

# Radio-anatomie cardiaque

Michel Montaudon

# Techniques

# Structures

Radiographie standard

Echocardiographie

Scintigraphie

KT et coronarographie

Tomodensitométrie

Imagerie par résonance magnétique

Parois

Cavités

Valves

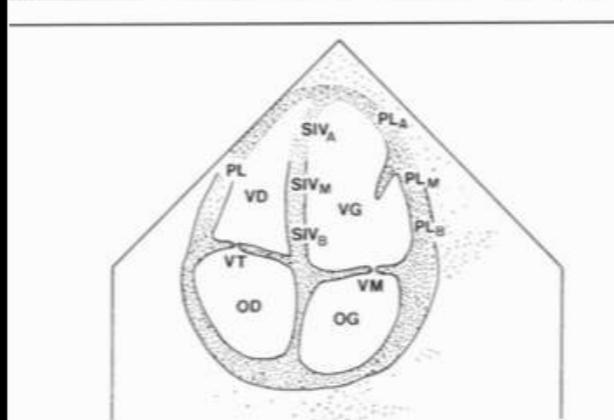
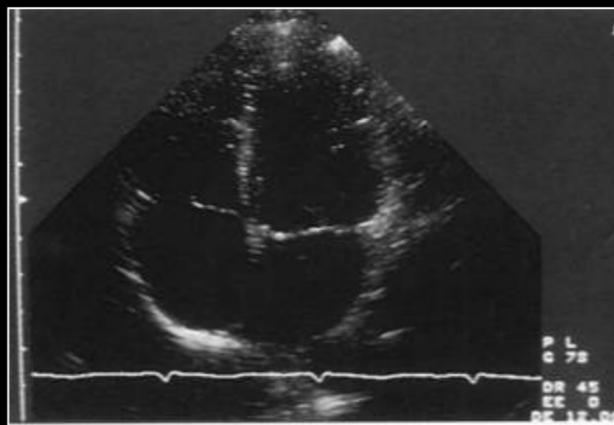
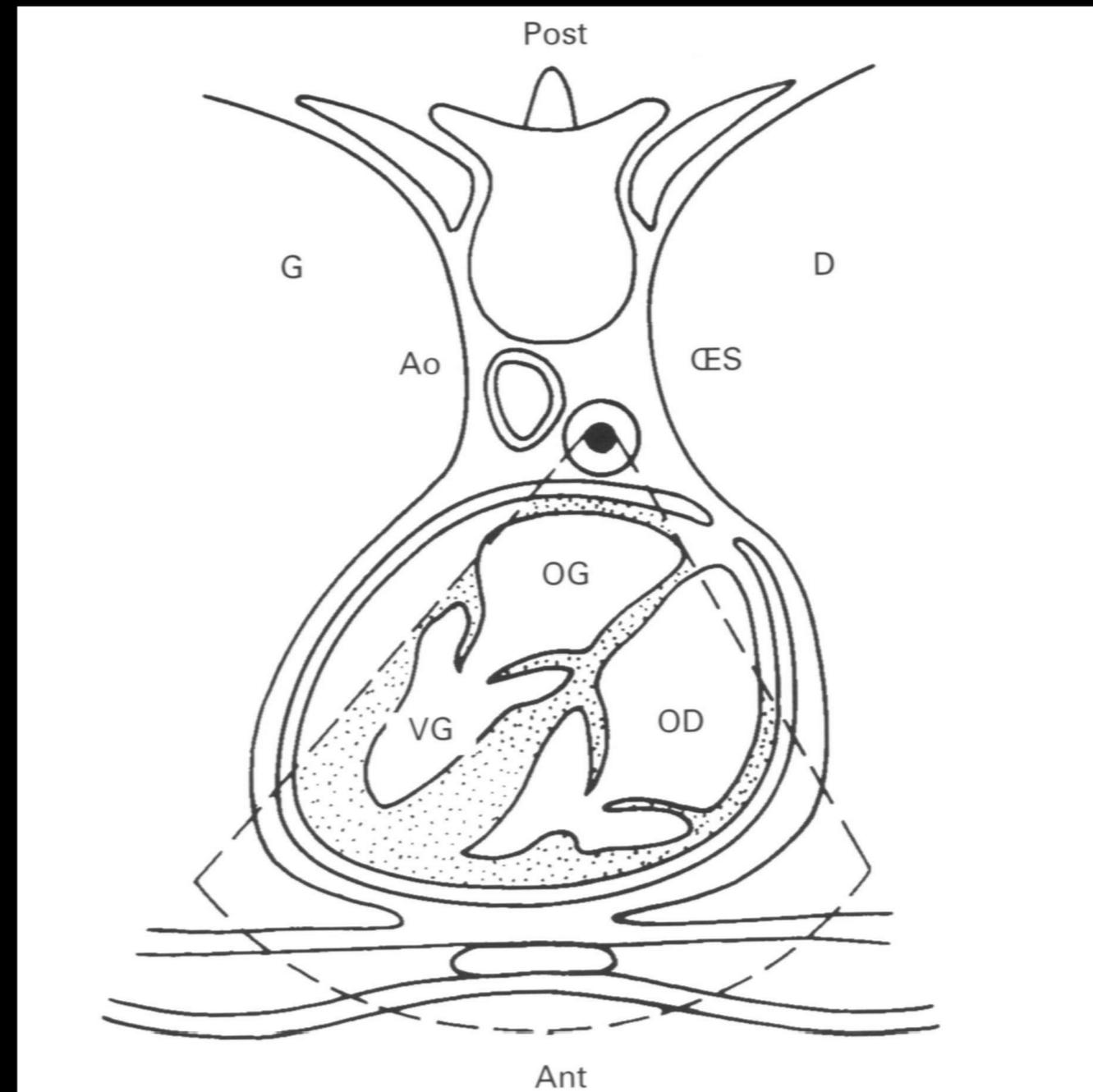
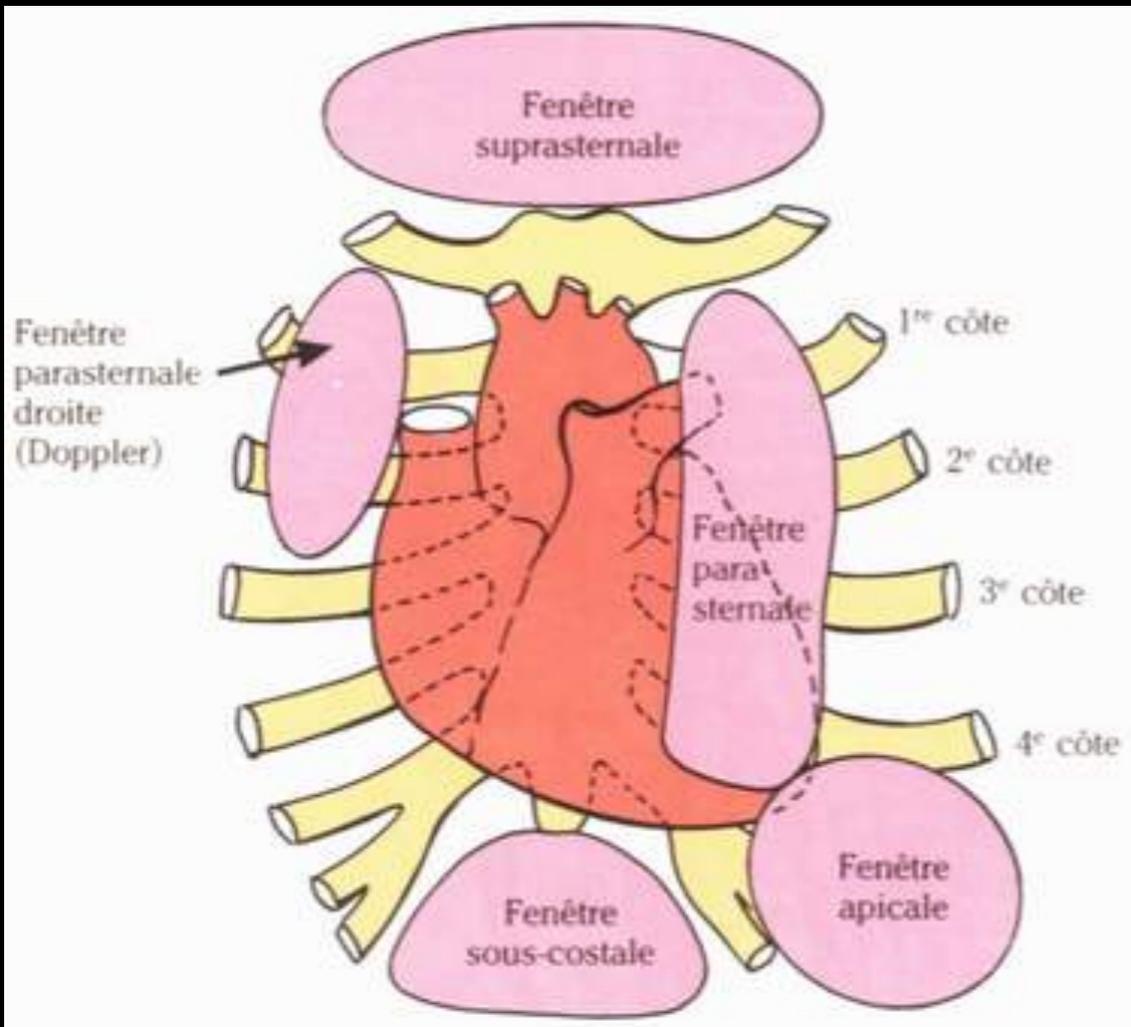
Vaisseaux

Systeme cardionecteur

Péricarde

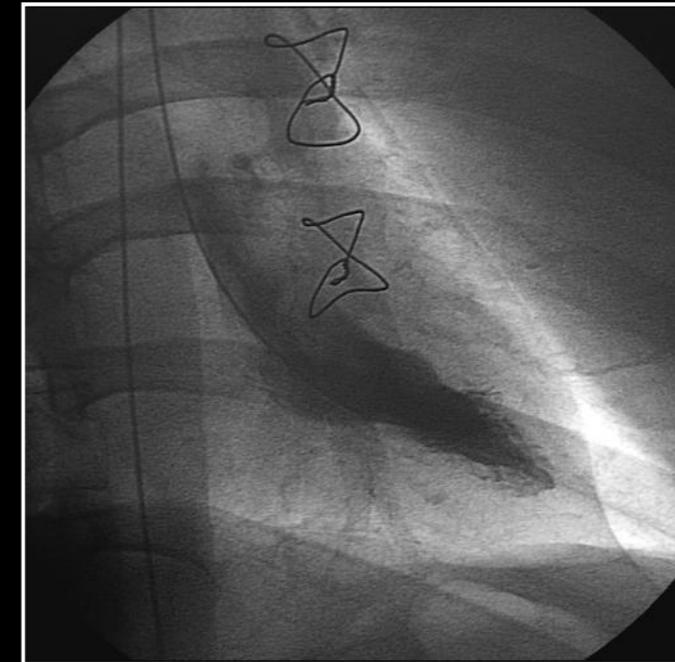
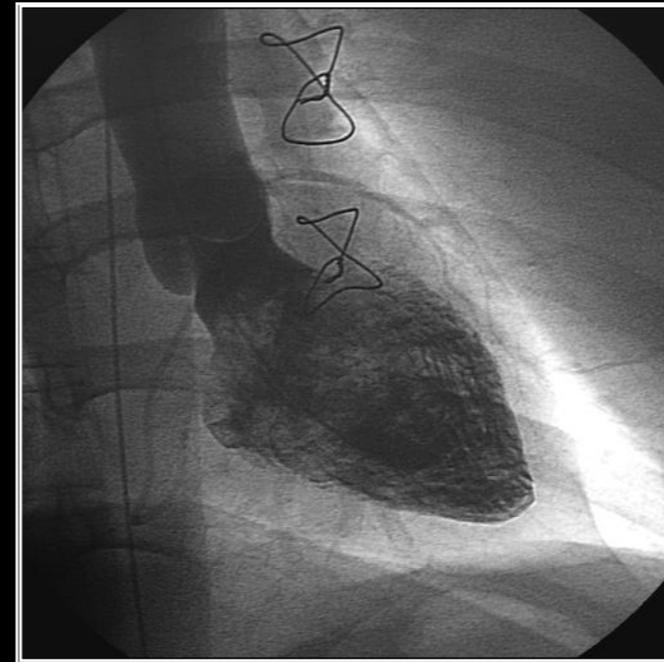
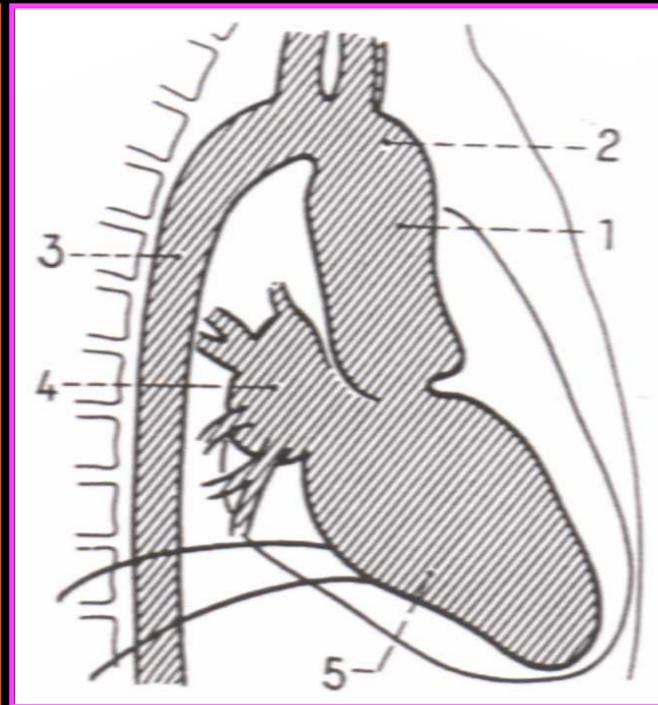
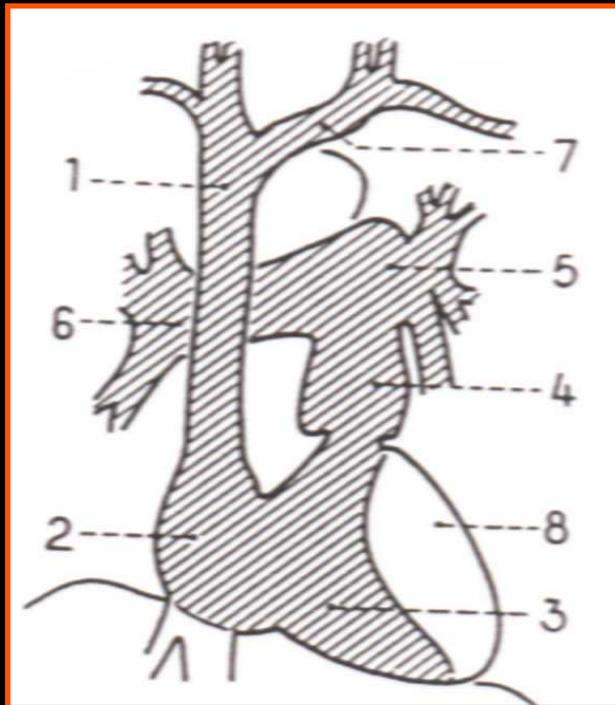
## Morphologie & Fonction

# ECHOCARDIOGRAPHIE



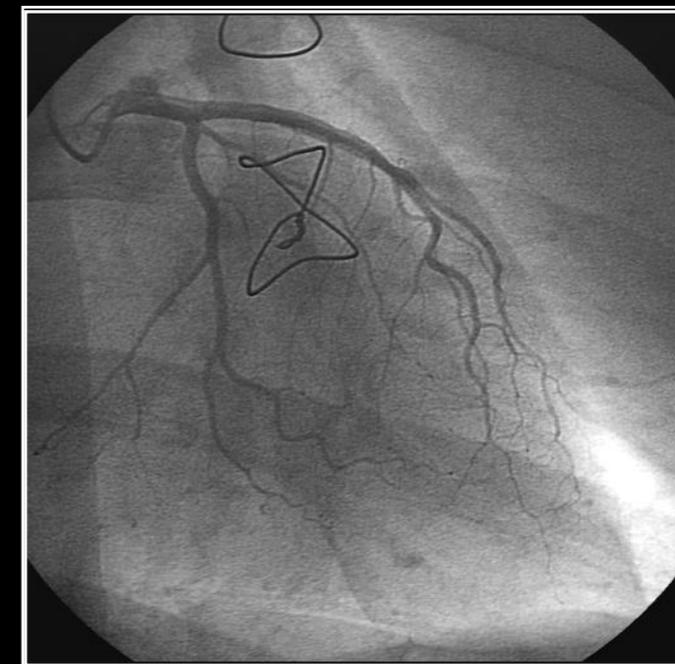
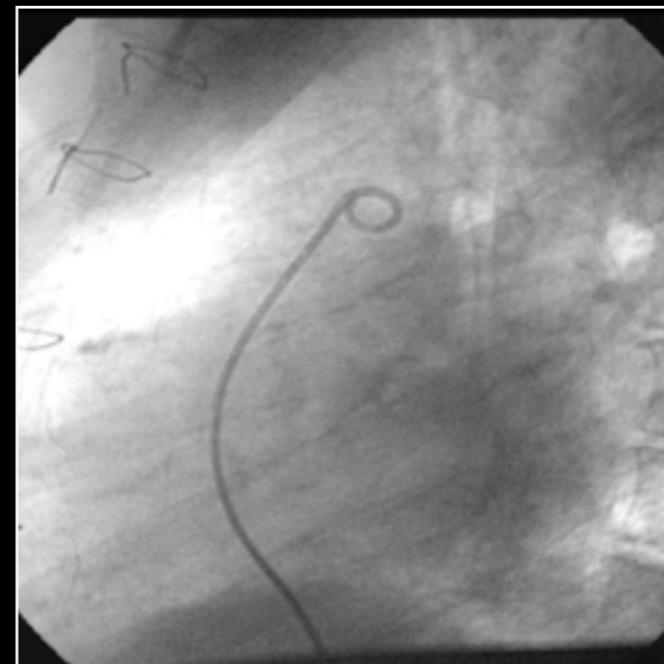
# CATHETERISME CARDIAQUE

taille des cavités, cinétique, fuite valvulaire, siège et taille des gros vx, pressions

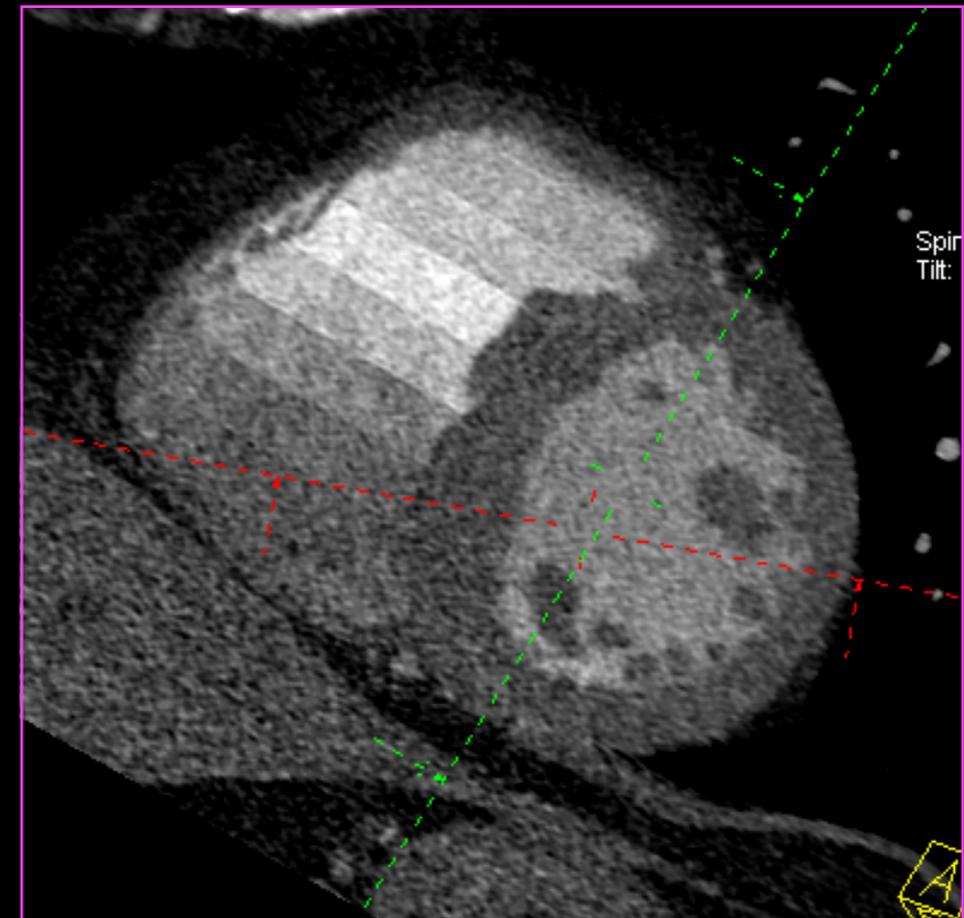
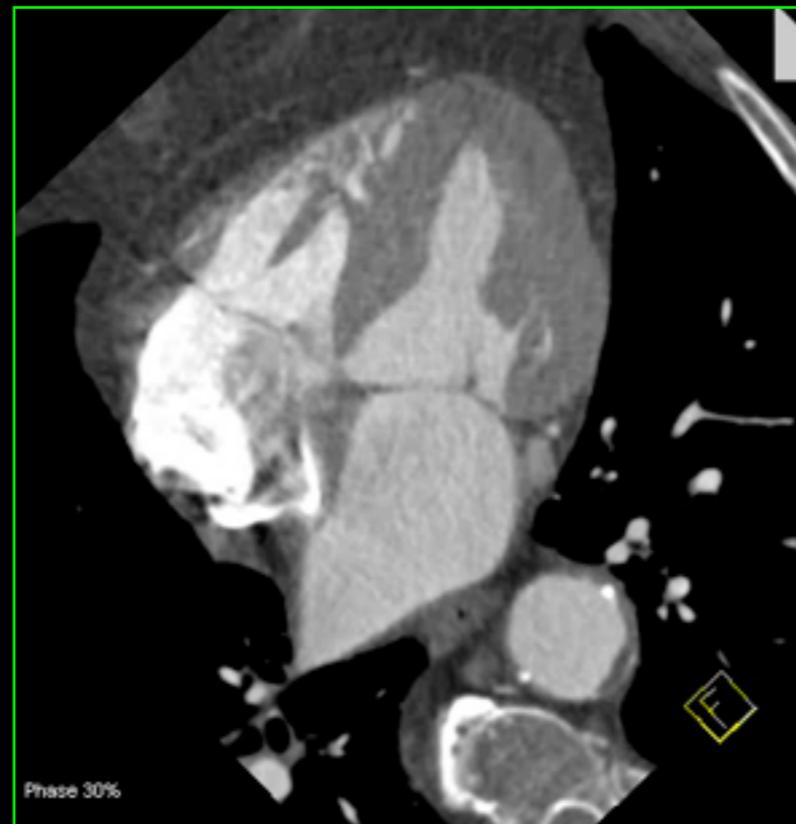
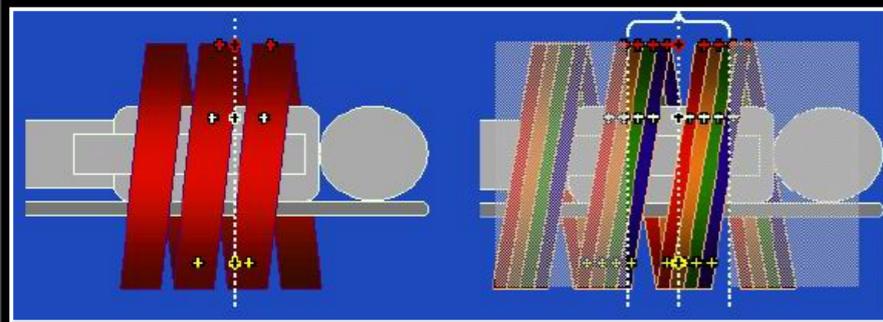


1 Veine Cave Supérieure  
2 Oreillette Droite  
3 Ventricule Droit  
4 Tronc Artère Pulmonaire  
5 Artère Pulmonaire Gauche  
6 Artère Pulmonaire Droite  
7 Tronc Veineux Innominé Gauche  
8 Ventricule Gauche

1 Aorte  
2 Crosse aortique  
3 Aorte descendante  
4 Oreillette gauche  
5 Ventricule gauche



# TDM



synchronisation **prospective** (tous les deux cycles) ou **rétrospective**

# IRM

Synchronisation ECG +/- respiration

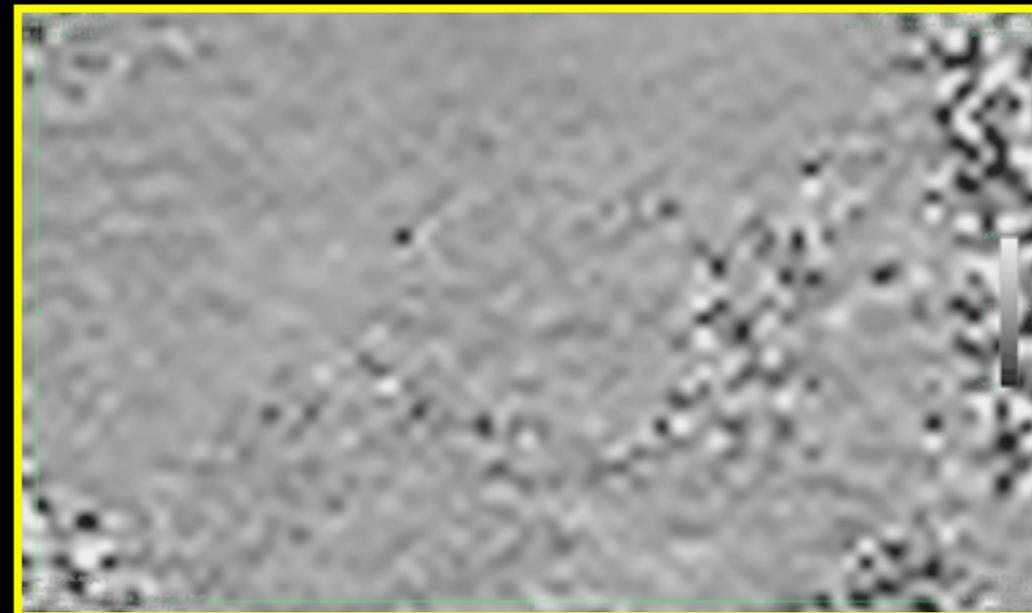
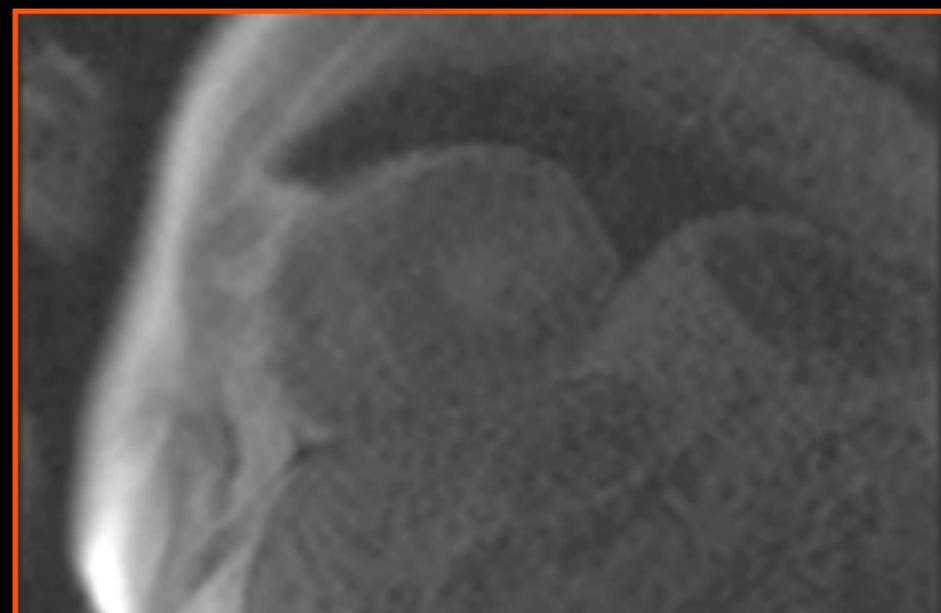
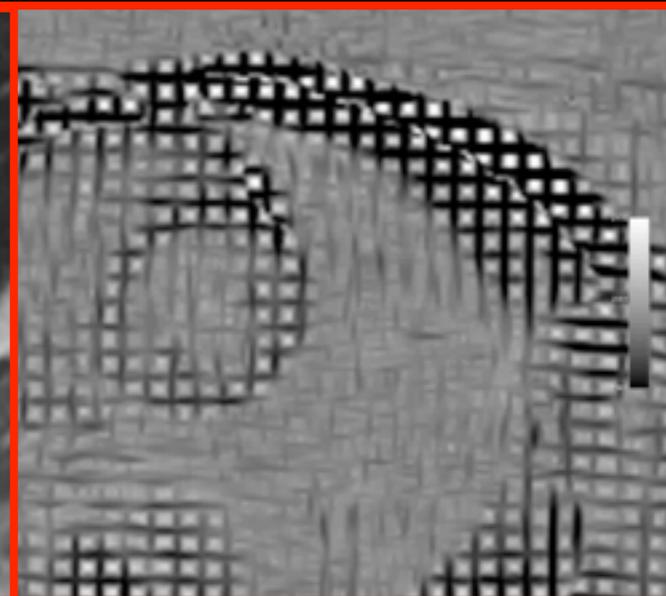
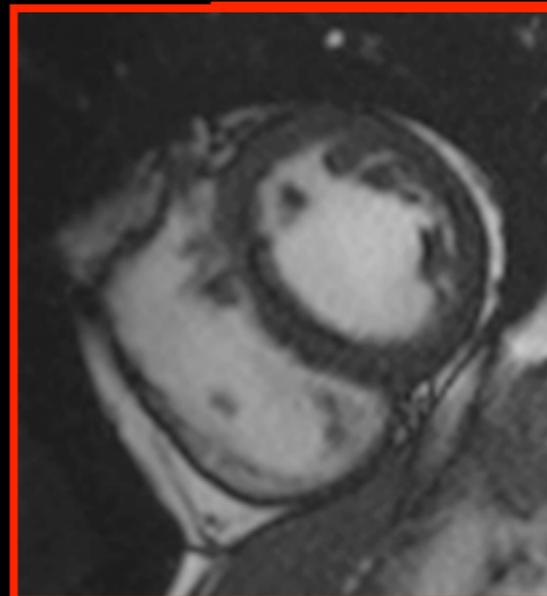
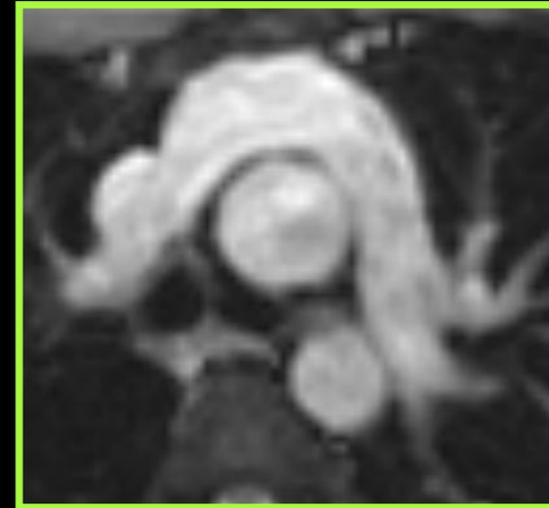
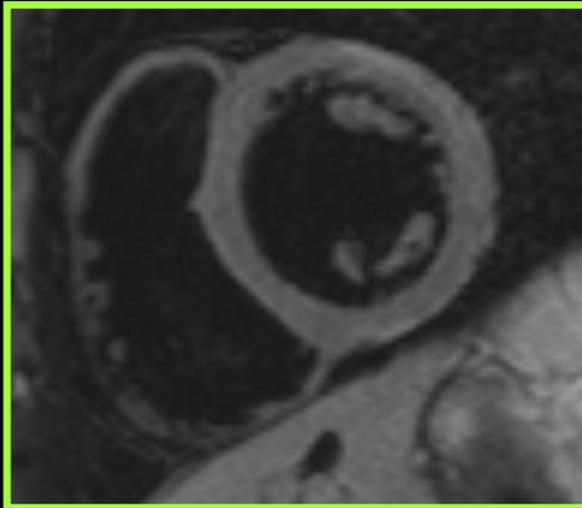
Morphologie: spin écho, ARM

Fonction: cinéIRM (SSFP), tagging

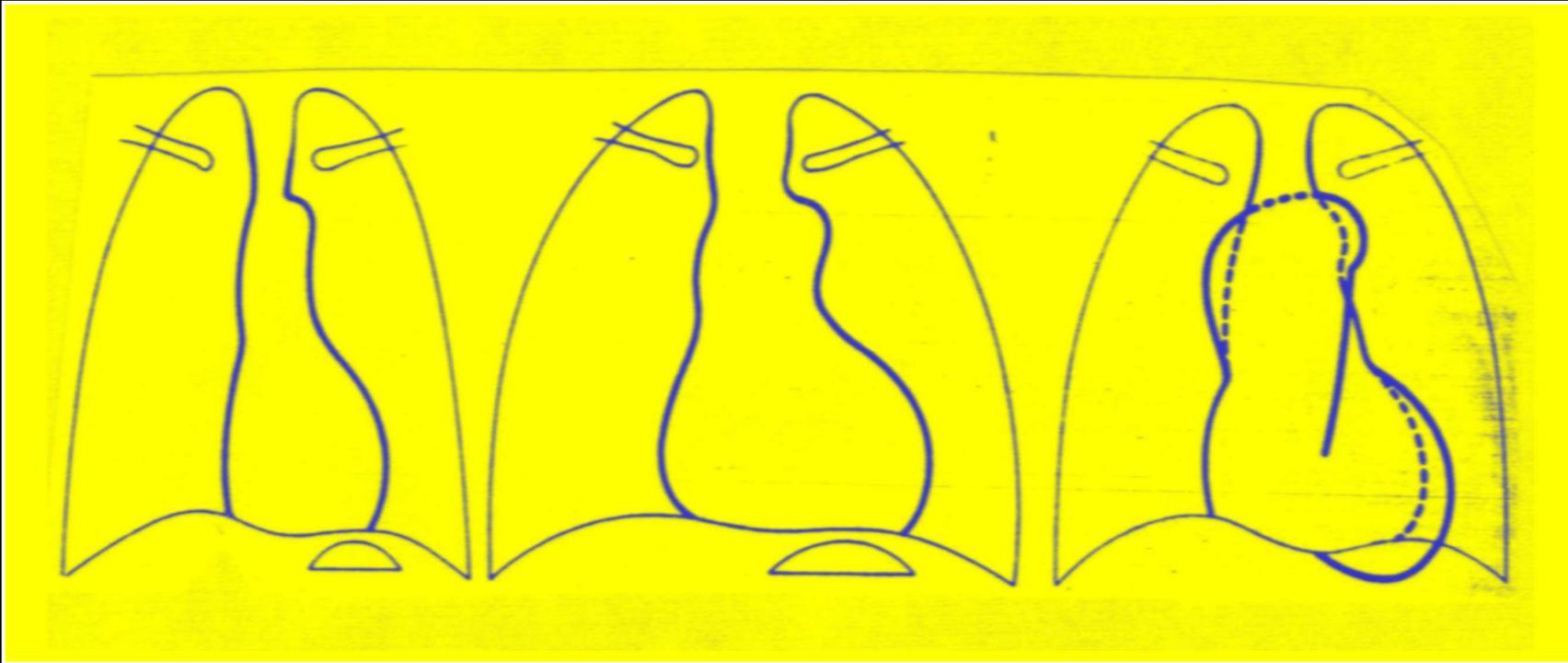
Flux: contraste de phase

Viabilité / fibrose: rehaussement tardif

Perfusion



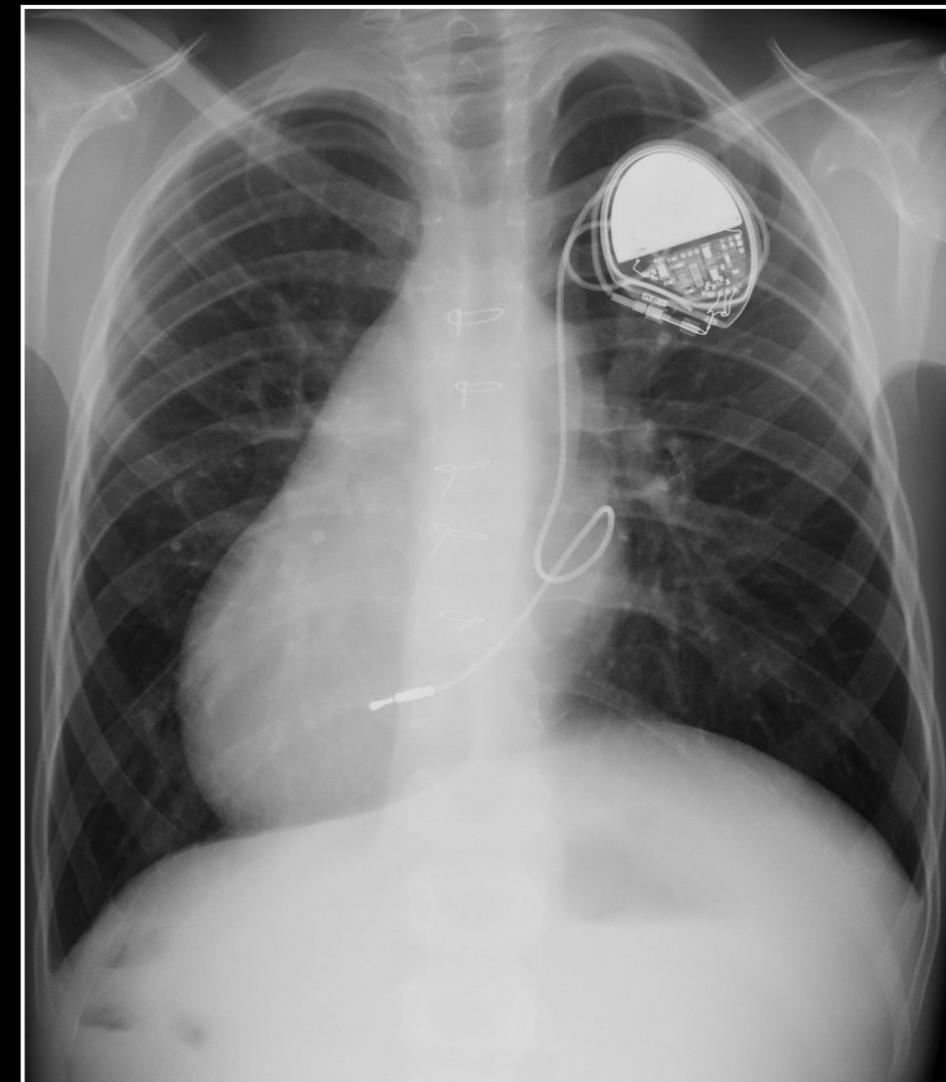
# Taille et position



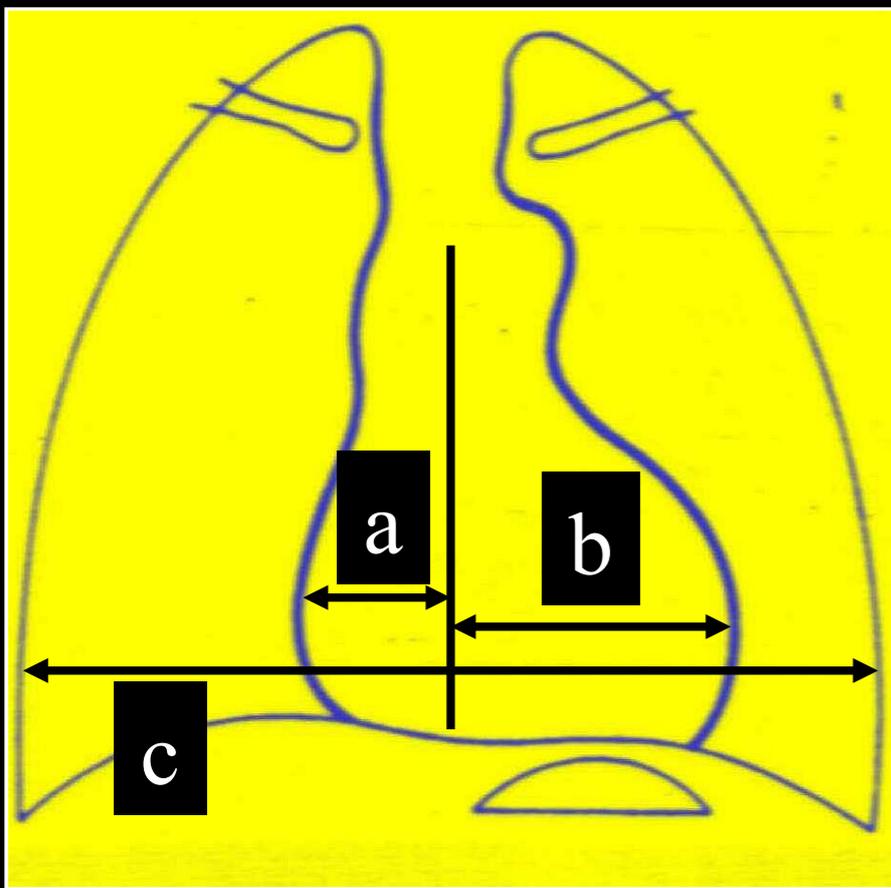
longiligne

bréviligne

âgé



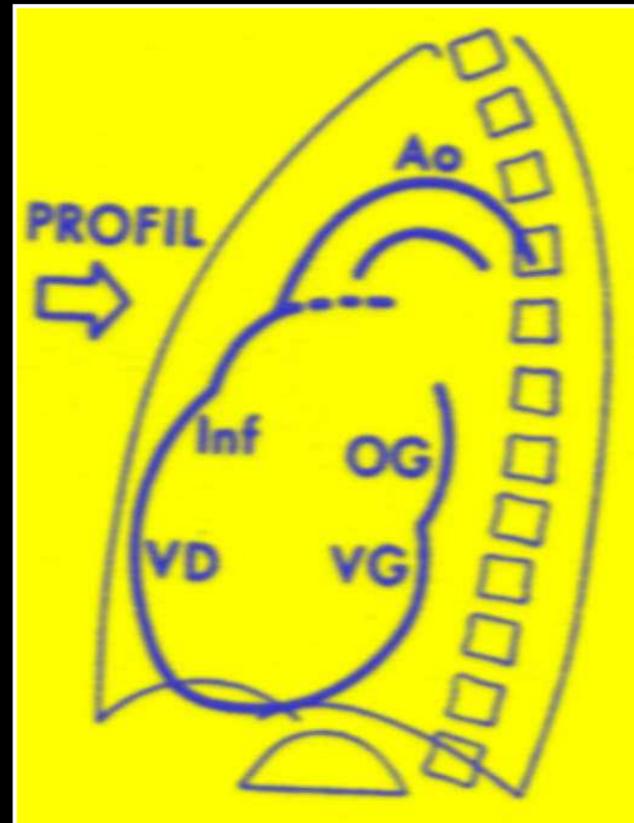
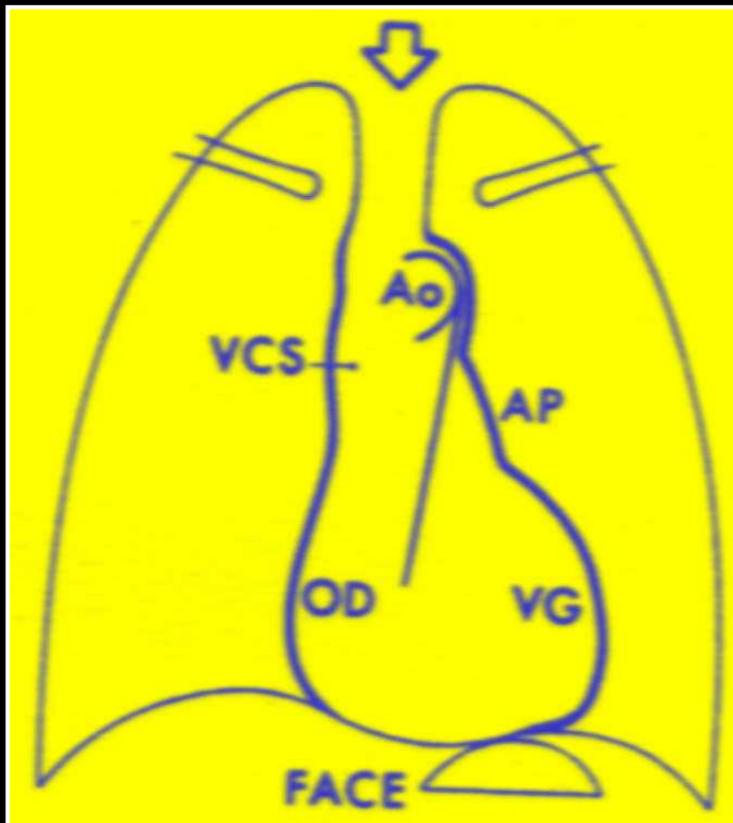
# Volume du coeur



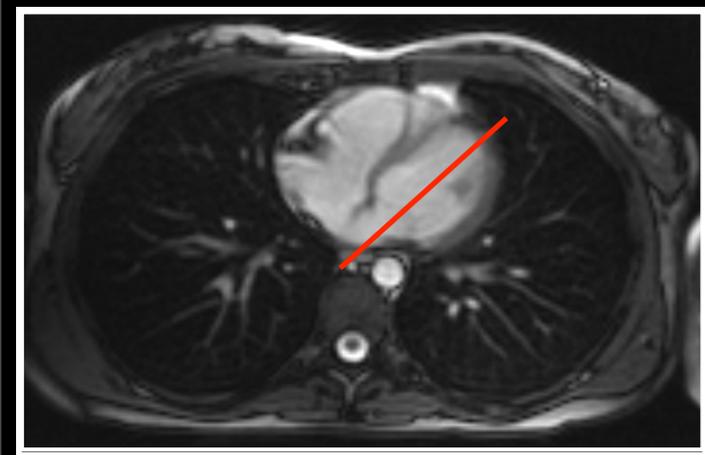
Degré d'inspiration  
Distance foyer-film < 1,80m  
Frange graisseuse épiscopordique  
Forme du thorax (pectus, scoliose)



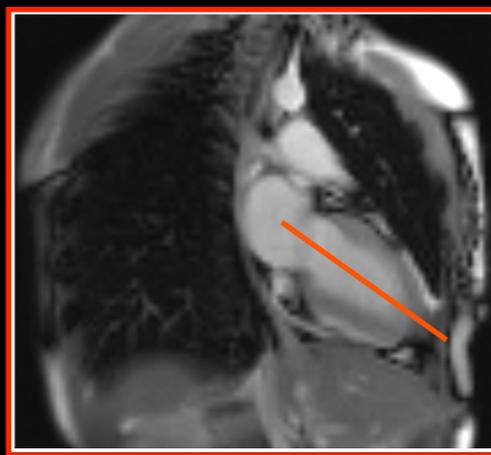
Index cardio-thoracique  
 $(a+b)/c$ : normal < 0,50



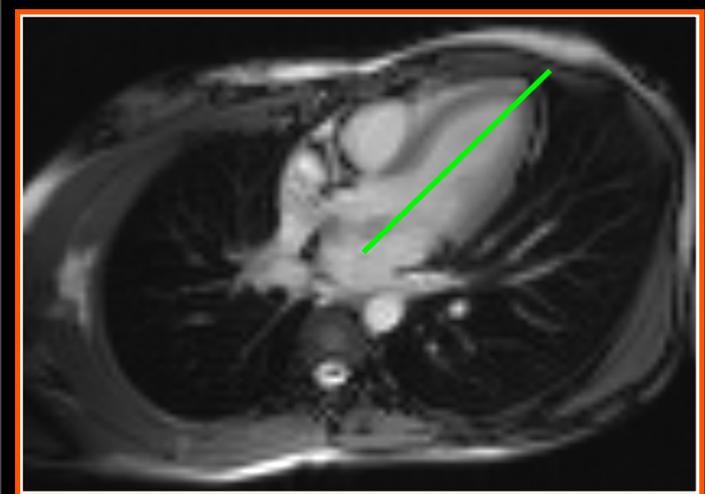
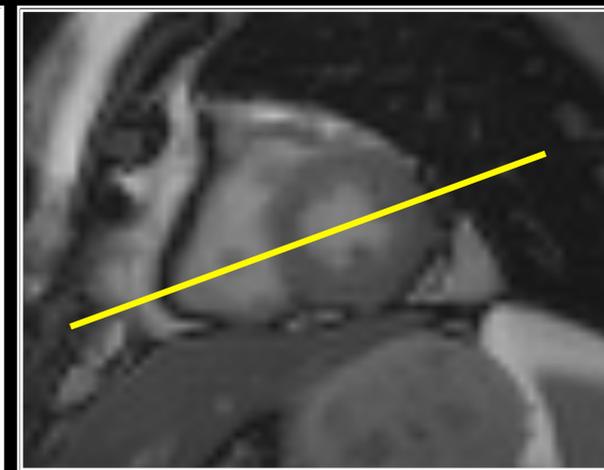
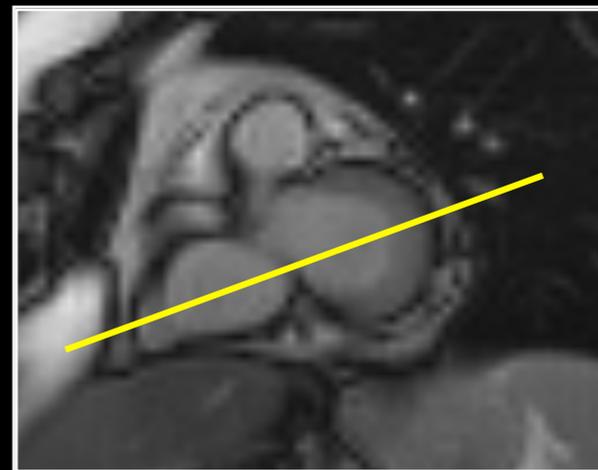
# Orientation, Plans des coupes



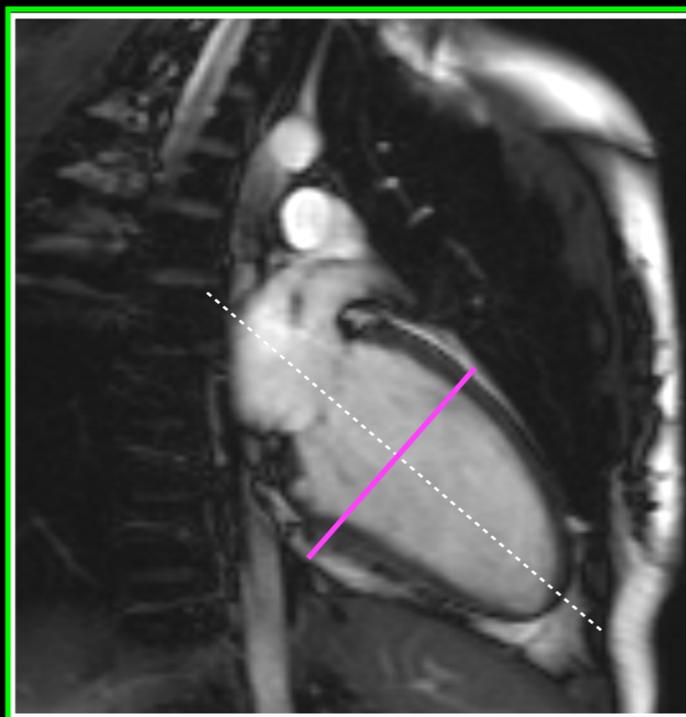
Horizontal



Faux grand axe



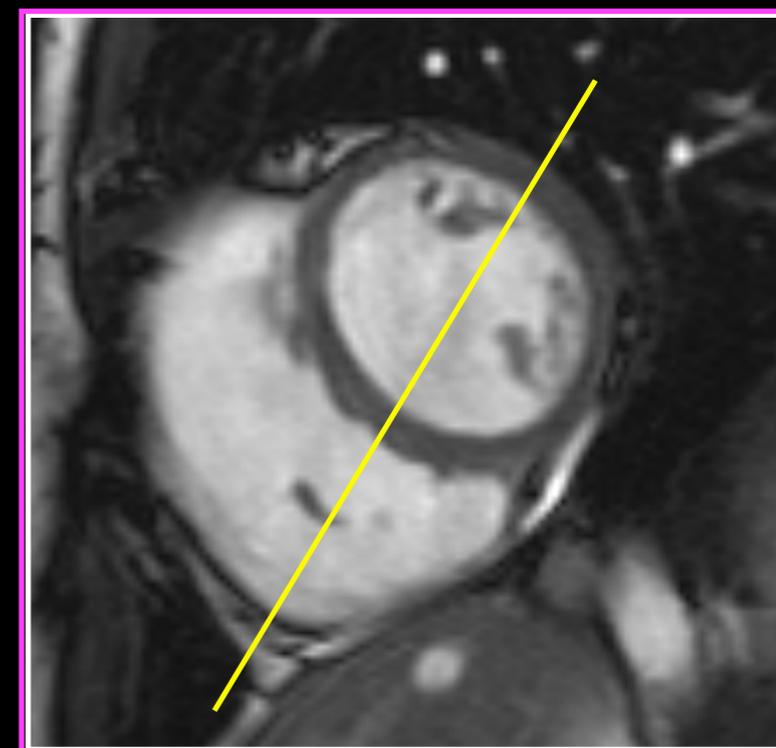
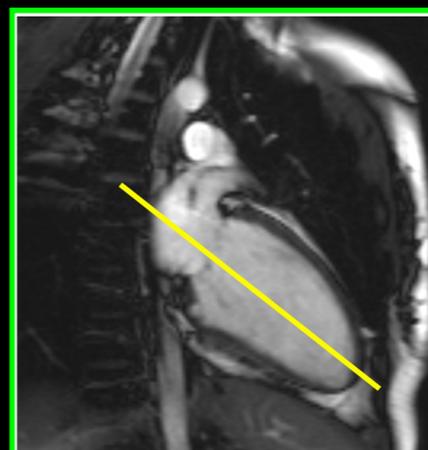
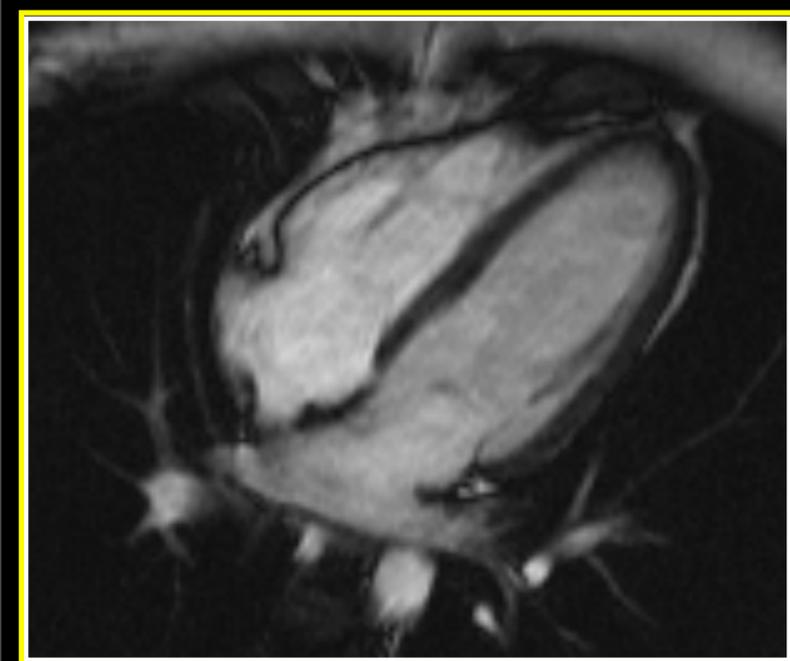
Faux 4 cavités  
4 cavités



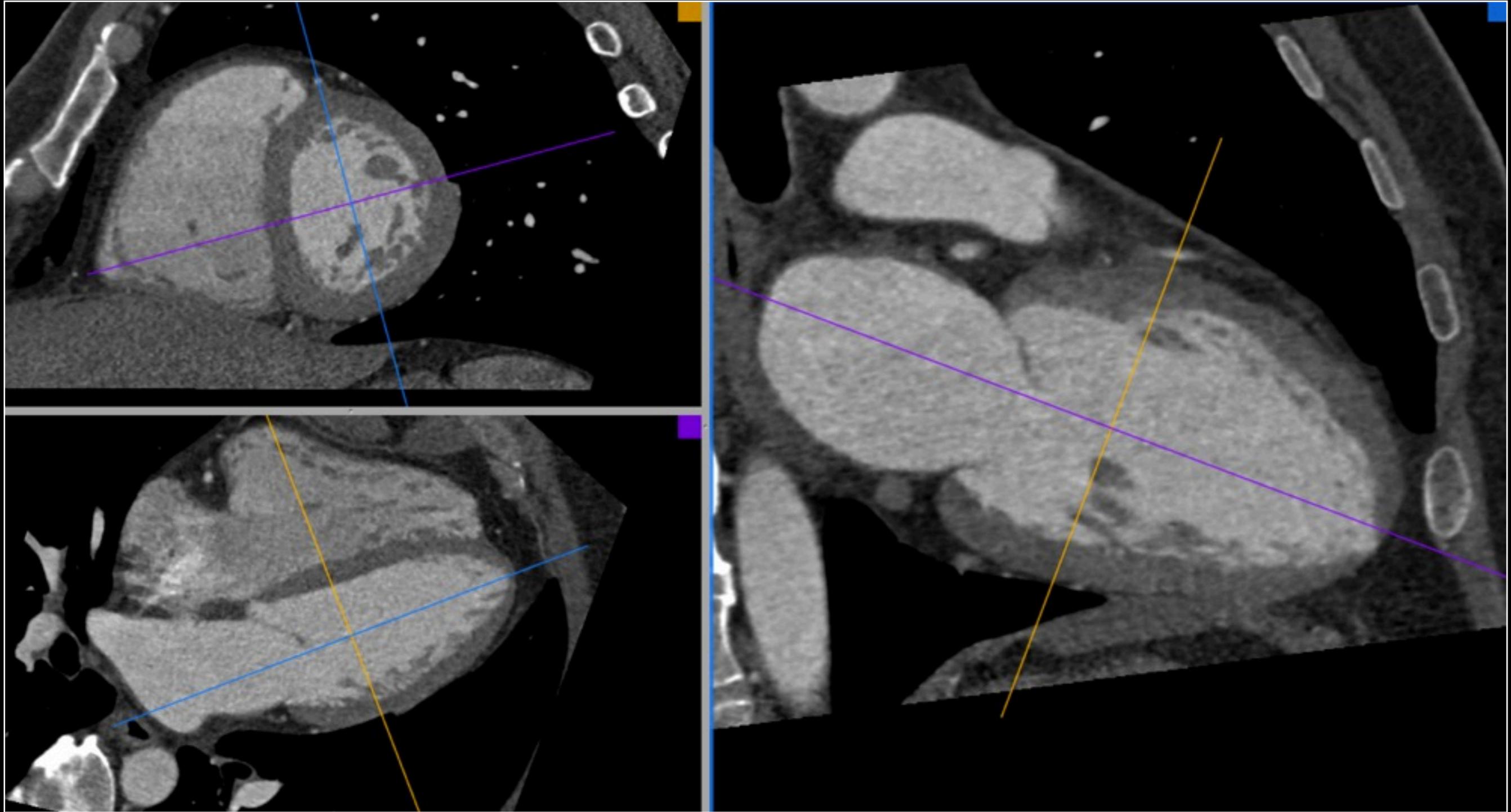
Grand axe



Petit axe

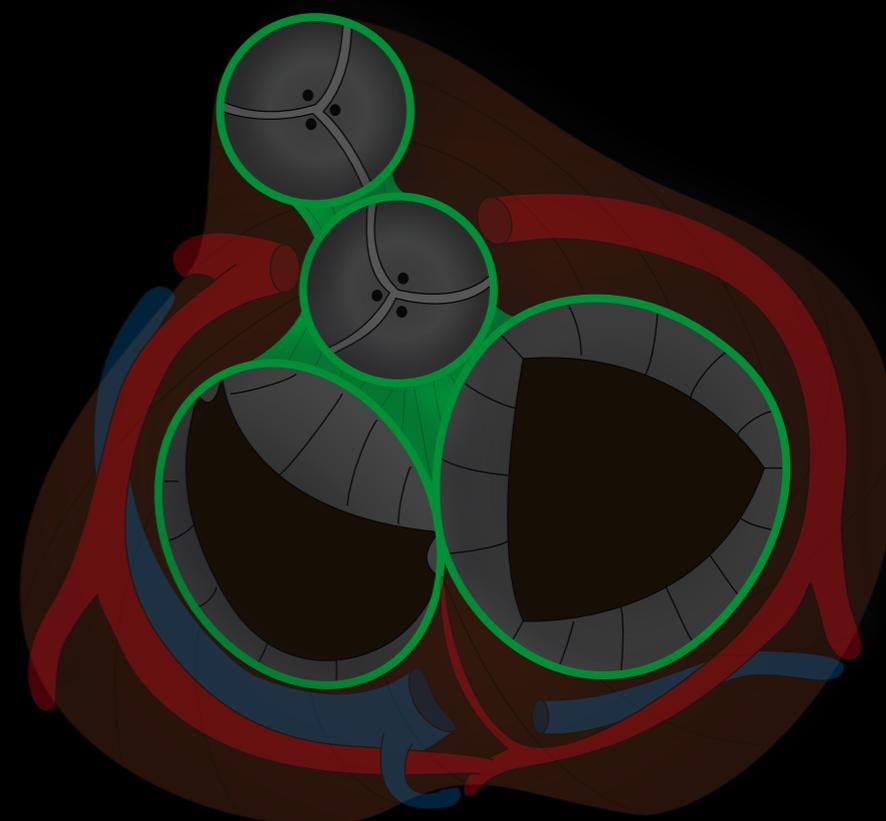
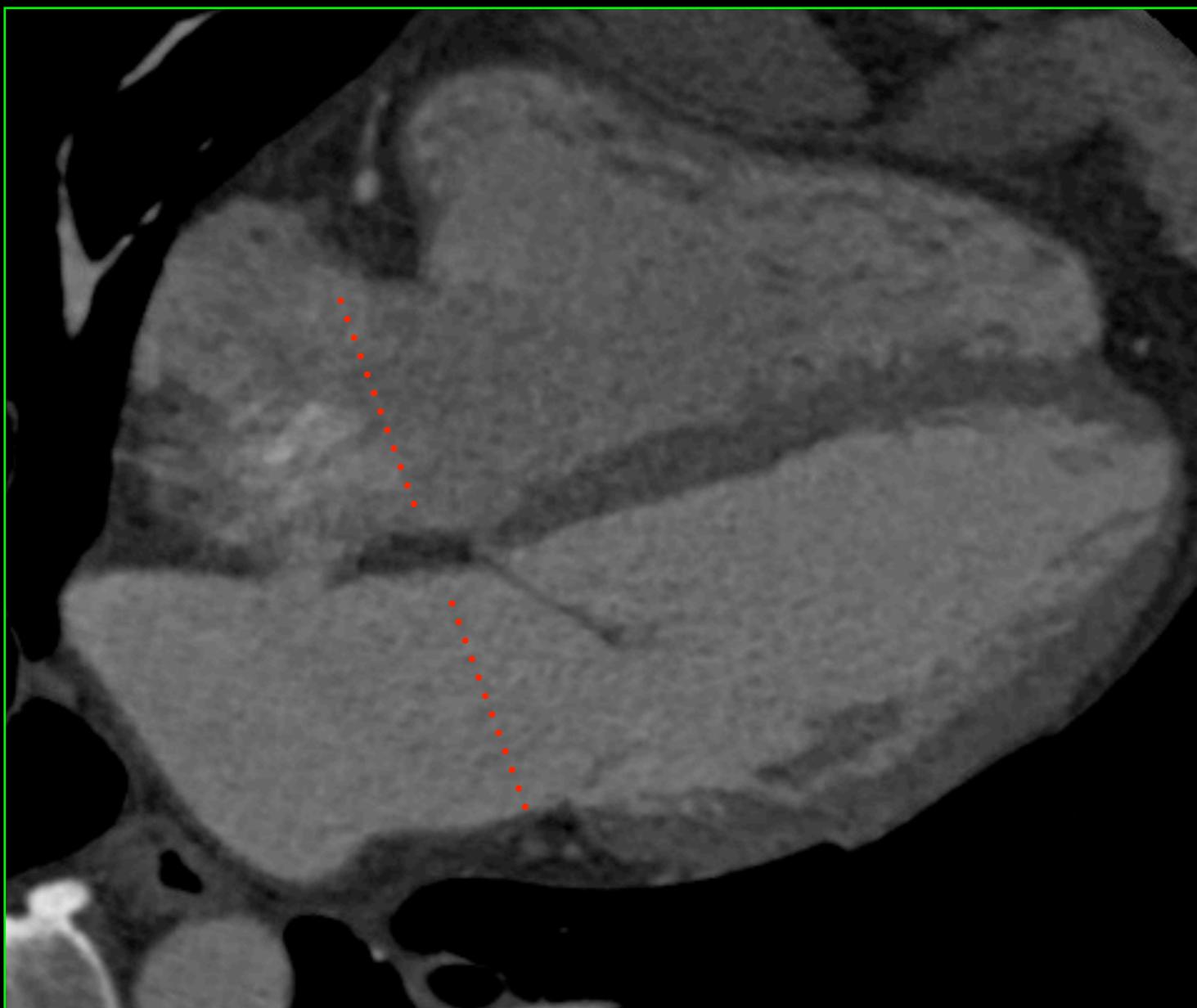
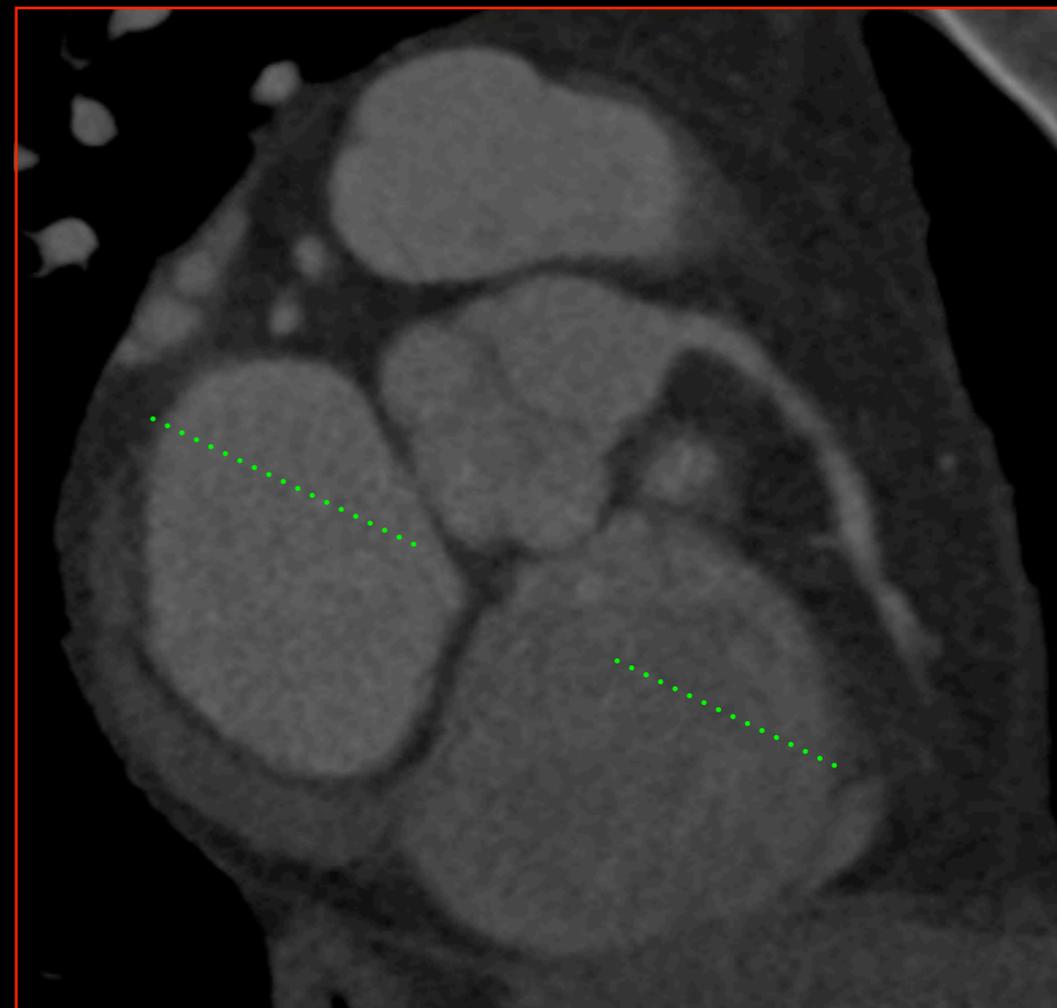


# Plans des coupes



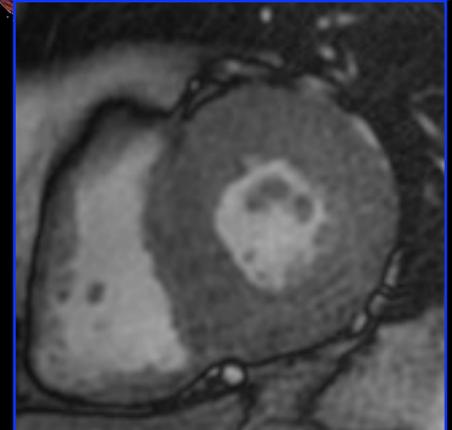
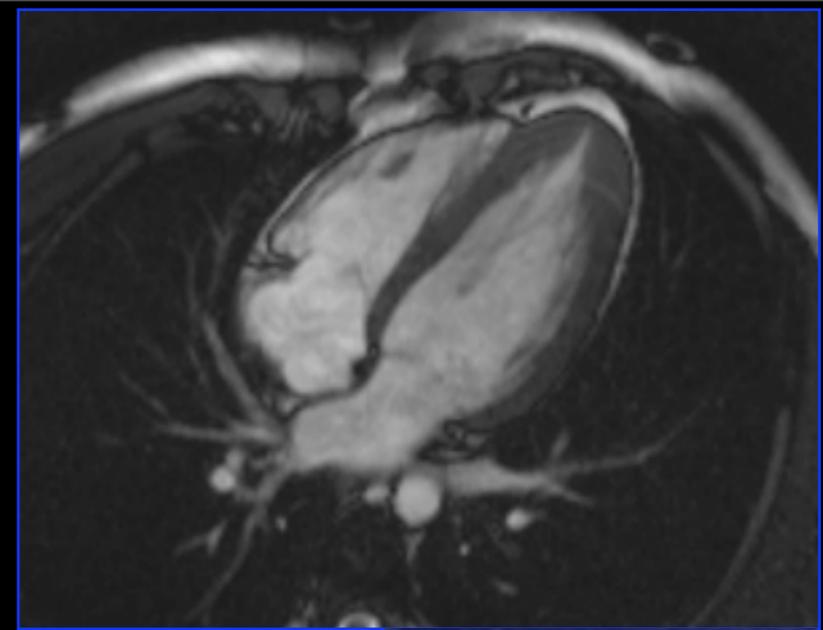
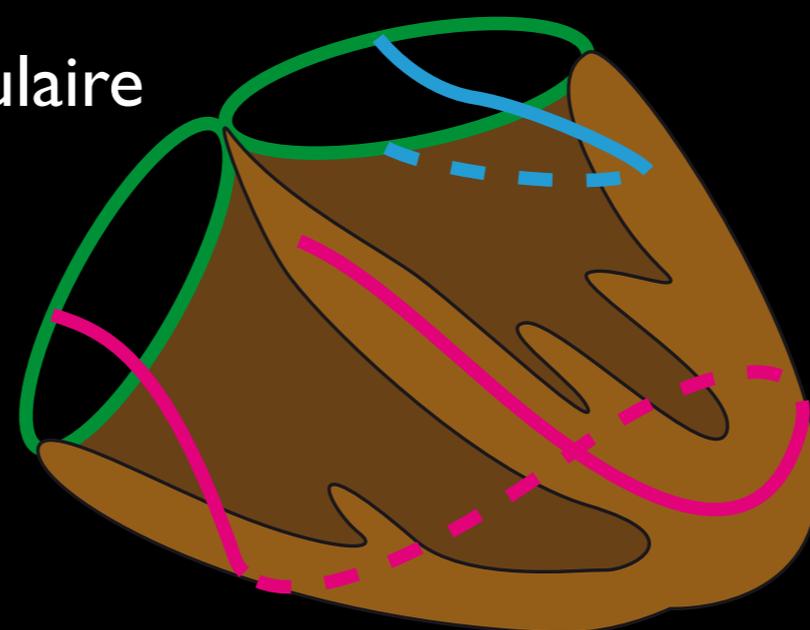
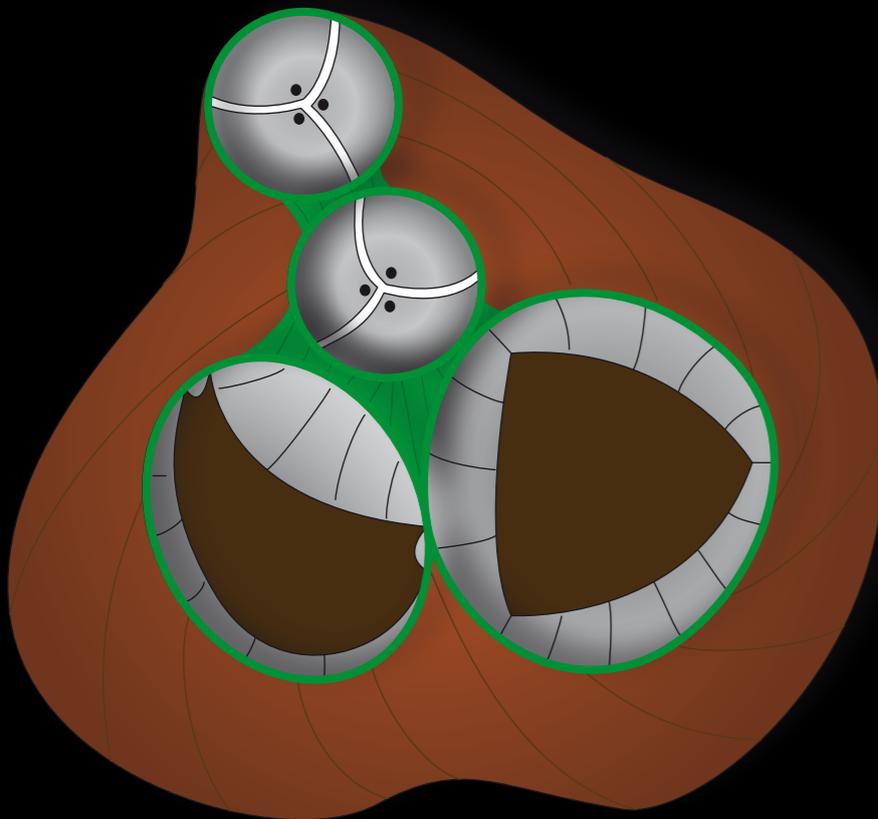
# Parois

Cercles tendineux & noyau fibreux central du coeur



# Parois

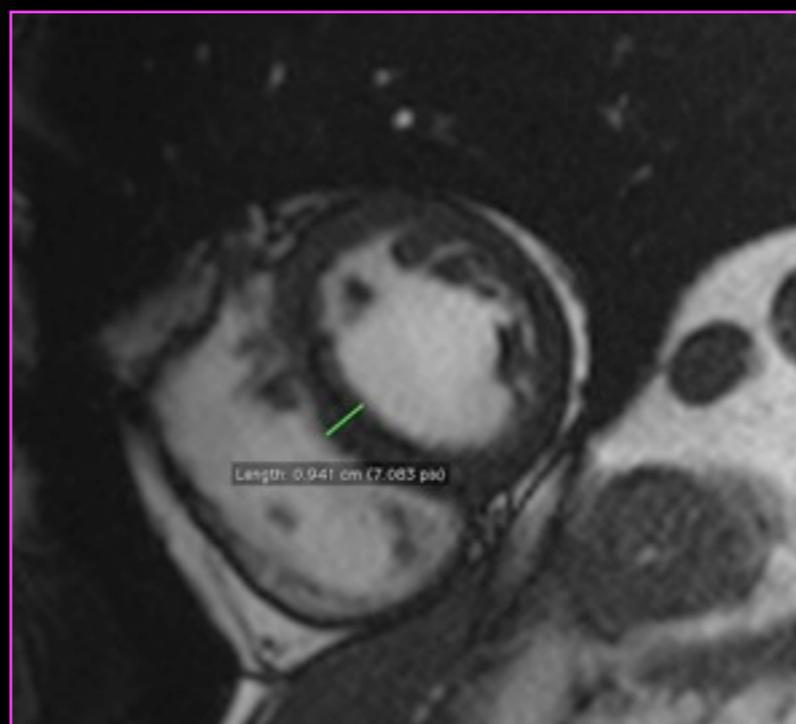
## Architecture musculaire



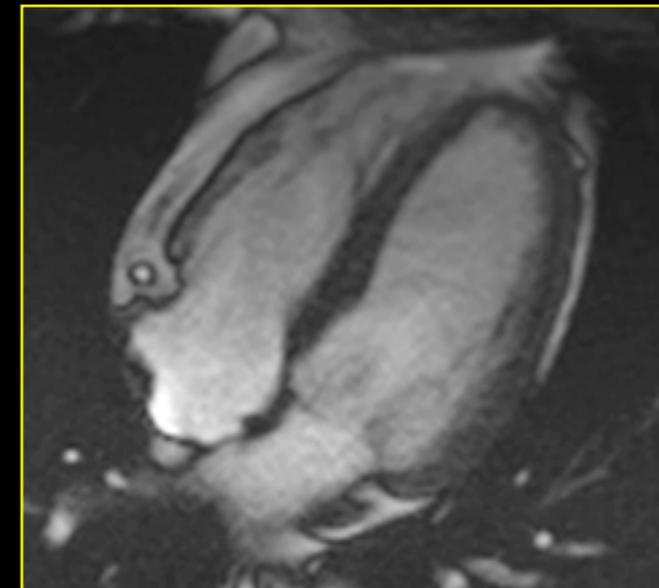
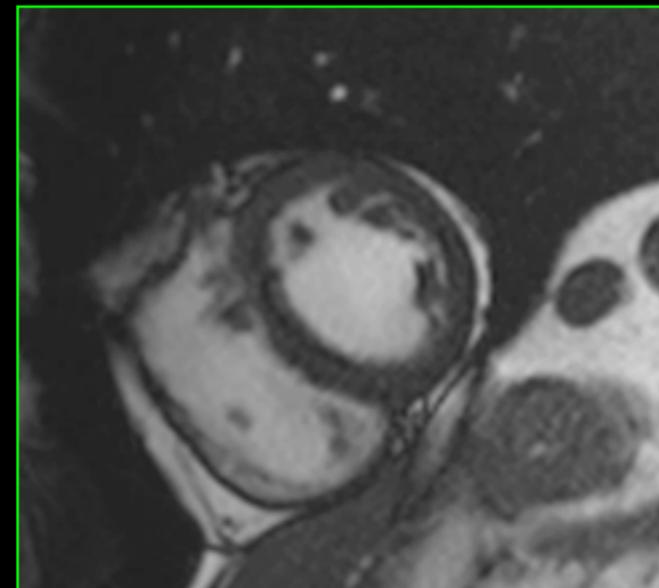
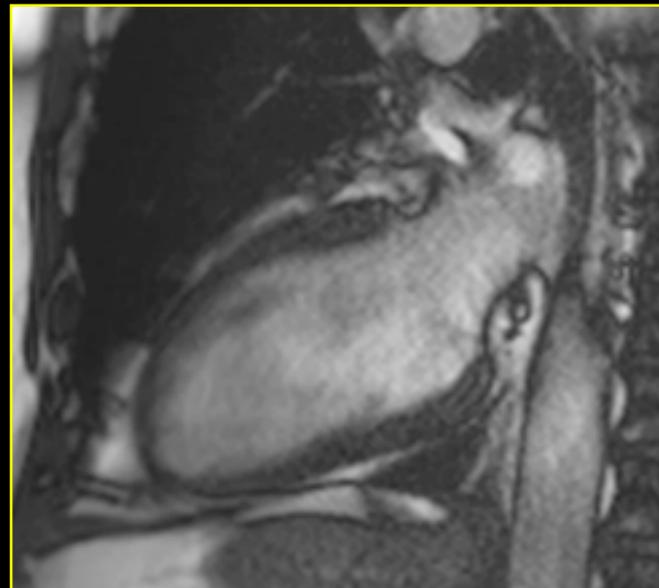
épaisseur: **MCH**  
- atrium: 2 mm  
- VD: 3 à 5 mm  
- **VG**: 5 à 12 mm

épaississement homogène

**IDM**

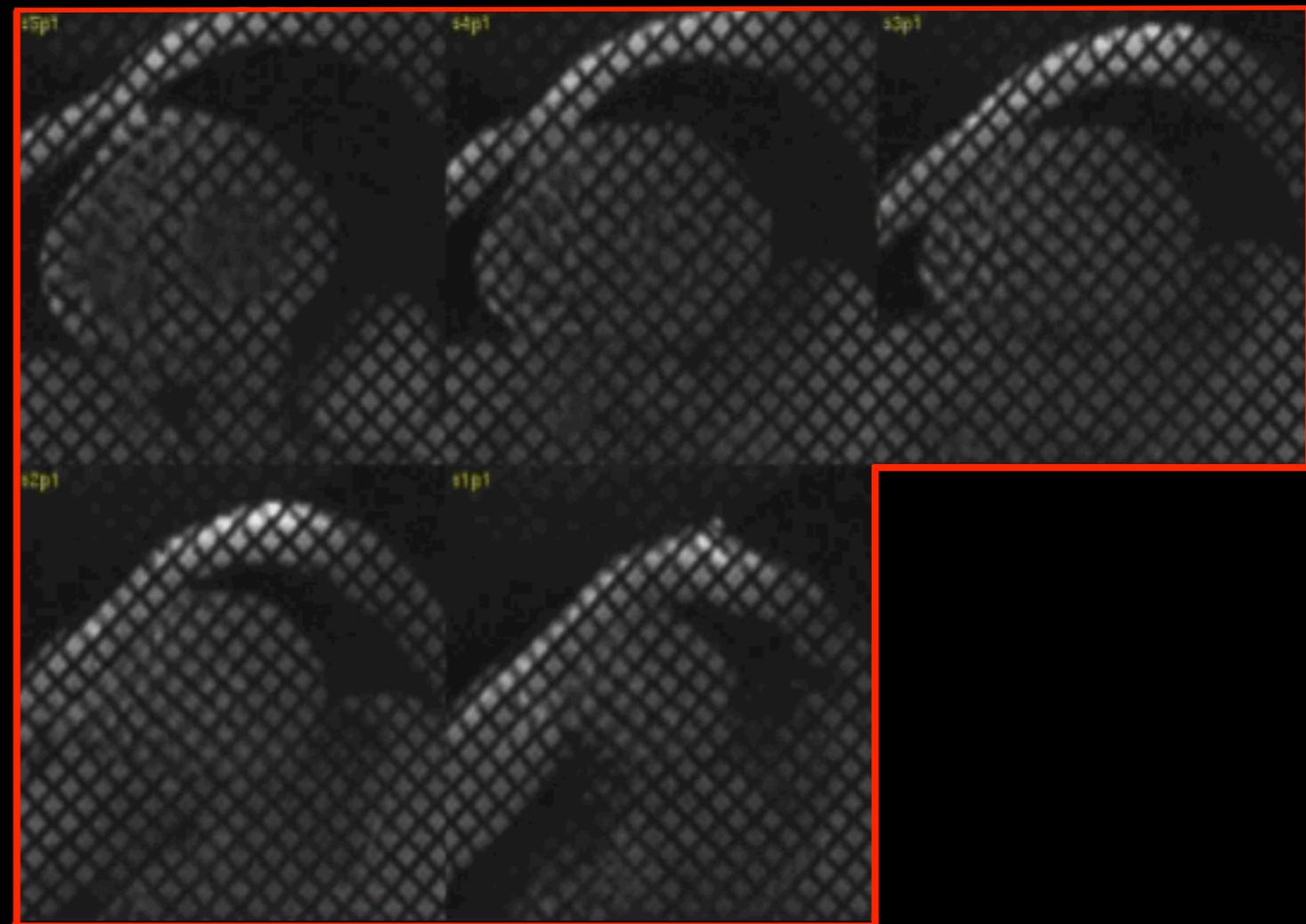
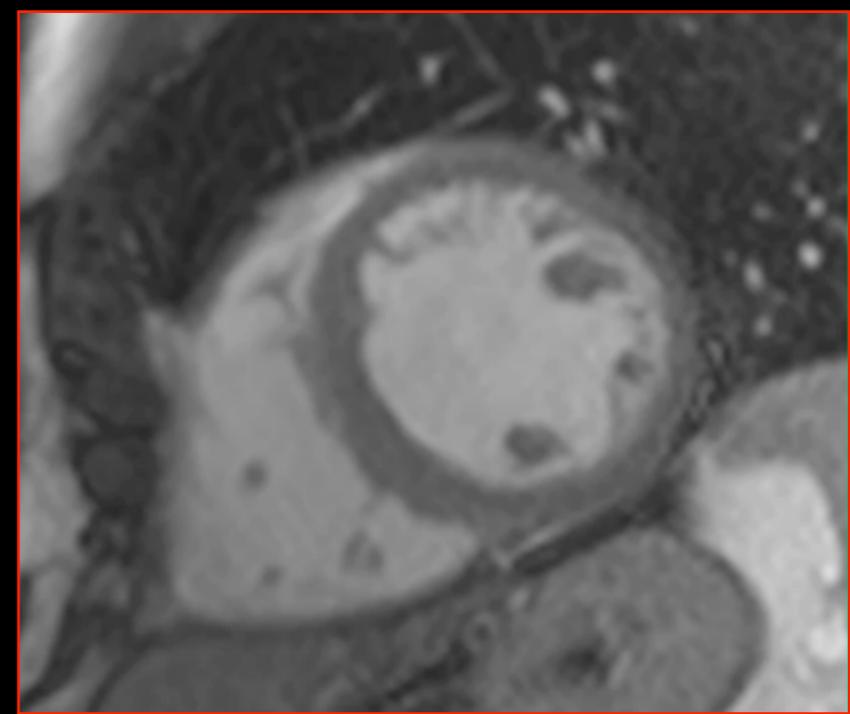
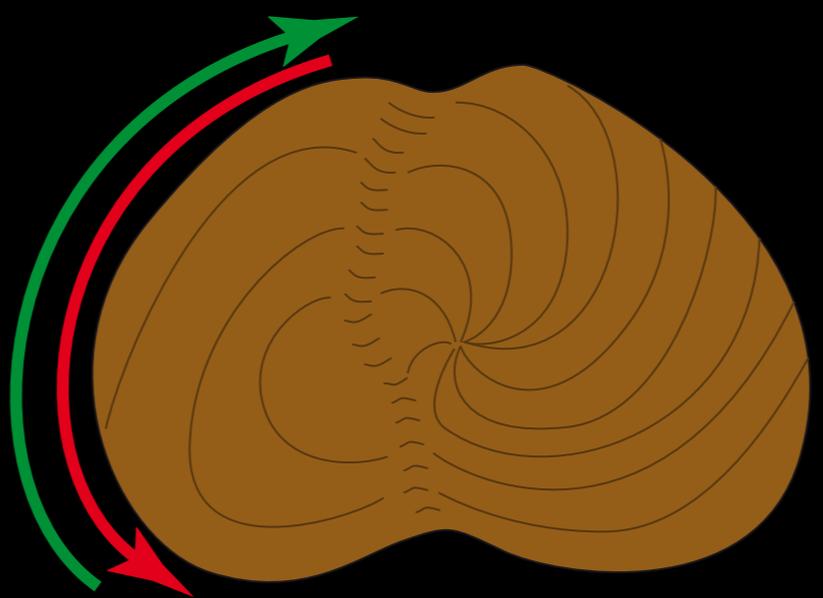
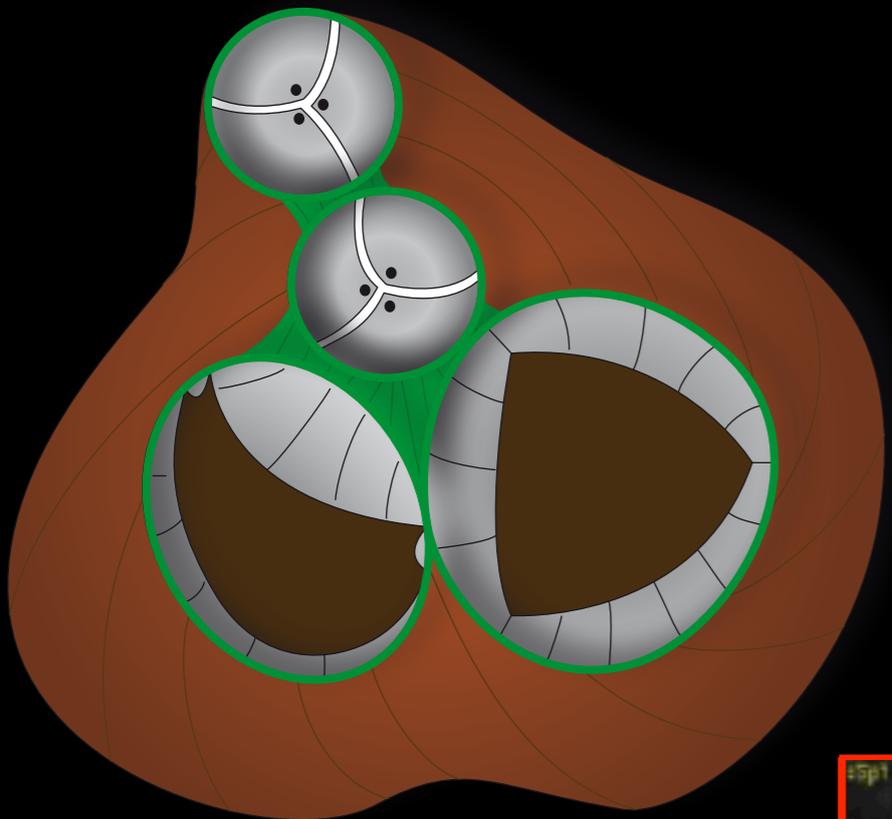


- raccourcissement:
- fibres: 10%
  - **longitudinal**: 15%
  - **diamètre**: 50%
  - fraction d'éjection: 65%



# Parois

Systole  
Diastole

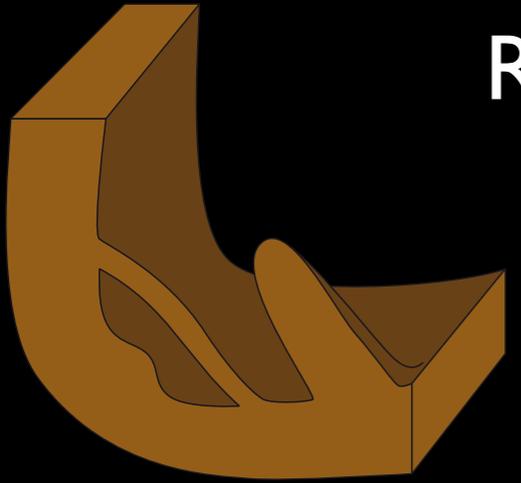


# Parois

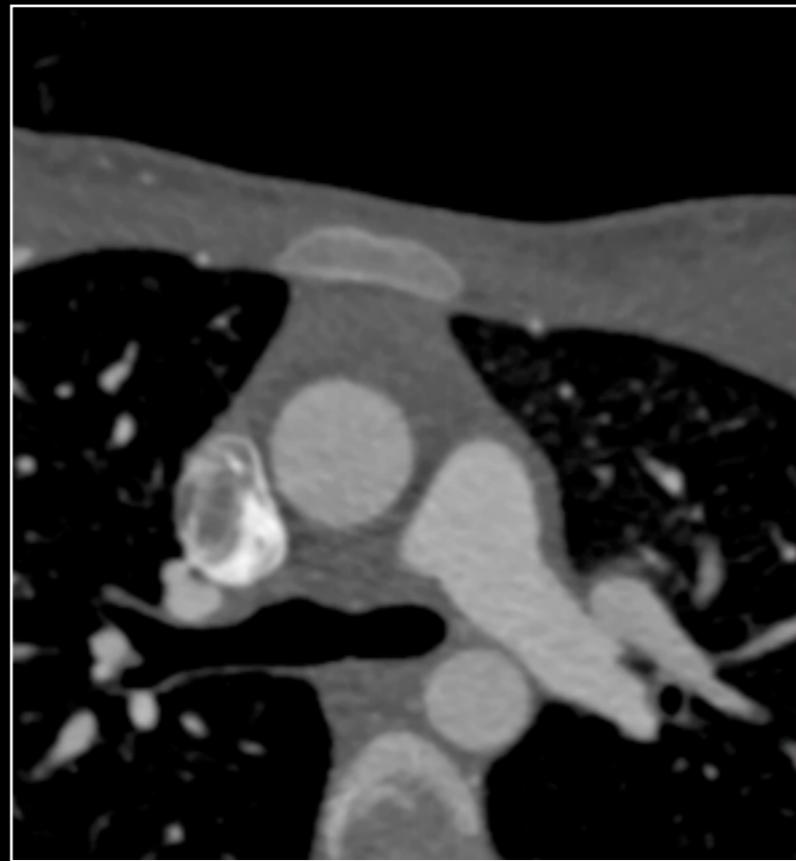
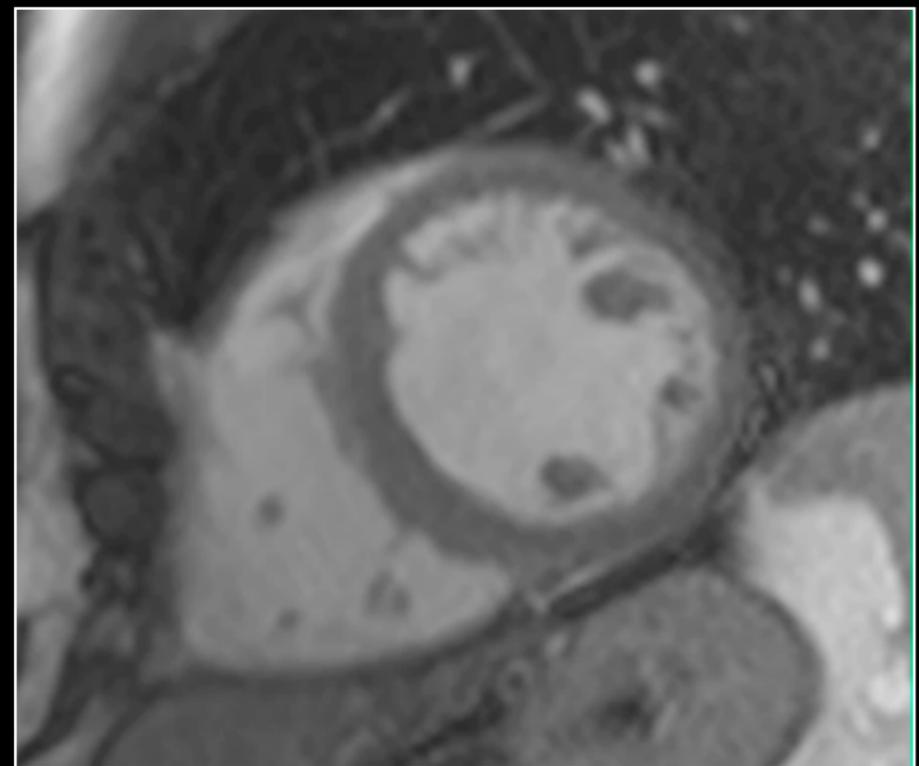
## Nomenclature

Epicarde  
Myocarde  
Endocarde

## Reliefs



Muscles papillaires  
Trabécules  
Colonnes charnues



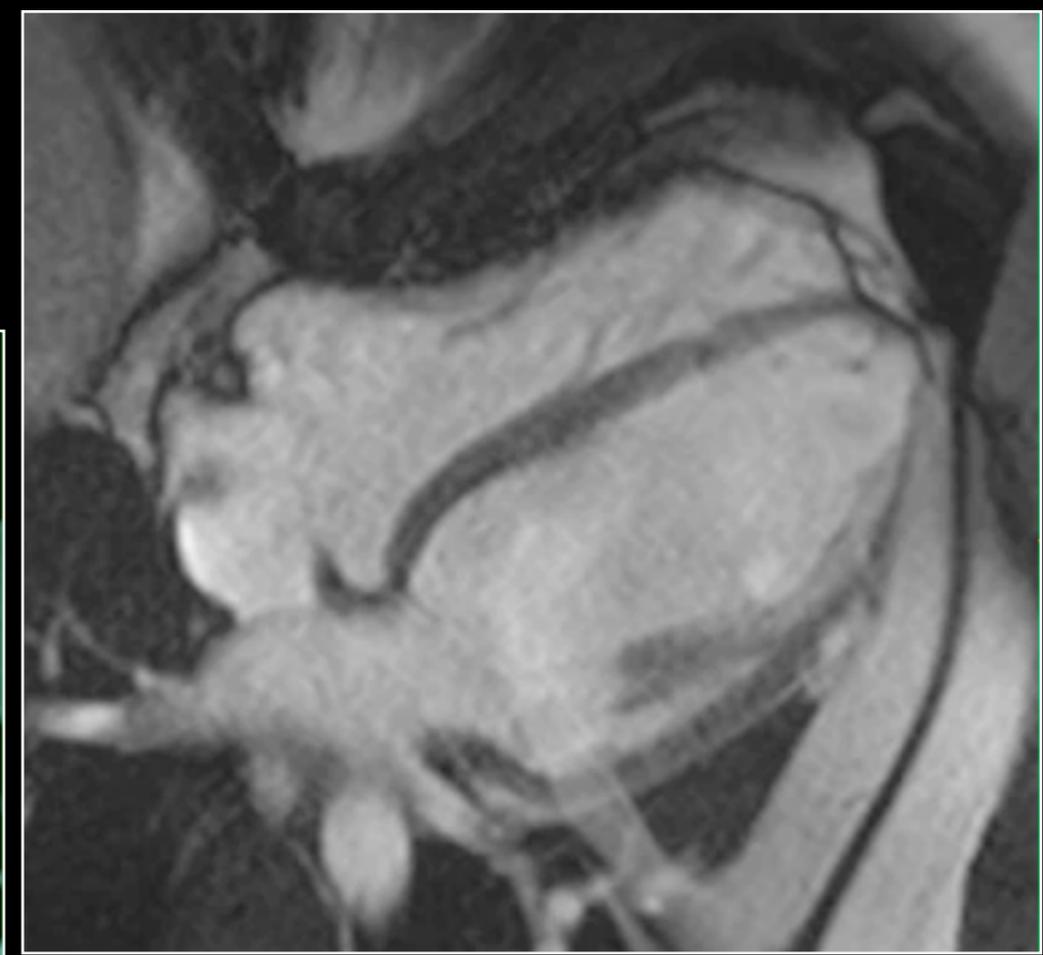
Libre

Septale

Antérieure

Latérale

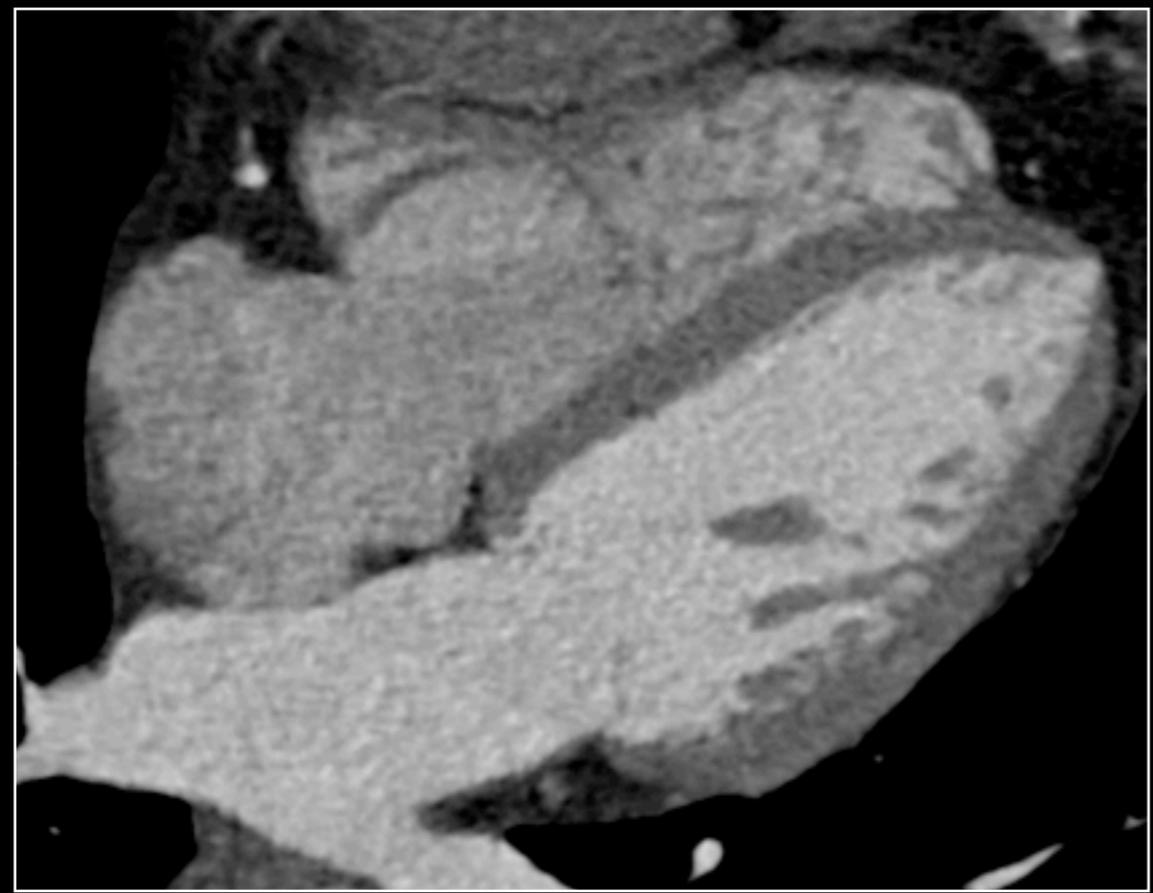
Inférieure



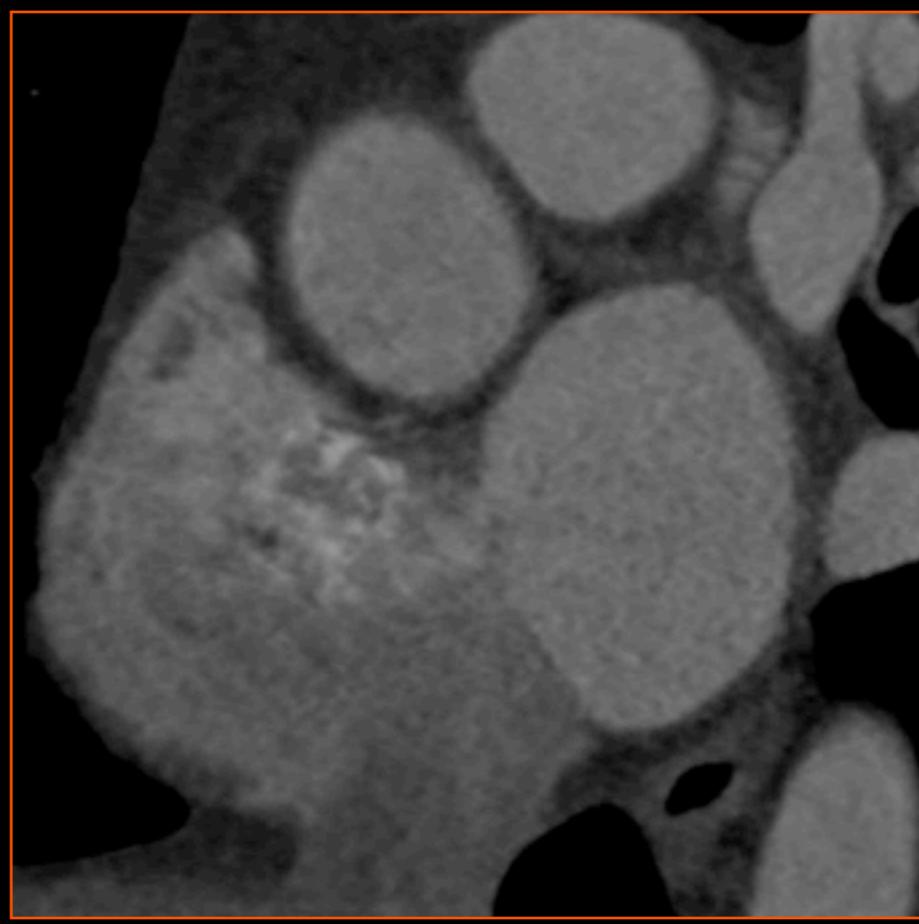
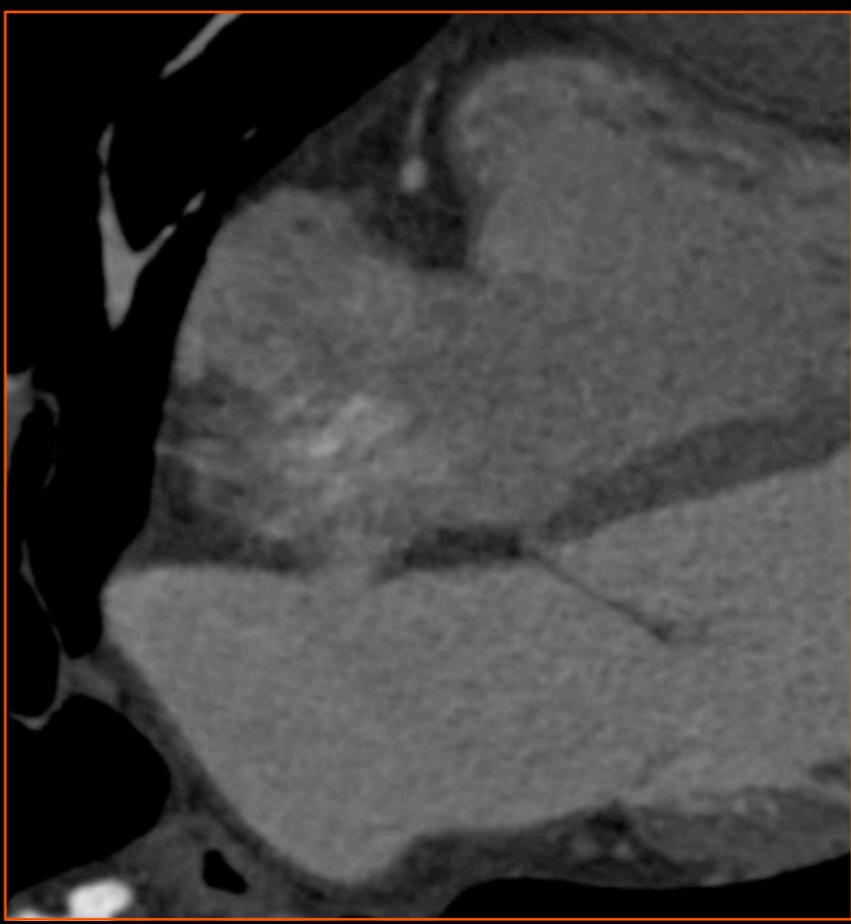
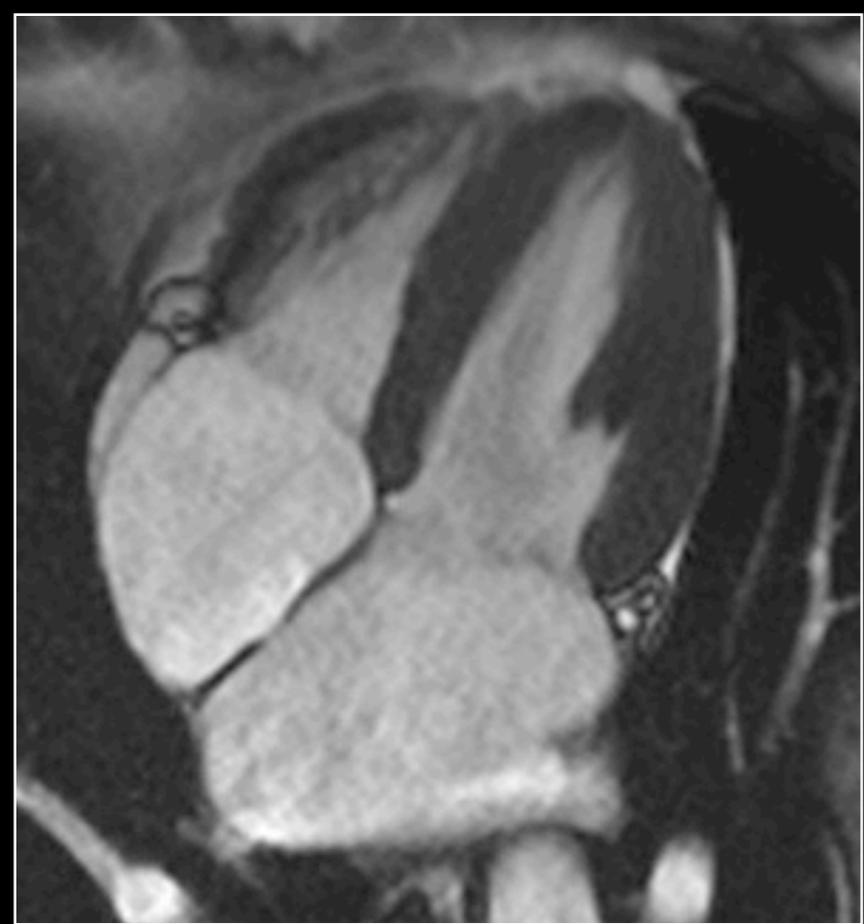
# Parois

# Septum interatrial

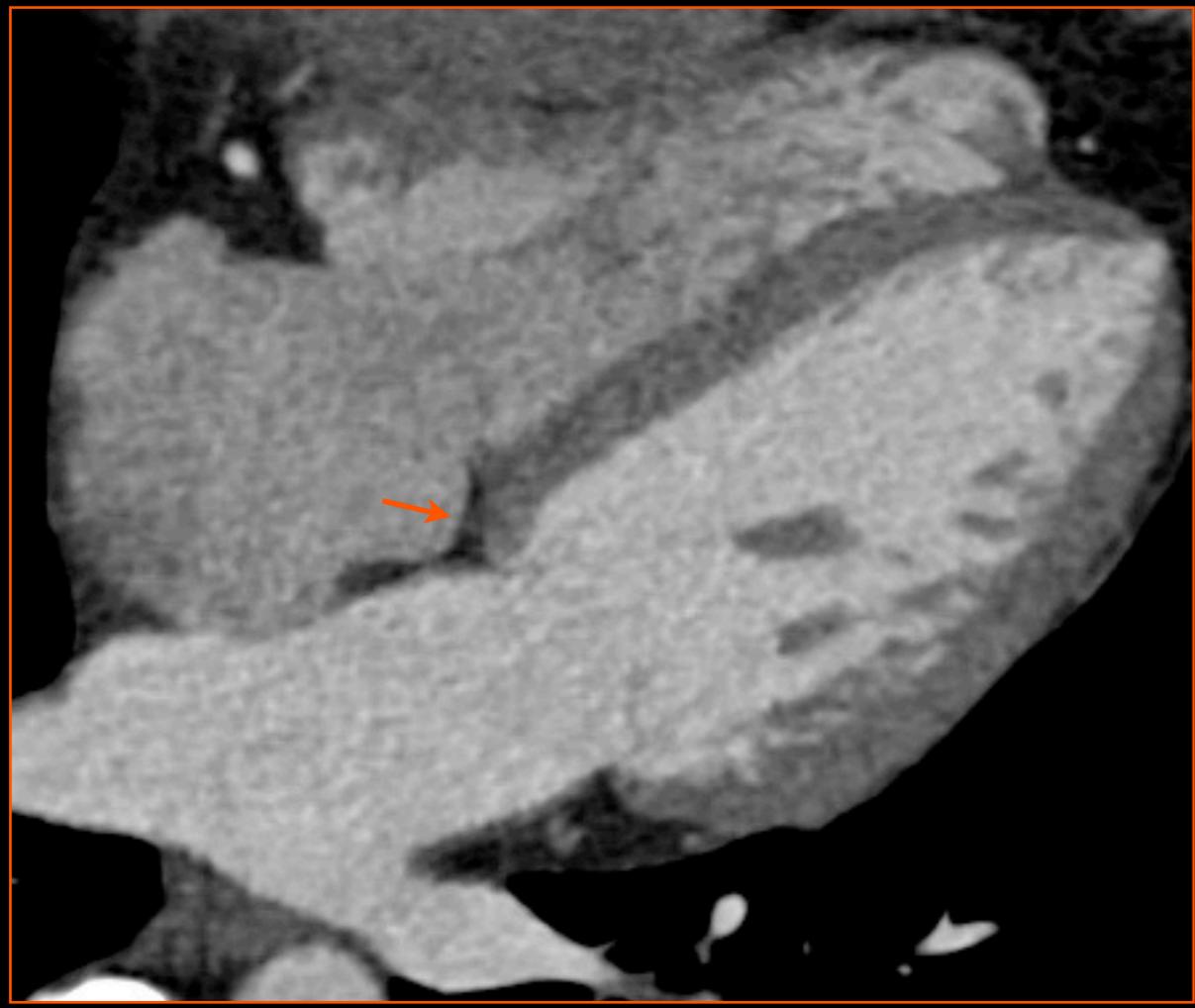
Musculaire



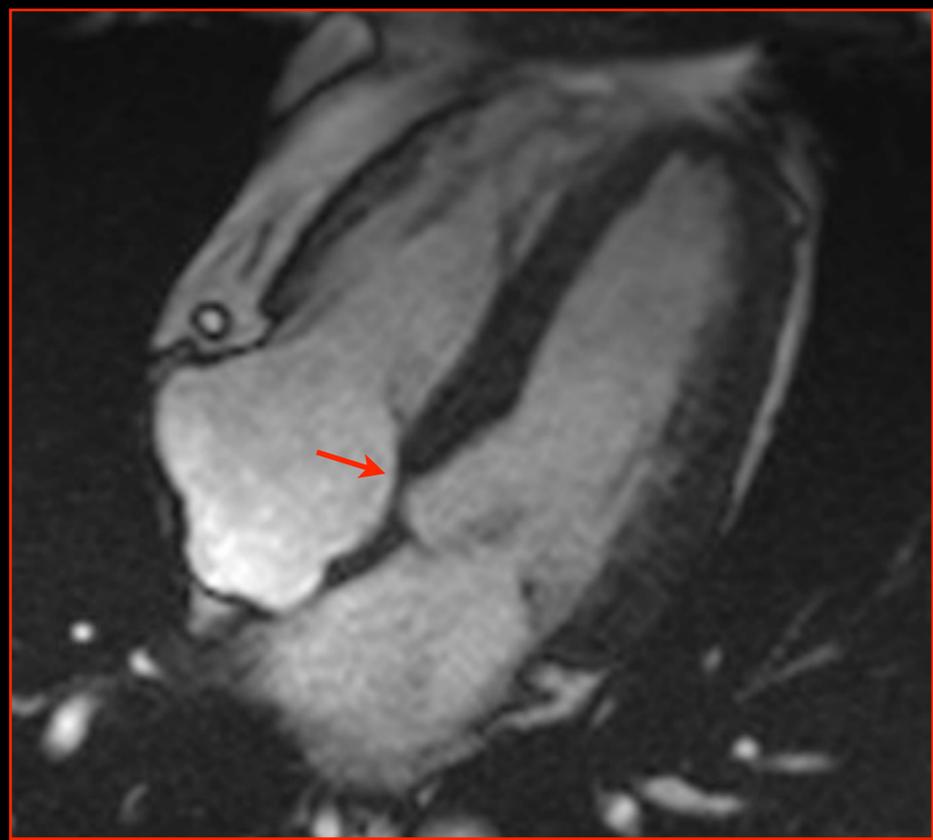
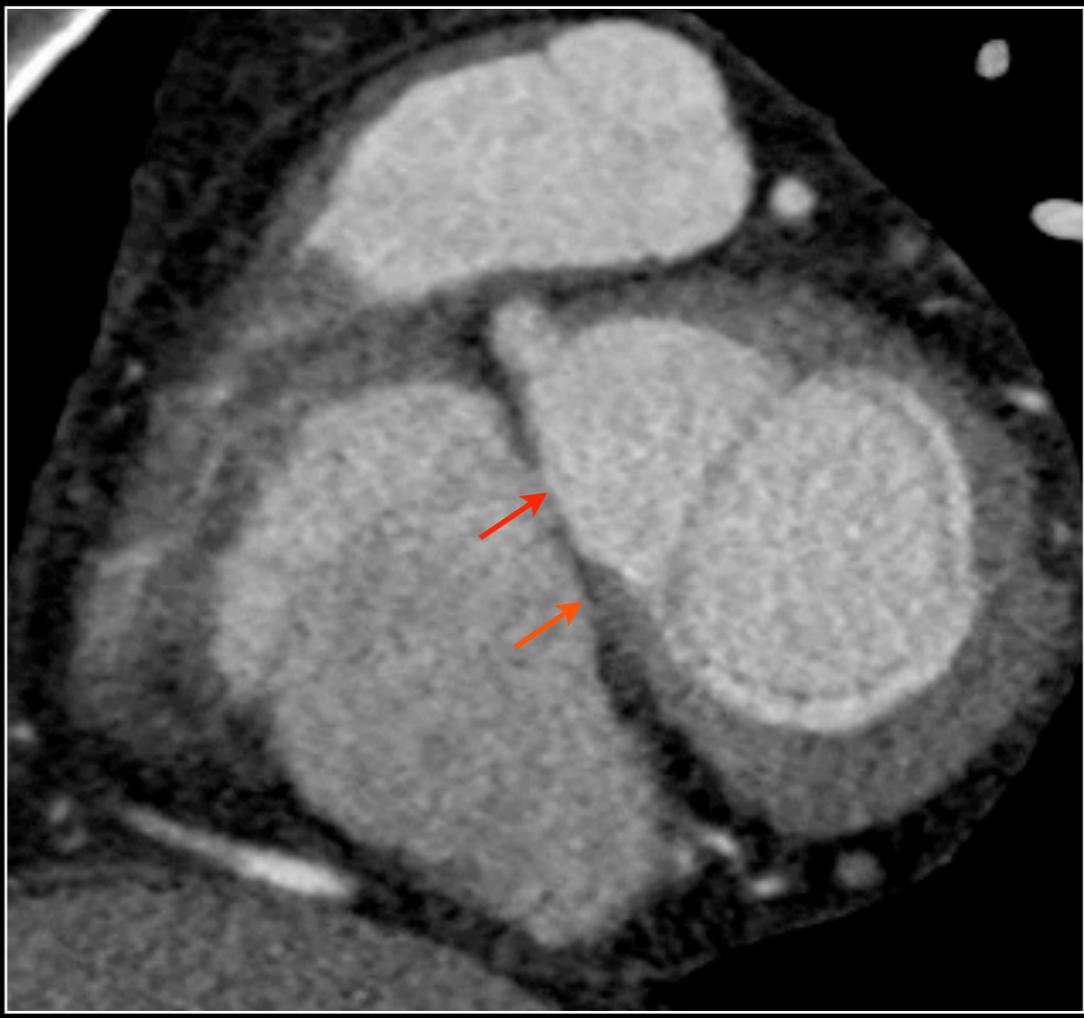
FOP (20%)  
CIA (5%)



# Parois



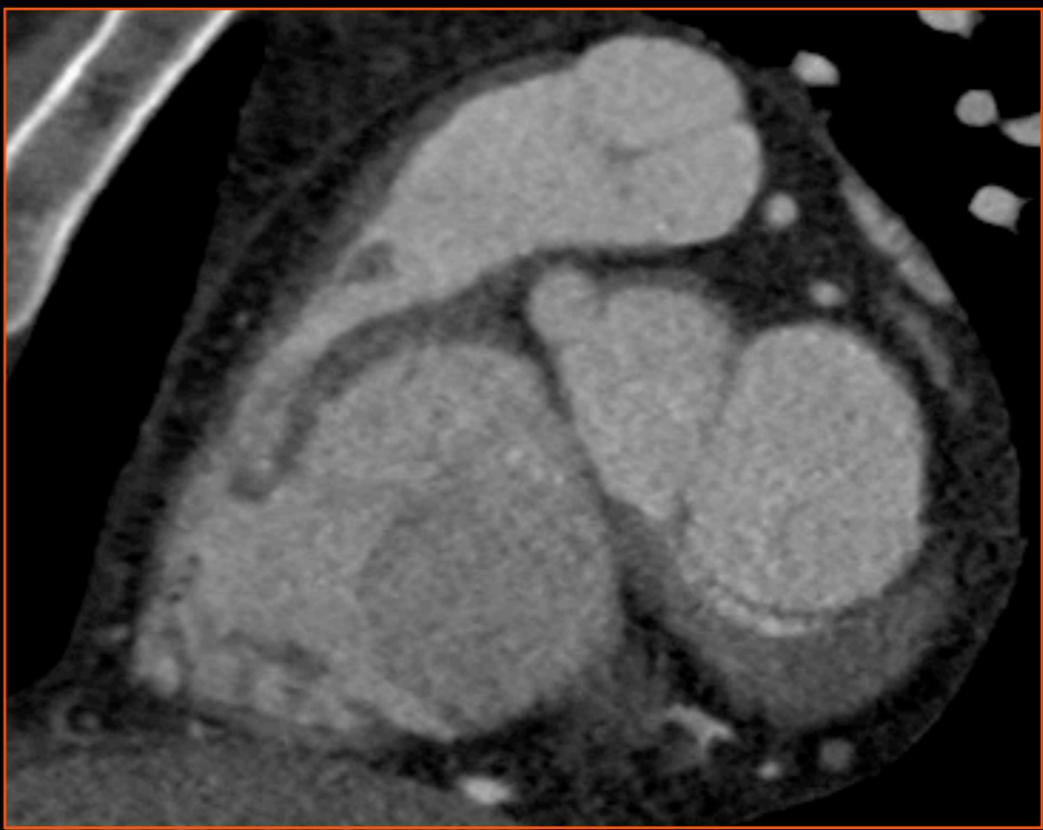
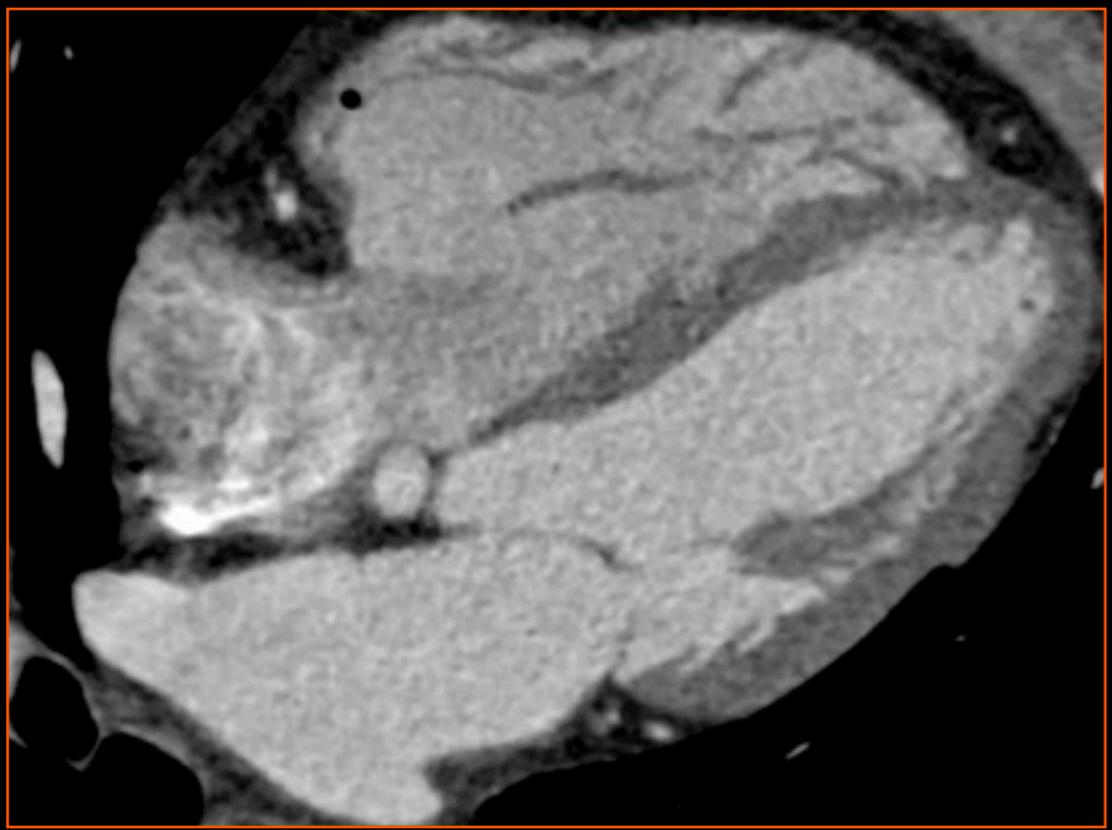
# Septum atrioventriculaire



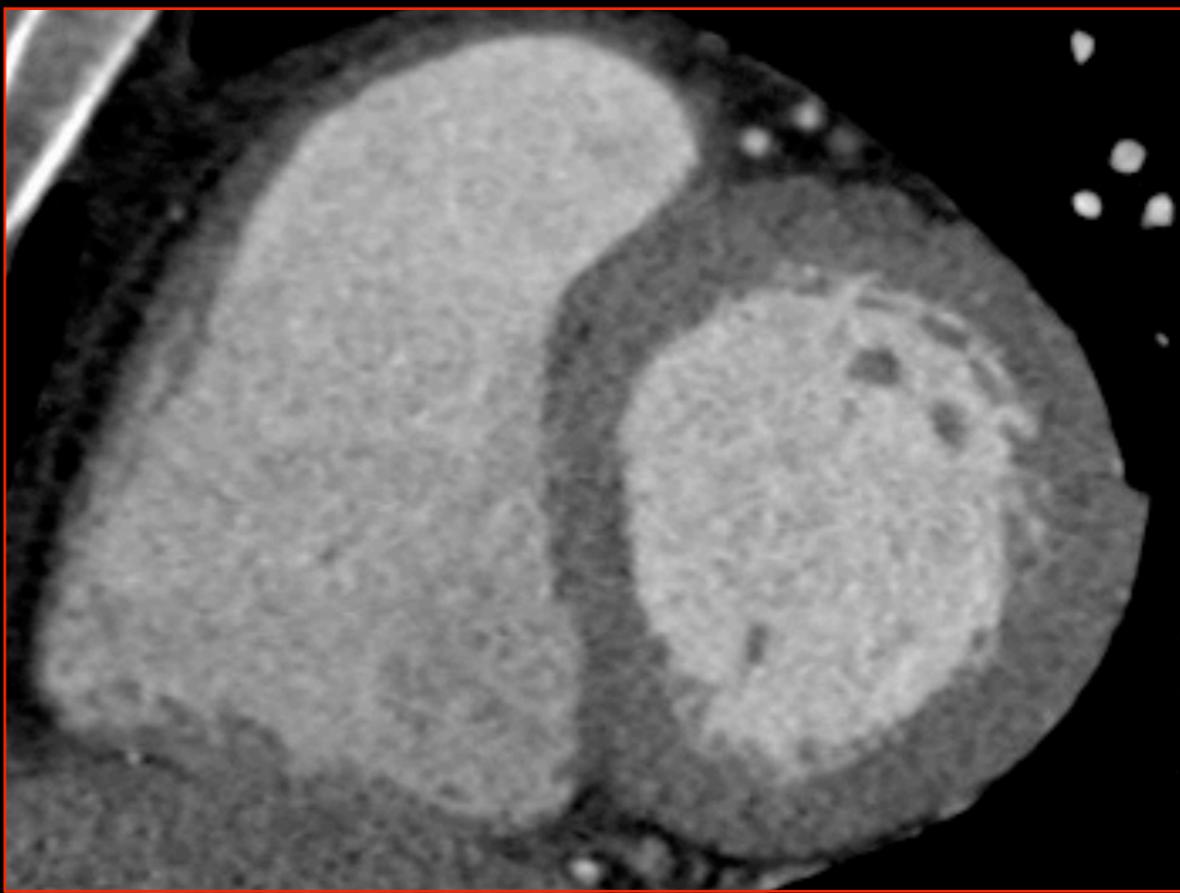
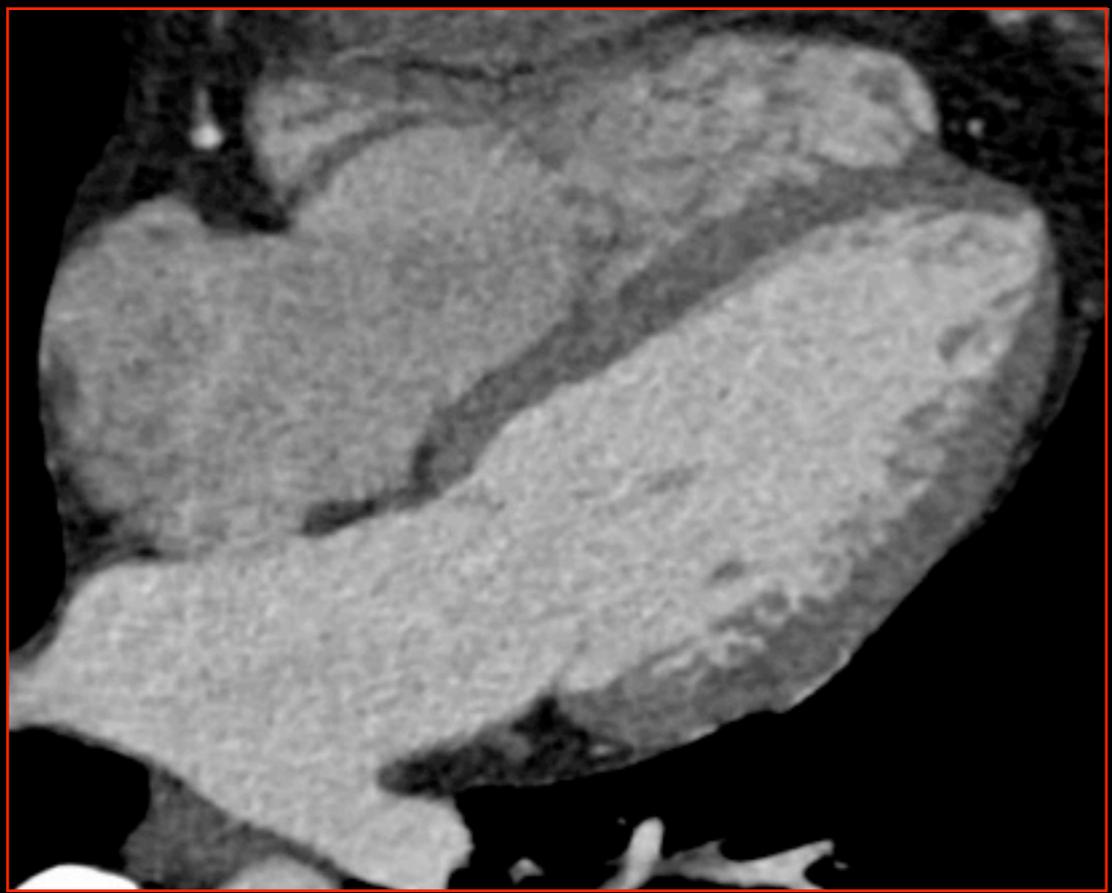
Musculaire  
Membraneux

# Parois

# Septum interventriculaire



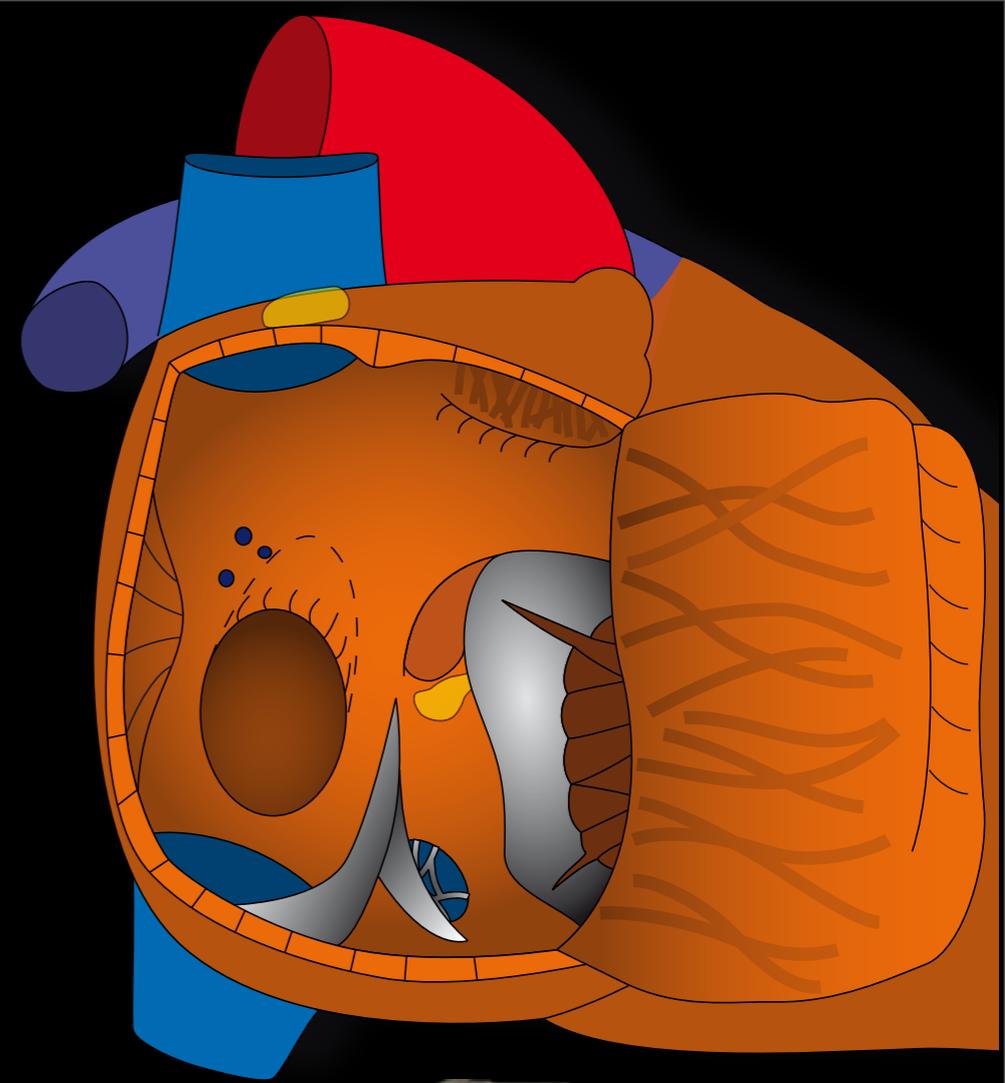
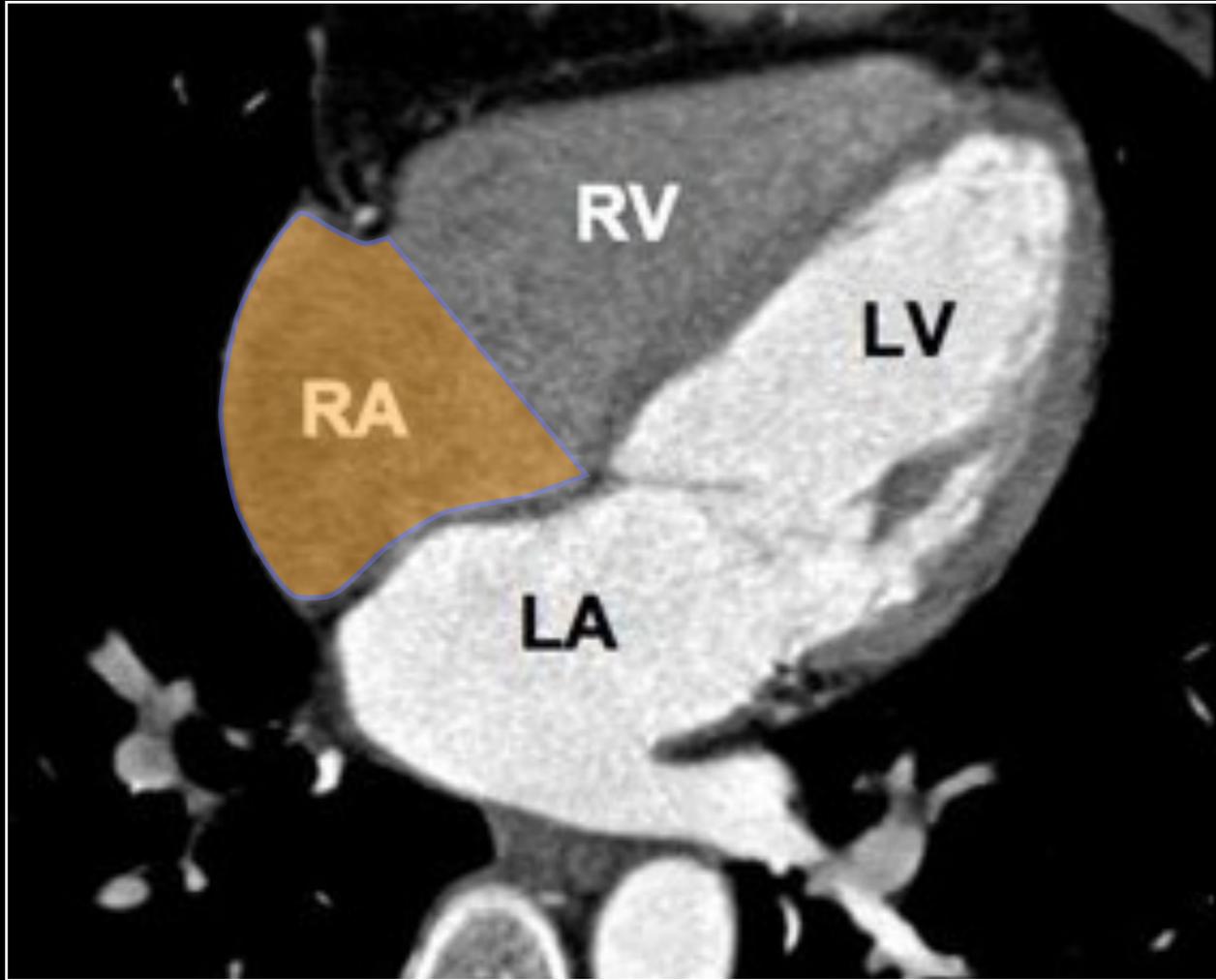
Membraneux

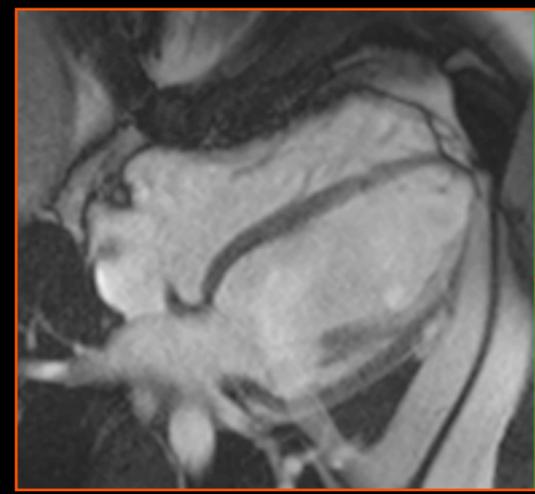
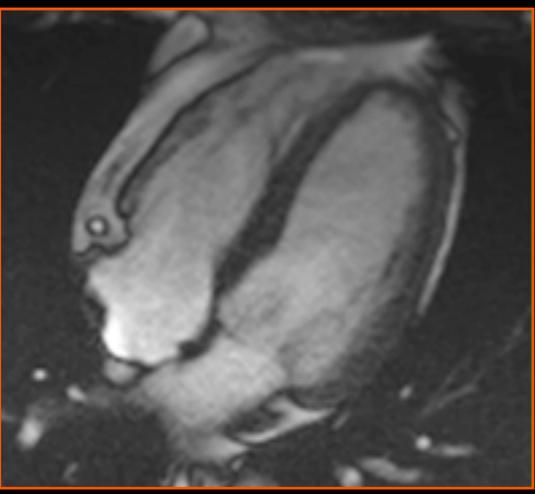
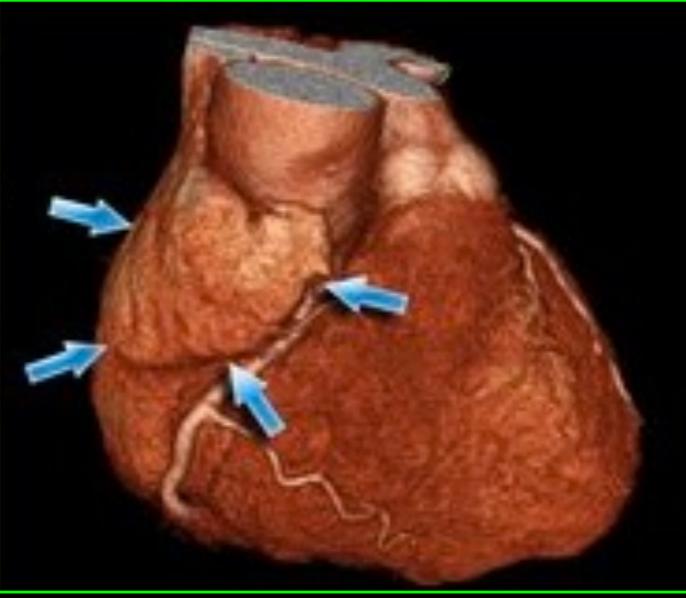
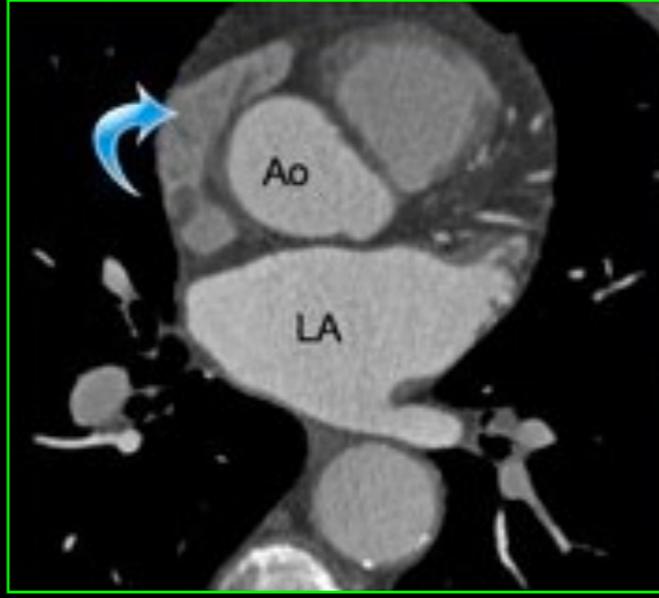
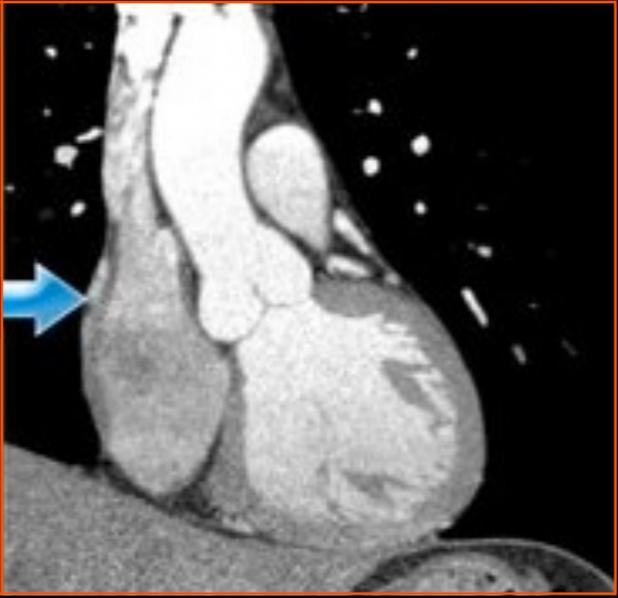
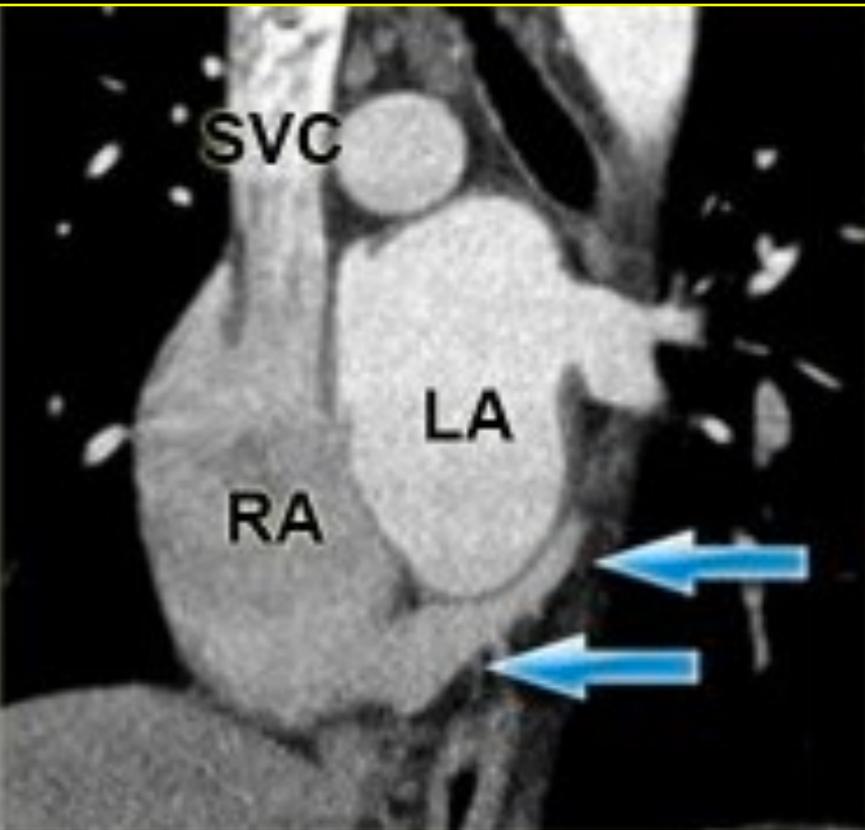
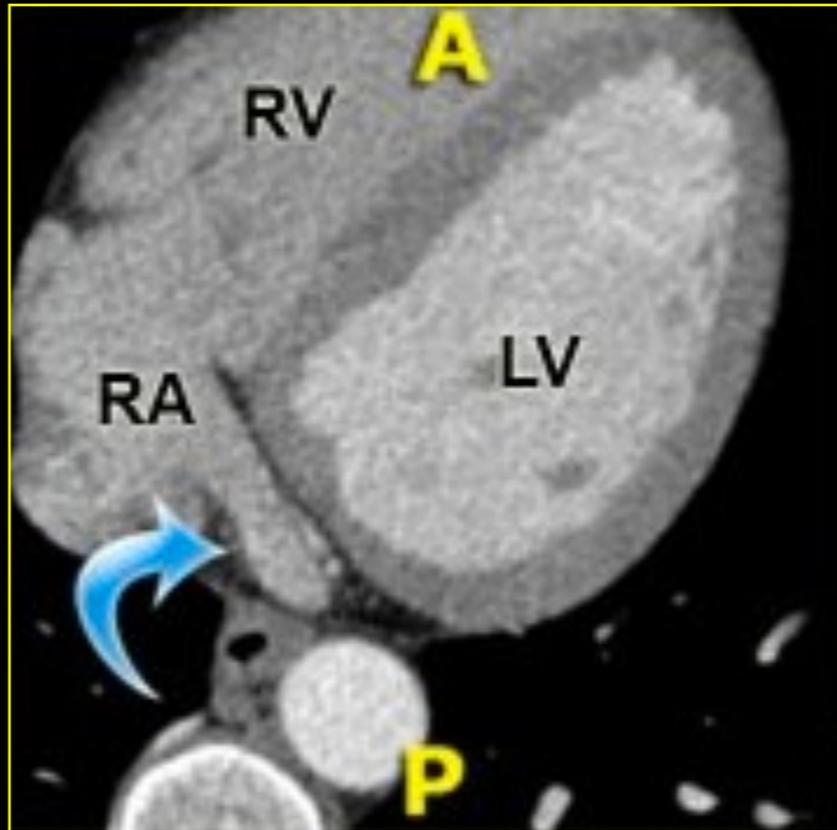
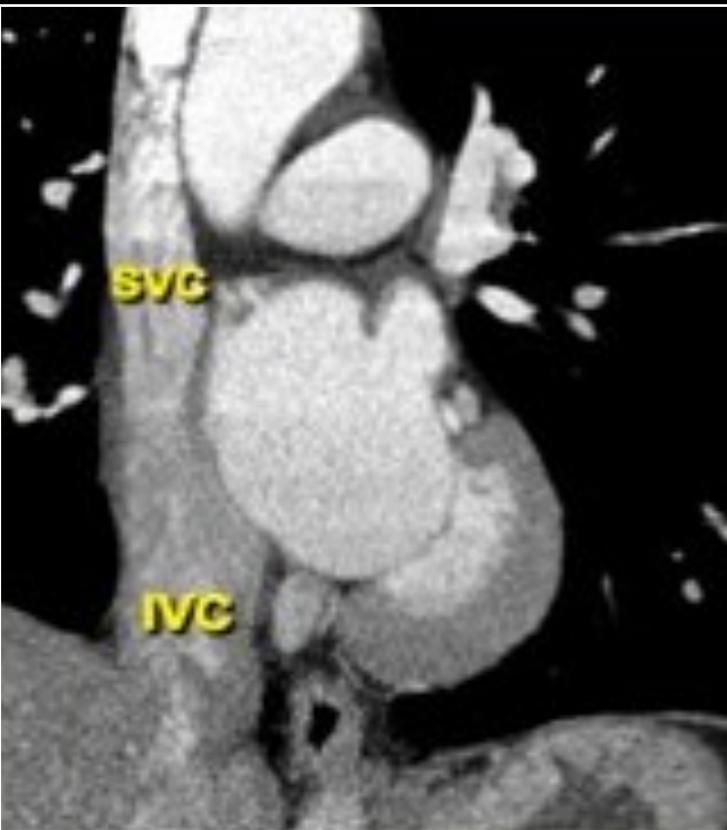


Musculaire

# Cavités

## Atrium droit

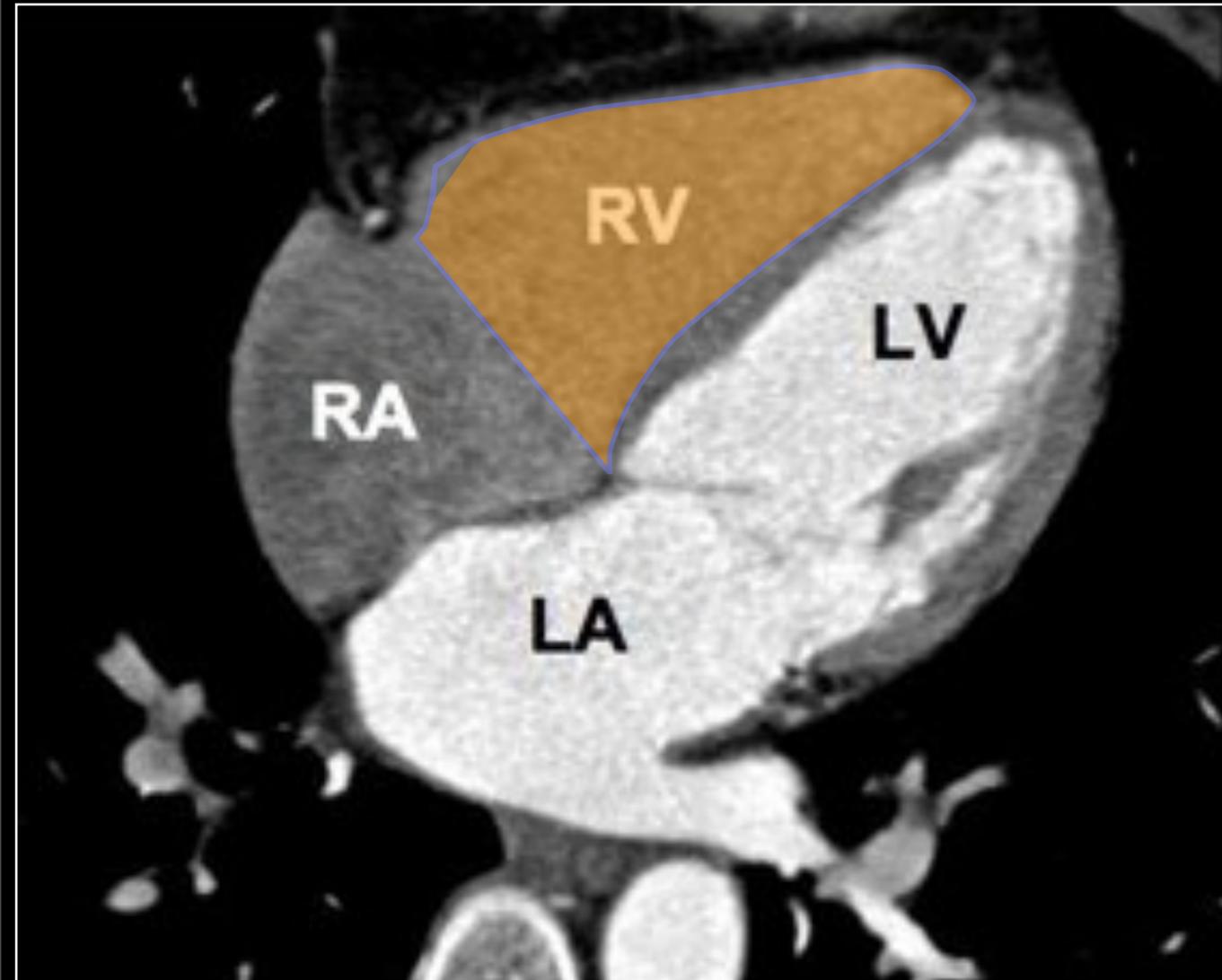


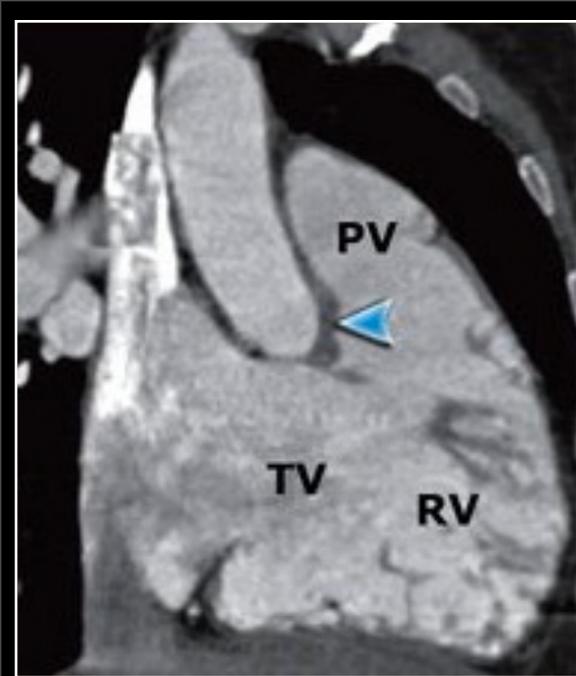


- veines caves
- sinus coronaire (sillon coronaire gauche)
- crête terminale
- auricule droit

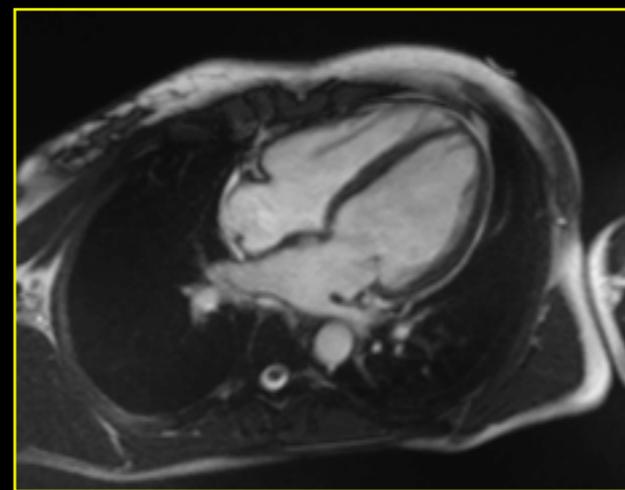
# Cavités

## Ventricule droit





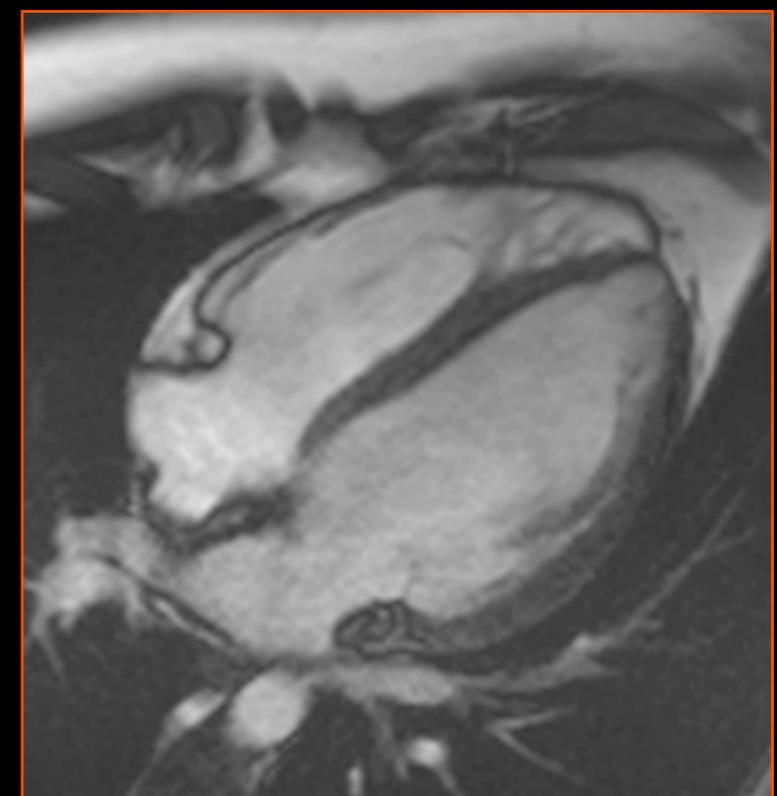
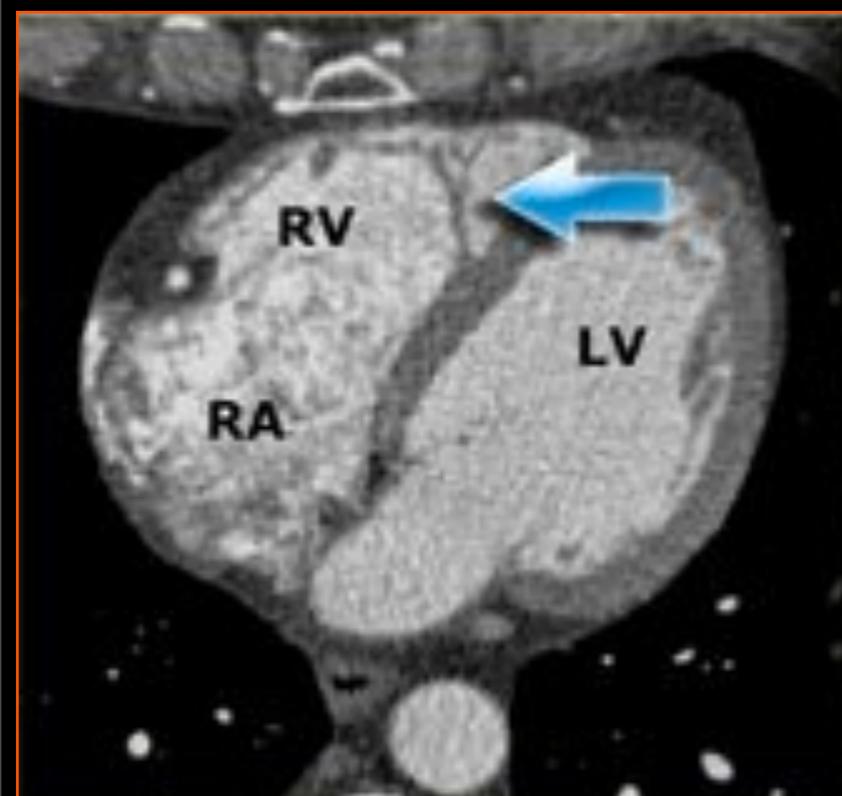
double discordance



- crête supra-ventriculaire

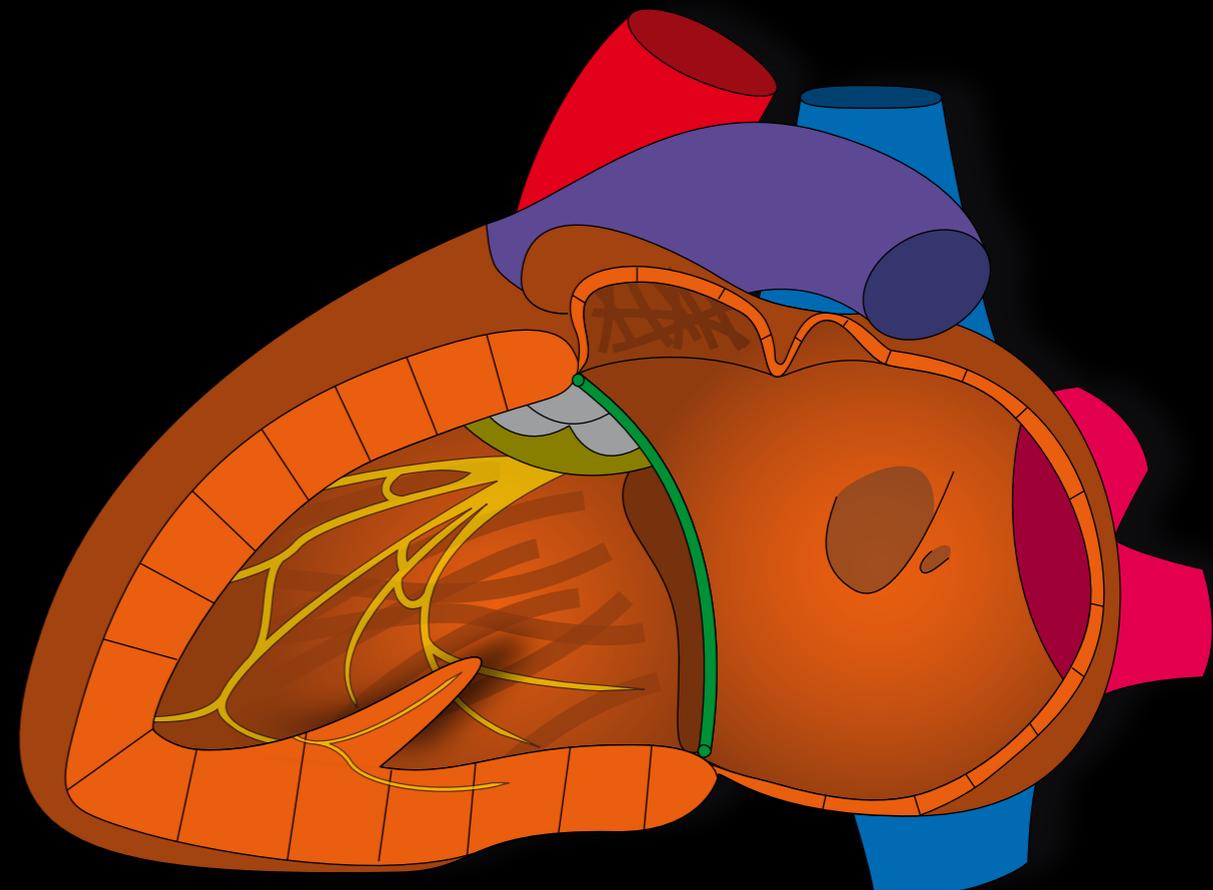
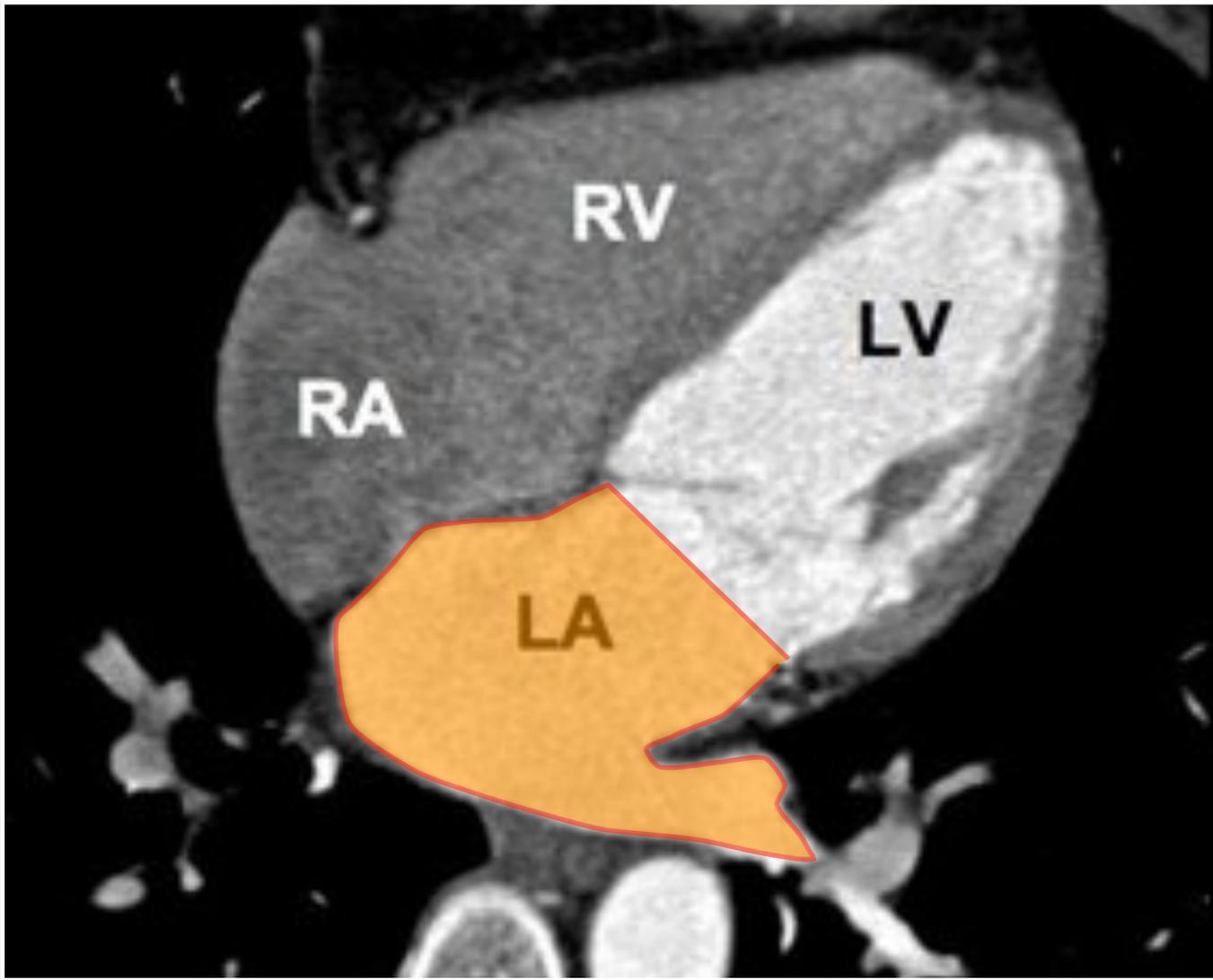
- muscles papillaires

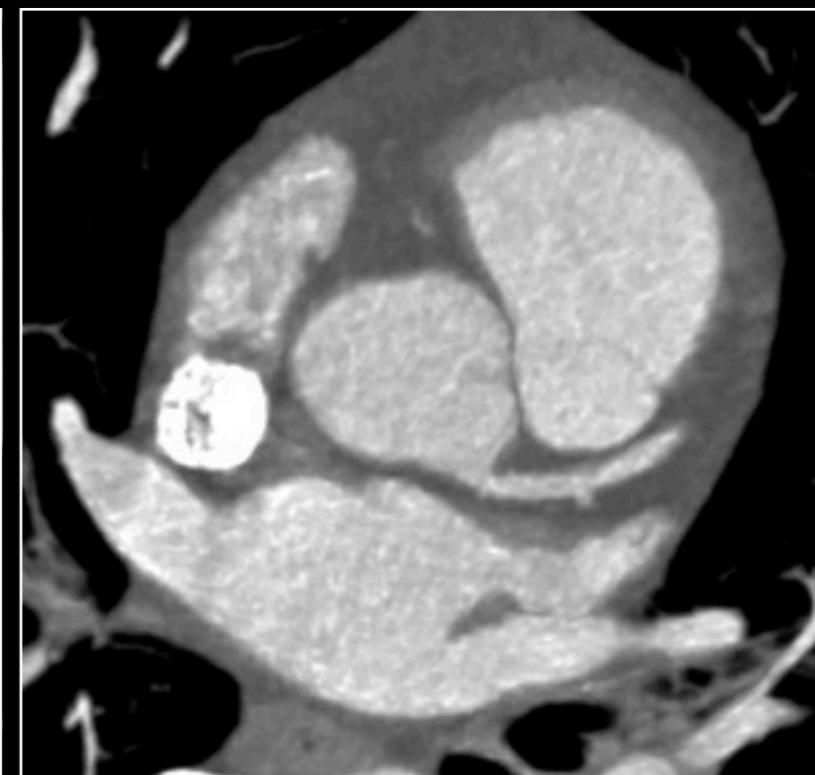
- trabécule septo-marginale = VD



# Cavités

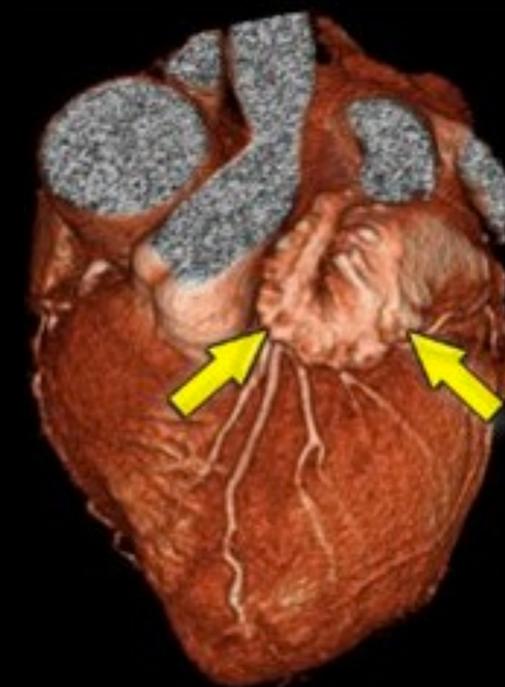
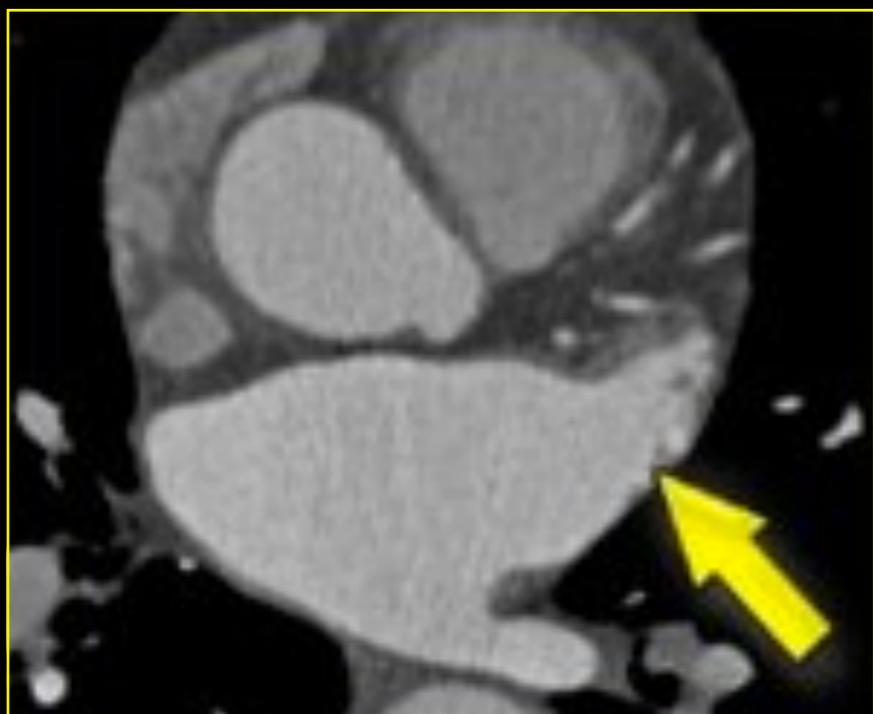
## Atrium gauche





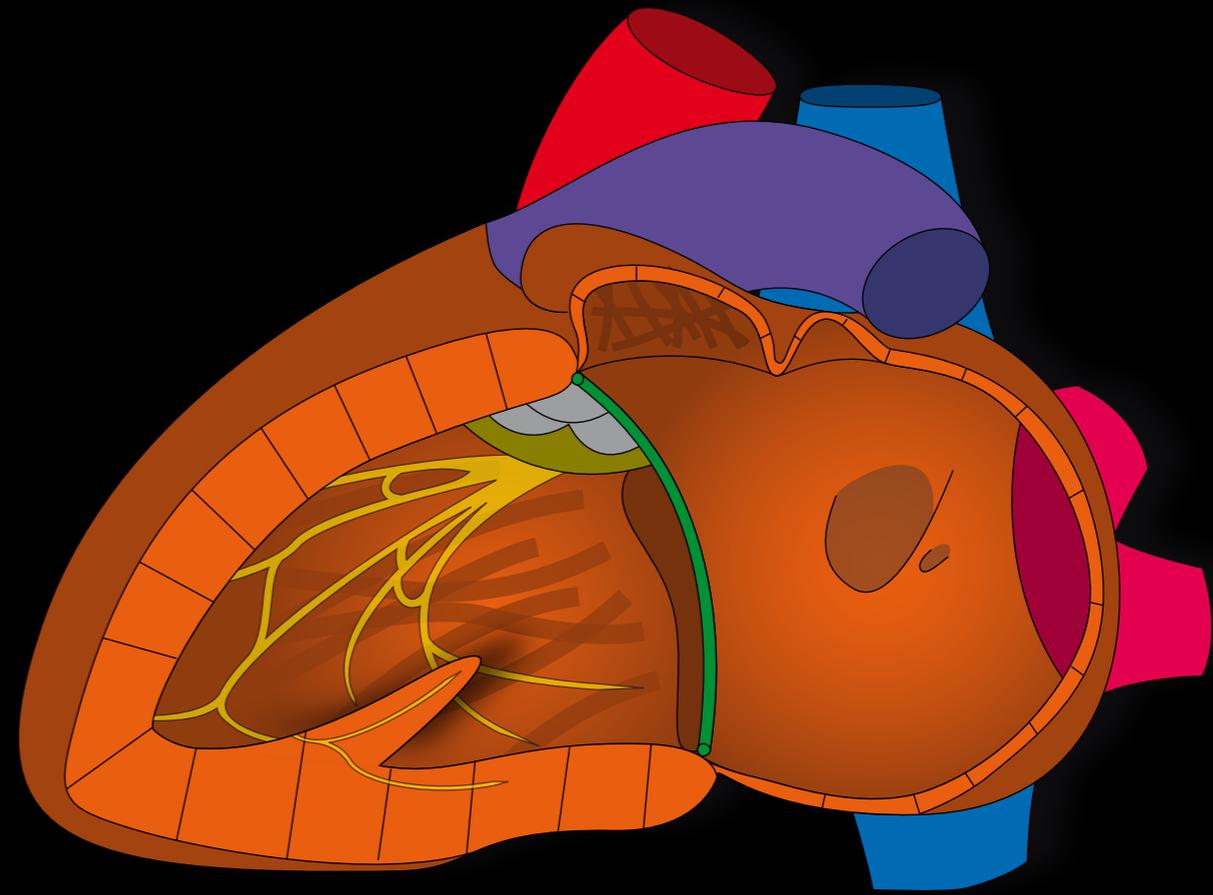
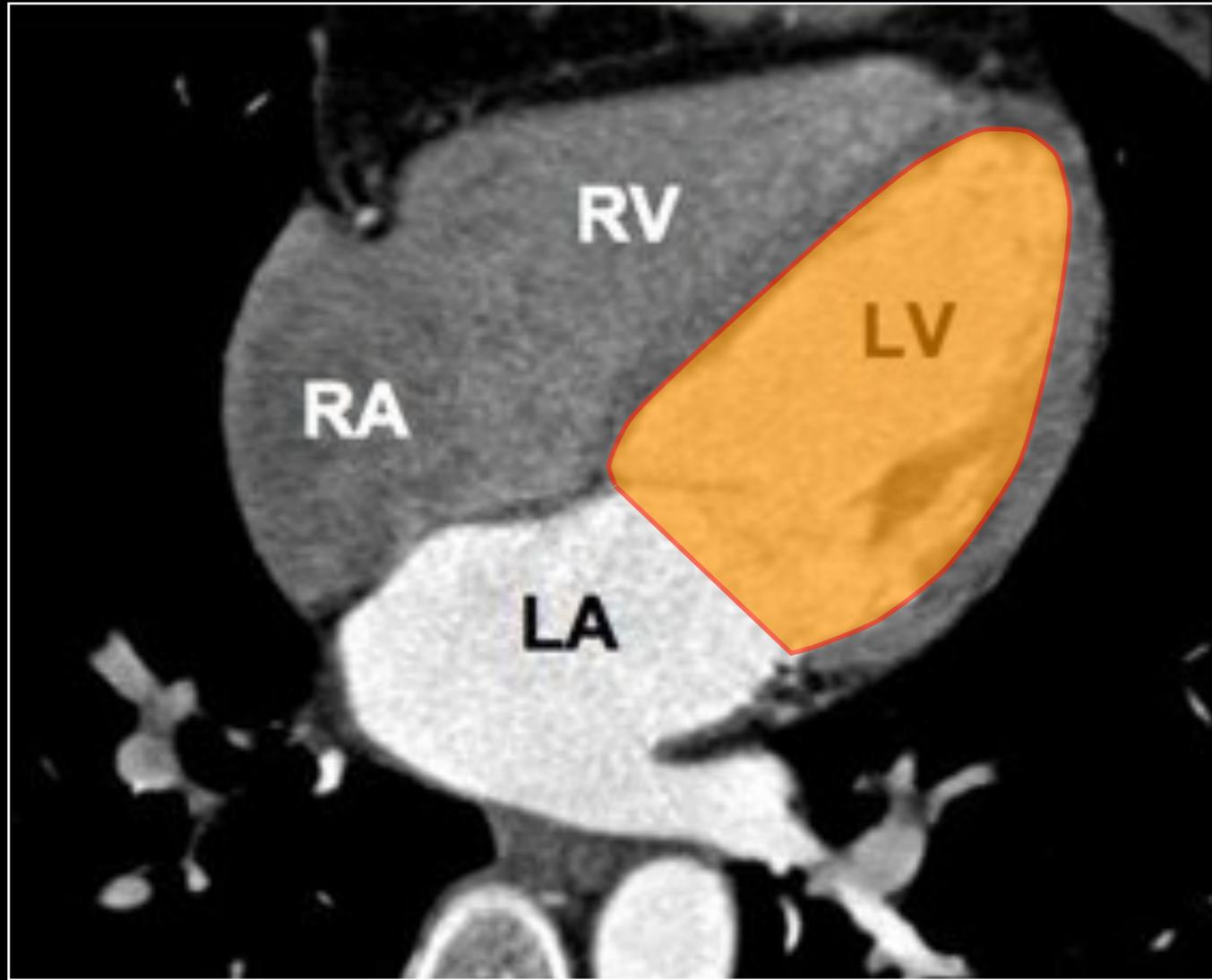
- veines pulmonaires

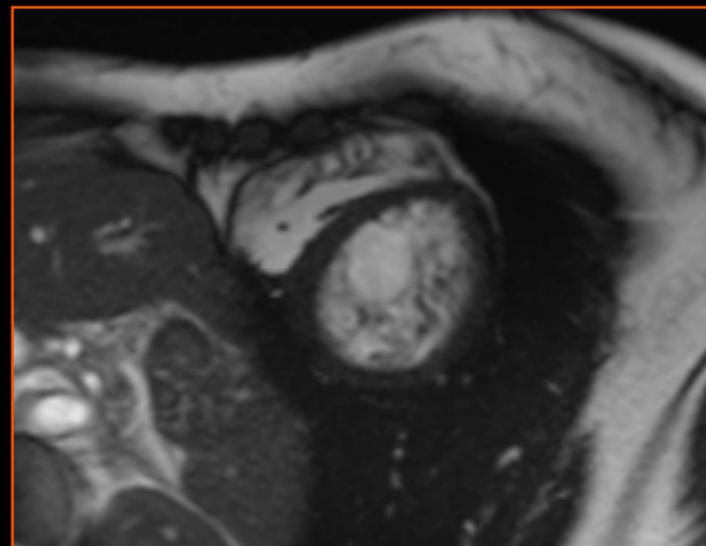
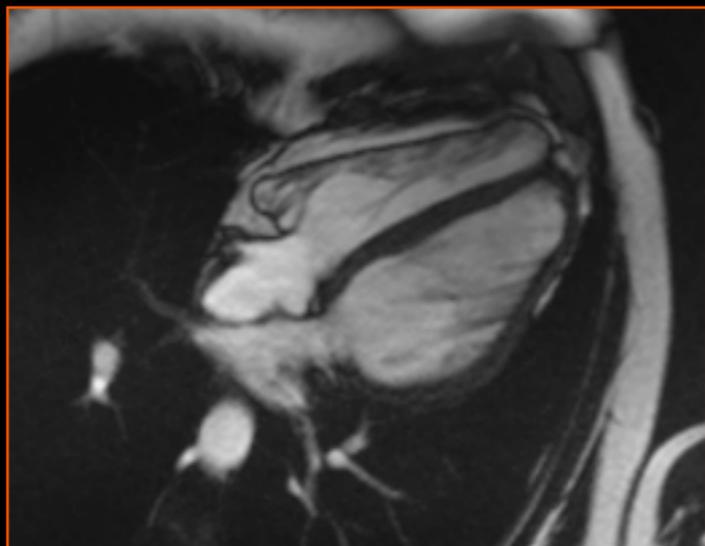
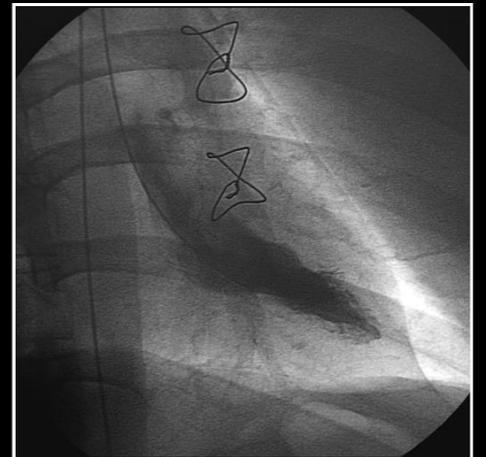
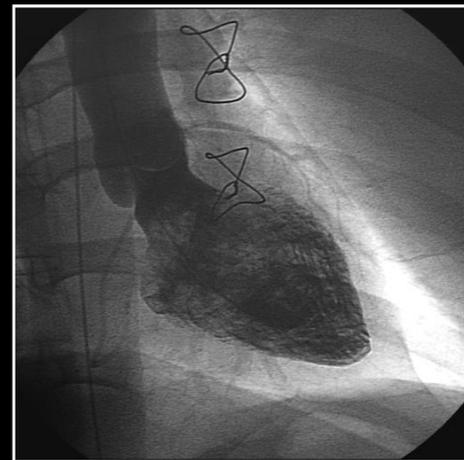
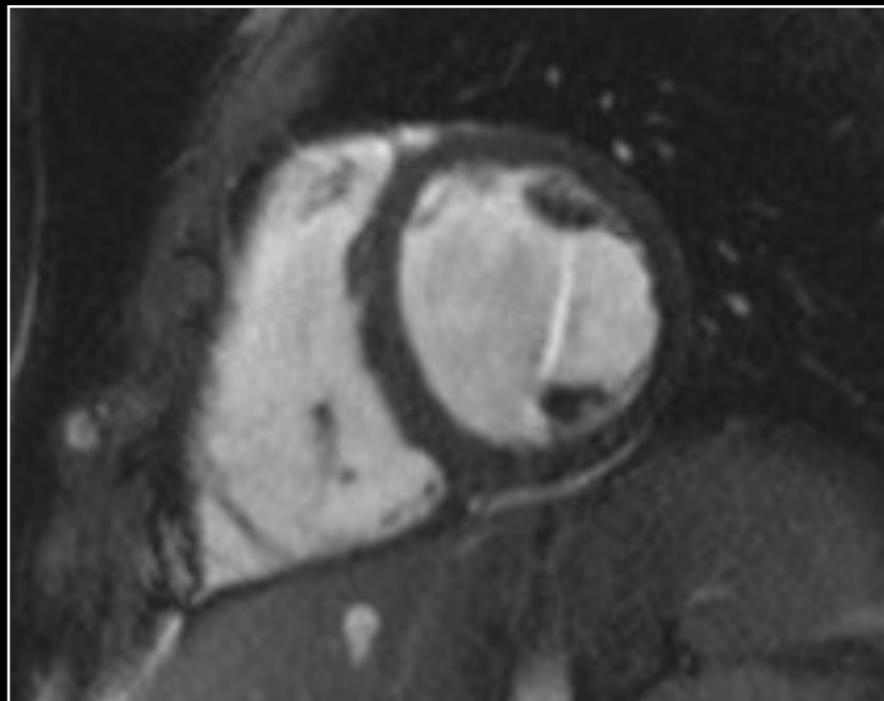
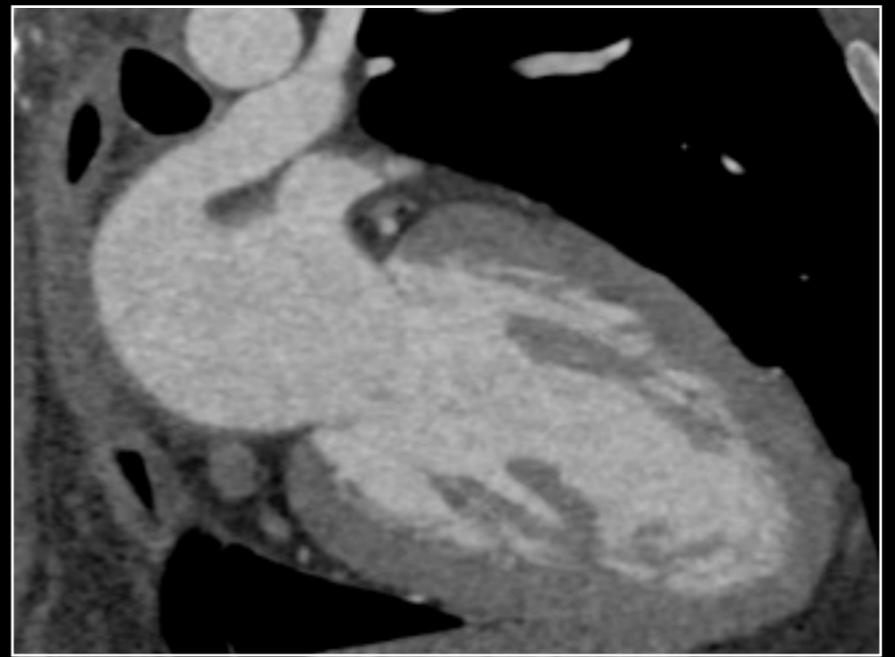
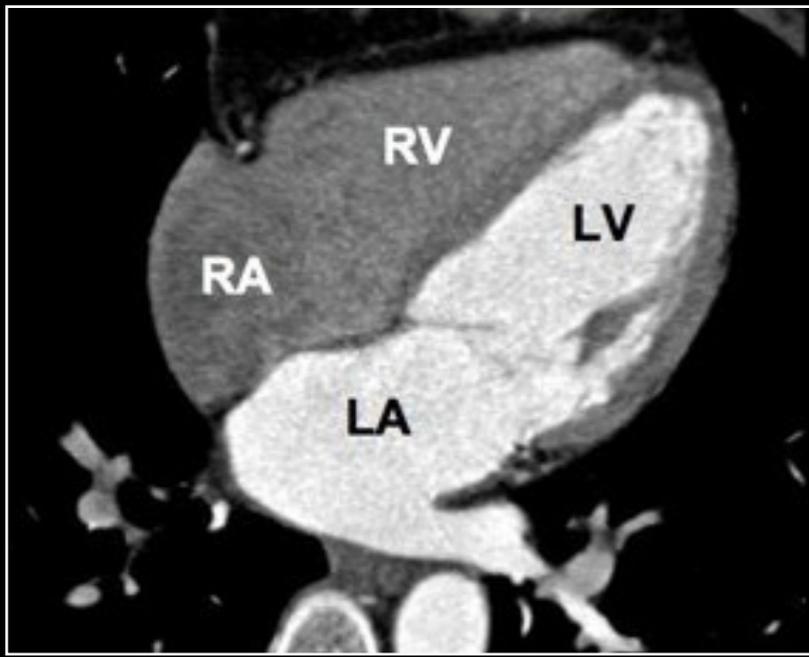
- auricule gauche



# Cavités

## Ventricule gauche





non compaction

# Fonctions Cardiaques

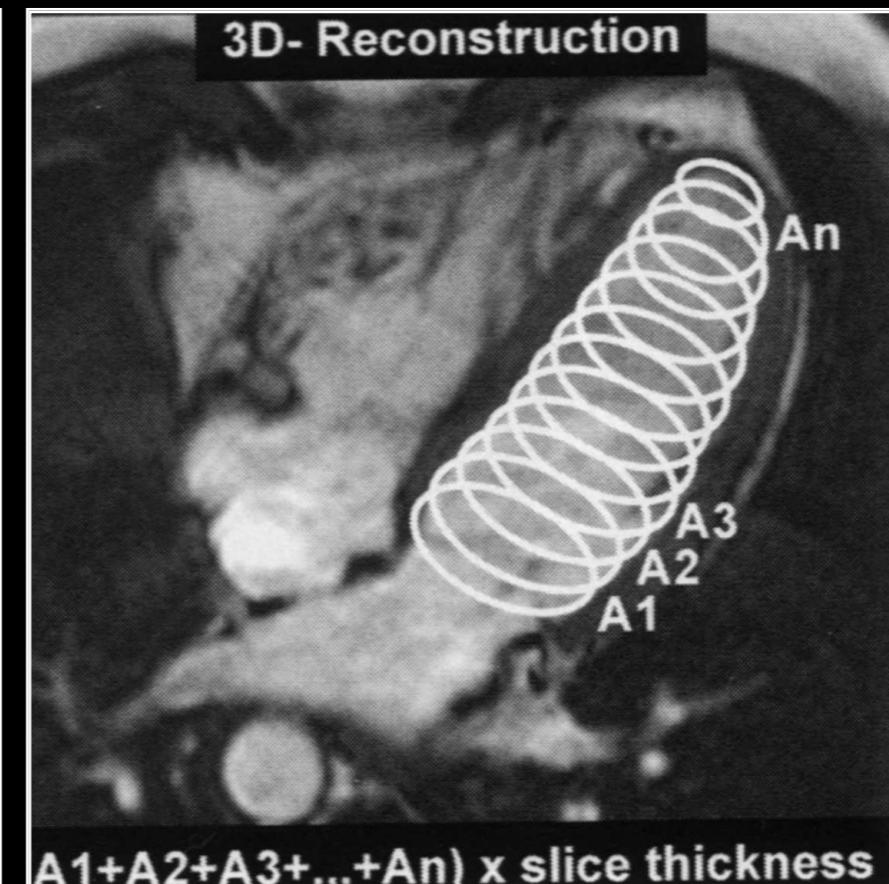
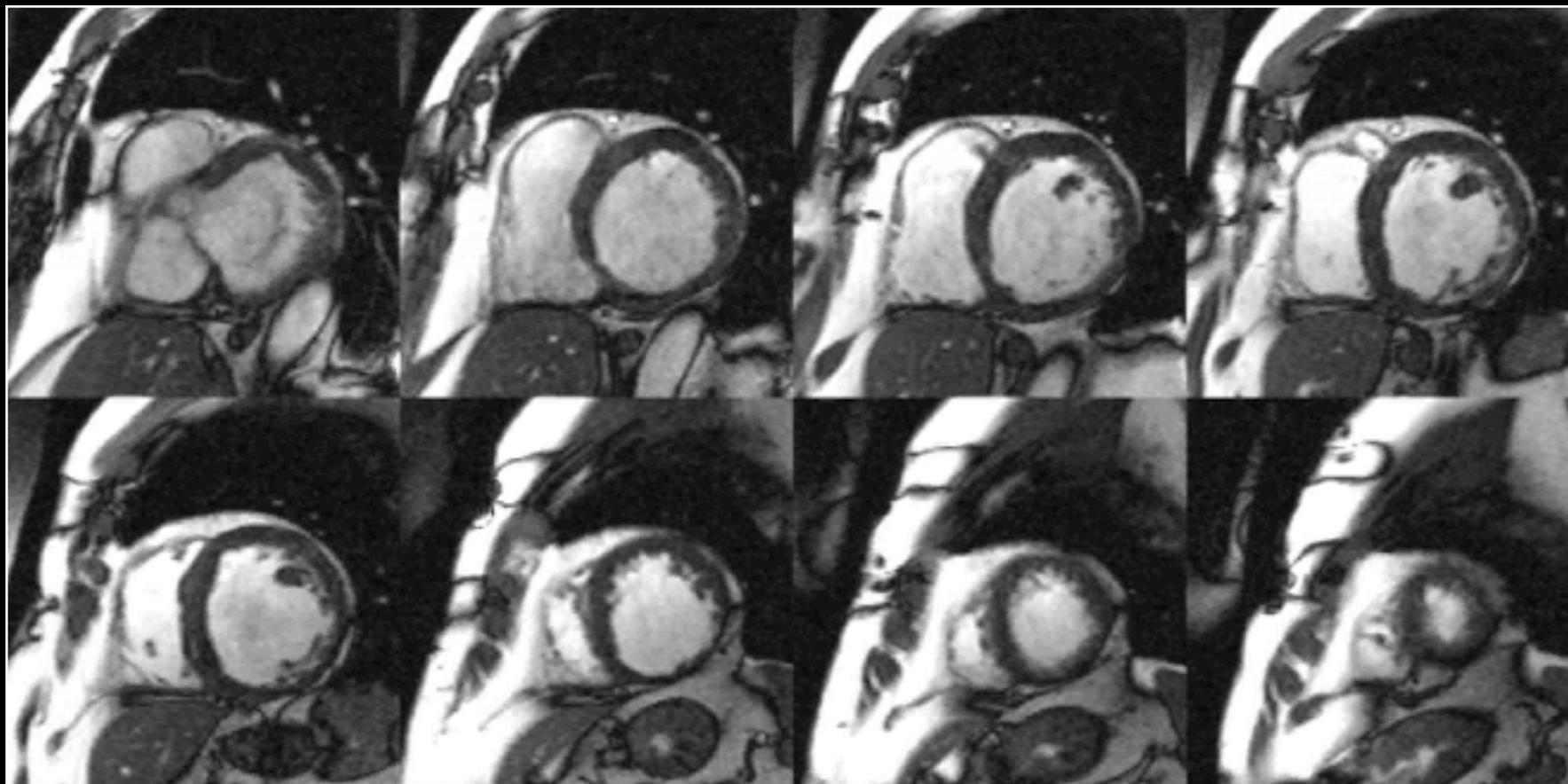
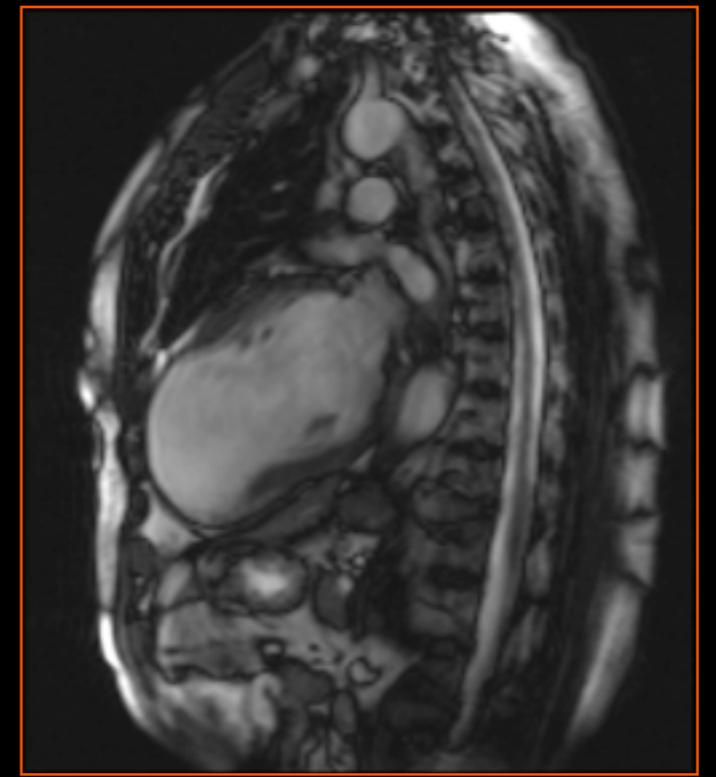
Globale ou régionale  
Ventriculaire ou atriale  
Droite ou gauche  
Systolique ou diastolique

Critères qualitatifs: Déplacement et épaisseur pariétaux

Paramètres quantitatifs:

Mesurés: volumes télé-systolique et télé-diastolique, volume musculaire ventriculaire, vitesses

Calculés: fraction d'éjection, volumes d'éjection, débit, masse ventriculaire ( $\rho=1,05\text{g/cm}^3$ ), épaisseur absolue ou relative



# Fonction systolique

MP:000000059479  
17/12/1941, F, 62Y  
#MSI00000055884  
STUDY:MSI00000055884  
P008/2004  
12:53:58  
28 IMA 1 / 25

Sonata  
MR 2002B  
HFS  
+LPH

AR  
MF 2.41  
TR 42.3  
TE 1.4  
TA 08.33  
BW 930.0  
MND/RETRO  
CT  
A1  
BO3,4;SP1,2,3  
Hf2h1\_15/55  
TT 22  
SP L55.6  
CINE TRUEFISP

SL 7.0  
FoV 324\*370  
118\*192  
Sag>Cor(41.3)>Tra(21.0)

W 482  
C 2.04

MP:000000059479  
17/12/1941, F, 62Y  
#MSI00000055884  
STUDY:MSI00000055884  
P008/2004  
12:53:58  
28 IMA 10 / 25

Sonata  
MR 2002B  
HFS  
+LPH

AR  
MF 2.41  
TR 42.3  
TE 1.4  
TA 09.04  
BW 930.0  
MND/RETRO  
CT  
A1  
BO3,4;SP1,2,3  
Hf2h1\_15/55  
TT 421  
SP L55.6  
CINE TRUEFISP

SL 7.0  
FoV 324\*370  
118\*192  
Sag>Cor(41.3)>Tra(21.0)

W 475  
C 1.95

	9	ES	11	12	13	14	15	16
1	TT 377 SP L55.6 CINE TRUEFISP	TT 421 SP L55.6 CINE TRUEFISP	TT 466 SP L55.6 CINE TRUEFISP	TT 510 SP L55.6 CINE TRUEFISP	TT 555 SP L55.6 CINE TRUEFISP	TT 599 SP L55.6 CINE TRUEFISP	TT 643 SP L55.6 CINE TRUEFISP	TT 688 SP L55.6 CINE TRUEFISP
2	TT 390 SP L62.6 CINE TRUEFISP	TT 435 SP L62.6 CINE TRUEFISP	TT 481 SP L62.6 CINE TRUEFISP	TT 527 SP L62.6 CINE TRUEFISP	TT 573 SP L62.6 CINE TRUEFISP	TT 619 SP L62.6 CINE TRUEFISP	TT 665 SP L62.6 CINE TRUEFISP	TT 710 SP L62.6 CINE TRUEFISP
3	TT 396 SP L76.6 CINE TRUEFISP	TT 442 SP L76.6 CINE TRUEFISP	TT 488 SP L76.6 CINE TRUEFISP	TT 535 SP L76.6 CINE TRUEFISP	TT 582 SP L76.6 CINE TRUEFISP	TT 628 SP L76.6 CINE TRUEFISP	TT 675 SP L76.6 CINE TRUEFISP	TT 721 SP L76.6 CINE TRUEFISP
4	TT 396 SP L83.6 CINE TRUEFISP	TT 442 SP L83.6 CINE TRUEFISP	TT 488 SP L83.6 CINE TRUEFISP	TT 535 SP L83.6 CINE TRUEFISP	TT 582 SP L83.6 CINE TRUEFISP	TT 628 SP L83.6 CINE TRUEFISP	TT 675 SP L83.6 CINE TRUEFISP	TT 722 SP L83.6 CINE TRUEFISP

**Dessin**

**Edition**

**Région activée**

**Edition**

**Propagation**

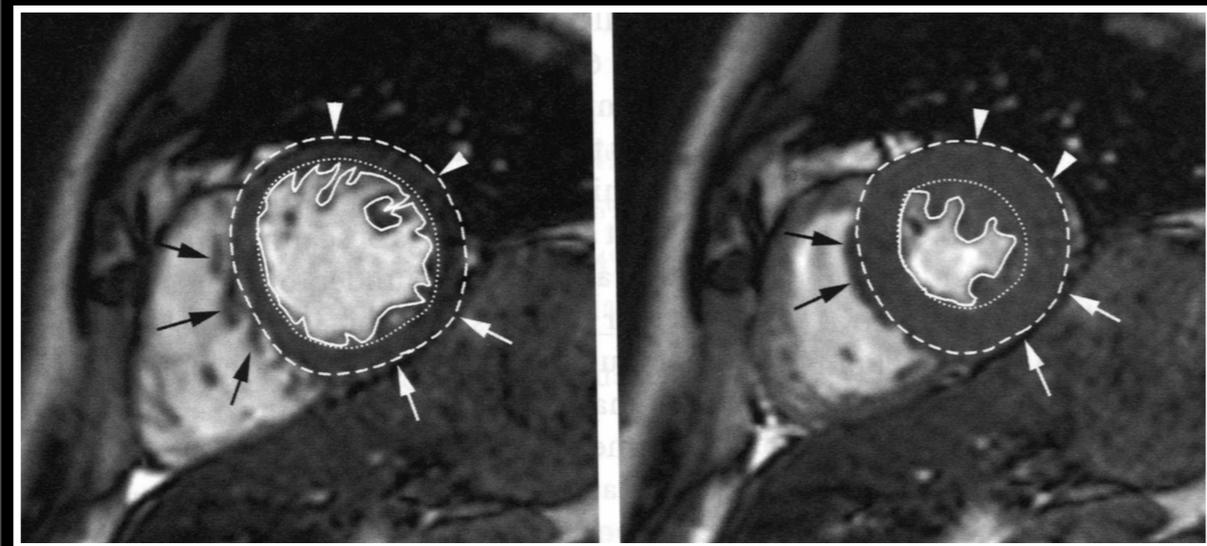
**Région activée**

**Visual.**

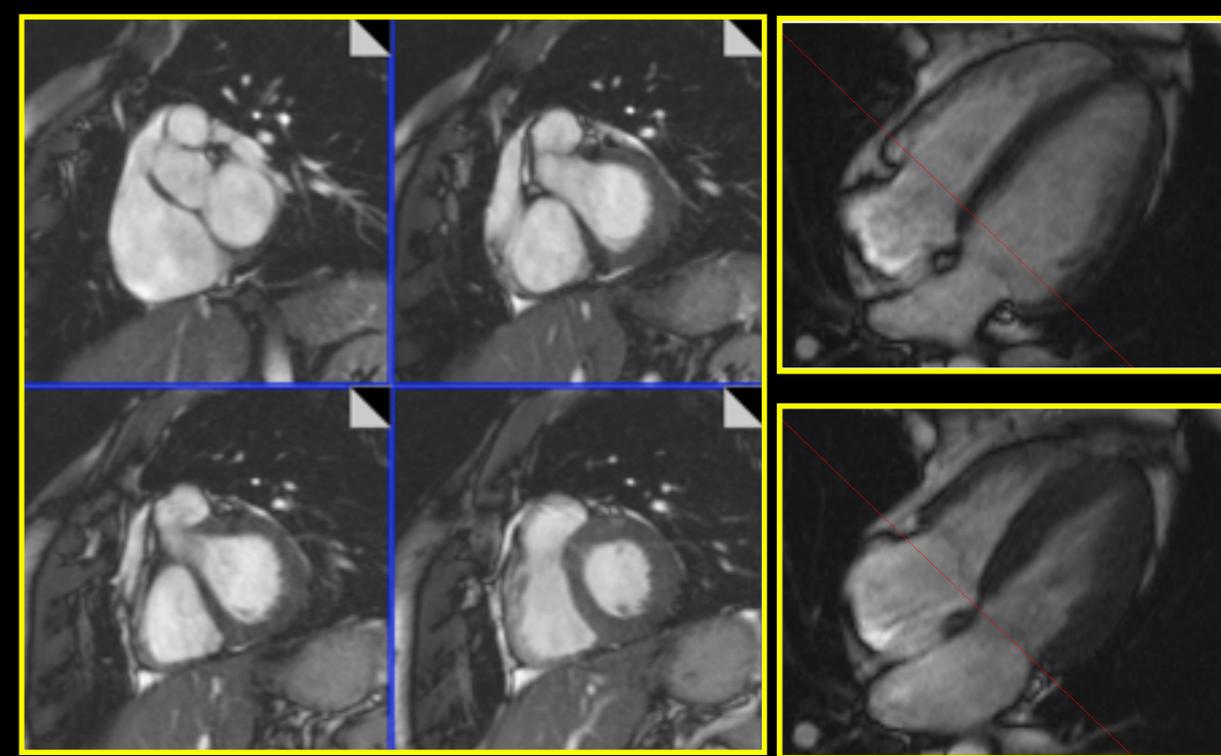
Lent ———— Rap.

**Découpe**

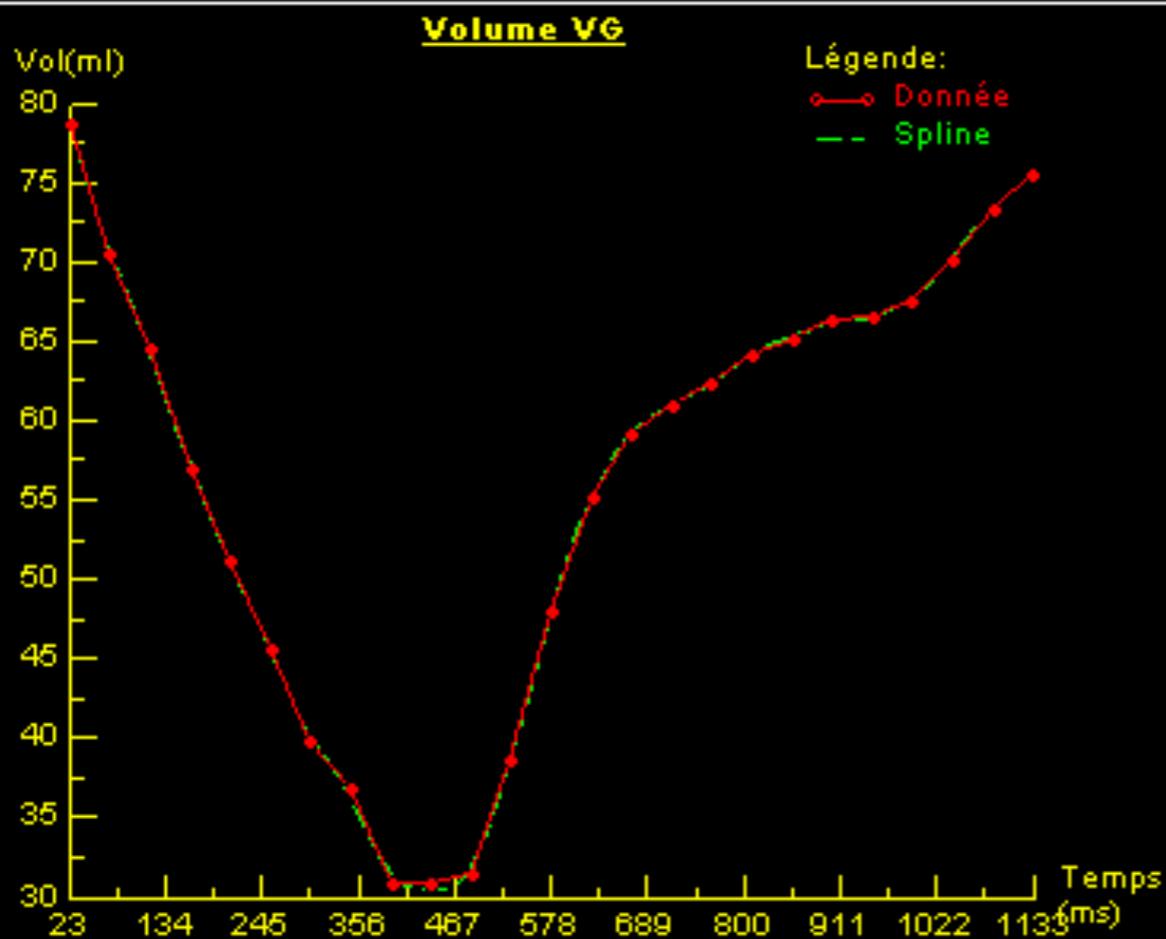
volumes cavitaires, épaissement pariétal  
masse musculaire



déplacement du plan atrio-ventriculaire



ID patient : MPI000000008479 l'examen : 30/09/2004  
 Taille patient : 170.00 cm Poids patient : 78.00 kg. Fréq. card. : 60 Batt./min



Vérifiez FD&FS. L'ordinateur a jugé les réglages FD&FS insuffisamment précis.  
 Vérifiez les contours. Ils semblent ne pas correspondre à l'anatomie.

ID patient : MPI000000008479 l'examen : 30/09/2004  
 Taille patient : 170.00 cm Poids patient : 78.00 kg. Fréq. card. : 60 Batt./min

### Ventricule gauche - absolu

Fonction cardiaque			Plage normale (F) (IRM)	Unités
Fraction d'éjection	EF	60.9	56.00 ... 78.00	%
Volume fin de diastole	FDV	78.8	52.00 ... 141.00	ml
Volume fin de systole	FSV	30.8	13.00 ... 51.00	ml
Volume battement	SV	48.0	33.00 ... 97.00	ml
Débit cardiaque	CO	2.88	2.65 ... 5.98	l/min
Masse myocardique (à FD)		58.4	75.00 ... 175.00	g
Masse myocardique (moyenne)		65.4 ± 4.7	75.00 ... 175.00	g

### Données remplissage et éjection

Taux d'éjection max.		184.4	n.a.	ml/sec
Temps d'éjection max.		23.1	n.a.	msec
Taux de remplissage max.		205.5	n.a.	ml/sec
Temps remplissage max. de FS		107.8	n.a.	msec

Vérifiez FD&FS. L'ordinateur a jugé les réglages FD&FS insuffisamment précis.  
 Vérifiez les contours. Ils semblent ne pas correspondre à l'anatomie.

ID patient : MPI000000008479 l'examen : 30/09/2004  
 Taille patient : 170.00 cm Poids patient : 78.00 kg. Fréq. card. : 60 Batt./min

### Ventricule gauche - normalisé

Fonction cardiaque			Plage normale (F) (IRM)	Unités
Volume fin de diastole	FDV	41.6	41.00 ... 81.00	ml/m <sup>2</sup>
Volume fin de systole	FSV	16.3	11.90 ... 20.74	ml/m <sup>2</sup>
Volume battement	SV	25.3	26.00 ... 56.00	ml/m <sup>2</sup>
Indice cardiaque	CI	1.52	1.75 ... 3.80	l/min/m <sup>2</sup>
Masse myocardique (à FD)		30.8	63.00 ... 95.00	g/m <sup>2</sup>
Masse myocardique (moyenne)		34.5 ± 2.5	63.00 ... 95.00	g/m <sup>2</sup>

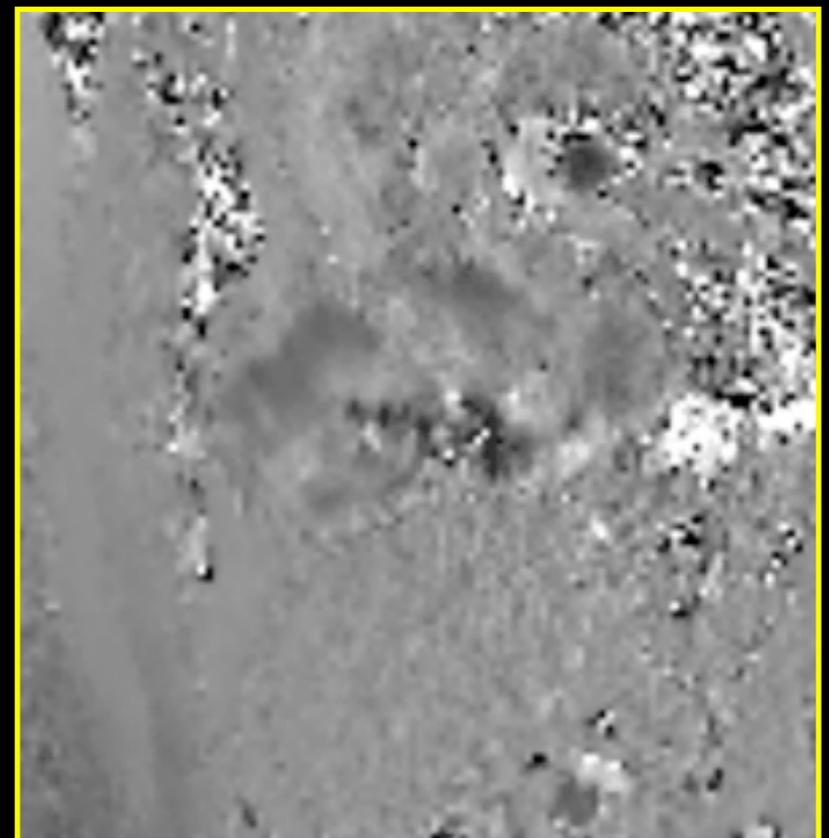
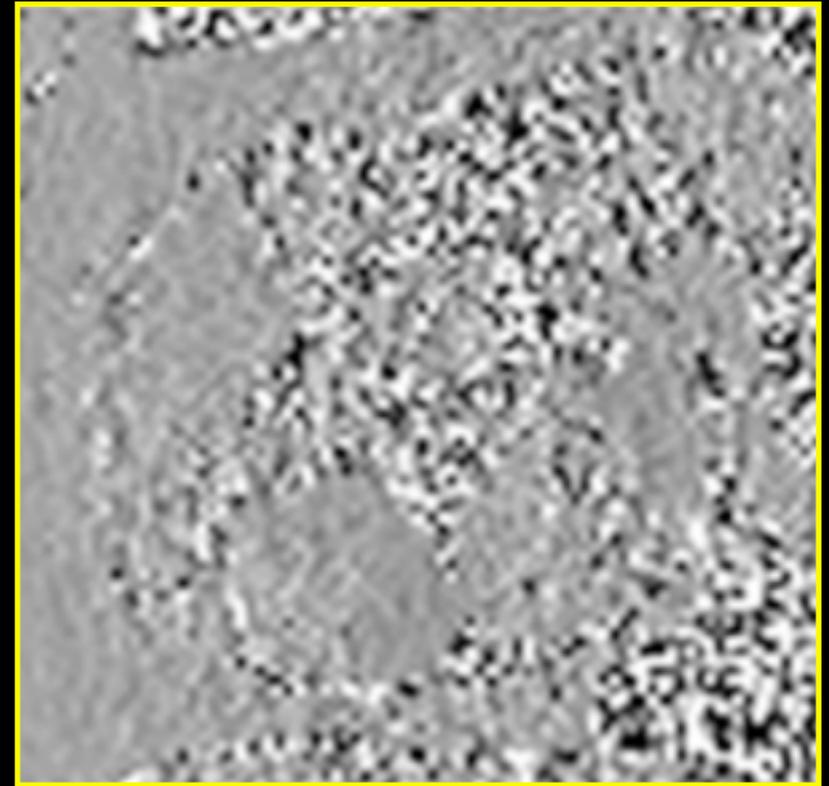
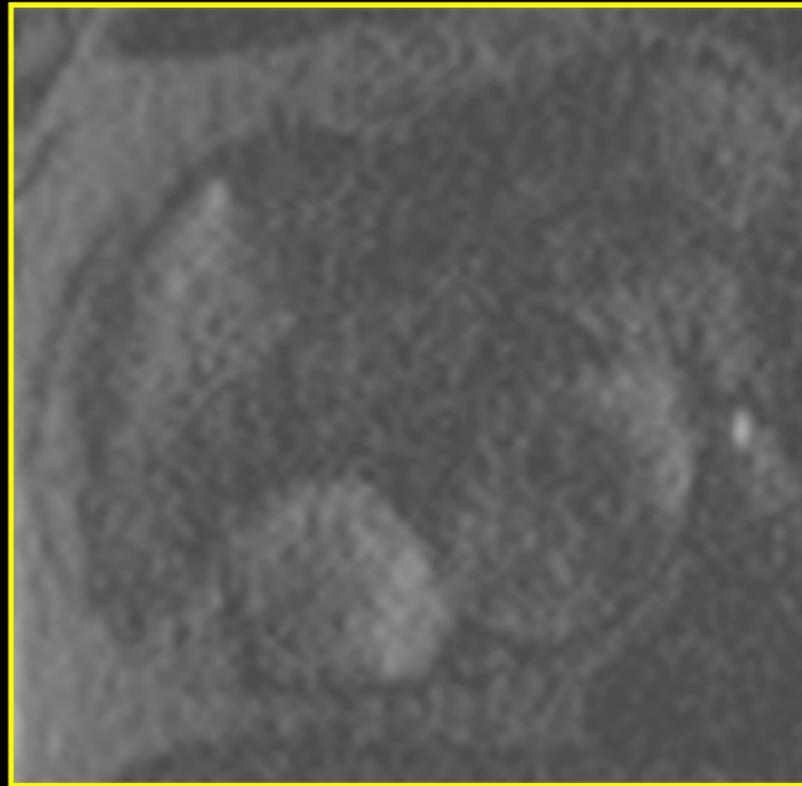
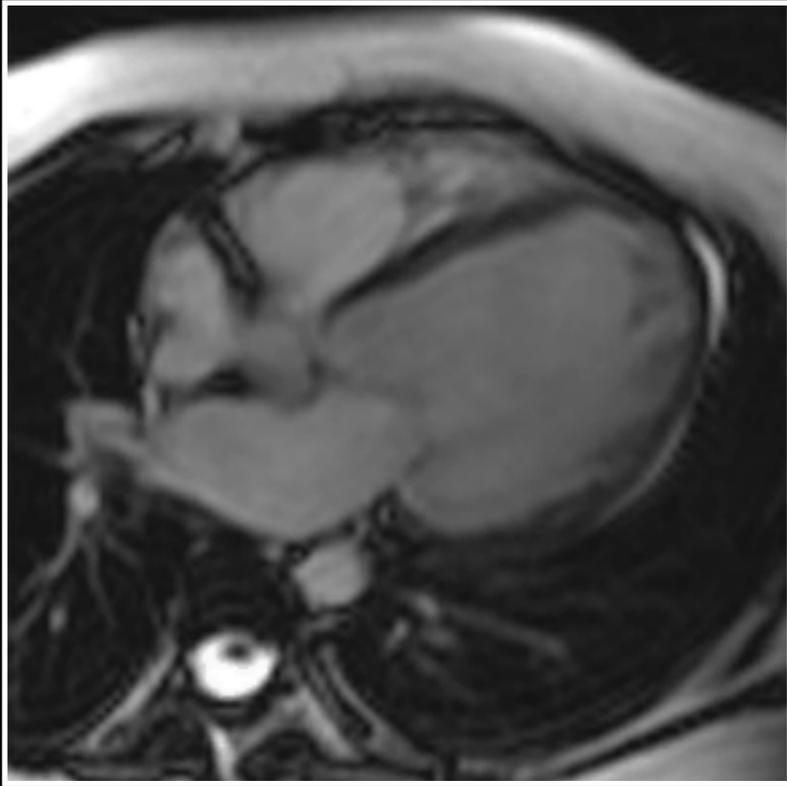
### Données remplissage et éjection

Taux d'éjection max.		2.3	n.a.	EDV/sec
Taux de remplissage max.		2.6	n.a.	EDV/sec

		Hommes	Femmes
<b>VG</b>	VTD (ml/m <sup>2</sup> )	69 ± 11	61 ± 10
	VTS (ml/m <sup>2</sup> )	23 ± 5	21 ± 5
	FE (%)	65 ± 10	65 ± 10
	Masse (g/m <sup>2</sup> )	91 ± 11	79 ± 8
<b>VD</b>	VTD (ml/m <sup>2</sup> )	80 ± 13	67 ± 10
	VTS (ml/m <sup>2</sup> )	32 ± 8	26 ± 6
	FE (%)	60 ± 7	63 ± 8

mesure des volumes: volume d'éjection d'une cavité  
antérograde et rétrograde

mesure du volume d'éjection antérograde ou rétrograde par vélocimétrie (contraste de phase)



# Fonction diastolique ventriculaire

Masse ventriculaire télé-diastolique: compliance ventriculaire

Variations de volume de la cavité dans le temps et leur vitesse : taux de remplissage maximum (augmentation maximale de volume entre deux phases), délai du pic par rapport à la télé-systole

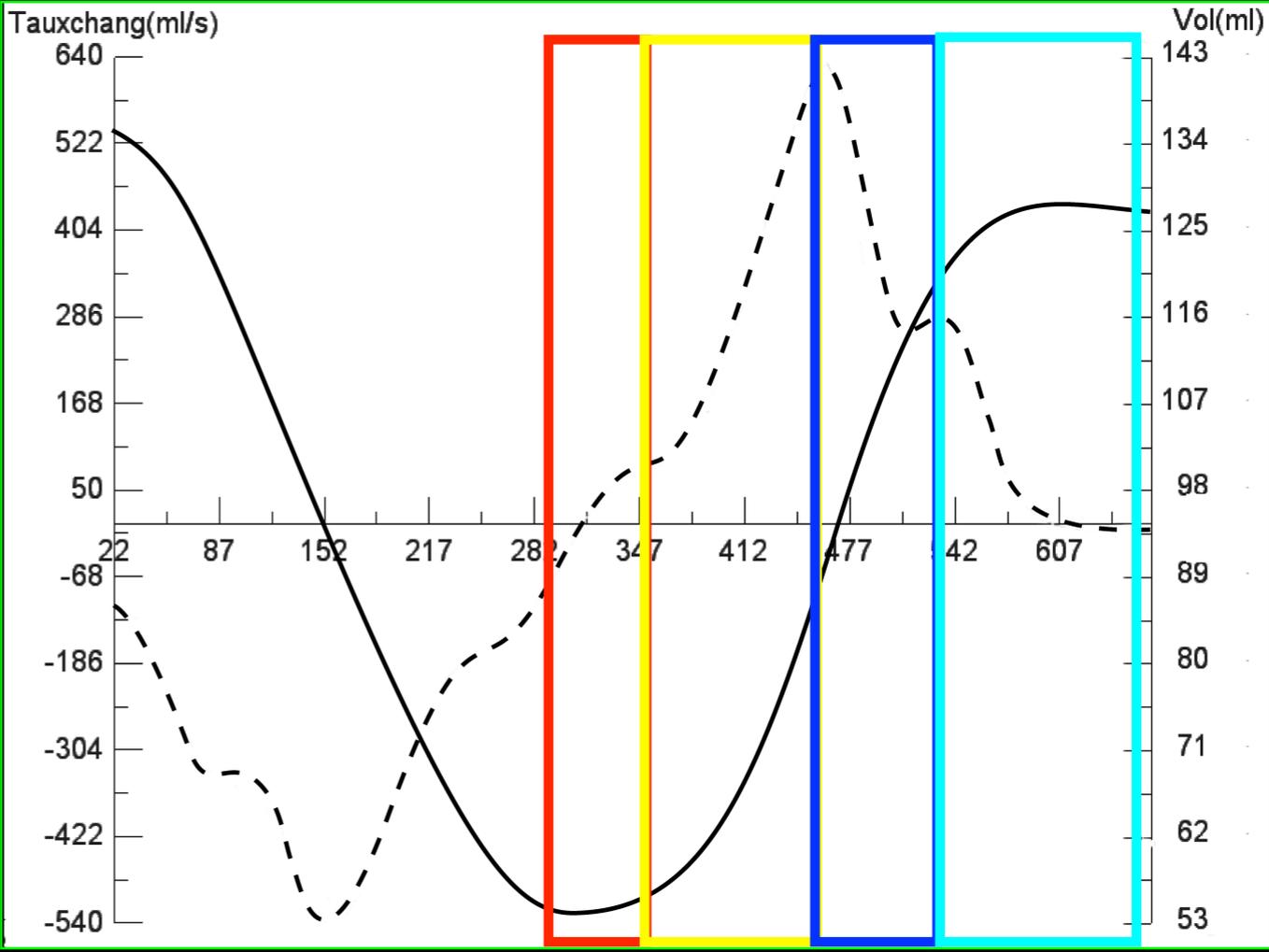
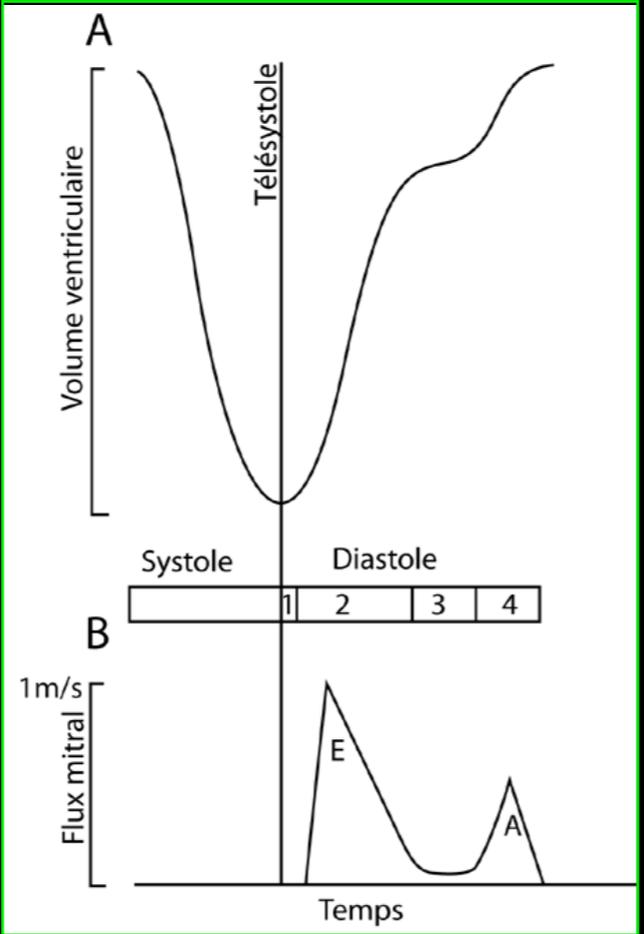
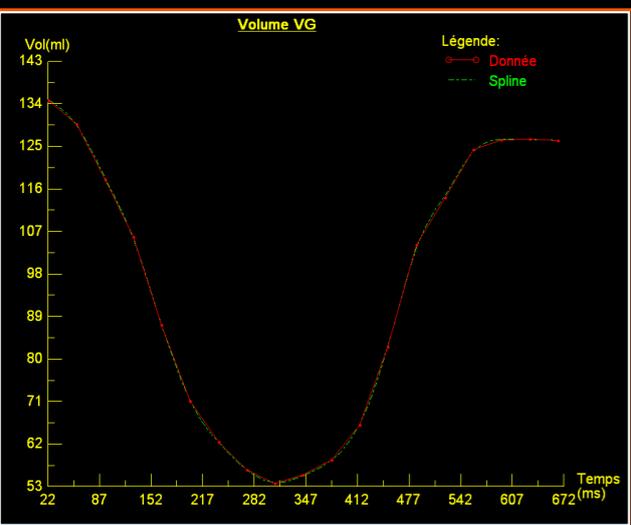
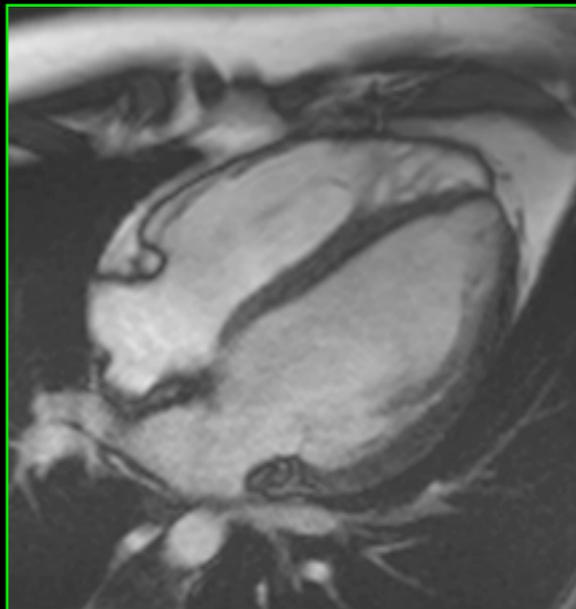
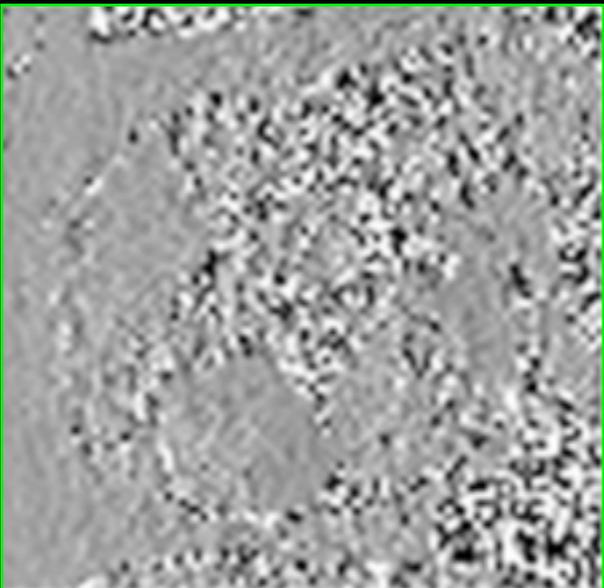
Quantification des volumes atriaux

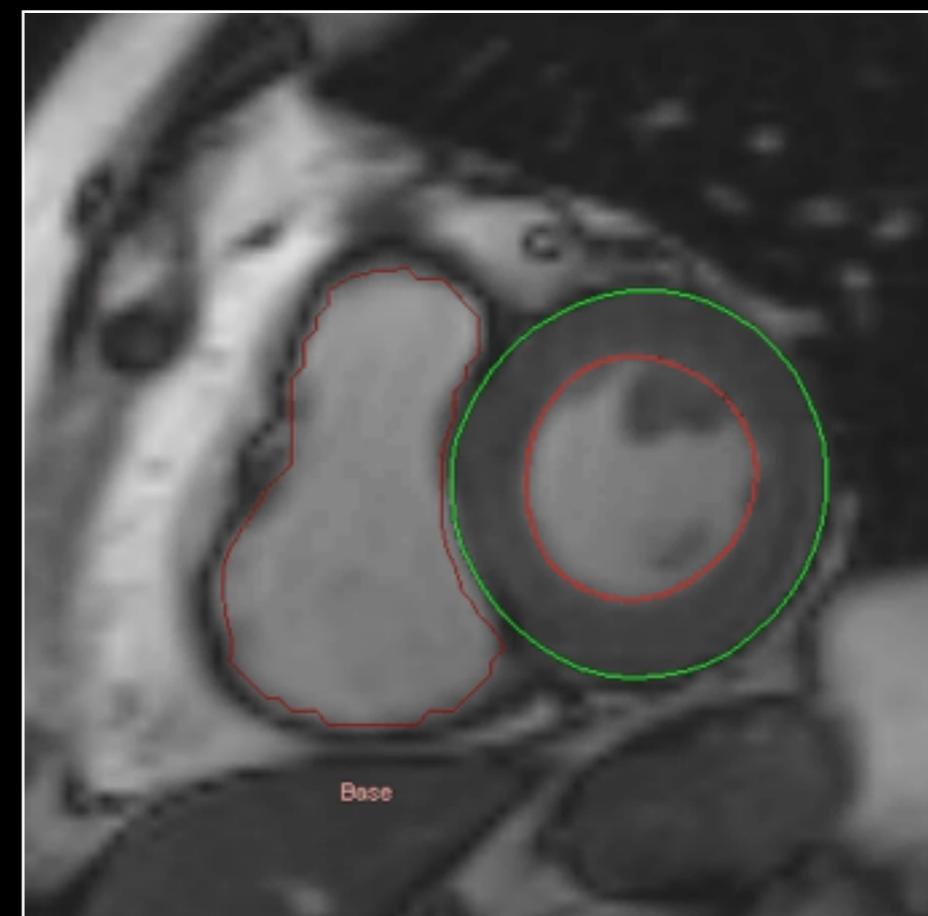
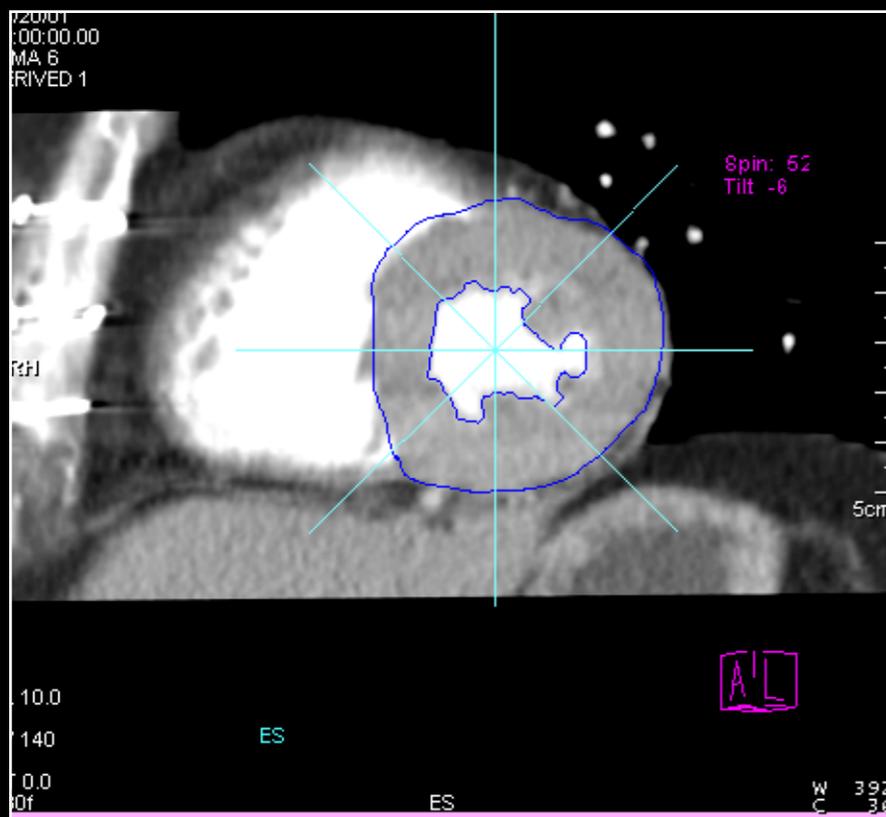
Flux veineux atrial

Flux atrio-ventriculaire (E/A > 1,5)

- Relaxation isovolumique (valves fermées) (60 à 80 ms)
- Remplissage rapide
- Remplissage lent
- Systole atriale

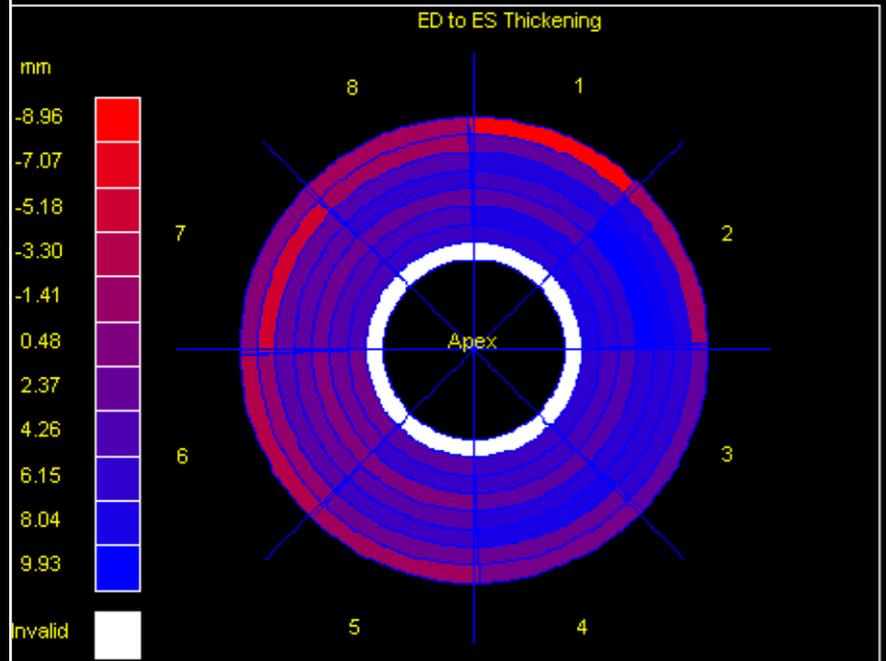
E/A < 1: anomalie de la relaxation  
E/A > 2: altération de la compliance





Thickening Bulls Eye Graph

Patient Name: [redacted]  
 Patient ID: 34161 Examination Date: 20010320  
 Patient Height: 71.00 in. Patient Weight: 158.00 lbs. R to R Interval: 840 ms.



ED -> ES Thickening Results Table

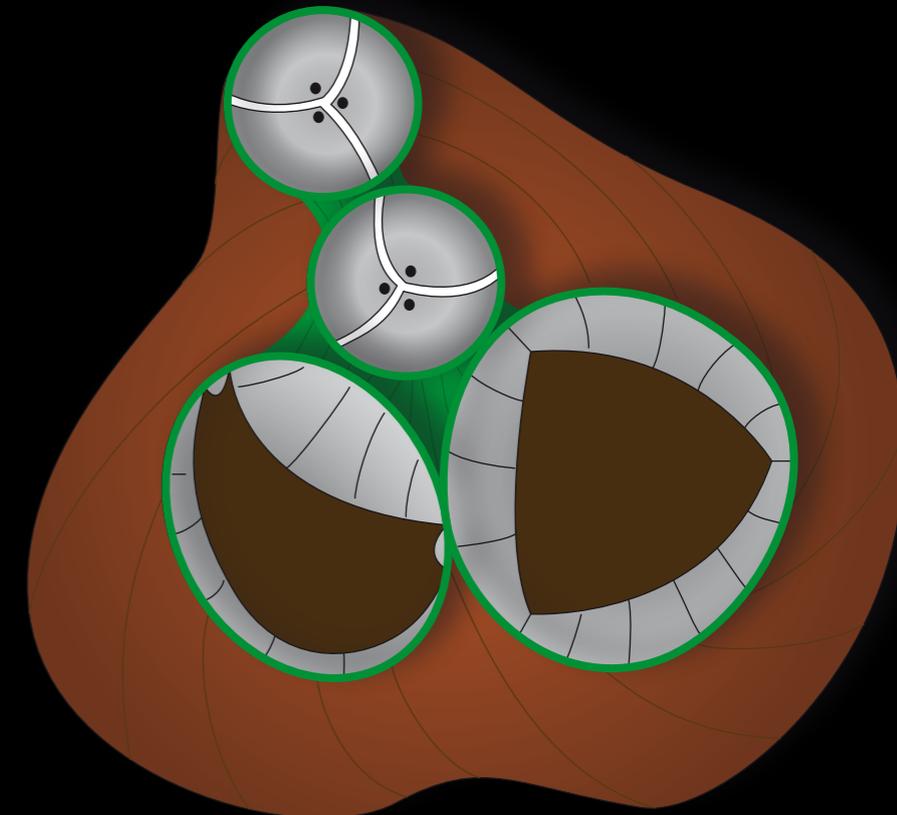
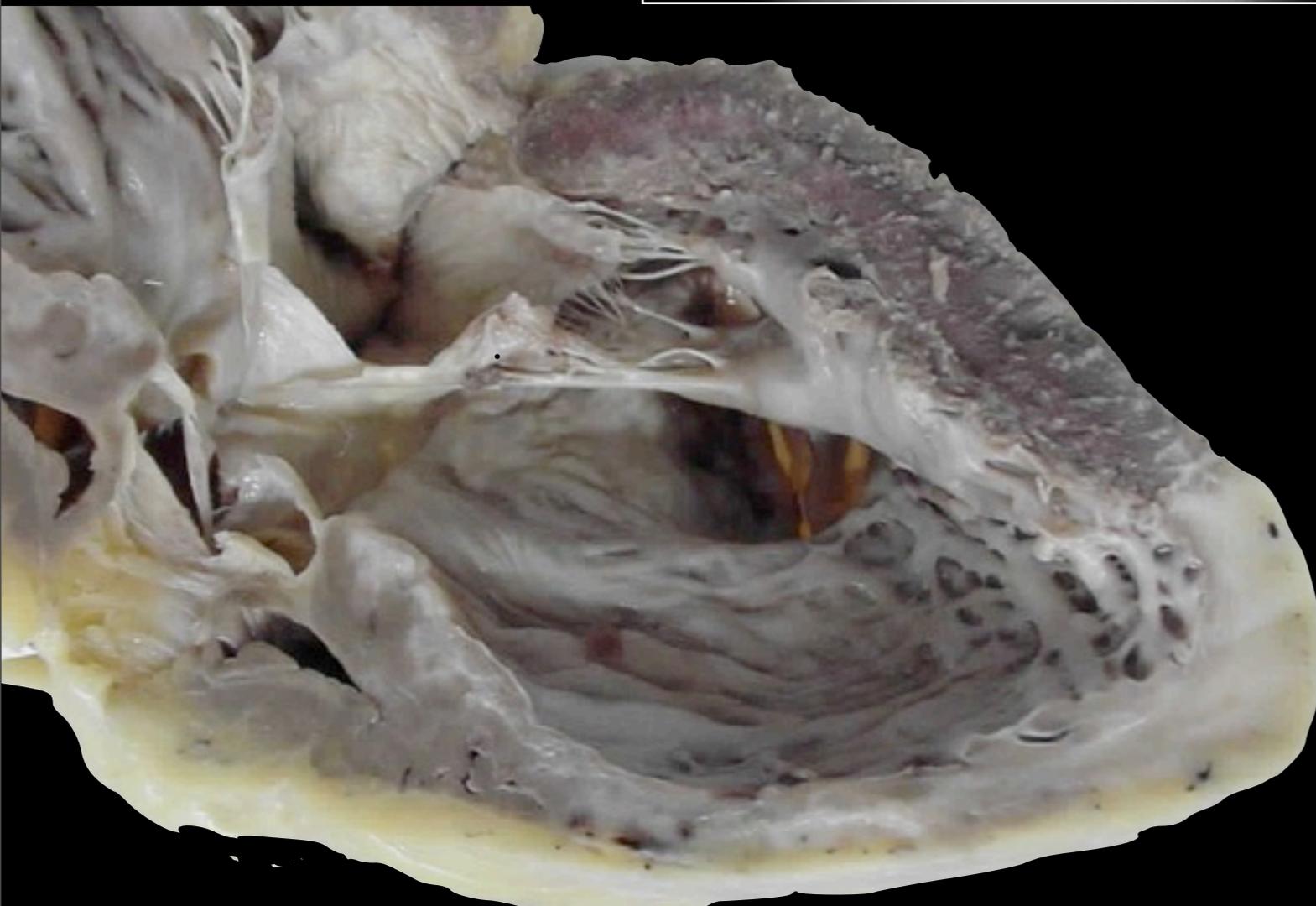
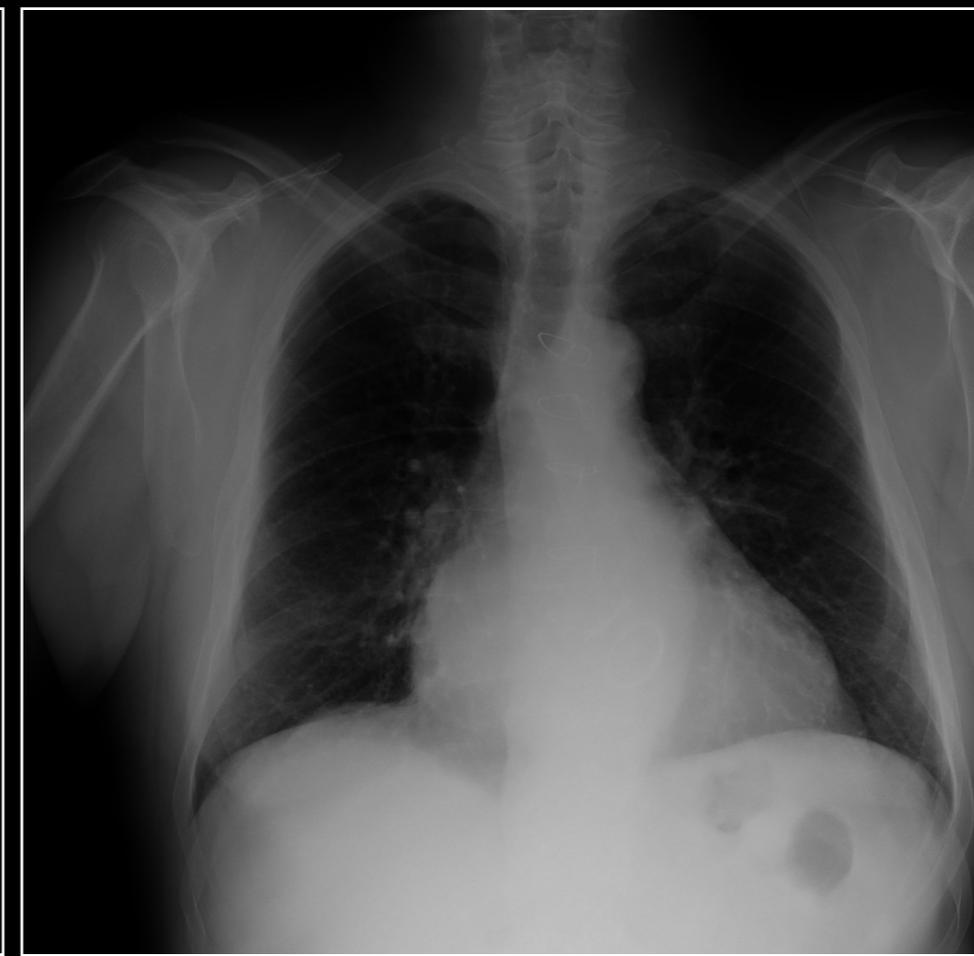
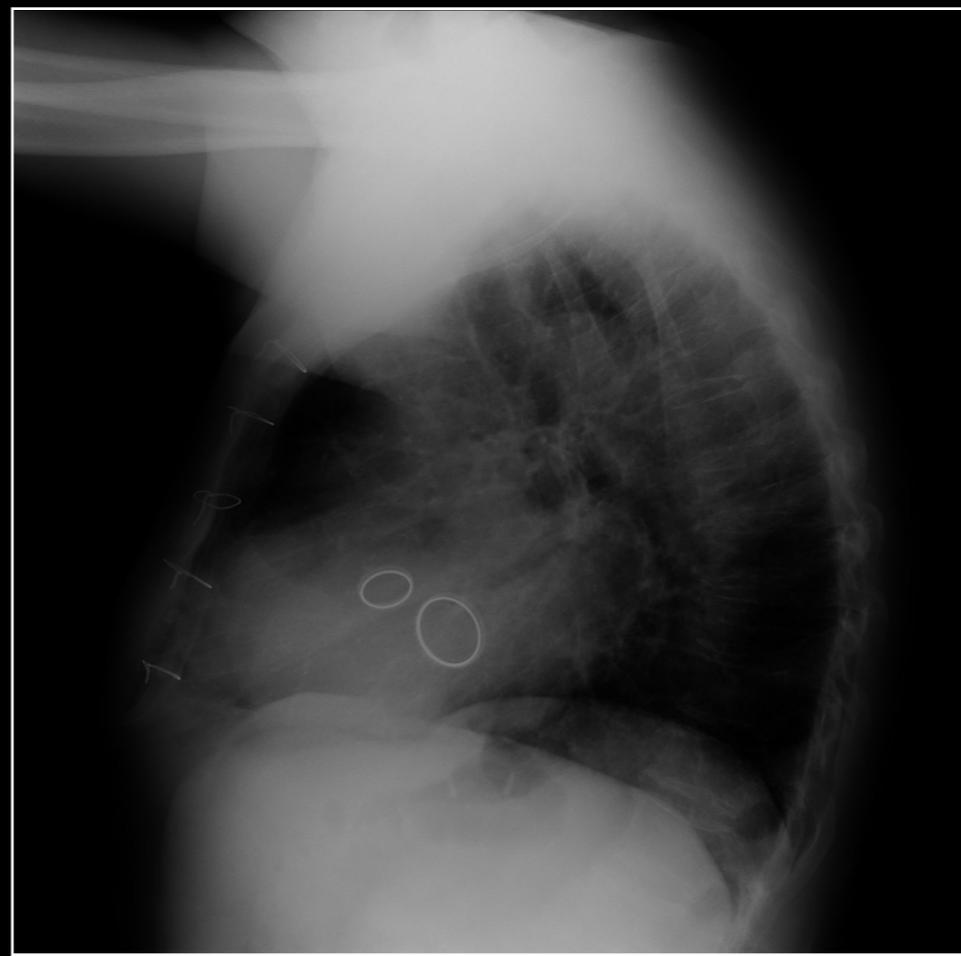
Patient Name: [redacted]  
 Patient ID: 34161 Examination Date: 20010320  
 Patient Height: 71.00 in. Patient Weight: 158.00 lbs. R to R Interval: 840 ms.

ED to ES thickening for: Slice 1			
From Slice Position 42 to 32 mm			
Sector	ES Thickness (mm)	Thickening (mm)	% Thickening (%)
1	4.39	-8.96	-67.11
2	9.24	-2.03	-17.99
3	12.64	2.83	28.84
4	8.05	1.18	17.10
5	6.00	-1.97	-24.73
6	5.06	-3.37	-39.96
7	5.29	0.08	1.63
8	4.98	-2.13	-29.96

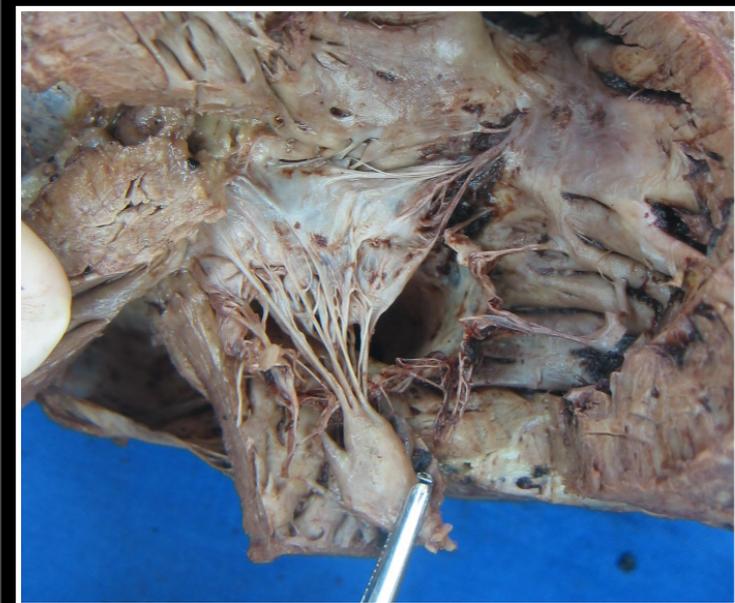
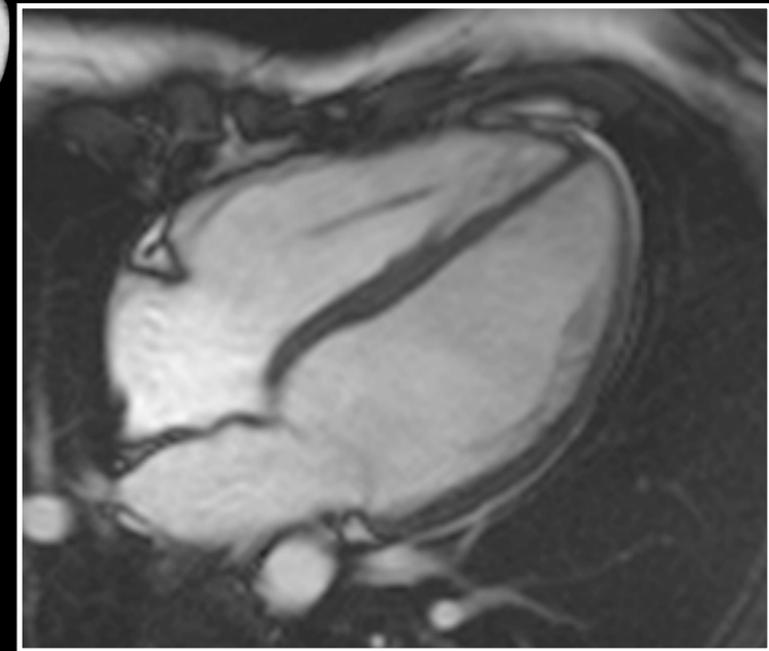
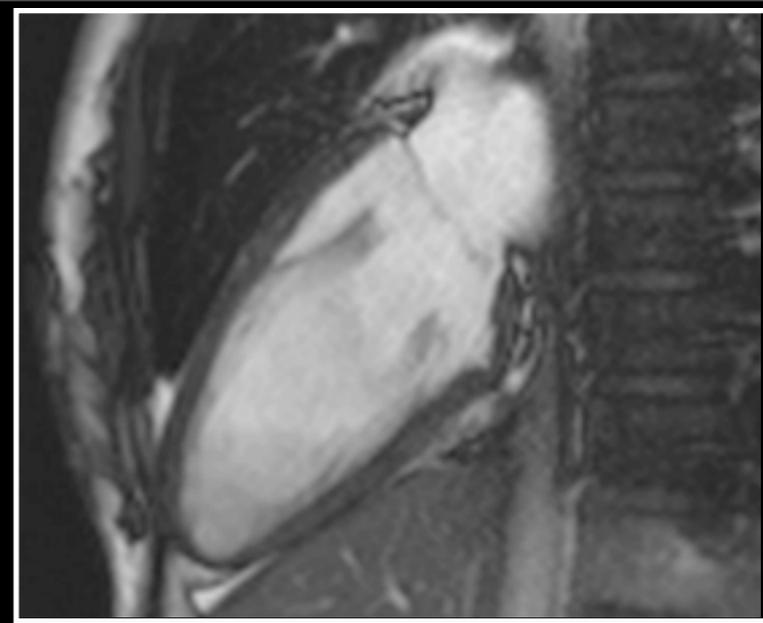
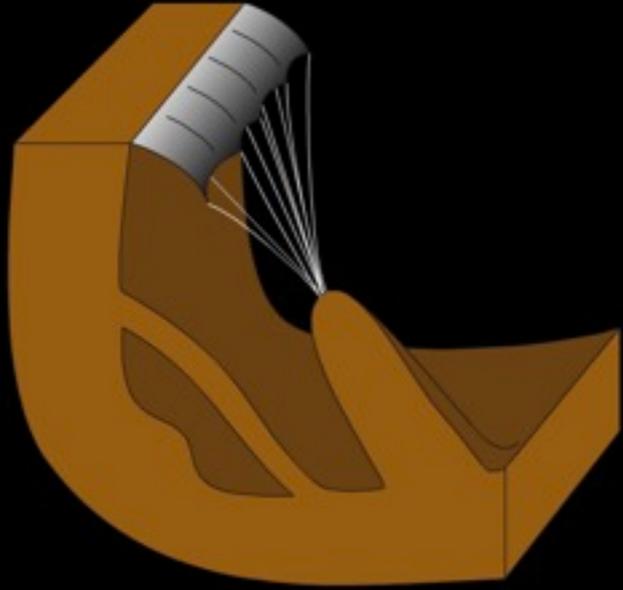
épaisseur  
 épaissement

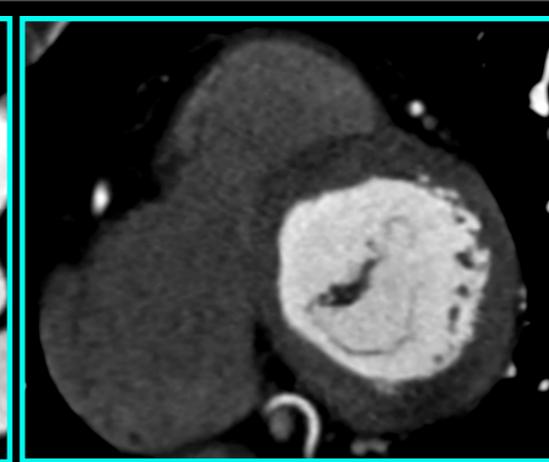
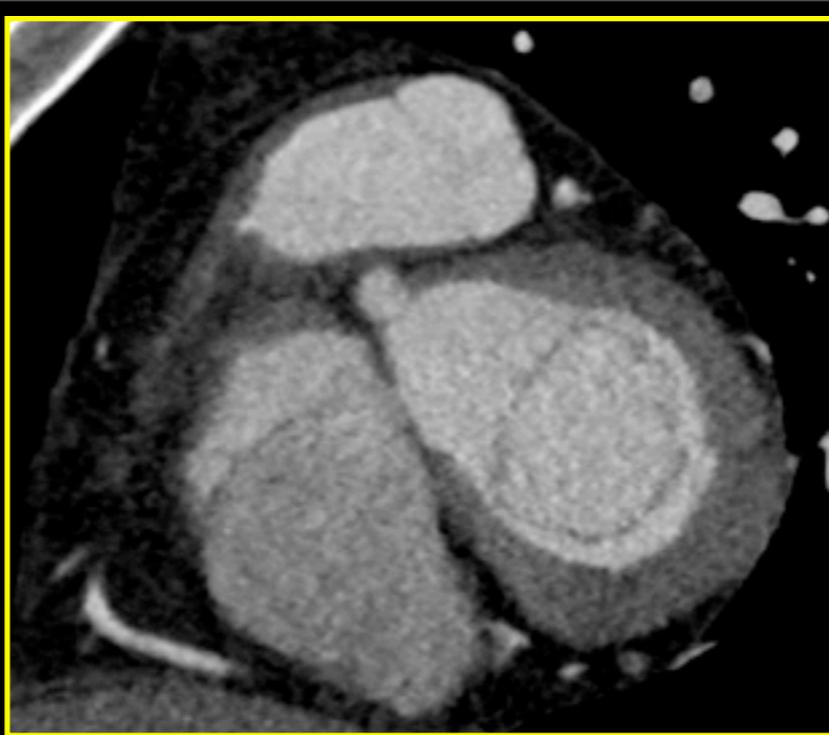
# Valves

- atrioventriculaires:  
mitrale et tricuspide
- ventriculo-artérielles:  
aortique et pulmonaire



# Valves appareil sous-valvulaire

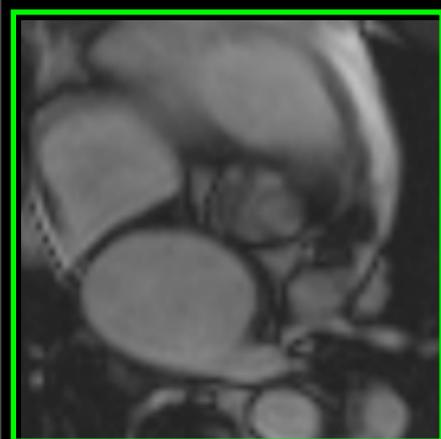




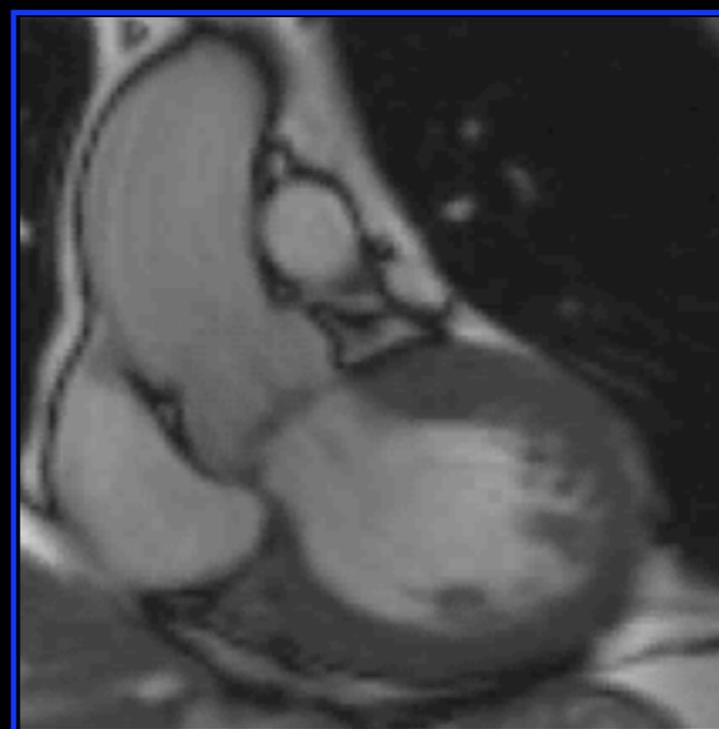
fibro-élastome

végétation

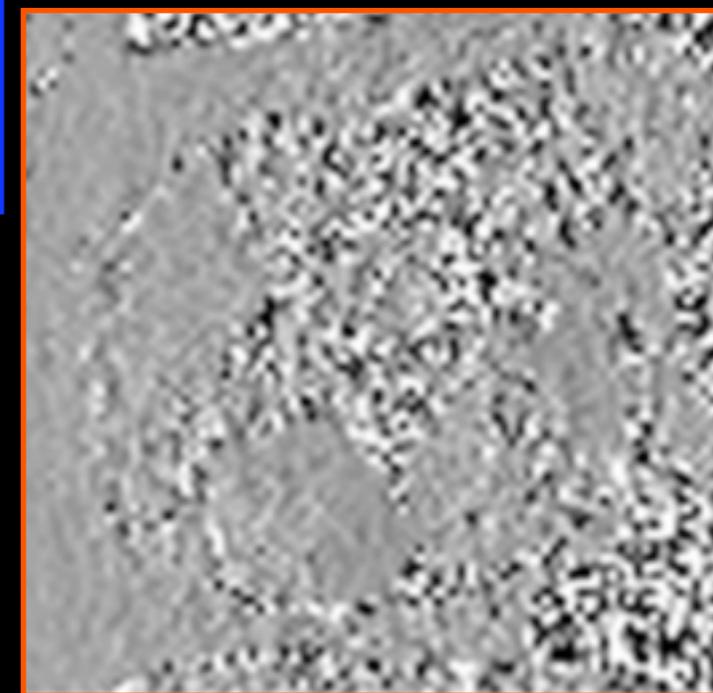
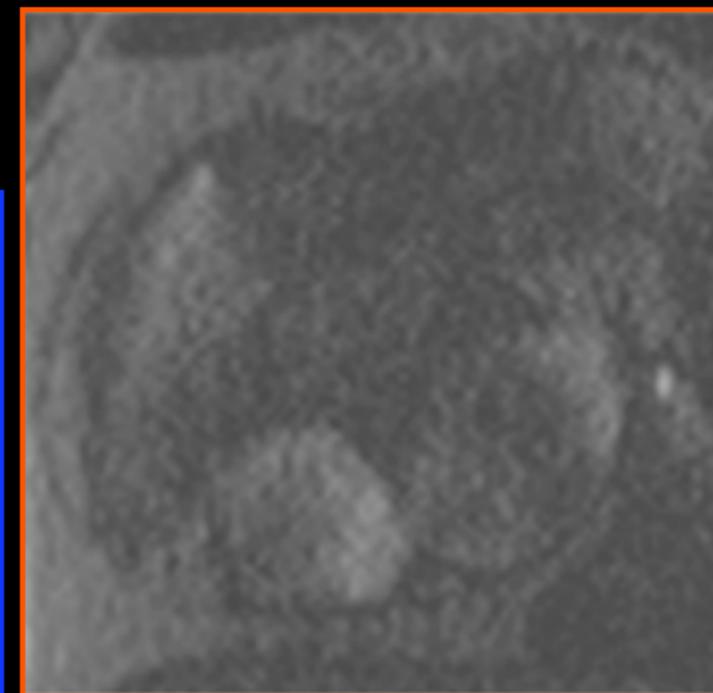
fines



bicuspidie



maladie aortique

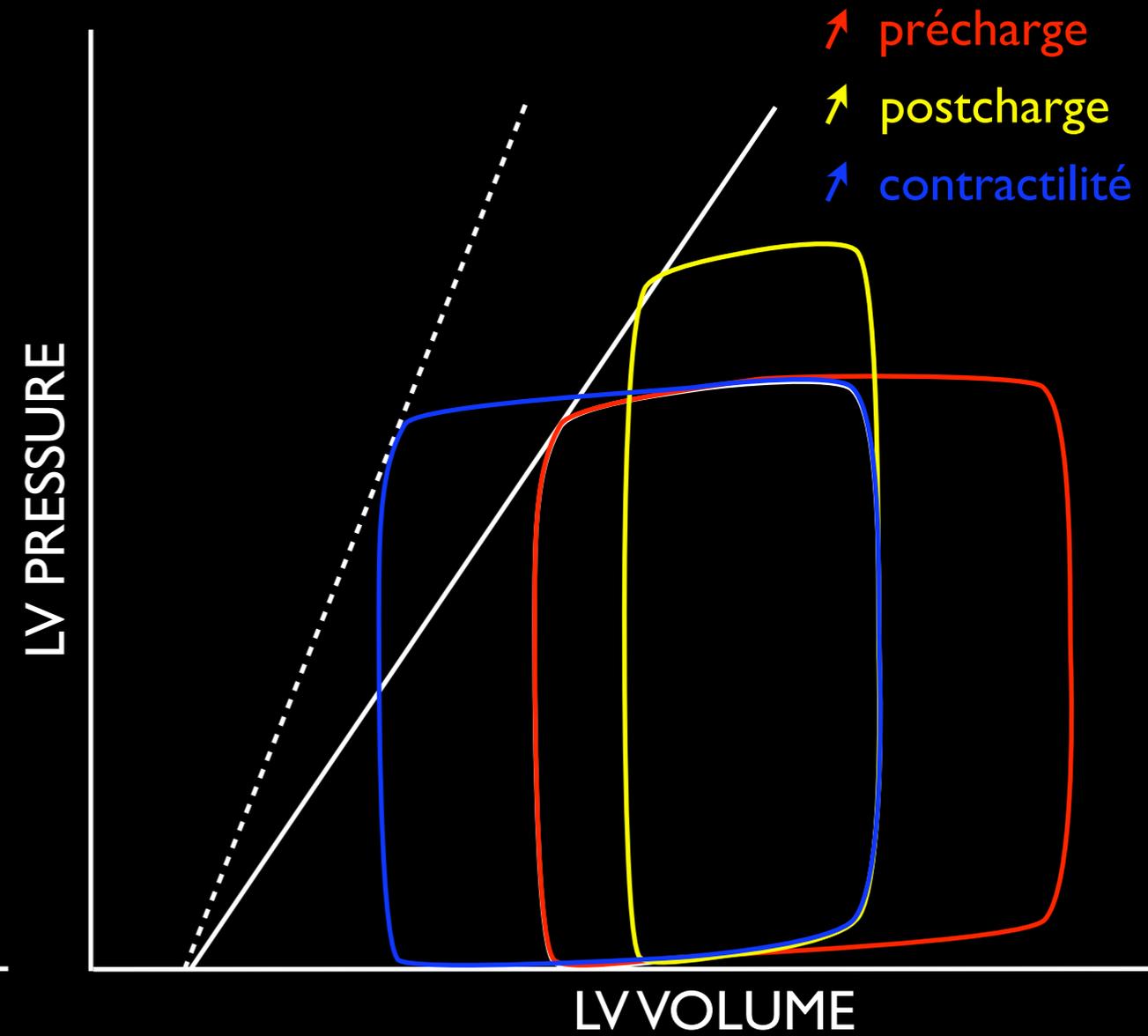
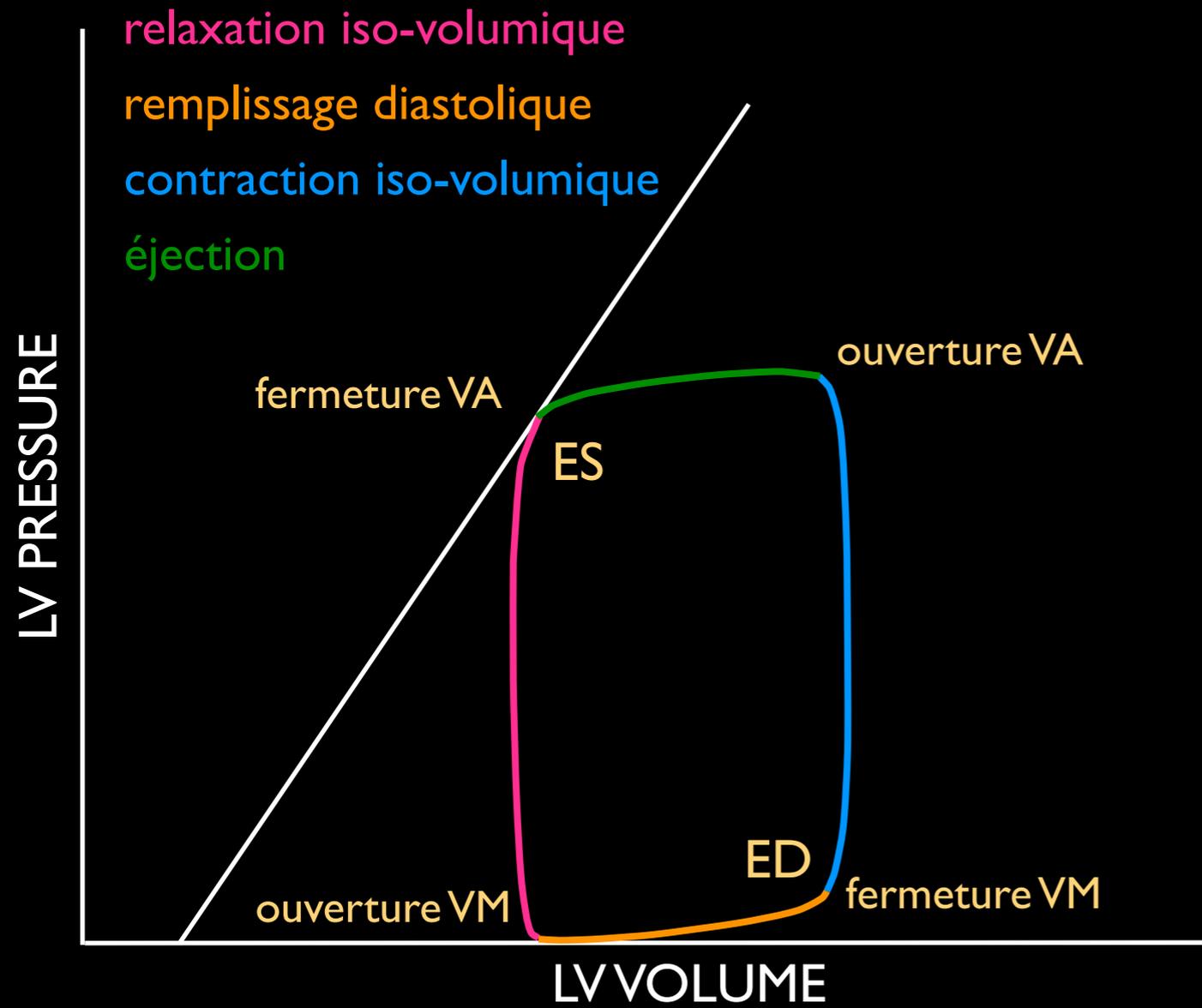


ouverture large  
contenance

RA

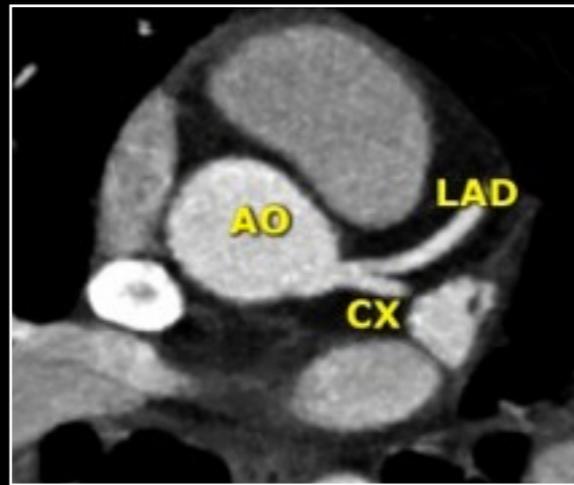
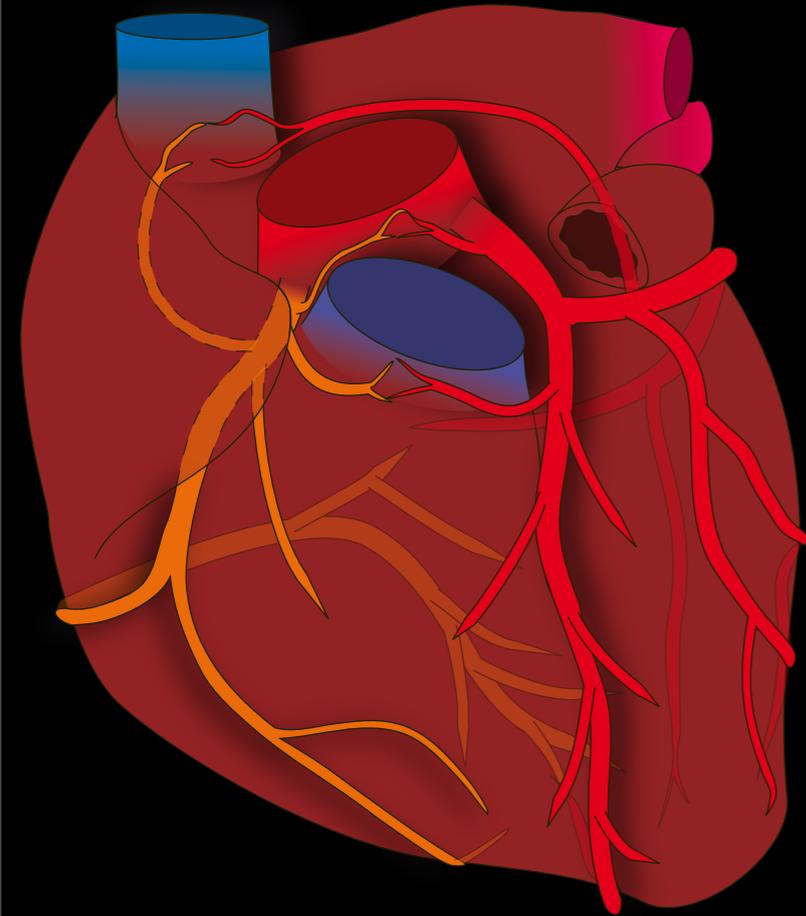


# Hémodynamique

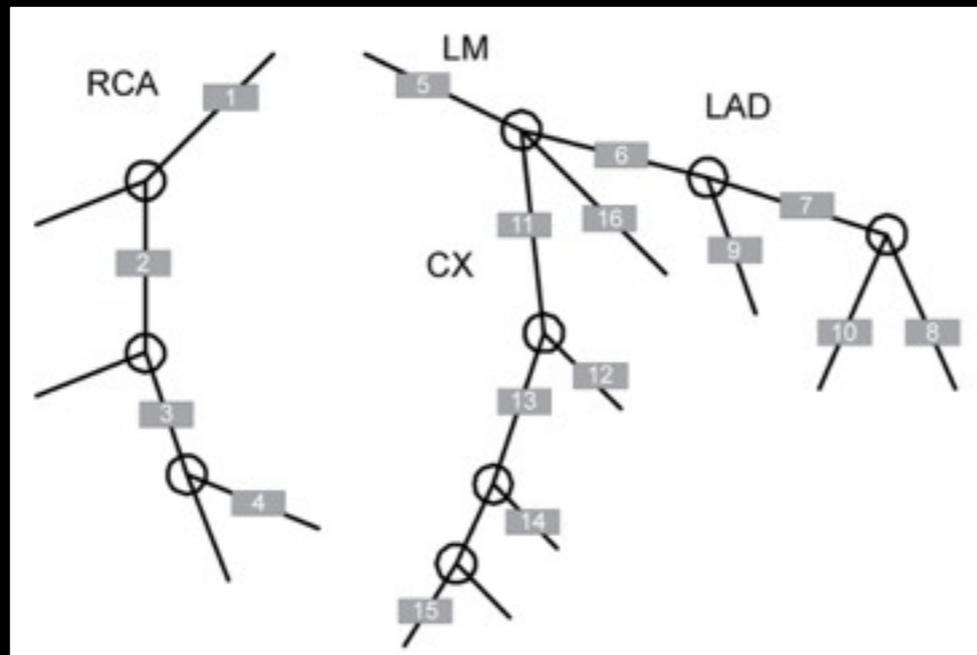
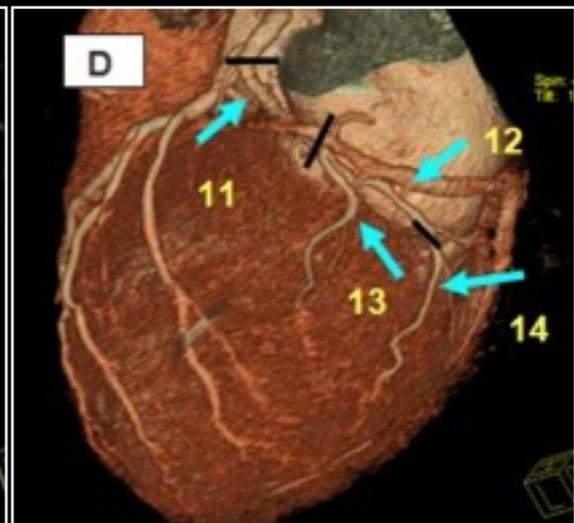
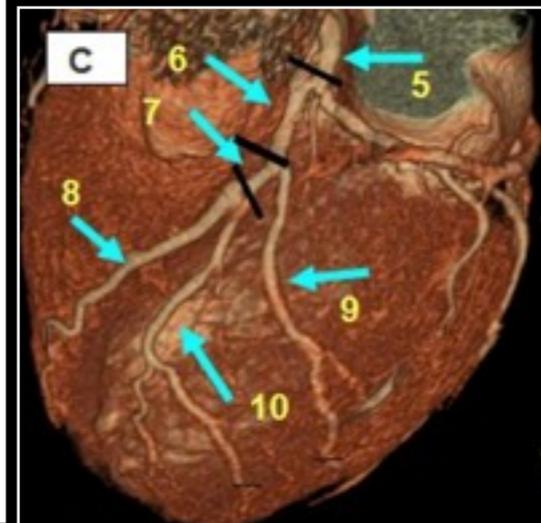
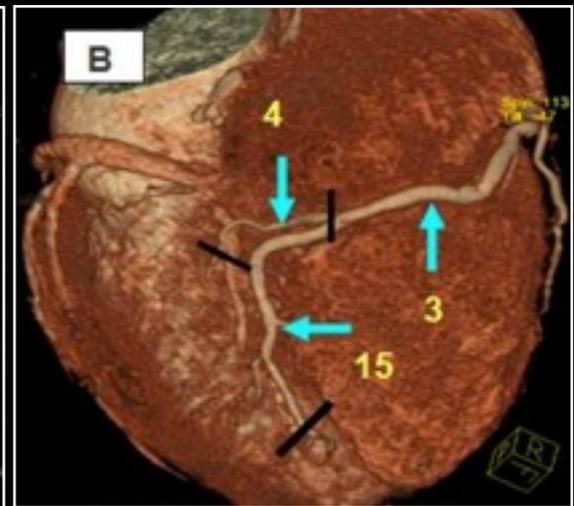


# Circulation coronaire

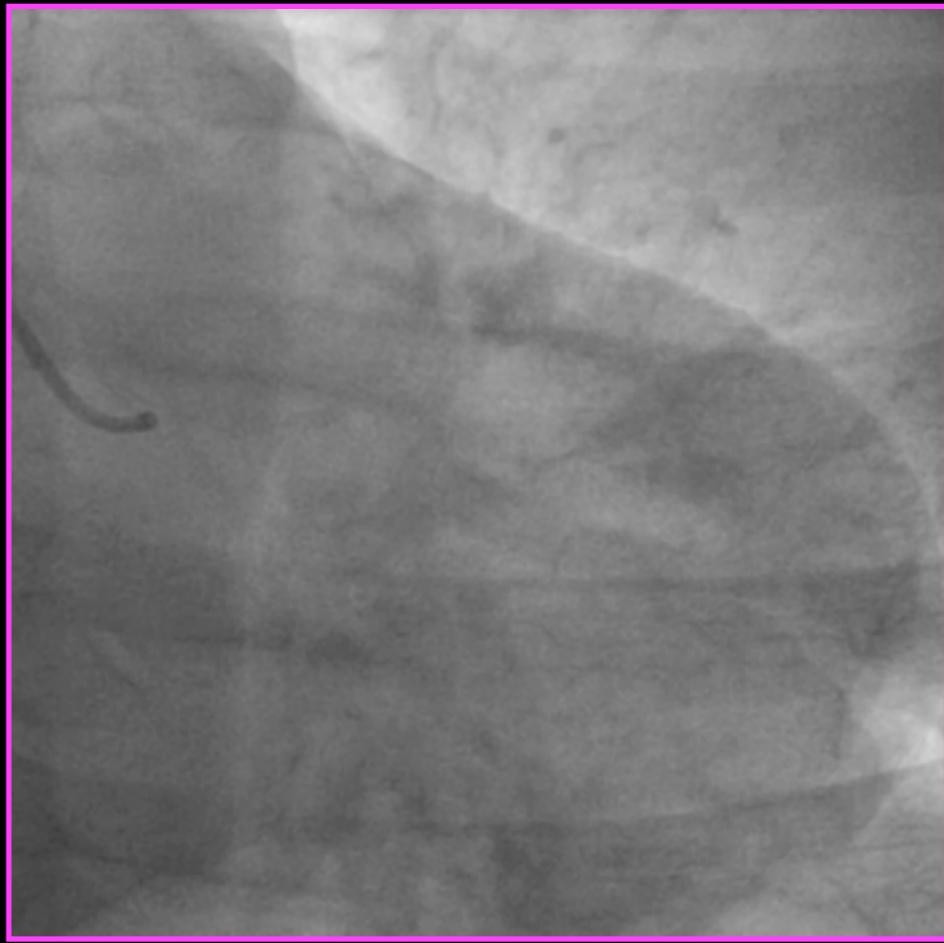
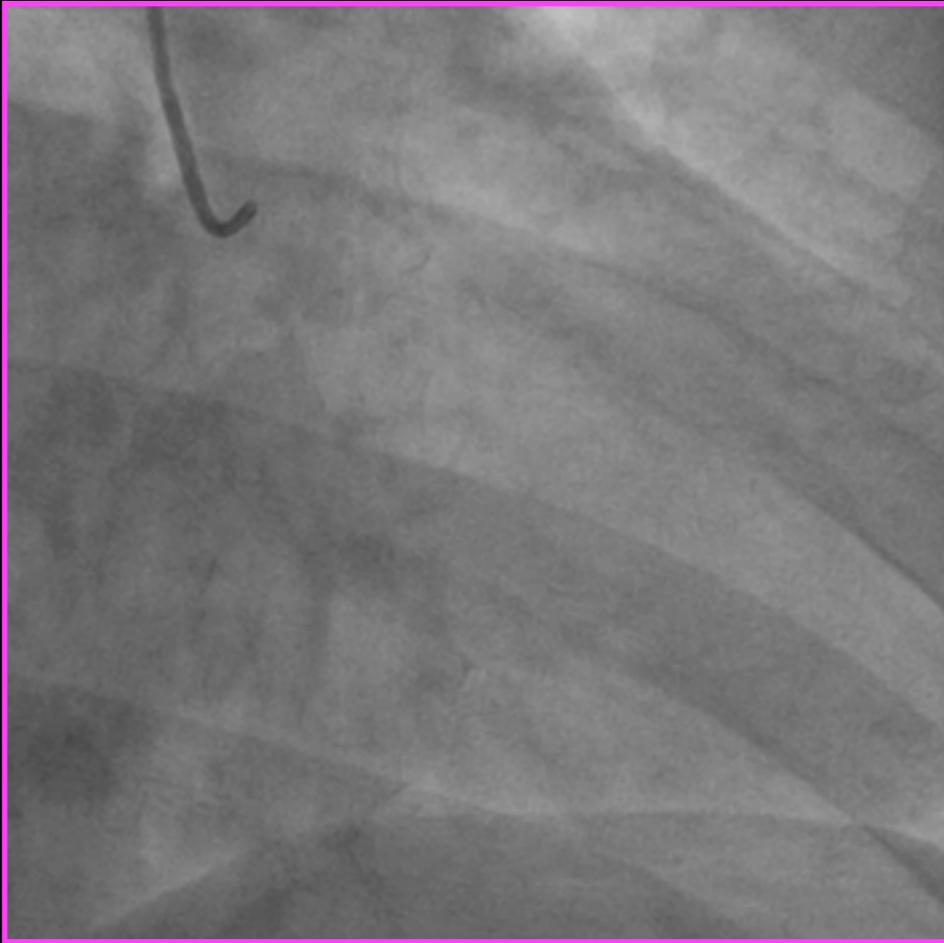
artères



anastomoses

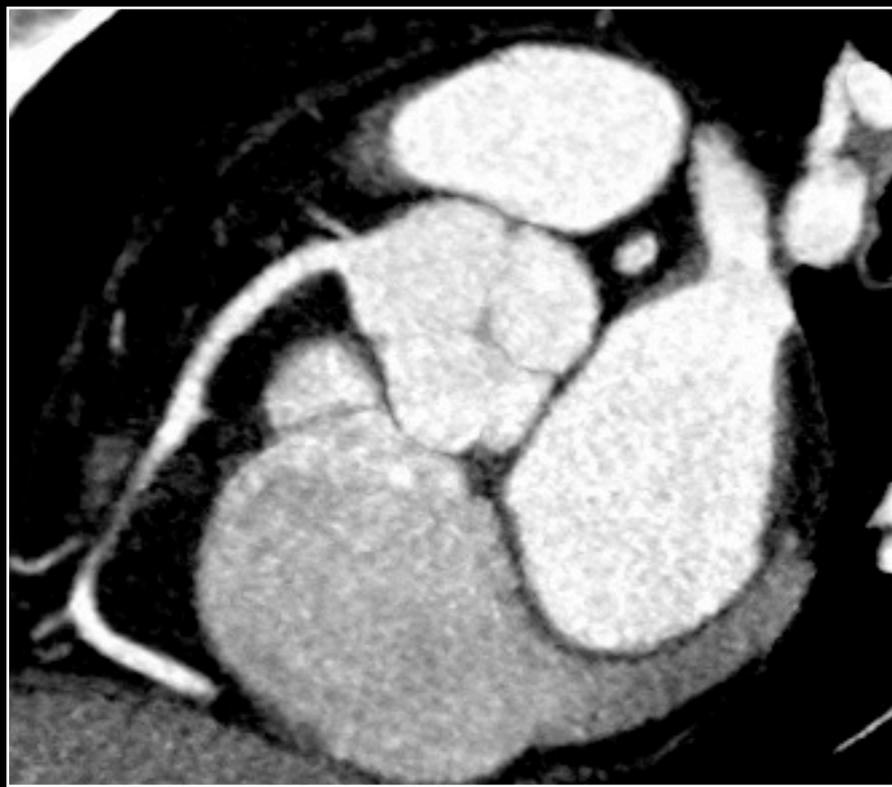
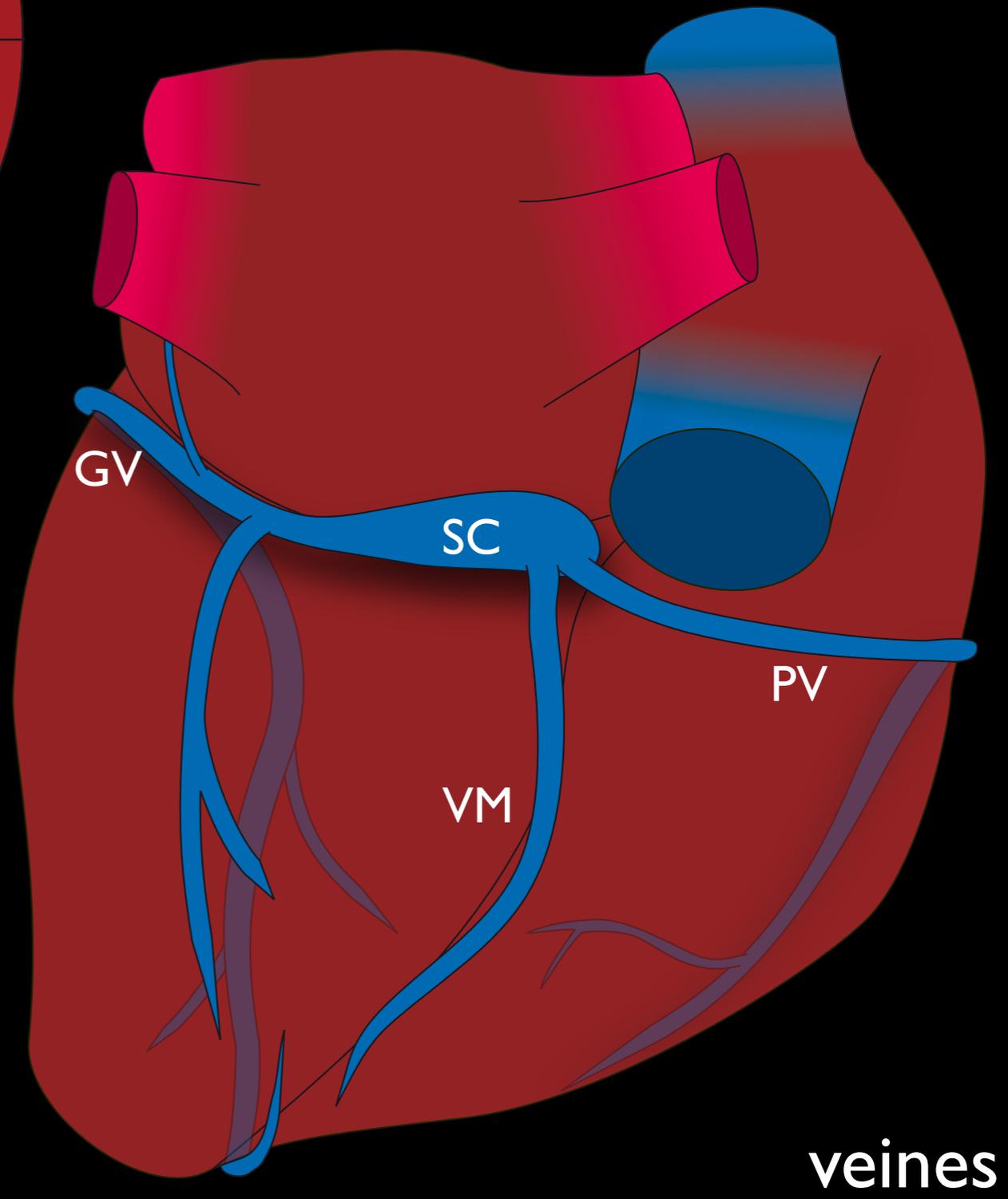
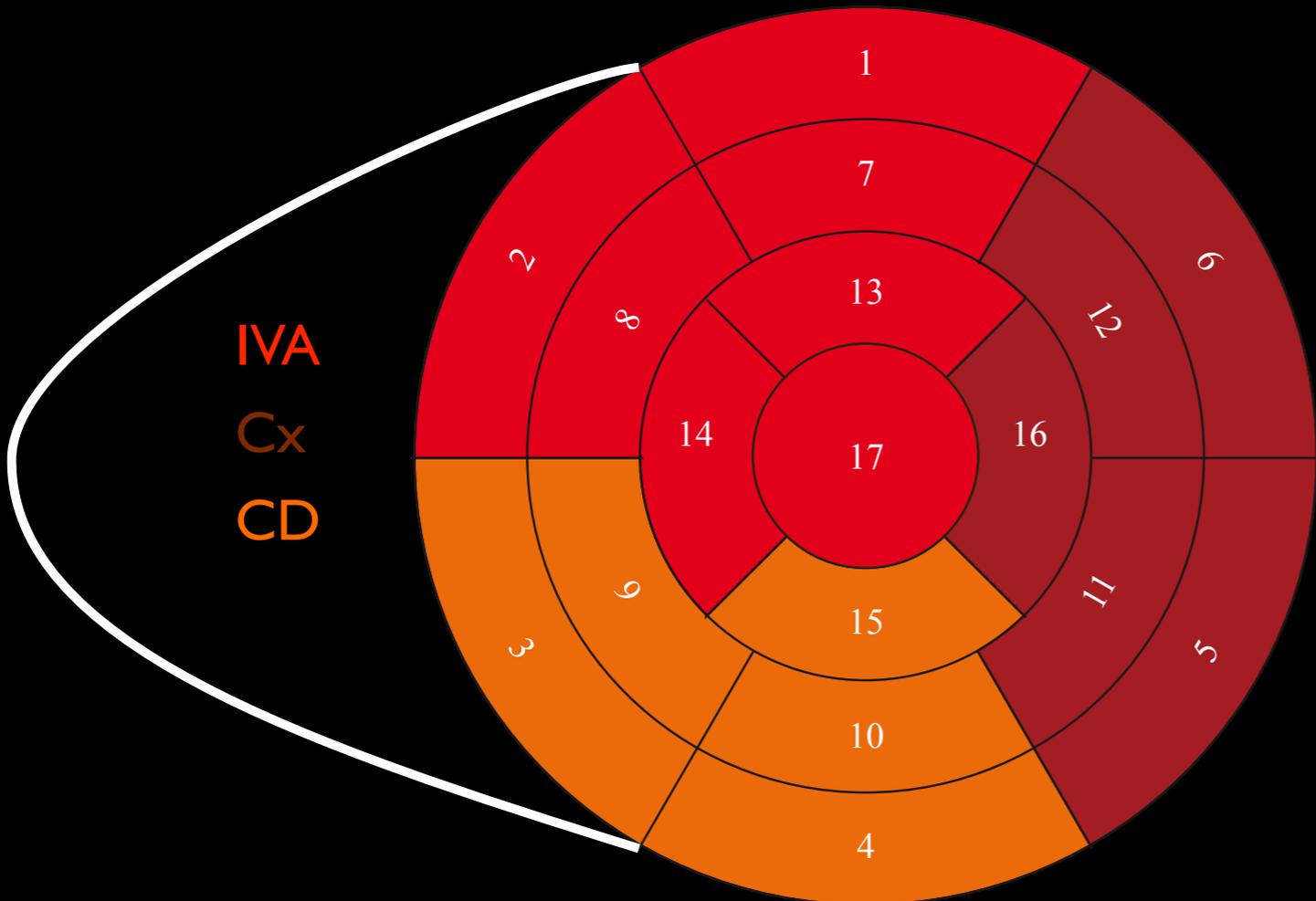


coronaire gauche



coronaire droite



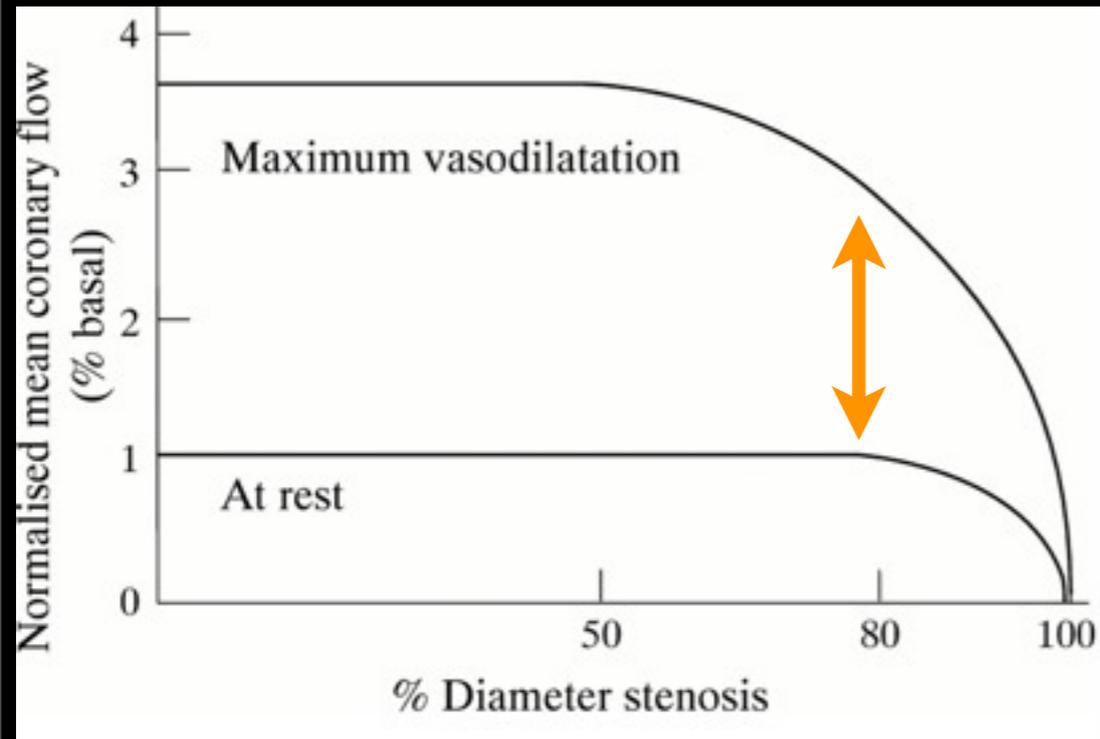


# Circulation coronaire physiologie

Perfusion diastolique, fragilité du sous-endocarde

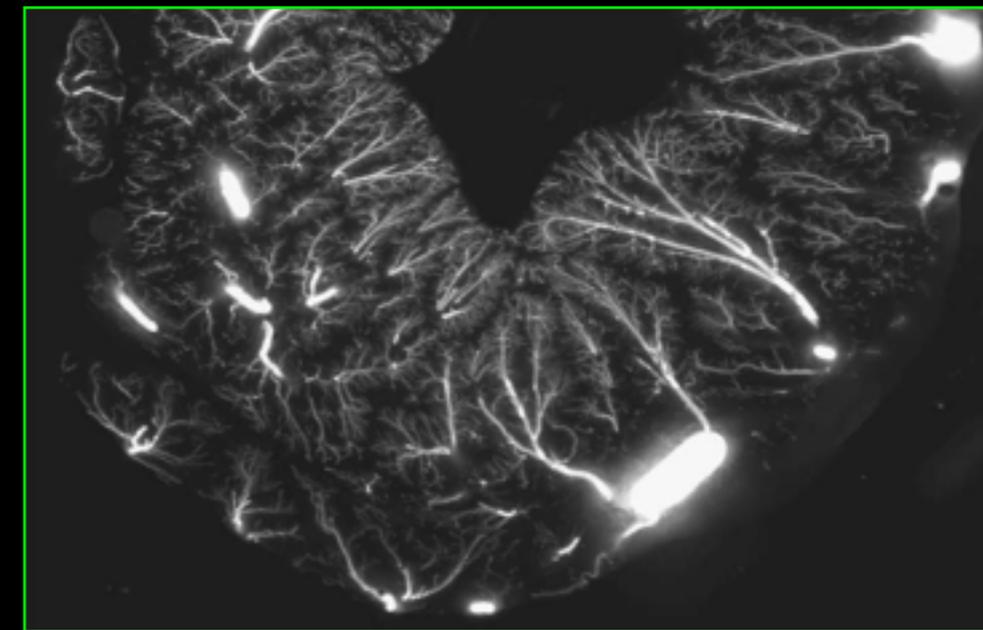
Adaptation du débit à l'effort

réserve coronaire



↑ CAPACITANCE

↓ RESISTANCES  
MICROCIRCULATION

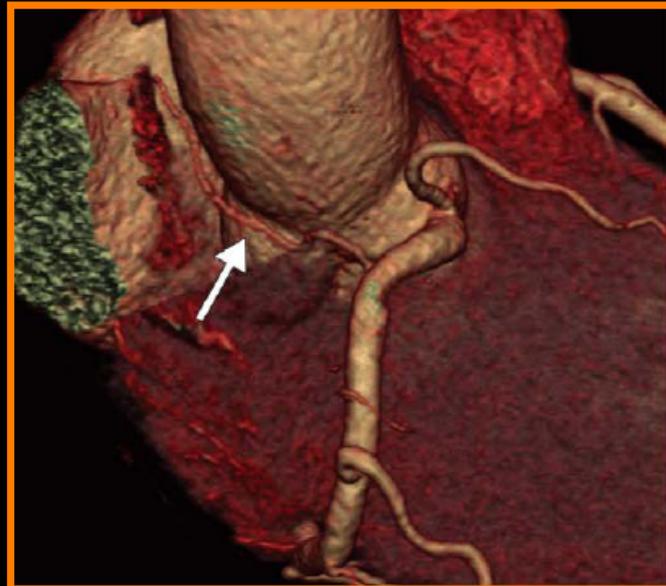
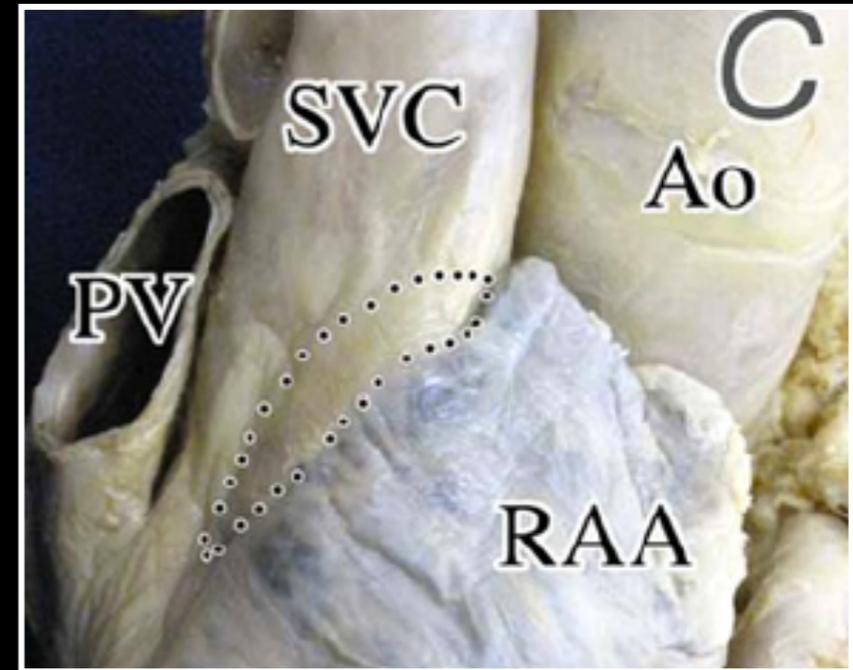
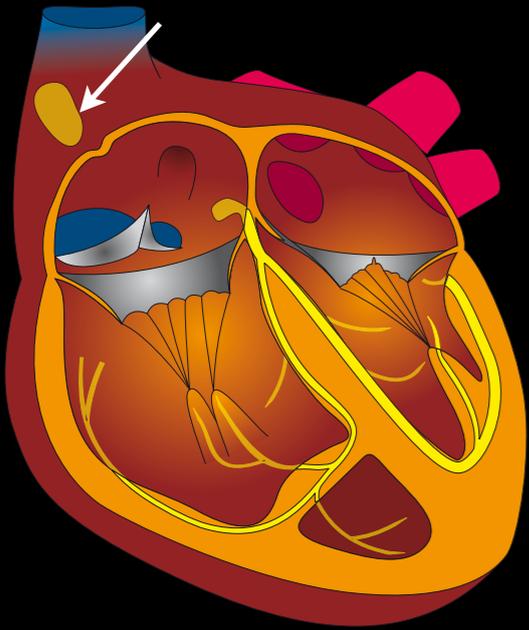


- plus loins des troncs épicaudiques
- plus fins et sensibles à la pression pariétale
- plus sensibles à la pression endocavitaire

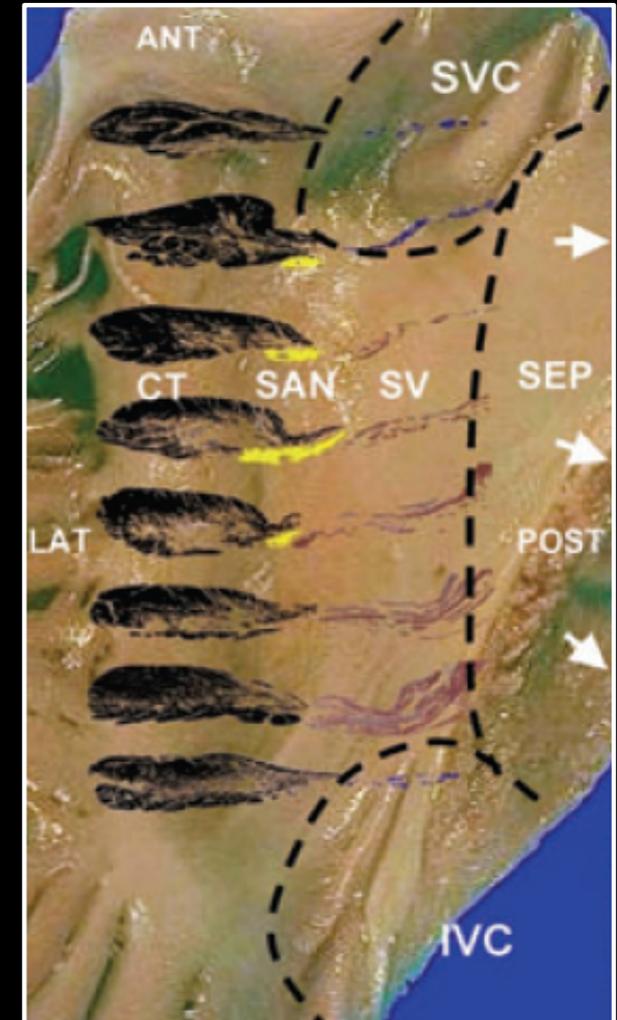
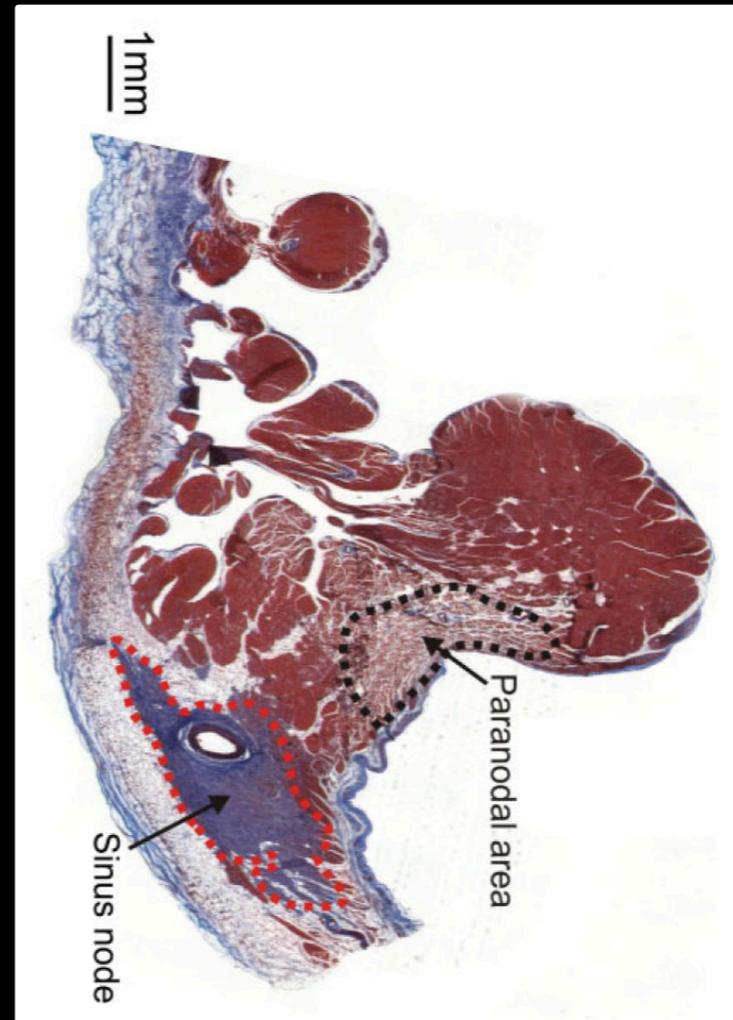
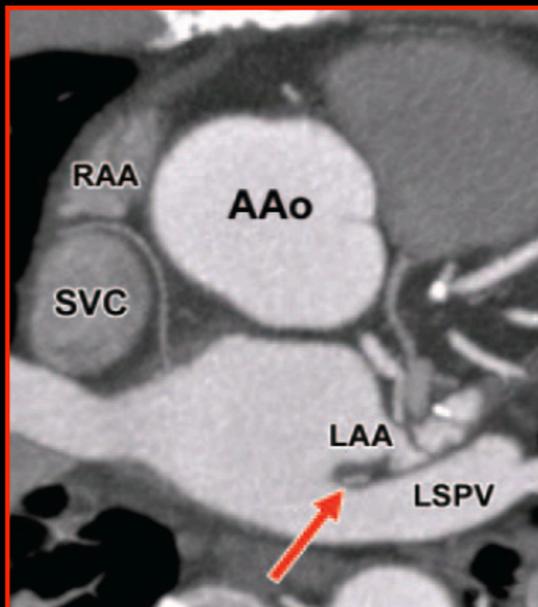
$Q_{\text{stress}}$  /  $Q_{\text{rest}}$

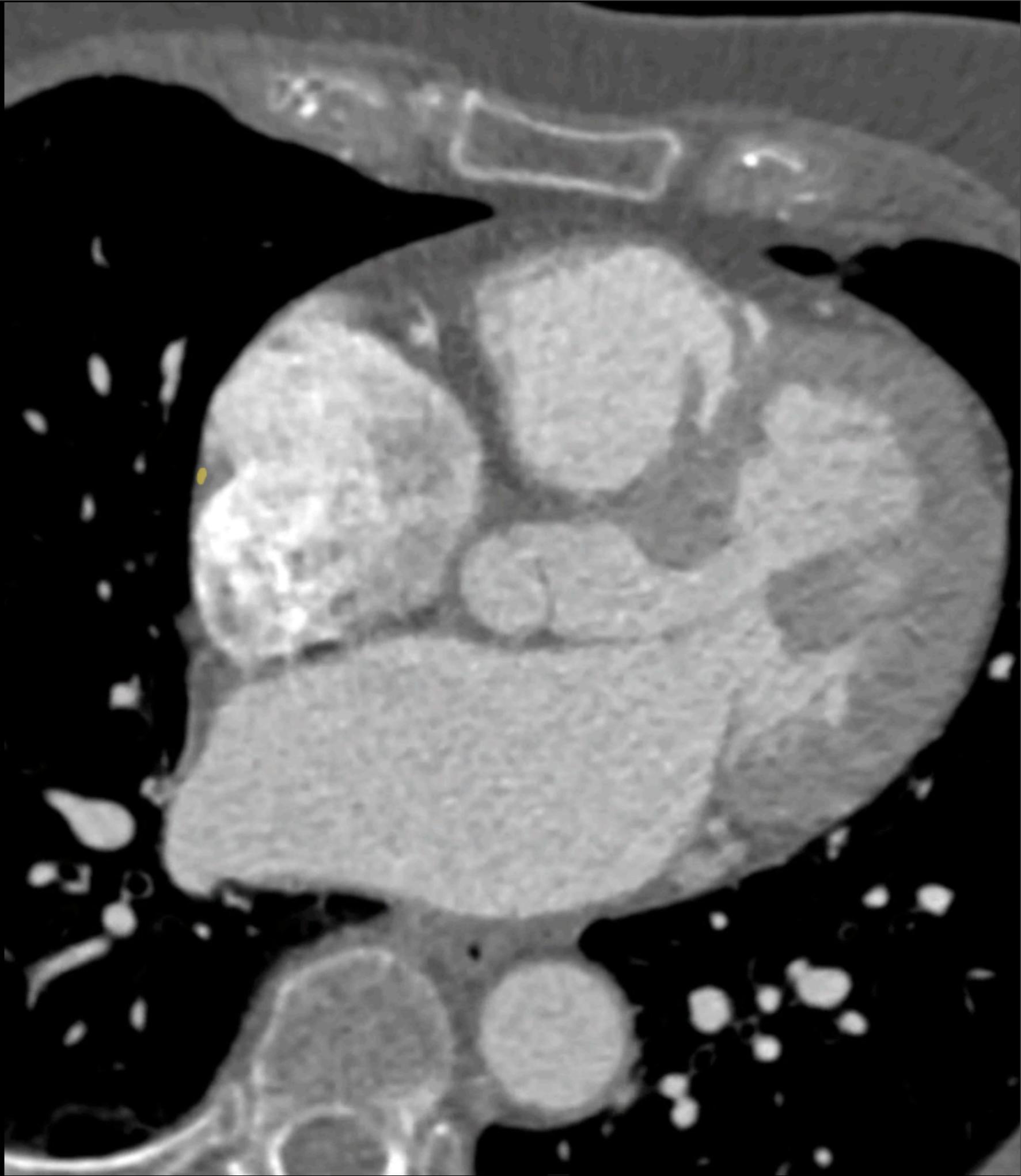
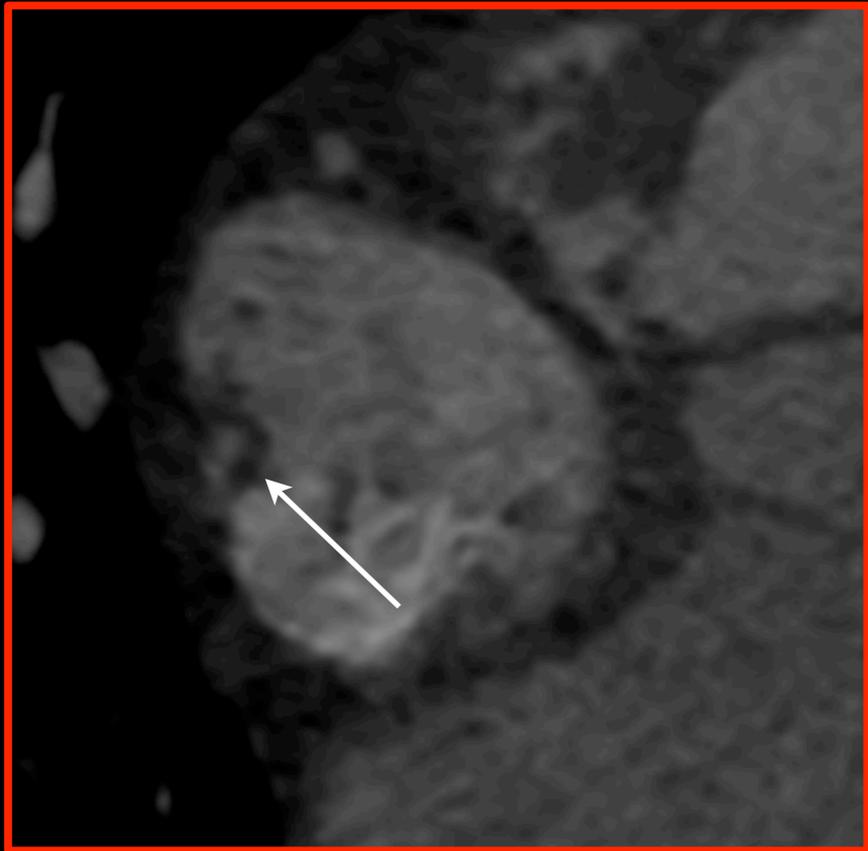
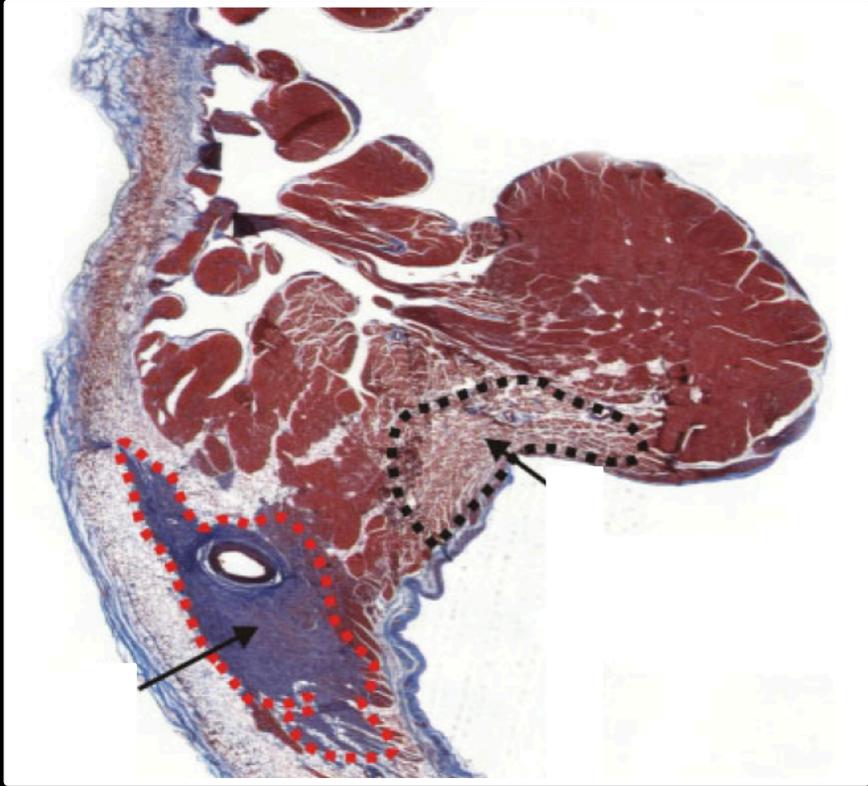
# Systeme cardionecteur

appareil atrio-necteur  
noeud sino-atrial



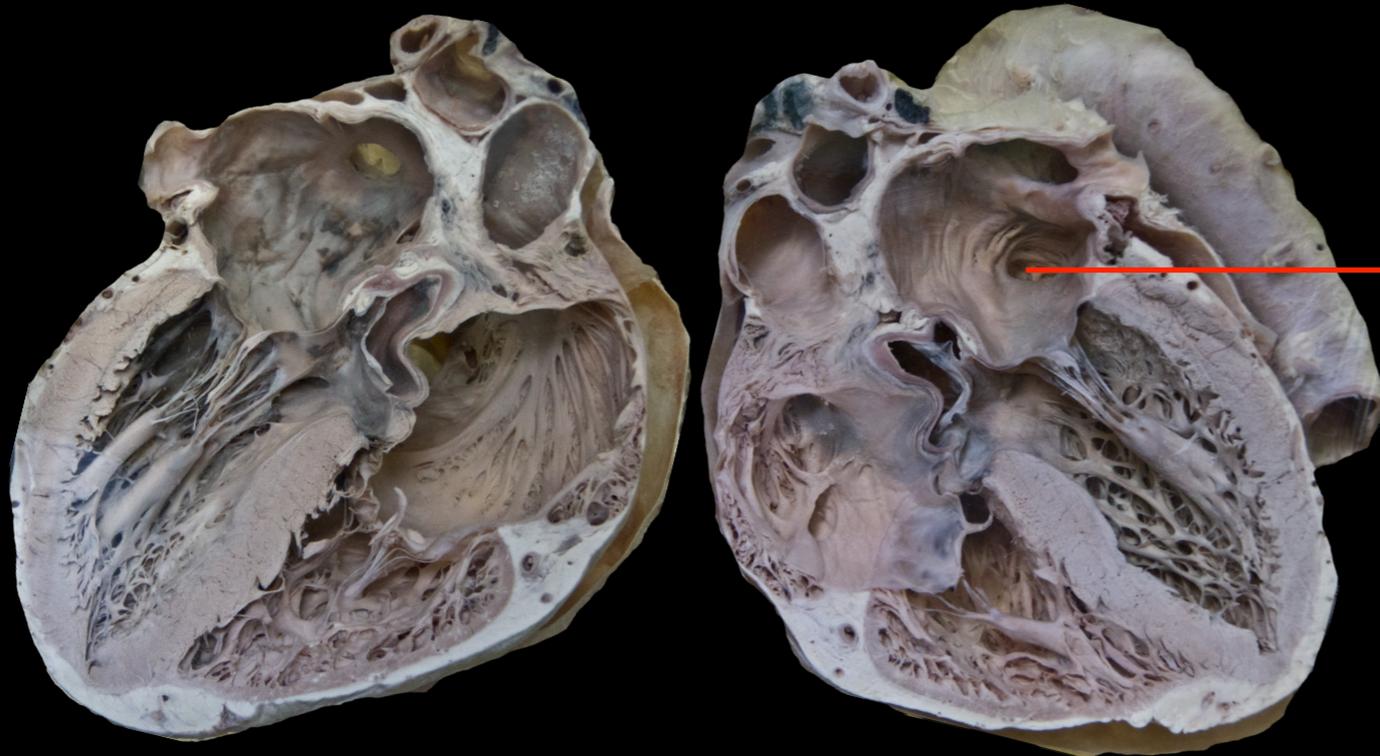
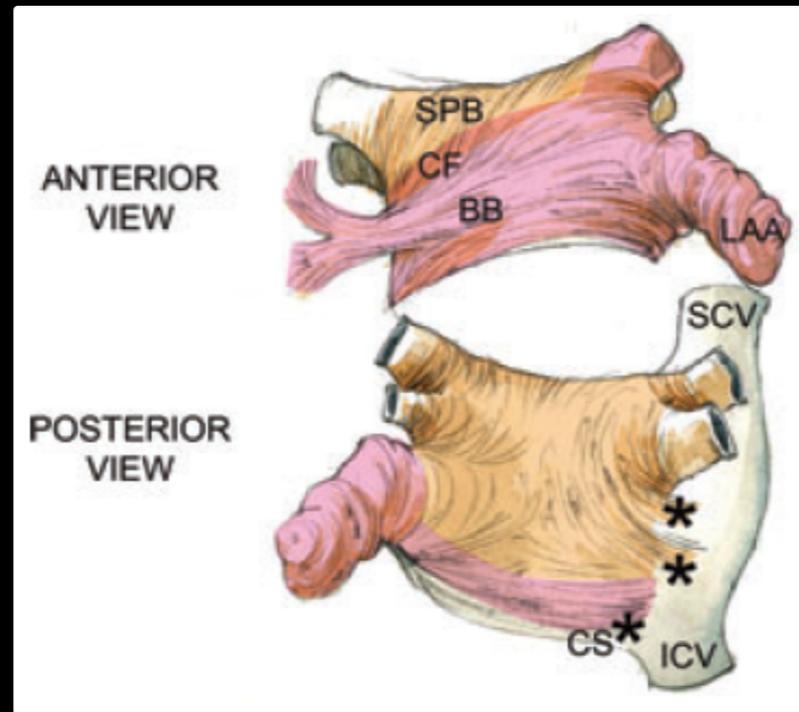
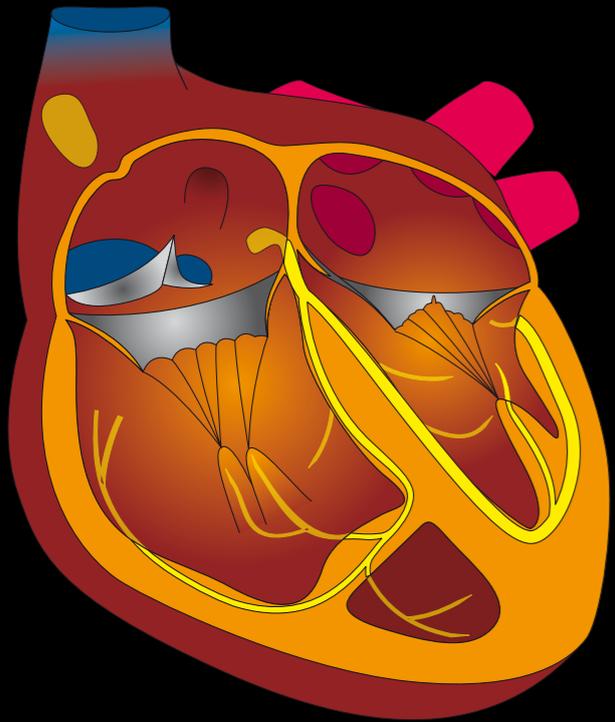
CD dans 70%  
CG dans 30%





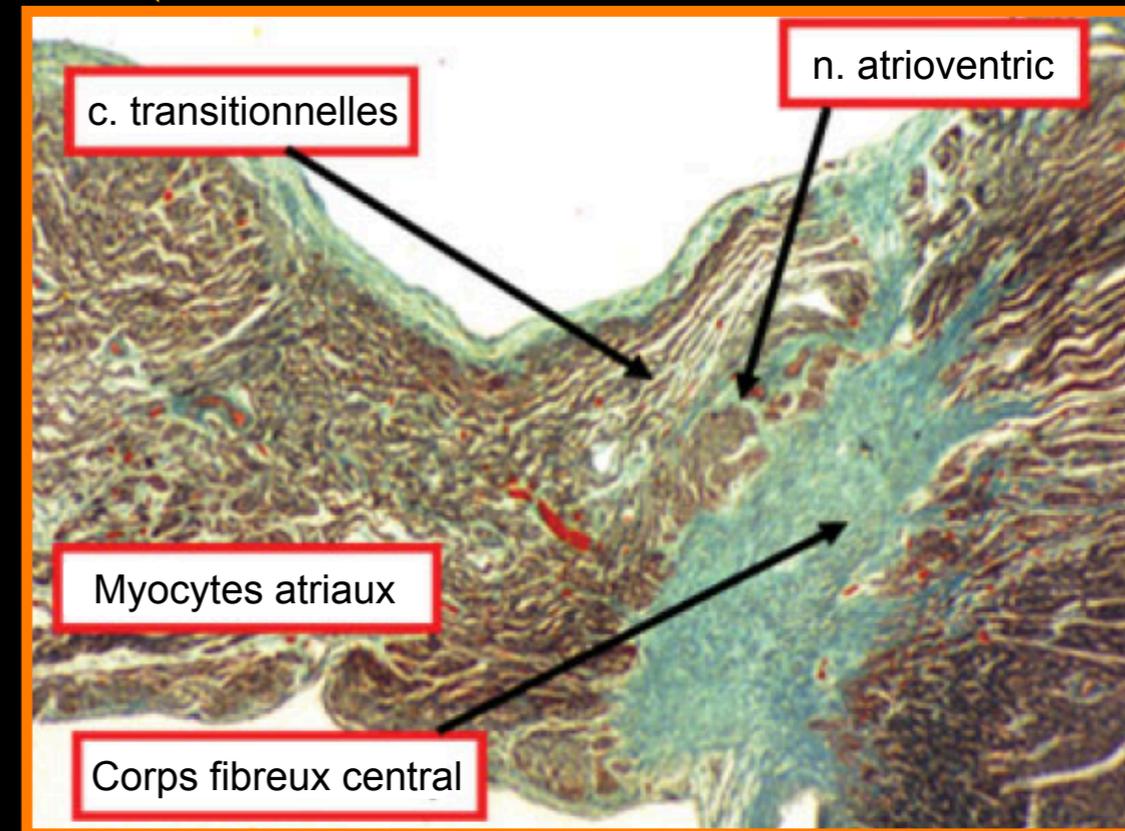
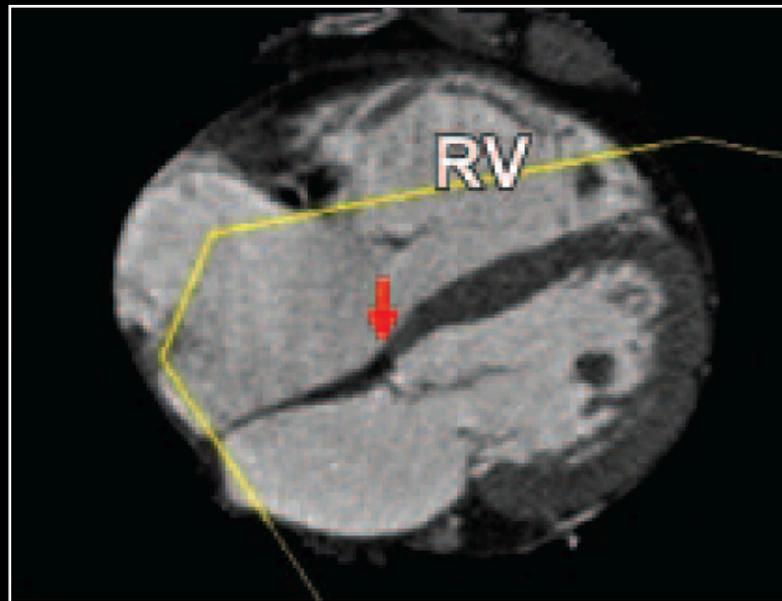
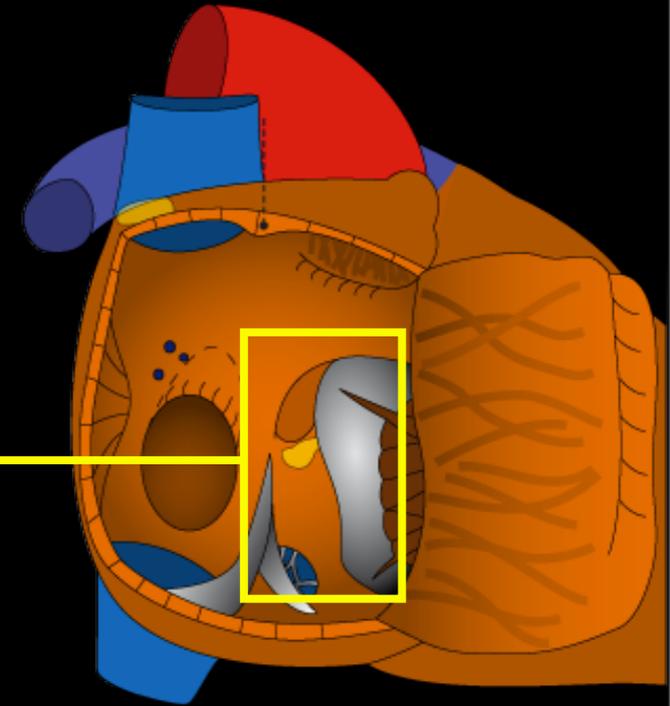
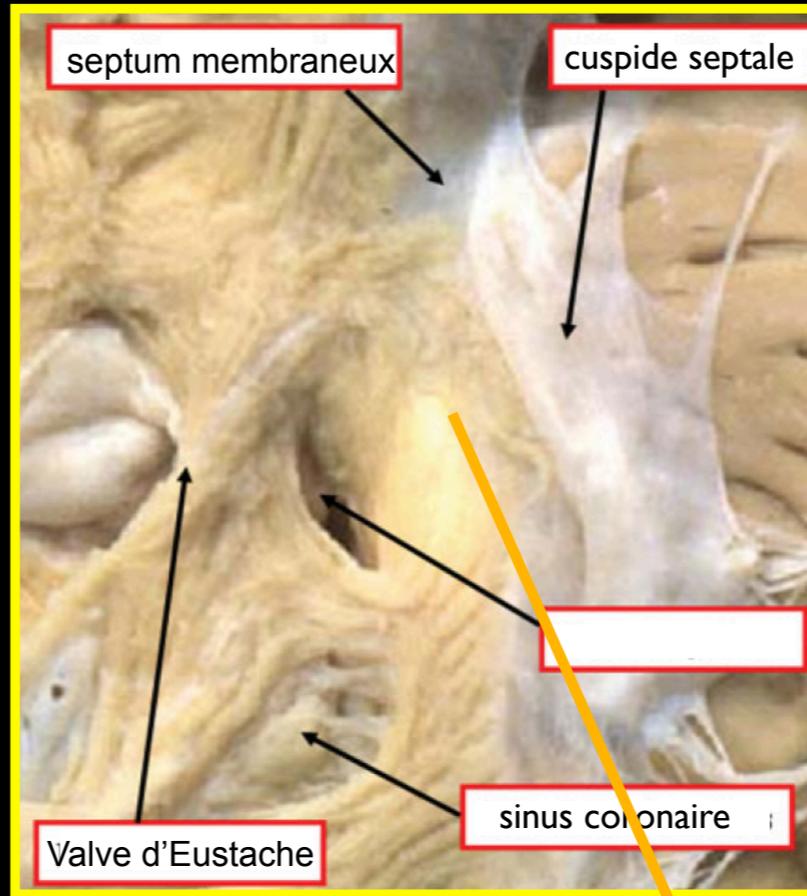
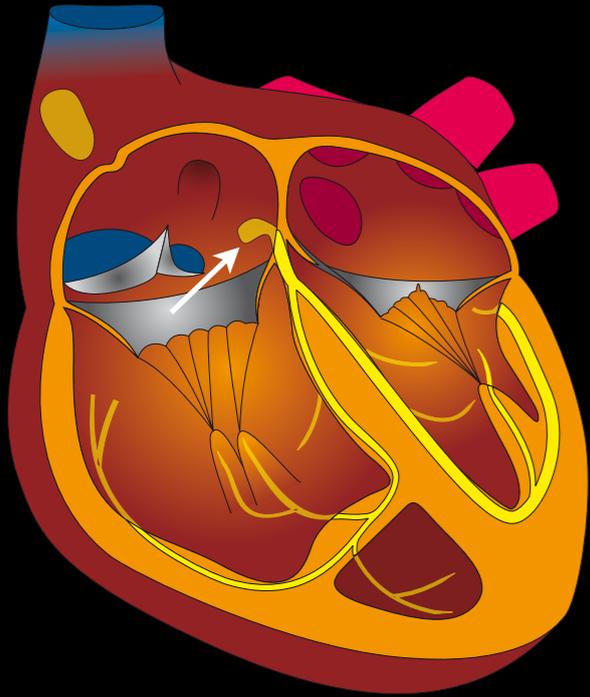
# Systeme cardionecteur

appareil atrio-necteur  
connexions intra et interatriales



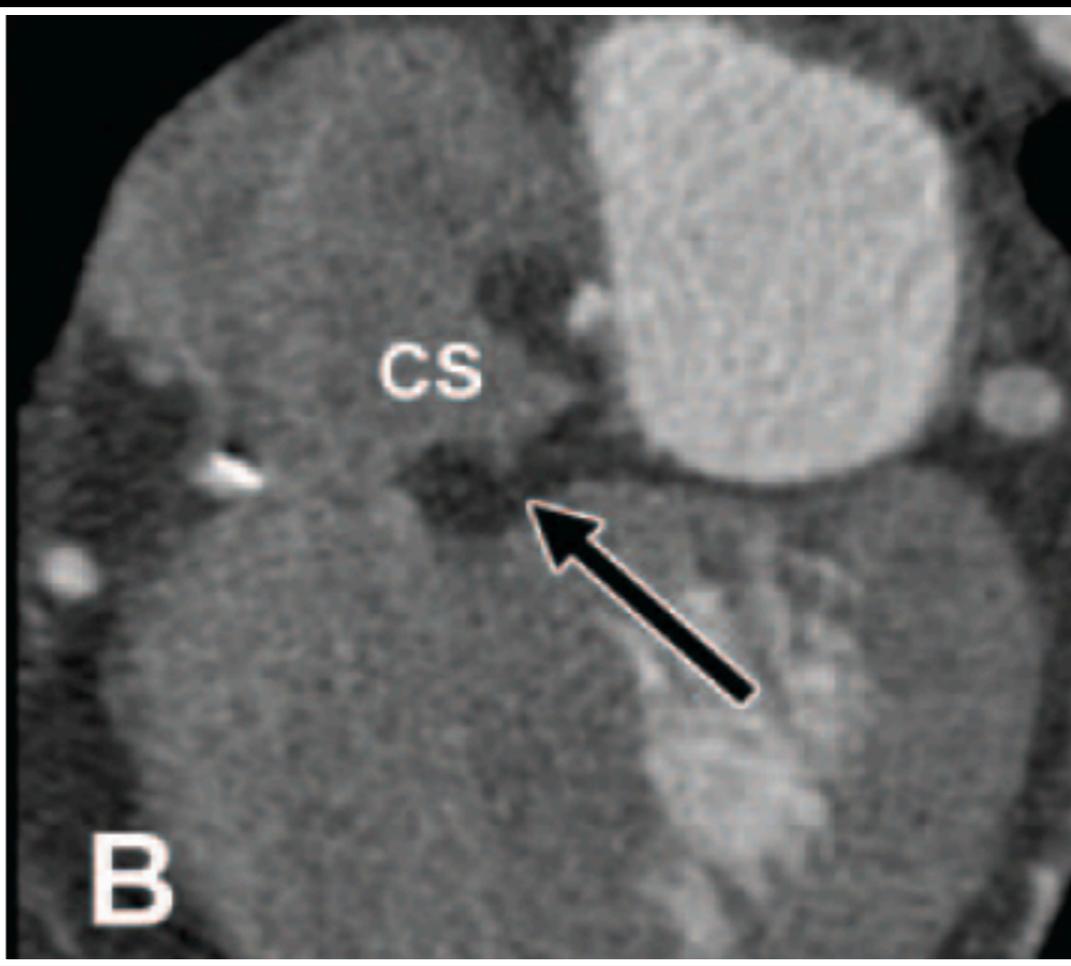
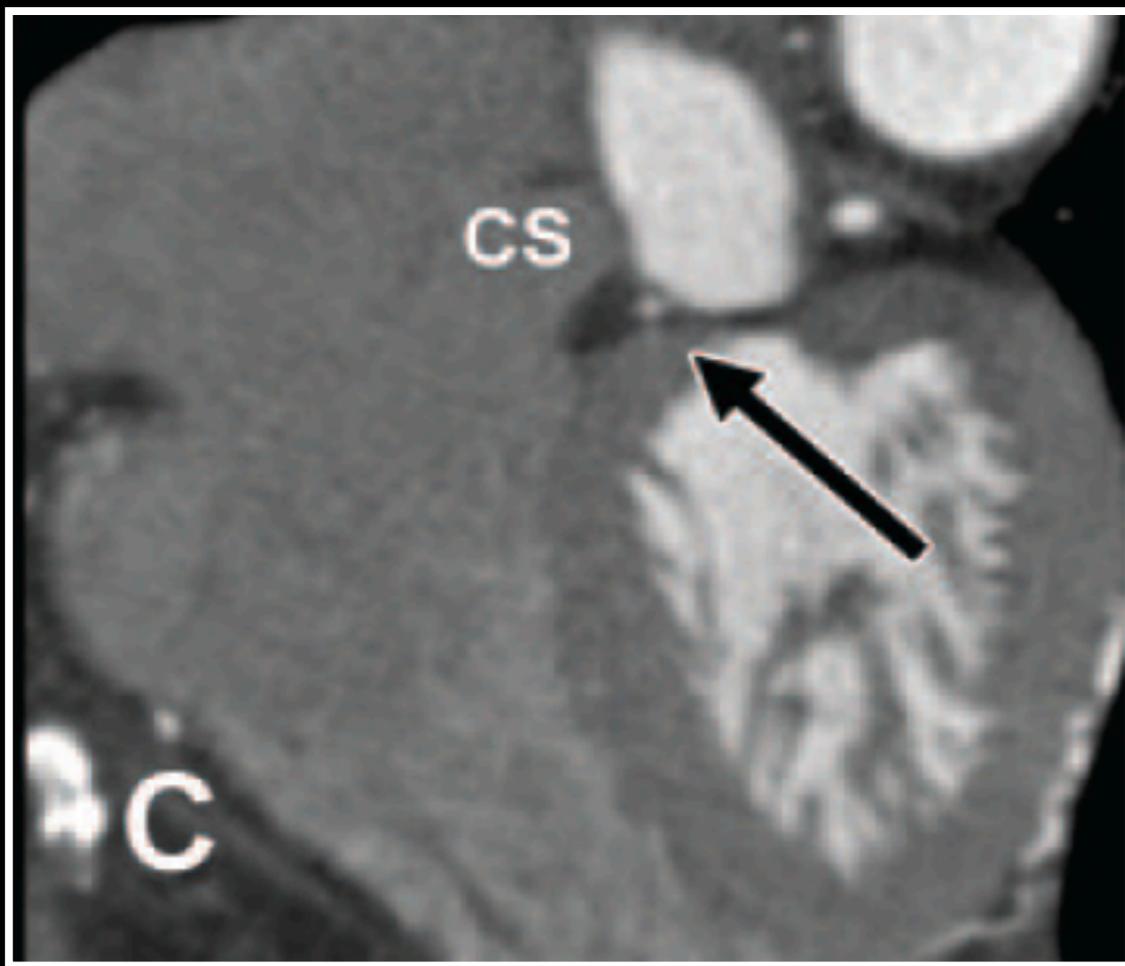
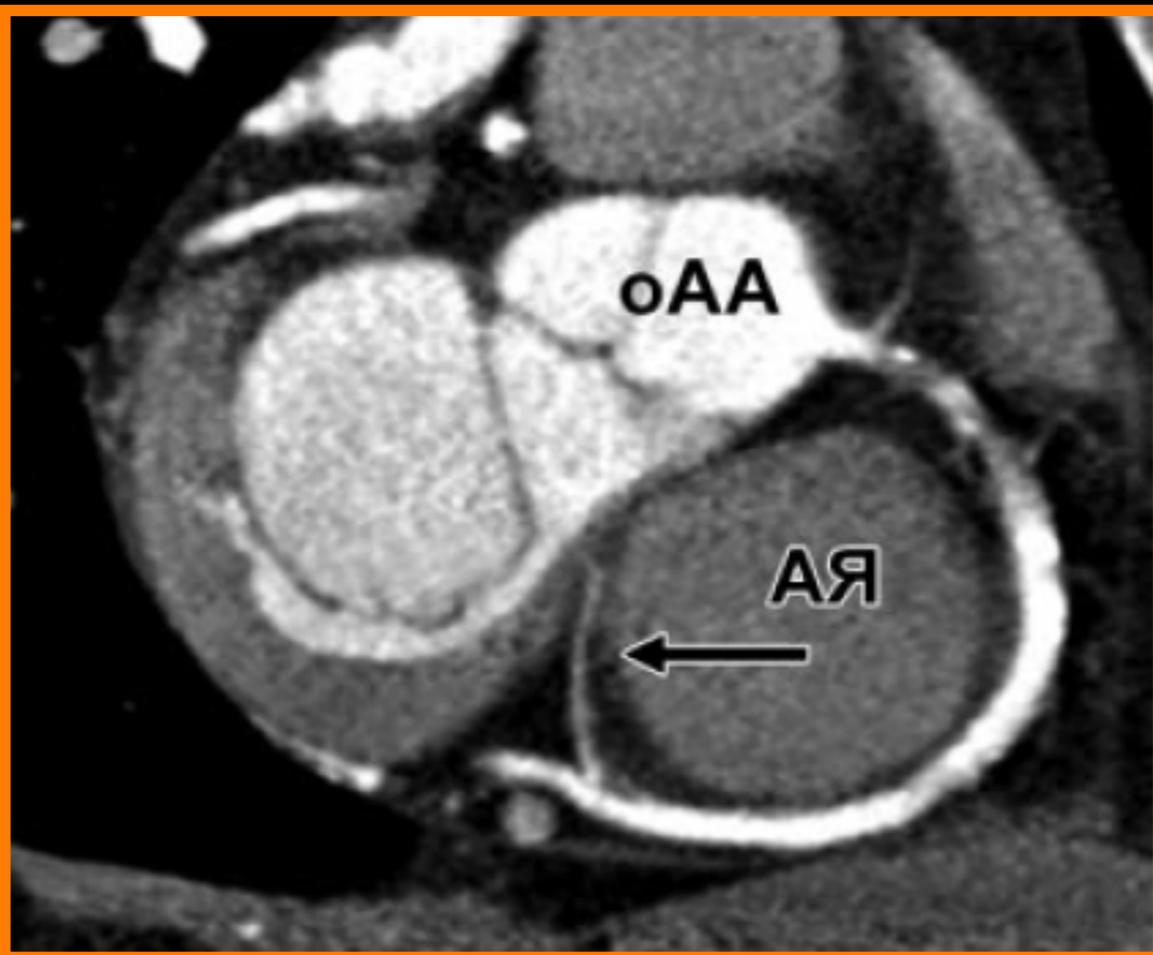
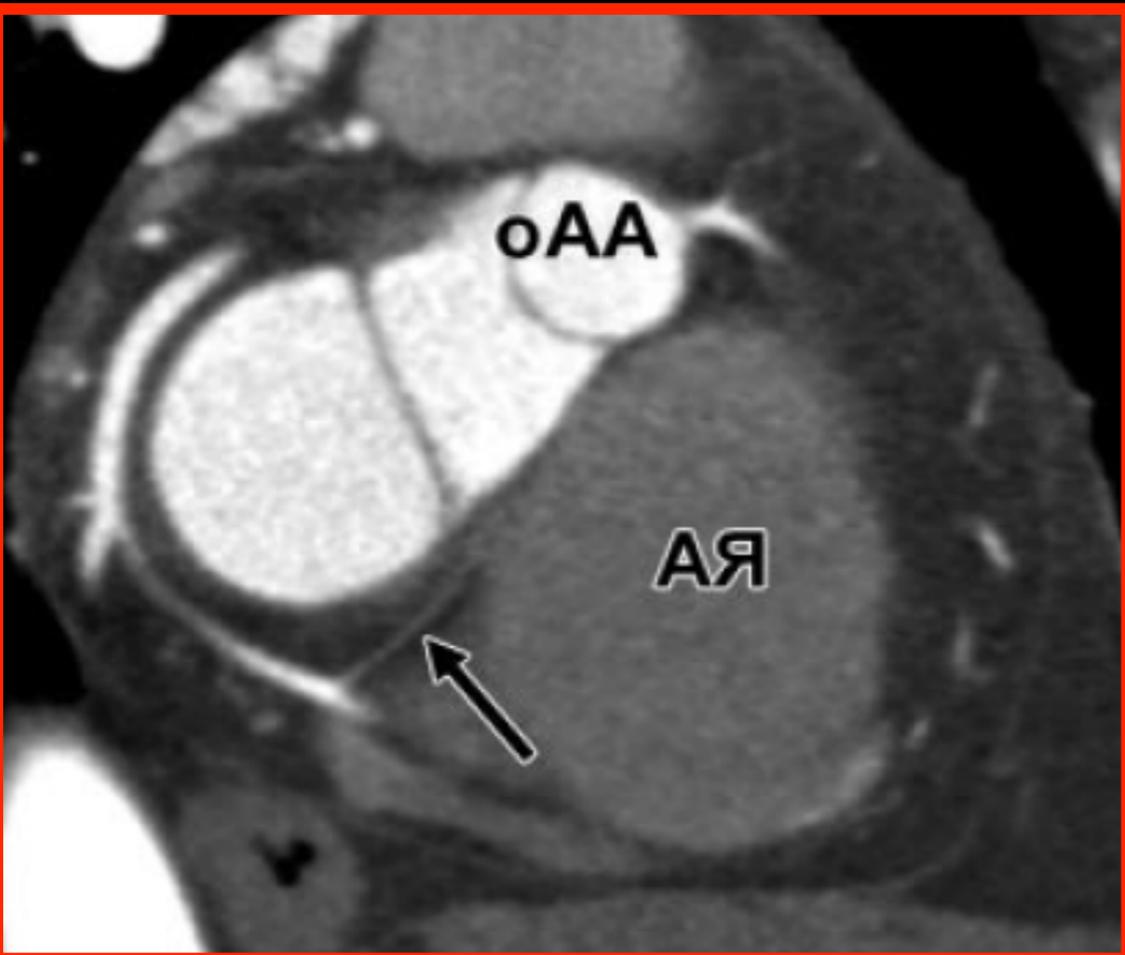
# Systeme cardionecteur

## appareil ventriculo-necteur noeud atrioventriculaire



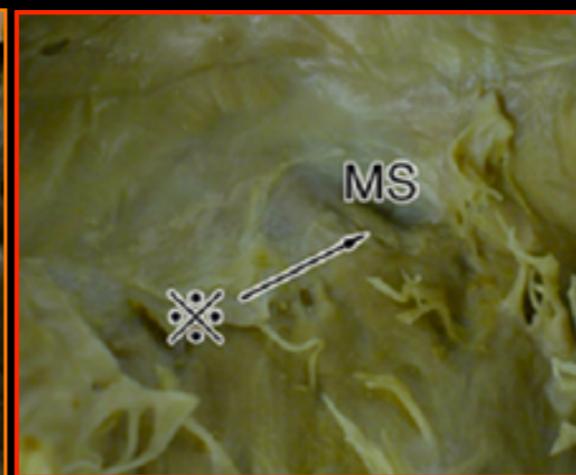
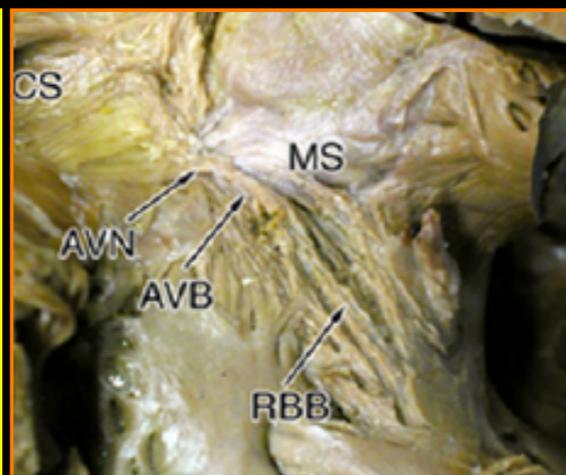
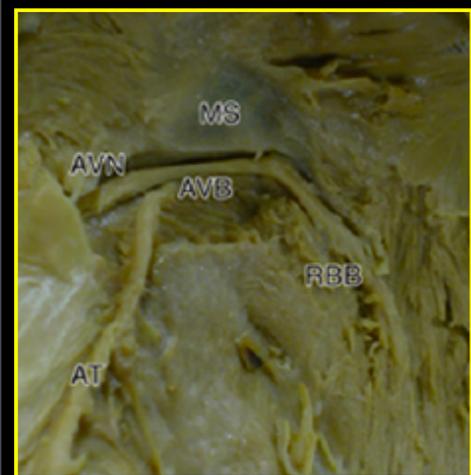
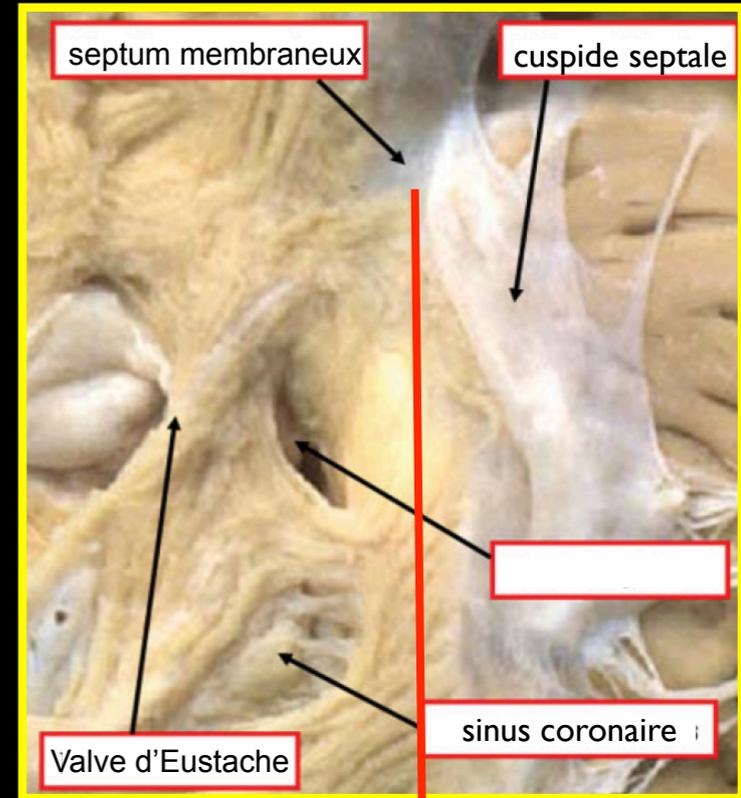
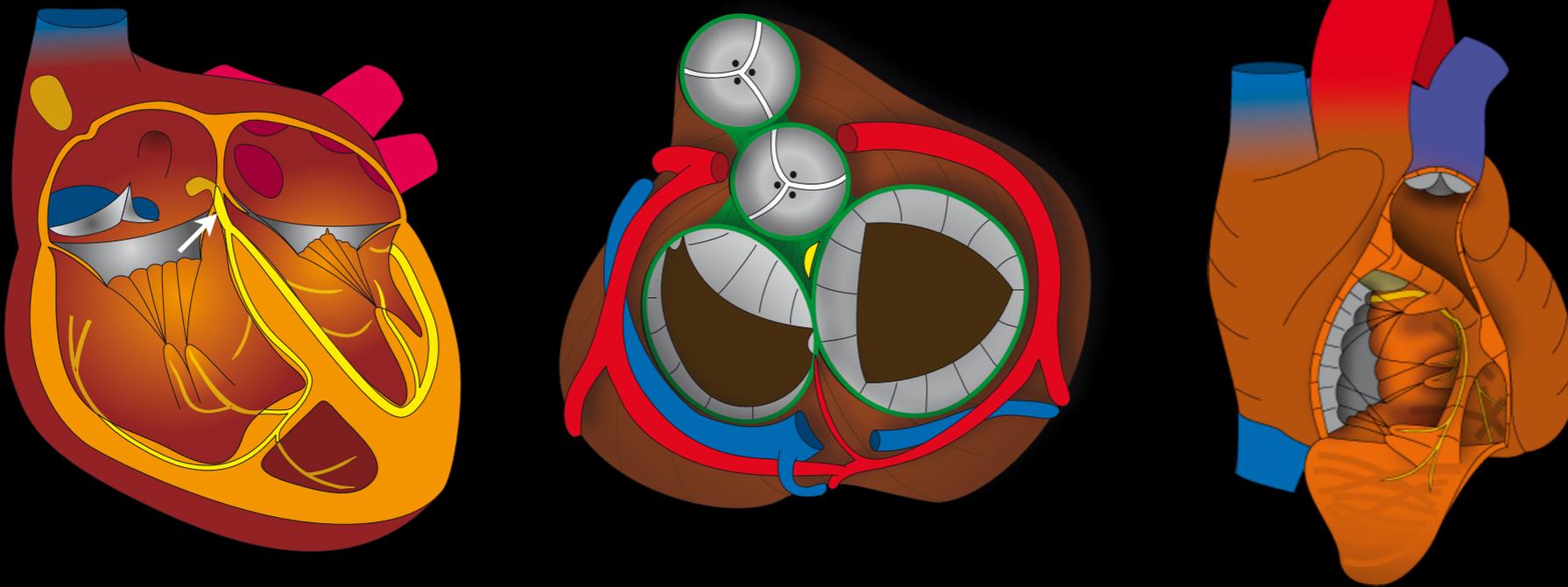
Cx: 10%

CD: 90%

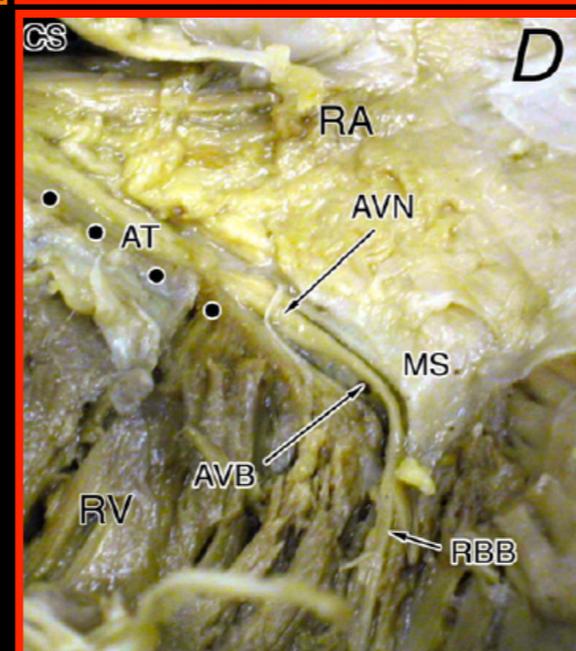
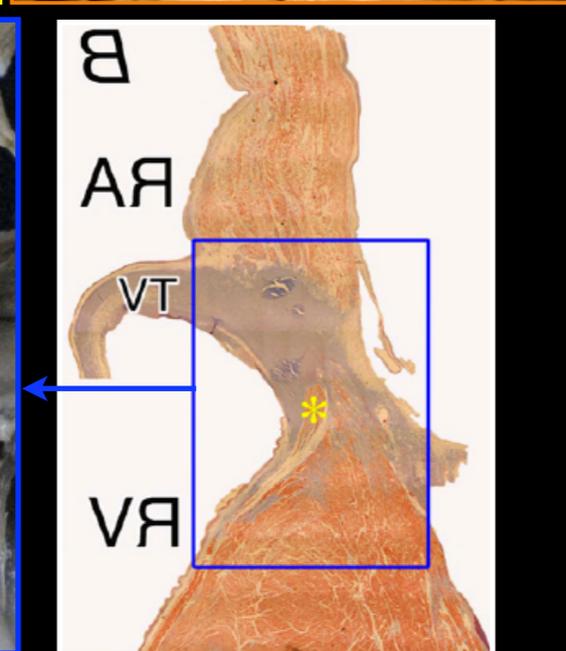
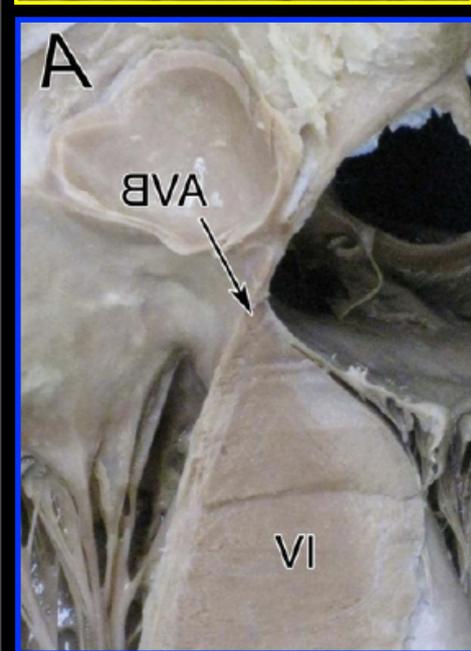


# Systeme cardionecteur

# appareil ventriculo-necteur faisceau atrioventriculaire

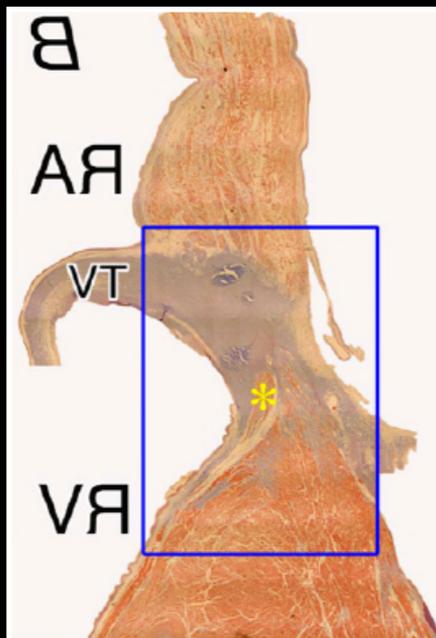
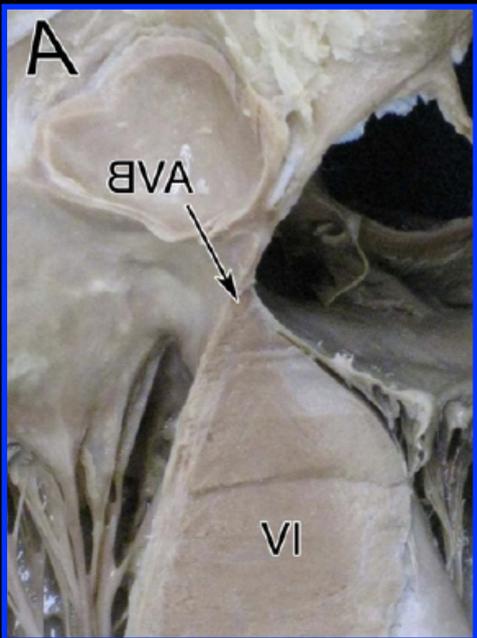
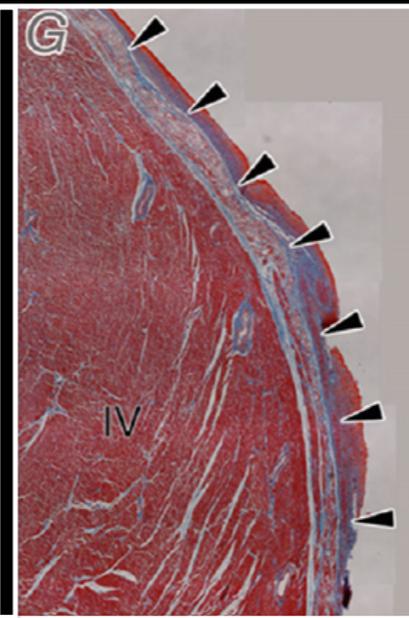
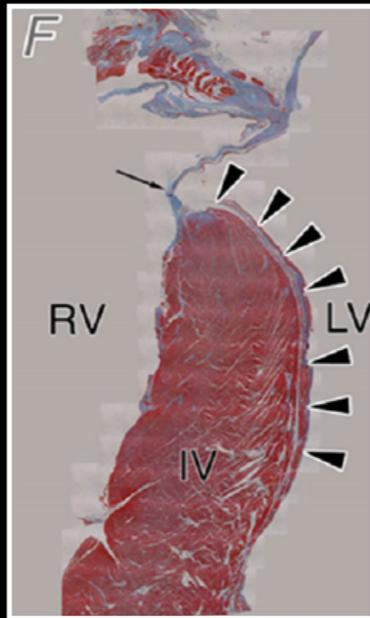
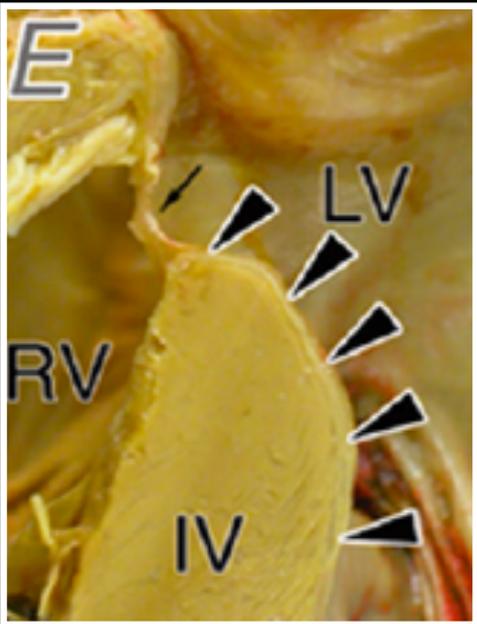
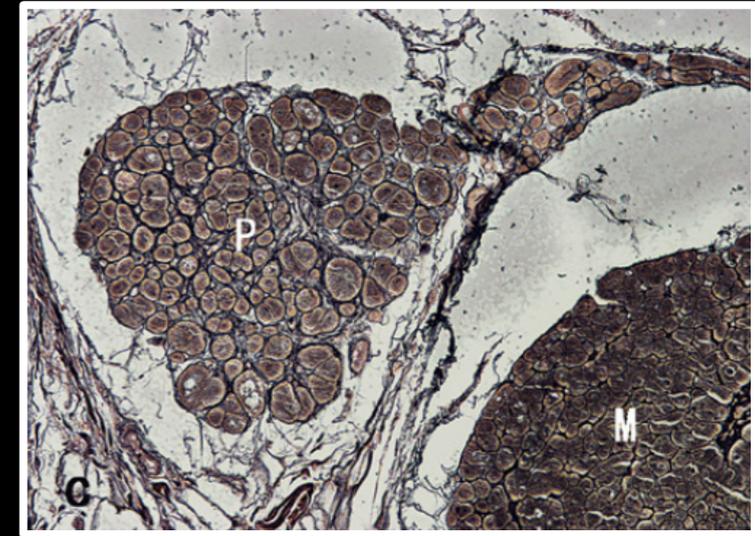
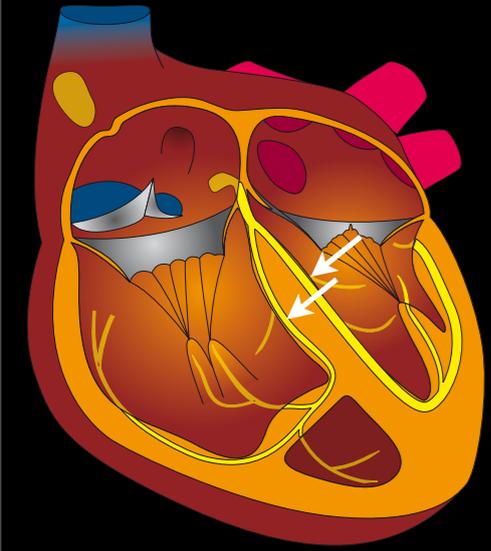


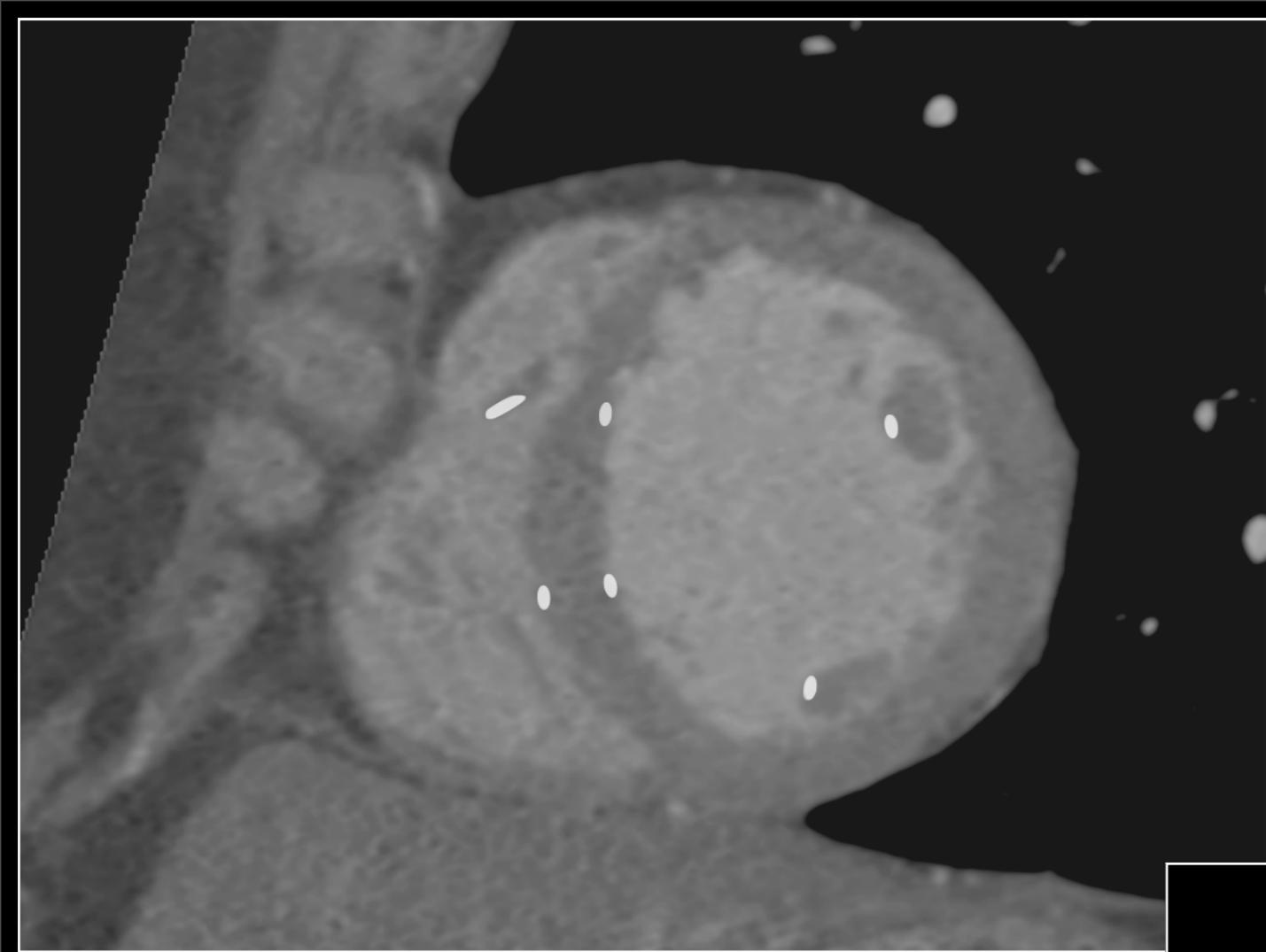
- type I: limite SIV Mb SIV Mu: 47%
- type II: dans le SIV Mu: 32%
- type III: dans le SIV Mb: 21% (protégé ou non)



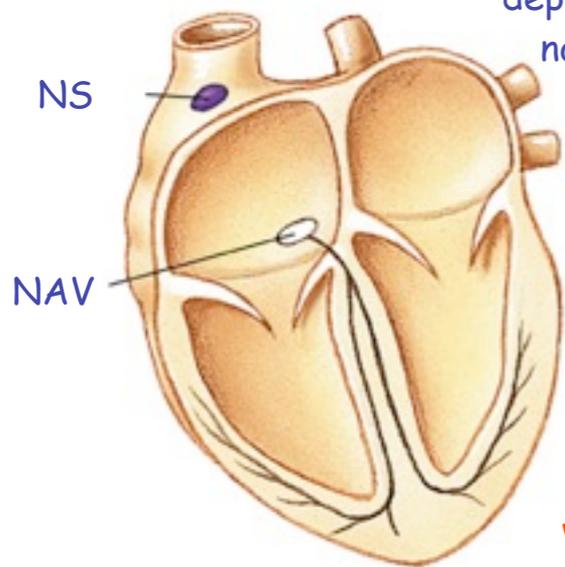
# Systeme cardionecteur

appareil ventriculo-necteur  
branches du faisceau AV



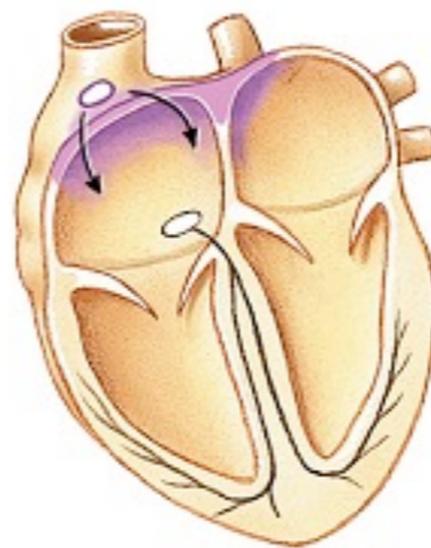


dépolarisation du  
nœud sinusal



$V_c = 0,05 \text{ m/s}$

dépolarisation du  
myocarde  
auriculaire



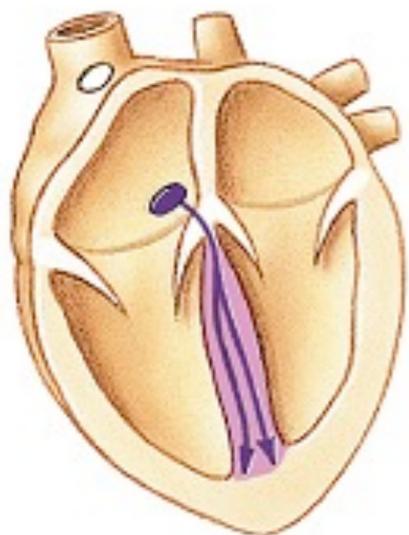
$V_c = 1 \text{ m/s}$

dépolarisation du  
nœud septal :  
ralentissement de  
la conduction



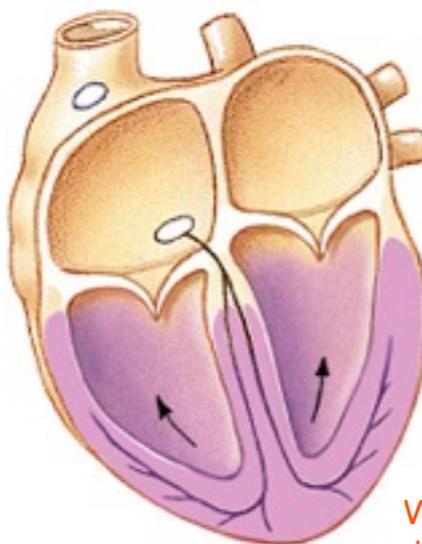
$V_c = 0,05 \text{ m/s}$

Conduction rapide de  
l'excitation vers l'apex  
du cœur par le  
faisceau de His

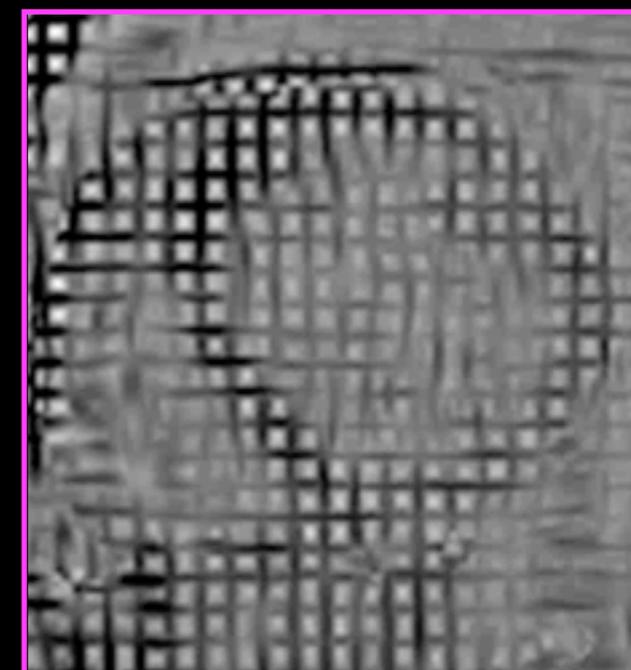
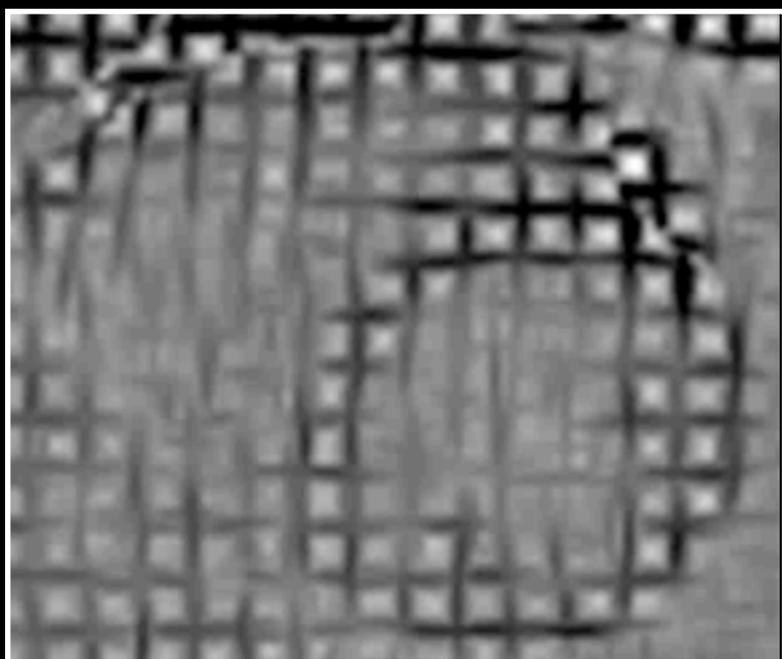
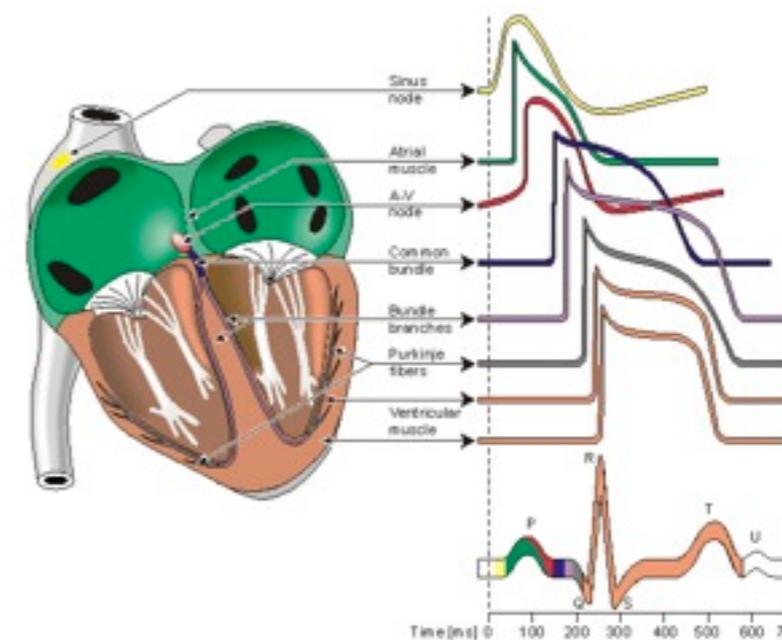


$V_c = 1 \text{ m/s}$

La dépolarisation  
remonte à partir de  
l'apex vers les  
oreillettes

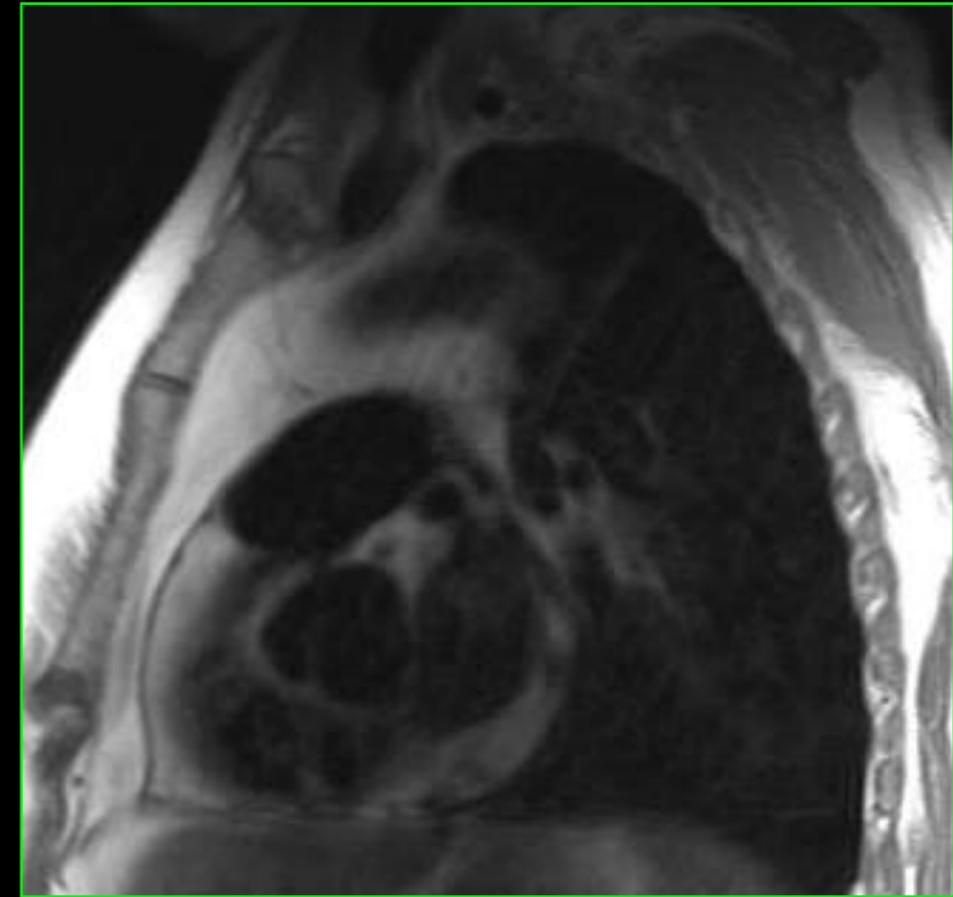


$V_c = 4 \text{ m/s}$  dans le réseau  
de Purkinje

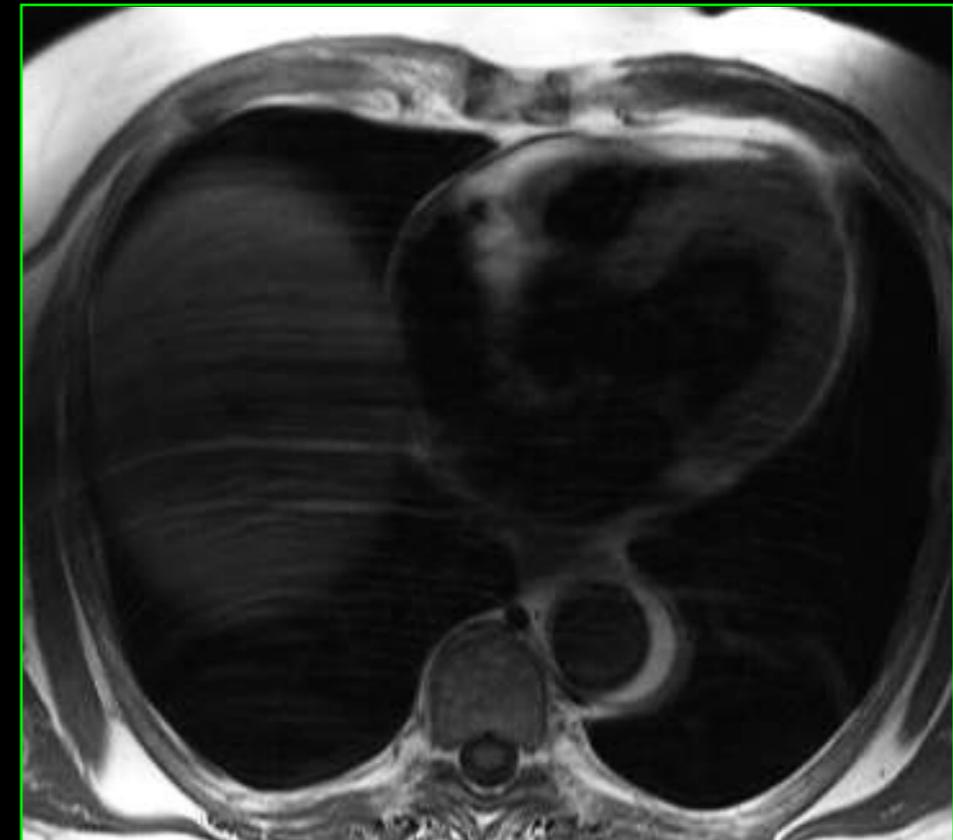
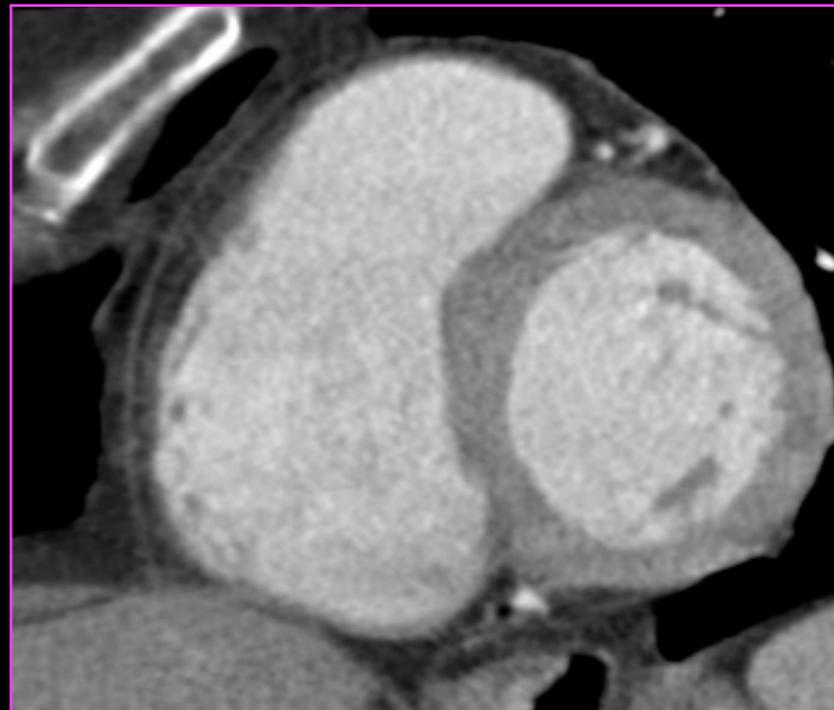


BBG

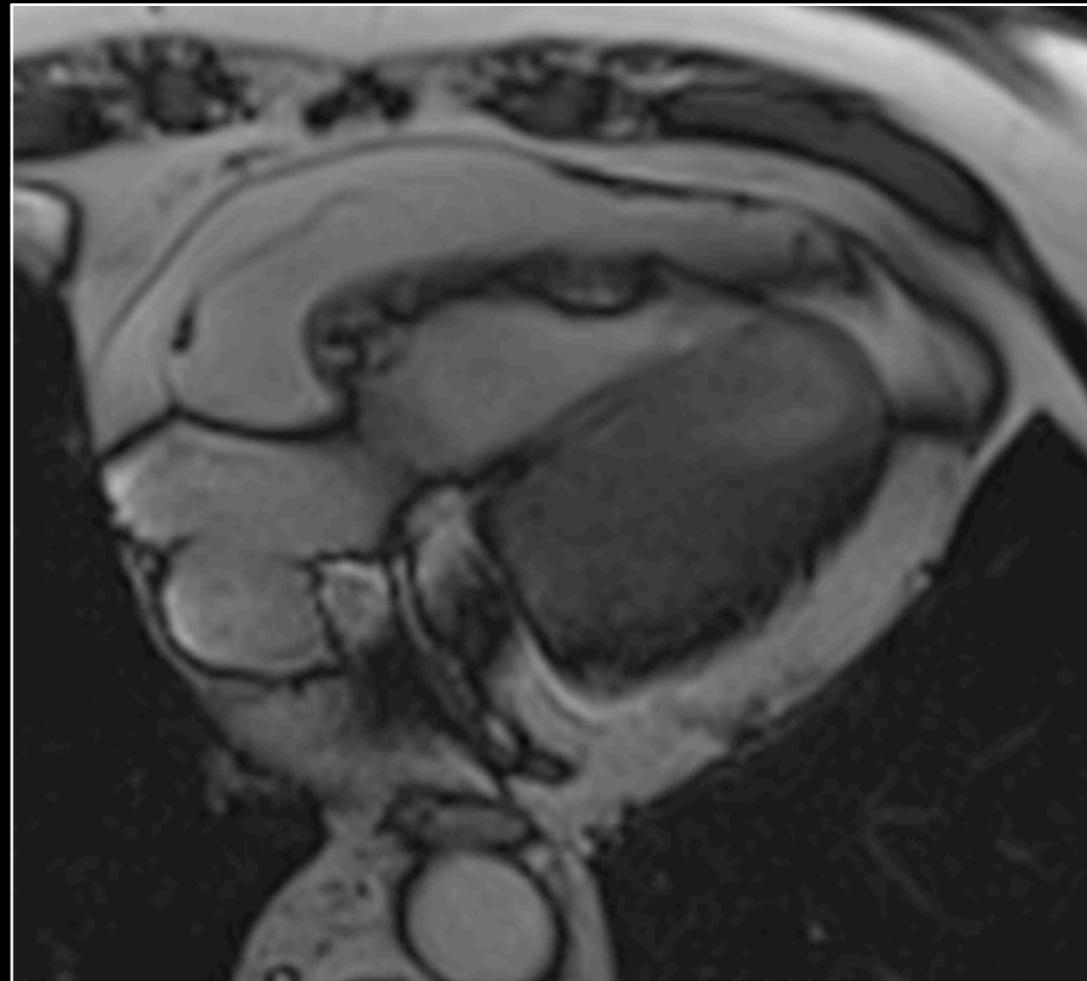
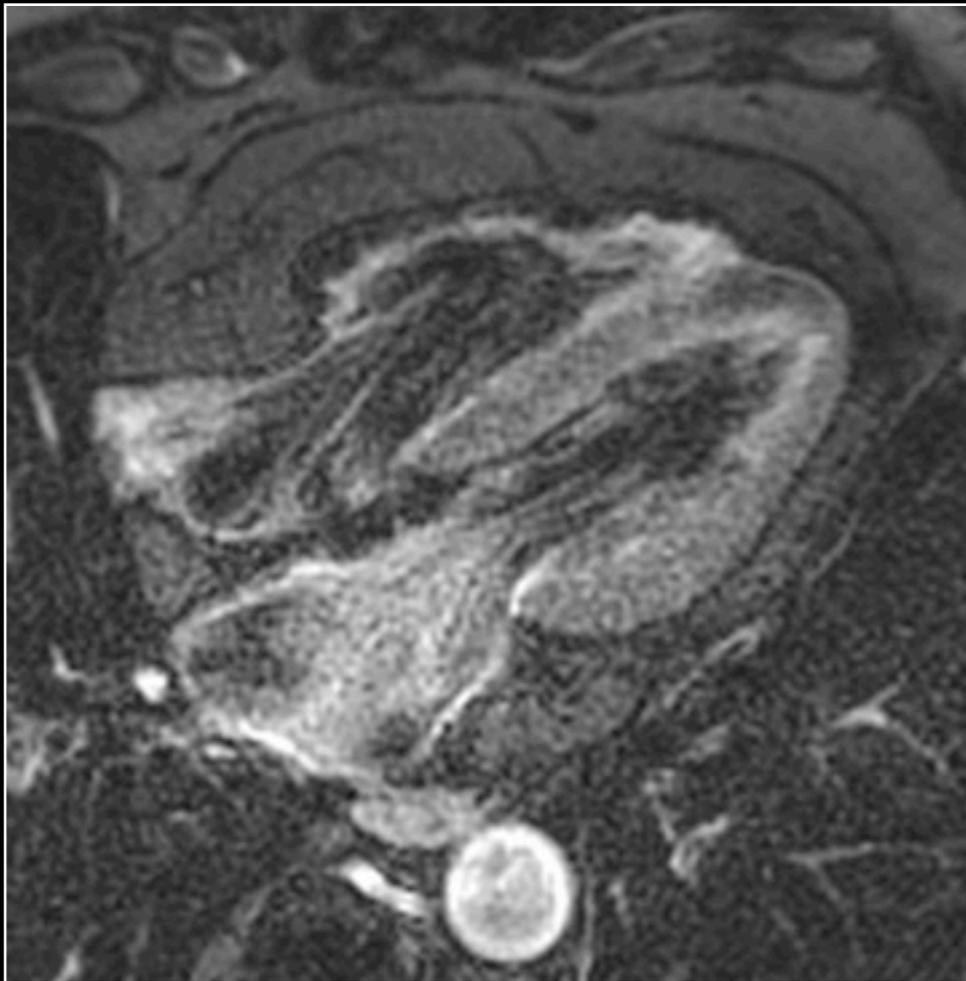
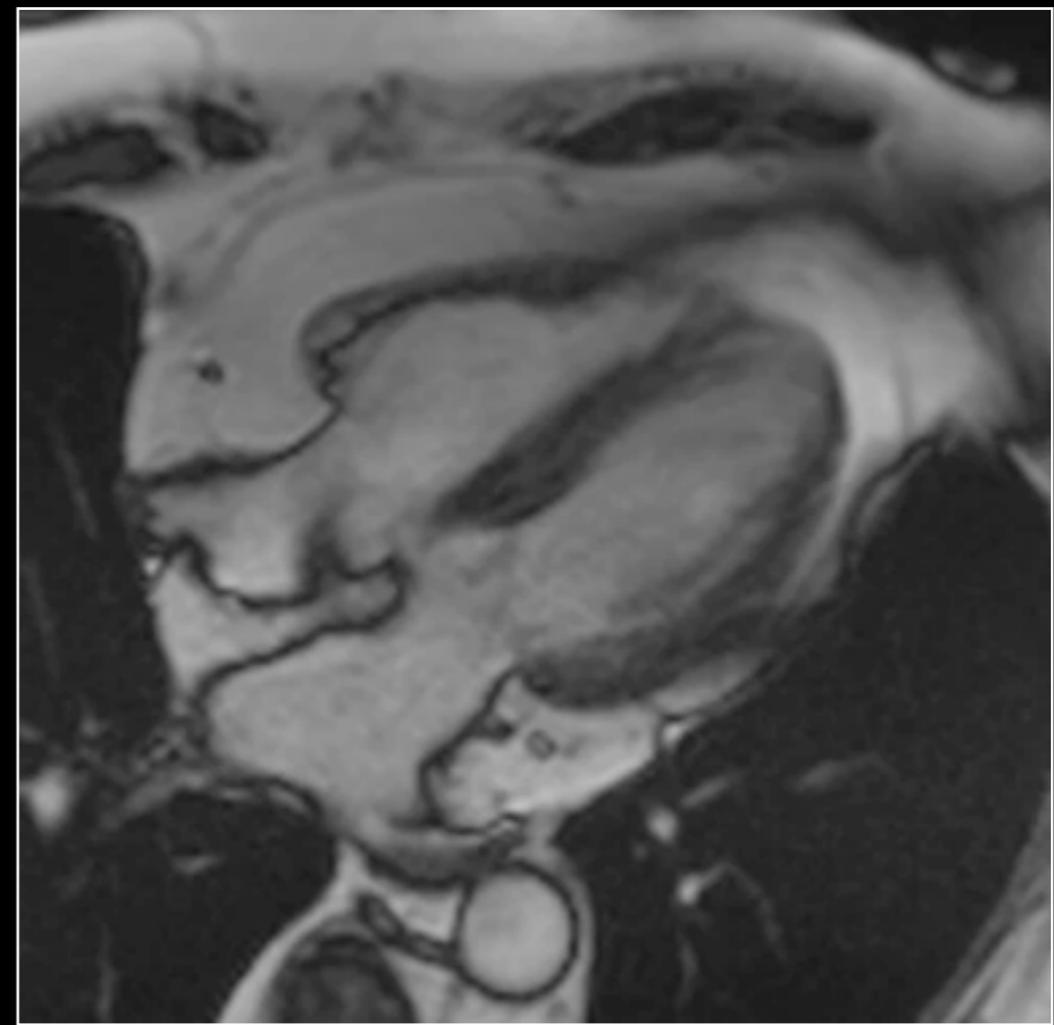
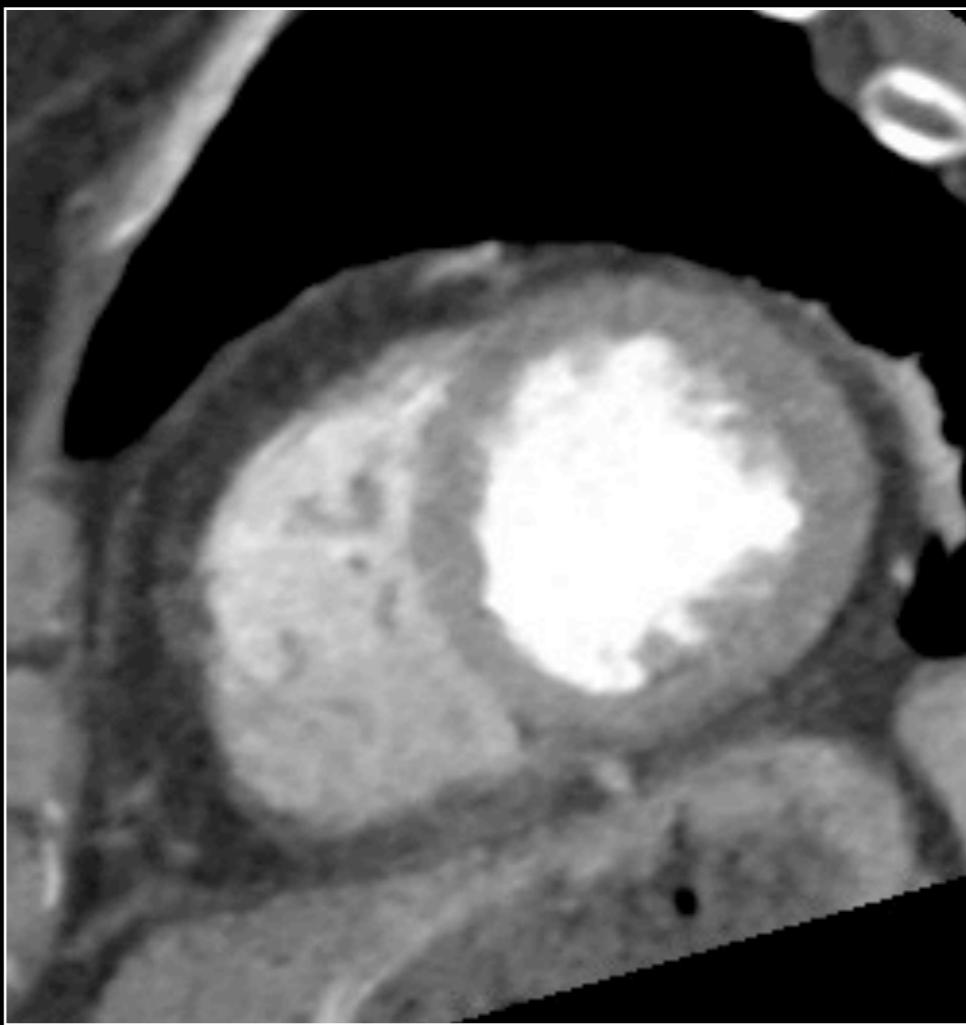
# Péricarde



- entouré par la graisse péricardique et la graisse sous-épicaudique
- épaisseur  $< 2$  mm (pathologique à partir de 4 mm)
- pas visible partout
- pas de rehaussement



graisse d'abondance  
variable

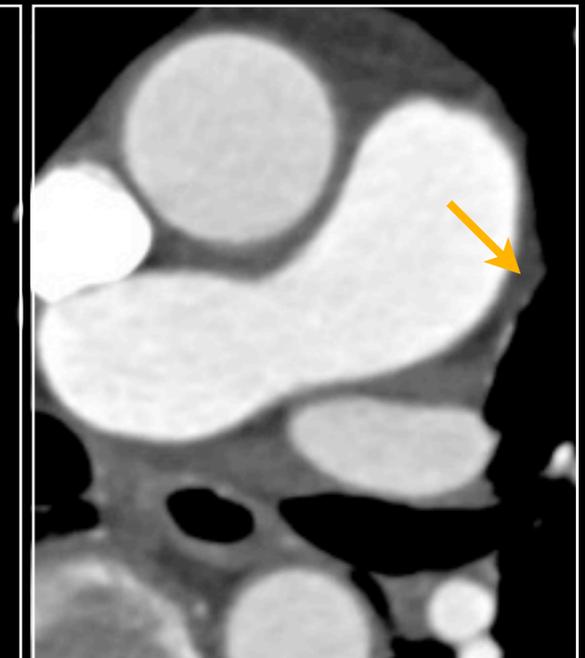
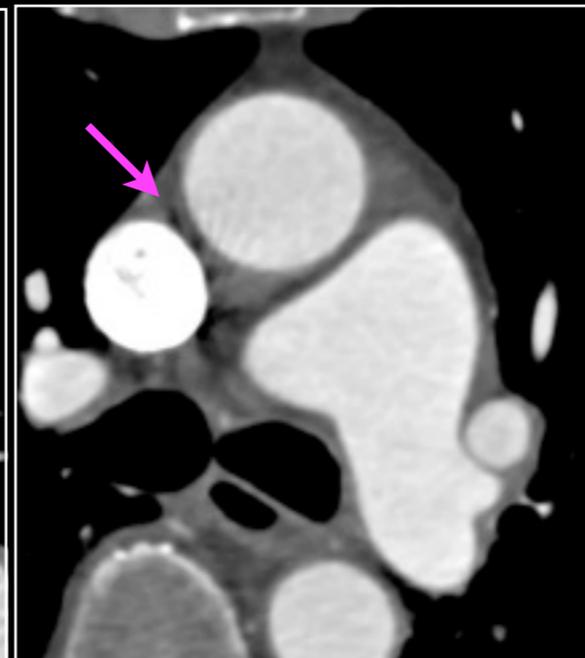
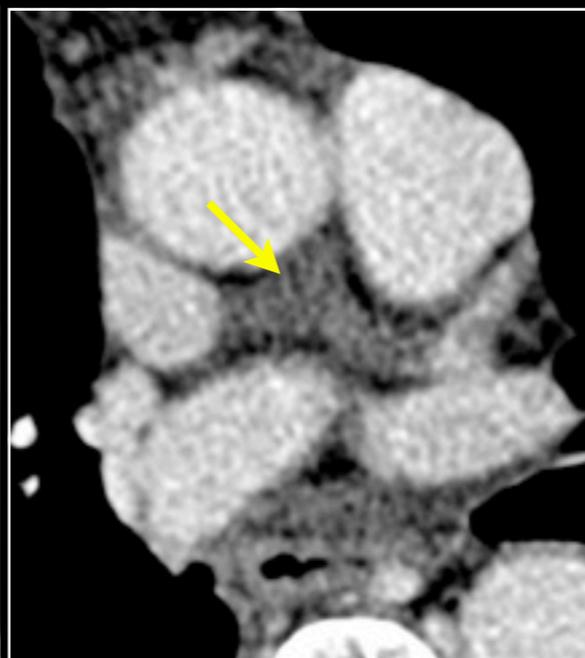
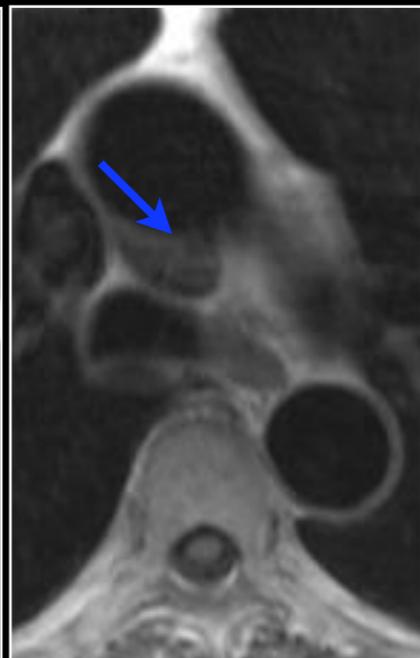
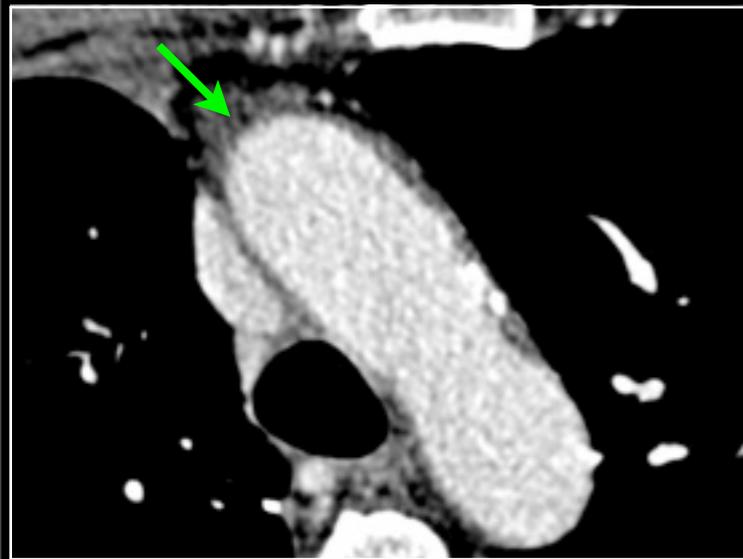
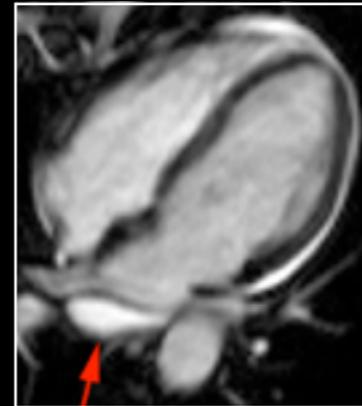
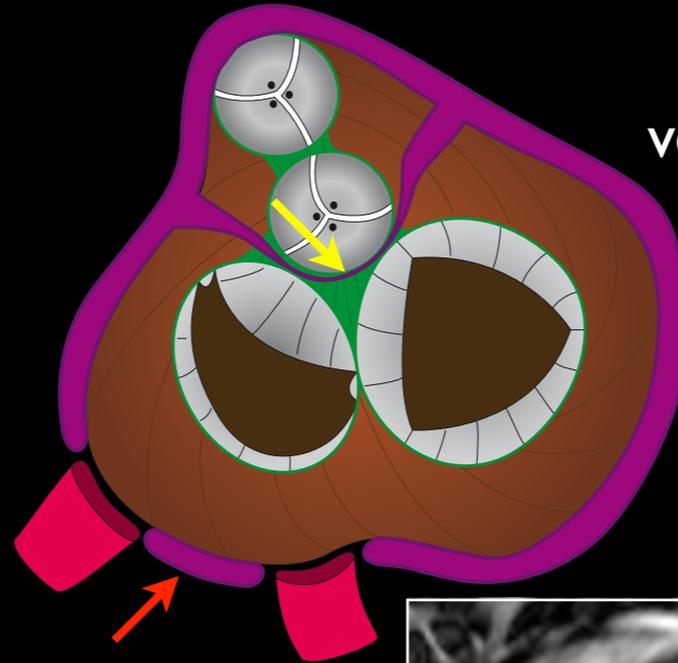
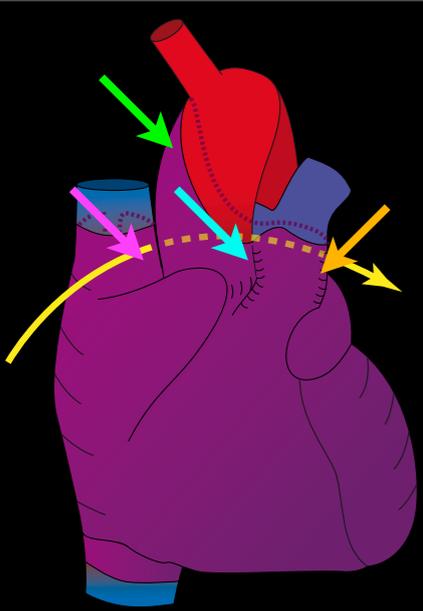


# récessus de la cavité péricardique

cavité péricardique: 15 à 50 ml de liquide sécrété par le feuillet séreux

fonctions:

- limite la dilatation ventriculaire en diastole et le reflux ventriculo-atrial en télé-diastole
- adapte le volume d'éjection du VD à celui du VG
- égalise la compliance des ventricules (interdépendance des remplissages VD et VG)
- fixe le coeur
- diminue les frottements
- protège des processus médiastinaux





The End