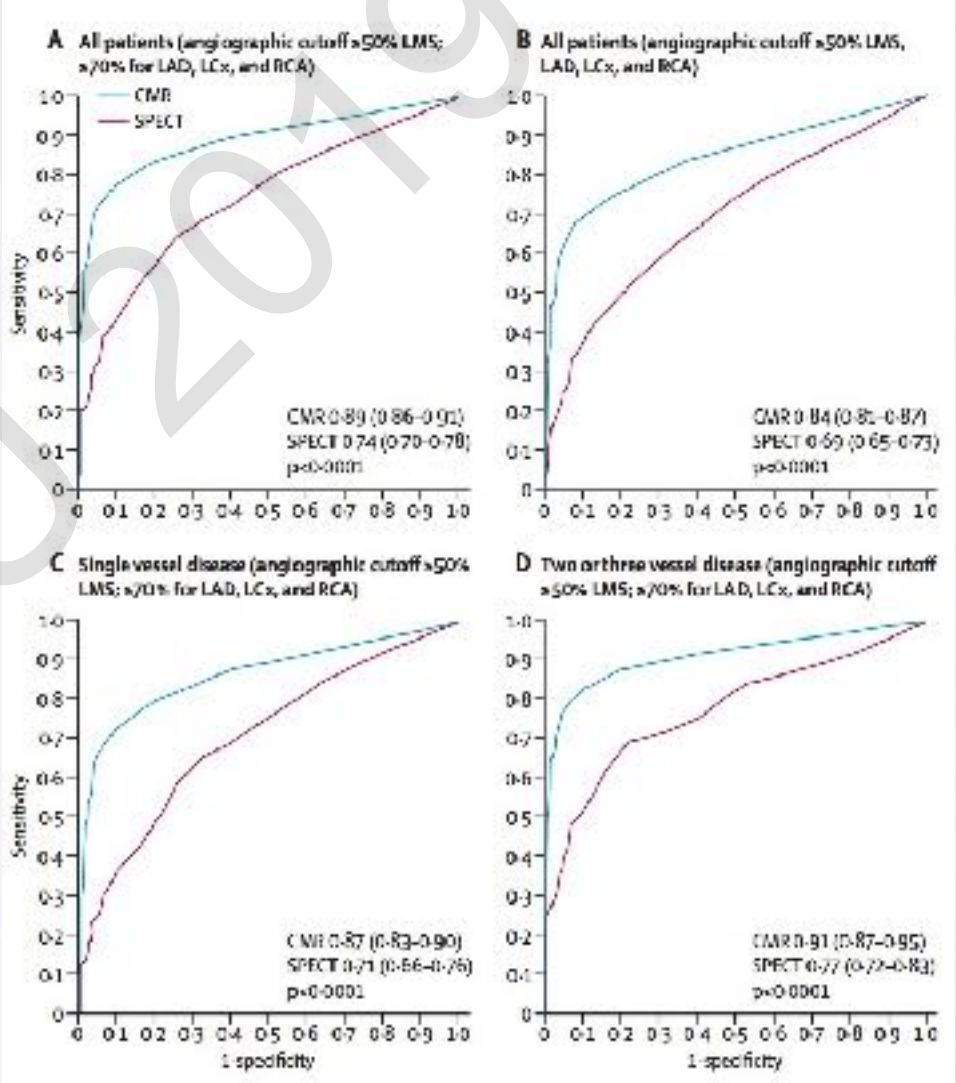
Cardiovascular magnetic resonance and single-photon emission computed tomography for diagnosis of coronary heart disease (CE-MARC): a prospective trial

John P Greenwood, Neil Maredia, John F Younger, Julia M Brown, Jane Nixon, Colin C Everett, Petra Bijsterveld, John P Ridgway, Aleksandra Radjenovic, Catherine J Dickinson, Stephen G Ball, Sven Plein

www.thelancet.com Published online December 23, 2011

- n=752 patients
  angina and 1 risk factor
  (prevalence CAD 39%)
- in randomized order
  tetrofosmin SPECT, CMR and
  Cath (no FFR)

CMR	SPECT
Se: 86.5%	Se: 66.5% p<0.001
Sp: 83.4%	Sp: 82.6%
PPV: 77%	PPV: 71%
NPV: 90.5%	NPV: 79% p<0.001

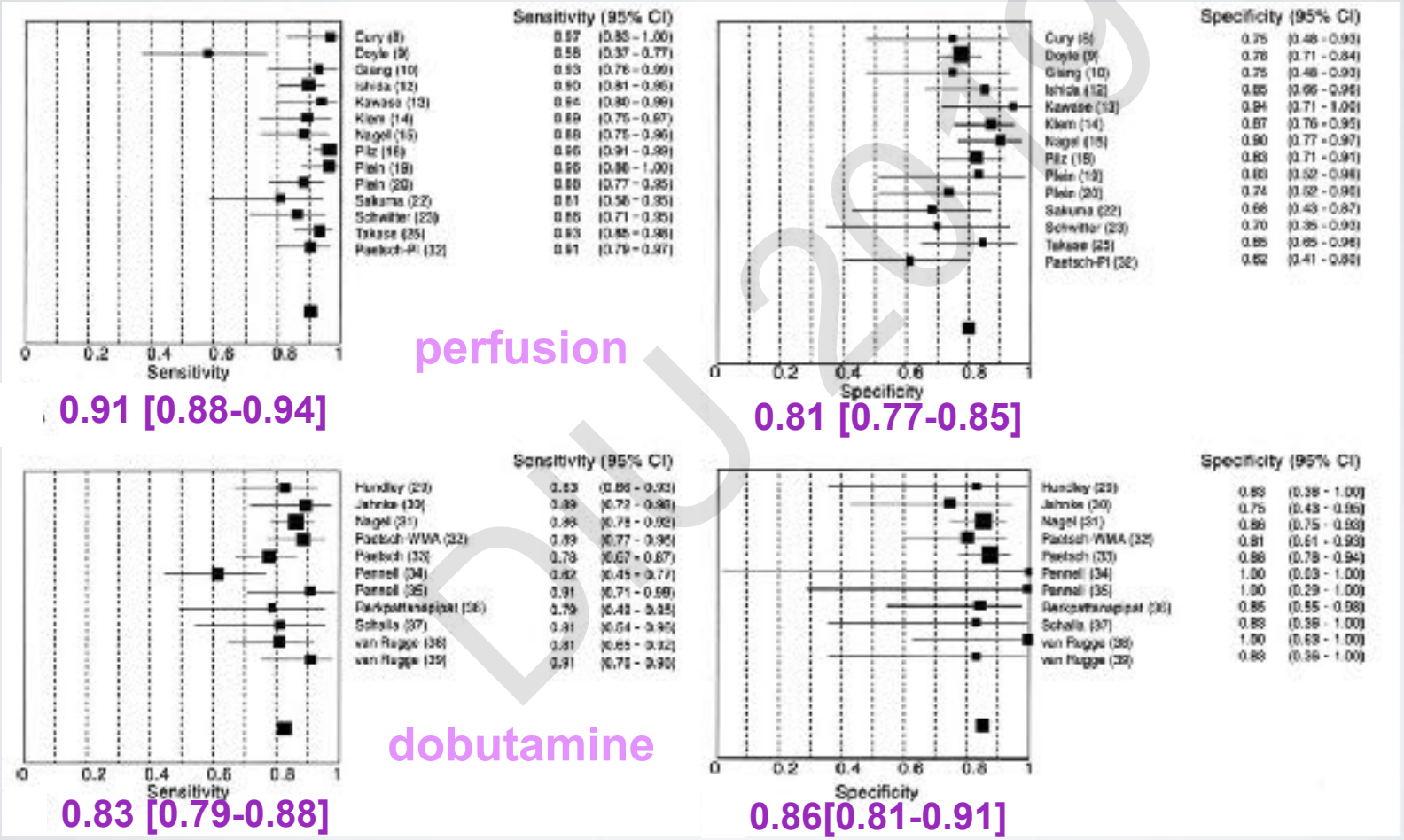


Diagnostic Performance of Stress Cardiac Magnetic Resonance Imaging in the Detection of Coronary Artery Disease

A Meta-Analysis

Kiran R. Nandalur, MD,* Ben A. Dwamena, MD,*† Asim F. Choudhri, MD,‡
Mohan R. Nandalur, MD,§ Ruth C. Carlos, MD, MS*

(J Am Coll Cardiol 2007;50:1343–53)



37 études, 2191 patients vs coro.(>50%), prévalence élevée 57.4%

Diagnostic Performance of Noninvasive Myocardial Perfusion Imaging Using Single-Photon Emission Computed Tomography, Cardiac Magnetic Resonance, and Positron Emission Tomography Imaging for the Detection of Obstructive Coronary Artery Disease

A Meta-Analysis

JACC 2012, 59:1719-28

Caroline Jaarsma, MD,*†‡ Tim Leiner, MD, PhD,†‡ Sebastiaan C. Bekkers, MD, PhD,*‡
Harry J. Crijns, MD, PhD,*‡ Joachim E. Wildberger, MD, PhD,†‡ Eike Nagel, MD, PhD,‖
Patricia J. Nelemans, MD, PhD,‡§ Simon Schalla, MD*‡

n=17901 patients

Table 1 Diagnostic Performance of SPECT, CMR, and PET Perfusion Imaging on Patient and Coronary Artery Territory Basis

	No. of Studies	Sensitivity (95% CI)	Specificity (95% CI)	DOR (95% CI)	RDOR (95% CI)	p Value
Patient basis						
SPECT	105	88 (88–89)	61 (59–62)	15.31 (12.66–18.52)		—
CMR	27	89 (88–91)	76 (73–78)	26.42 (17.69–39.47)	1.67 (1.07–2.61)	<0.05
PET*	11	84 (81–87)	81 (74–87)	36.47 (21.48–61.92)	2.25 (1.05–4.84)	<0.05
Coronary territory basis						
SPECT	45	69 (68–70)	79 (78–80)	11.75 (9.26–14.91)		—
CMR	17	84 (81–86)	83 (81–86)	24.11 (15.68–37.07)	2.58 (1.53–4.35)	<0.001
PET†	7	77 (73–81)	88 (84–90)	24.74 (16.57–39.30)	2.30 (1.10–4.77)	<0.05

vs SPECT

DOR: Diagnostic Odd Ratio, RDOR: relative Diagnostic Odd Ratio

PET vs CMR:

patient basis : RDOR=1.44[0.62-3.34] p=0.39

coronary territory basis RDOR=0.95[0.42-2.18] p=0.91

Valeur pronostique de l'IRM de stress?

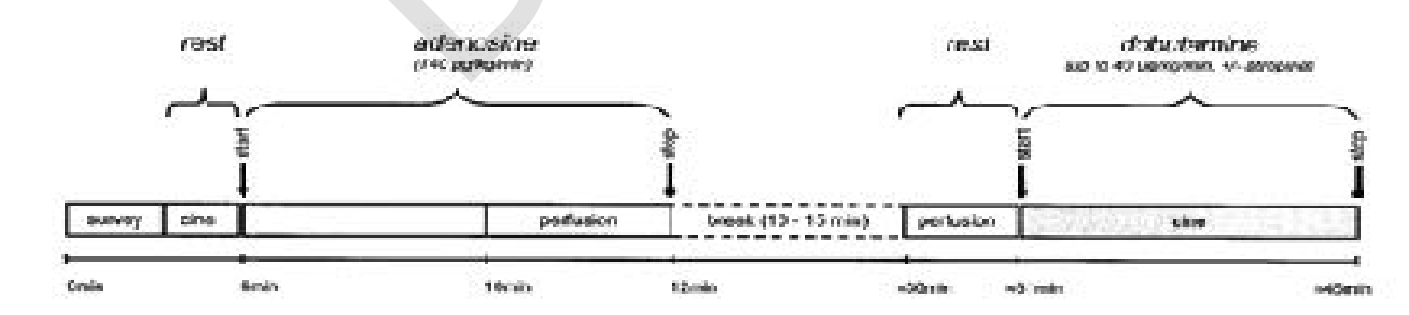
Prognostic Value of Cardiac Magnetic Resonance Stress Tests

Adenosine Stress Perfusion and Dobutamine Stress Wall Motion Imaging

Cosima Jahnke, MD; Eike Nagel, MD; Rolf Gebker, MD; Thomas Kokocinski, MD;
Sebastian Kelle, MD; Robert Manka, MD; Eckart Fleck, MD; Ingo Paetsch, MD

(*Circulation*. 2007;115:1769-1776.)

- 513 patients
- suspicion ou CAD avérée, douleurs thoraciques / dyspnée
- comparaison Stress Dobutamine & adénosine
- suivi sur médiane 2,3 ans (*0.6-4.5*) MACE (décès ou IDM)



Valeur prédictive de l'IRM de stress?

analyse univariée

TABLE 3. Univariate Predictors of Cardiac Death and Nonfatal Myocardial Infarction in Patients Undergoing Combined Adenosine Stress MRP and DSMR Wall Motion Imaging

	Univariate		
Parameter	HR	95% CI	*P*
Clinical			
Age*	1.52	0.92–2.51	0.100
Gender, male	2.45	0.71–8.42	0.154
Smoking	1.44	0.59–3.55	0.426
Hypertension	1.62	0.47–5.57	0.080
Hyperlipoproteinemia	3.70	0.85–16.00	0.440
Diabetes mellitus	2.55	1.00–6.48	0.049
Known CAD	3.60	1.19–10.84	0.023
Total risk factors >4	4.20	1.64–10.58	0.002
MR imaging			
WMA at rest	4.43	1.59–12.39	0.004
LVEF†	0.56	0.40–0.79	0.001
LVESV‡	1.18	1.08–1.28	<0.001
Inducible WMA	5.42	2.18–13.50	<0.001
Inducible MRP deficit	12.51	3.64–43.03	<0.001

LVEF indicates left ventricular ejection fraction; LVESV, left ventricular end-systolic volume.

*Per decade.

†Per 10% LVEF points.

‡Per 10-mL change.

(*Circulation*. 2007;115:1769-1776.)

Valeur prédictive de l'IRM de stress?

analyse univariée

TABLE 3. Univariate Predictors of Cardiac Death and Nonfatal Myocardial Infarction in Patients Undergoing Combined Adenosine Stress MRP and DSMR Wall Motion Imaging

	Univariate		
Parameter	HR	95% CI	*P*
Clinical			
Age*	1.52	0.92–2.51	0.100
Gender, male	2.45	0.71–8.42	0.154
Smoking	1.44	0.59–3.55	0.426
Hypertension	1.62	0.47–5.57	0.080
Hyperlipoproteinemia	3.70	0.85–16.00	0.440
Diabetes mellitus	2.55	1.00–6.48	0.049
Known CAD	3.60	1.19–10.84	0.023
Total risk factors >4	4.20	1.64–10.58	0.002
MR imaging			
WMA at rest	4.43	1.59–12.39	0.004
LVEF†	0.56	0.40–0.79	0.001
LVESV‡	1.18	1.08–1.28	<0.001
Inducible WMA	5.42	2.18–13.50	<0.001
Inducible MRP deficit	12.51	3.64–43.03	<0.001

LVEF indicates left ventricular ejection fraction; LVESV, left ventricular end-systolic volume.
*Per decade.
†Per 10% LVEF points.
‡Per 10-mL change.

analyse multivariée

DSMR (≥1 segments)
HR:4.7 (1.8-12.7) p=0.002

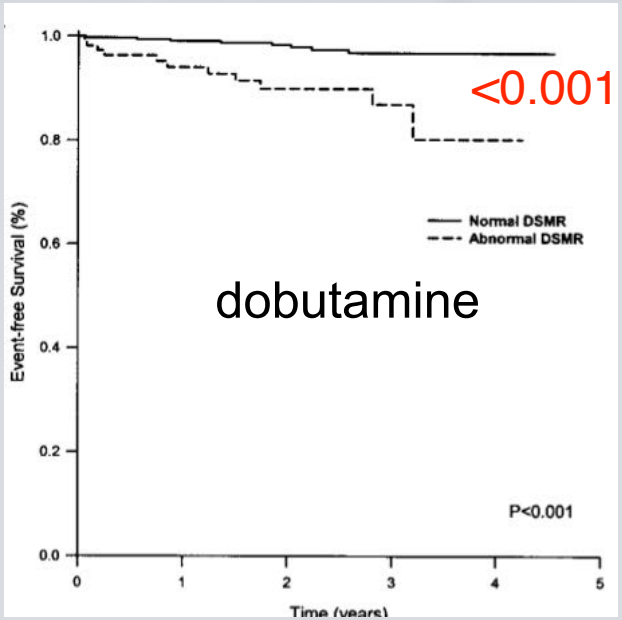
MRP (≥1 segments)
HR: 10.6 (2.8-39.1) p<0.001

autres variables NS

IRM stress (DSMR et MRP):
- seuls prédicteurs indépendants MACE
- valeur supérieure aux données cliniques et anomalies de repos pour prédire les événements

(*Circulation*. 2007;115:1769-1776.)

L'IRM de stress peut être utilisée pour la stratification du risque



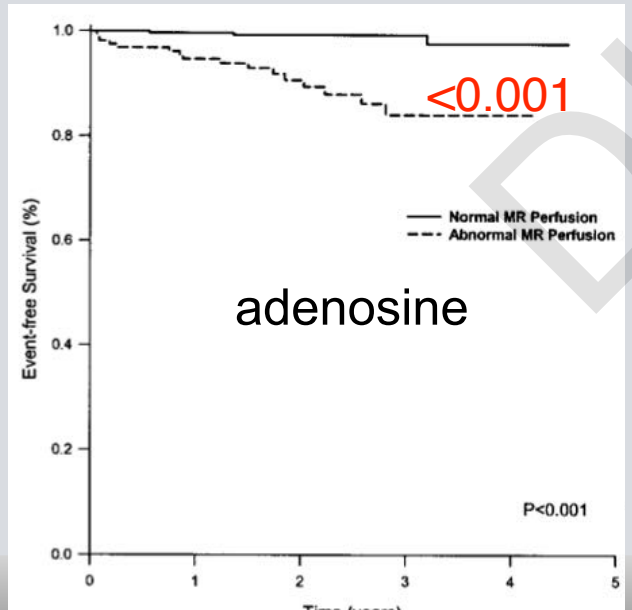


TABLE 4. Cumulative Event Rate During 3-Year Follow-Up According to the Results of MRP and DSMR Testing

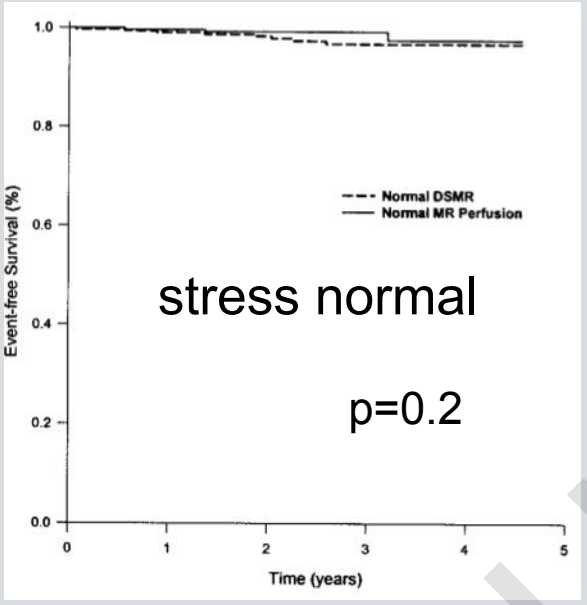
Result of MR Stress Testing	Cumulative Event Rate at Follow-Up Intervals, %		
	1 y	2 y	3 y
Normal DSMR	1.2	2.6	3.3
Abnormal DSMR	7.3	10.3	18.8
Normal MRP	0.7	0.7	2.3
Abnormal MRP	6.2	12.2	16.3
Normal DSMR and MRP	0.8	0.8	0.8
Abnormal DSMR and MRP	9.0	12.8	16.5

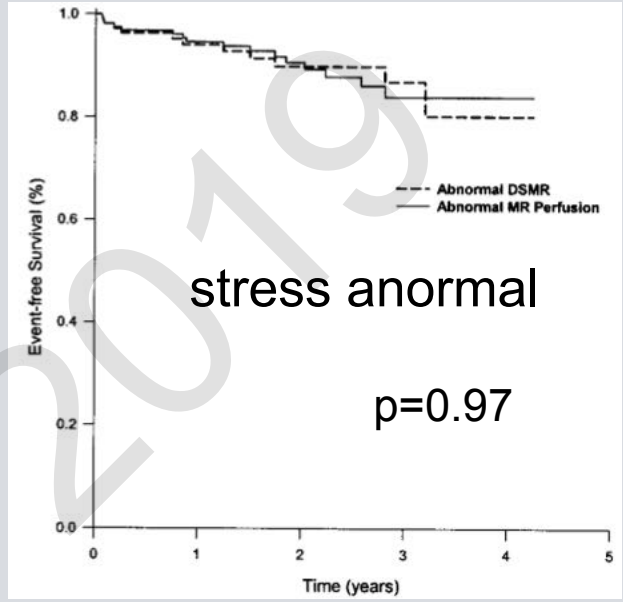
IRM stress permet d'identifier les patients à faible risque à court et moyen terme

valeur pronostique similaire au SPECT et echo dobutamine ≈ 1% évenements/an

(*Circulation*. 2007;115:1769-1776.)

Dobutamine ou adenosine?





les deux tests ont une valeur diagnostique et pronostique superposable

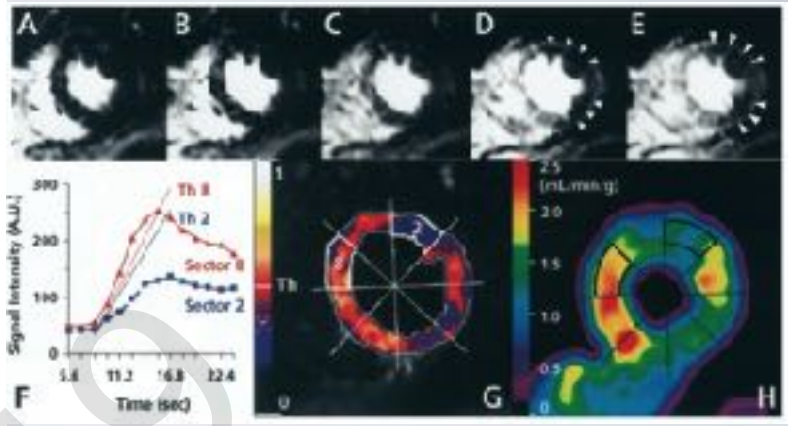
(*Circulation*. 2007;115:1769-1776.)

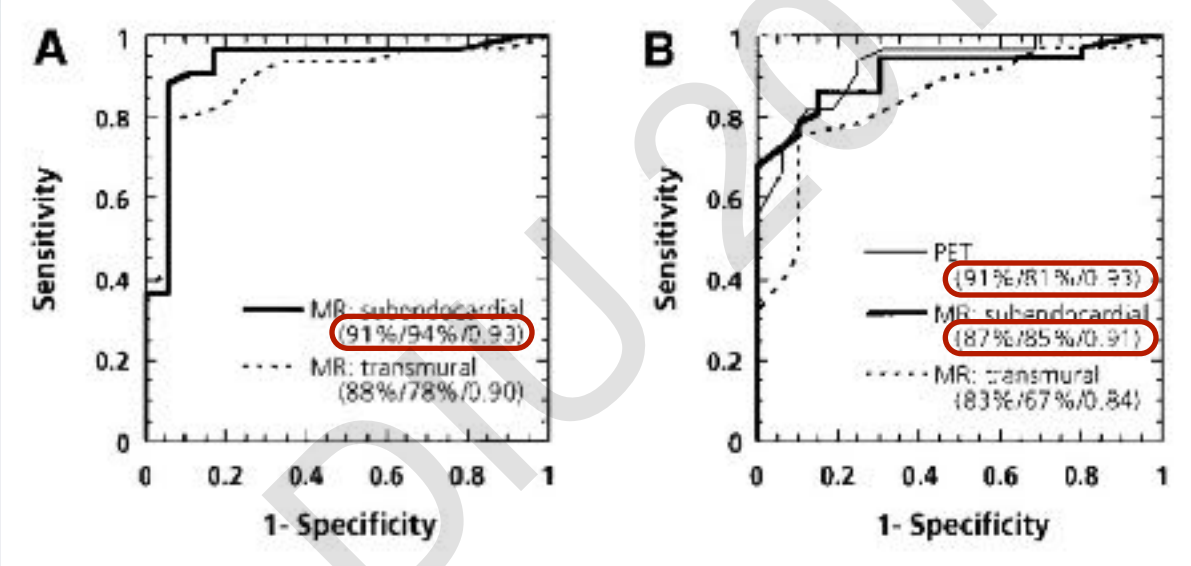
Circulation
JOURNAL OF THE AMERICAN HEART ASSOCIATION
American Heart Association.
Learn and Live.

Assessment of Myocardial Perfusion in Coronary Artery Disease by Magnetic Resonance : A Comparison With Positron Emission Tomography and Coronary Angiography

J. Schwitter, D. Nanz, S. Kneifel, K. Bertschinger, M. Büchi, P. R. Knüsel, B. Marincek, T. F. Lüscher and G. K. von Schulthess

Circulation 2001, 103:2230-2235



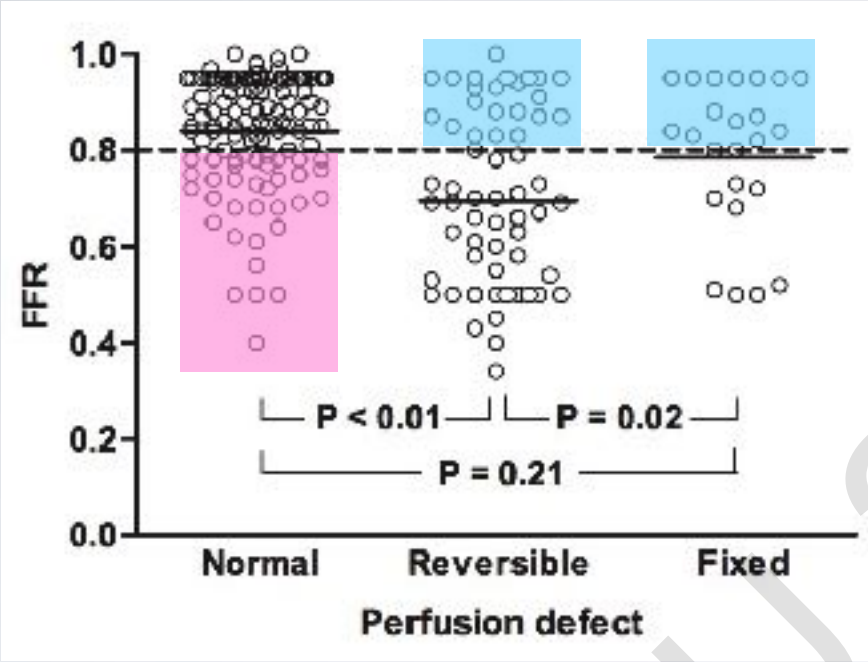


MR vs PET

MR and PET vs QCA

diagnostic performance of CMR and ^{13}N-PET are comparable
(based on sub-endocardial upslope data)

SPECT vs. FFR (patients multitronculaires)



- concordance FFR(<.8) et ischémie reversible en SPECT dans 42% cas

- Sur-estimation: 22%
- Sous-estimation:36%

67 pts (201 territoires) 2- ou 3-vx disease

Conclusions Myocardial perfusion imaging with single-photon emission computed tomography has poor concordance with FFR and tends to underestimate or overestimate the functional importance of coronary stenosis seen at angiography in comparison with FFR in patients with multivessel disease. These findings might have important consequences in using MPI to determine the optimal revascularization strategy in patients with multivessel coronary disease. (J Am Coll Cardiol Intv 2010;3:307–14)

Melikian et al. JACC interv (**2010**) 3; 3:307

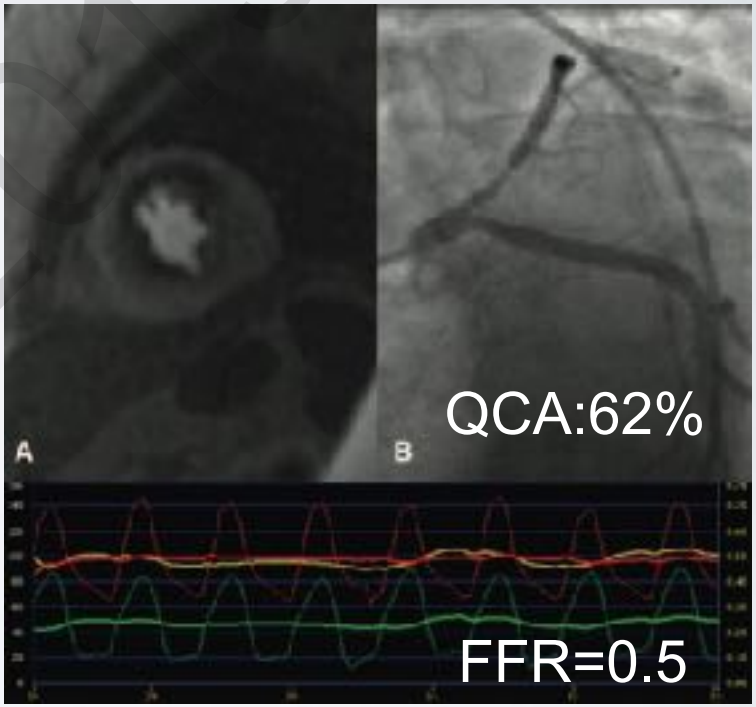
Validation of Magnetic Resonance Myocardial Perfusion Imaging With Fractional Flow Reserve for the Detection of Significant Coronary Heart Disease

Stuart Watkins, Ross McGeoch, Jonathan Lyne, Tracey Steedman, Richard Good, Mairi-Jean McLaughlin, Tony Cunningham, Vladimir Bezlyak, Ian Ford, Henry J. Dargie and Keith G. Oldroyd

Circulation 2009;120;2207-2213; originally published online Nov 16, 2009;
DOI: 10.1161/CIRCULATIONAHA.109.872358
Circulation is published by the American Heart Association. 7272 Greenville Avenue, Dallas, TX 72514

	FFR <0.75
Sensitivity, %	90.9 (84.2–97.6)
Specificity, %	93.9 (88.9–98.8)
PPV, %	90.9 (84.3–97.5)
NPV, %	93.9 (88.9–98.9)

n=103



IRM adenosine, 0.1mmol/kg Gd, SR-TFL, **quantification** (ratio pentes)

Conclusion—MRMPI can detect functionally significant coronary heart disease with excellent sensitivity, specificity, and positive and negative predictive values compared with FFR. (***Circulation*. 2009;120:2207-2213.**)

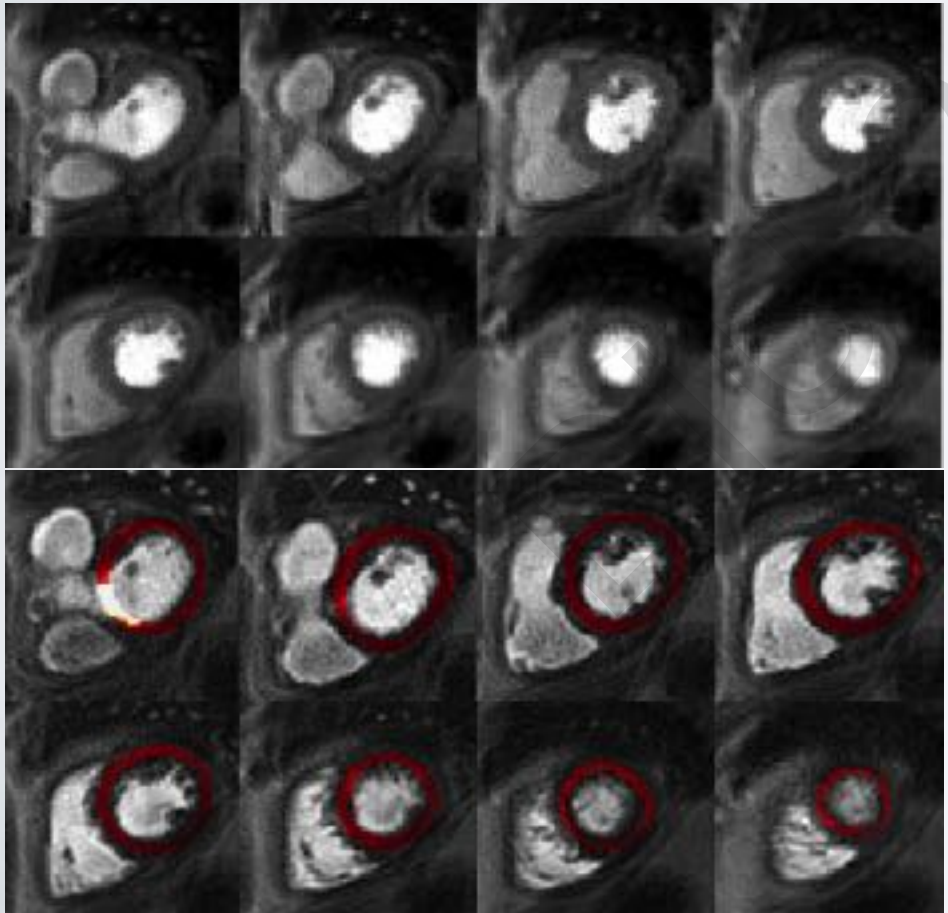
Watkins et al Circulation 2009;120:2207

3D WHOLE-HEART QUANTITATIVE FIRST-PASS PERFUSION IMAGING WITH A STACK-OF SPIRALS TRAJECTORY

Yang Yang[1], Xiao Chen[1], Frederick H. Epstein[1,2], Craig H. Meyer[1,2], Christopher M. Kramer[2,3], and Michael Salerno[2,3]
[1]Biomedical Engineering, University of Virginia, Charlottesville, VA, United States, [2]Radiology, University of Virginia, Charlottesville, VA, United States, [3]Medicine, University of Virginia, Charlottesville, VA, United States

acquisition 3D spiral - compress-sensing - moco
integrated AIF and FERMI modelling for absolute whole heart pixelwise perfusion quantification

(2.1mm², 240ms temporal window)



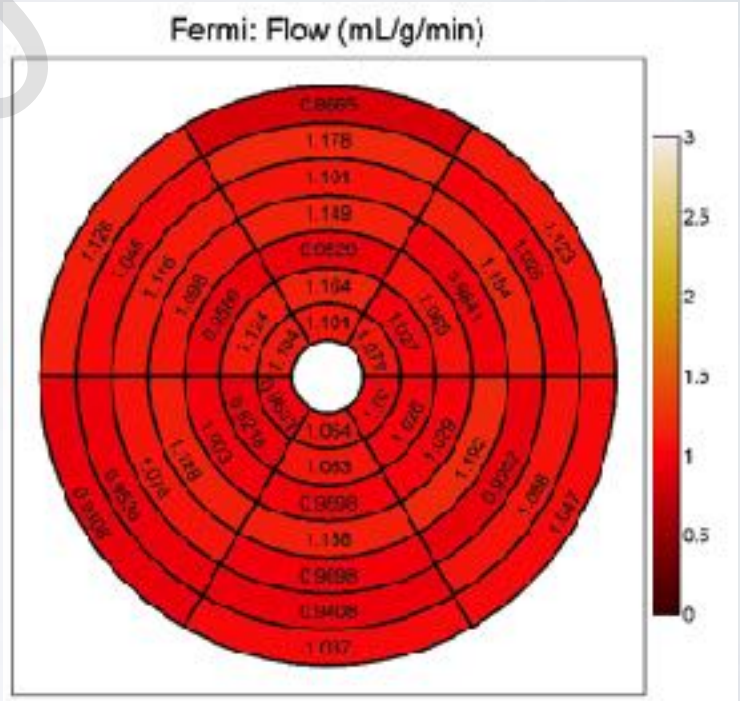
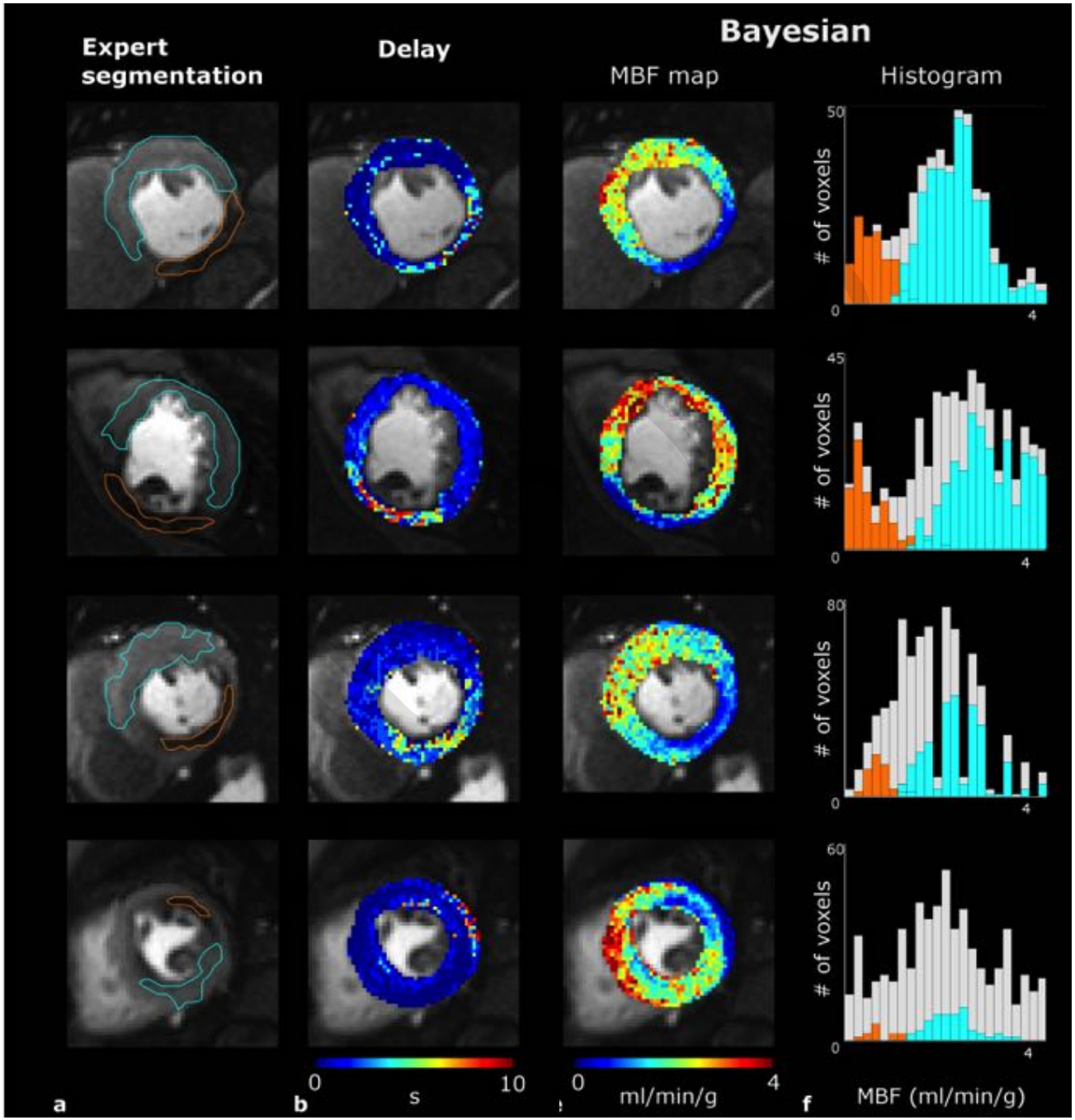
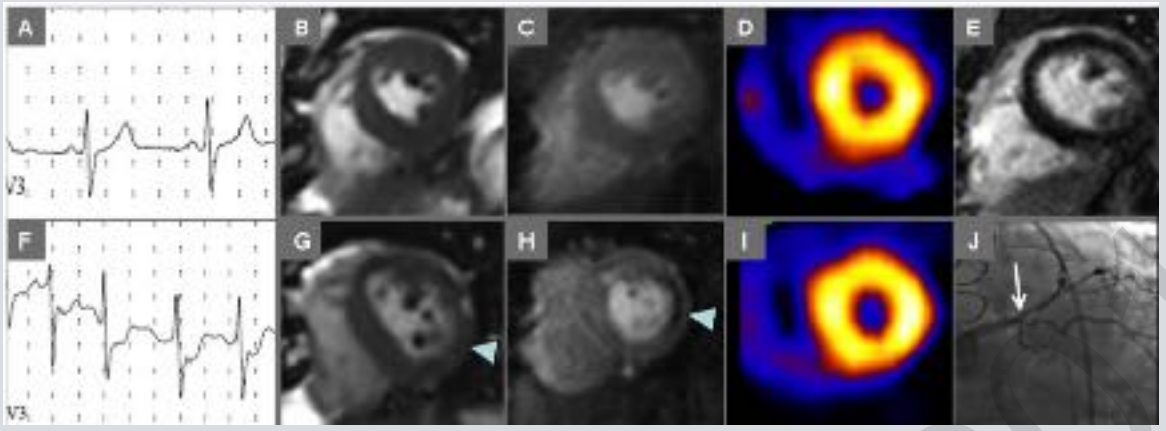


Figure 3. Bull-eye segmental perfusion map

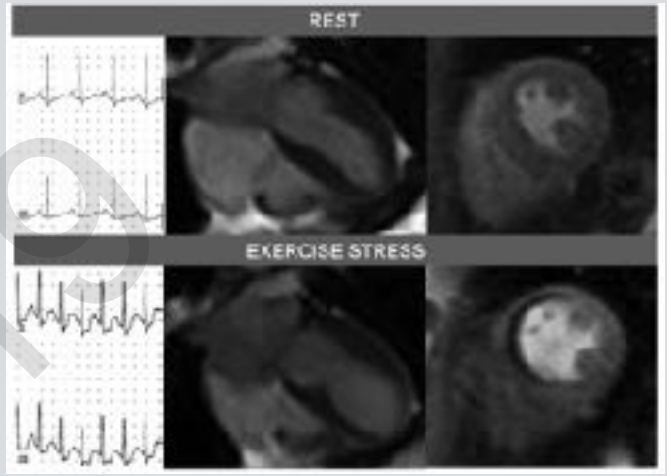
#0878-ISMRM 2014


Expert segmentation
Delay
Bayesian
MBF map
Histogram
# of voxels
50
0
4
45
80
60
0
s
10
ml/min/g
MBF (ml/min/g)
a
b
f

CMR à l'effort ?



Raman JCMR 2010



Raman, sv JACC 2008

Large bore MRI


SIEMENS

Conclusion

IRM de stress:

- performance diagnostique ≥ SPECT + avantages IRM spécifiques
- valeur pronostique et stratification du risque
- dobutamine ≈ perfusion mais nécessite formation et expérience
- valeur ajoutée d'une analyse semi-quantitative voire quantitative

UNIVERSITÉ DE LYON

SIEMENS

Cours Particuliers d'IRM Cardiaque

(places limitées à 10 personnes, 2 personnes par simulateur/console)

Prochaines dates: 25-29 Juin 2018

La Plateau IRM

L'IRM cardiaque est effectuée sur le site de l'hôpital Nord du CHU de Saint Etienne (RdC IRMAS), sur un plateau composé de deux IRM Siemens: MAGNETOM Prisma 3T et MAGNETOM 1,5T Aera).

IRM 3T Prisma (Siemens Healthcare)

IRM 1.5T Aera (Siemens Healthcare)

On-Site training

L'Apprentissage personnalisé sur site (On-site training) est une modalité de formation destinée aux professionnels qui souhaitent une formation urgente et/ou individualisée (accueil et formation dédiée et réservée à vous et votre équipe de 2 manipulateurs IRM maximum), en complément de celles que nous organisons en ateliers intensifs niveau 1 et 2 (groupes de 10).

Cette formation comprend un approfondissement théorique « à la demande », ainsi que qu'un apprentissage didactique pragmatique car "pratique" au fil des vacat… Professeur Croisille, incluant le suivi de la… des examens cardiaque, le post-traitement … logiciels utilisés sur le site, l'utilisat…

Théorie et applications sur Simulateurs

Applications Pratiques sur volontaires et patients

Contact: croisille@creatis.insa-lyon.fr

Merci