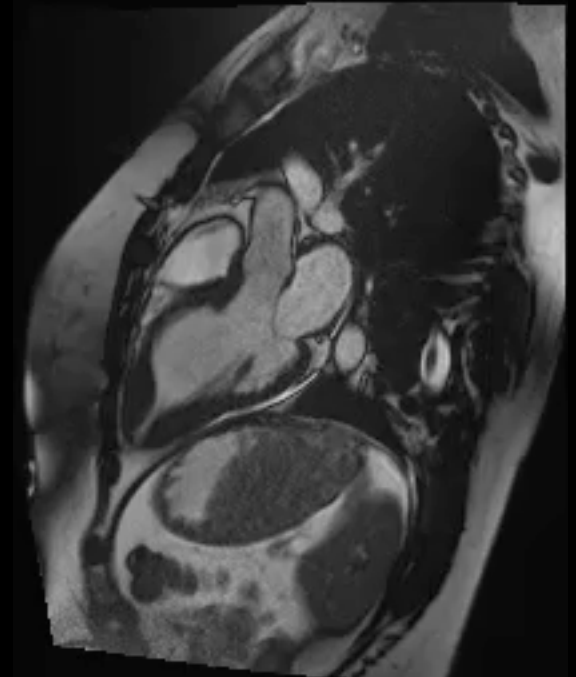


L'IRM en cardiologie du sport

O. Corneloup, M. Montaudon, H. Cochet,
F. Laurent, V. Latrabe, G. Dournes, M. Salel

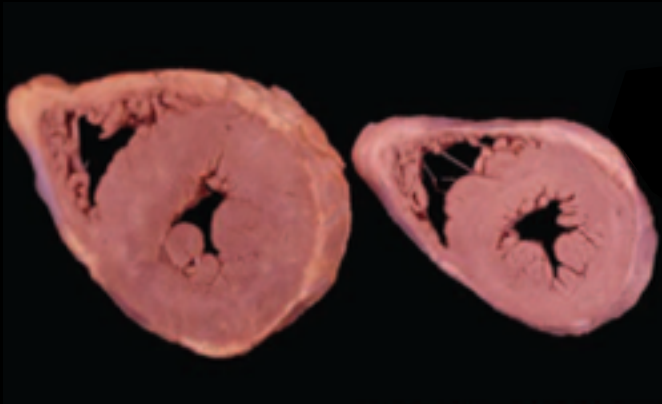


Unité d'imagerie thoracique et cardio-vasculaire



Plan retenu

- Suspicion de MCH
- Bilan d'ESV

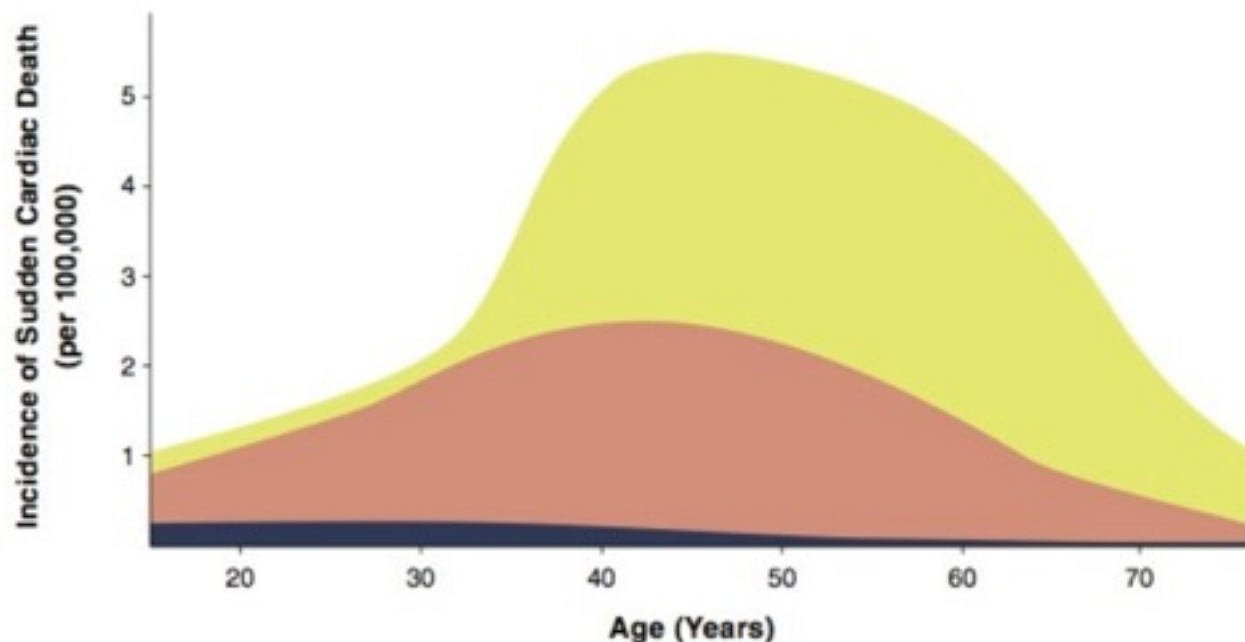




REVIEWS

STATE-OF-THE-ART PAPER

Cardiac Imaging and Stress Testing Asymptomatic Athletes to Identify Those at Risk of Sudden Cardiac Death



Channelopathies

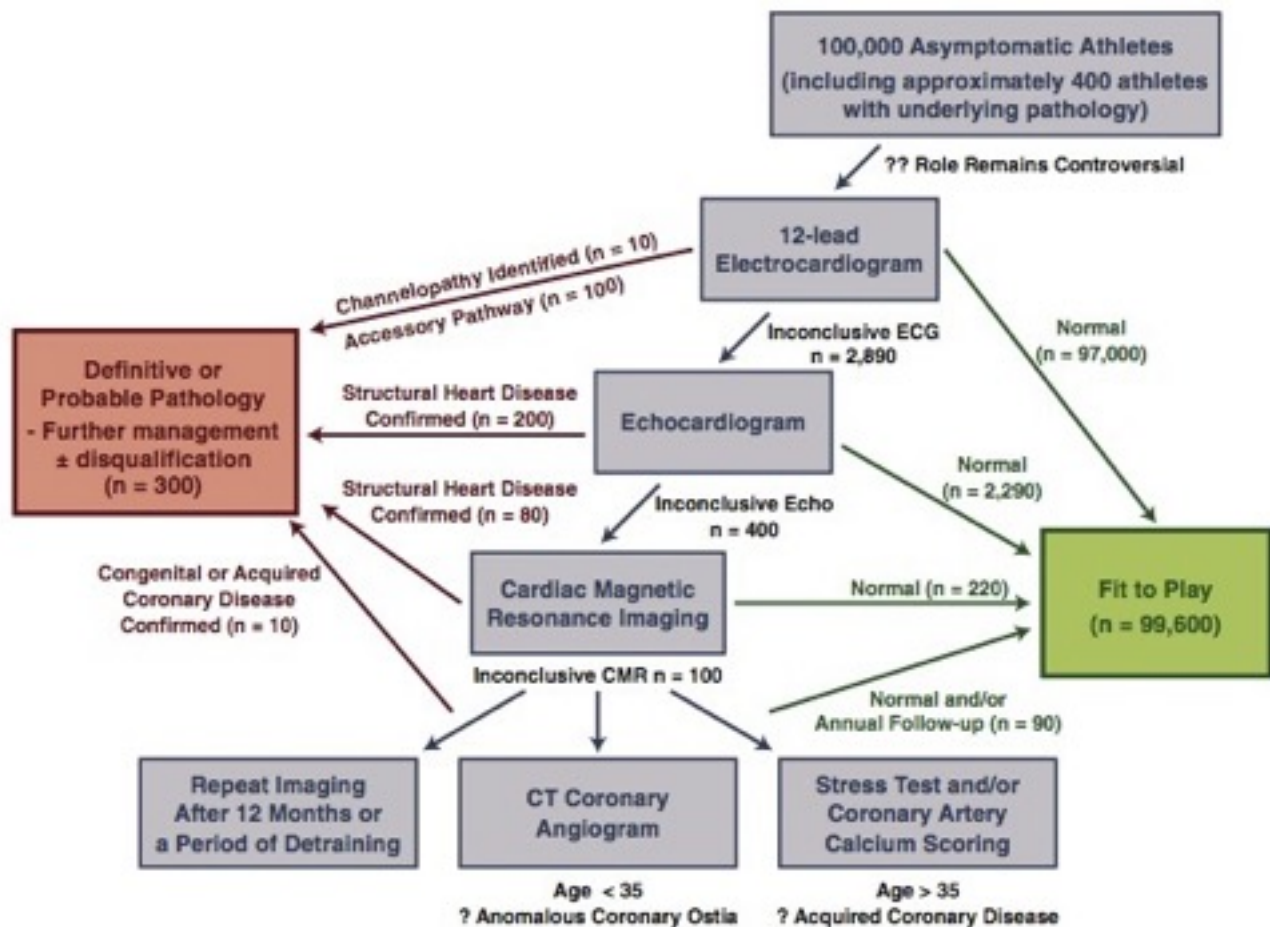
Long QT Syndrome
Brugada Syndrome
Catecholaminergic VT

Cardiomyopathies

Hypertrophic Cardiomyopathy
Arrhythmogenic RV Cardiomyopathy
Dilated Cardiomyopathy

Coronary Artery Pathology

Atherosclerotic
Anomalous Coronary Ostia



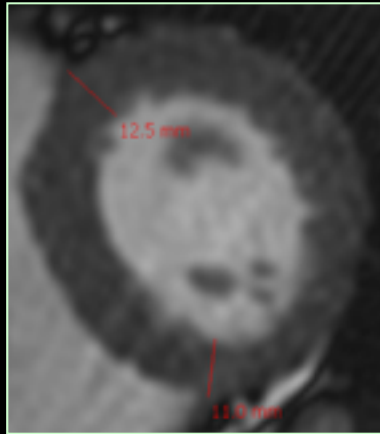
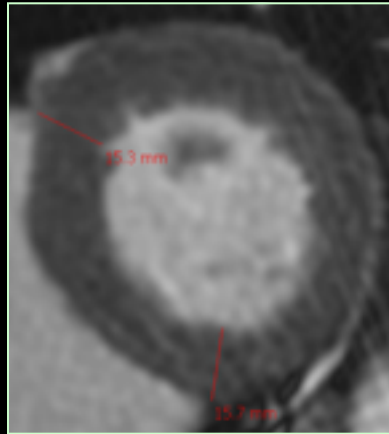
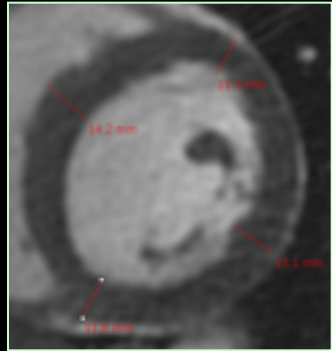
IRM et myocardiopathies hypertrophiques

étiologie

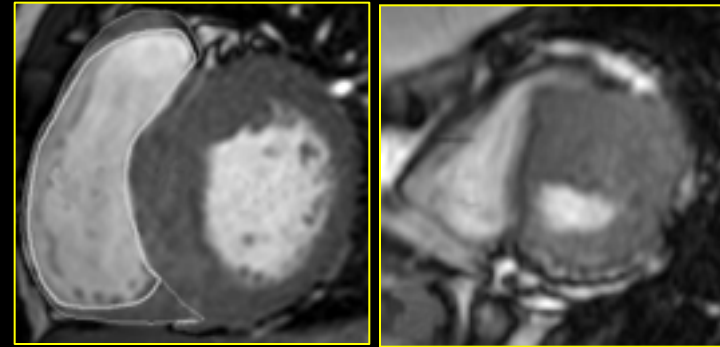
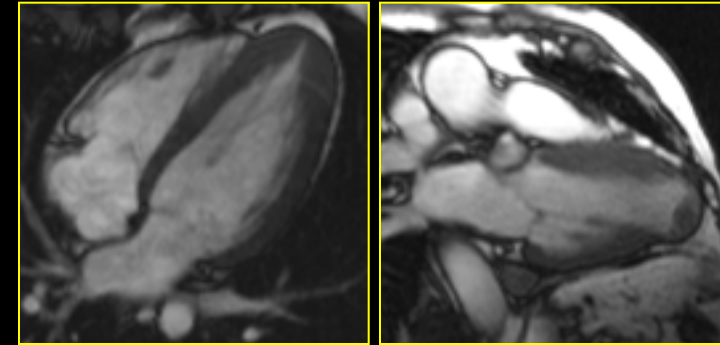
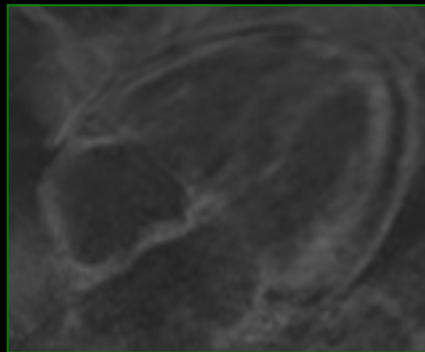
secondaire

primitive

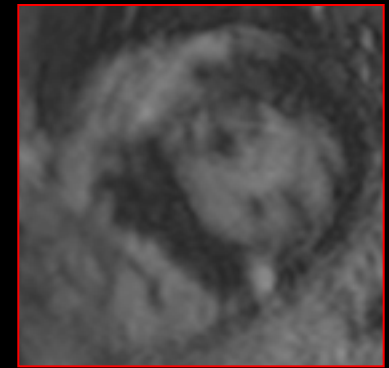
HVG adaptative



HVG infiltrative,
surcharge



fibrose?



HVG du sportif

en général symétrique, < 15mm

parfois prédomine sur le septum

disparaît après le déconditionnement

diminution de 2 mm

Maron British J Sport Med 2009

épaisseur / volume TD < 0,15 mm.m²/ml

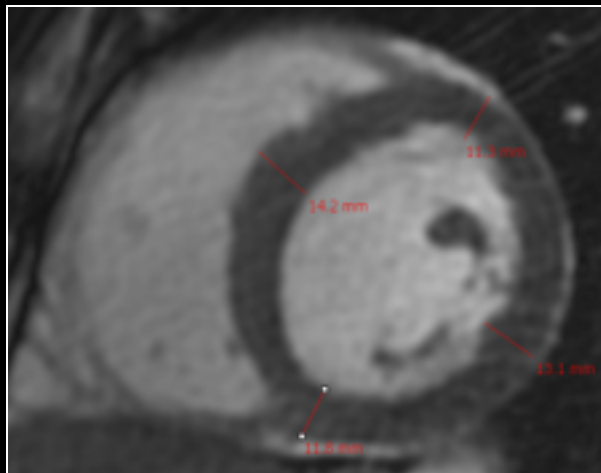
Petersen JCMR 2005

sens: 80%, spe: 99% athlètes vs MCH

jamais de rehaussement tardif

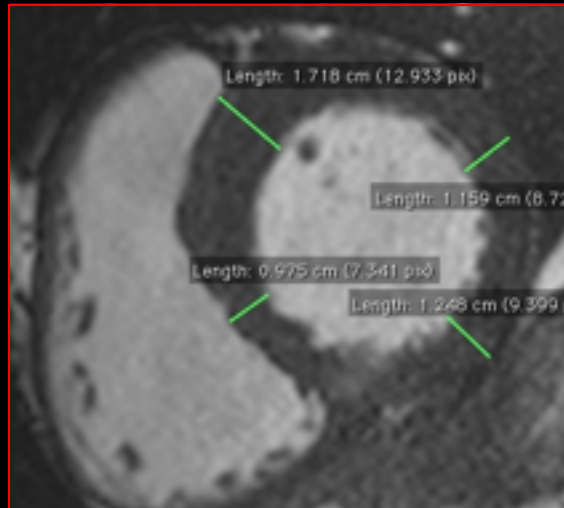
Hansen AJR 2007

42 ans, échographie, test d'effort
et VO2 max en faveur d'un cœur
sportif

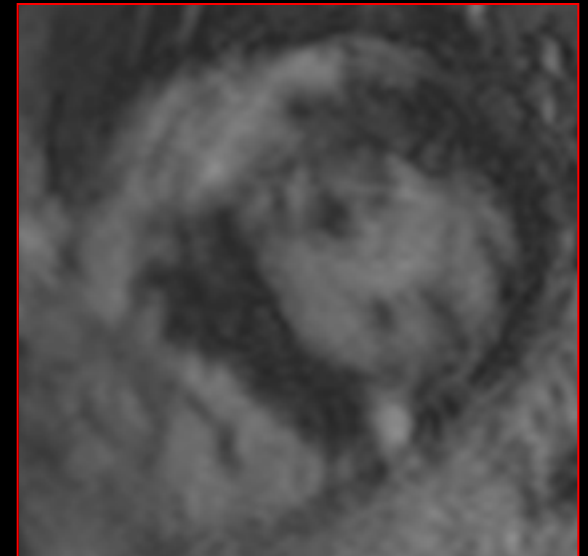
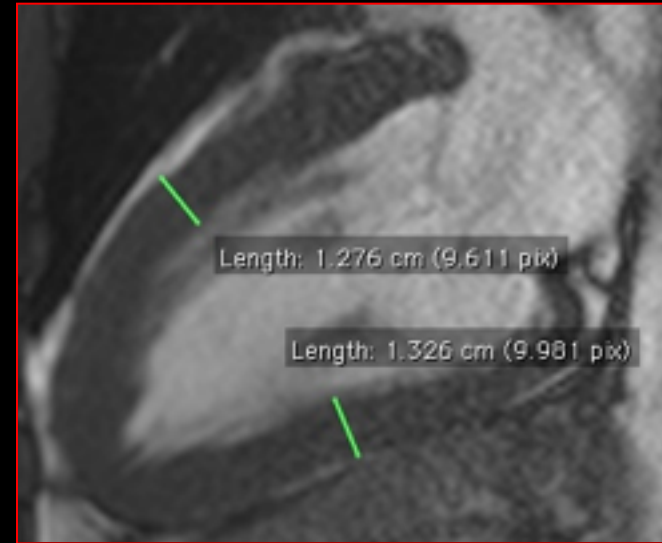


17 ans, 14 mm

VTD = 98 E/VTD = 0,142



VTD = 68 E/VTD = 0.25



MCH

épaisseur > 15 mm sans dilatation associée
ou > 12 mm avec contexte familial

Maron JACC 2003

morphologie hétérogène: asymétrique, prédomine sur le septum+++

ratio des épaisseurs septum / paroi latérale > 1,3 (90%)

atteinte des muscles papillaires +++

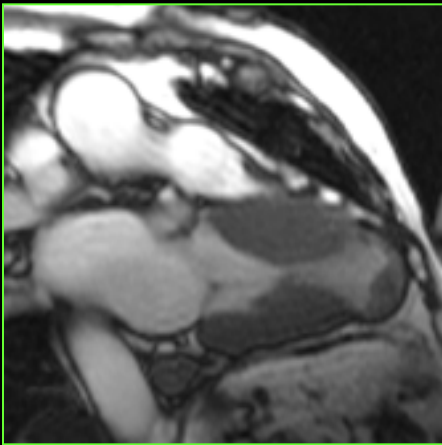
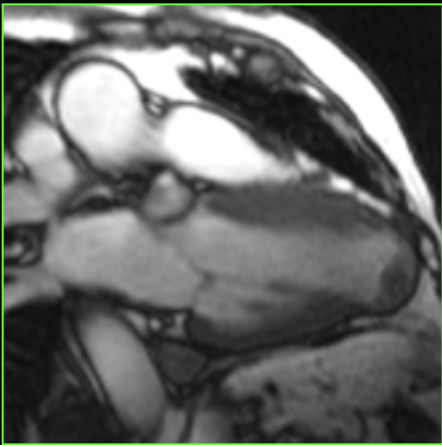
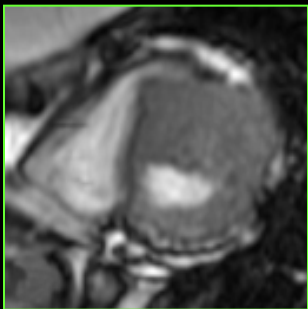
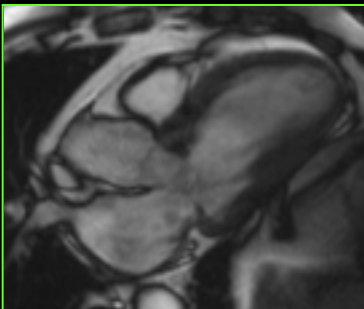
atteinte symétrique dans moins de 10% des cas

IRM > écho
apex,
antérolat,
septum post

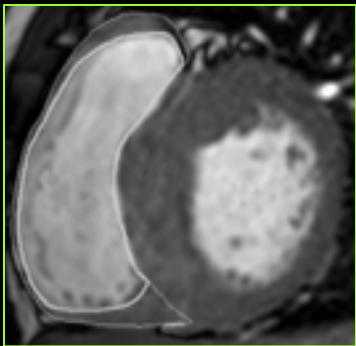


bourrelet, obstructive

pseudo-tumorale

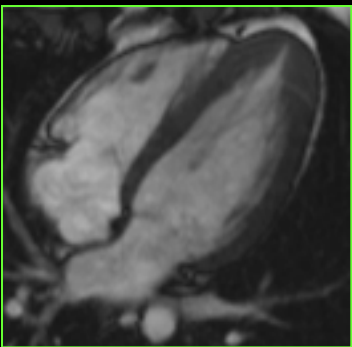


médioventriculaire (anévrisme apical)



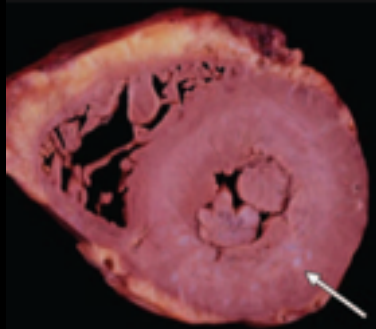
droite: 42% des patients avec MH du VG

apicale

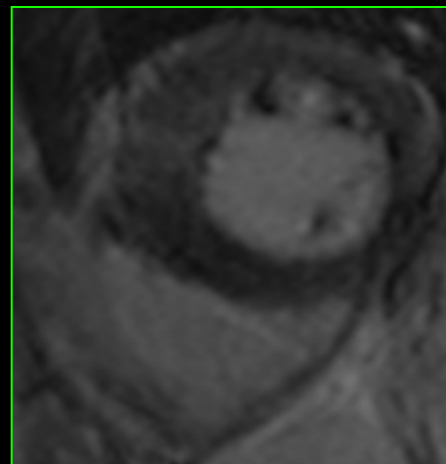
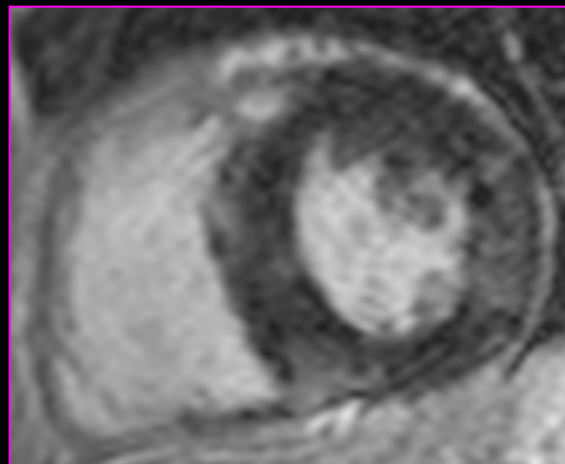
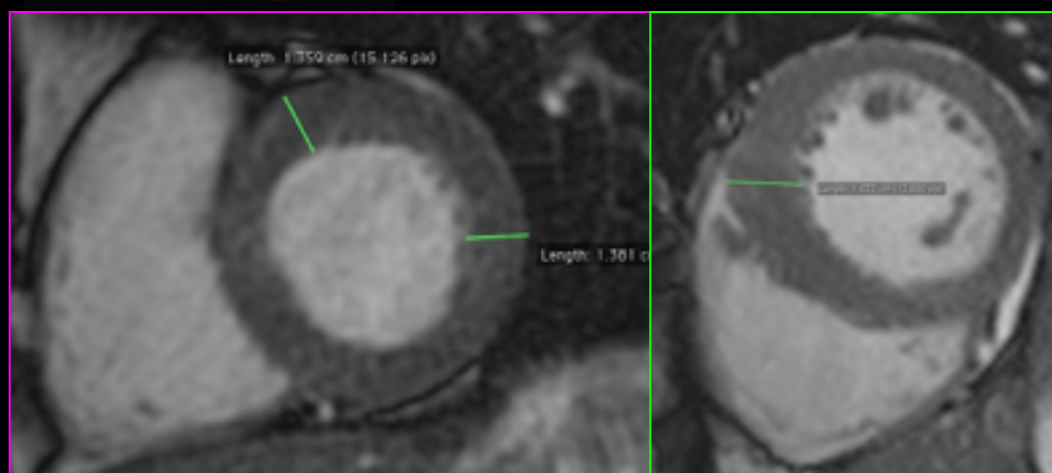
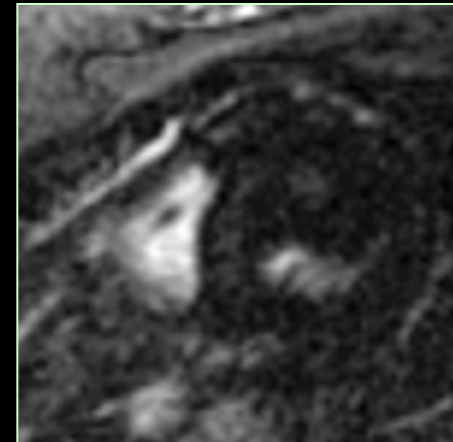
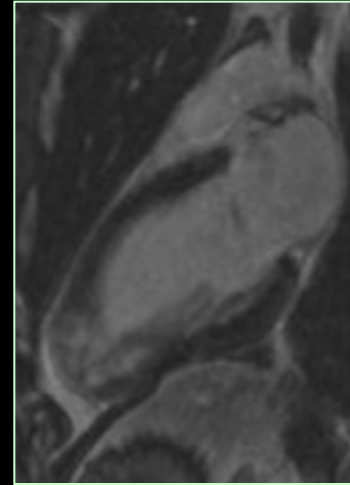
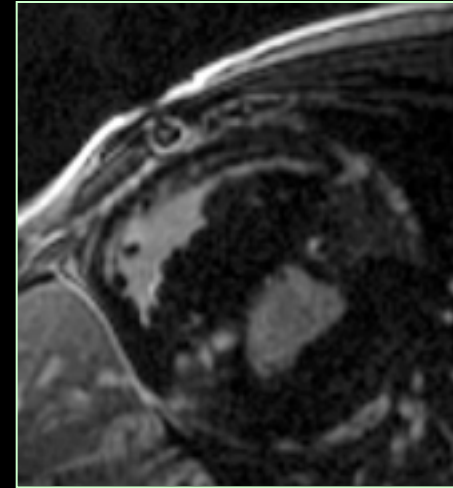


mm. papillaires

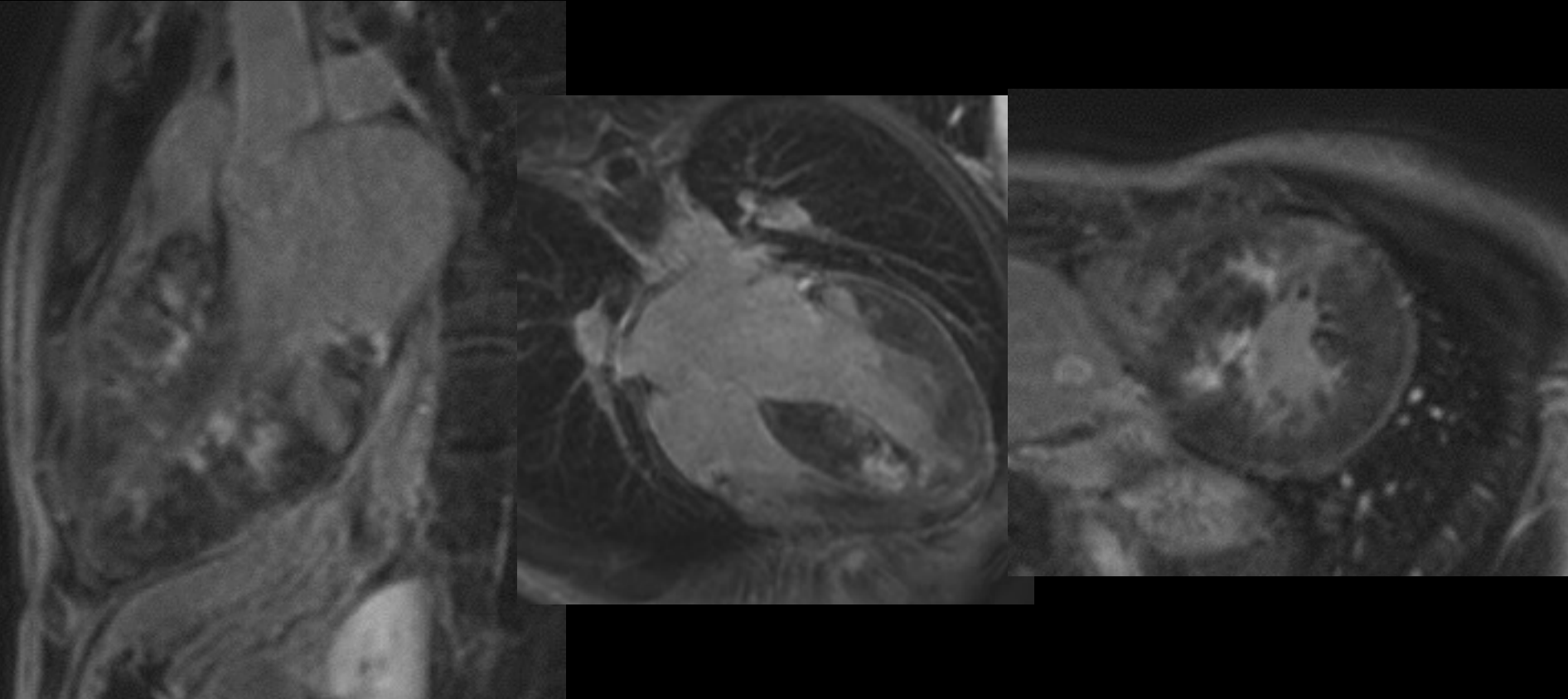
MCH rehaussement tardif permet de confirmer le caractère pathologique d'une hypertrophie



foyers
mésopariétaux, dans l'hypertrophie
en regard de l'insertion du VD (idem HTAP)



FIBROSE: PDC méso-myocardique

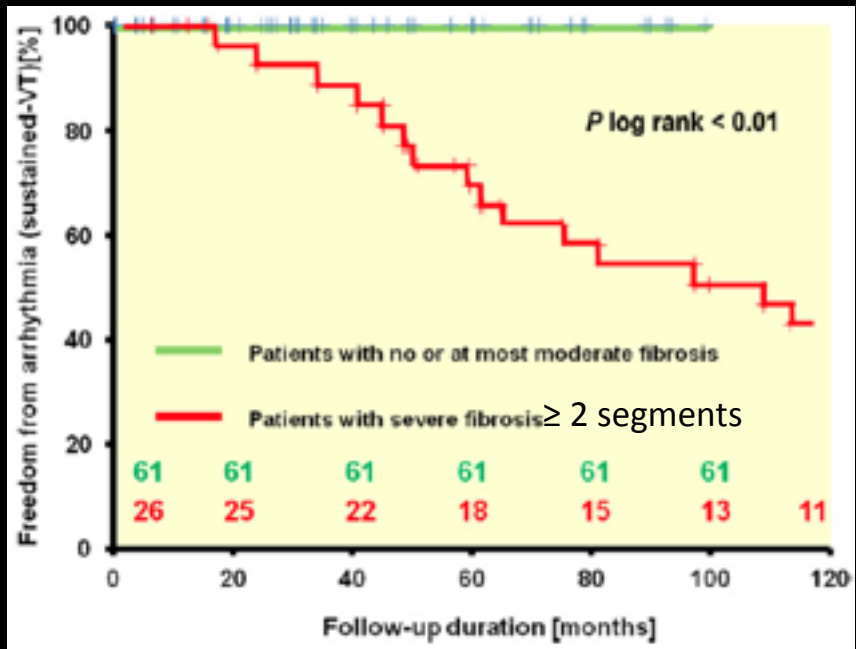
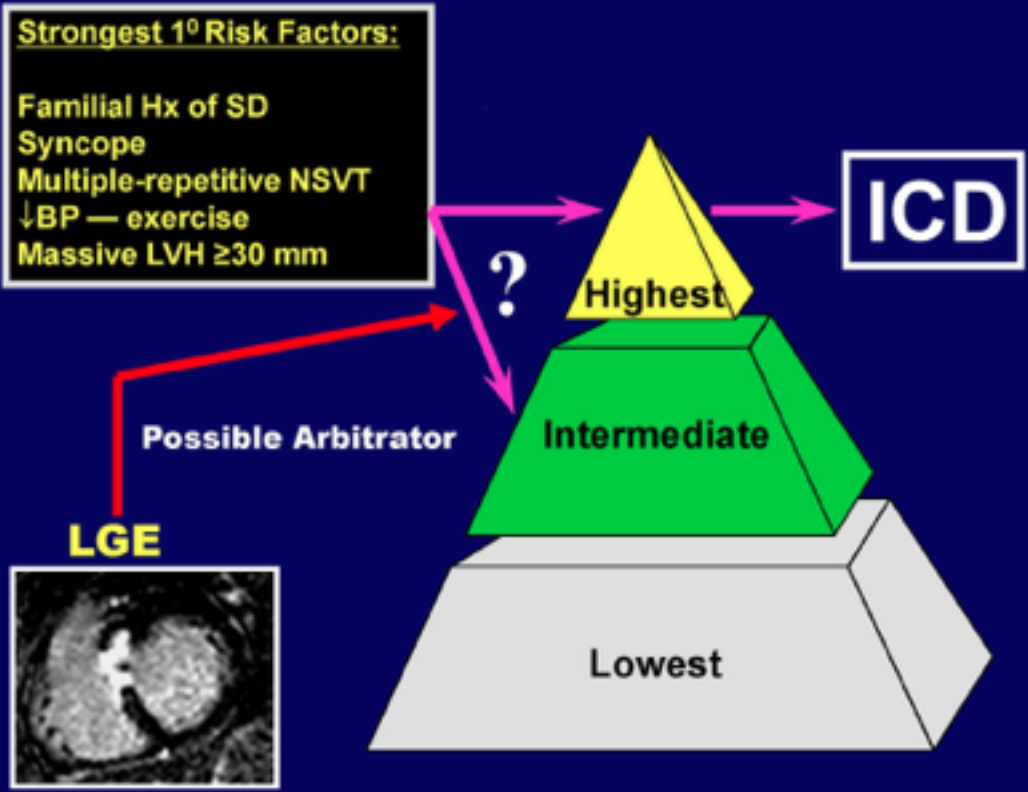


MCH fibrose et FDR

fibrose x7 risque rythmique majeur *Adabag JACC 2008*

fibrose prédit la mortalité cardiovasculaire et l'insuffisance cardiaque *Green JACC CVI 2012*

l'extension de la fibrose est un FDR d'arythmies *Prinz Can J Cardiol 2013*

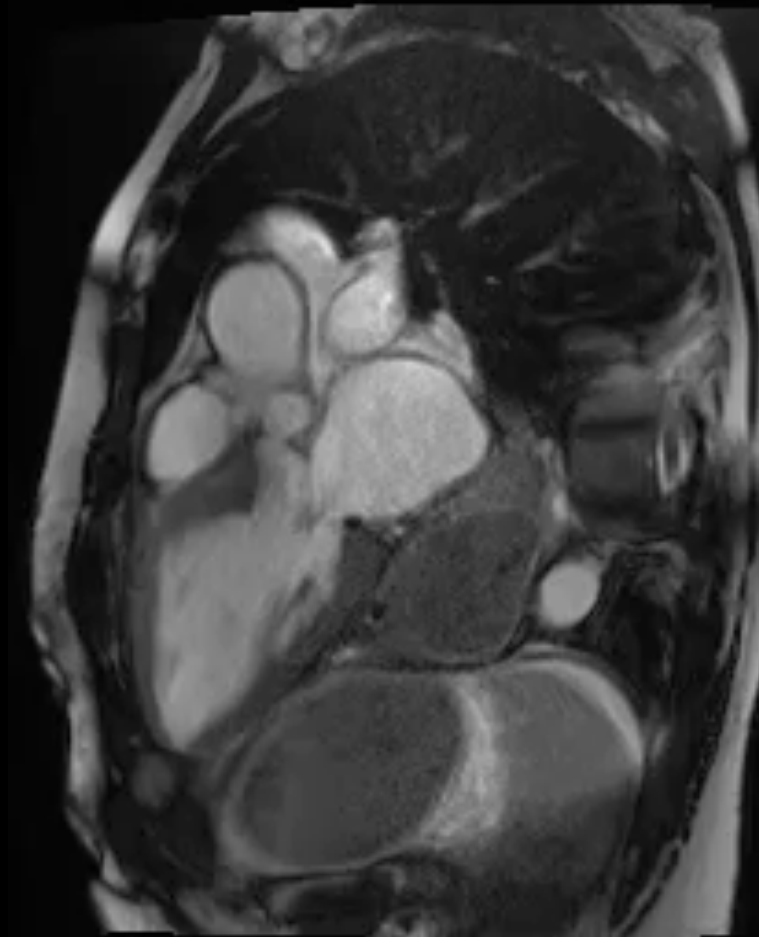


2 FDR: défibrillateur

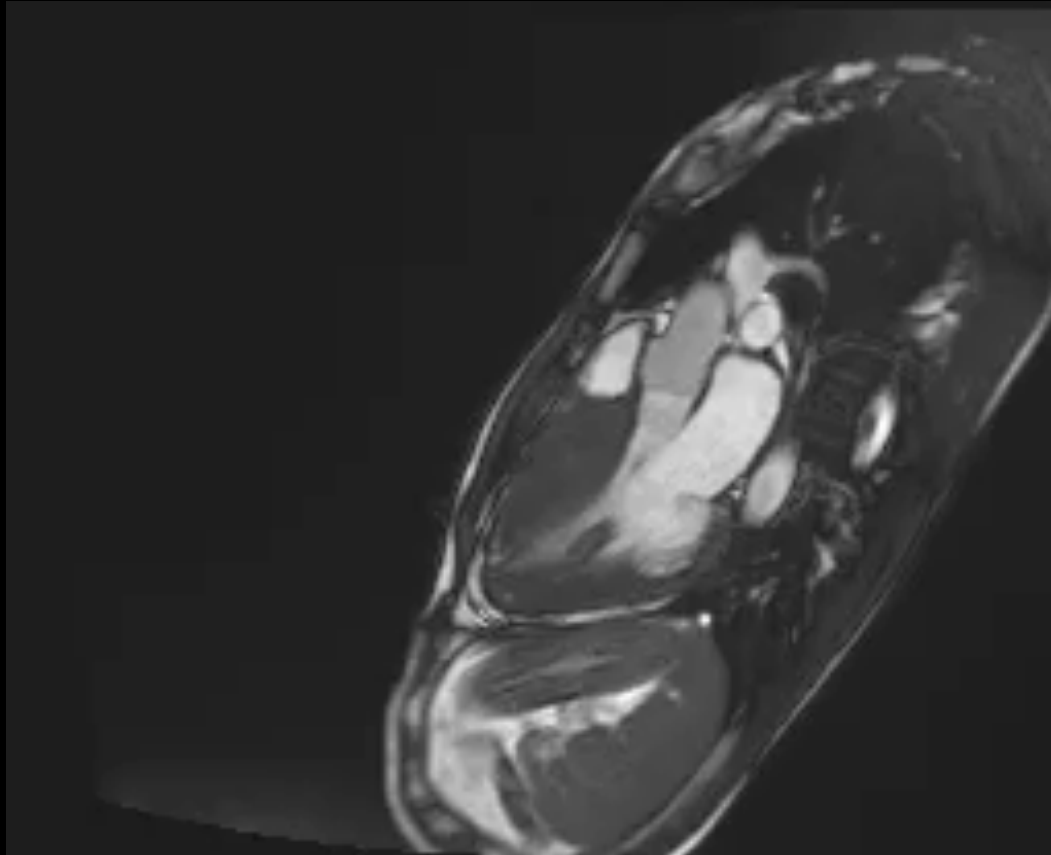
0 FDR: pas de défibrillateur

1 FDR: ??? fibrose?

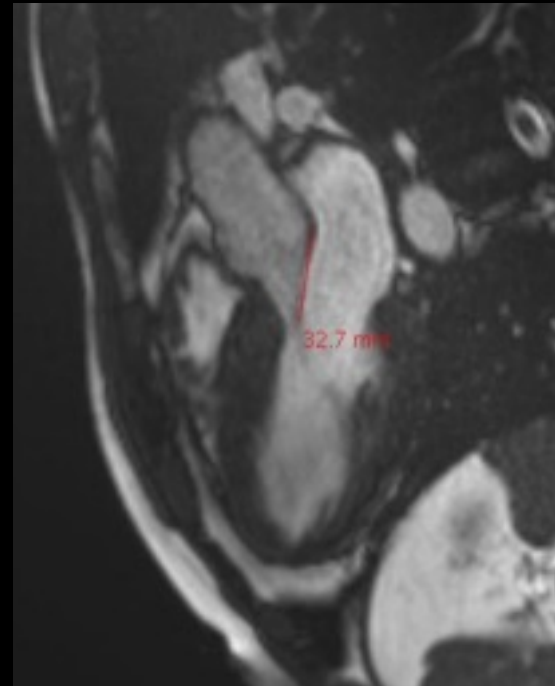
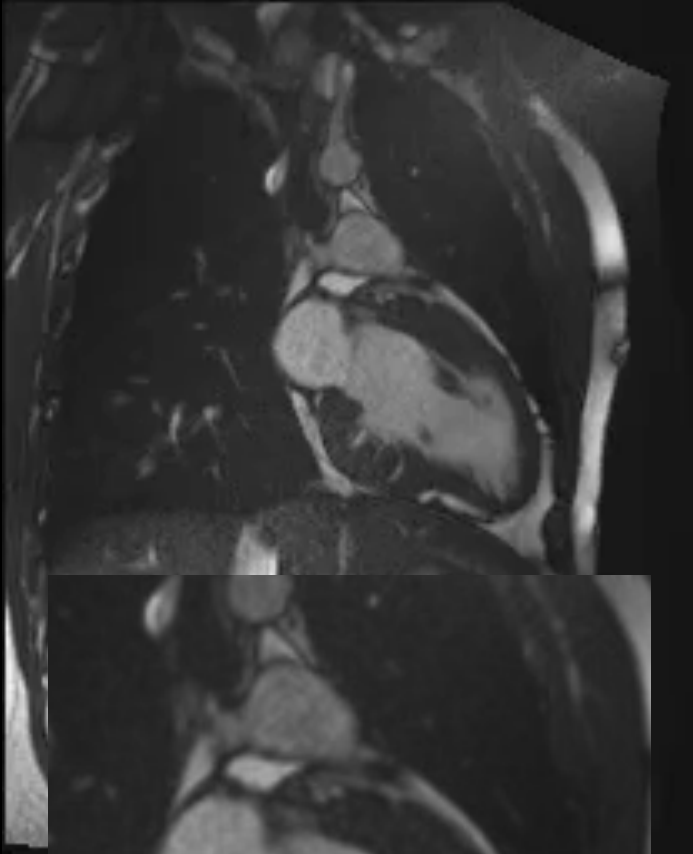
MCH obstructive + SAM



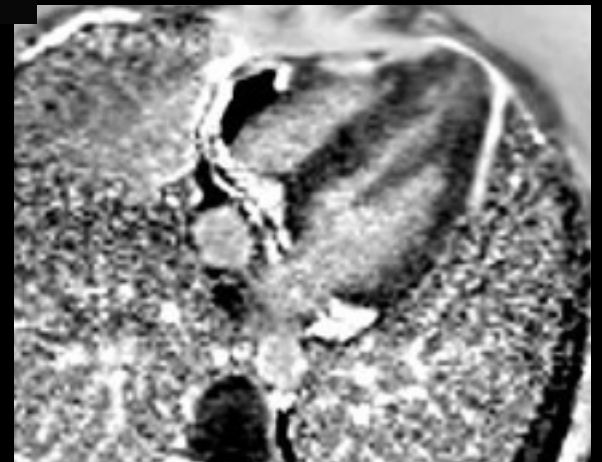
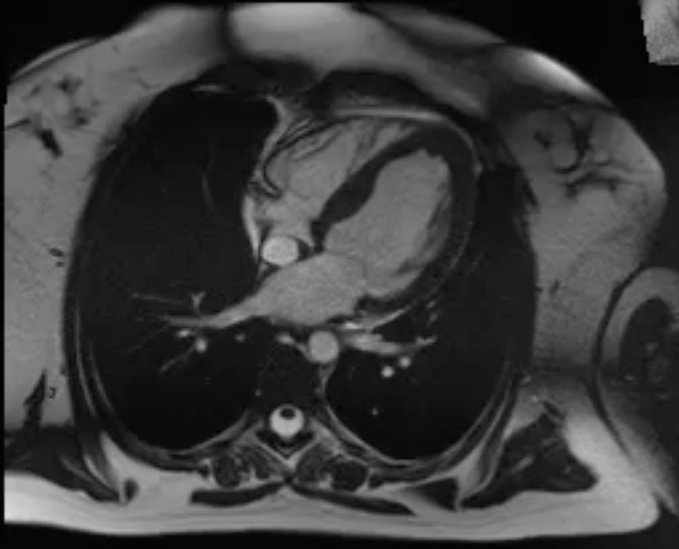
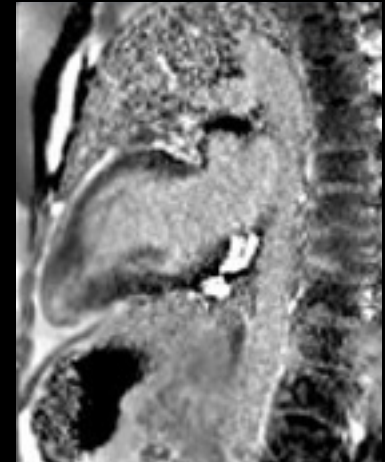
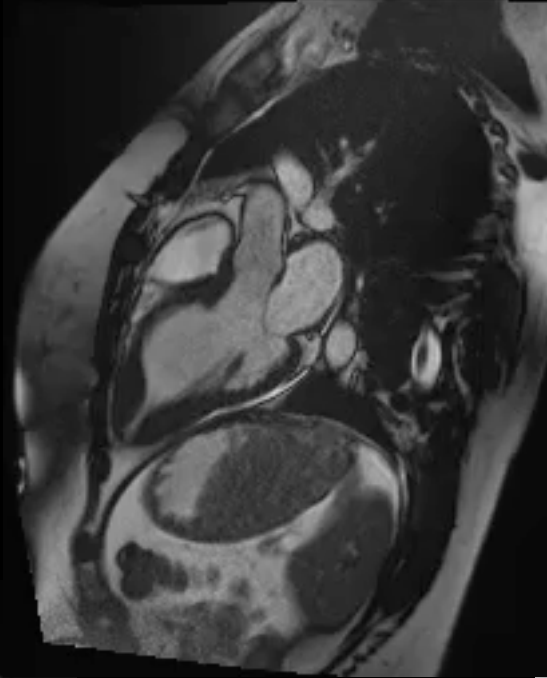
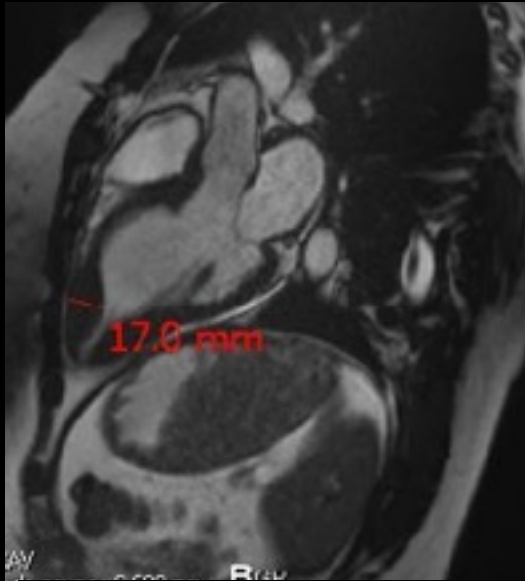
SAM Obstructif



Cryptes et gde V Mitrale

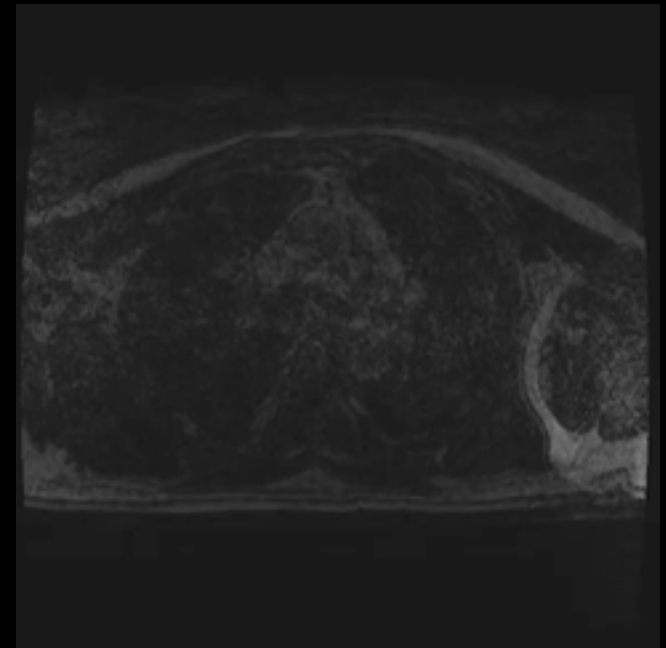


MCH apicale

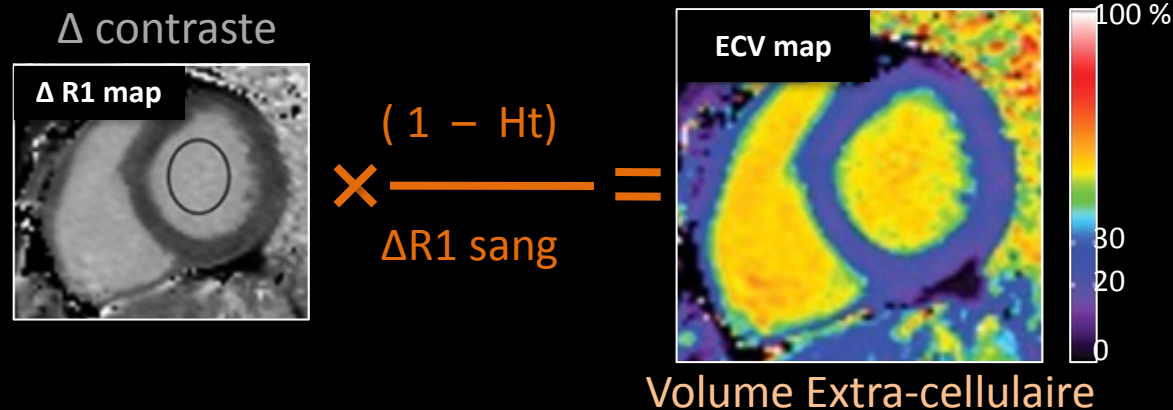


HVG/MCH: avancées technologiques

- Séquences Haute Résolution



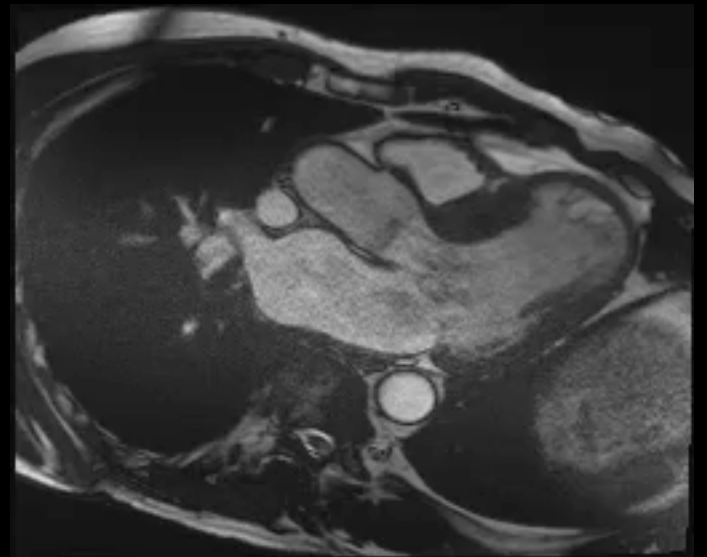
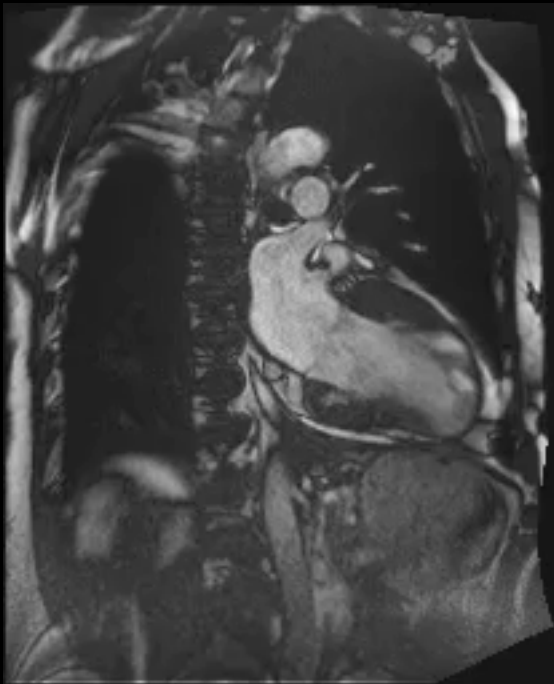
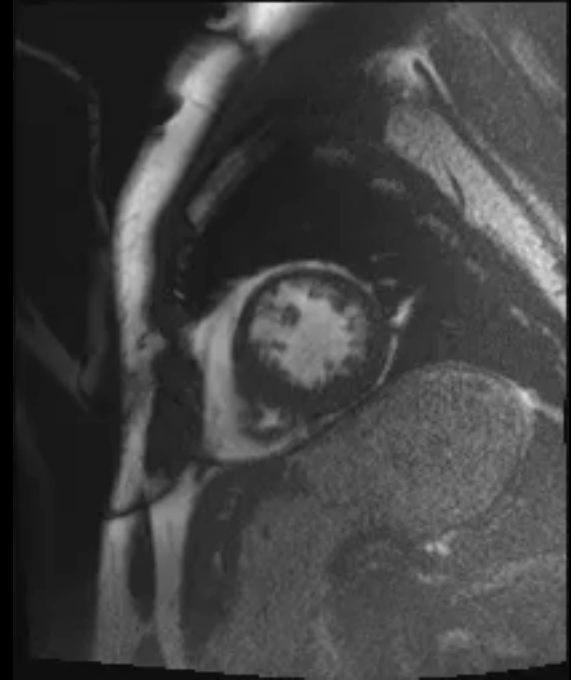
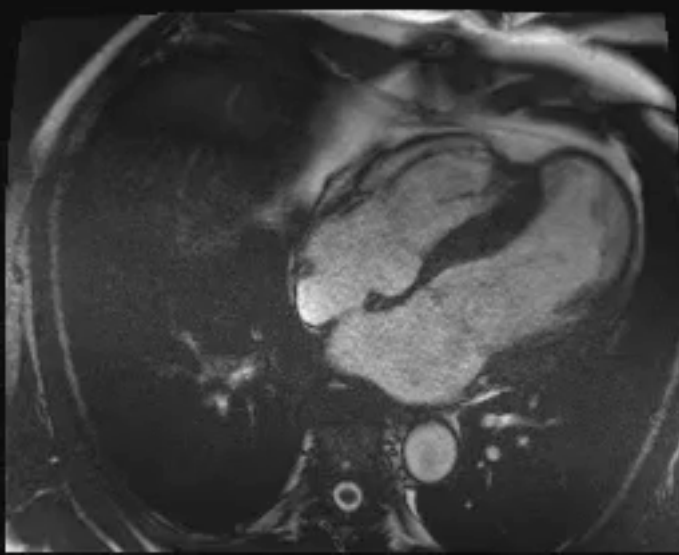
- T1 mapping avec calcul de la fraction extra-cellulaire myocardique



Diagnostics différentiels

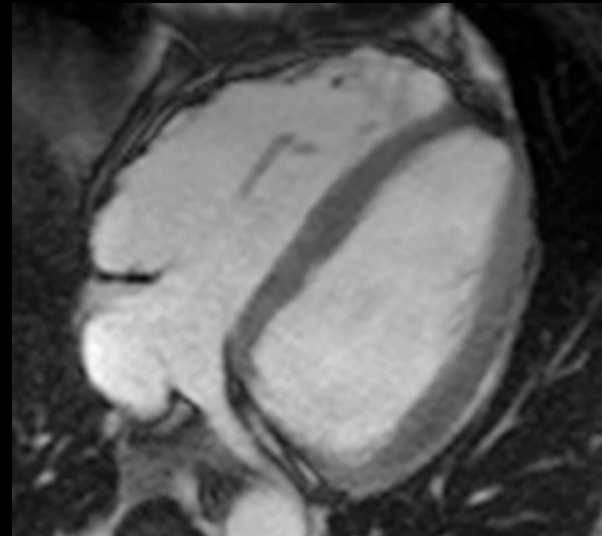
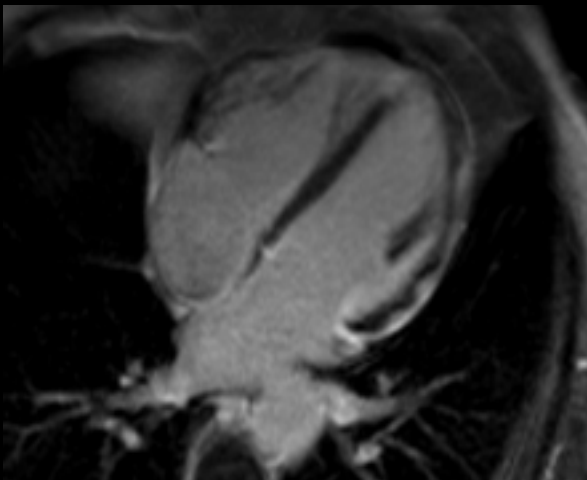
HTA, RA, Amylose, Fabry, non
compaction...

MCH et Non compaction

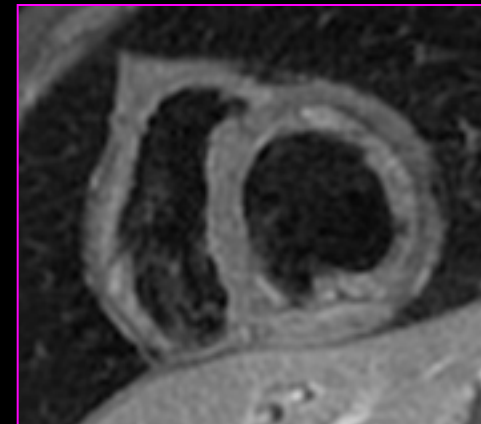
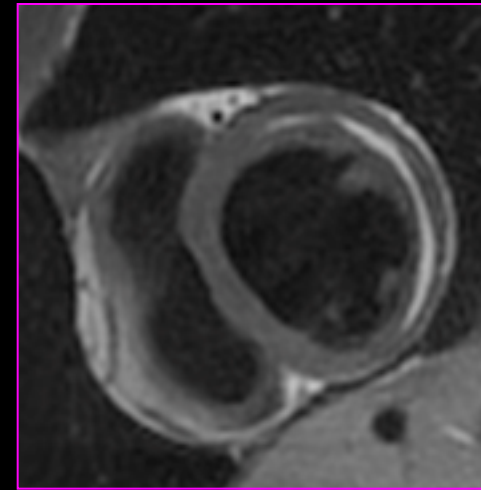
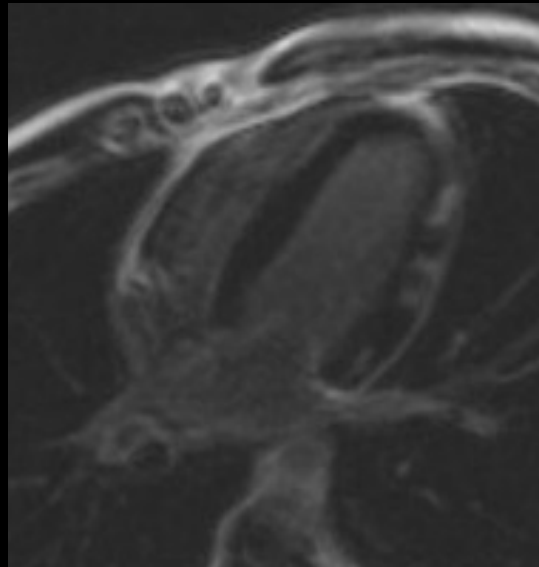
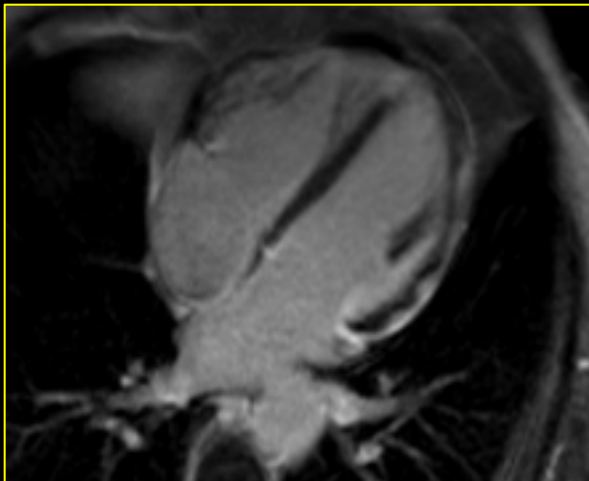
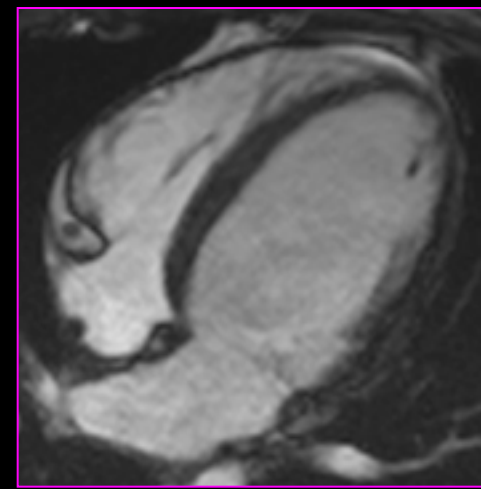
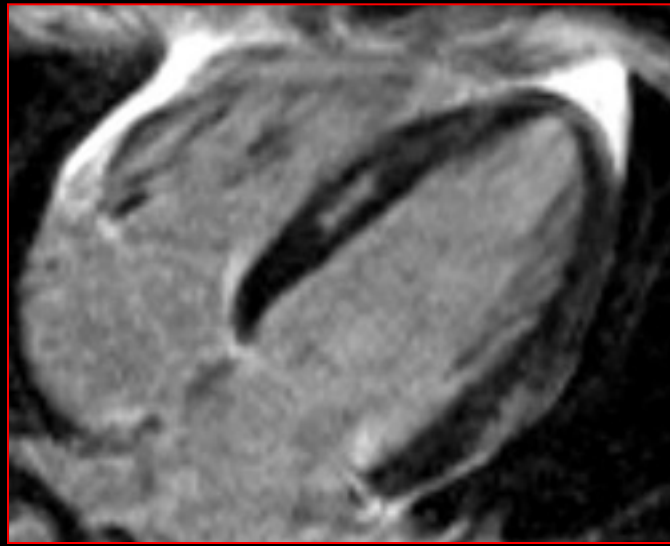
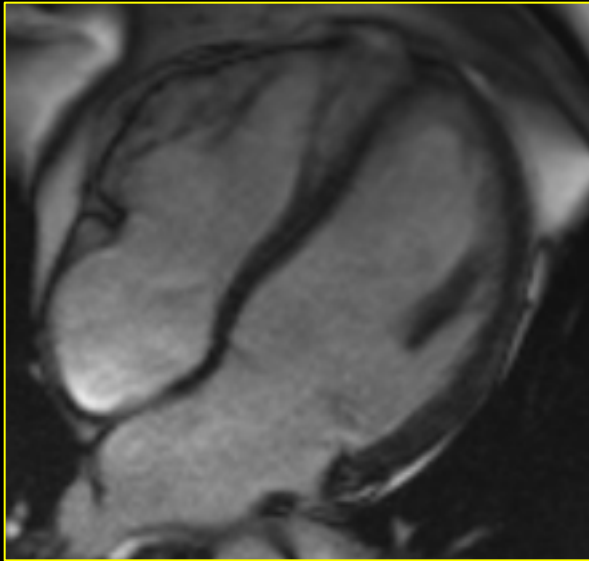


Bilan d'ESV du sportif

- Séquelles de myocardite
- DAVD



Myocardite



Prises de contrastes tardives sous-épicaudiques ou mésomyocardiques,
non systématisées, « patchy »

DAVD

Cas cliniques

DIAGNOSTIC DE DAVD

Imaging task force criteria for diagnosing arrhythmogenic right ventricular cardiomyopathy

Major criteria

Regional RV akinesia or dyskinesia, or dyssynchronous RV contraction

And 1 of the following:

RV end-diastolic volume $\geq 110 \text{ mL/m}^2$ (male) or $\geq 100 \text{ mL/m}^2$ (female)

or RV ejection fraction $\leq 40\%$

Minor criteria

Regional RV akinesia or dyskinesia, or dyssynchronous RV contraction

And 1 of the following:

RV end-diastolic volume $> 100 < 150 \text{ mL/m}^2$ (male) or $> 90 < 140 \text{ mL/m}^2$ (female)

or RV ejection fraction $> 40 \leq 45\%$

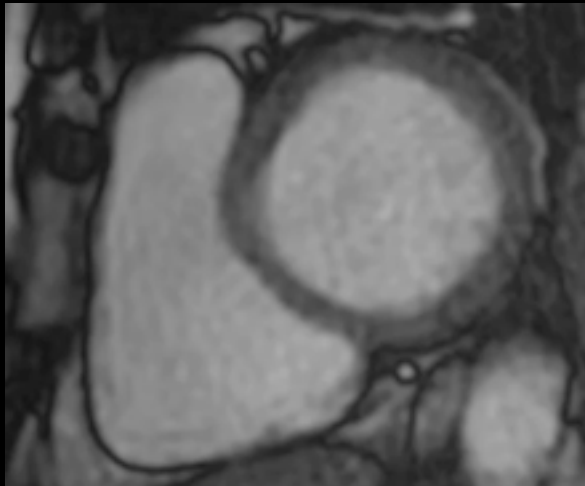
- + biopsie
- + repolarisation (T neg ant)
- + depolarisation (onde ϵ) & conduction (PTV, TAD...)
- + ESV & TV
- + ATCD familiaux



DAVD = 2M ou 2m+1M ou 4m

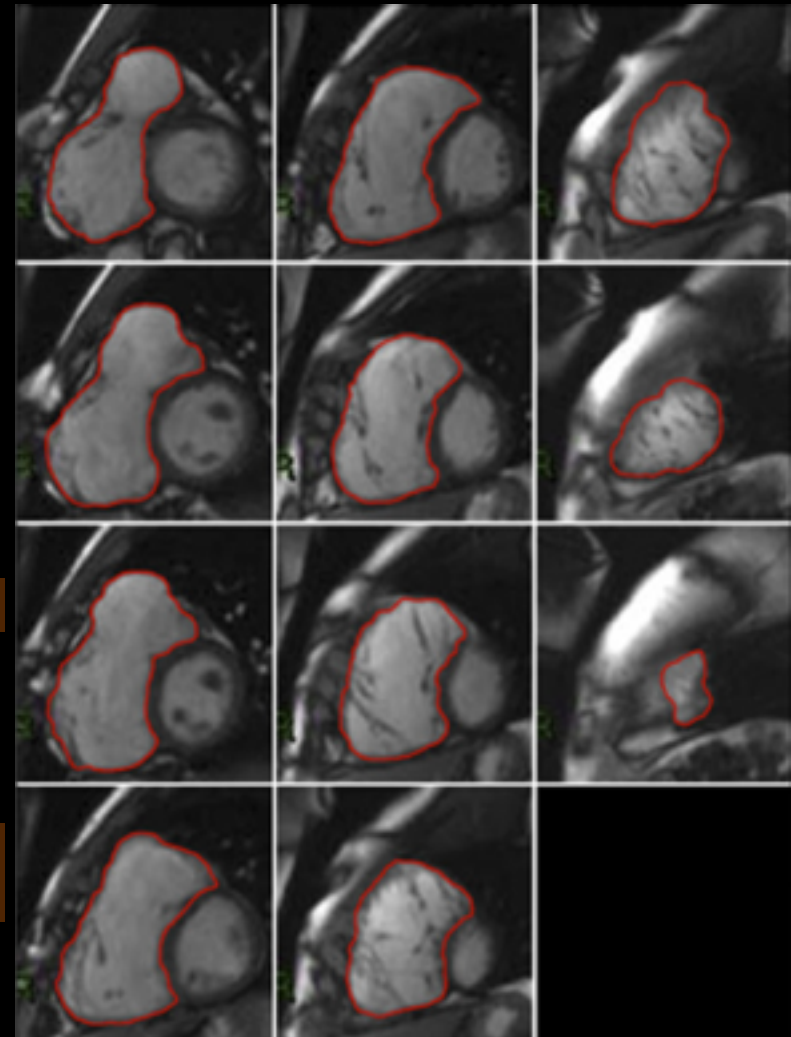
VOLUMETRIE VD => VTD & FE

SÉQUENCES CINE SSFP COUVRANT L'ENSEMBLE DU VD



Right Ventricle - Absolute

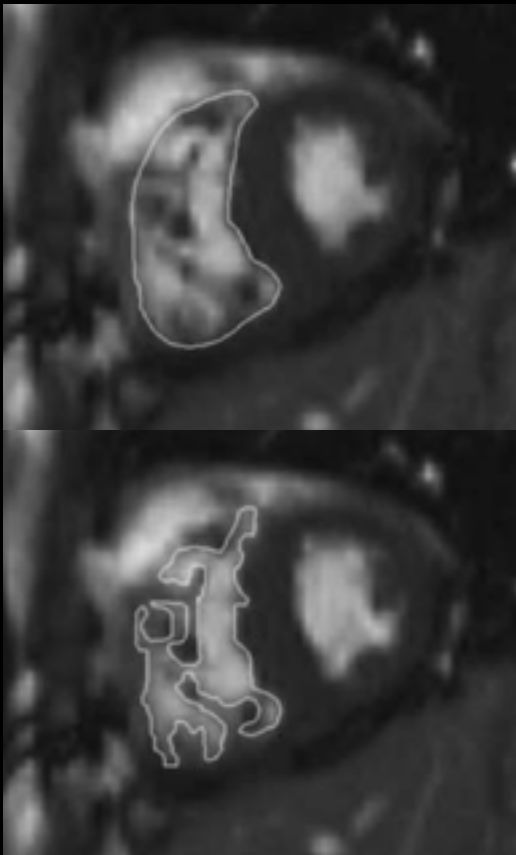
Cardiac Function		Normal Range (M)		Units
		(MRI)		
Ejection Fraction	EF	63.9	47.00 ... 74.00	%
End Diastolic Volume	EDV	126.4	88.00 ... 227.00	ml
End Systolic Volume	ESV	45.6	23.00 ... 103.00	ml
Stroke Volume	SV	80.8	52.00 ... 138.00	ml
Cardiac Output	CO	4.77	2.82 ... 8.82	l/min
End Diastolic Volume	EDV	59.3	55.00 ... 105.00	ml/m ²
End Systolic Volume	ESV	21.4	15.43 ... 42.91	ml/m ²
Stroke Volume	SV	37.9	32.00 ... 64.00	ml/m ²
Cardiac Index	CI	2.24	1.74 ... 4.20	l/min/m ²



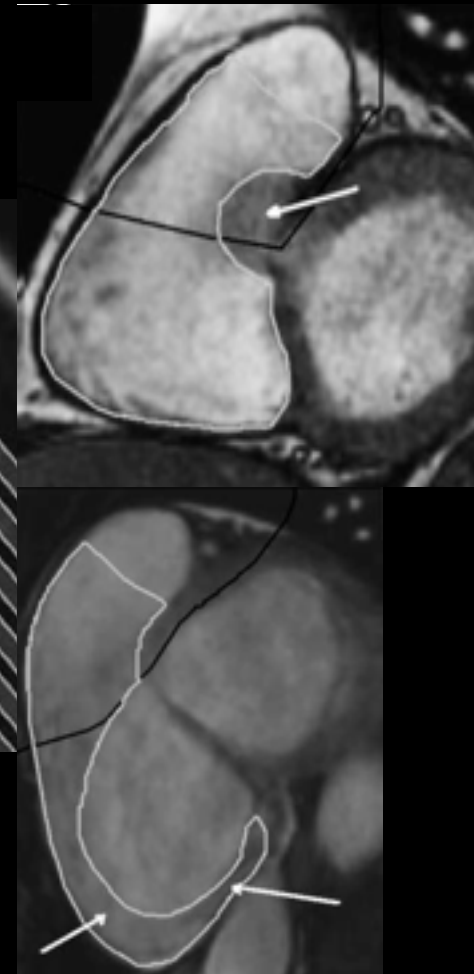
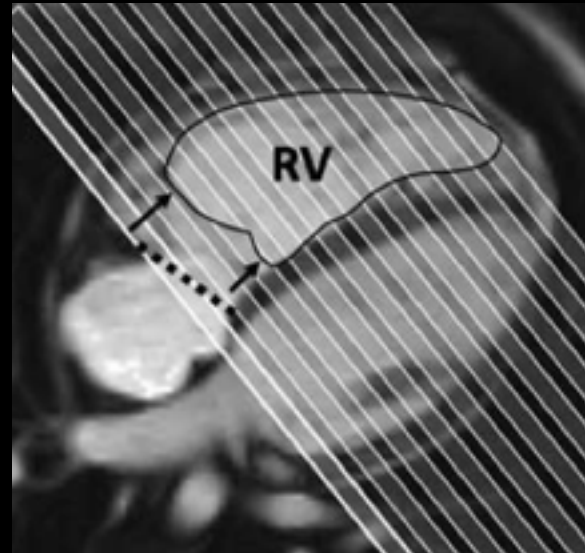
VOLUMETRIE VD => VTD & FE

CAUSES DE VARIABILITÉ DES MESURES

TRABECULATIONS

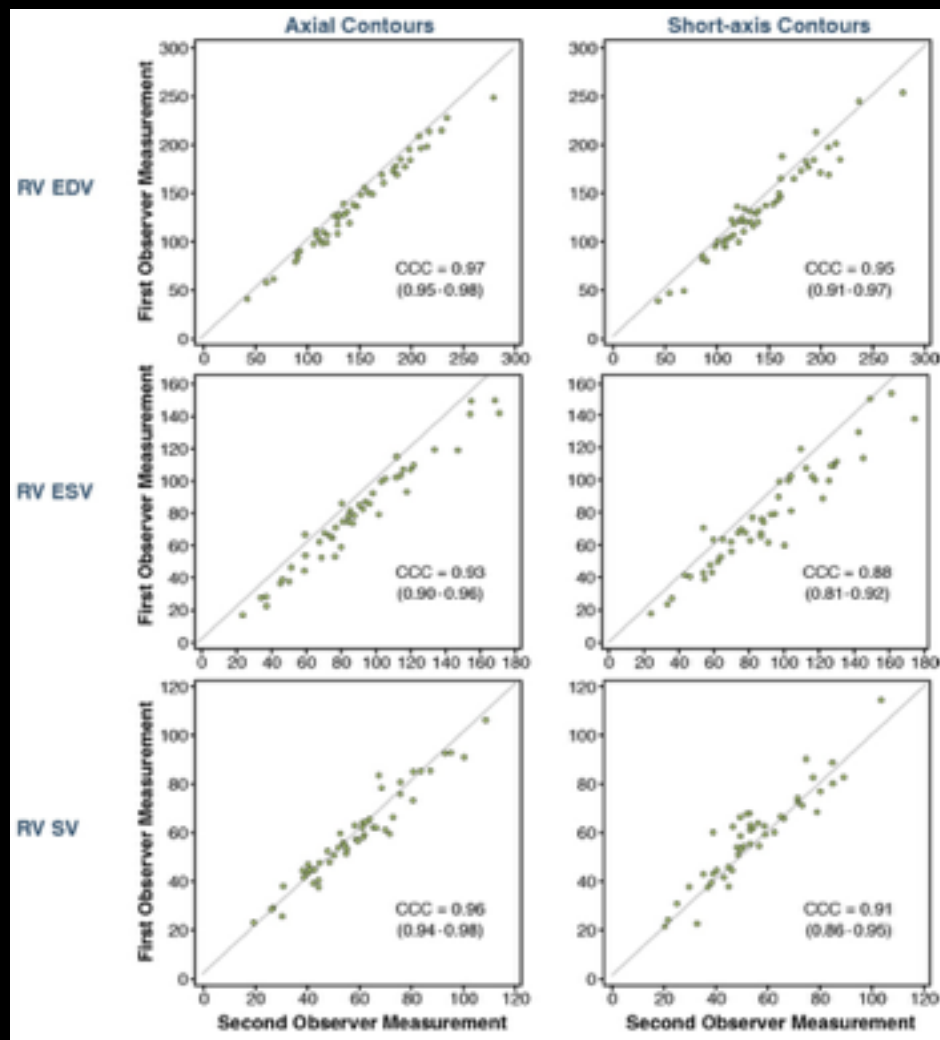
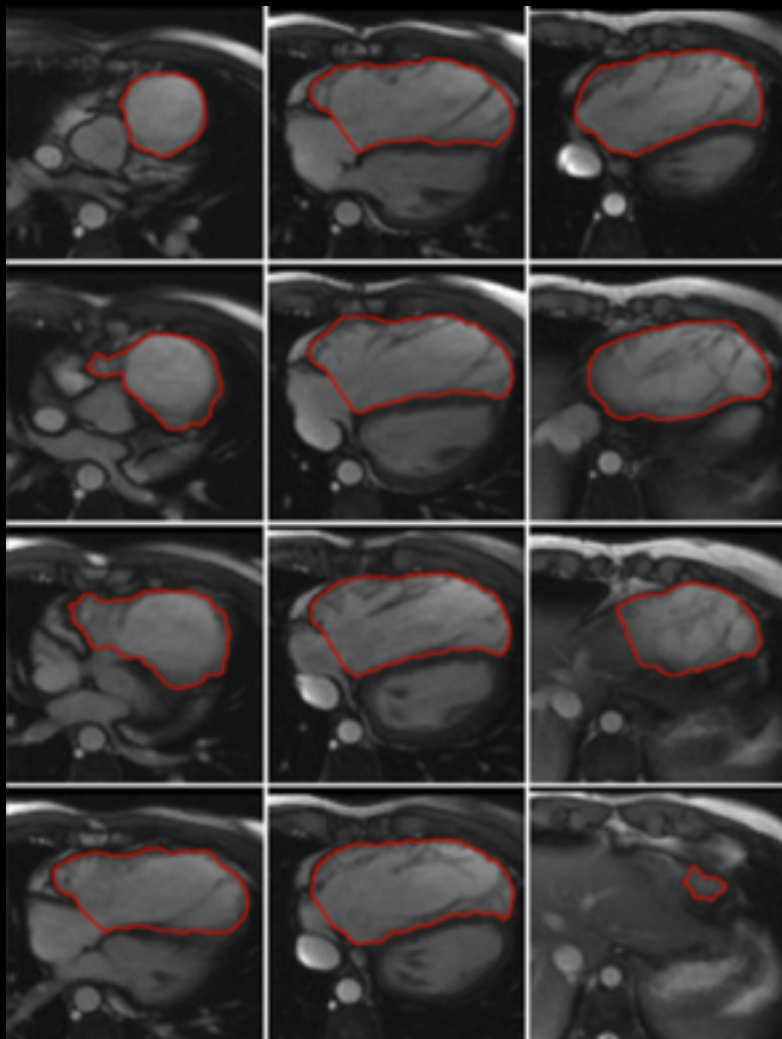


PLANS VALVULAIRES



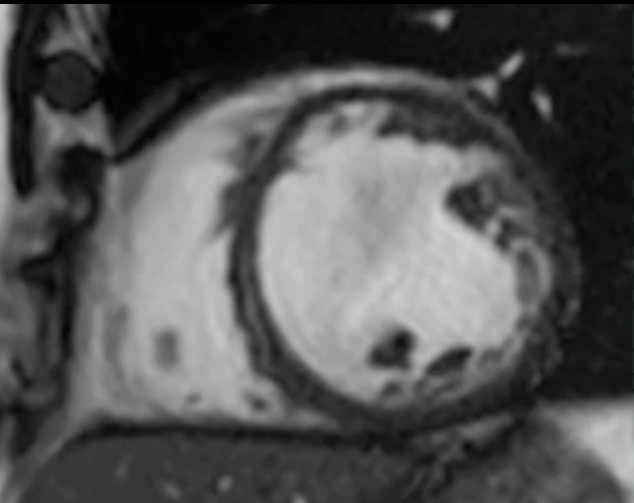
VOLUMETRIE VD => VTD & FE

REPRODUCIBILITÉ

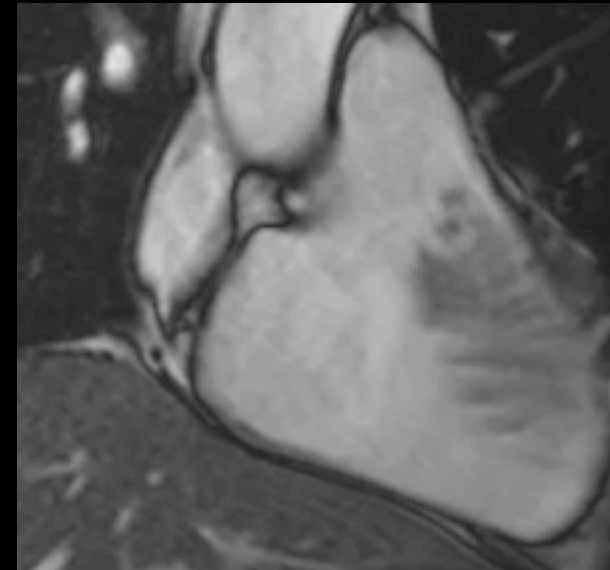
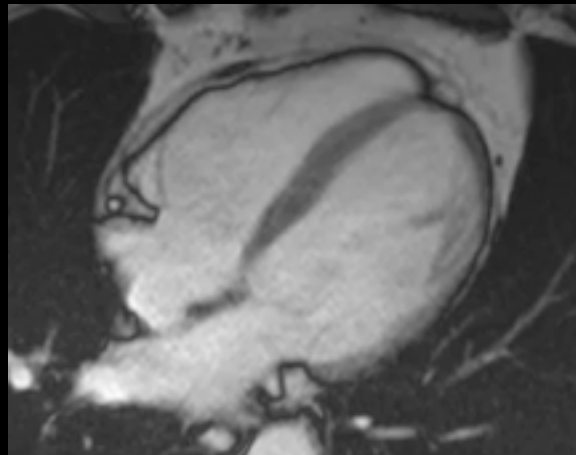


FONCTION SEGMENTAIRE VD = LONG AXE

CINETIQUE
SEGMENTAIRE VG
=
PETIT AXE

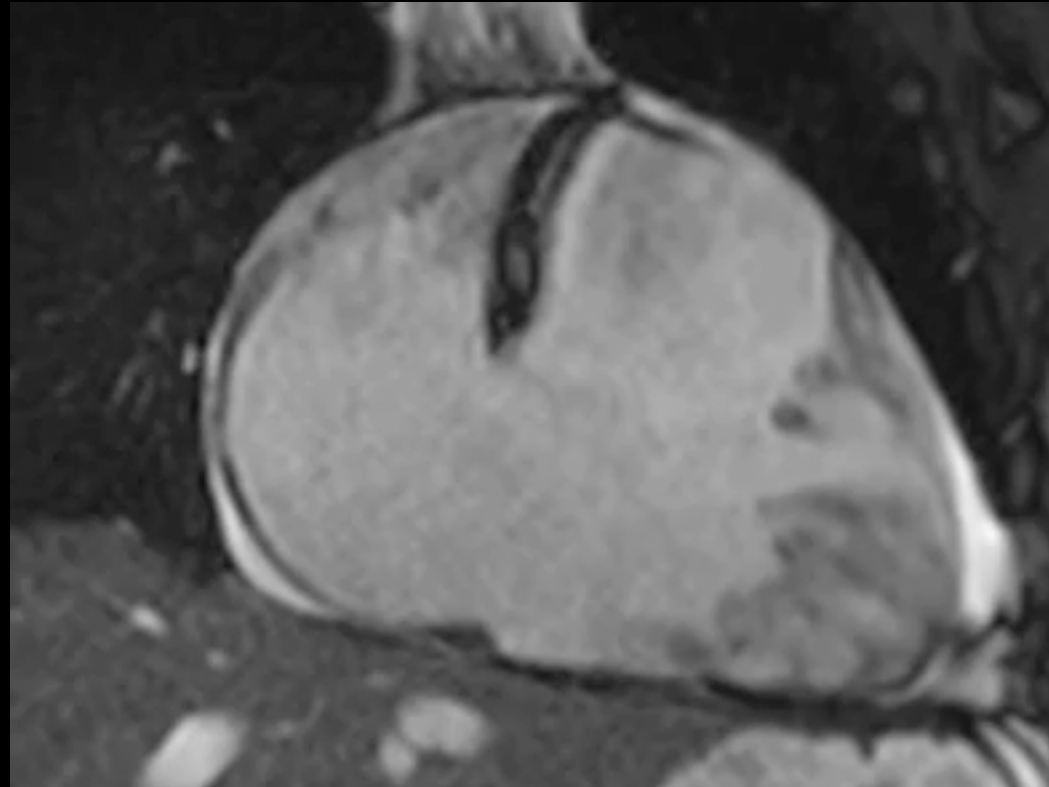
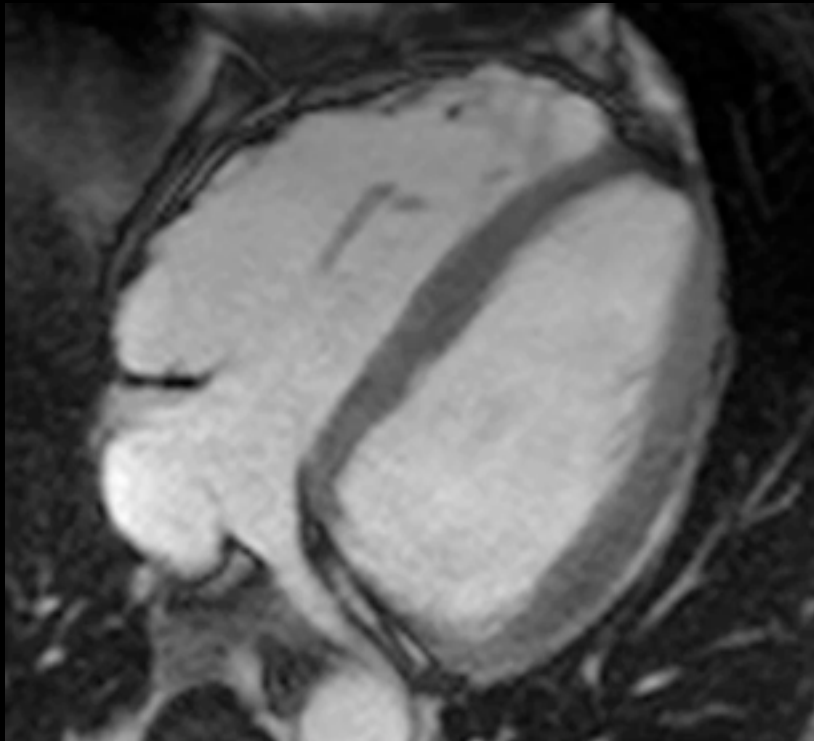


CINETIQUE
SEGMENTAIRE VD
=
LONG AXE



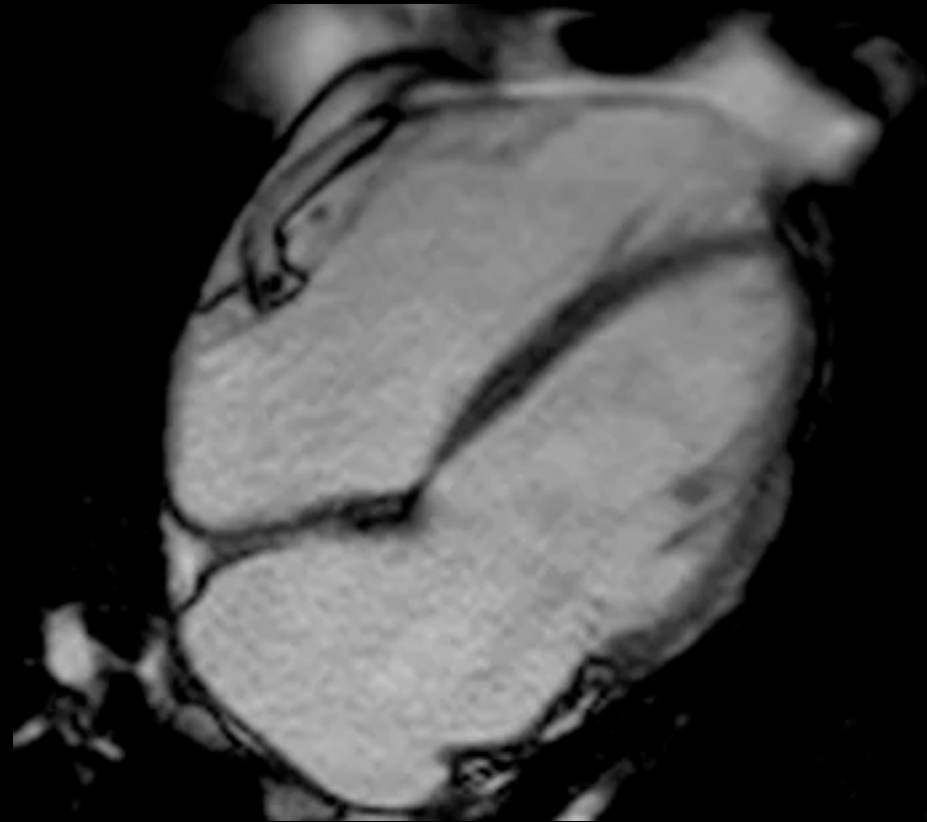
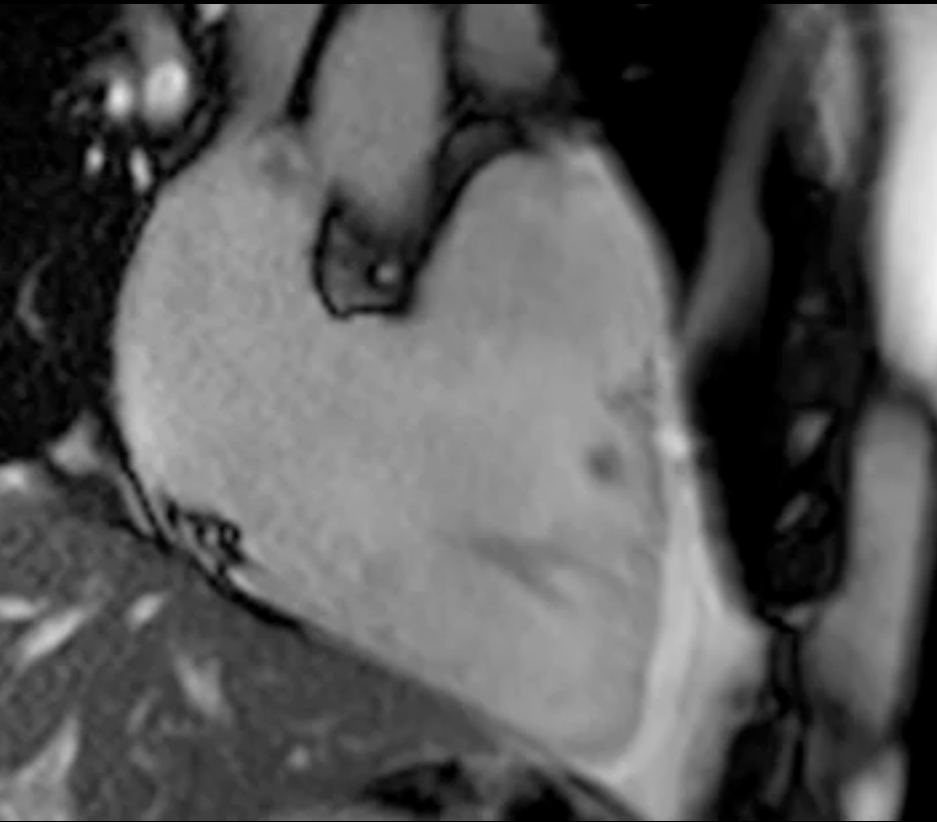
IMAGES PATHOLOGIQUES

DAVD FORME DIFFUSE



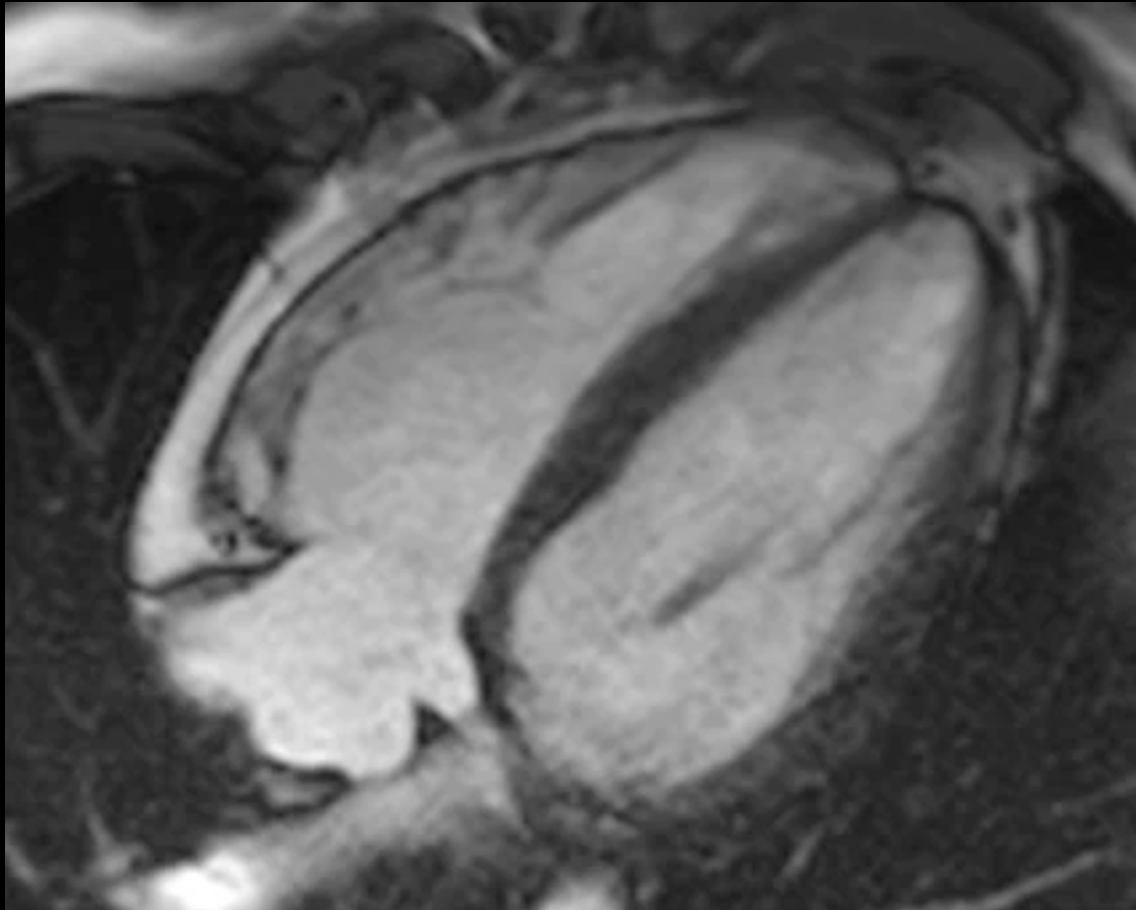
IMAGES PATHOLOGIQUES

DAVD FORME INTERMEDIAIRE

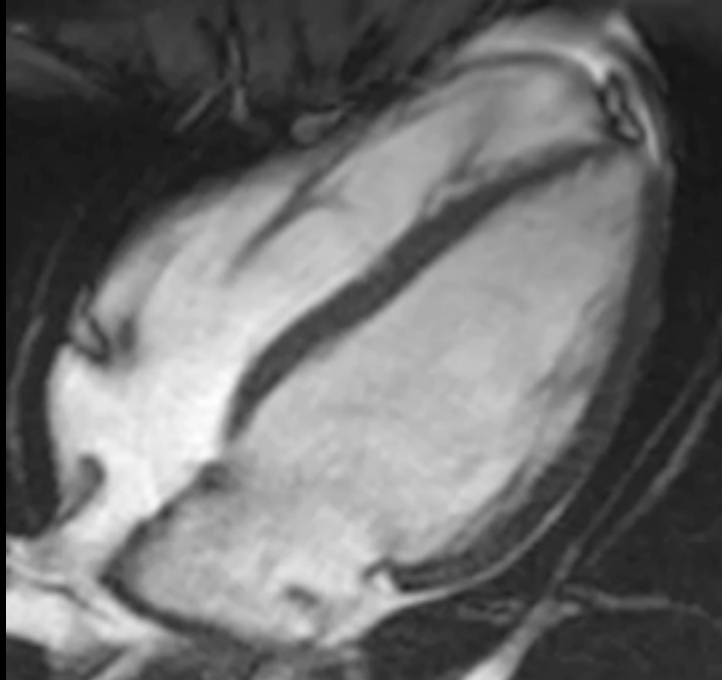


IMAGES PATHOLOGIQUES

DAVD FORME FOCALE

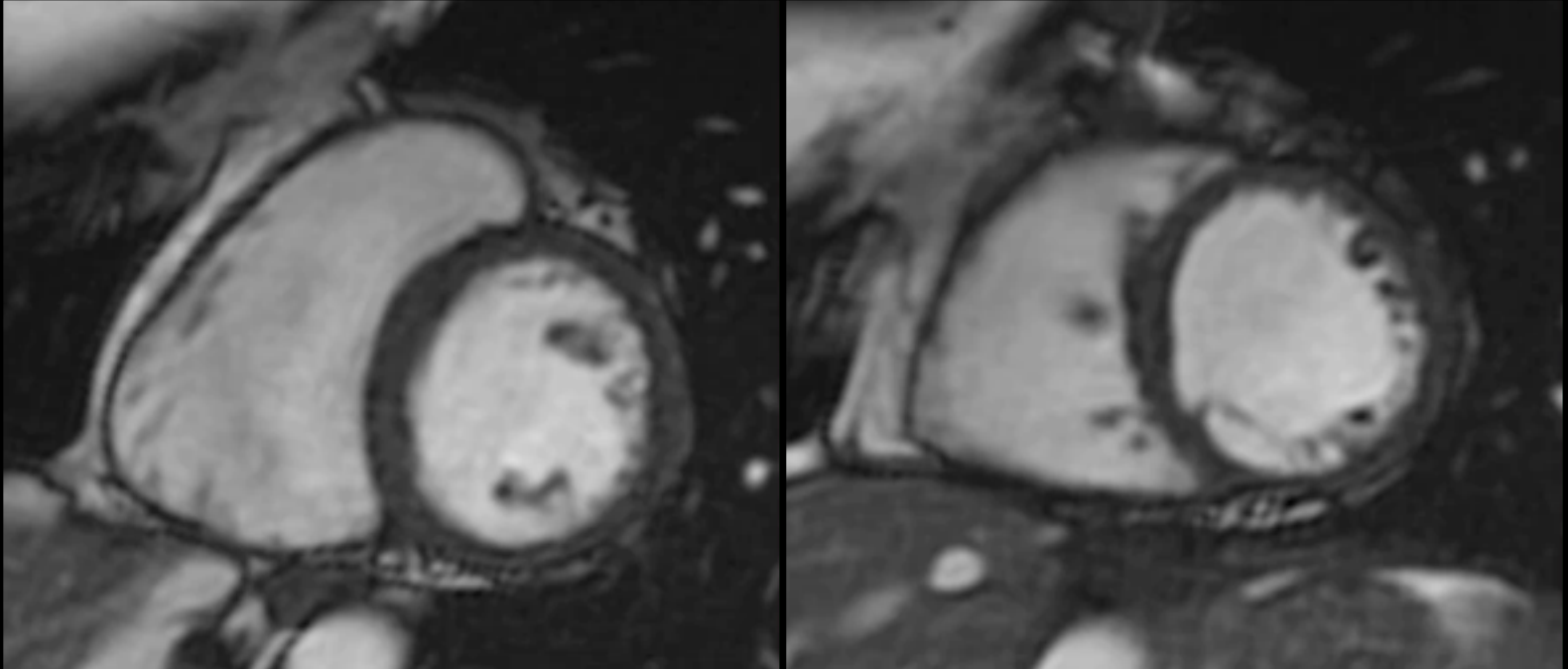


IMAGES NON PATHOLOGIQUES



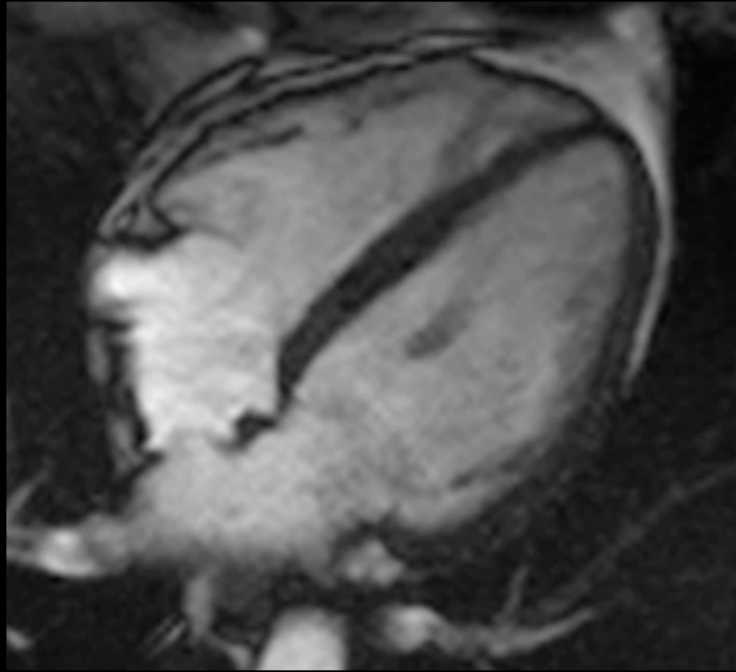
Graisse épocardique

IMAGES NON PATHOLOGIQUES



Entrée de coupe

IMAGES NON PATHOLOGIQUES



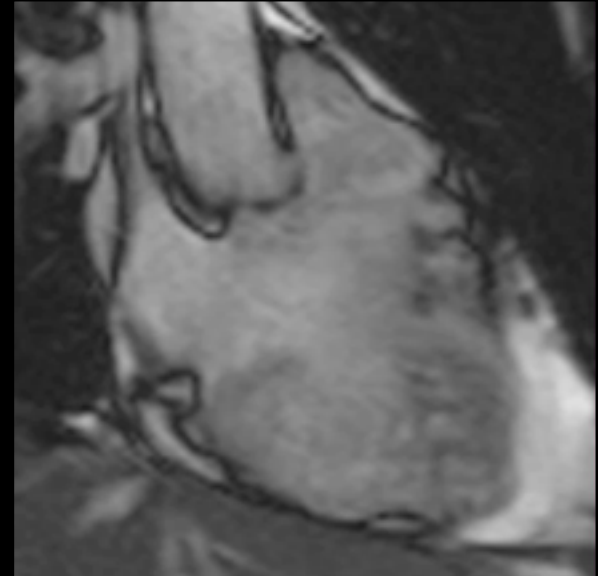
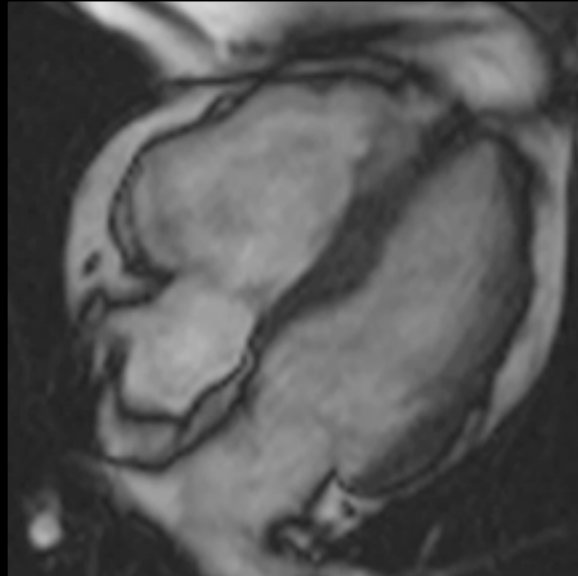
Insertion bandelette septo-marginale

Mme D . 62 ans.

- ESV symptomatiques >500/24h m
- T negatives en V1-V3 M

VTD 131 mL/m²

FE 24%



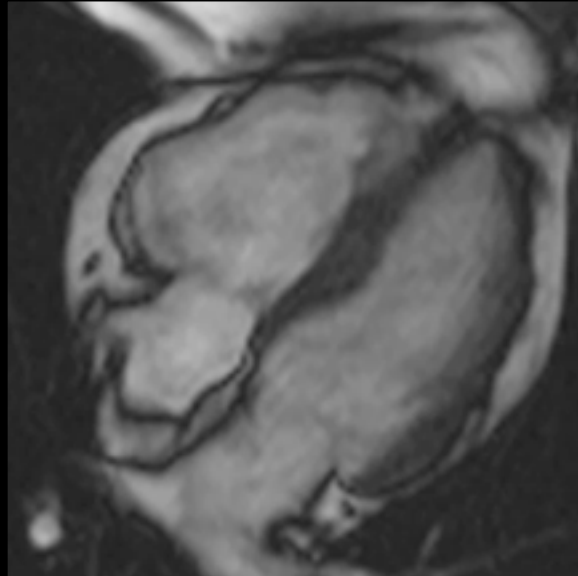
➔ M = DAVD

Mme D . 62 ans.

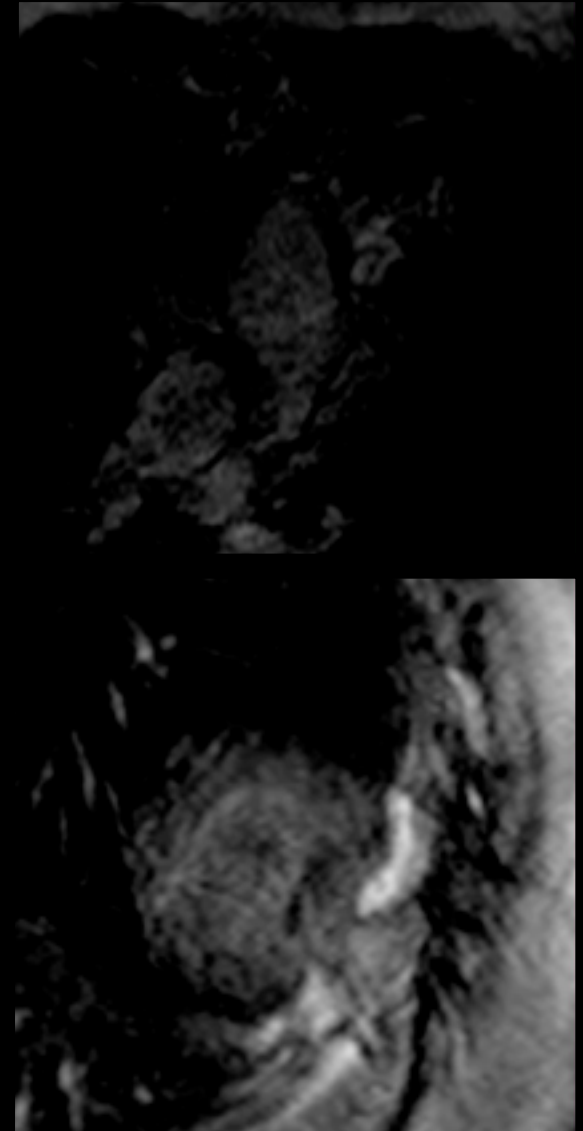
- ESV symptomatiques >500/24h m
- T negatives en V1-V3 M

VTD 131 mL/m²

FE 24%



➔ M = DAVD

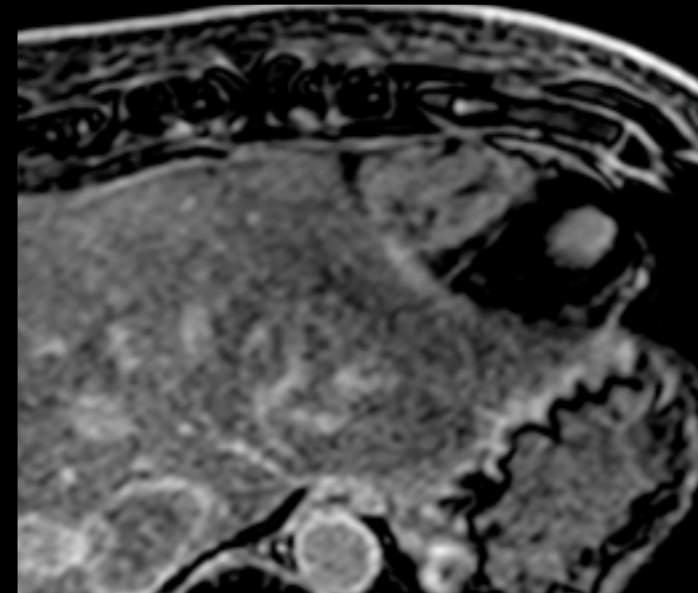
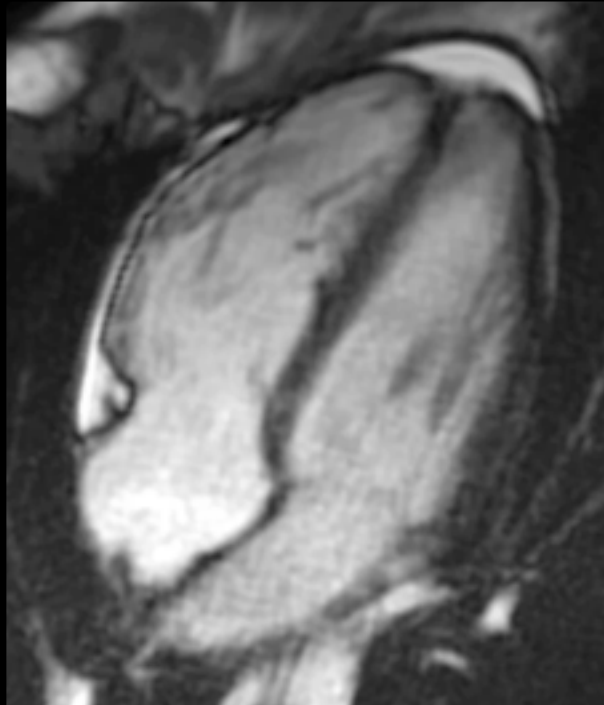


Mr F. 18 ans.

- Asymptomatique
- Frère porteur d'une DAVD **M**

VTD 92 mL/m²

FE 38 %



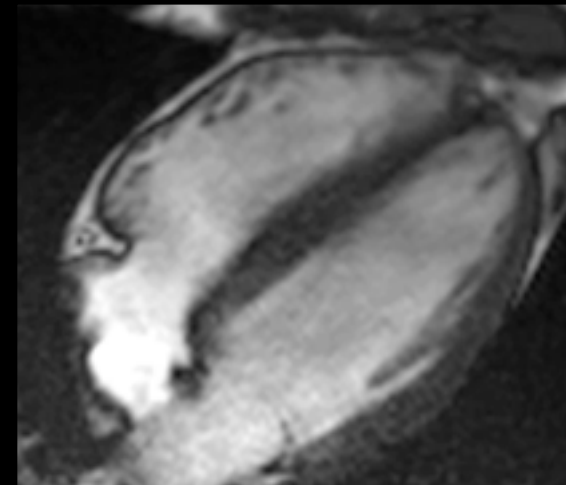
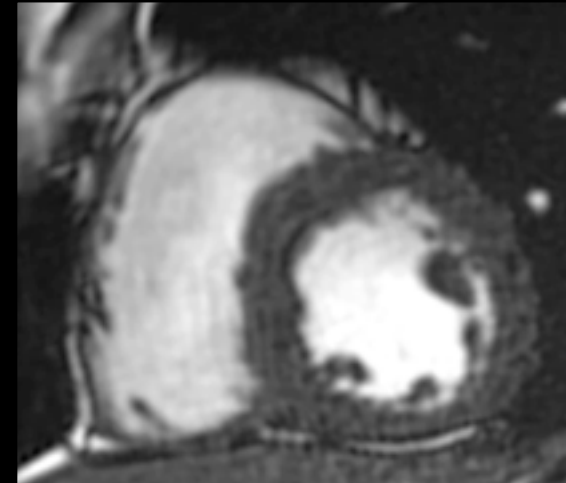
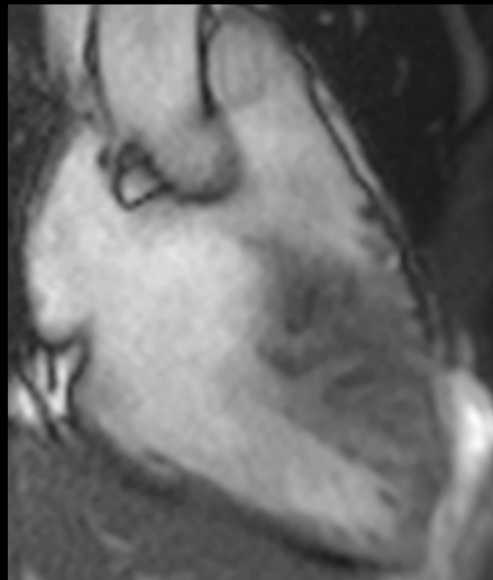
➔ M = DAVD

Mr M. 46 ans.

- T neg V1-V3 M
- ESV>500/24h m
- TVNS morpho indéterminée M
- Trouble conducteur (TAD>55ms) m

VTD 90 mL/m²

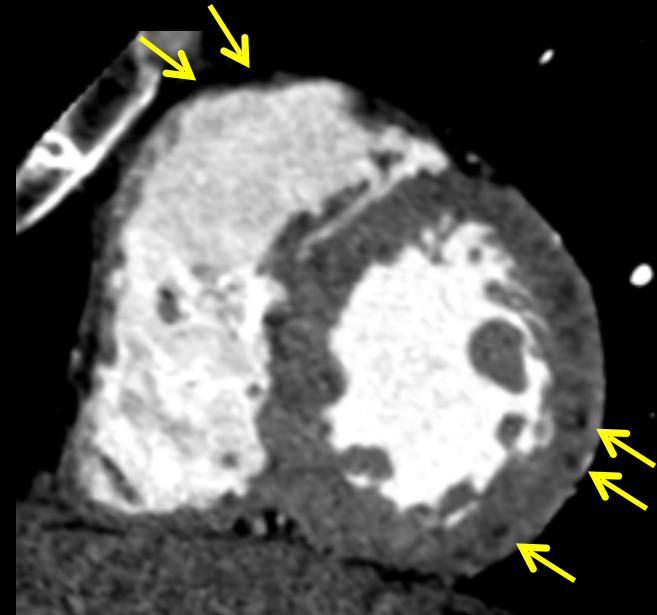
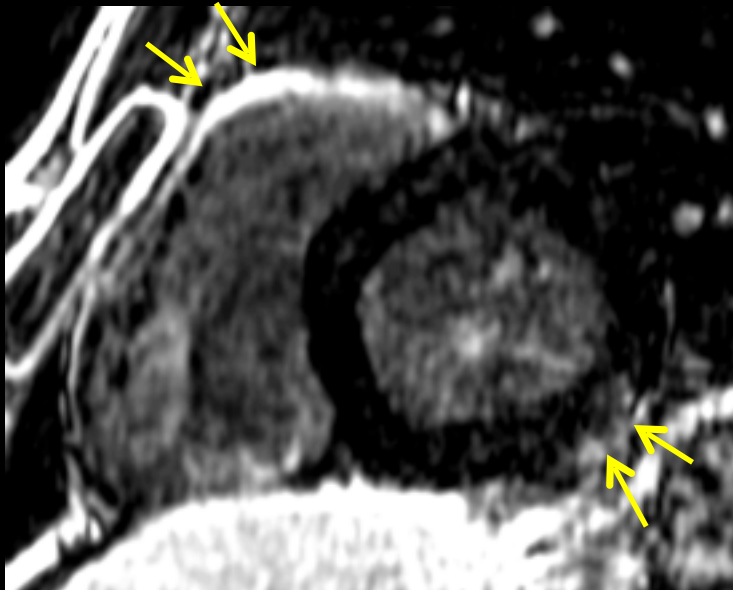
FE 48 %



➔ 0 = DAVD

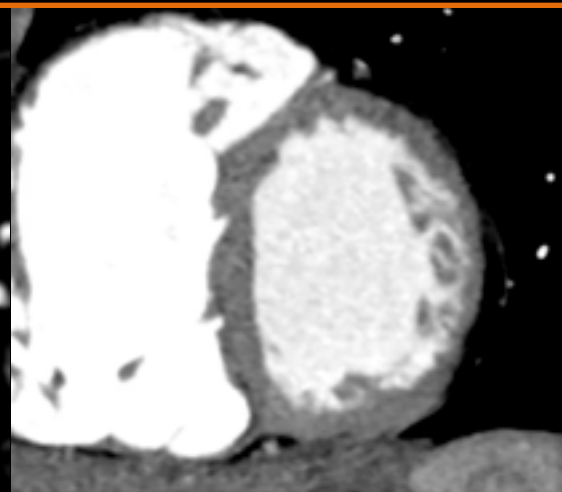
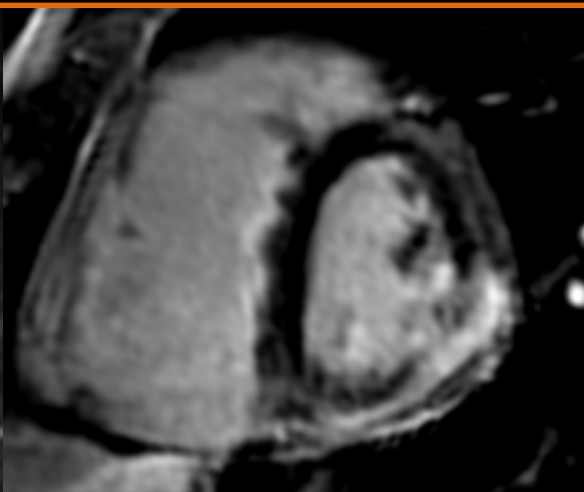
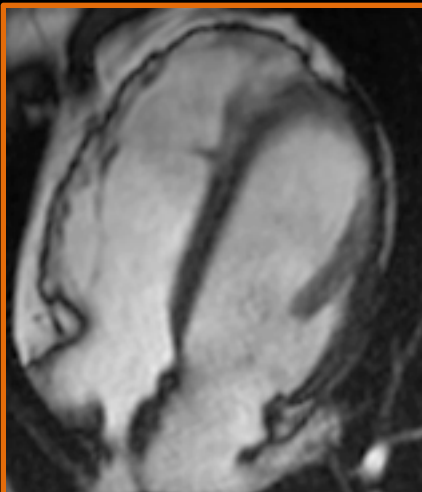
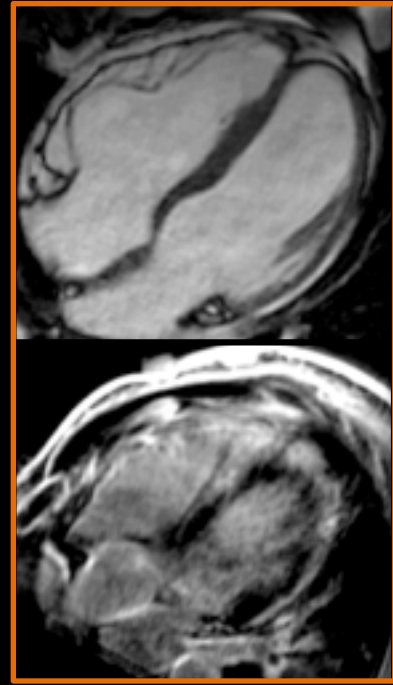
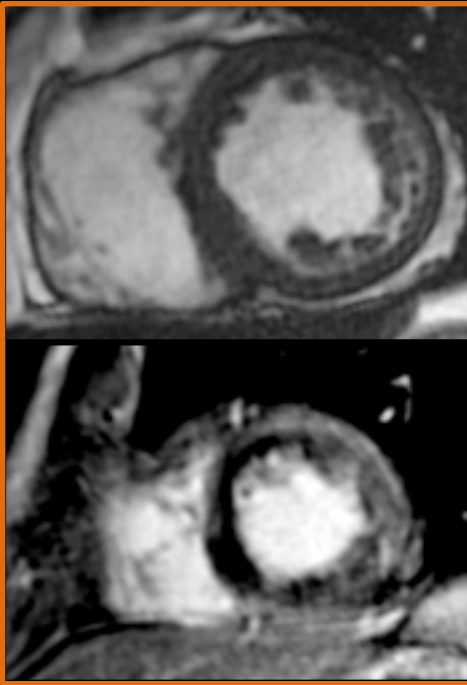
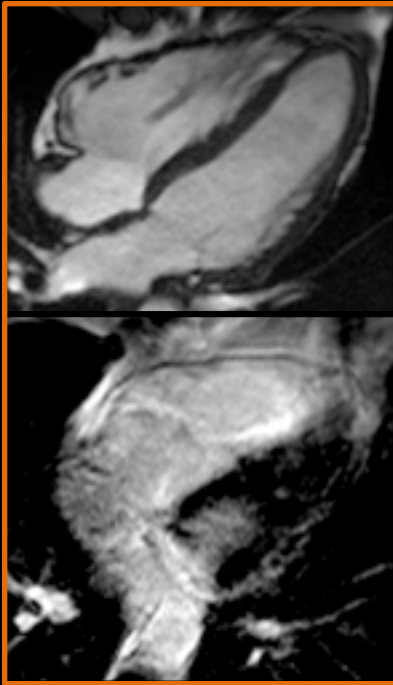
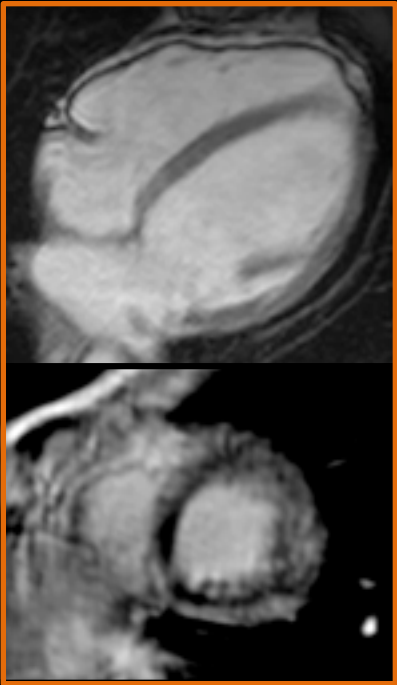
Mr M. 46 ans.

- T neg V1-V3 M
- ESV>500/24h m
- TVNS morpho indéterminée M
- Trouble conductif (TAD>55ms) m



➔ 0 = DAVD

ATTEINTES BIV: RHSST TARDIF +++




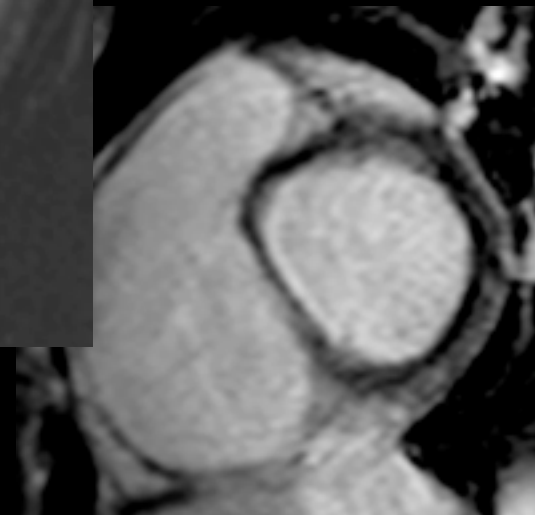
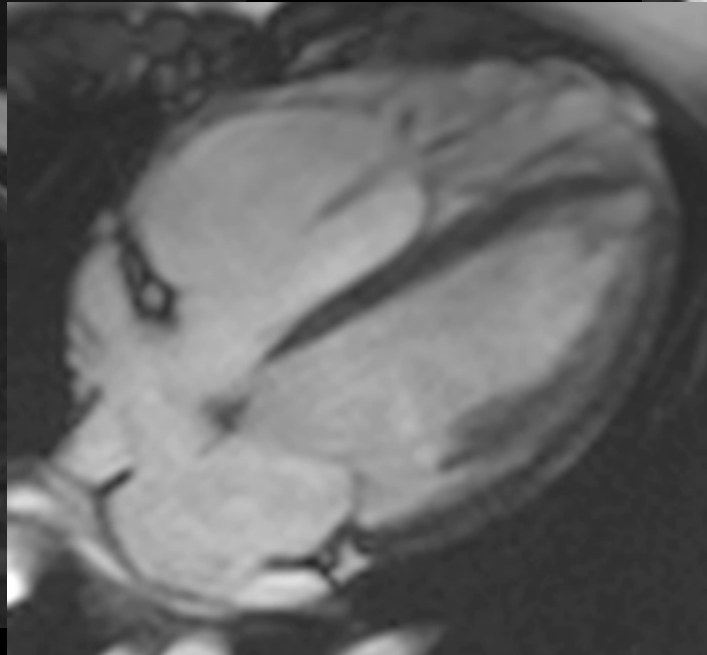
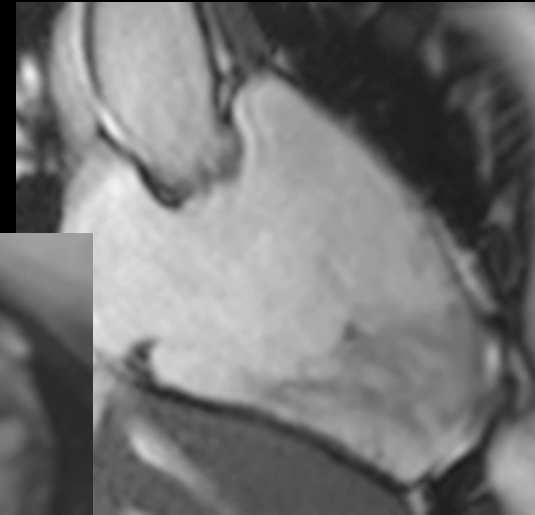
Mme C. 25 ans.

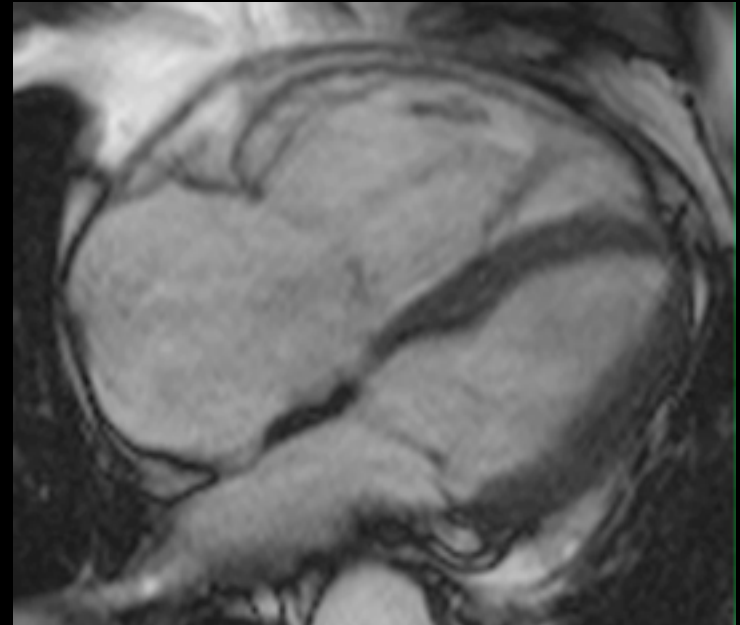
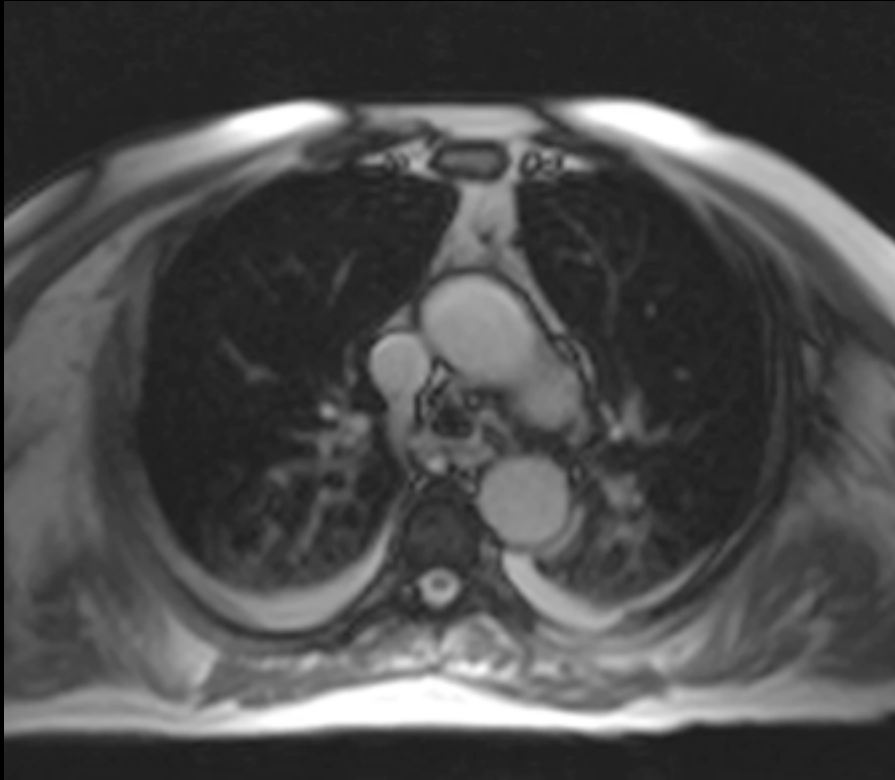
- T neg V1-V3 **M**
- ESV type retard G >500/24h **m**

VTD 144mL/m²

FE 45%

 **0 = CIA**





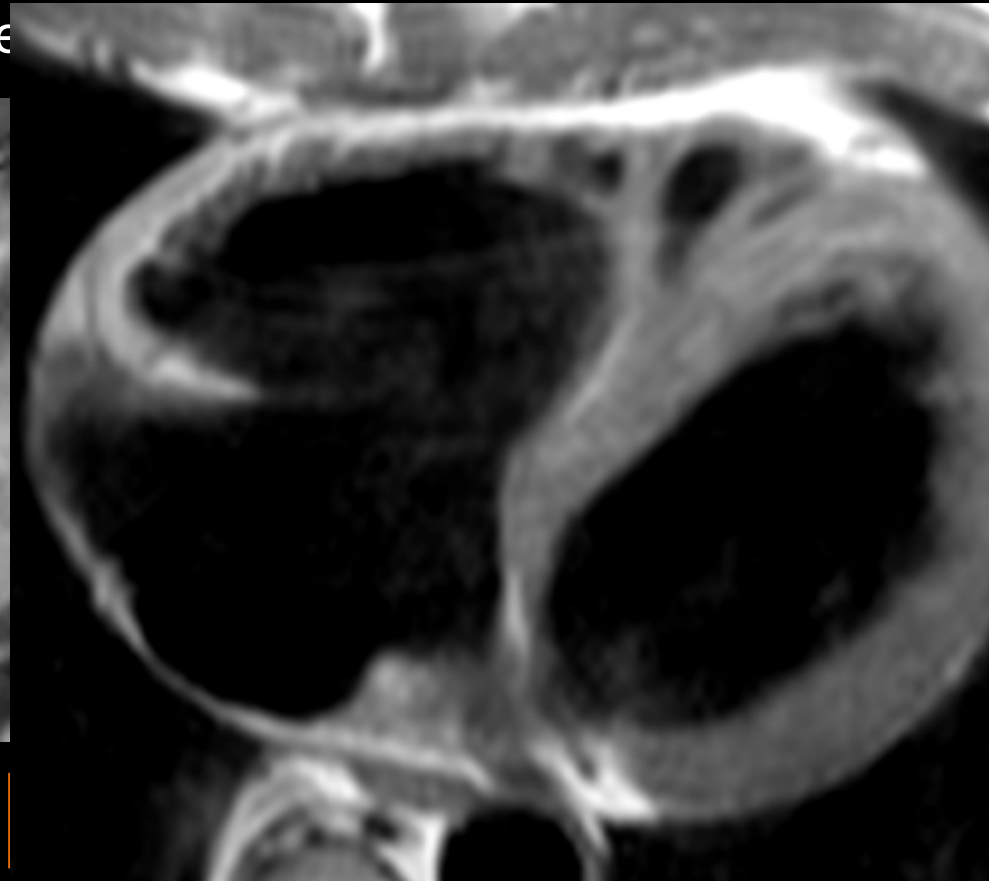
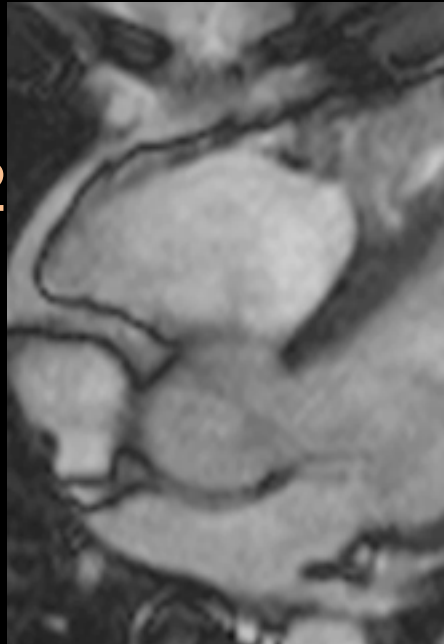
HTAP

Mr B. 58 ans.

- TVS infundibulaire m
- PTV positifs m
- ATCD mort subite chez le frère

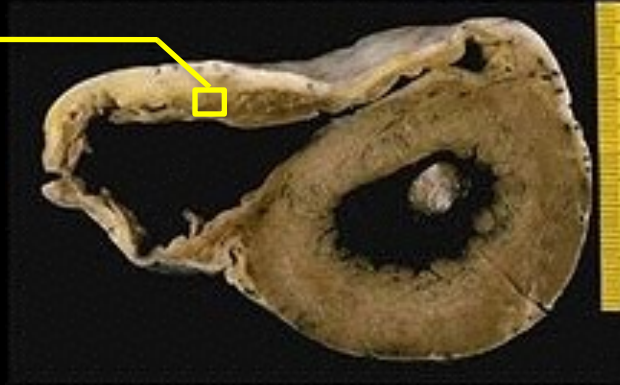
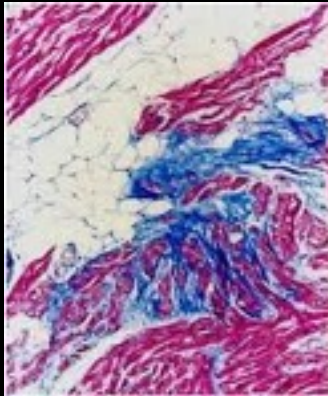
VTD 126mL/m²

FE 33%

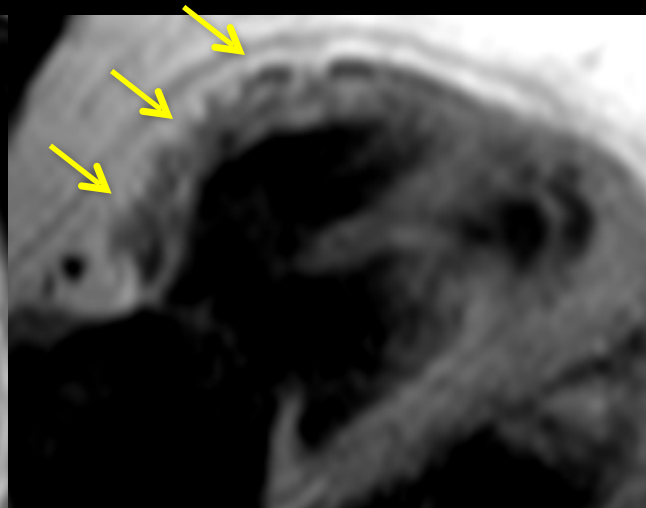
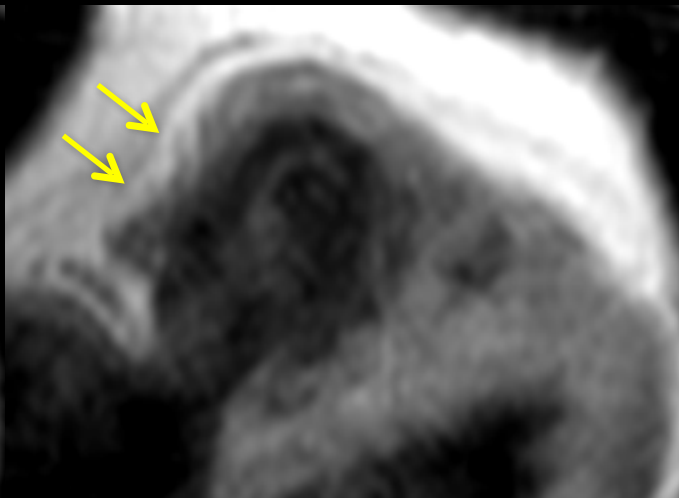
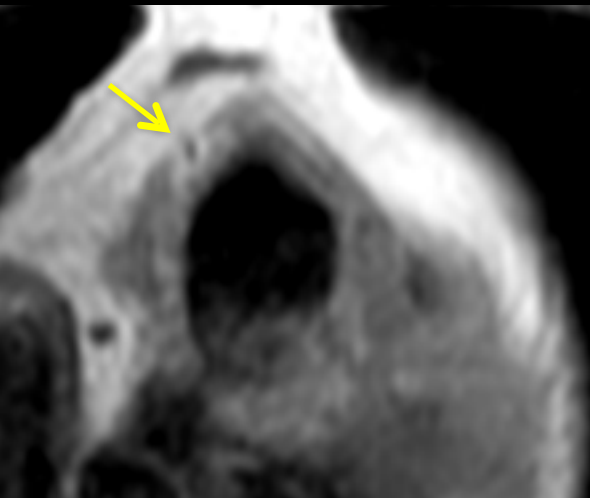


➡ M = DAVI

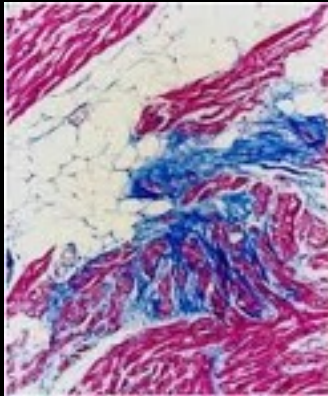
CARACTERISATION TISSULAIRE ?



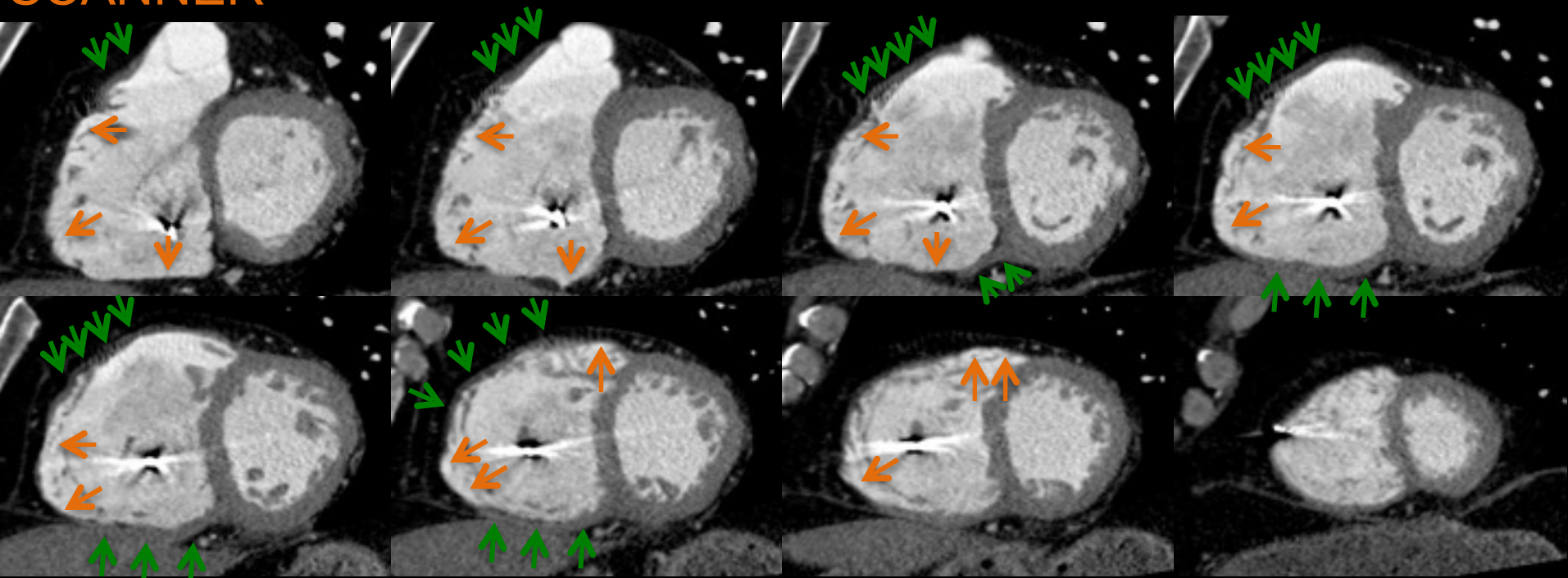
T1 TSE DB

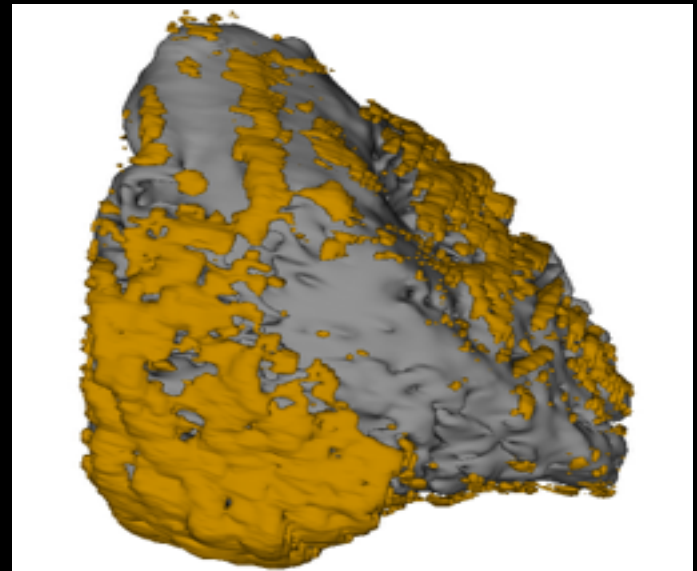
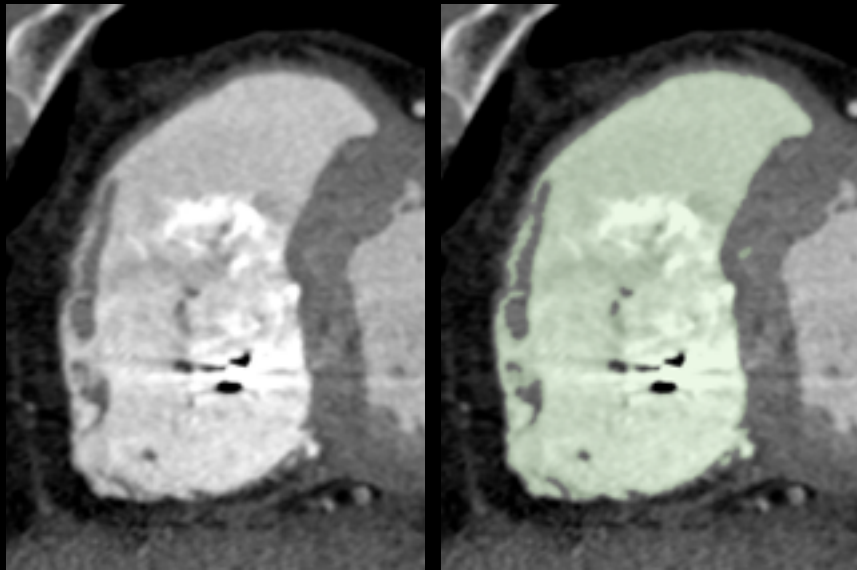


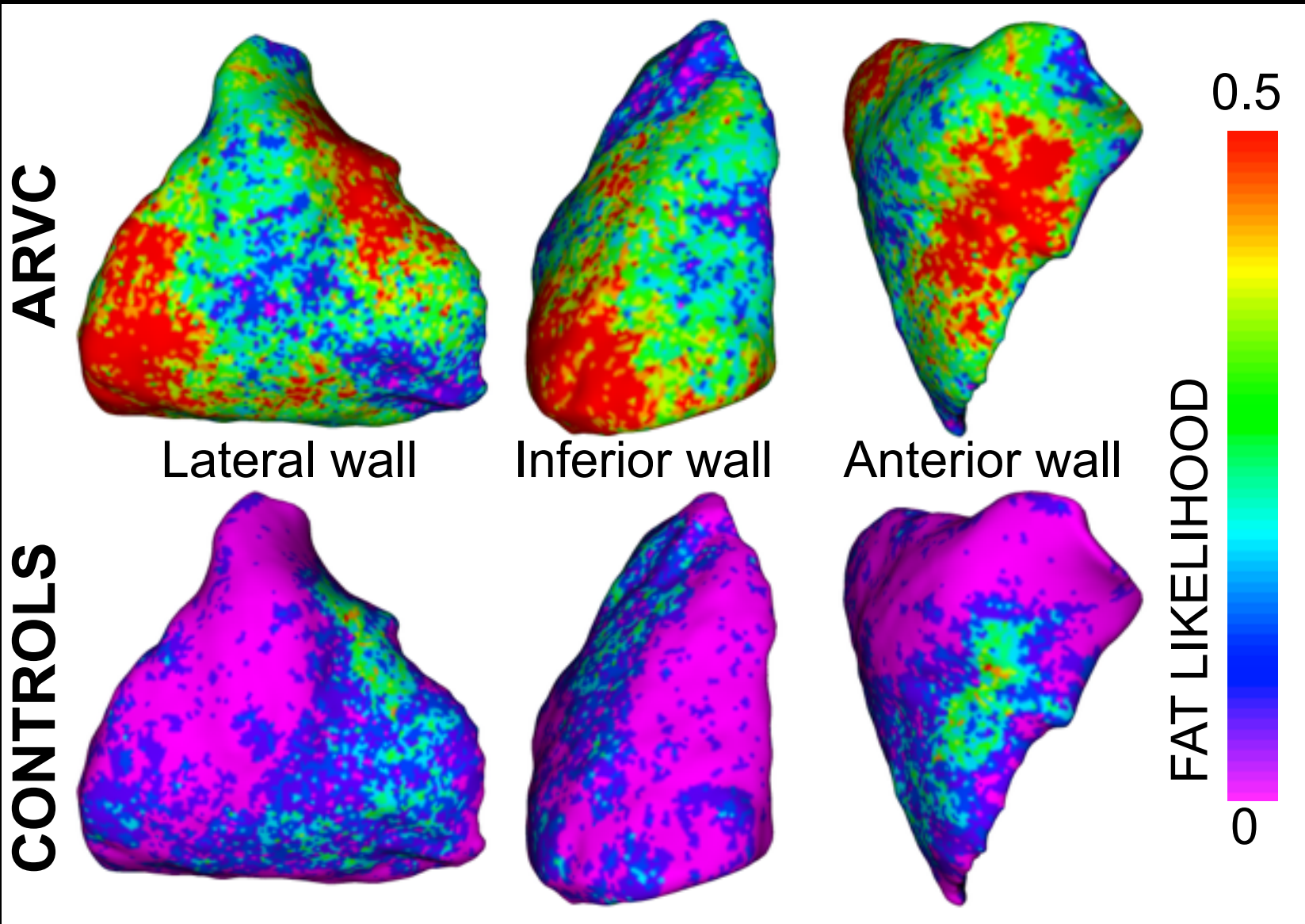
CARACTERISATION TISSULAIRE ?



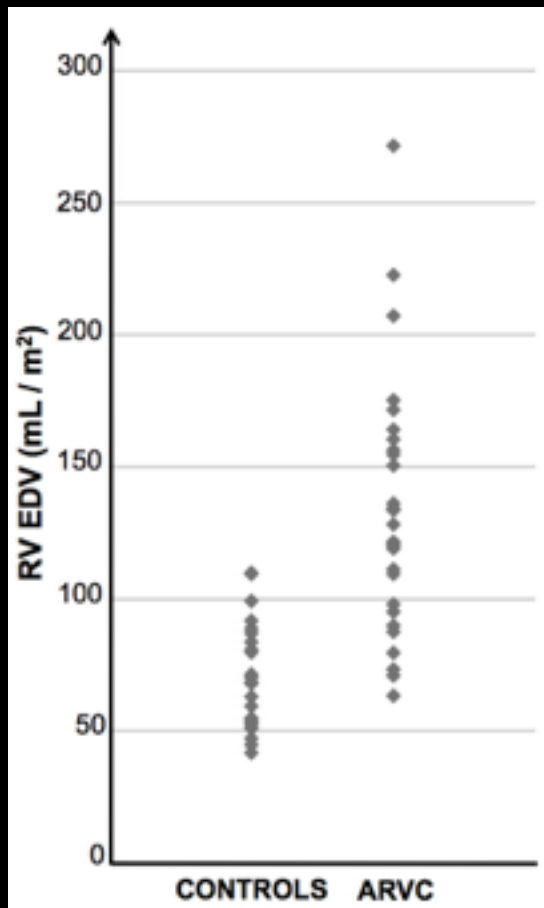
SCANNER





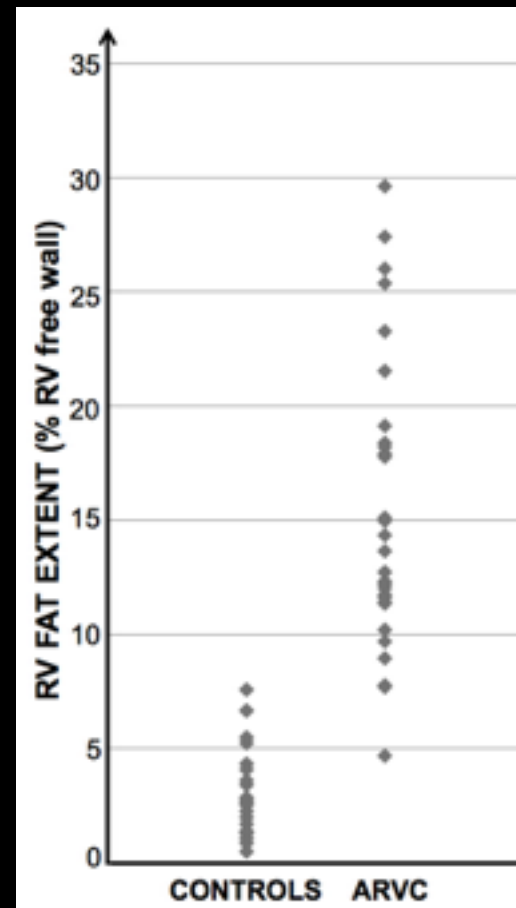


VTD



seuil 109.8 mL/m2)
Se: 69% (95%CI 53-80)
Sp: 100% (95%CI 85-100)

GRAISSE



seuil 7.69% paroi libre VD
Se: 86% (95%CI 69-95)
Sp: 100% (95%CI 87-100)

DAVD : CONCLUSION

DAVD = Diagnostic algorithmique



➡ EXPERIENCE +++

➡ RAPPEL: DAVD indication fréquente mais maladie rare

Actualité: retour de l'imagerie (quantitative) du substrat?

Conclusion générale

- L'IRM a un rôle grandissant et de plus en plus incontournable dans l'étude morphologique et fonctionnelle des cardiopathies rythmiques ainsi que des autres myocardiopathies
- Les dernières avancées technologiques promettent une approche de caractérisation tissulaire fine pouvant renforcer les performances de cette modalité