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recommandations

J Radiol 2009;90:1144-60

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**formation médicale continue**

**recommandations**

## Indications cliniques appropriées de l'IRM en pathologie cardio-vasculaire





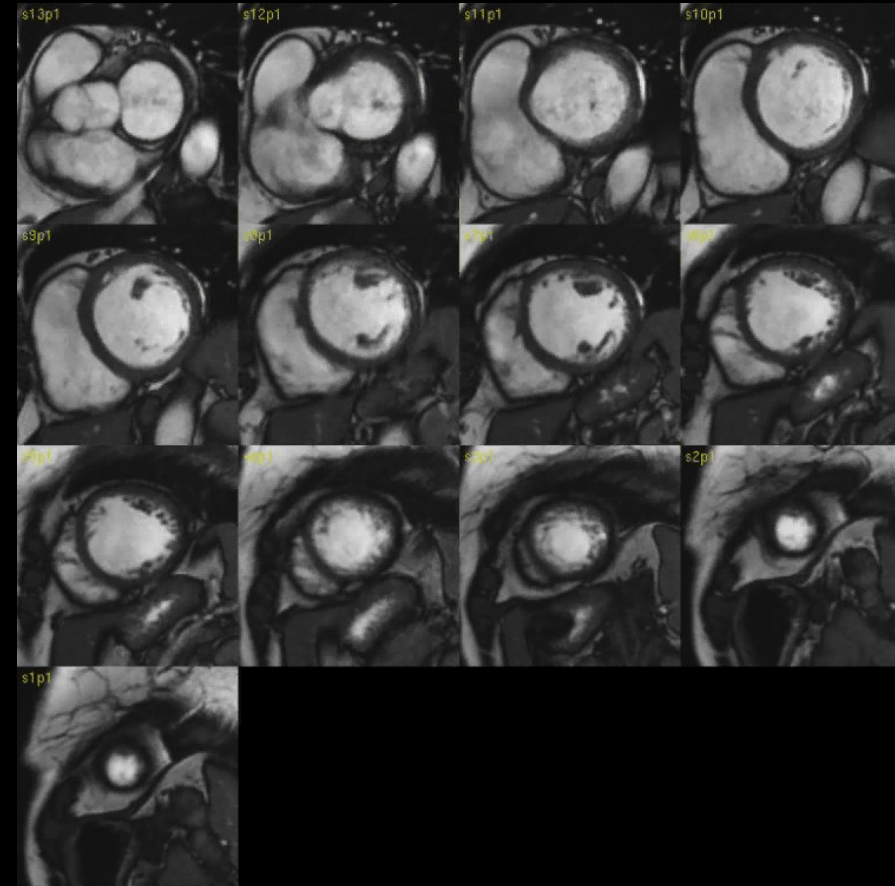
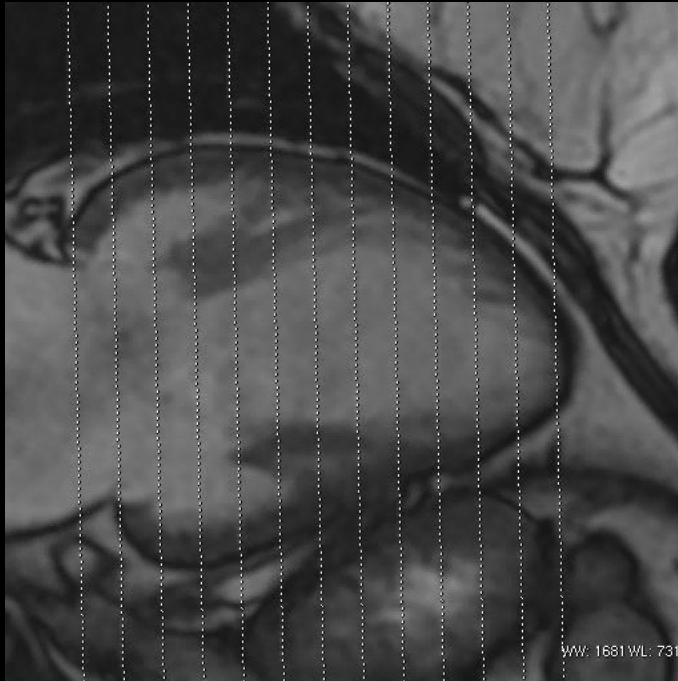
## IRM cardio-vasculaire

**Technique incontournable** en pathologie cardiovasculaire grâce, notamment :

1. à ses performances dans l'évaluation des fonctions ventriculaires droite et gauche
2. aux séquences de « viabilité » acquises tardivement après injection de gadolinium.

Particulièrement intéressant dans la surveillance au long cours.

# Précession à l'équilibre (SSFP)



- **Paramètres mesurés** : volume VG,  
: fonction VG globale et segmentaire,  
: masse myocardique.

➤ Mesures plus précises et plus reproductibles qu'en échographie.  
**Paramètres mesurés**

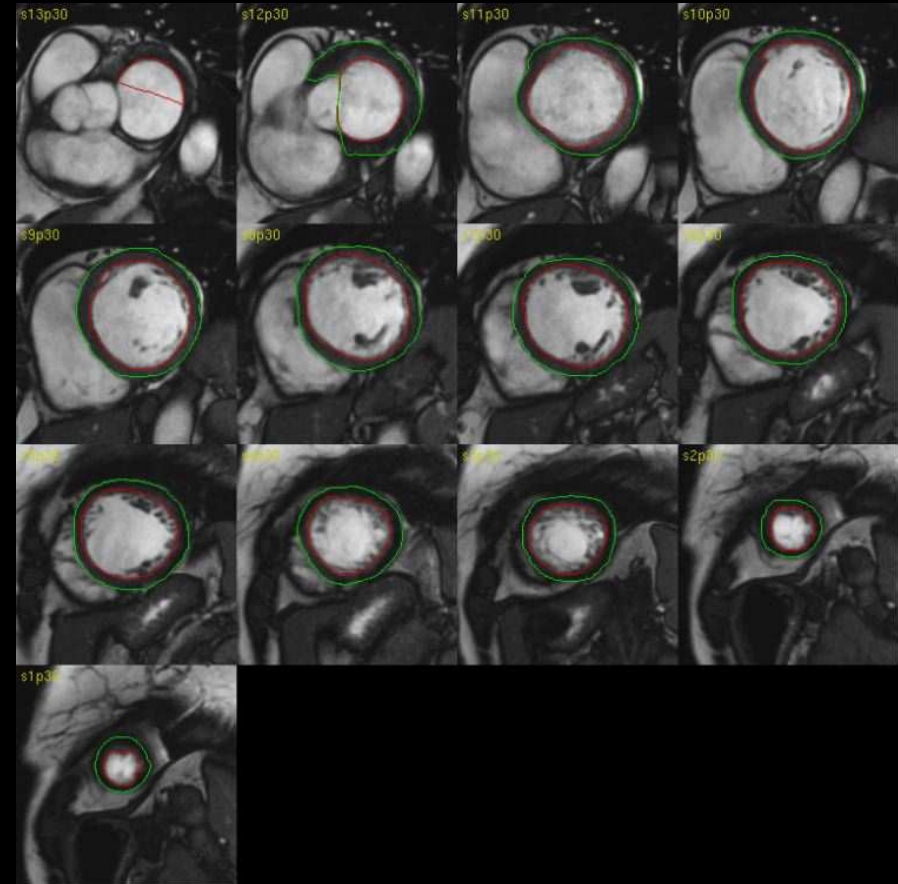
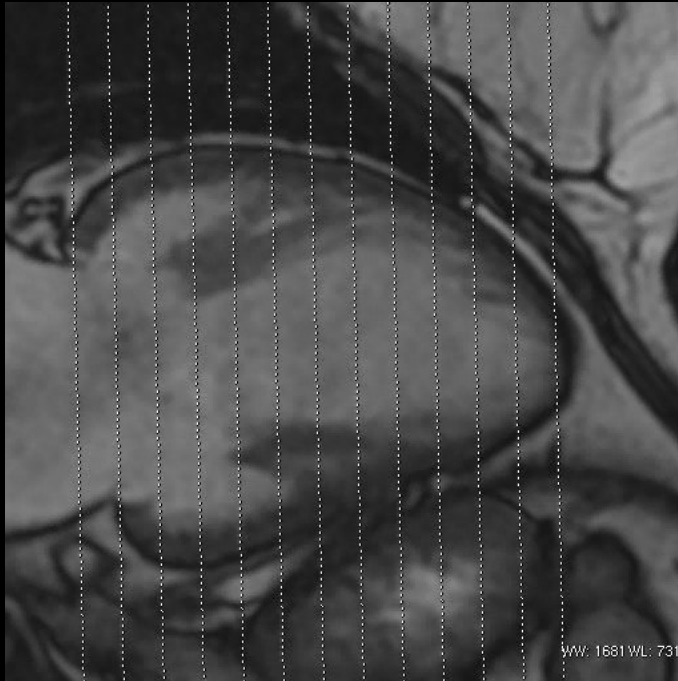
Higgins CB. *J Am Coll Cardiol.* 1992;19:1608.

Katz J, et al.. *Radiology.* 1988;169:495-8.

Mogelvang J et al. *Eur Heart J.* 1992;13:1677.

Rehr RB, et al. *Radiology.* 1985;156:717-9.

# Précession à l'équilibre (SSFP)



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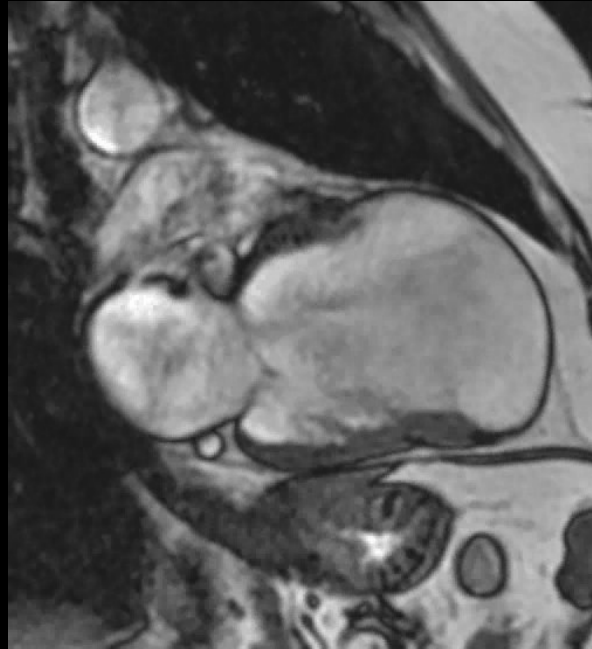
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## Précession à l'équilibre (SSFP)

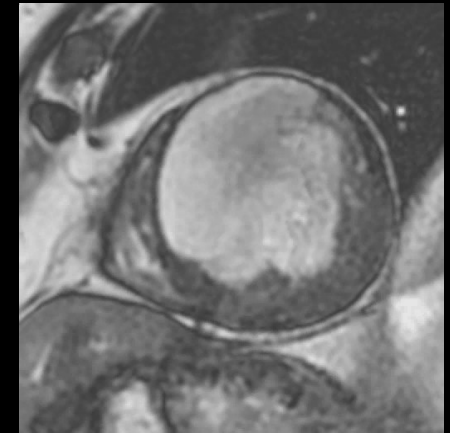
*Grand-axe horizontal*



*Grand-axe vertical*



*Petit-axe*



- Paramètres mesurés : volume VG,  
: fonction VG globale et segmentaire,  
: masse myocardique.
- Mesures plus précises et plus reproductibles qu'en échographie.

➔ **Identification des dysfonctions VG sévères (FEVG < 35%)**

# Volume, ejection fraction and myocardial mass of LV

## SSFP ( $\pm$ parallel imaging)

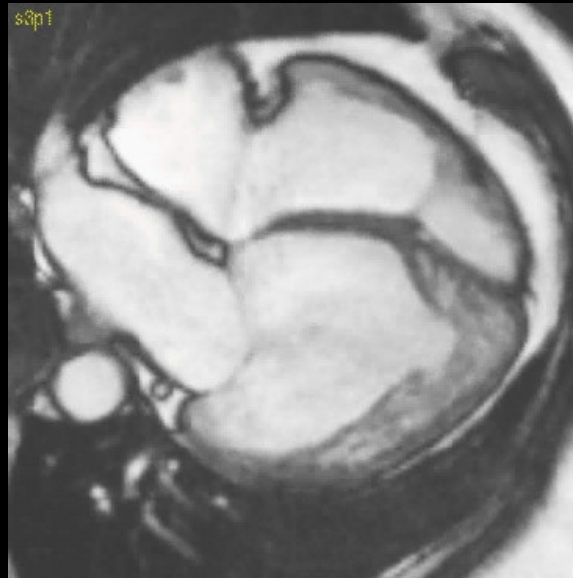
For the differentiation with other causes of cardiomyopathy: valvular, hypertrophic...

➔ Apical forms of non-compacted myocardium

VLA



HLA



*Petersen SE, et al.  
Left Ventricular Non-  
Compaction Insights  
From Cardiovascular  
Magnetic Resonance  
Imaging.  
J Am Coll Cardiol  
2005; 46:101-105.*

- ✓ Apical forms may be difficult to identify at echography
- ✓ MRI diagnosis criterion: NC / C ratio  $>$  2.3 in diastole

# Détection des foyers de nécrose et/ou fibrose, 10 à 20 min après l'injection de chélates de gadolinium

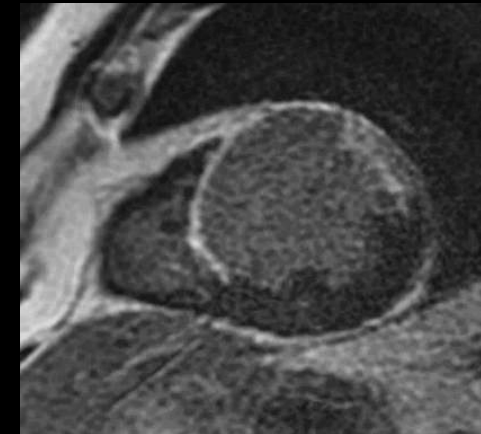
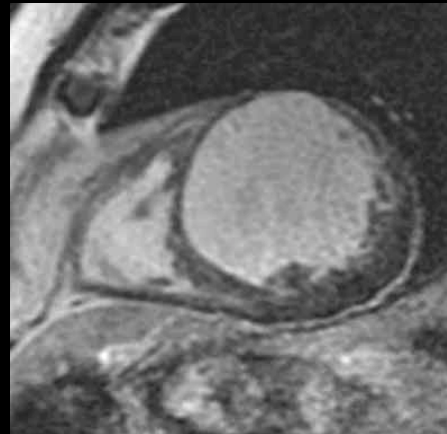
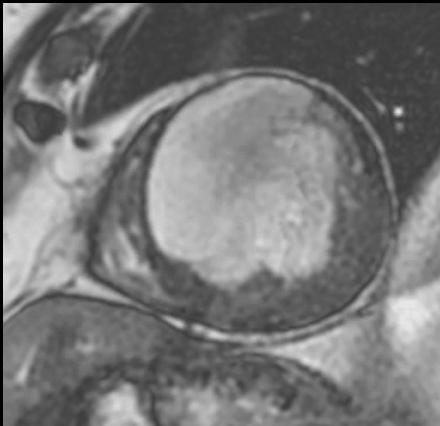
*Wu E et al. Lancet 2001;357: 21-8, Ricciardi MJ et al. Circulation 2001;103:2780-3.*

**SSFP**

**Ga<sup>++</sup>-DTPA**

*1 min post-injection*

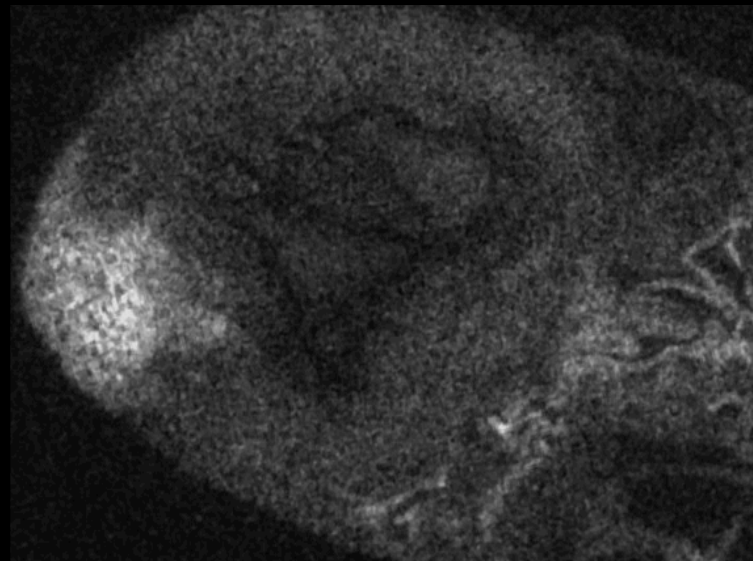
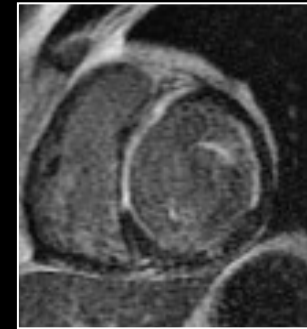
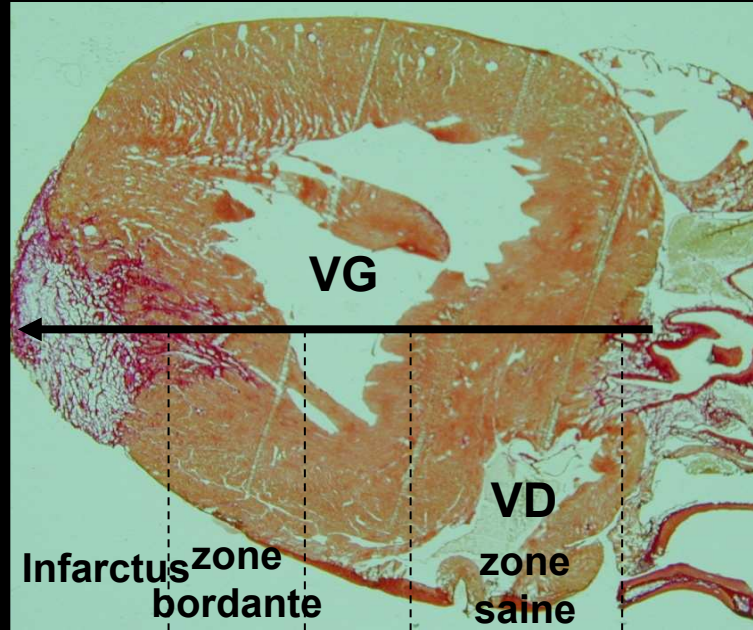
*rétenion-15min*



**Nécrose transmurale  
antéro-septale**

**I - Séquence statique écho de gradient 2-D**

**3 mois après occlusion de l'IVA chez un rat**  
*Maskali F. J Nucl Cardiol 2005*



**Injection avant le sacrifice :**  
➤  $^{111}\text{In}$ -DTPA (IRM)

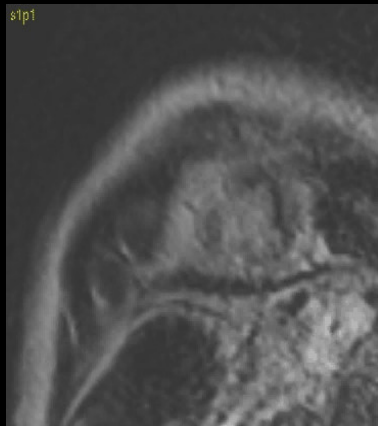
**$\mu$ -imager**

**Rouge Sirius**  
Fibrose collagène

# Détection des foyers de nécrose et/ou fibrose, 10 à 20 min après l'injection de chélates de gadolinium

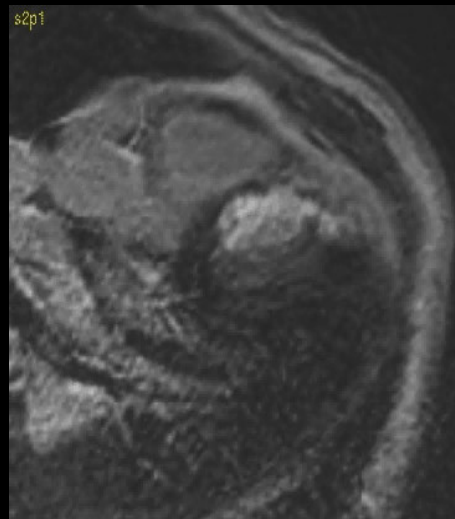
*Wu E et al. Lancet 2001;357: 21-8, Ricciardi MJ et al. Circulation 2001;103:2780-3.*

*Petit-axe*

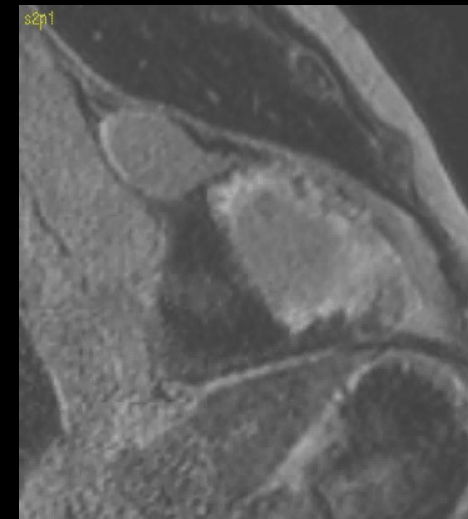


*Grand-axes*

*horizontal*



*vertical*



**Séquence statique écho de gradient 3-D**



## Les principales indications

1. La viabilité pour les cardiopathies ischémiques et les syndromes coronariens aigus,
2. L'étiologie et l'évaluation pronostique des cardiopathies non ischémiques, incluant les myocardites et les dysplasies arythmogènes du VD,
3. les péricardites chroniques et les masses cardiaques,
4. Les anévrysmes et dissections aortiques en dehors de l'urgence,
5. Les cardiopathies congénitales : malformations vasculaires et contrôle de chirurgie correctrice ou palliative.

Bilan et suivi des cardiomyopathies et de l'insuffisance cardiaque

➡ des perspectives d'utilisation croissante



## Les principales indications

1. La viabilité pour les cardiopathies ischémiques et les syndromes coronariens aigus, → **localisation des foyers arythmogènes**
2. L'étiologie et l'évaluation pronostique des cardiopathies non ischémiques, incluant les myocardites et les dysplasies arythmogènes du VD, → **présence de foyers arythmogènes**
3. les péricardites chroniques et les masses cardiaques,
4. Les anévrysmes et dissections aortiques en dehors de l'urgence,
5. Les cardiopathies congénitales : malformations vasculaires et contrôle de chirurgie correctrice ou palliative.

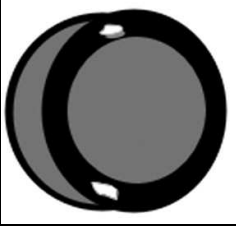
Bilan et suivi des cardiomyopathies et de l'insuffisance cardiaque

➡ des perspectives d'utilisation croissante

## Delayed contrast enhancement

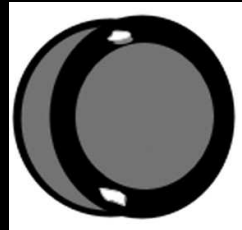
### For detecting focal areas of dense fibrosis

- detected in the majority of patients with **hypertrophic cardiomyopathy**



*HCM*

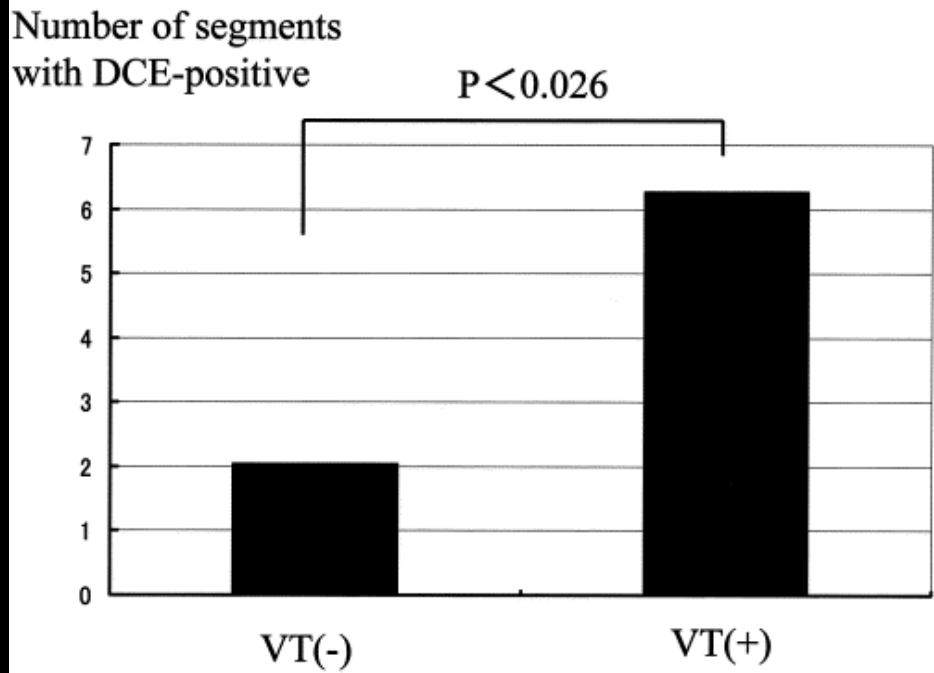
# Delayed contrast enhancement



**HCM**

## For detecting focal areas of dense fibrosis

- detected in the majority of patients with **hypertrophic cardiomyopathy**
  - correspond to a substrate for arrhythmias
- Teraoka K, et al. Magn Reson Imaging 2004; 22:155 –161*



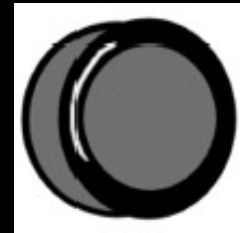
HCM patients with (n=14) or without (n=45) ventricular tachycardia

# Delayed contrast enhancement

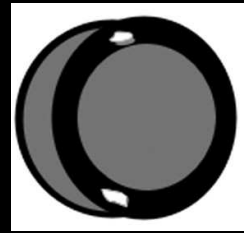
## For identifying the causes of cardiomyopathies

Mahrhold H et al. *Eur Heart J* (2005) 26, 1461–1474

Soriano CJ, et al. *J Am Coll Cardiol*. 2005 1;45(5):743-8.



**DCM**

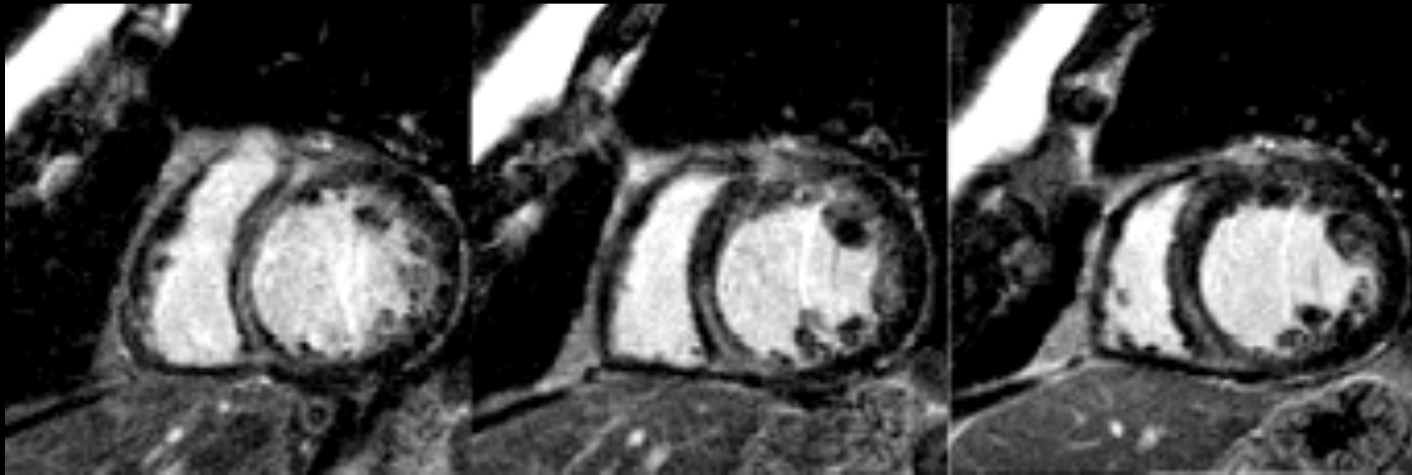


**HCM**

**Dilated cardiomyopathy:** midwall fibrosis in  $\approx$  30% of cases

McCrohon, et al. *Circulation* 108 (2003), pp. 54–59.

## DCE

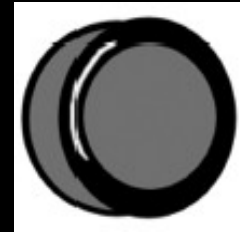


# Delayed contrast enhancement

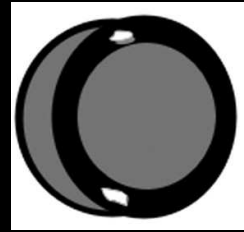
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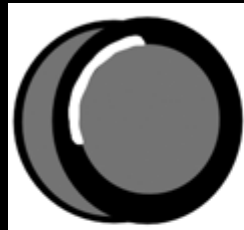
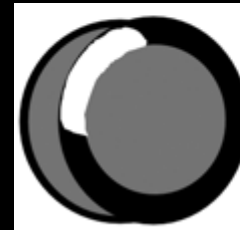
*Soriano CJ, et al. J Am Coll Cardiol. 2005 1;45(5):743-8.*



**DCM**



**HCM**



**Sub-endocardial  
or transmural MI**

# Delayed contrast enhancement

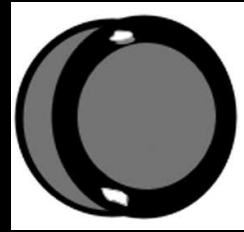
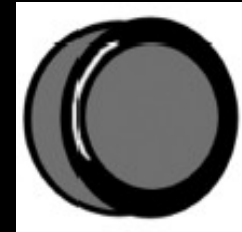
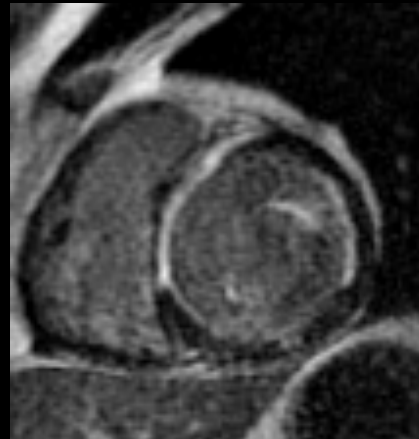
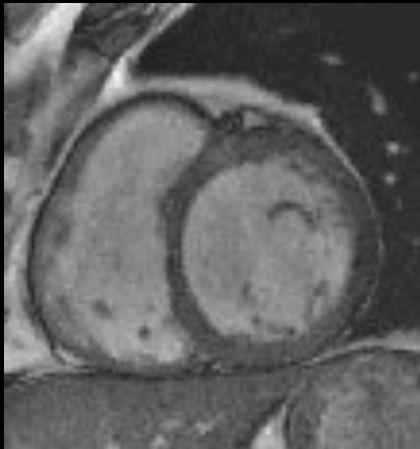
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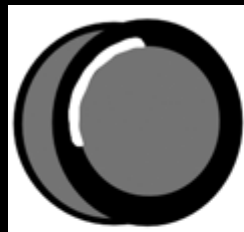
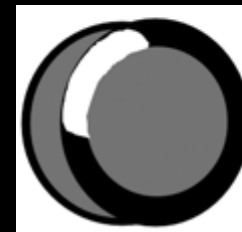
*Soriano CJ, et al. J Am Coll Cardiol. 2005 1;45(5):743-8.*

## Myocardial infarction

DCE



*DCM*



*Sub-endocardial  
or transmural MI*

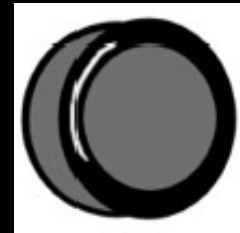
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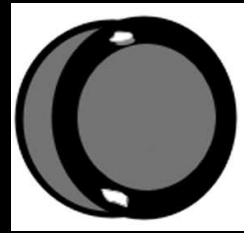
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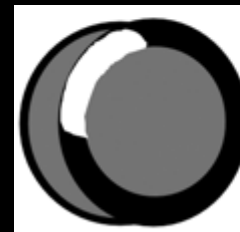
## Small areas of myocardial infarction



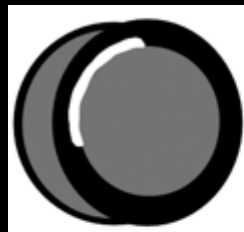
**DCM**



**HCM**



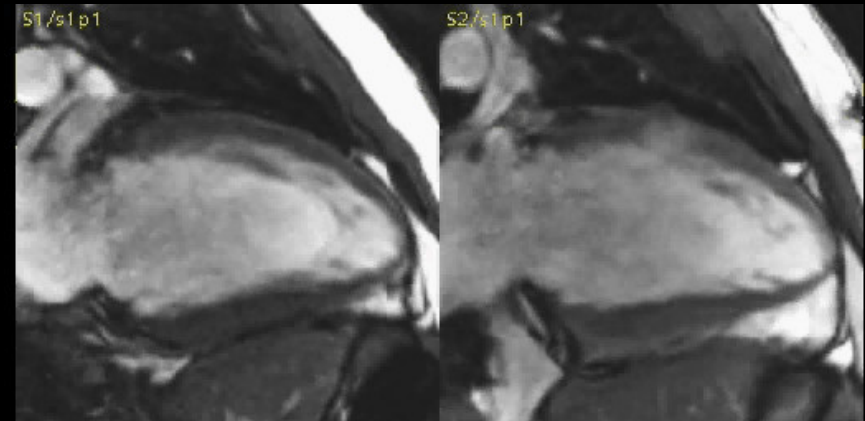
**Sub-endocardial  
or transmural MI**



**DCE**

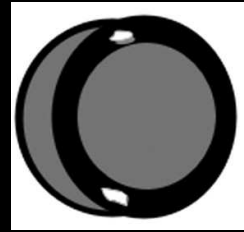
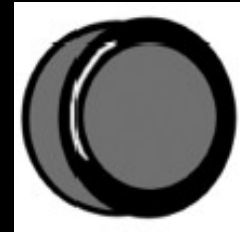


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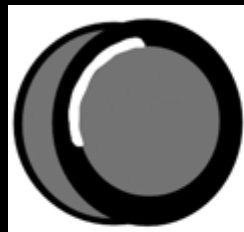
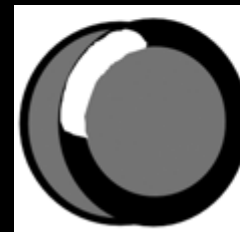


# Delayed contrast enhancement

For identifying the causes of cardiomyopathies



*DCM*

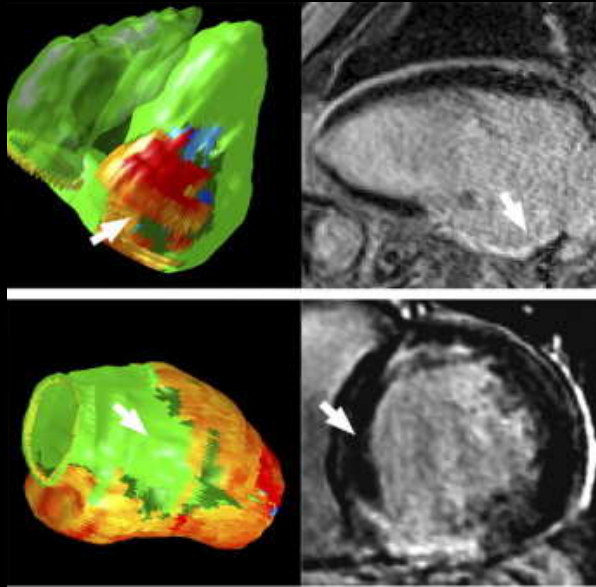


*Sub-endocardial  
or transmural MI*

**Myocardial infarction: scar localisation**

3D-MRI

MRI



**Electroanatomic Characterization  
of Post-Infarct Scars: Comparison  
With 3-Dimensional Myocardial  
Scar Reconstruction Based on  
Magnetic Resonance Imaging**

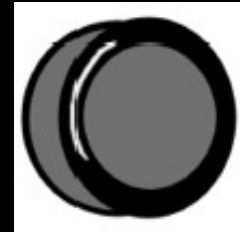
Andrei Codreanu, ...Christian de Chillou

J Am Coll Cardiol 2008; 52:839-842

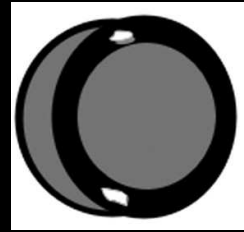
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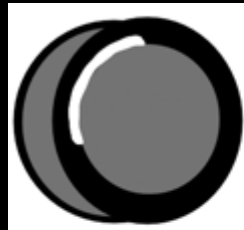
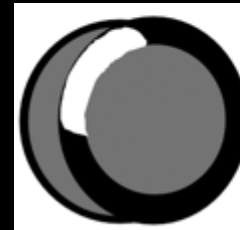
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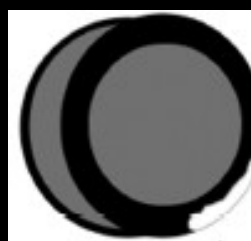
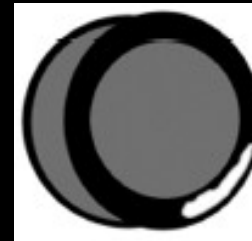
**DCM**



**HCM**



**Sub-endocardial  
or transmural MI**



- Myocarditis
- Sarcoidosis
- Amyloidosis...

# Delayed contrast enhancement

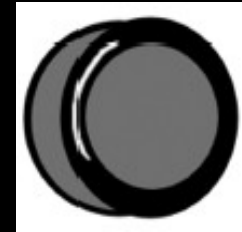
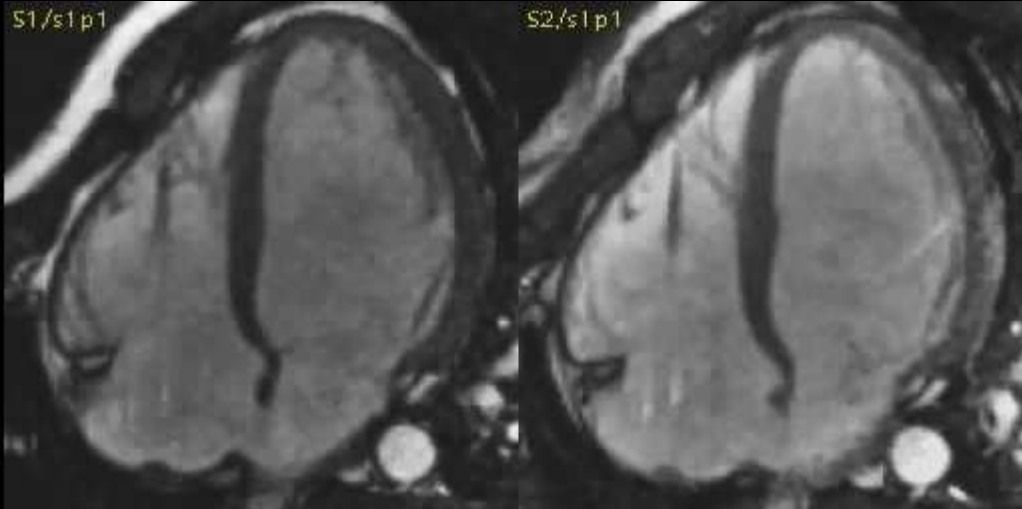
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*Mahrhold H et al. Eur Heart J (2005) 26, 1461–1474*

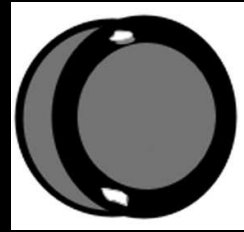
### ***Acute myocarditis***

*Codreanu A, et al. J Magn Reson Imaging. 2007*

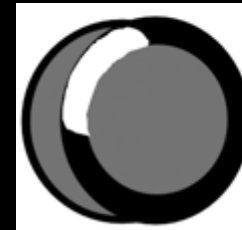
**DCE**



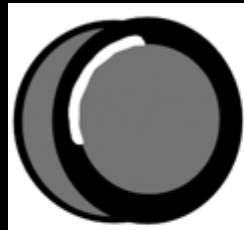
***DCM***



***HCM***



***Sub-endocardial  
or transmural MI***



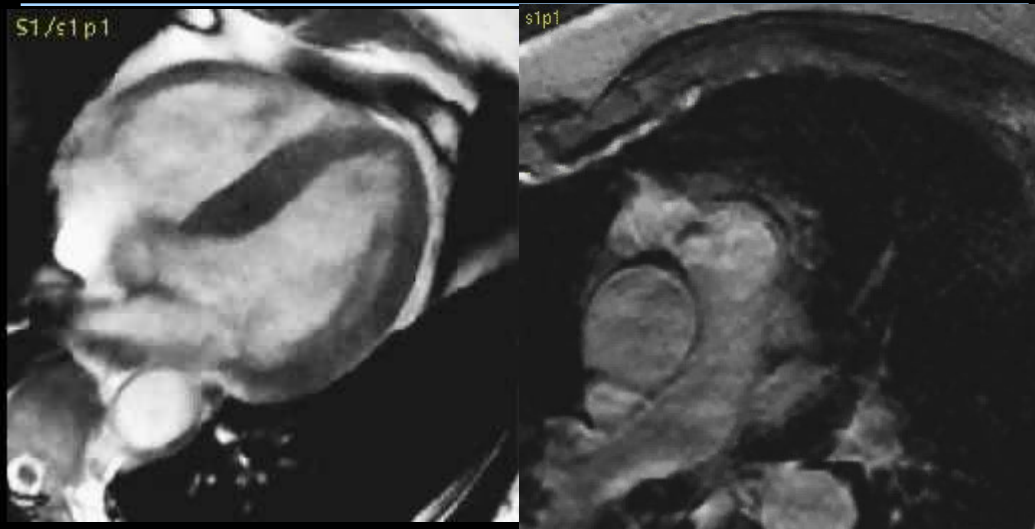
- ***Myocarditis***
- ***Sarcoidosis***
- ***Amyloidosis...***

# Delayed contrast enhancement

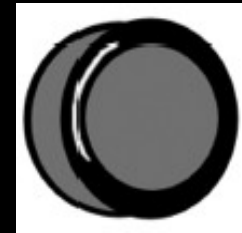
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Mahrhold H et al. *Eur Heart J* (2005) 26, 1461–1474

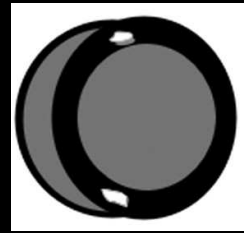
### *Sarcoidosis*



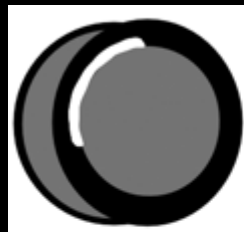
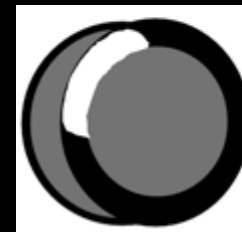
**DCE**



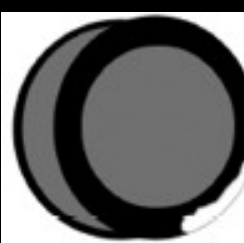
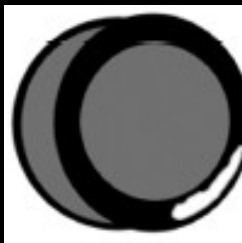
**DCM**



**HCM**

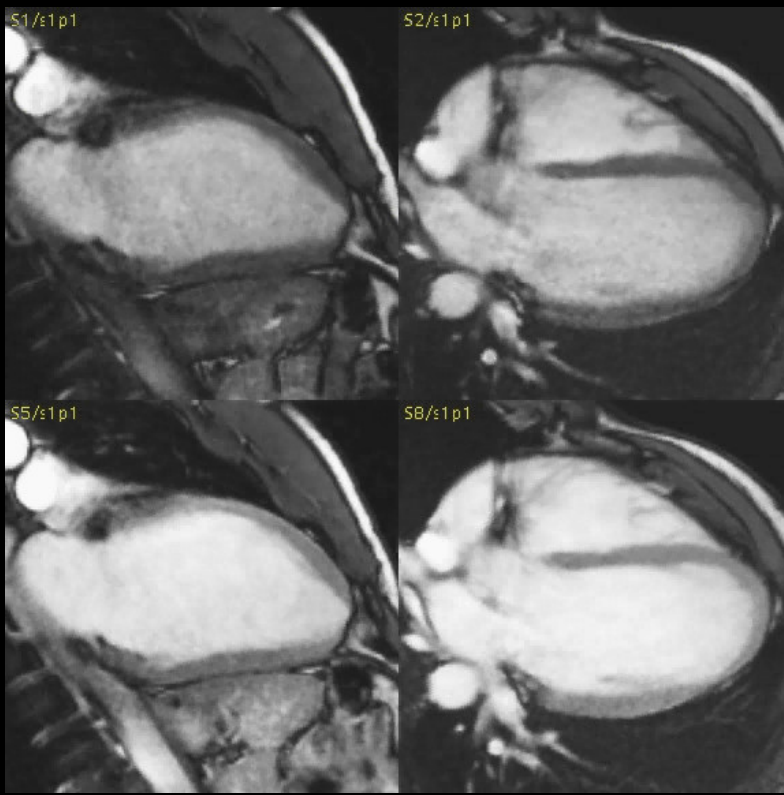


**Sub-endocardial  
or transmural MI**



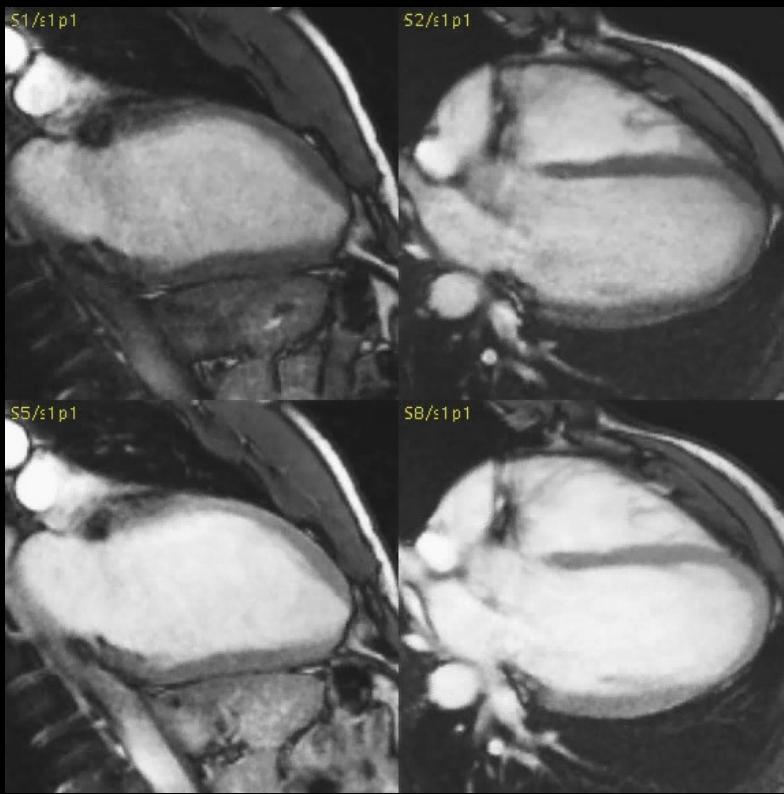
**- Myocarditis  
- Sarcoidosis  
- Amyloidosis...**

Rétention tardive



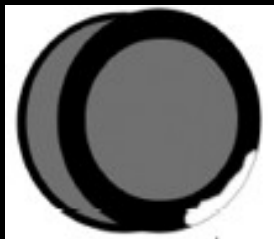
- ✓ Cycliste professionnel, 30 ans,
- ➔ TV provenant du cœur gauche

Rétention tardive

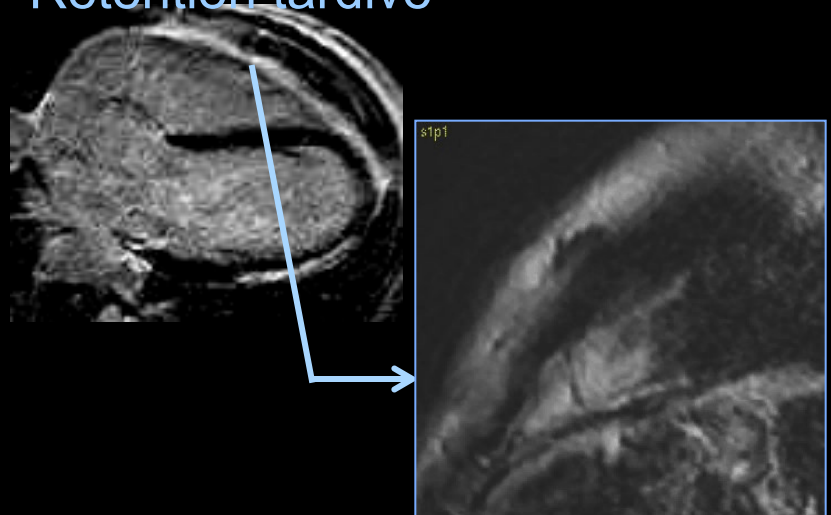


✓ Cycliste professionnel, 30 ans,  
➔ TV provenant du cœur gauche

Recherche de foyers de  
fibrose, nécrose, oedème  
Rétention tardive

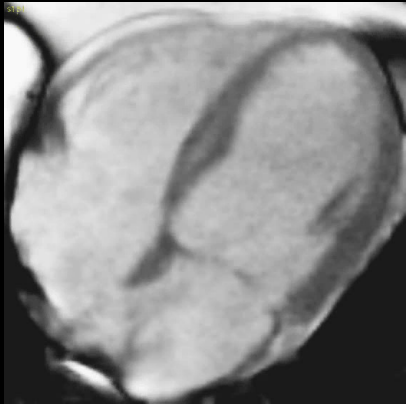


*Séquelle ancienne  
de myocardite ?*

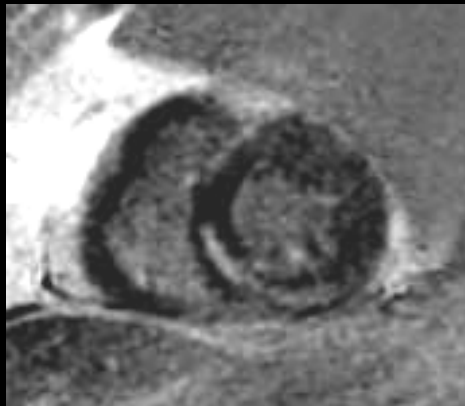
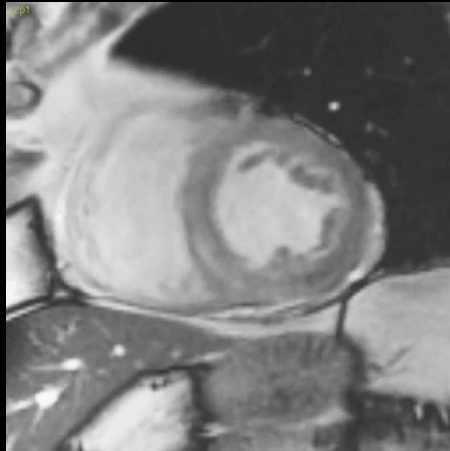


➔ TV provenant du septum basal

GAH



PA



Recherche de foyers de  
fibrose, nécrose, oedème  
Rétention tardive



*Sarcoïdose, ...  
ou autre ?*

## L'IRM cardiaque dans les cardiomyopathies, pour :

1. identifier l'atteinte cardiaque,
2. en préciser la sévérité (FEVG < 35%),
3. en recherche la cause,
4. rechercher et localiser un substrat arythmogène,
5. en suivre l'évolution.