

# QUELQUES ACTUALITES EN CARDIOLOGIE ISOTOPIQUE

Scintigraphie myocardique de perfusion  
Scintigraphie myocardique d'innervation  
Analyse des dépolarisations intra-ventriculaires

**APPROPRIATE USE CRITERIA**

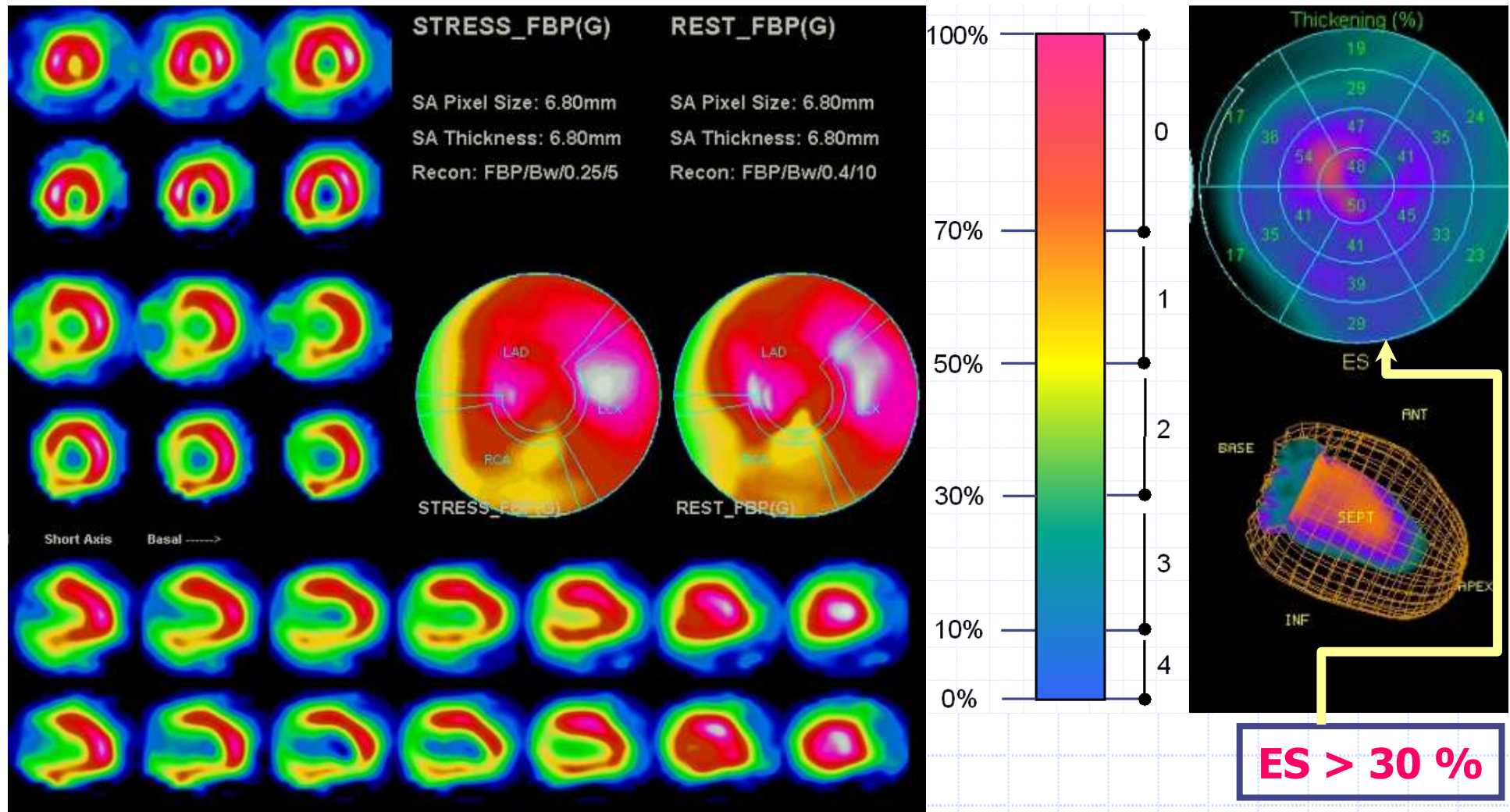
# INDICATIONS

## **ACCF/ASNC/ACR/AHA/ASE/SCCT/SCMR/SNM 2009 Appropriate Use Criteria for Cardiac Radionuclide Imaging**

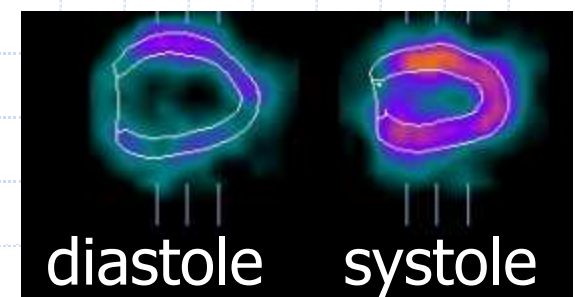
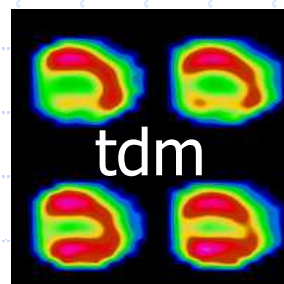
A Report of the American College of Cardiology Foundation Appropriate Use Criteria Task Force, the American Society of Nuclear Cardiology, the American College of Radiology, the American Heart Association, the American Society of Echocardiography, the Society of Cardiovascular Computed Tomography, the Society for Cardiovascular Magnetic Resonance, and the Society of Nuclear Medicine

*Endorsed by the American College of Emergency Physicians*

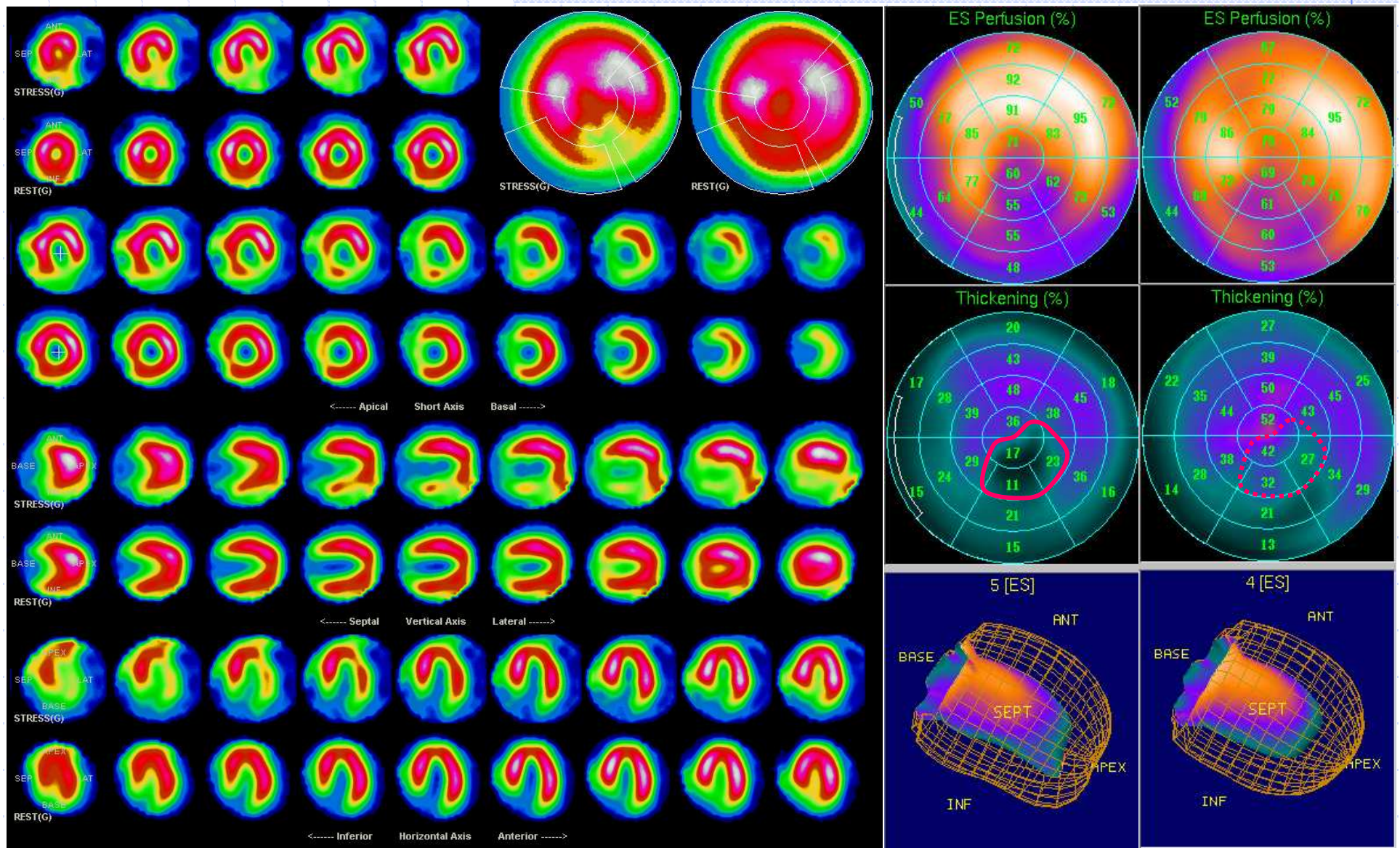
- ◆ Douleur thoracique aiguë (ECG n, BBG, pace)
- ◆ Après un syndrome coronarien aiguë
- ◆ Contrôle après un examen douteux
- ◆ Bilan pré-opératoire si 1 FRCV
- ◆ Bilan initial de FE ↓, TV, syncope + FRCV
- ◆ Facteurs de RCV(10 ans)>20%, dont
  - Coronariens connus, artériopathie périphérique
  - Diabète>40 ans ± artériopathie, rétinopathie, néphropathie, 2 FRCV



- Sensibilité  $\approx 90\%$
- Spécificité  $\approx 80\%$



EJNM 2005;32(7) - Semin Nucl Med 2005;35:37-51 - J Nucl Cardiol 2009;16(4):590-596 - J Nucl Cardiol 2002;9:183-187 -  
 Semin Nucl Med 2005;35:37-51 - G. Mowatt. Health Technology Assessment 2004; 8(30):1-222 (3032 patients)



Ischémie + ↓ ES ⇒ sidération d'effort: Sténose > 80%

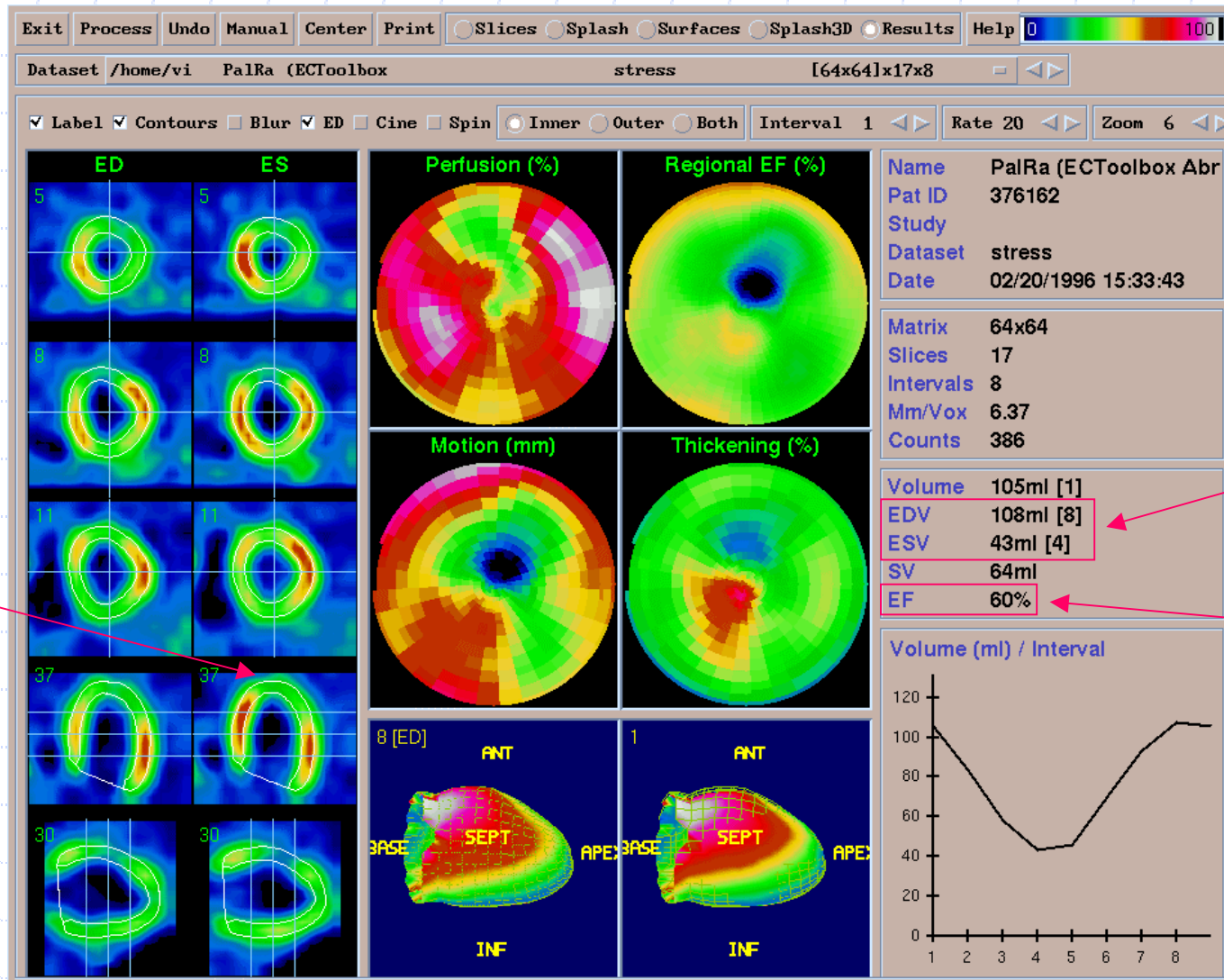
J Am Coll Cardiol 2002;39:991-8 - Clin Nucl Med 2009;34(10) :731-3

# « Spirale ischémique... »

STRESS	REPOS	REDISTRIBUTION	FONCTION	DIAGNOSTIC
N HYPO	N HYPO	N HYPO	N	Normal
± N	± N	± N	HYPO	REMODELAGE
HYPO	N	N	N	ISCHEMIE
HYPO	± N	± N	HYPO	SIDERATION
HYPO	HYPO	N	HYPO	HIBERNATION
HYPO	HYPO	HYPO	HYPO	NECROSE

+ Etude possible de la réserve contractile  
 (↑ fonction sous 5 µg/kg/min de dobutamine)

# Volumes et FE du ventricule gauche



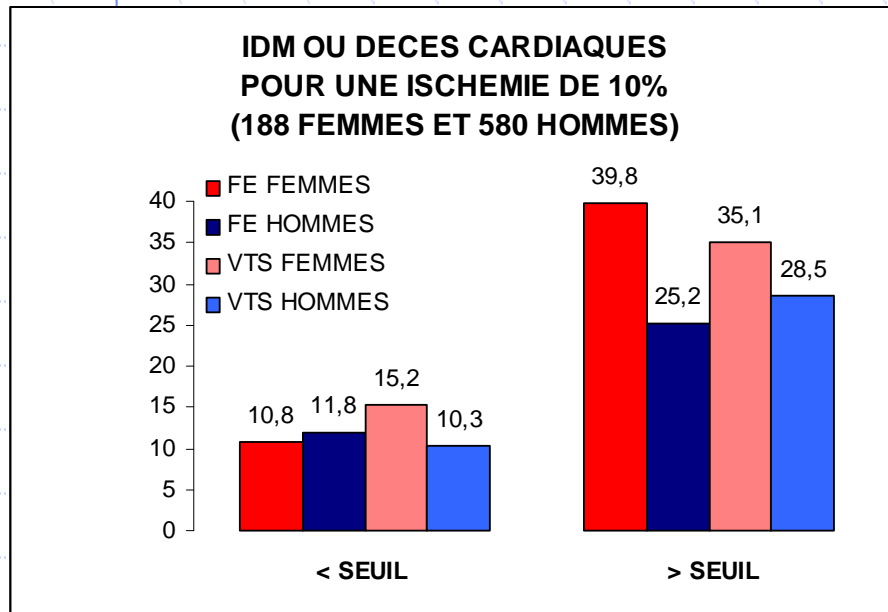
Épaississement systolique

volumes

fraction

# Intérêt pronostique de la FE et du VTS

Suivi sur 3 ans

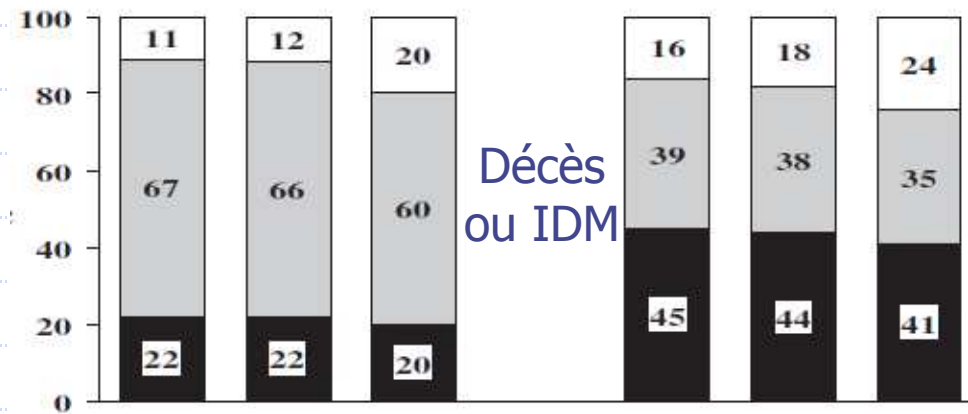
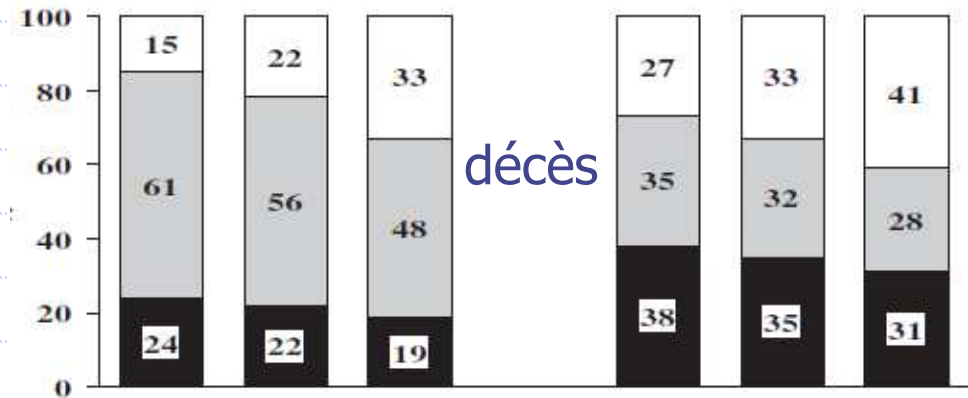


SEUILS :

Femmes : FE 51%    VTS 27 ml/m<sup>2</sup>

Hommes : FE 43%    VTS 39 ml/m<sup>2</sup>

% $\chi^2$

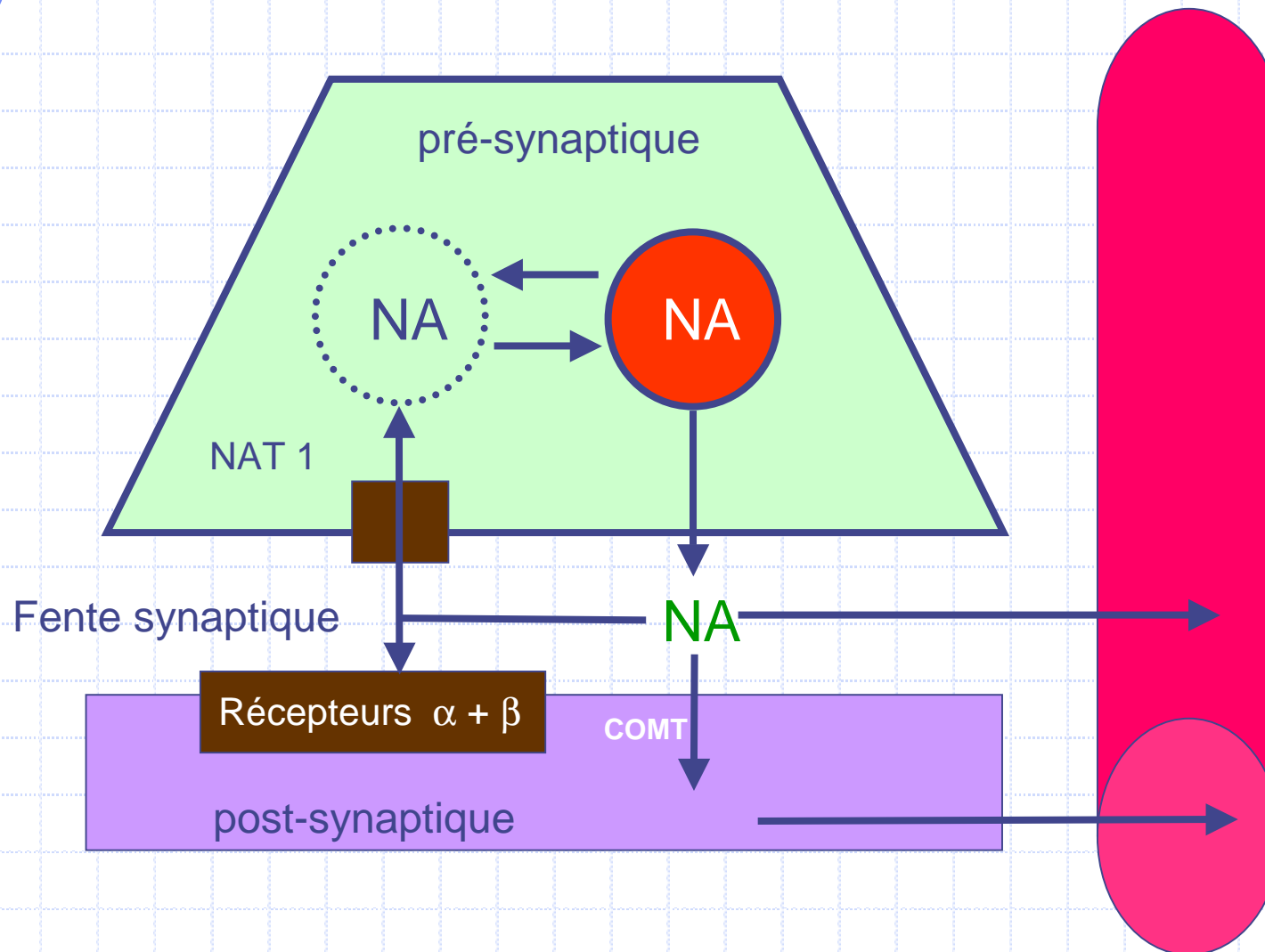


Prescan+ % myo stress+ EF	Prescan+ % myo stress+ EDVi	Prescan+ % myo stress+ ESVi	Prescan+ % myo stress+ EF	Prescan+ % myo stress+ EDVi	Prescan+ % myo stress+ ESVi
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**2735 femmes**

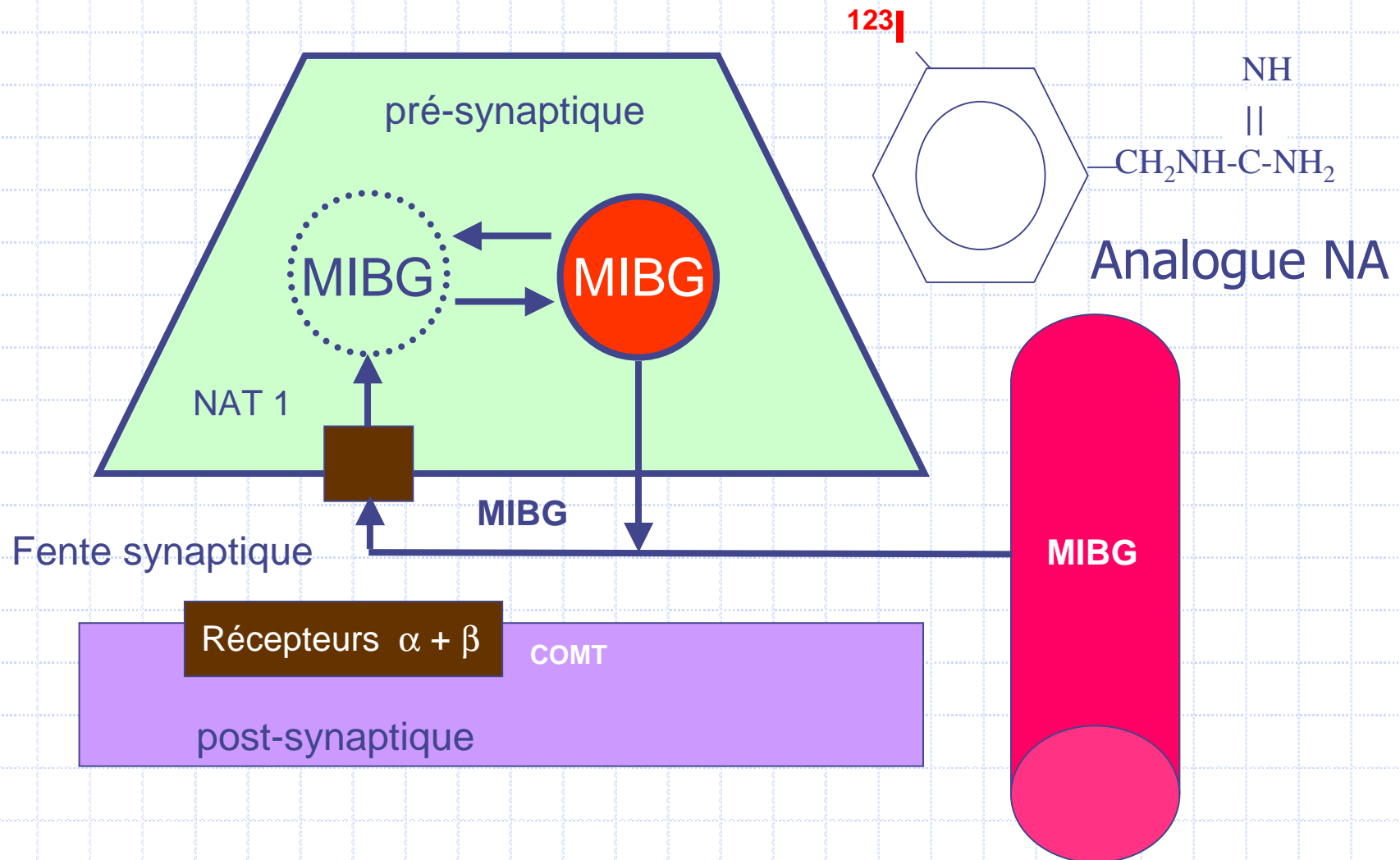
**3978 hommes**

# Innervation sympathique

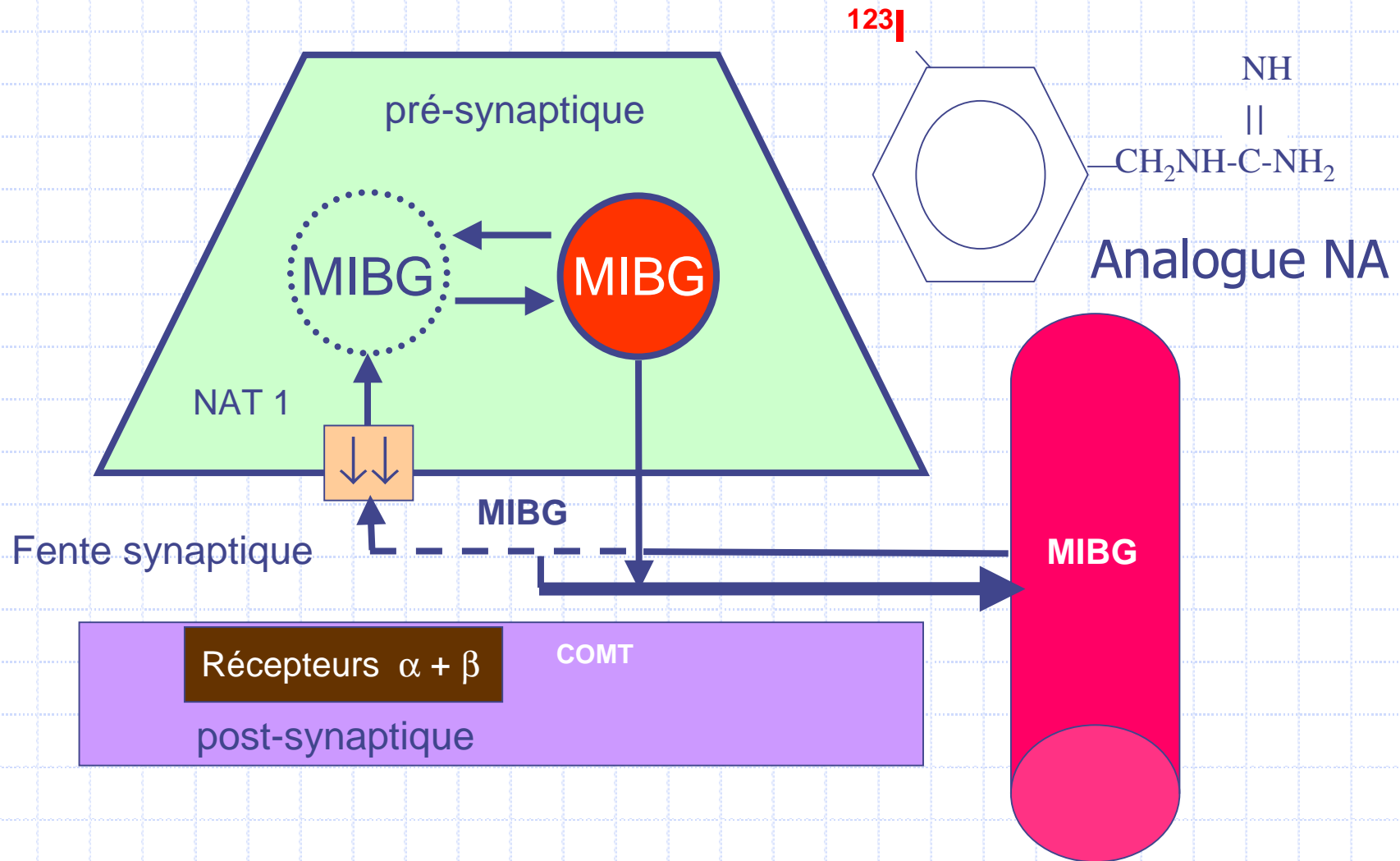




# La MIBG : fixation normale



# Innervation sympathique patho.

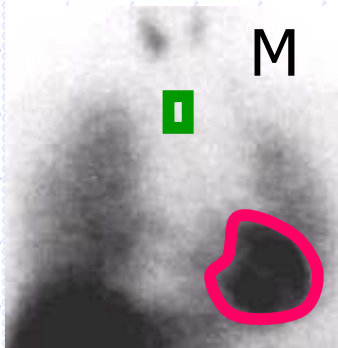


# ASPECTS SCINTIGRAPHIQUES

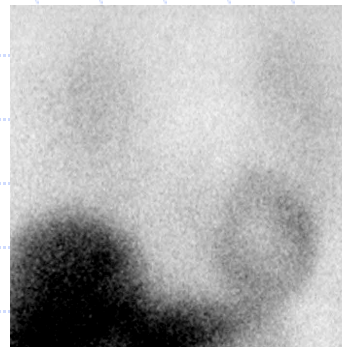
MIBG = « stock » adrénérgique des fibres pré-synaptiques



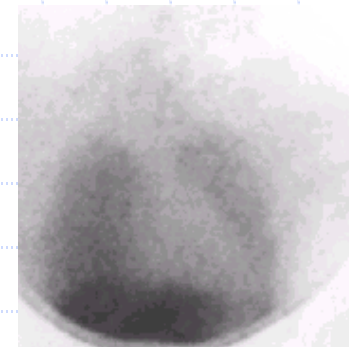
Evolution progressive de l'insuffisance cardiaque



Innervation normale



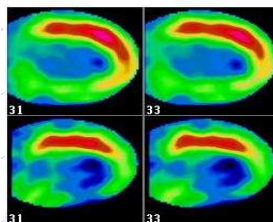
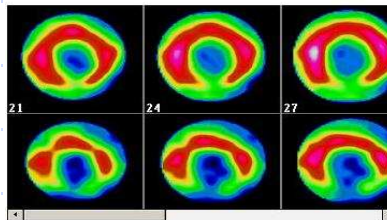
NYHA II



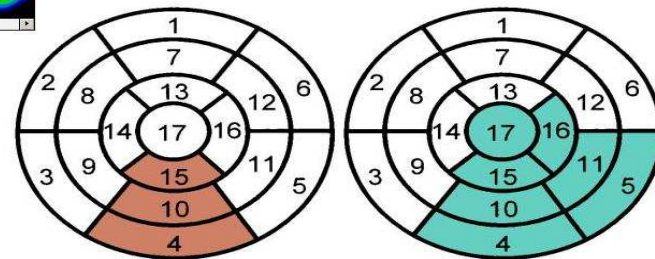
NYHA IV

Rapport H/M  
washout (15'-4h)

SPECT



Infarction  
Dysinnervation



# 20 ans déjà...

Plus de 250 publications...

**Mais...**

Monocentriques, petits nombre de patients

Protocole d'imagerie non standardisé

Critères diagnostiques et endpoints pas toujours initialement définis

Pronostique  
Manrique et al  
EJNMMI

ADMIRE-HF

1992

2008

2009

2010

Prognostique  
Merlet et al  
J Nucl Med

Meta-analyse  
Verberne et al  
European Heart

Etude rétrospective  
Agostini et al  
EJNMMI

BOOGERS

ADMIRE-HF

# Etude ADMIRE HF

◆ 95 centres

◆ 961 patients

- 66% ischémique / 34% non-ischémique
- Classe II / III NYHA
- FEVG < 35% (écho, ventriculographie isotopique)
- 33% de la population implantée avec DAI
- Suivi sur 2 ans de
  - l'évolution de l'IC,
  - d'évènements arythmiques et de
  - mort subite

◆ Traitement optimisé : IEC (94%),  $\beta$ B (92%)

◆ MIBG, Perfusion, BNP, FE, NA plasma.

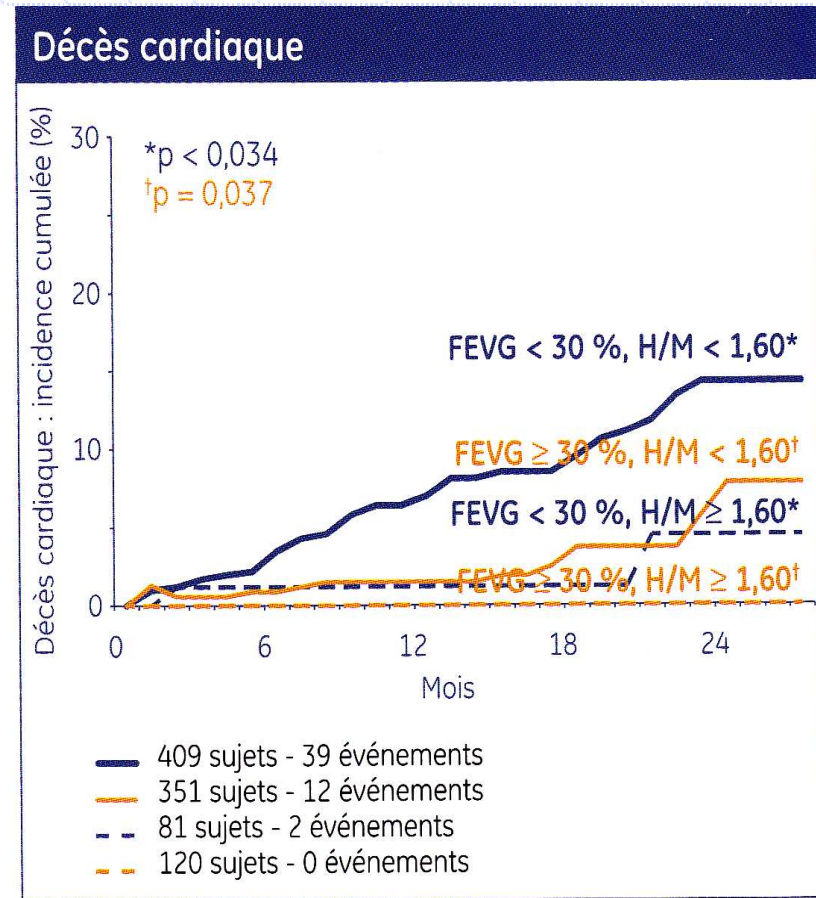
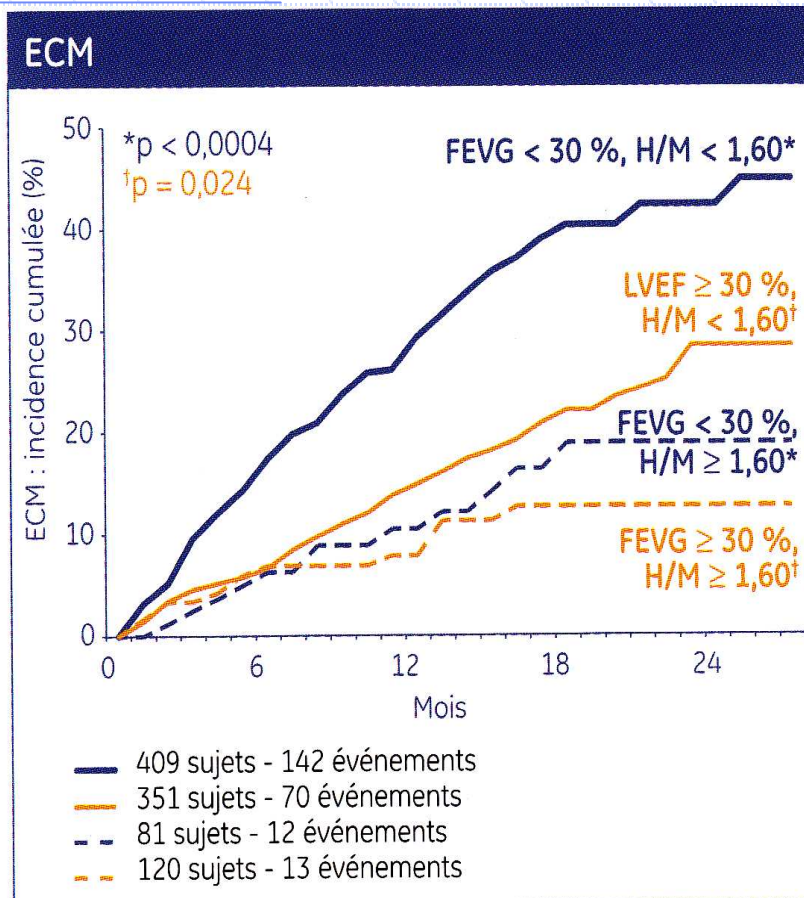
## Myocardial Iodine-123 Meta-Iodobenzylguanidine Imaging and Cardiac Events in Heart Failure

Results of the Prospective ADMIRE-HF (AdreView  
Myocardial Imaging for Risk Evaluation in Heart Failure) Study

Arnold F. Jacobson, MD, PhD,\* Roxy Senior, MD,† Manuel D. Cerqueira, MD,‡  
Nathan D. Wong, PhD,§ Gregory S. Thomas, MD, MPH,§ Victor A. Lopez, BS,§  
Denis Agostini, MD, PhD,|| Fred Weiland, MD,¶ Harish Chandna, MD,# Jagat Narula, MD, PhD,§  
on behalf of the ADMIRE-HF Investigators

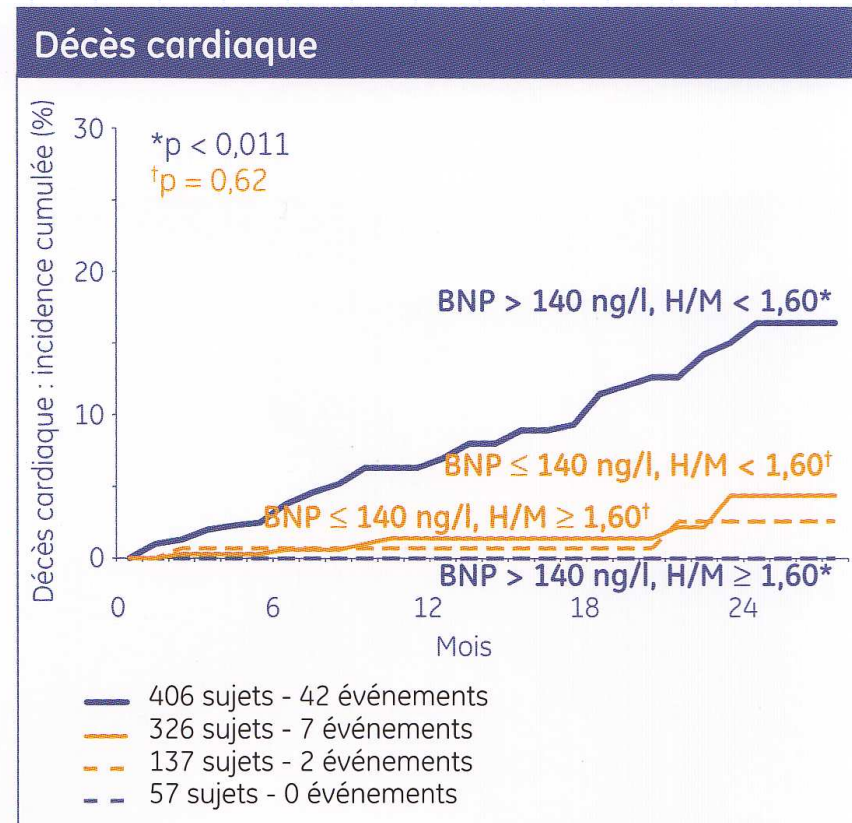
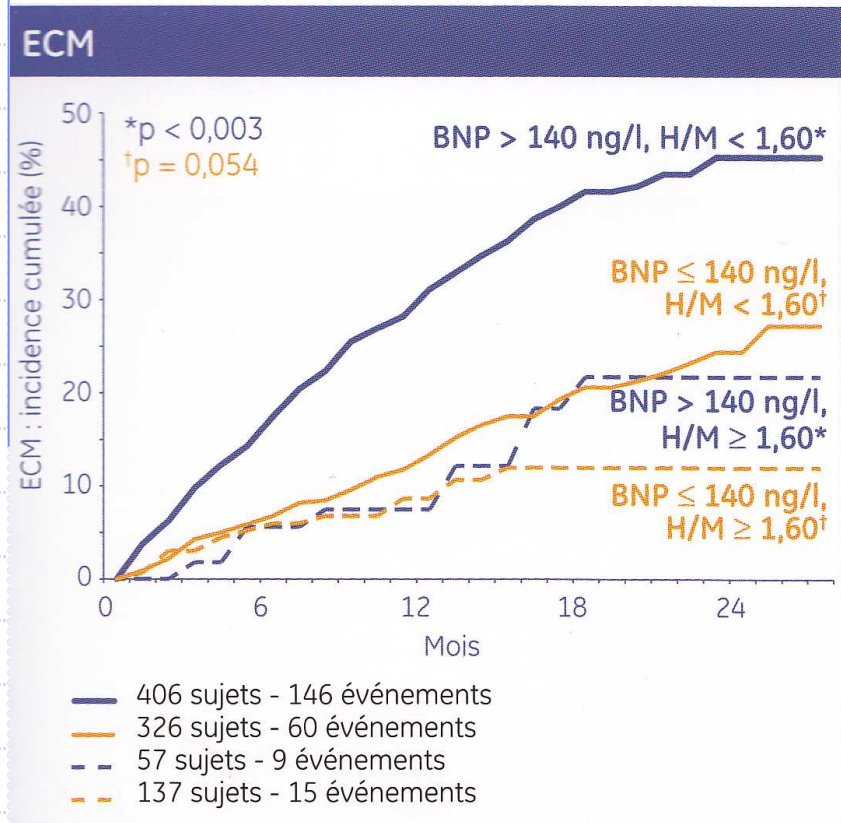
*Princeton, New Jersey; London, United Kingdom; Cleveland, Ohio; Irvine, California; Caen, France;  
Roseville, California; and Victoria, Texas*

# MIBG et FEVG (médiane 29%)



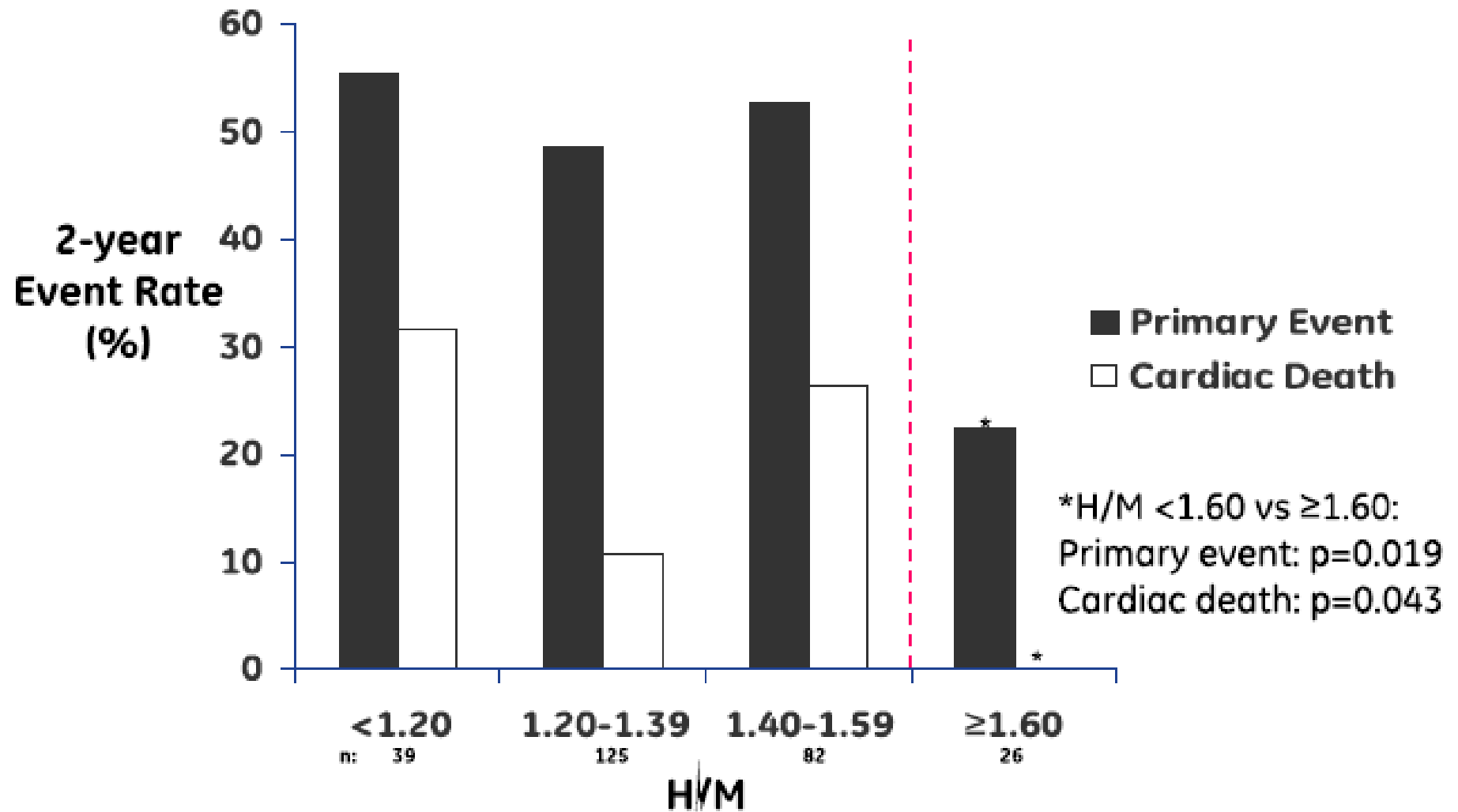
ECM = NYHA ↑ (176), arythmie (64), décès cardiaque (53) = 30%

# MIBG et BNP (médiane 140 ng/L)



ECM = NYHA ↑ (176), arythmie (64), décès cardiaque (53) = 30%

# 273 avec BNP > 140 ng/L & FE < 30%





# Etude Boogers

## Cardiac Sympathetic Denervation Assessed With 123-Iodine Metaiodobenzylguanidine Imaging Predicts Ventricular Arrhythmias in Implantable Cardioverter-Defibrillator Patients

Mark J. Boogers, MD,\*† C. Jan Willem Borleffs, MD,\* Maureen M. Henneman, MD,\* Rutger J. van Bommel, MD,\* Jan van Ramshorst, MD,\* Eric Boersma, PhD,§ Petra Dibbets-Schneider, MSc,† Marcel P. Stokkel, MD, PhD,† Ernst E. van der Wall, MD, PhD,\* Martin J. Schalij, MD, PhD,\* Jeroen J. Bax, MD, PhD\*  
*Leiden, Utrecht, and Rotterdam, the Netherlands*

### ◆ 116 patients

- ◆ **Indication sur FE de DAI** : 89 % primaire, 11% secondaire
- 74% ischémique / 26% non-ischémique
- NYHA =  $2.9 \pm 0.6$
- FEVG =  $28 \pm 8$
- Suivi sur  $23 \pm 15$  mois : chocs appropriée  $\pm$  décès cardiaque

### ◆ Traitement optimisé :

- IEC (85%),  $\beta$ B (71%), Amiodarone (19%), diurétiques (88%)

### ◆ MIBG, Perfusion en SPECT

Donc : situation clinique de décision de DAI sur NYHA II-III

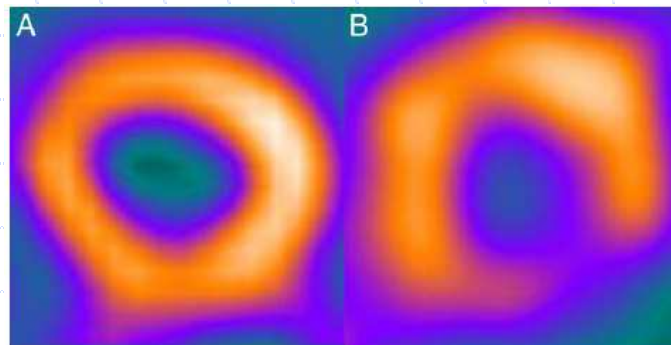
# Facteurs prédictifs cliniques

	Univariable Analysis		Multivariable Analysis	
	HR (95% CI)	p Value	HR (95% CI)	p Value
Age (yrs)	1.02 (0.98–1.08)	0.3		
Male sex	1.52 (0.57–4.06)	0.4		
CRT-D	1.15 (0.34–3.86)	0.8		
ICD Indication (secondary vs. primary prevention)	4.55 (1.95–10.65)	<0.01*	3.85 (1.43–10.37)	<0.01†
Ischemic cardiomyopathy	3.16 (0.94–10.60)	0.06*	2.10 (0.58–7.64)	0.3
NYHA functional class	1.10 (0.54–2.24)	0.8		
LVEF (%)	1.02 (0.97–1.07)	0.5		
<b>Cardiovascular risk factors</b>				
Diabetes	0.60 (0.14–2.54)	0.5		
Hypertension	1.13 (0.48–2.65)	0.8		
Hypercholesterolemia	1.08 (0.43–2.73)	0.9		
Smoking	1.39 (0.61–3.19)	0.4		
Positive family history of CAD	0.87 (0.36–2.09)	0.7		
<b>Medication use</b>				
Beta-blockade	1.03 (0.43–2.47)	1.0		
Amiodarone	1.64 (0.65–4.12)	0.3		
ACE-I/ATII antagonist	1.23 (0.37–4.14)	0.7		
Oral anticoagulant	0.61 (0.27–1.37)	0.2		
Statin	1.45 (0.57–3.65)	0.4		
Diuretic	1.13 (0.27–4.83)	0.9		

# Facteurs prédictifs cliniques

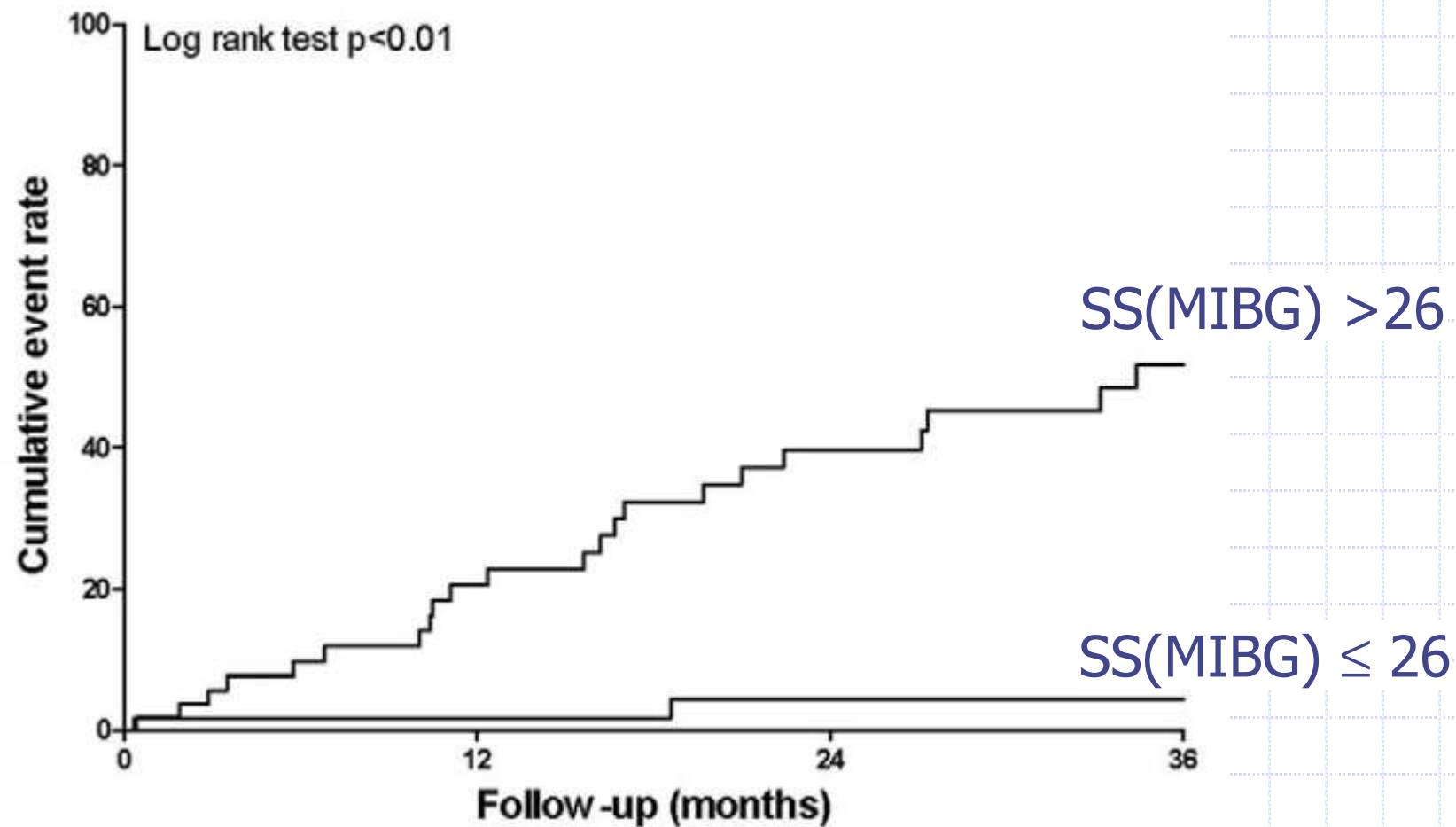
	Univariable Analysis		Multivariable Analysis	
	HR (95% CI)	p Value	HR (95% CI)	p Value
<b>123I MIBG imaging</b>				
Early H/M ratio	0.35 (0.04–3.30)	0.4		
Late H/M ratio	0.27 (0.03–2.32)	0.2		
Cardiac washout rate (%)	1.02 (0.95–1.09)	0.6		
Early 123I MIBG SPECT defect score	1.07 (1.03–1.12)	<0.01*		
Late 123I MIBG SPECT defect score	1.14 (1.08–1.20)	<0.01*	1.13 (1.05–1.21)	<0.01†
<b>Myocardial perfusion imaging</b>				
Rest perfusion defect score	1.02 (0.98–1.06)	0.4		
Stress perfusion defect score	1.03 (0.99–1.07)	0.2		
Summed perfusion difference score	1.09 (0.98–1.22)	0.12*	0.93 (0.83–1.05)	0.3
123I MIBG/perfusion mismatch score	1.06 (1.02–1.09)	<0.01*	1.01 (0.97–1.06)	0.5

Perfusion

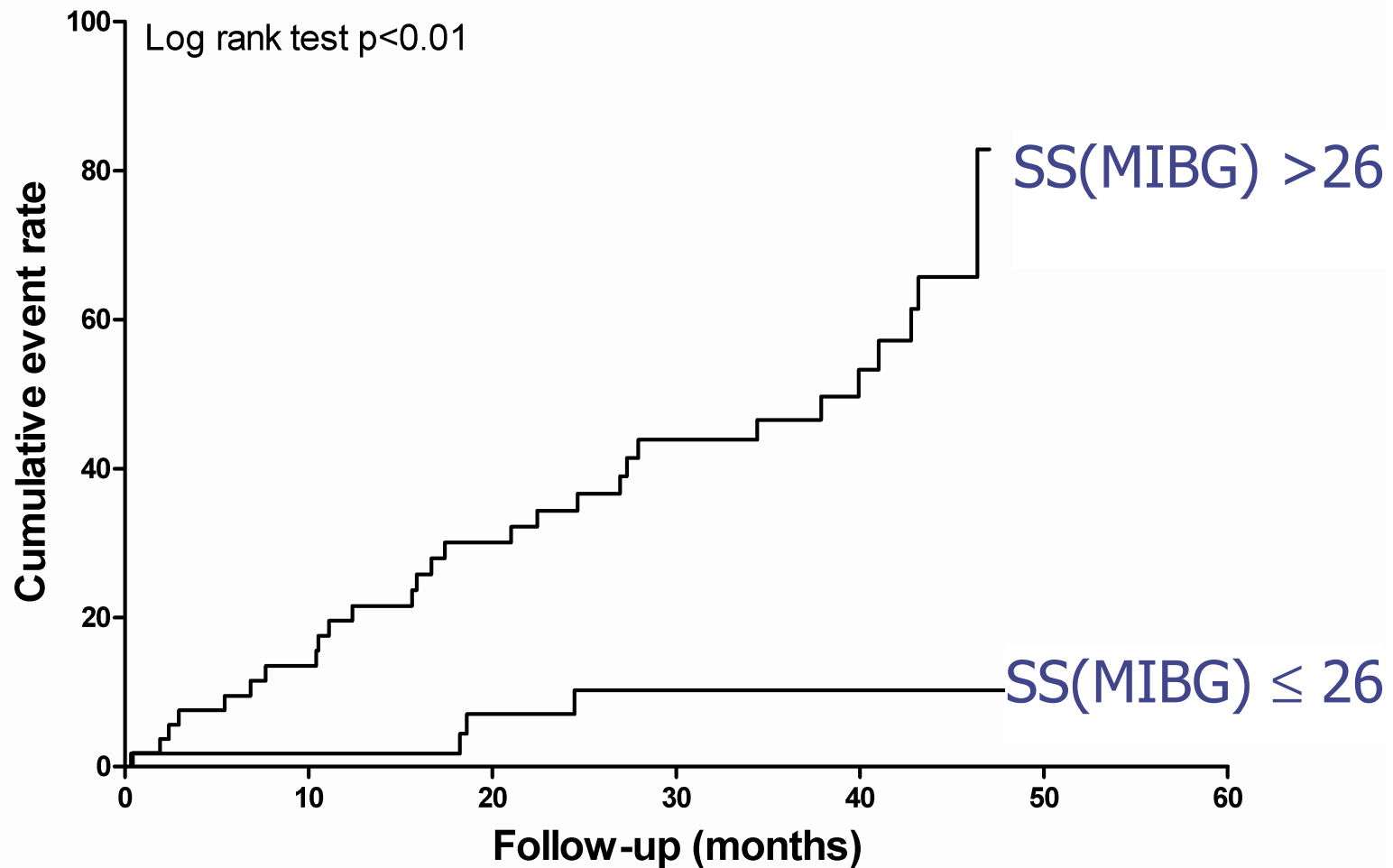


<sup>123</sup>I-MIBG

# Décharge appropriée



# Décharge appropriée ou décès



# CONCLUSIONS SUE LA MIBG

◆  $H/M \geq 1.6 \Rightarrow$

- ni arythmie (VNP 96%) ni décès cardiaques (VPN 98%) pendant 2 ans.
- incidence annuelle de décès cardiaque  $< 1\%$ .

◆  $H/M < 1.6 \Rightarrow \uparrow$  probabilité d'arythmie.

◆  $H/M =$  info prono complémentaire / BNP & FEVG

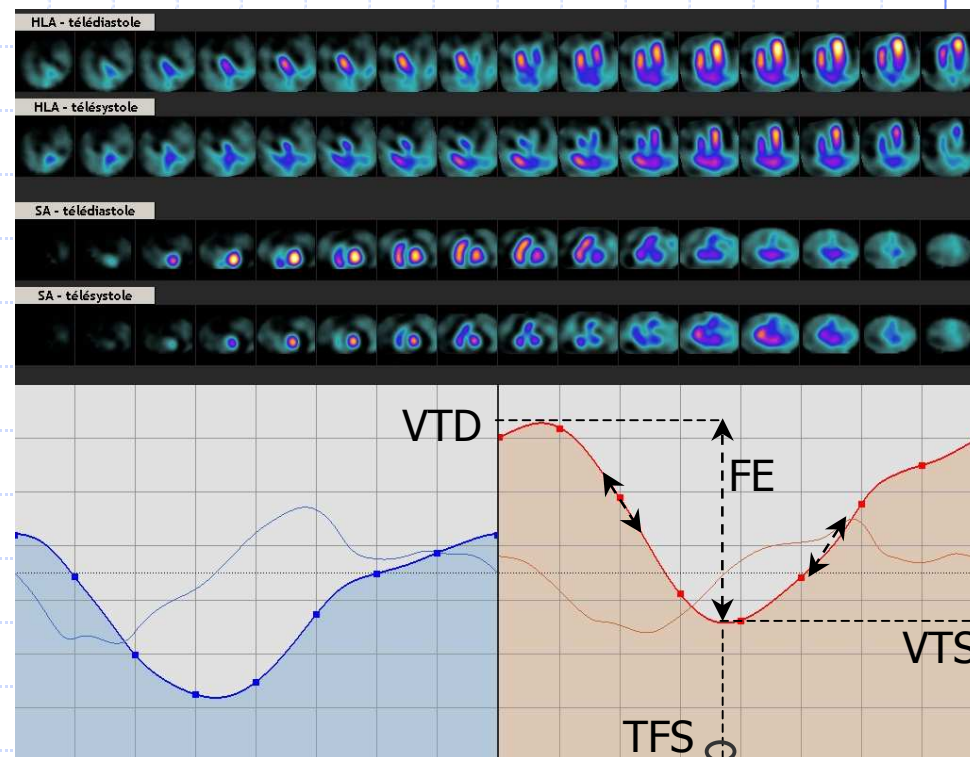
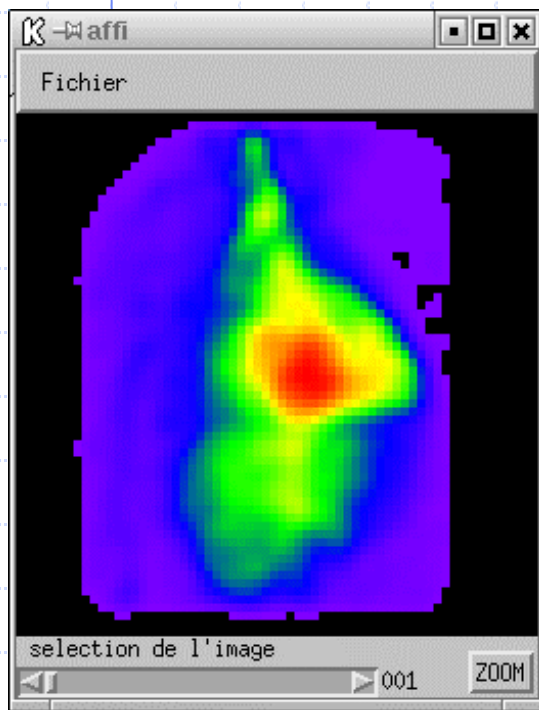
↳ **DAI indiqué  $H/M = 1,3$  à  $1,6$**  (prono. global)

◆  $S > 26 \Rightarrow \uparrow$  probabilité décharge de DAI (x 13).

◆  $S < 26 \Rightarrow$  Pas de décharges: VPN 95% sur 3 ans

↳ **DAI si  $S > 26$  OU MISMATCH** (prono. indiciduel)

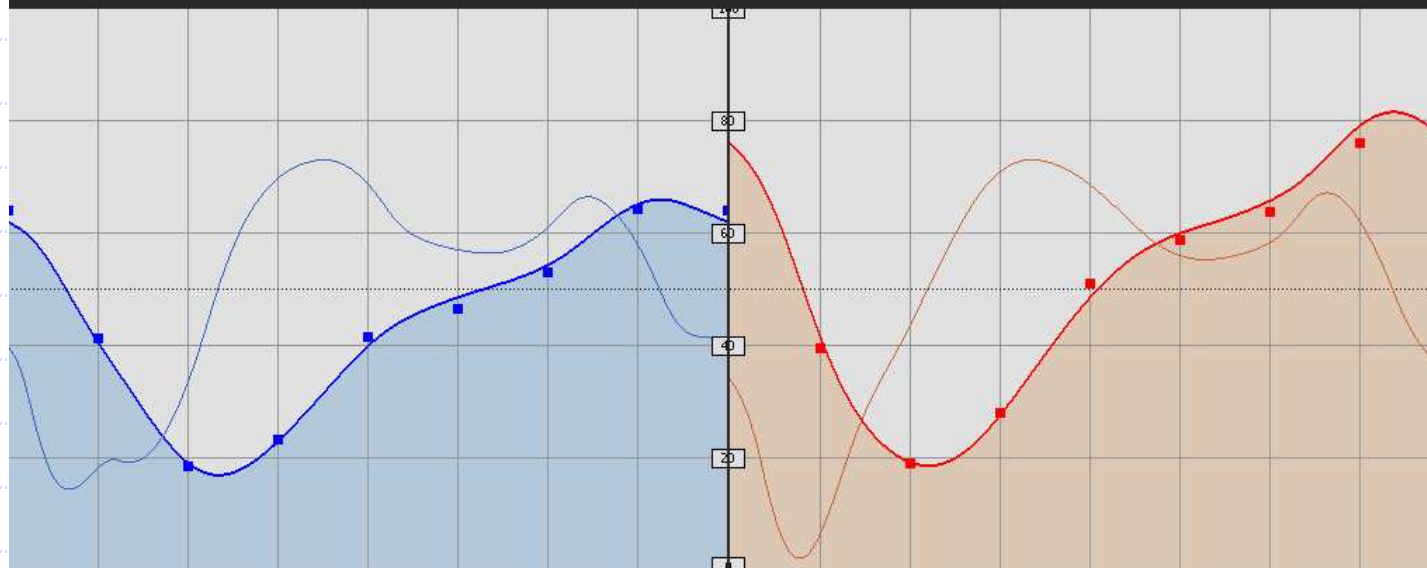
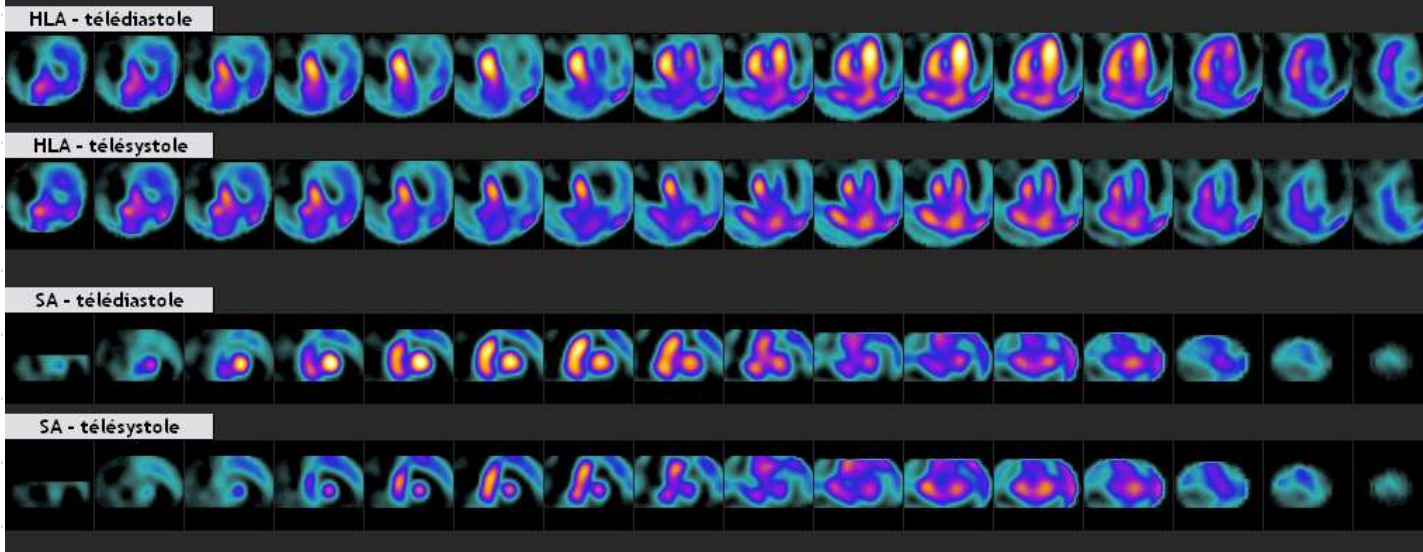
# TOMO-VENTRICULOGRAPHIE



Mariano-Goulart et al. EJNM 1998;22 et EJNM 2001;28- Daou et al. JNM 2001;42

# TVI

Mr NOM PRENOM ( 01/01/2000 ) - Ex : 21/07/2010 - Fq : 51 bpm



Volume télédiastolique = 66 cc  
Volume tèlesystolique = 17 cc  
Volume d'éjection = 49 cc - Débit = 2.5 L / min

Fraction d'éjection = 74 %  
Temps de fin de systole : 344 ms

Débit eject. max. = -187 cc/s (-2.85) - t-DEM = 101 ms  
Débit remp. max. = 121 cc/s (1.84) - t-DRM = 517 ms

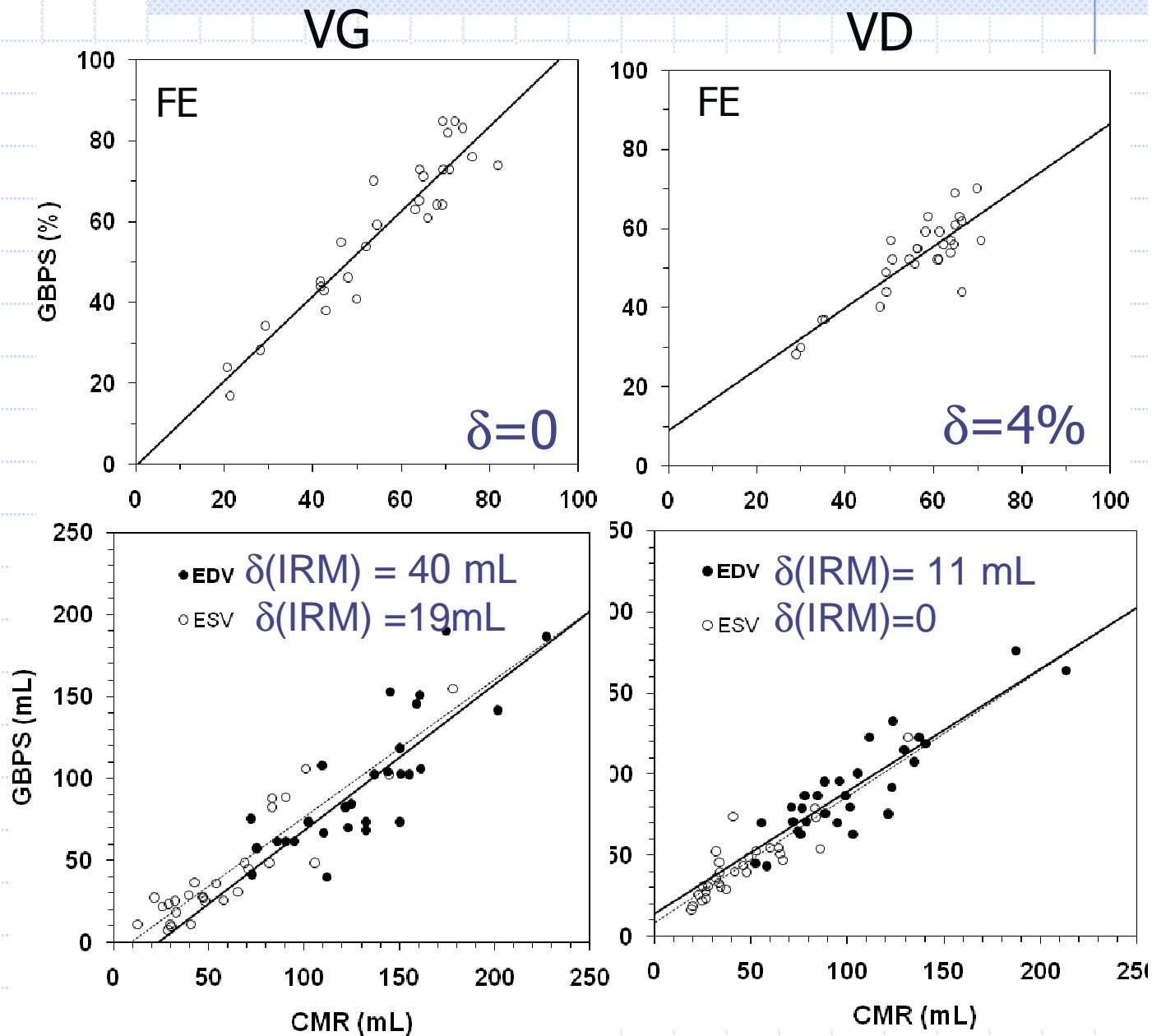
Volume télédiastolique = 81 cc  
Volume tèlesystolique = 18 cc  
Volume d'éjection = 63 cc - Débit = 3.2 L / min

Fraction d'éjection = 77 %  
Temps de fin de systole : 323 ms

Débit eject. max. = -311 cc/s (-3.83) - t-DEM = 114 ms  
Débit remp. max. = 150 cc/s (1.85) - t-DRM = 491 ms



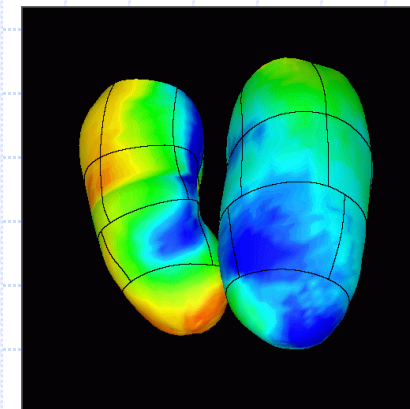
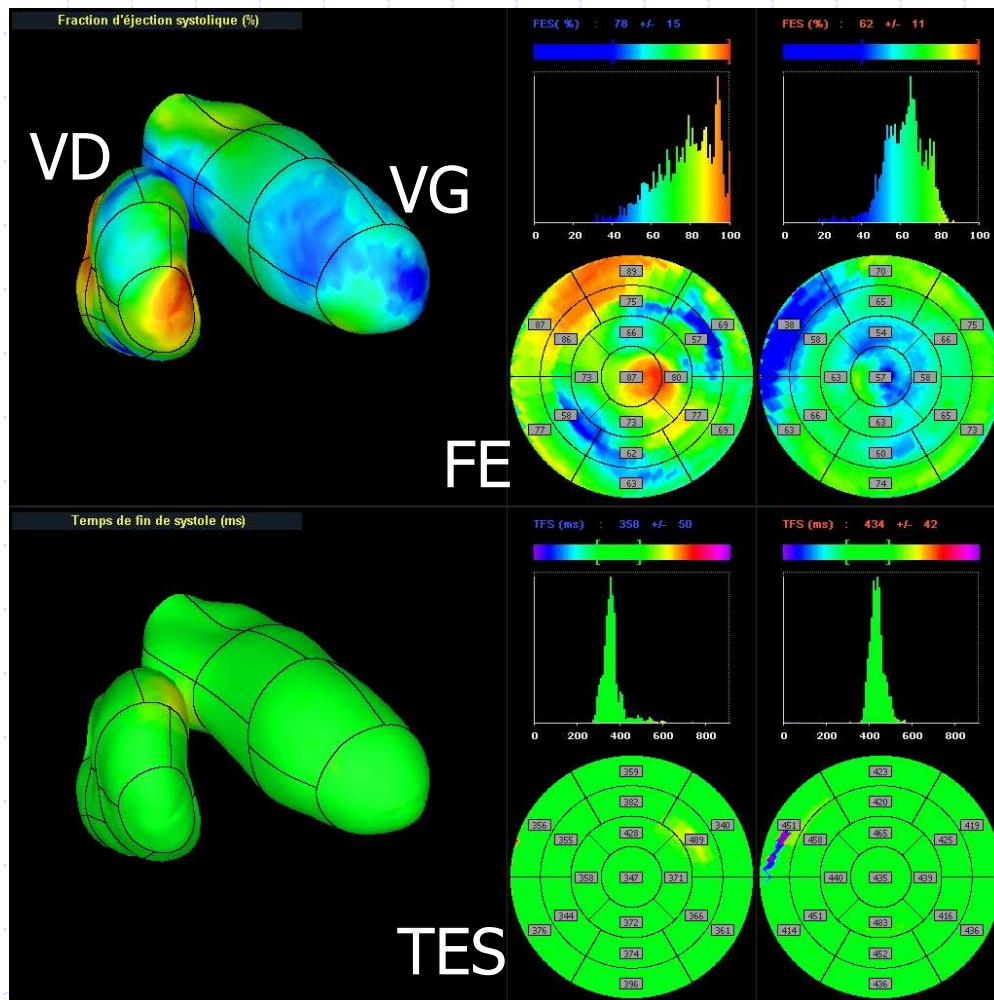
# TVI versus IRM



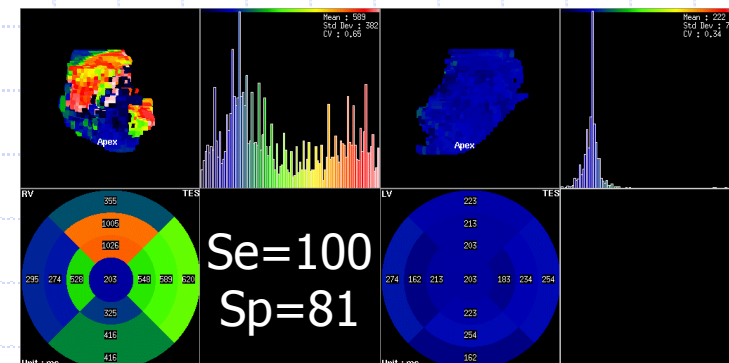
VES(G-D):  $9 \pm 14$  (GBPS) versus  $18 \pm 13$  (IRM)

L. Sibille et D. Mariano-Goulart, An. Nucl. Med 2010.

# ANALYSE 3D DE CTA LOCALES



Parameter	Control subjects	Patients with localized ARVD	Patients with diffuse ARVD
EF (%)	63 ± 7	60 ± 5	33 ± 12 <sup>†</sup>
EDV (mL)	101 ± 17	107 ± 20	180 ± 81 <sup>†</sup>
ESV (mL)	37 ± 8	43 ± 10	124 ± 70 <sup>†</sup>
σ-EF (%)	13 ± 3	14 ± 2	11 ± 3
σ-TES (ms)	63 ± 24	167 ± 64 <sup>†</sup>	277 ± 106 <sup>†</sup>



S=80 ms

# CONCLUSIONS

- ◆ Perfusion: Se, Spé >85% si SDS>3
  - ◆ sidération, information pronostique
- ◆ MIBG: NYHA II-III avec FE < 35%
  - ◆ H/M < 1,6 ⇒ prono ↓, indépendant FE et BNP
  - ◆ H/M ≥ 1,6 ⇒ < 1%/an décès; 0 arythmie/ 2 ans
  - ◆ S >26 ⇒ ↑ probabilité **décharge de DAI (x 13)**.
  - ◆ mismatch ⇒ ↑ probabilité **décharge de DAI**
- ◆ Coûts :
  - ◆ Perfusion : 77 € (EE) + 495 € (effort) et 332 € (repos)
  - ◆ MIBG = 180 €
  - ◆ Ventriculographie = 279 € (suivi) ou 414 € (rythmologie)



**Merci de votre attention...**