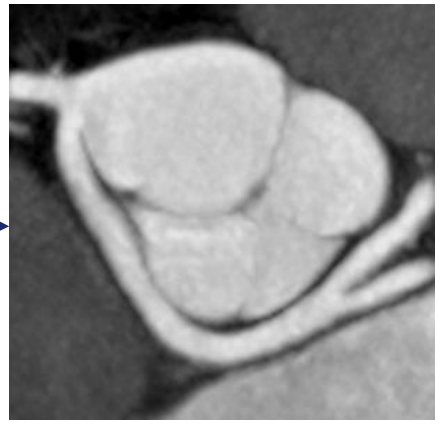
DIU cardiologie interventionnelle
année universitaire 2023-2024

Anomalies Coronaires congénitales (ANOCOR) classification

Pierre Aubry
Hôpital Bichat, Paris 75018
Centre Hospitalier, Gonesse 95500

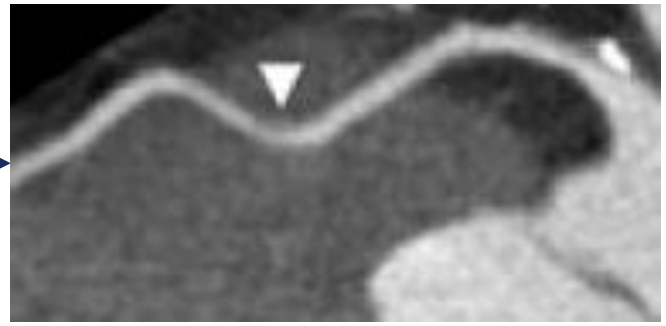
ANOMALIES CORONAIRES CONGENITALES

Connexion proximale



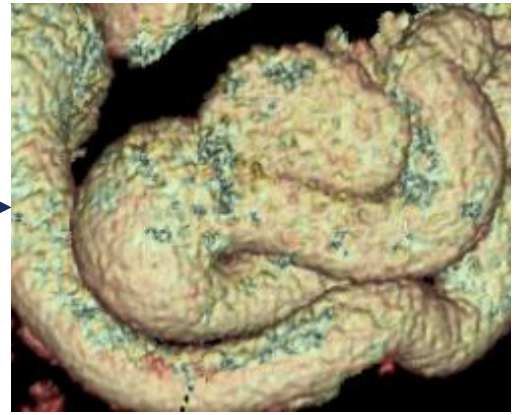
ANOCOR

Trajet



PM

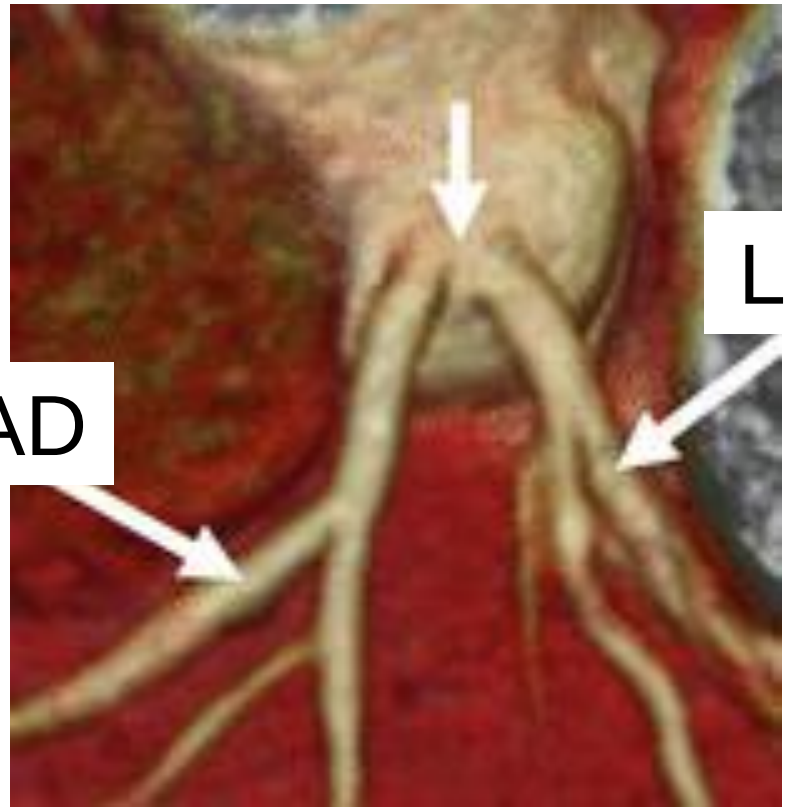
Connexion distale



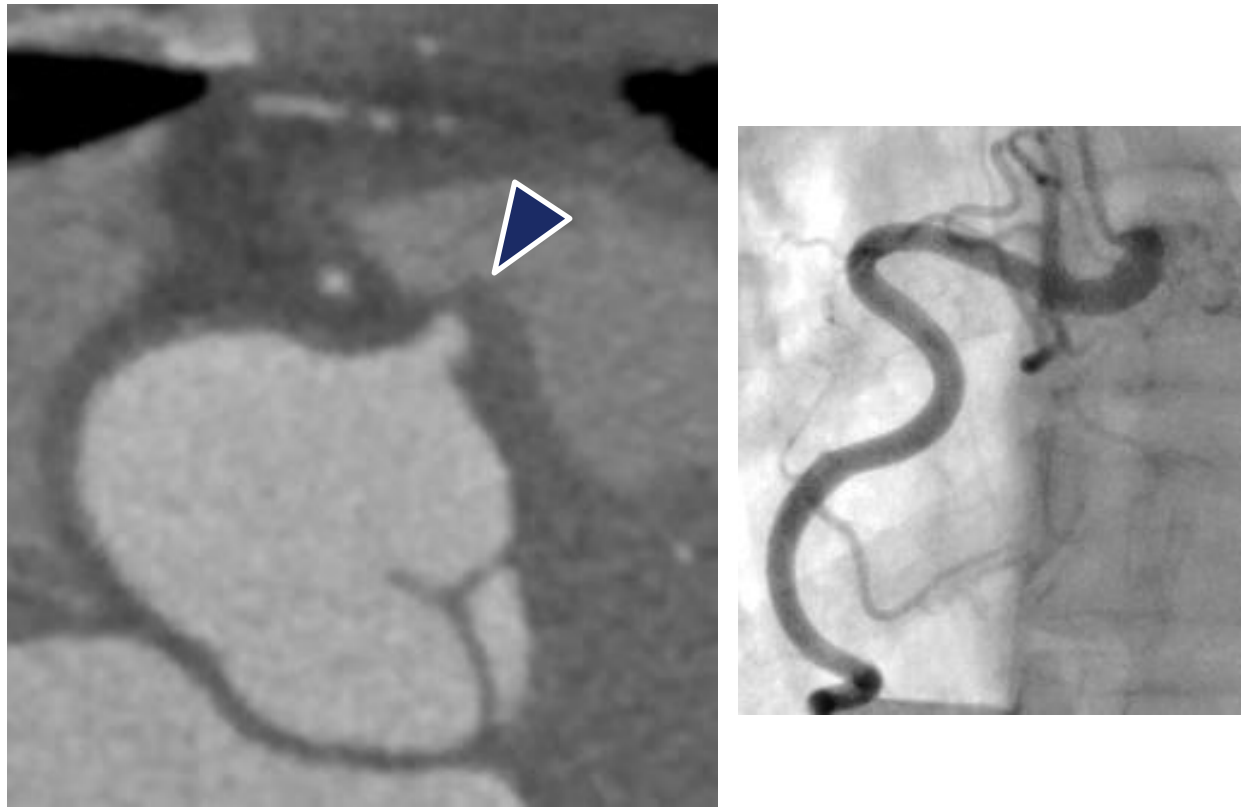
Fistule

- Variantes anatomiques
- Anomalies sur le trajet
- Connexions anormales distales
- Connexions anormales proximales

Variantes anatomiques coronaires



Absence de tronc commun

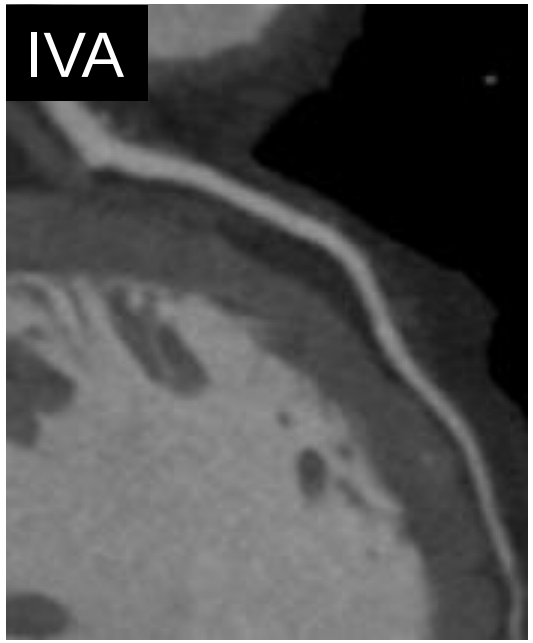


Rotation aortique anti-horaire (anatomique)

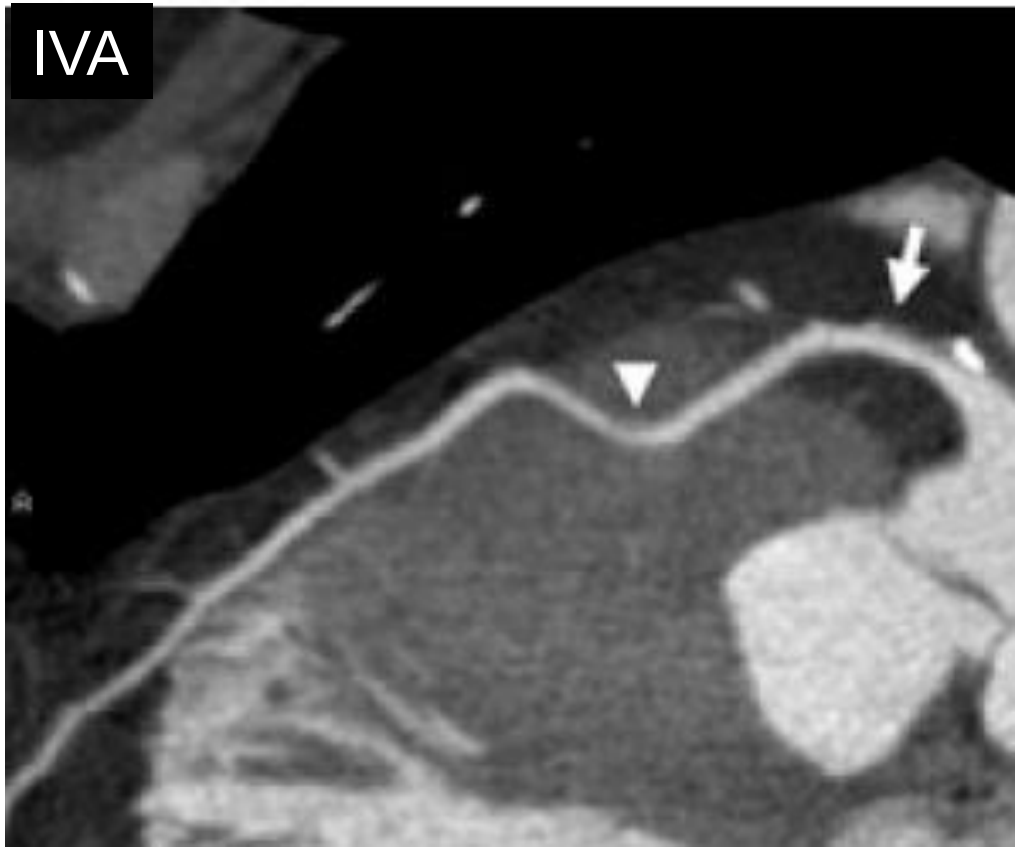
Courtesy of Siegel MJ. Radiology Key. 2016.

- Variantes anatomiques
- Anomalies sur le trajet
- Connexions anormales distales
- Connexions anormales proximales

Trajet coronaire intramyocardique



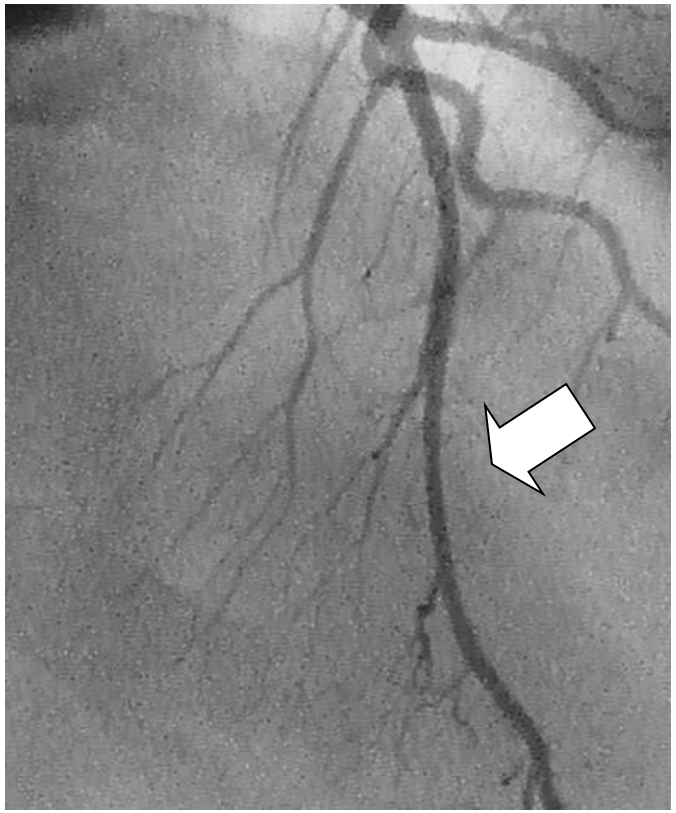
Trajet normal



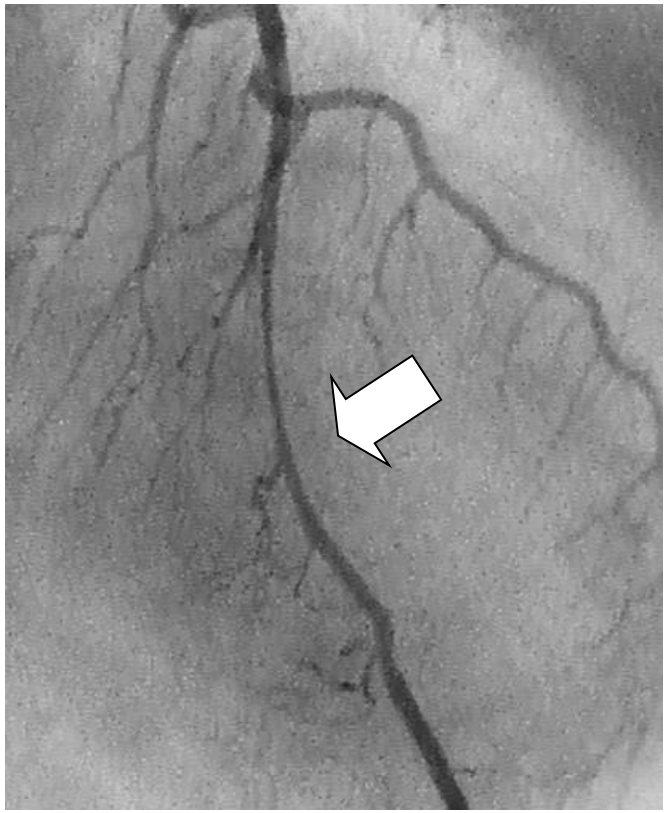
Pont musculaire

- coronarographie 5%
- scanner coronaire 20%

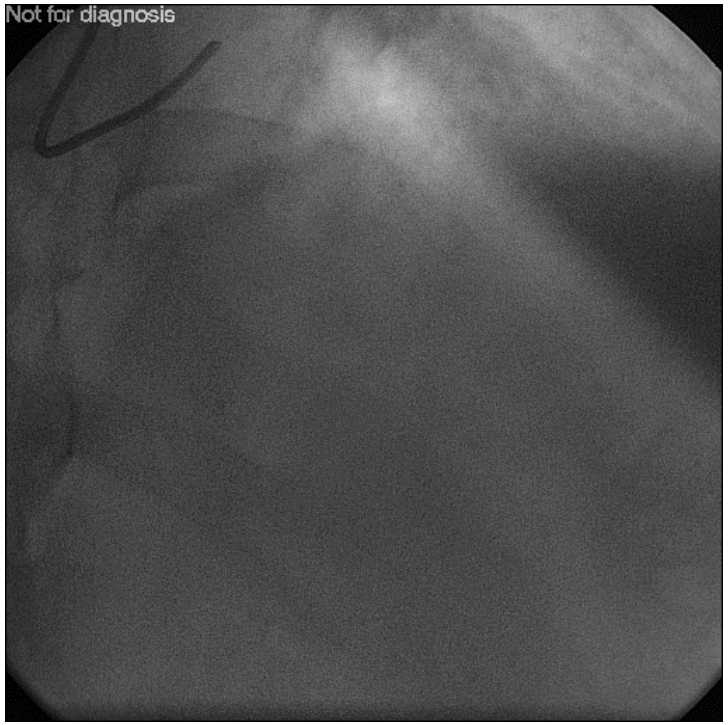
Trajet coronaire intramyocardique



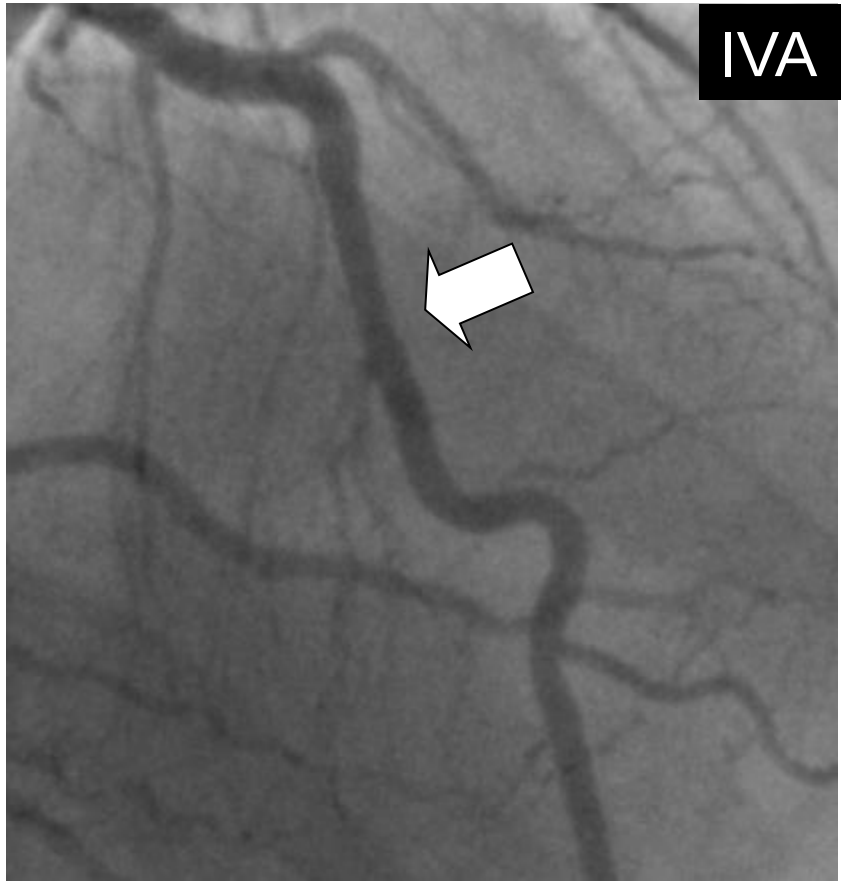
diastole



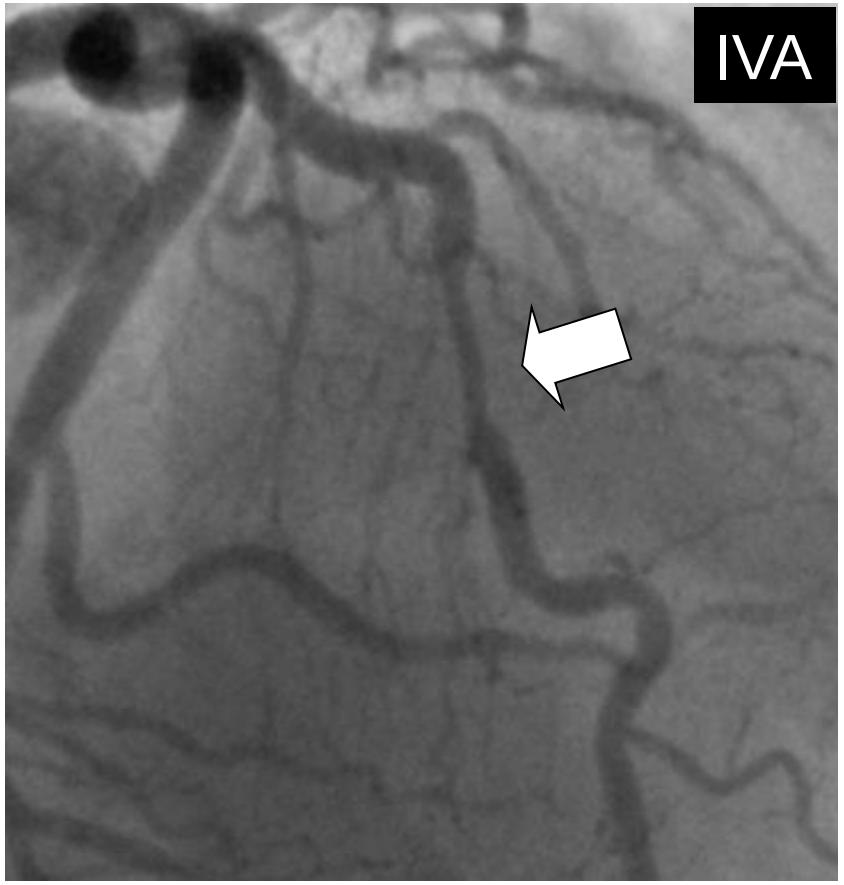
systole



Trajet coronaire intramyocardique



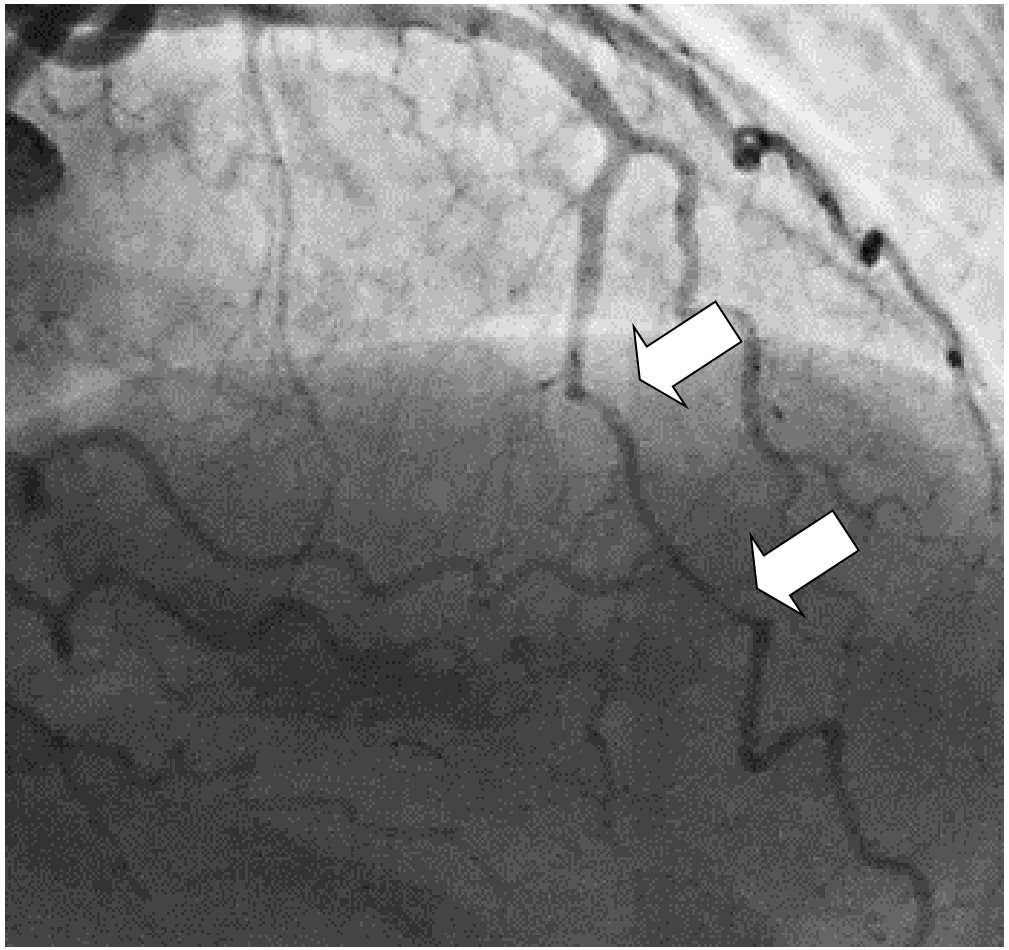
Systole avant nitré

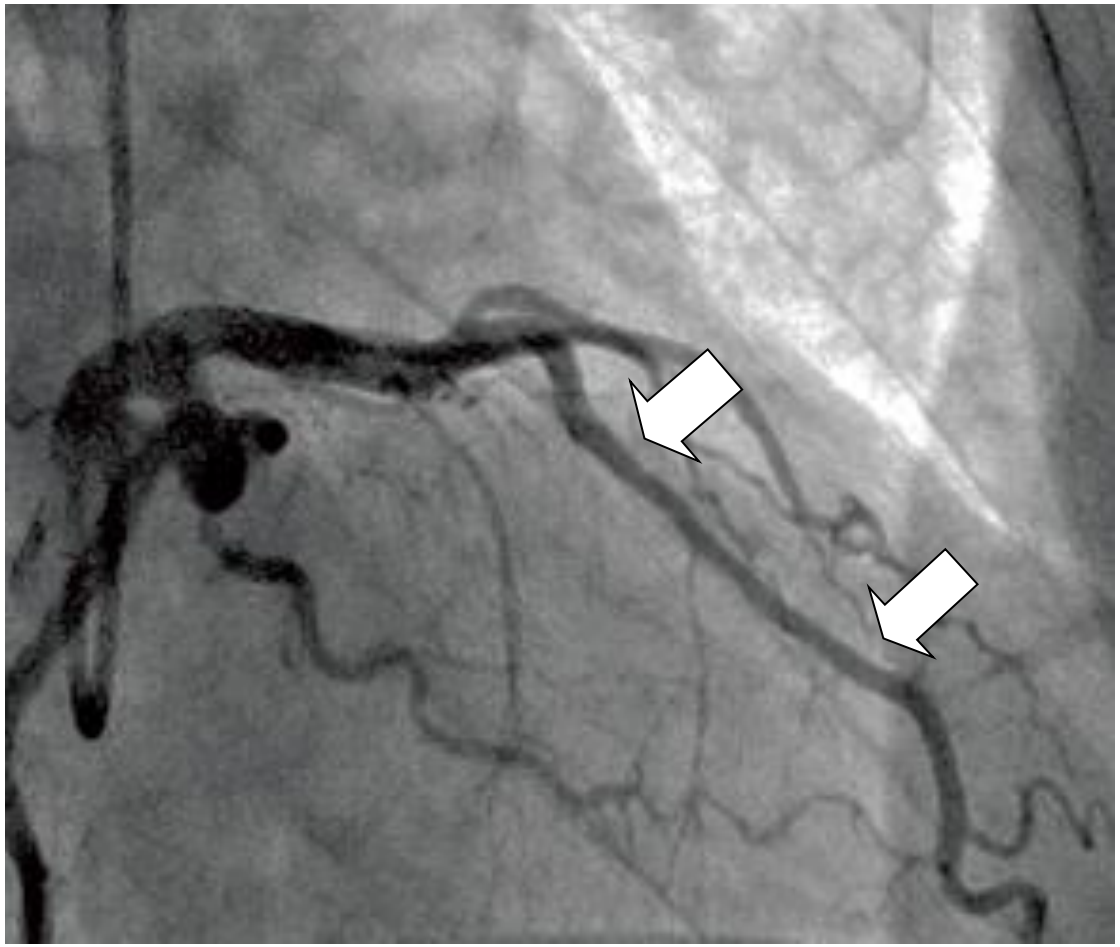


Systole après nitré

DIU cardiologie interventionnelle

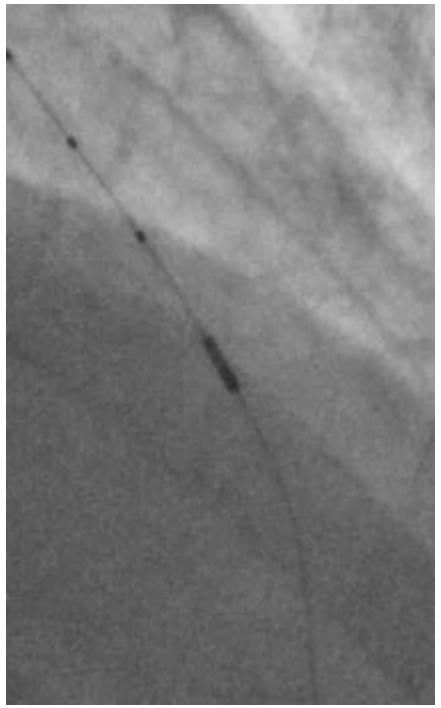
Trajet coronaire intramyocardique ?

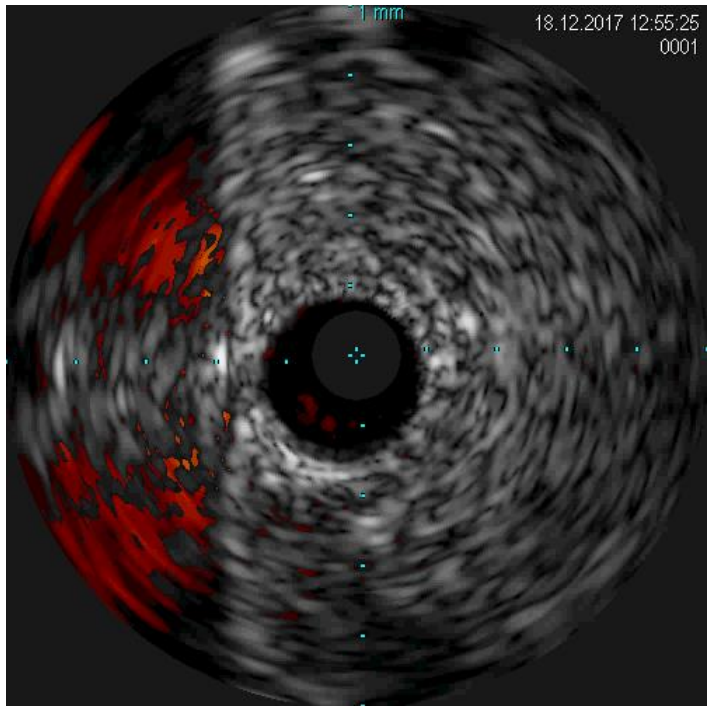




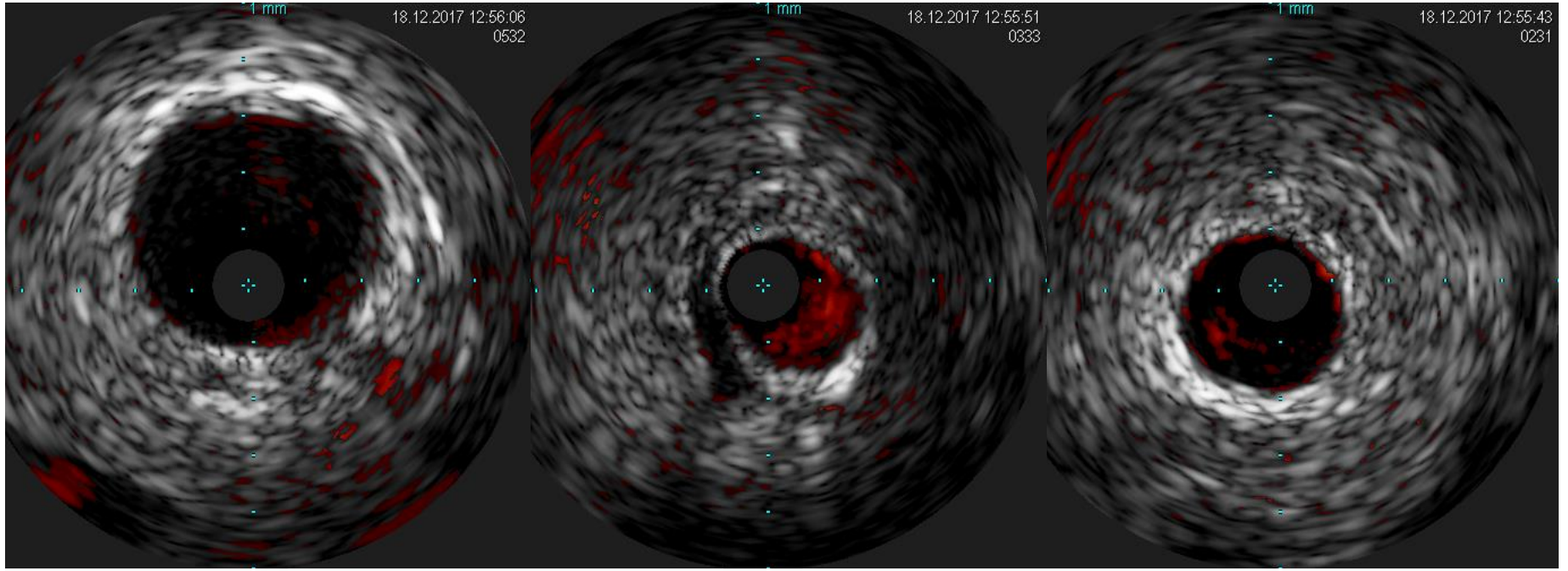
Trajet coronaire intramyocardique ?

Imagerie endocoronaire



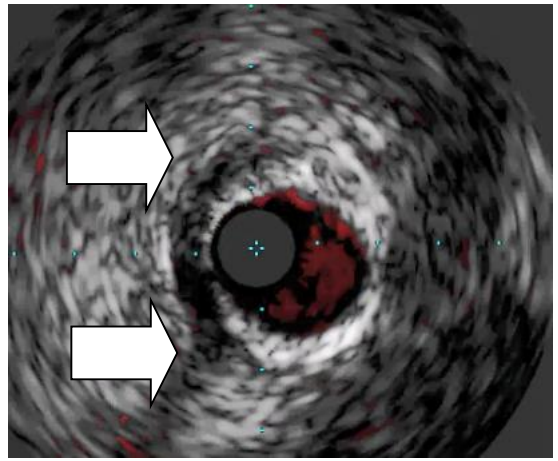


Trajet coronaire intramyocardique



IVA I IVA II (pont musculaire) IVA III

Half-moon sign



Trajet coronaire intramyocardique

douleur thoracique suspecte
(événement cardiaque fréquent)
+
trajet coronaire intramyocardique
(particularité anatomique non rare)

situation non rare

lien de causalité ?

trajet intramyocardique incident

trajet intramyocardique pathologique

Trajets coronaires intramyocardiques

JOURNAL OF THE AMERICAN COLLEGE OF CARDIOLOGY VOL. 78, NO. 22, 2021
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THE PRESENT AND FUTURE

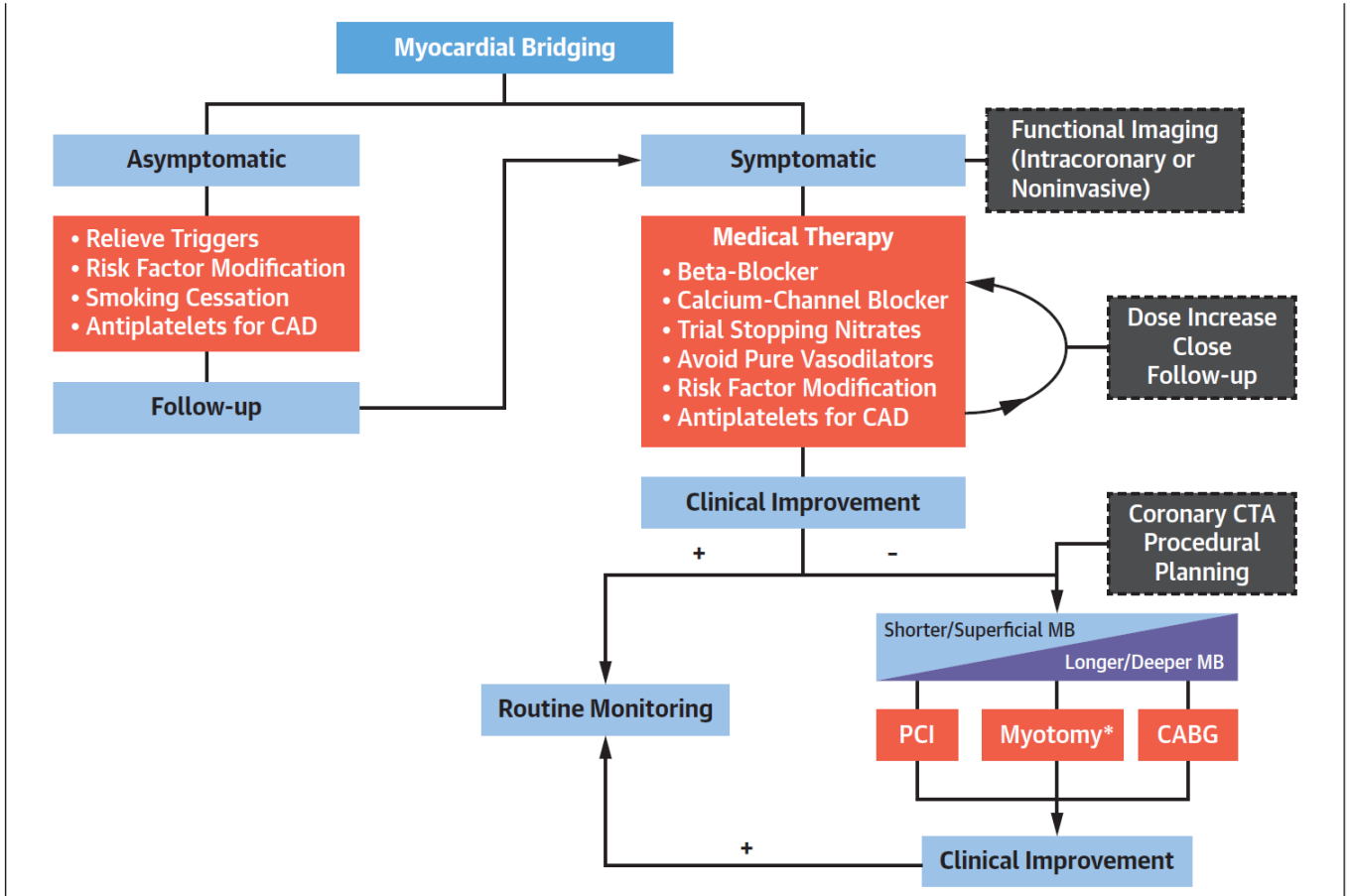
JACC STATE-OF-THE-ART REVIEW

Myocardial Bridging: Diagnosis, Functional Assessment, and Management

JACC State-of-the-Art Review

David Sternheim, MD,[a,*] David A. Power, MD,[a,*] Rajeev Samtani, MD,[a] Anapoorna Kini, MD,[a] Valentin Fuster, MD, PHD,[a,b] Samin Sharma, MD[a]

Trajet coronaire intramyocardique



Flow diagram with proposed strategy for the management of asymptomatic and symptomatic MB. Triggers include coronary vasospasm, smoking and stimulants (cocaine), physiological stress, poor functional exercise reserve. *Surgical myotomy should be considered as a first-line therapy if performed at an experienced myotomy center *and* if favorable anatomy is present. CABG = coronary artery bypass grafting, CAD = coronary artery disease; CTA = computed tomography angiography; MB = myocardial bridging; PCI = percutaneous coronary intervention.

Sternheim, D. et al. J Am Coll Cardiol. 2021;78(22):2196-2212.

Trajets coronaires intramyocardiques

Description dans un compte-rendu

- trajet intramyocardique : certain/vraisemblable
- compression systolique : oui (degré) / non

- Variantes anatomiques
- Anomalies sur le trajet
- Connexions anormales distales
- Connexions anormales proximales

Connexions anormales distales ou fistules coronaires

Prévalence angiographique ≈ 0.1%

Classification

- Vaisseau donneur
- Origine sur vaisseau donneur
- Site de connexion distale
- Nombre
- Taille de la fistule
- Retentissement

Fistules coronaires - sites de connexion distale

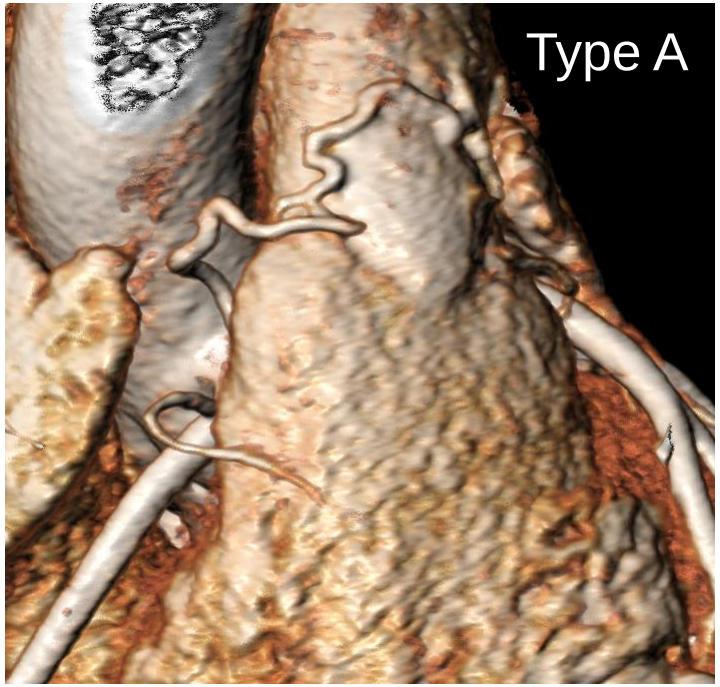
ANOMALIES DE TERMINAISON
=
FISTULES CORONAIRES

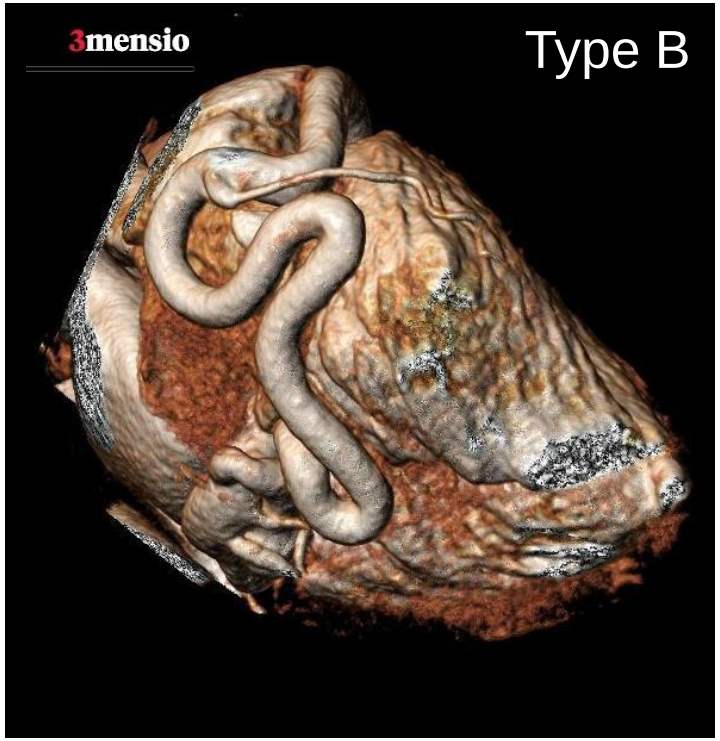
CORONARO - CAMÉRALES	DRAINAGE : OD VD OG VG CONGÉNITALES +++
CORONARO - VEINEUSES	DRAINAGE : VCS VCI SC CONGÉNITALES +++
CORONARO - PULMONAIRES	DRAINAGE : TRONC PULMONAIRE CONGÉNITALES SOUVENT
CORONARO - BRONCHIQUES	ANASTOMOSES AVEC RESEAU ARTERIEL BRONCHIQUE ACQUISES SOUVENT

Fistules coronaires
Classification

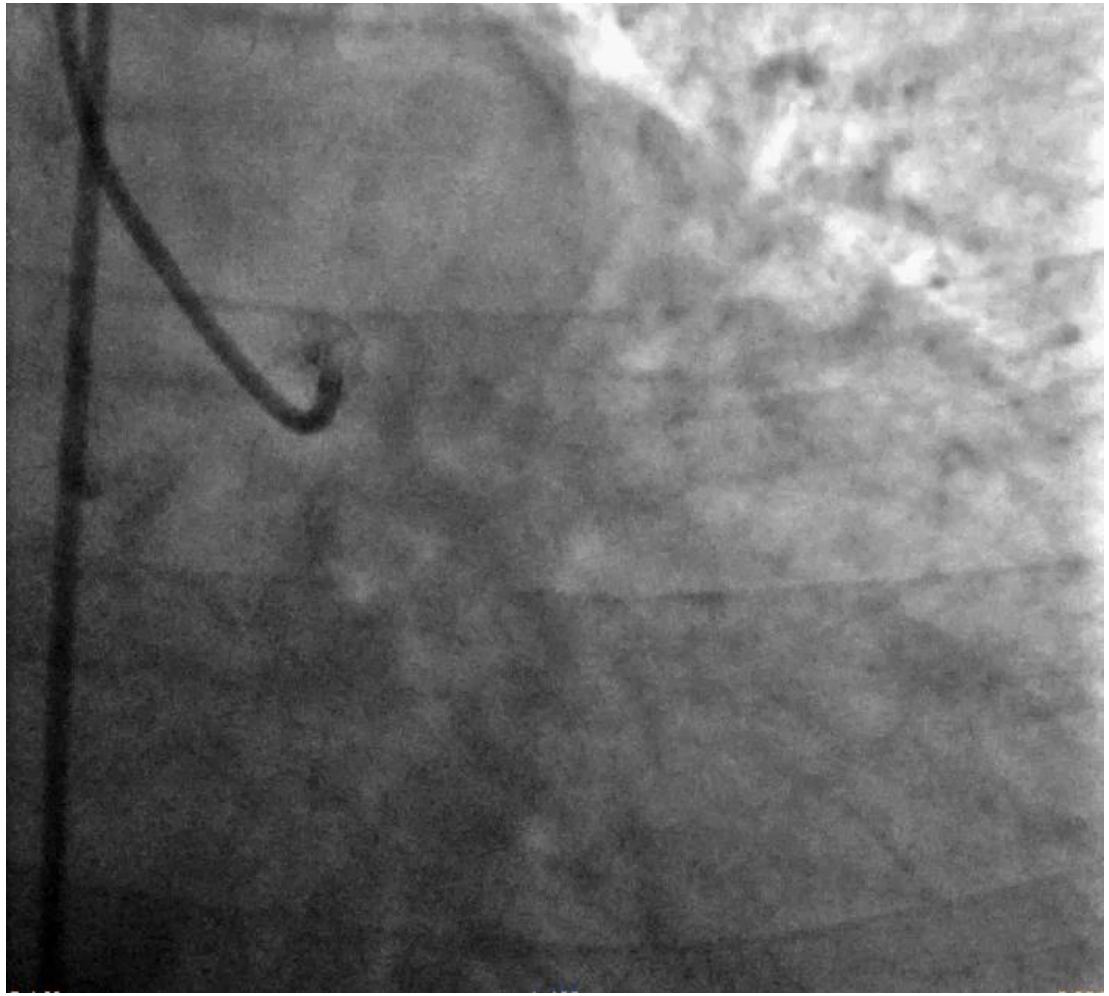
- Vaisseau coronaire donneur

- Origine sur vaisseau donneur
  type A : tiers proximal
  type B : tiers moyen ou distal

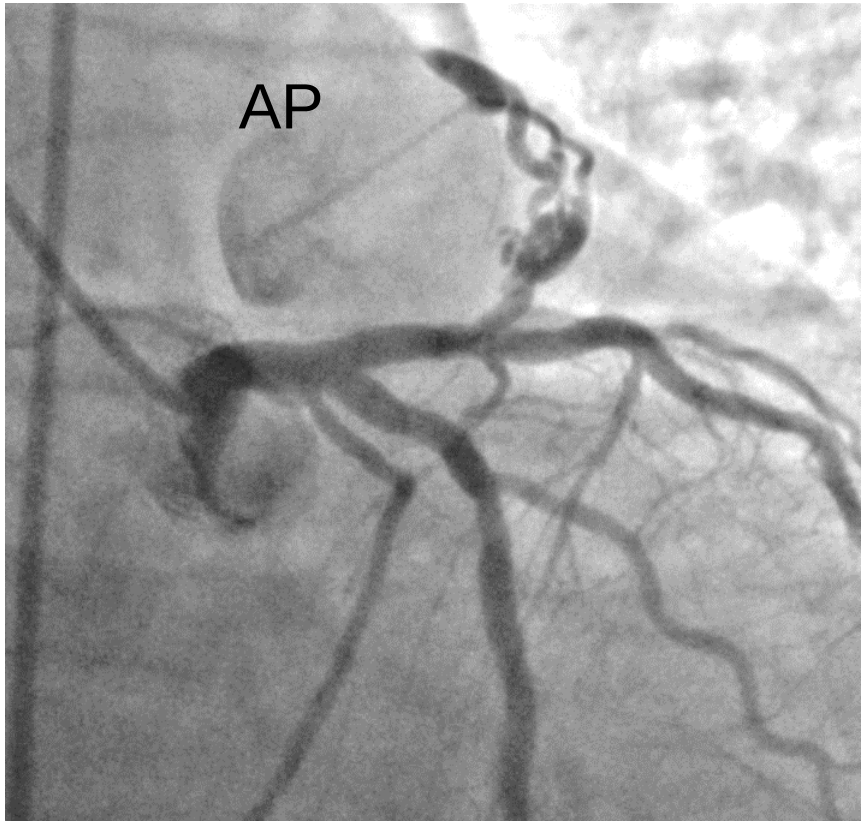




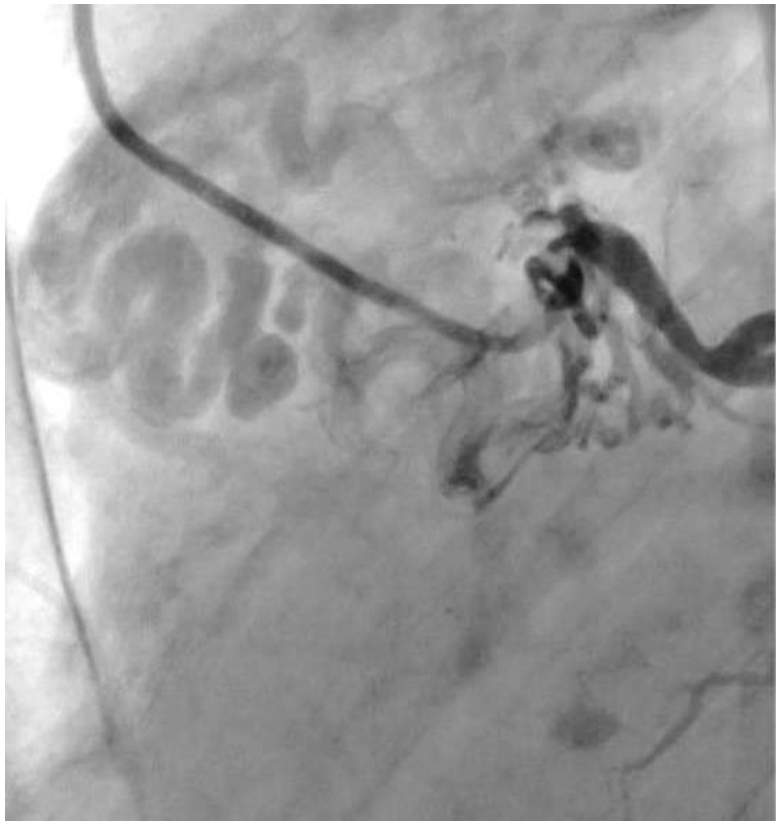
Fistule IVA-AP

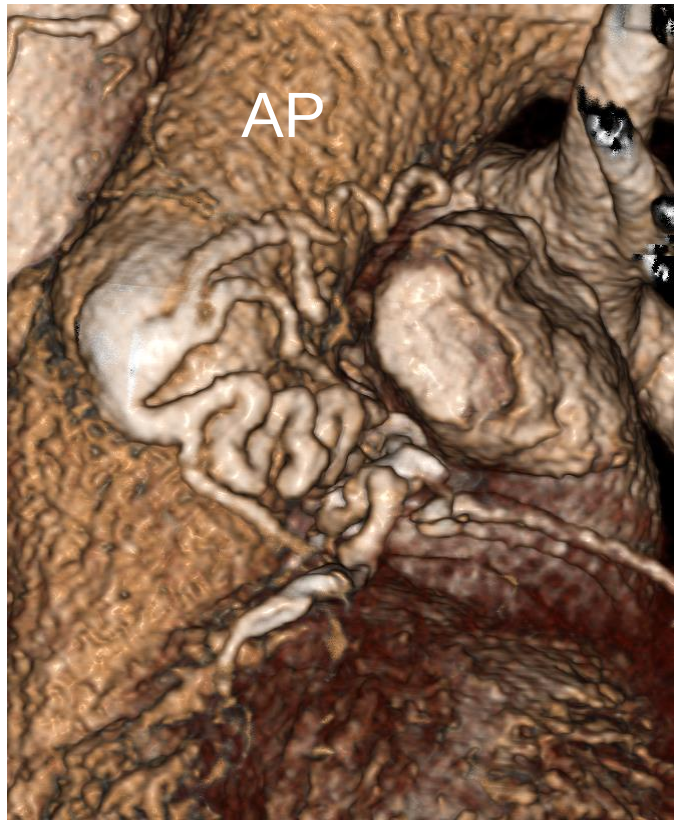


Fistules coronaropulmonaires

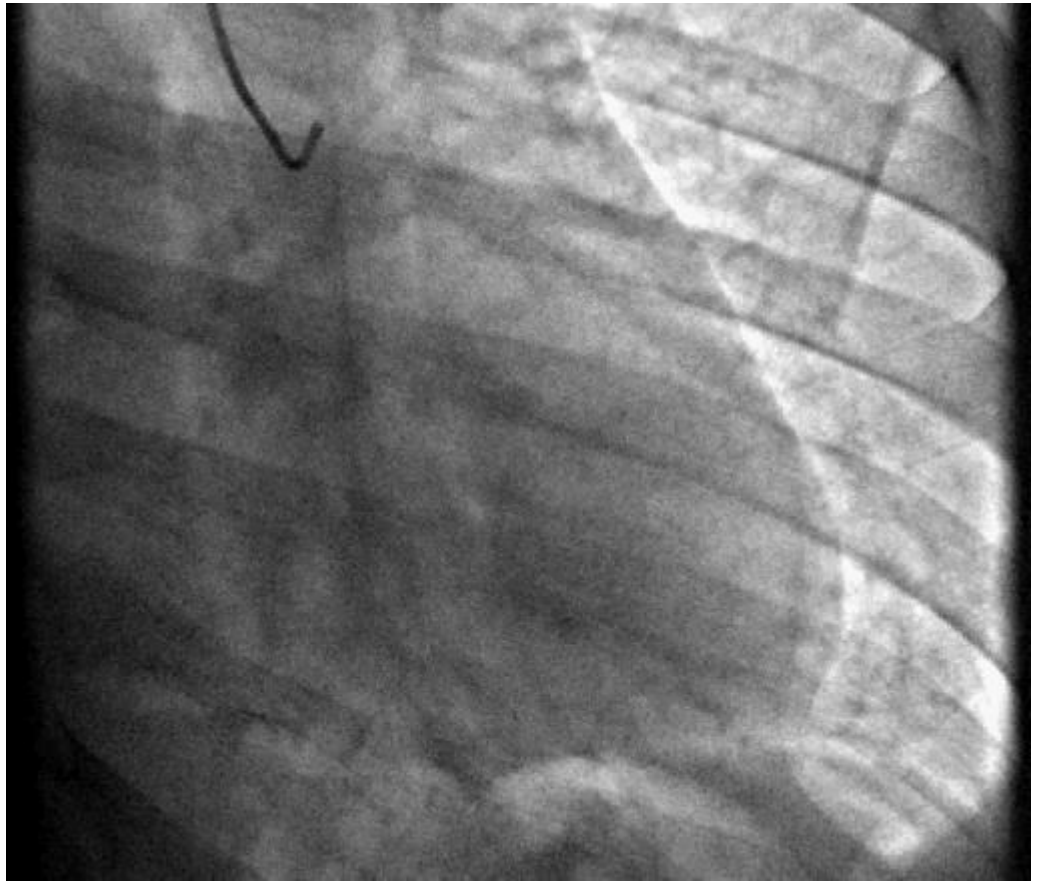


Fistule IVA-AP



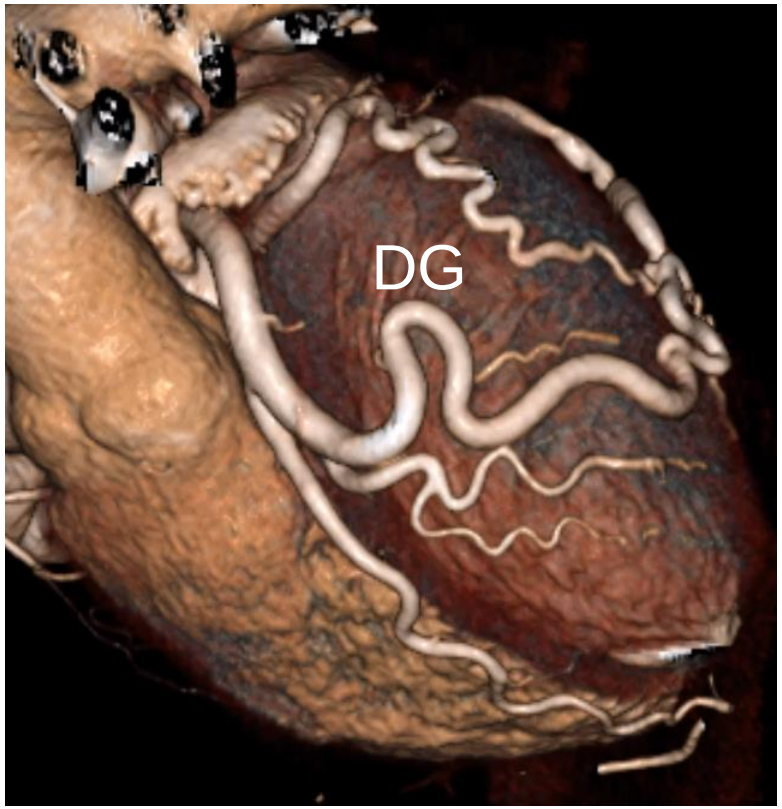


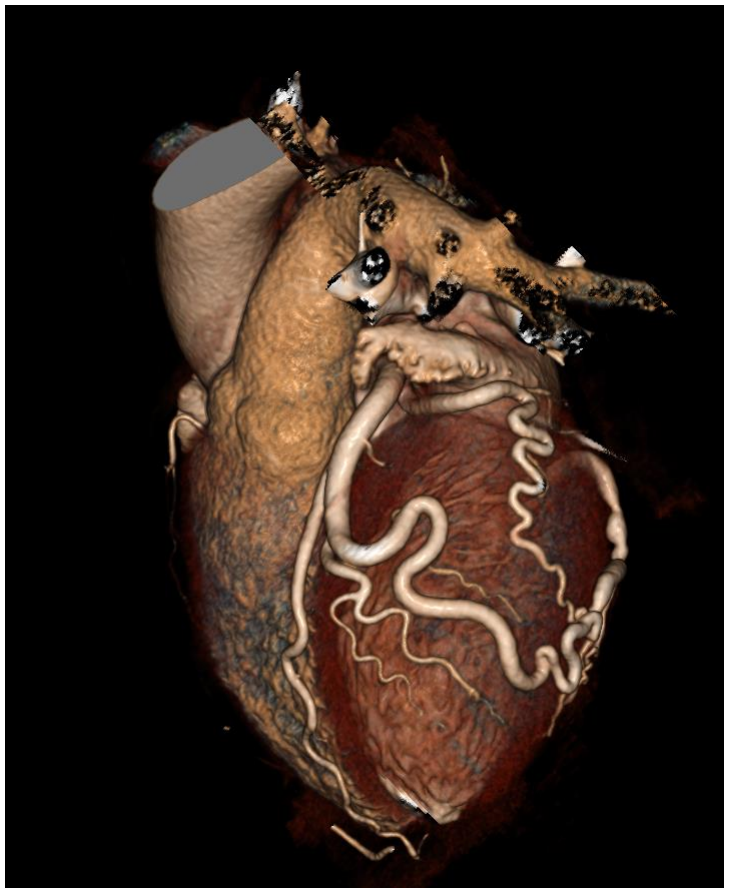
Fistules IVA-AP

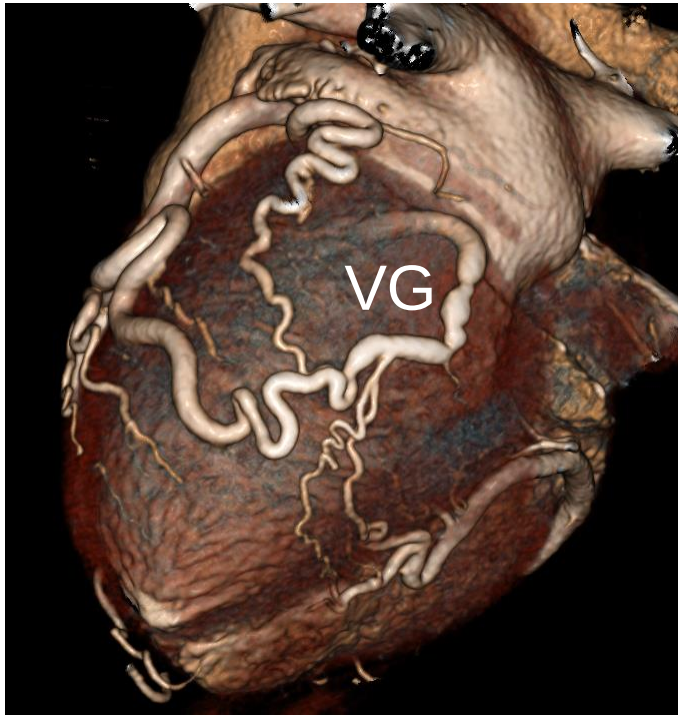


Fistule CX-sinus coronaire (type B)

Fistules coronaroventriculaires gauches (type B)







Fistules multiples

Fistules coronaires

JACC: CARDIOVASCULAR INTERVENTIONS
VOL. 14, NO. 13, 2021
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STATE-OF-THE-ART REVIEW

CORONARY

Coronary Artery Fistulas

Indications, Techniques, Outcomes, and Complications of Transcatheter Fistula Closure

Mohammed Al-Hijji, MD,[a,b] Abdallah El Sabbagh, MD,[c] Stephanie El Hajj, MD,[a] Mohamad AlKhouli, MD,[a] Bassim El Sabawi, MD,[a] Allison Cabalka, MD,[a] William R. Miranda, MD,[a] David R. Holmes, MD,[a] Charanjit S. Rihal, MD[a]

Classification

- Taille du vaisseau donneur (type A)

  - fistule large :
  >2 fois taille vaisseau donneur en aval connexion
  - fistule moyenne :
  1-2 fois taille vaisseau donneur en aval connexion
  -b fistule petite :
  <1 fois taille vaisseau donneur en aval connexion

Reddy G et al. Circ Cardiovasc Int. 2015.

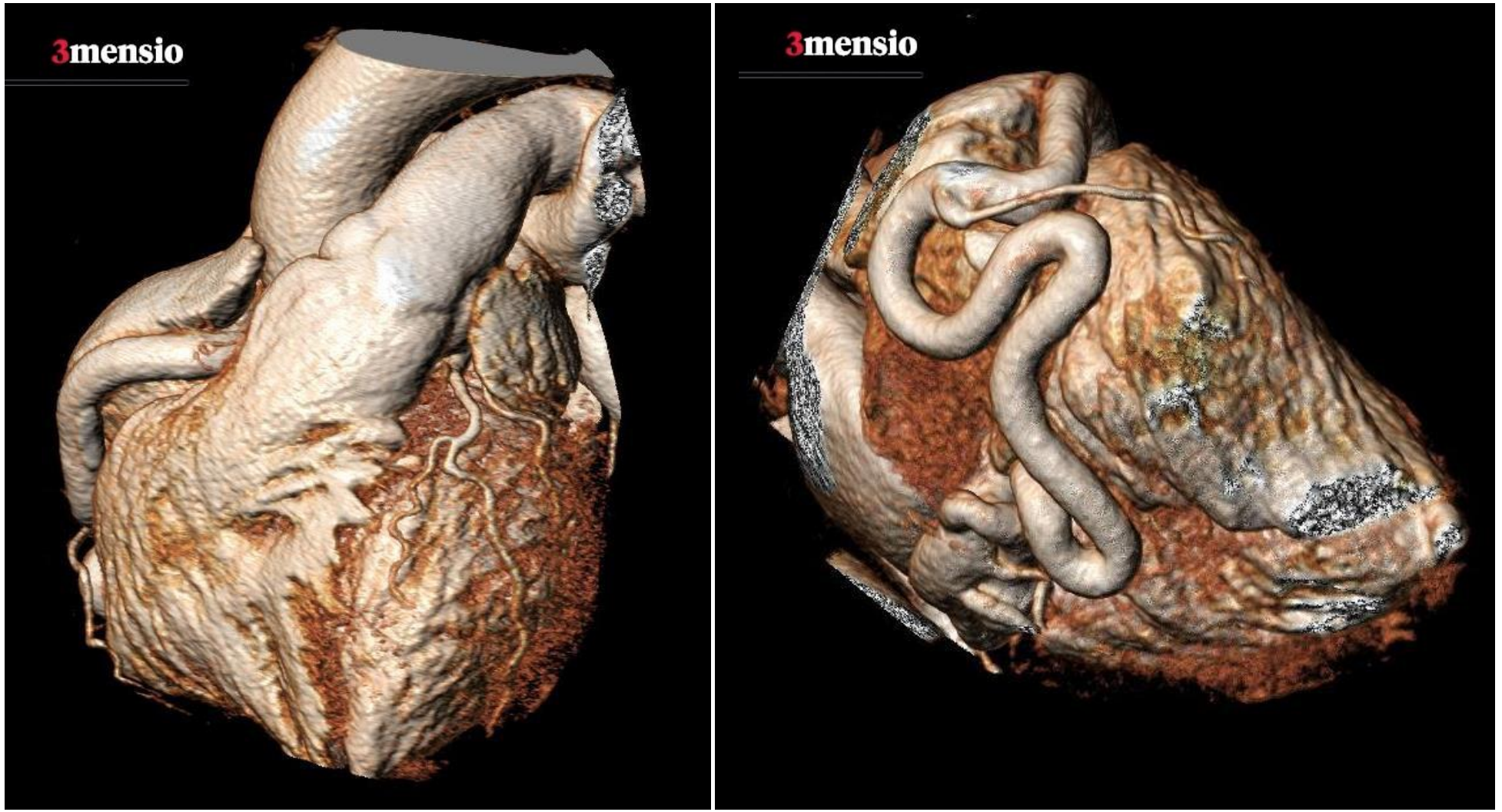
- Taille du vaisseau donneur (type B)

  - comparaison à artère controlatérale
  - mêmes critères que précédement

Al-Hijji M et al. JACC cv int. 2021.




Fistule coronaire droite - sinus coronaire (type B)

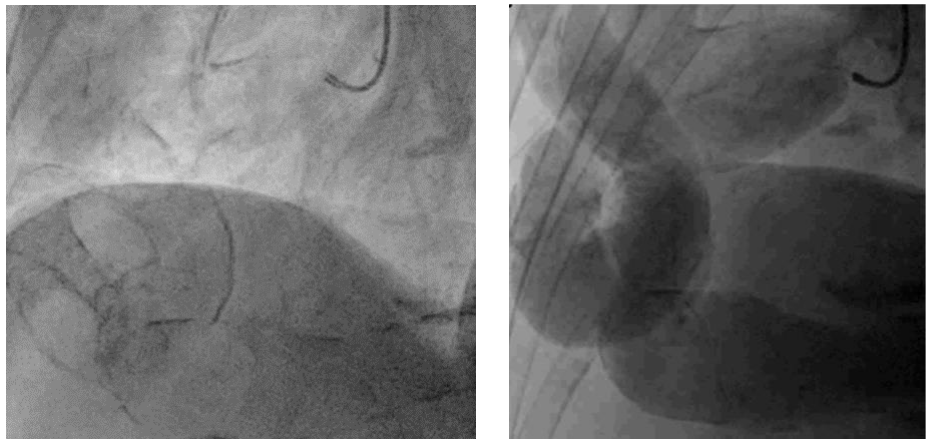


Fistules coronaires

- Retentissement physiologique : pas toujours présent
  - shunt gauche-droit significatif
  - shunt gauche-gauche significatif
  - vol coronaire

- Retentissement anatomique : fréquent avec le temps
  - déformation anévrismale
  - allongement vasculaire avec tortuosités
  - calcifications

- Insuffisance cardiaque droite
- VG dilaté
- Angor



ESC European Society of Cardiology
European Heart Journal (2020) 00, 1–83
doi:10.1093/eurheartj/ehaa554
ESC GUIDELINES

4.17 Coronary anomalies

2020 ESC Guidelines for the management of adult congenital heart disease

4.17.1.3 Coronary artery fistulae

A coronary artery fistula, whether congenital or acquired, is an abnormal connection between a coronary artery and cardiac chamber or vessel. Small fistulae have a good prognosis without treatment. Medium or large fistulae are associated with long-term complications (angina, myocardial infarction, arrhythmias, heart failure, and endocarditis). The presence of symptoms, complications, and a significant shunt are the main indications for percutaneous or surgical closure.

Fistules coronaires

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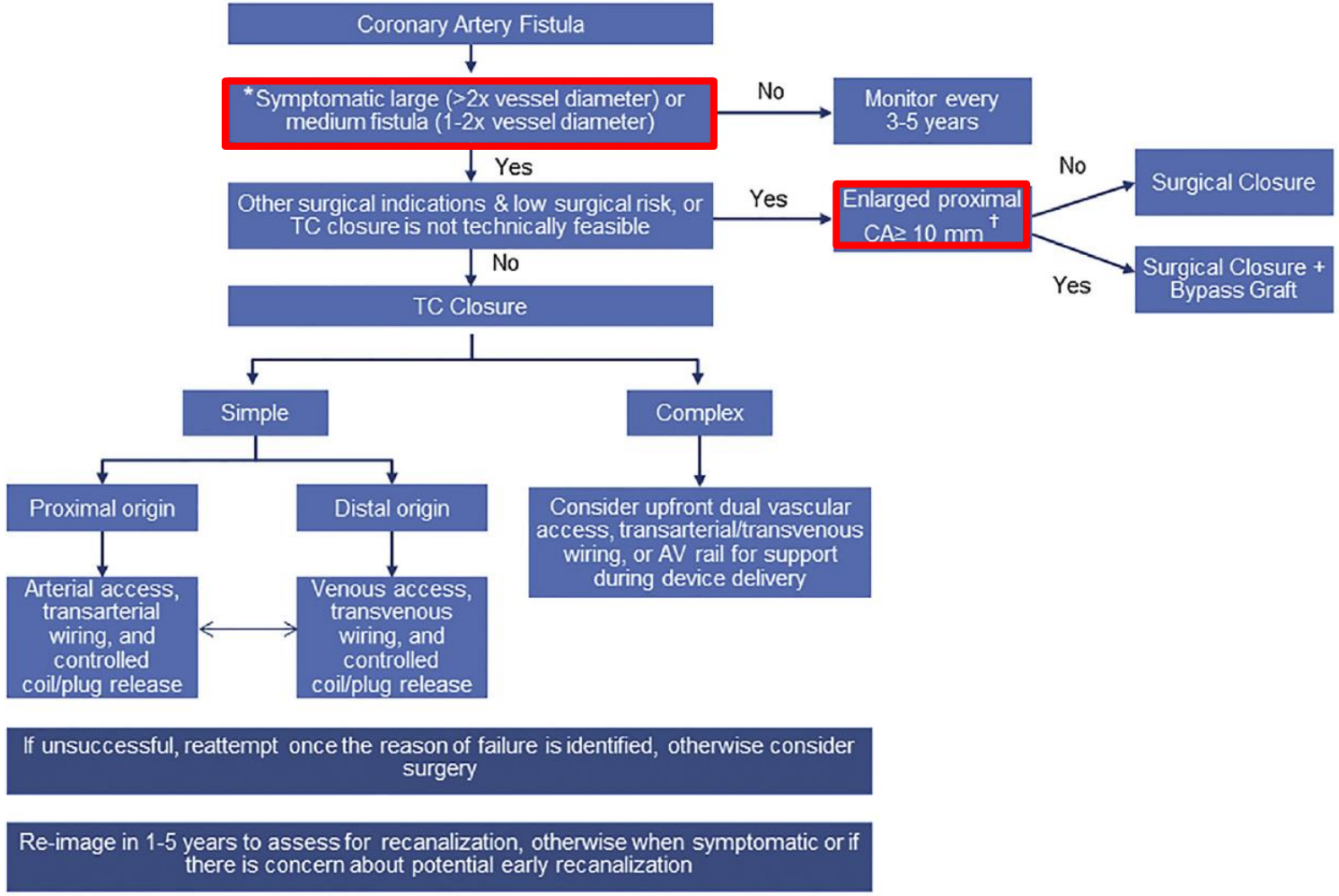
FIGURE 1 Algorithm of Coronary Artery Fistula Evaluation and Management



*Symptomatic fistulas are coronary artery (CA) fistulas that potentially lead to myocardial ischemia, vessel aneurysm and rupture, endocarditis, unexplained cardiac chamber enlargement/dysfunction, or arrhythmia. †An enlarged proximal CA with diameter ≥10 mm has a tendency to thrombose after fistula closure, resulting in myocardial infarction. A simple fistula has a single-vessel origin, simply defined pathways, and a clearly defined termination. A complex fistula is a large fistula with multiple origins and plexiform formation.
AV = arteriovenous; TC = transcatheter.

- Procédure complexe
- Risque IDM (10%)

- Variantes anatomiques
- Anomalies sur le trajet
- Connexions anormales distales
- Connexions anormales proximales

- Embryologie et anatomie
- Classification anatomique
- Prévalence
- Imagerie
- Ischémie myocardique
- Mort subite

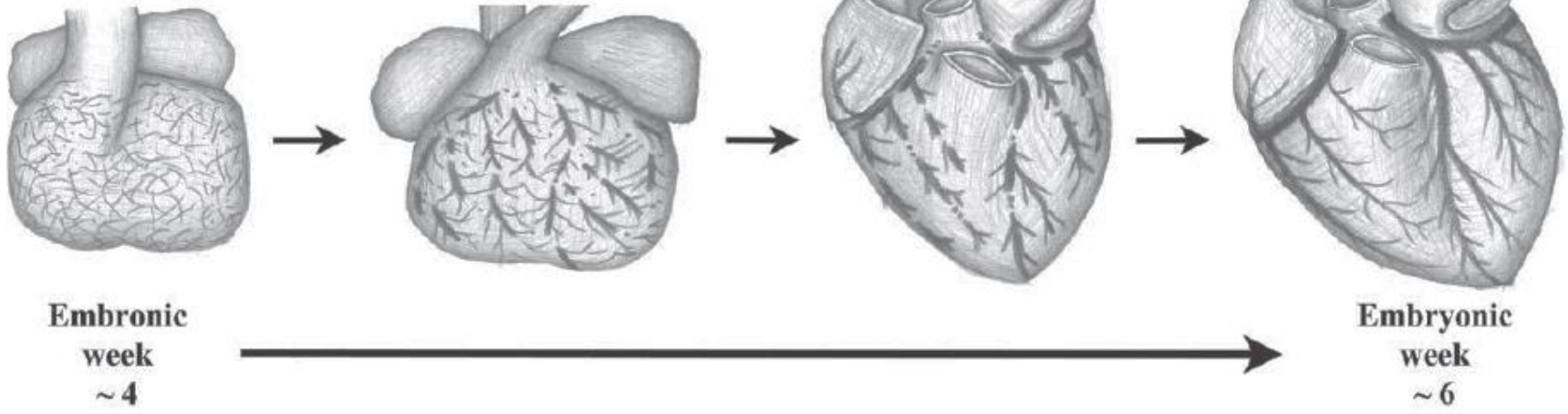
Origine anormale

Développement à partir de l'aorte

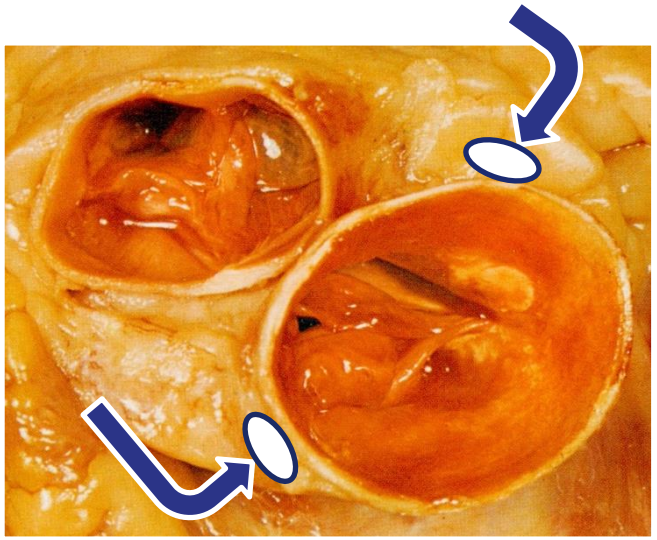
Connexion anormale

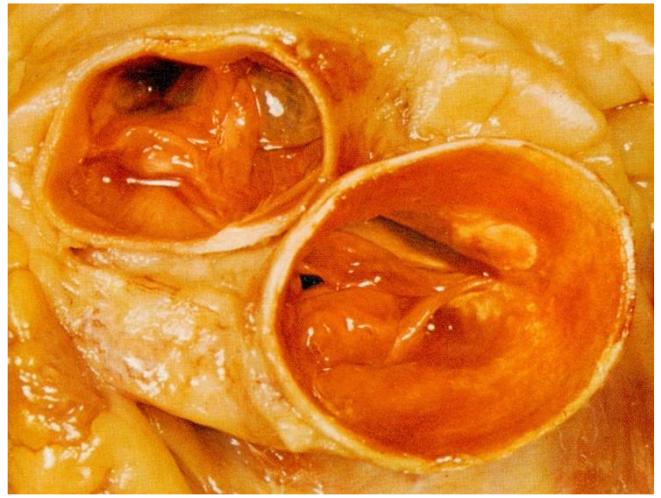
Développement vers l'aorte

Embryologie et anatomie



Development of coronary vessels during embryogenesis.

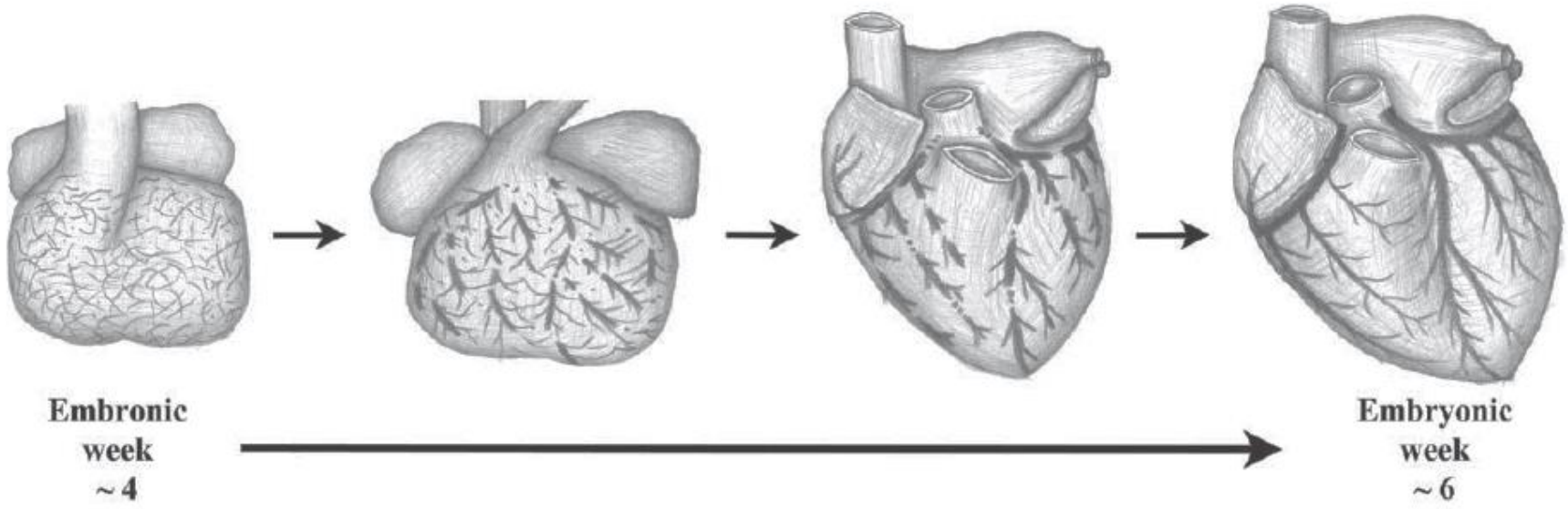




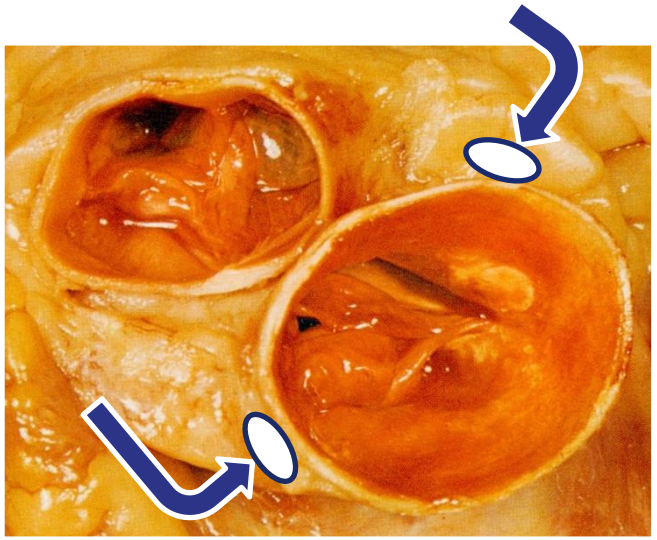
Lluri G. *Clin Cardiol* 2014
Bogers AJ. *Anat Embryol* 1989

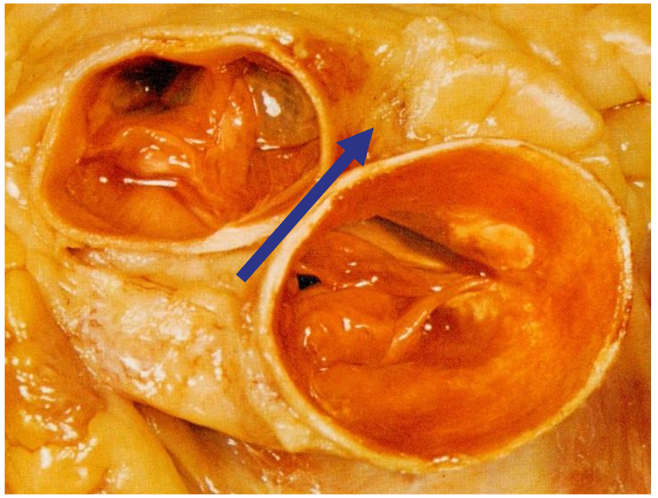
DIU cardiologie interventionnelle

Embryologie et anatomie



Development of coronary vessels during embryogenesis.



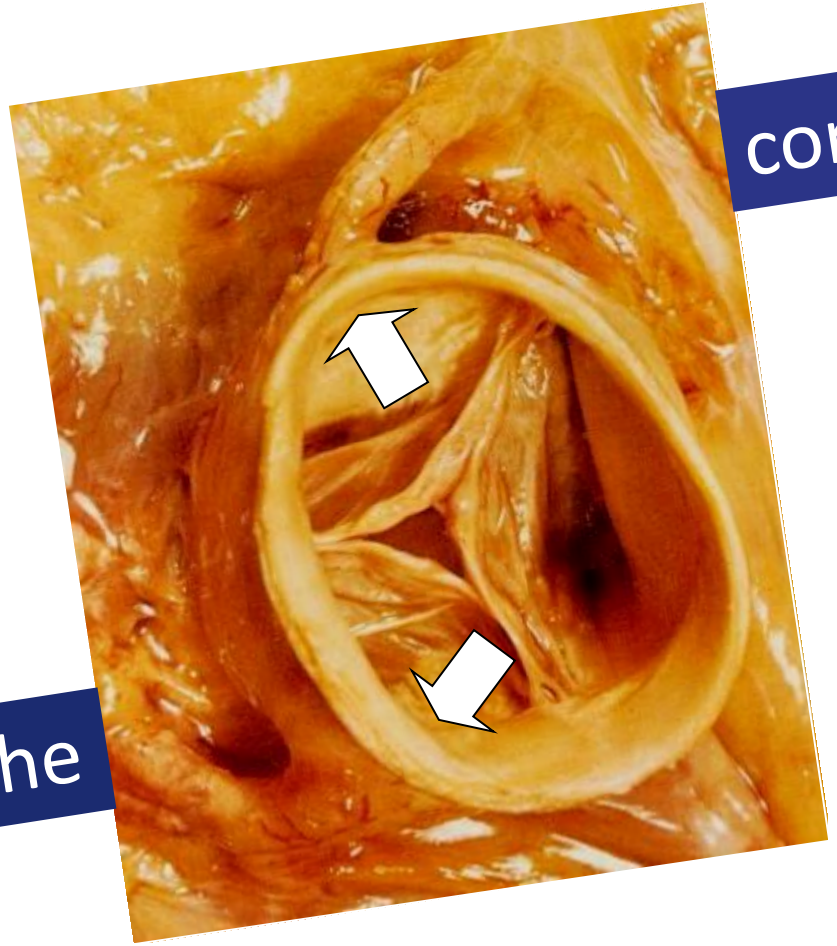


Lluri G. *Clin Cardiol* 2014
Bogers AJ. *Anat Embryol* 1989

DIU cardiologie interventionnelle

Connexions coronaires normales

avant



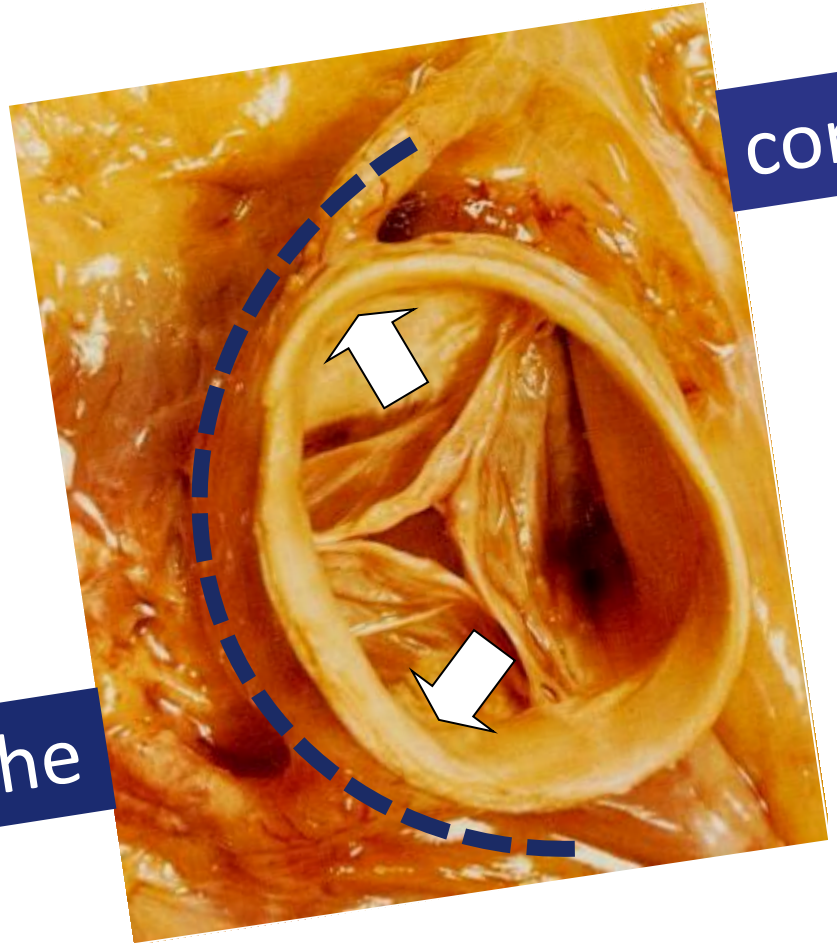
coronaire droite

coronaire gauche

arrière

Connexions coronaires anormales (- - -)

avant

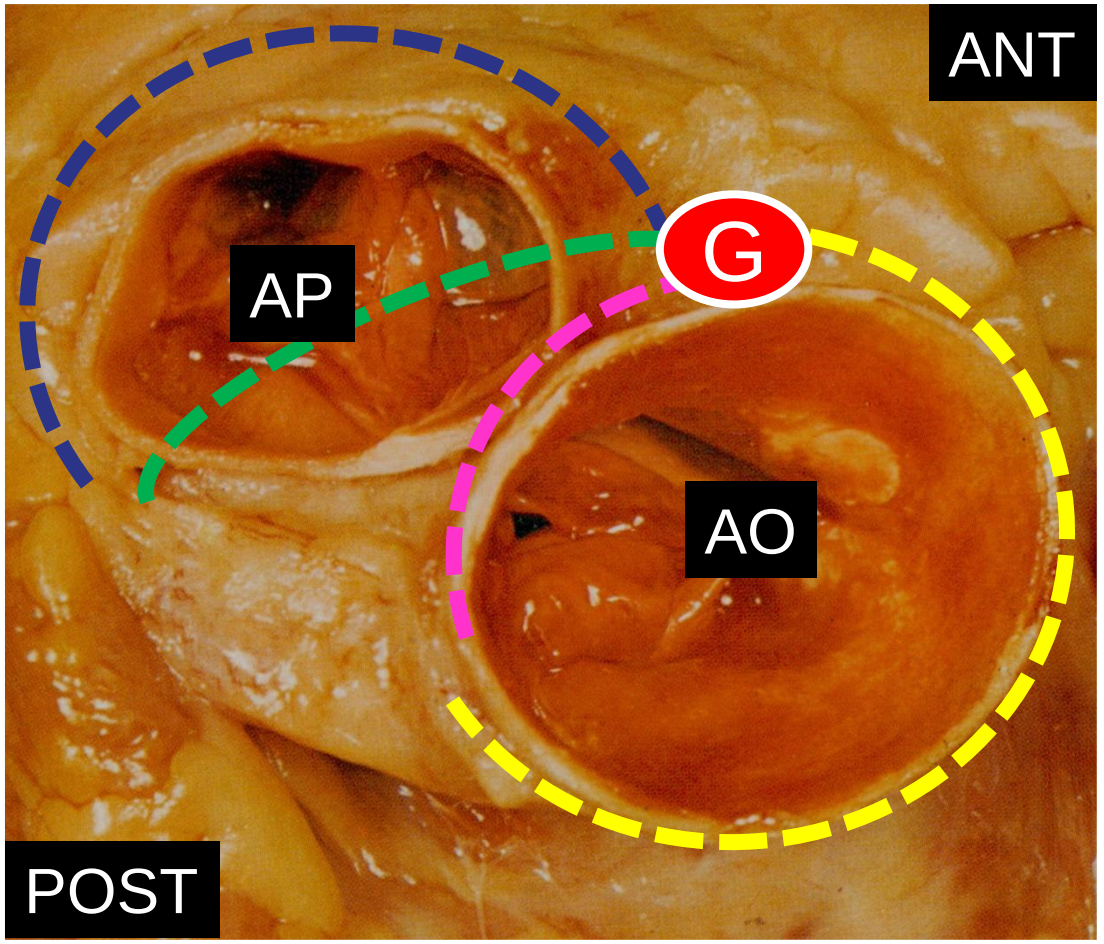


coronaire droite

coronaire gauche

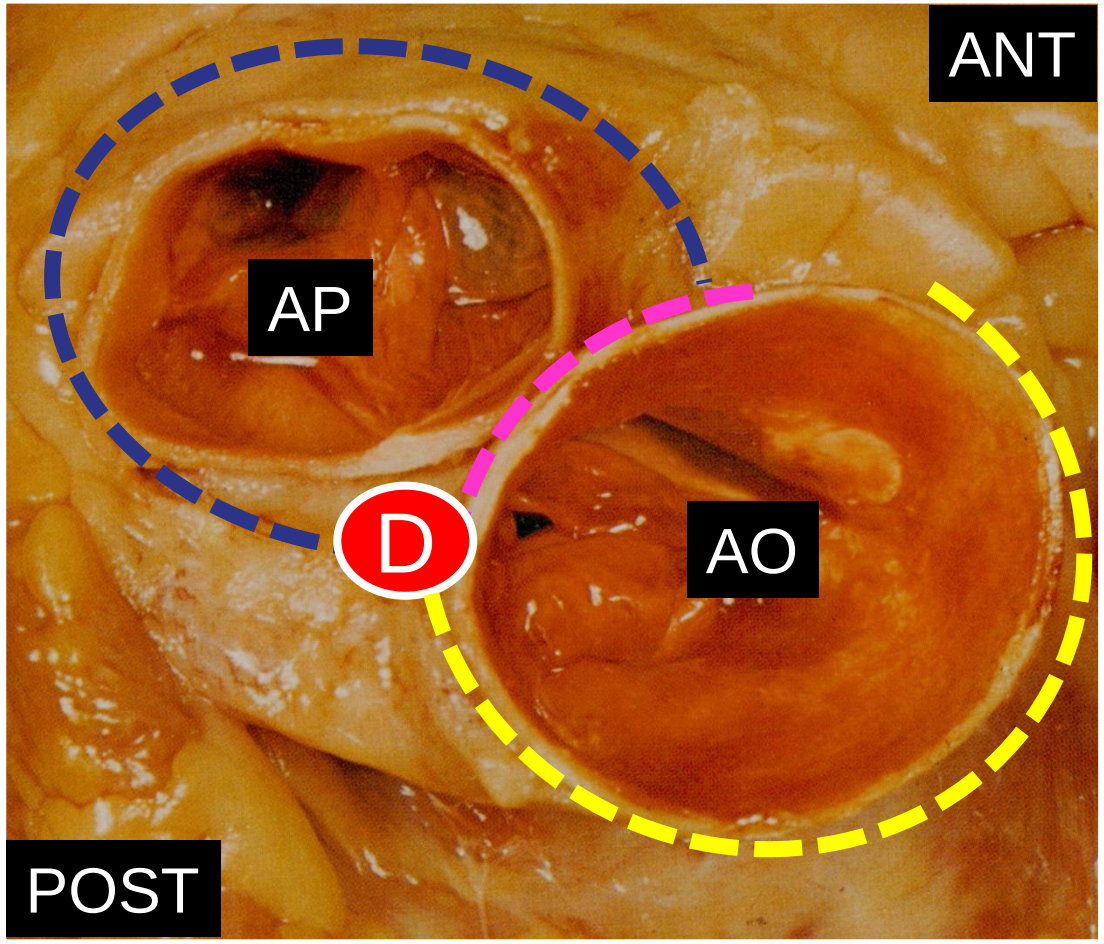
arrière

Trajets ectopiques pour la coronaire gauche



- prépulmonaire
- rétropulmonaire (intraseptal)
- interartériel (préaortique)
- rétroaortique

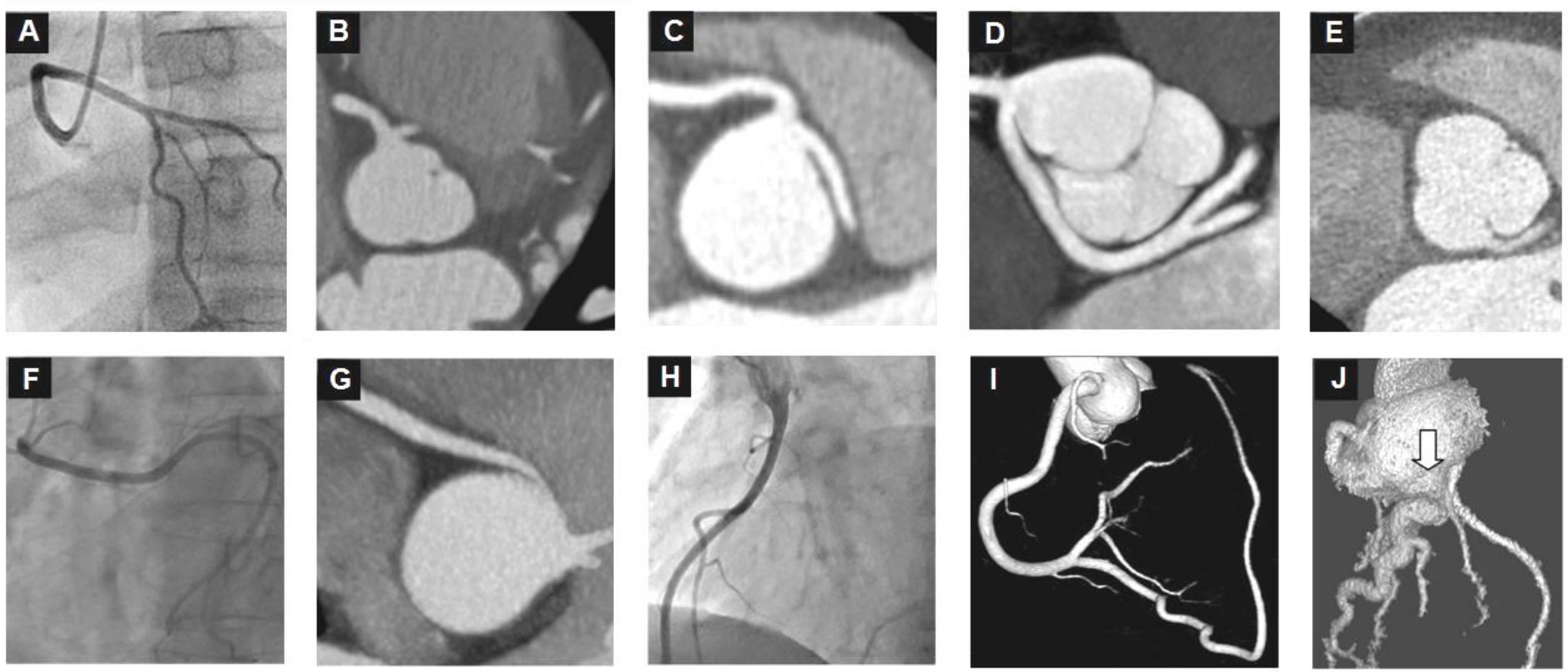
Trajets ectopiques pour la coronaire droite



- prépulmonaire
- interartériel (préaortique)
- rétroaortique

- Embryologie et anatomie
- Classification anatomique
- Prévalence
- Imagerie
- Ischémie myocardique
- Mort subite

Nombreuses formes anatomiques



Classification

- Type d'artère
  - Tronc
  - IVA
  - Circonflexe
  - Droite
  - Septale
- Trajet
  - Prépulmonaire
  - Rétropulmonaire
  - Interartériel
  - Rétroaortique
  - Normal
- Site de connexion
  - Artère controlatérale
  - Sinus controlatéral
  - Sinus non coronaire
  - Sinus approprié
  - Aorte thoracique
  - Artère pulmonaire
- Risques
  - Mort subite
  - Arrêt cardiaque
  - Arythmies V
  - Ischémie
  - Absents

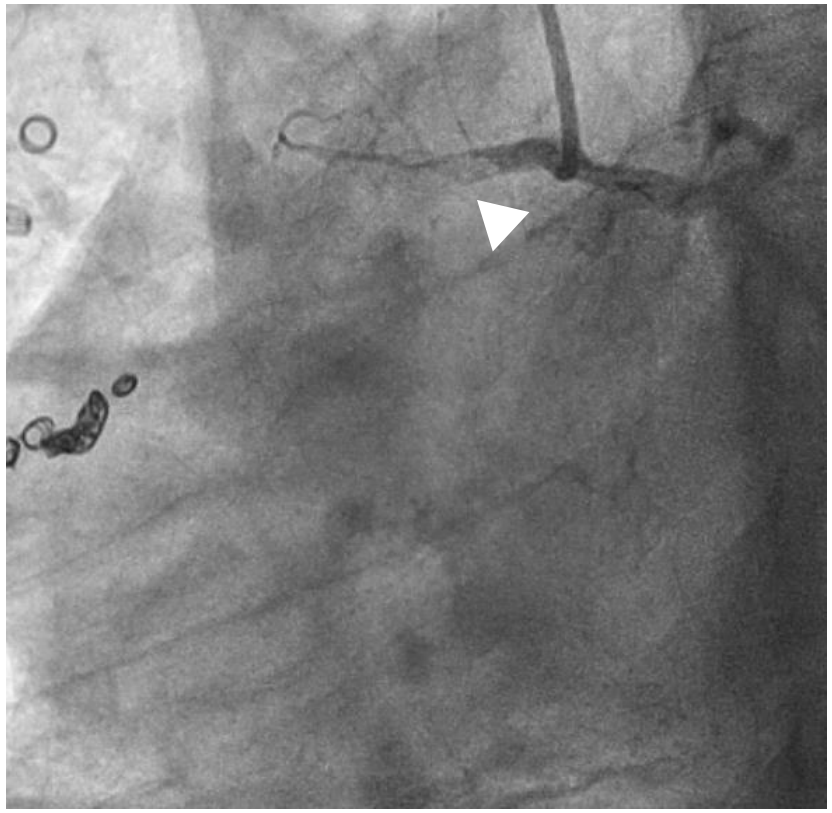
Classification

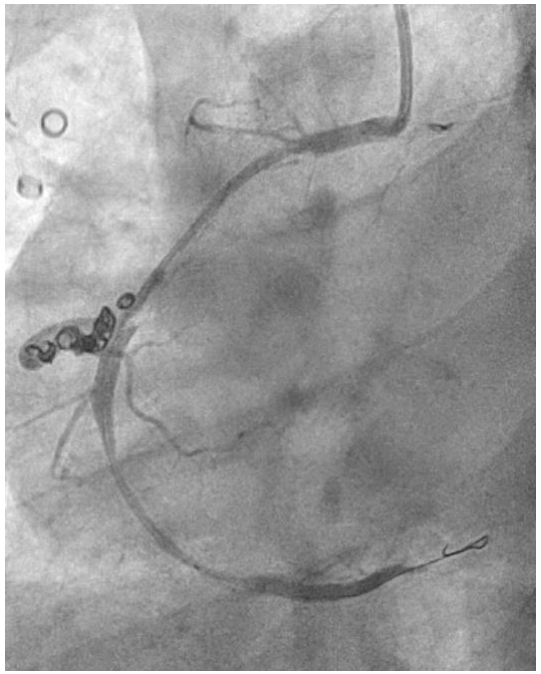
- Liens de causalité :
  - entre anomalie coronaire et symptomatologie
  - entre anomalie coronaire et ischémie myocardique
  - entre anomalie coronaire et arythmie ventriculaire
  - entre anomalie coronaire et arrêt cardiaque

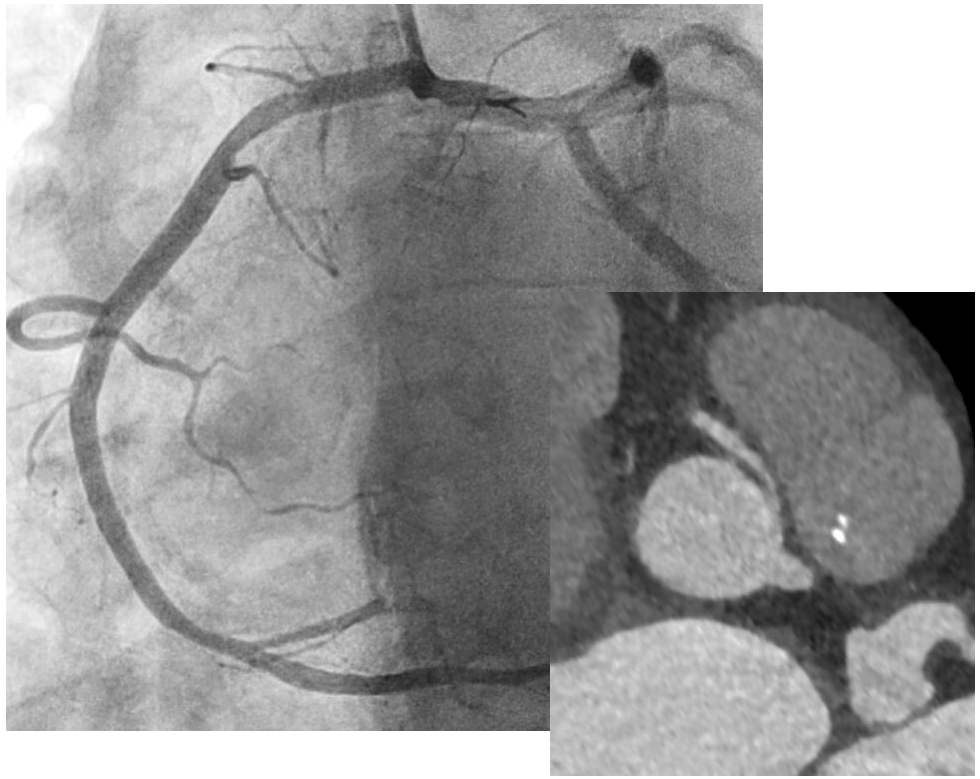
Absent | Possible/Probable | Certain

Classification

Homme de 35 ans – Maladie Rendu-Osler – MVA cérébrales/pulmonaires
SCA ST+ inférieur lors activité sportive

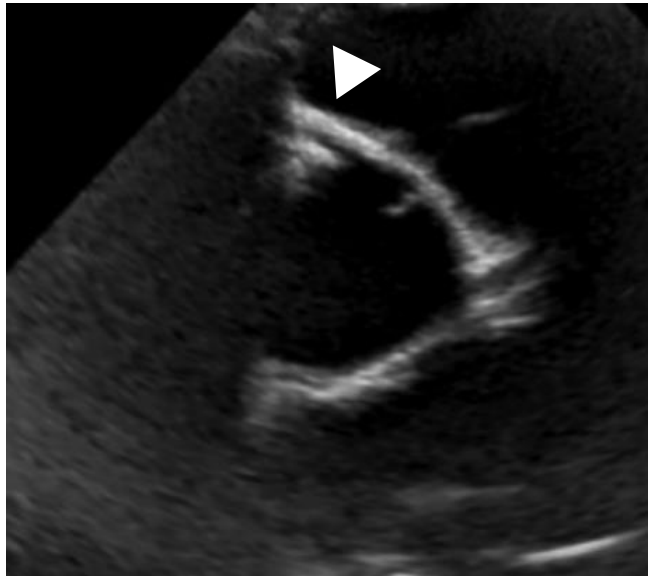






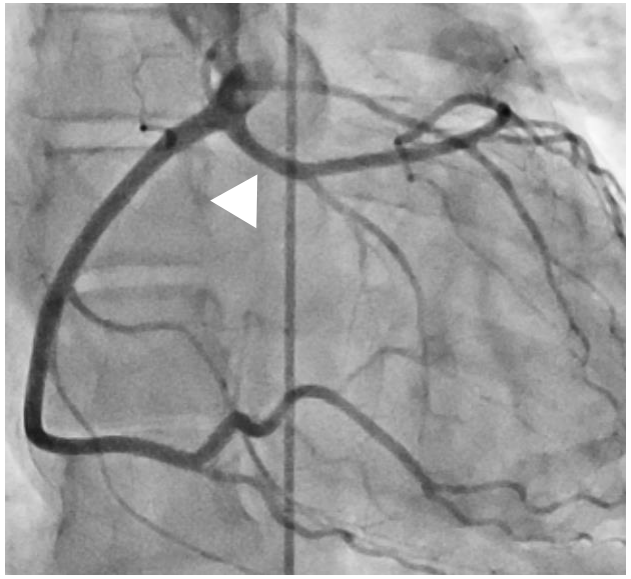
- Embryologie et anatomie
- Classification anatomique
- **Prévalence**
- Imagerie
- Ischémie myocardique
- Mort subite

Prévalence



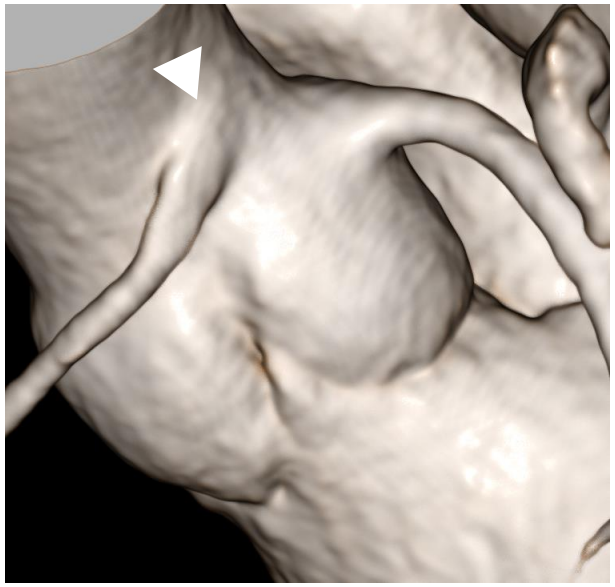
Echocardiographie

0.2%



Coronarographie

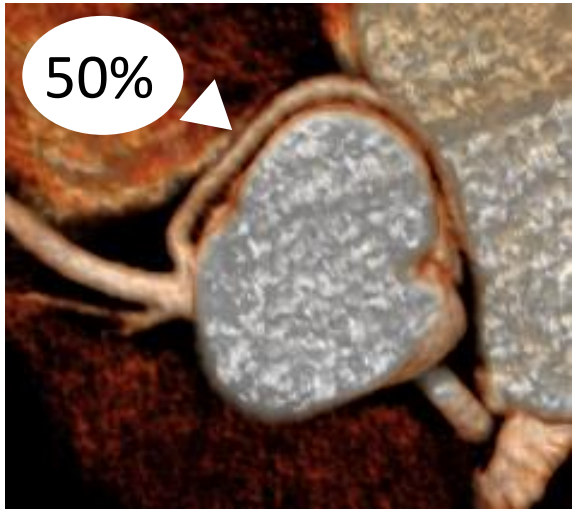
0.8%



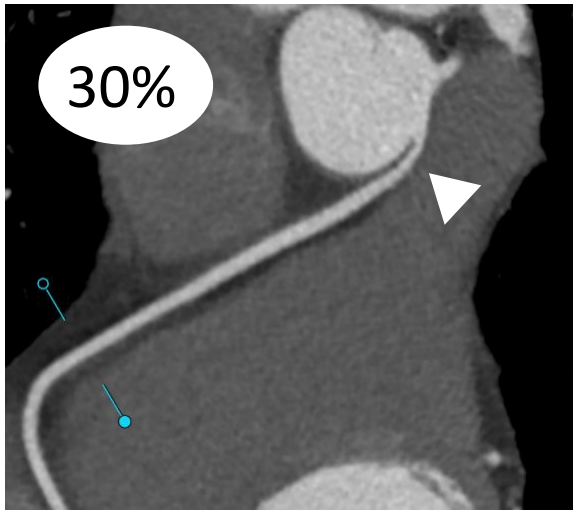
Scanner

1.2%

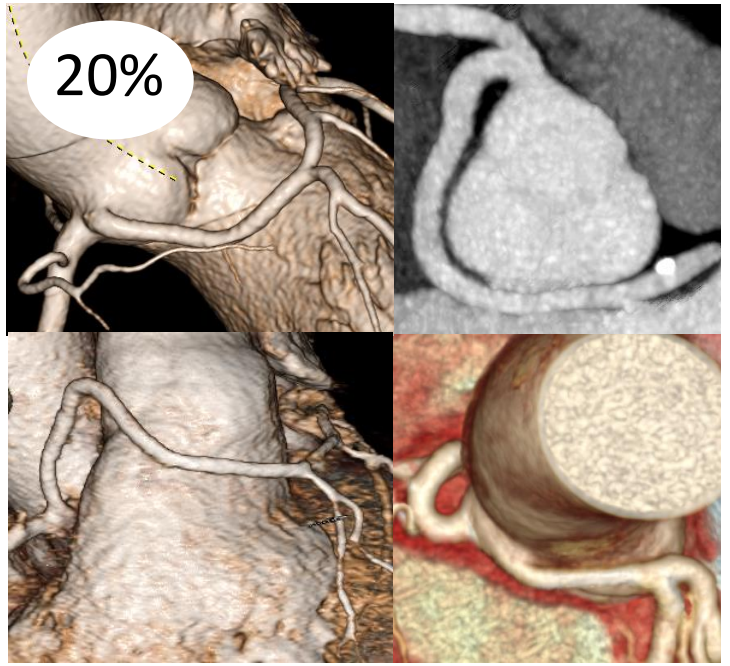
Prévalence selon l'artère coronaire



Circonflexe rétroaortique (99%)



Droite interartérielle (95%)



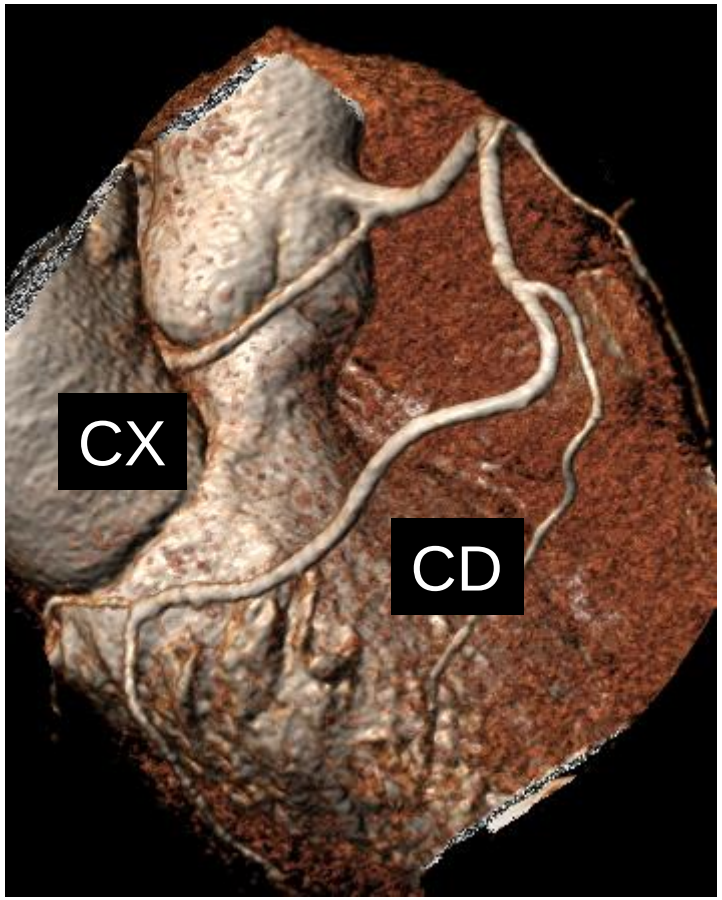
TC/IVA rétropulmonaire (45%)
prépulmonaire (30%)
rétroaortique (15%)
interartériel (10%)

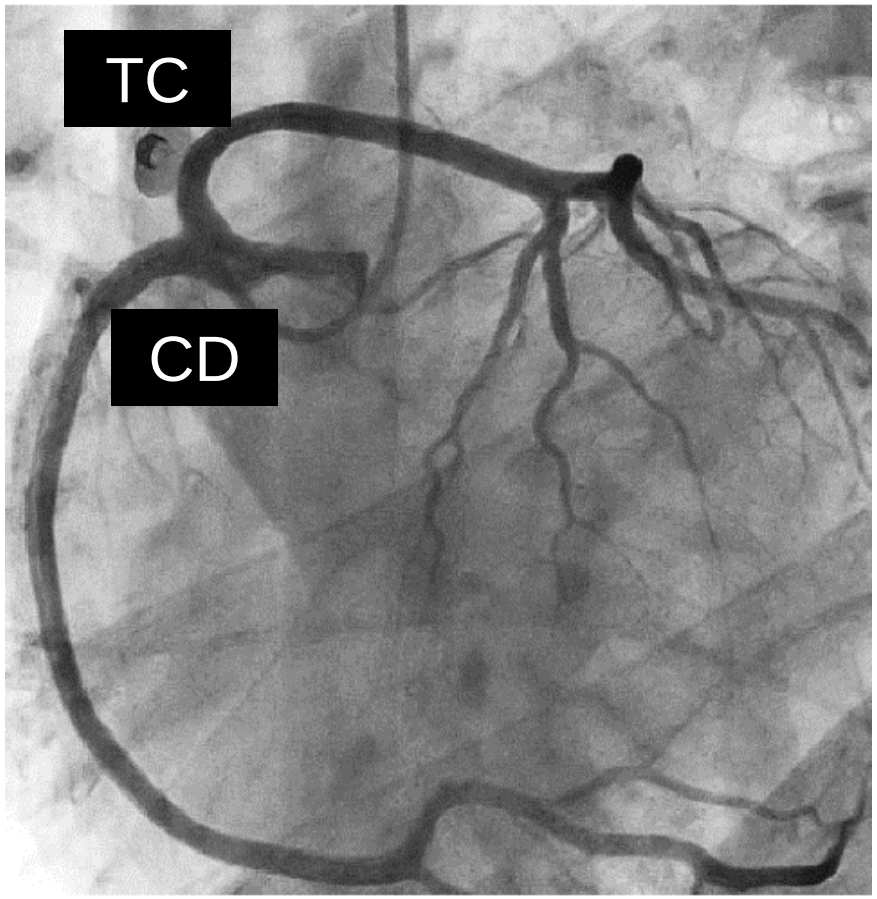
Prévalence selon le trajet ectopique

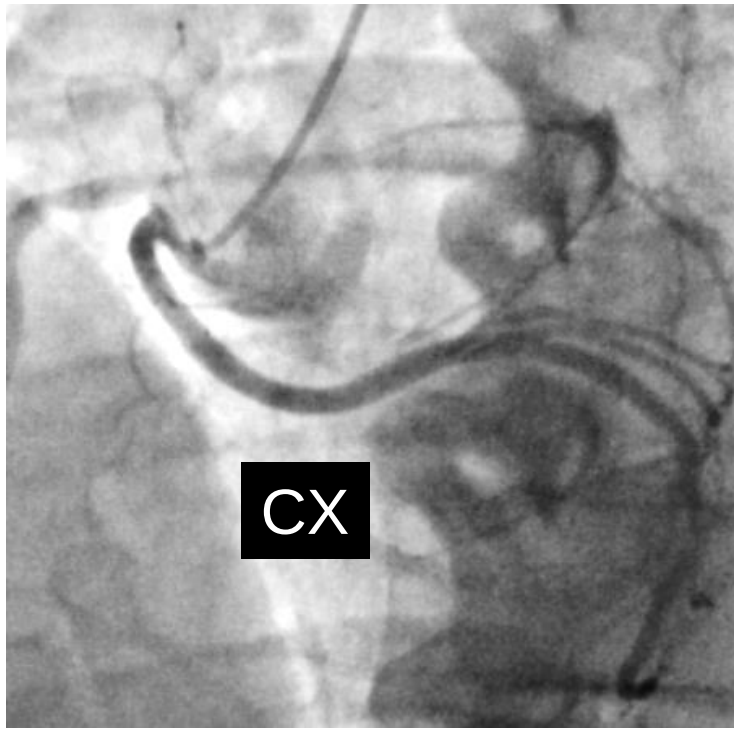
Prévalence selon le site de connexion

site de connexion	%
connexion dans sinus controlatéral	47.0
connexion dans artère controlatérale	43.5
connexion au-dessus jonction sinotubulaire	1.0
connexion anormale dans sinus habituel	1.0
artère coronaire unique	1.0
connexion avec artère pulmonaire	1.0
connexion dans sinus non coronaire	0.4
autres connexions anormales	0.1

* à partir des données du registre ANOCOR (ESC 2015)
472 patients – 496 anomalies coronaires


CX
CD


TC
CD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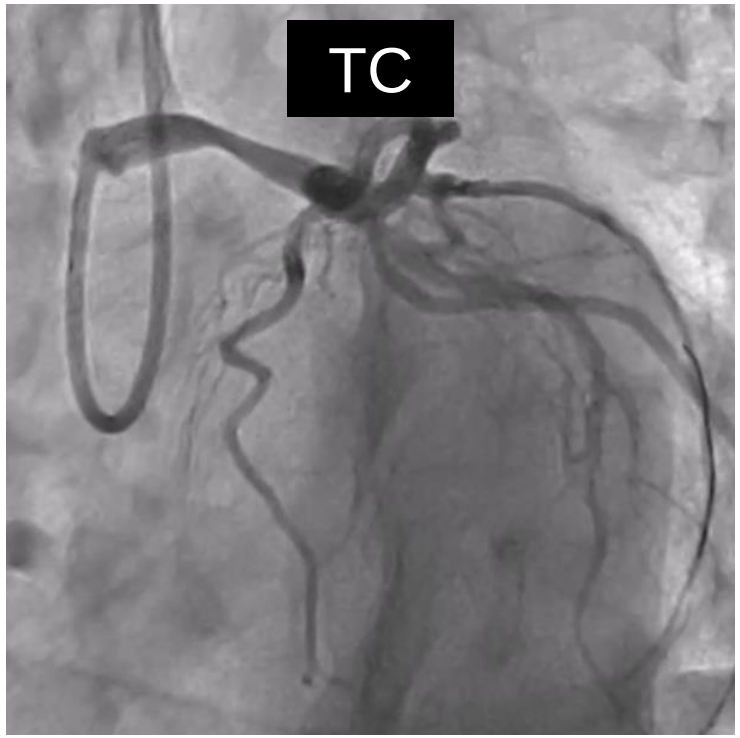
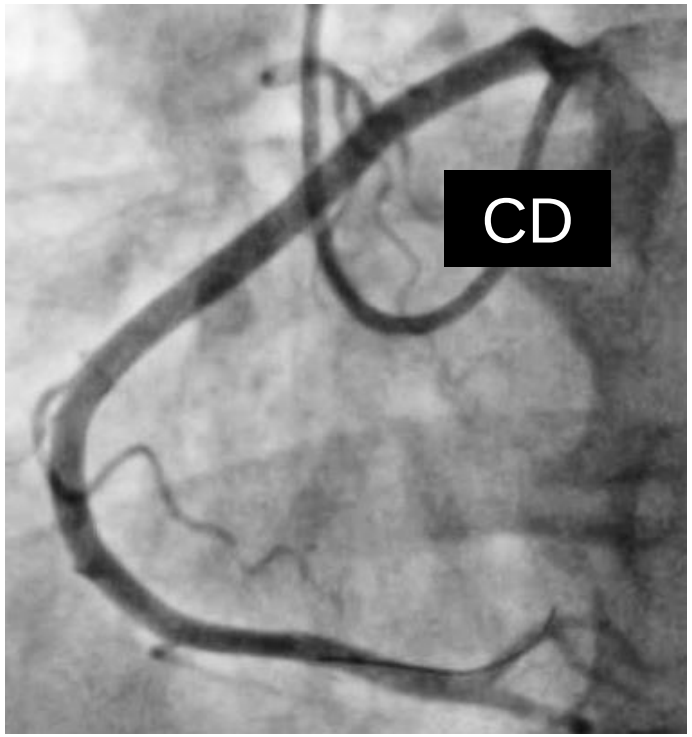

TC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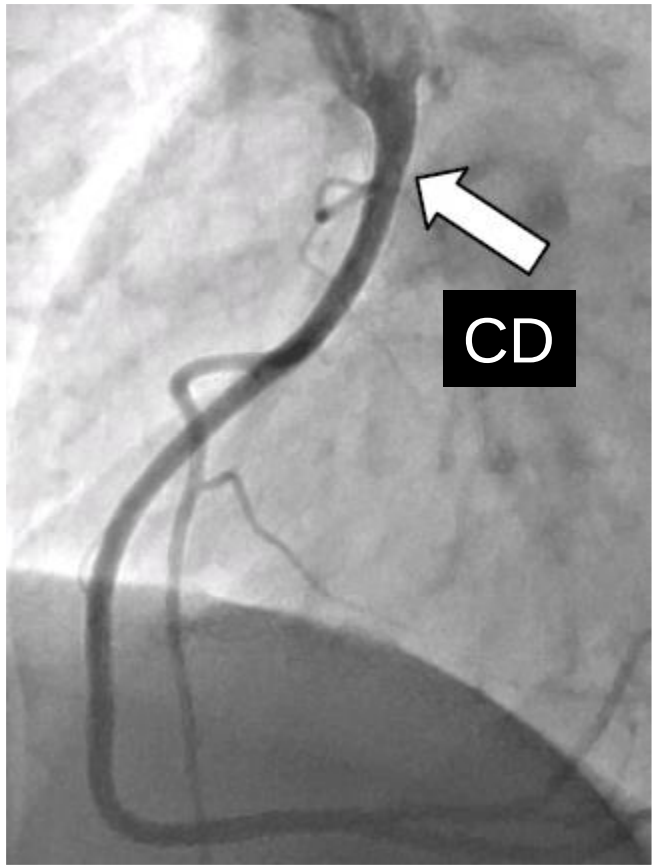
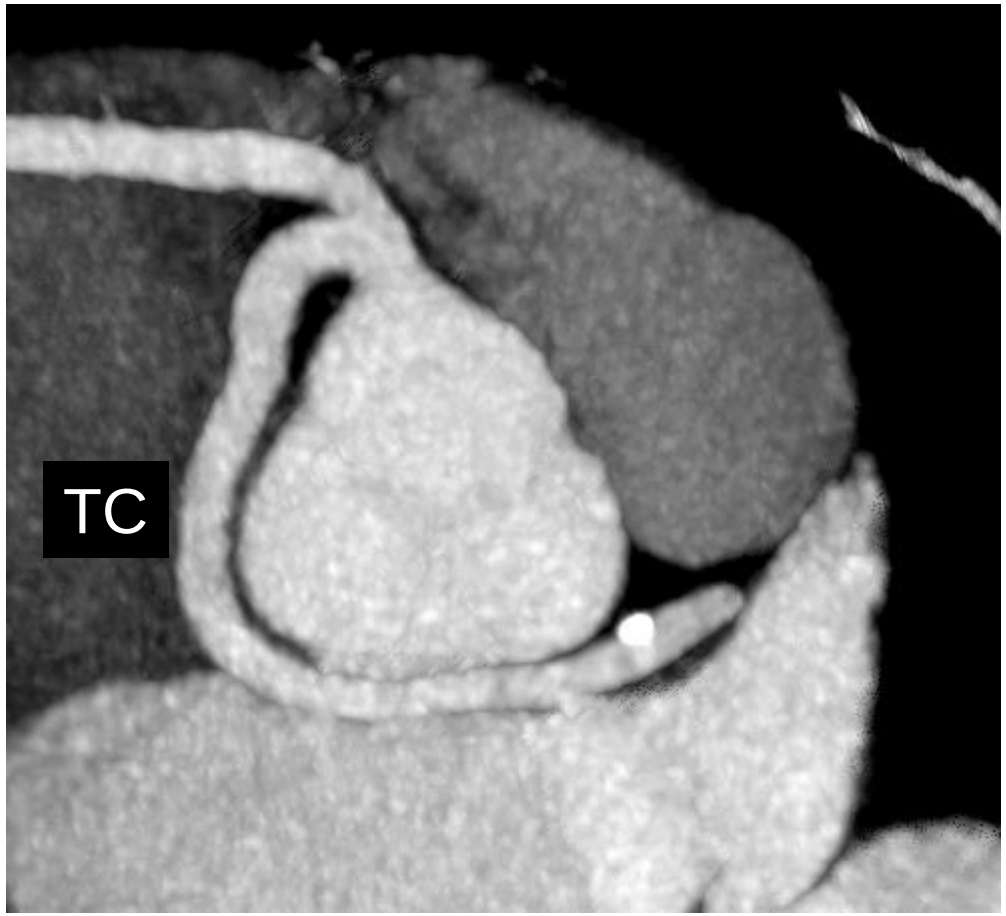
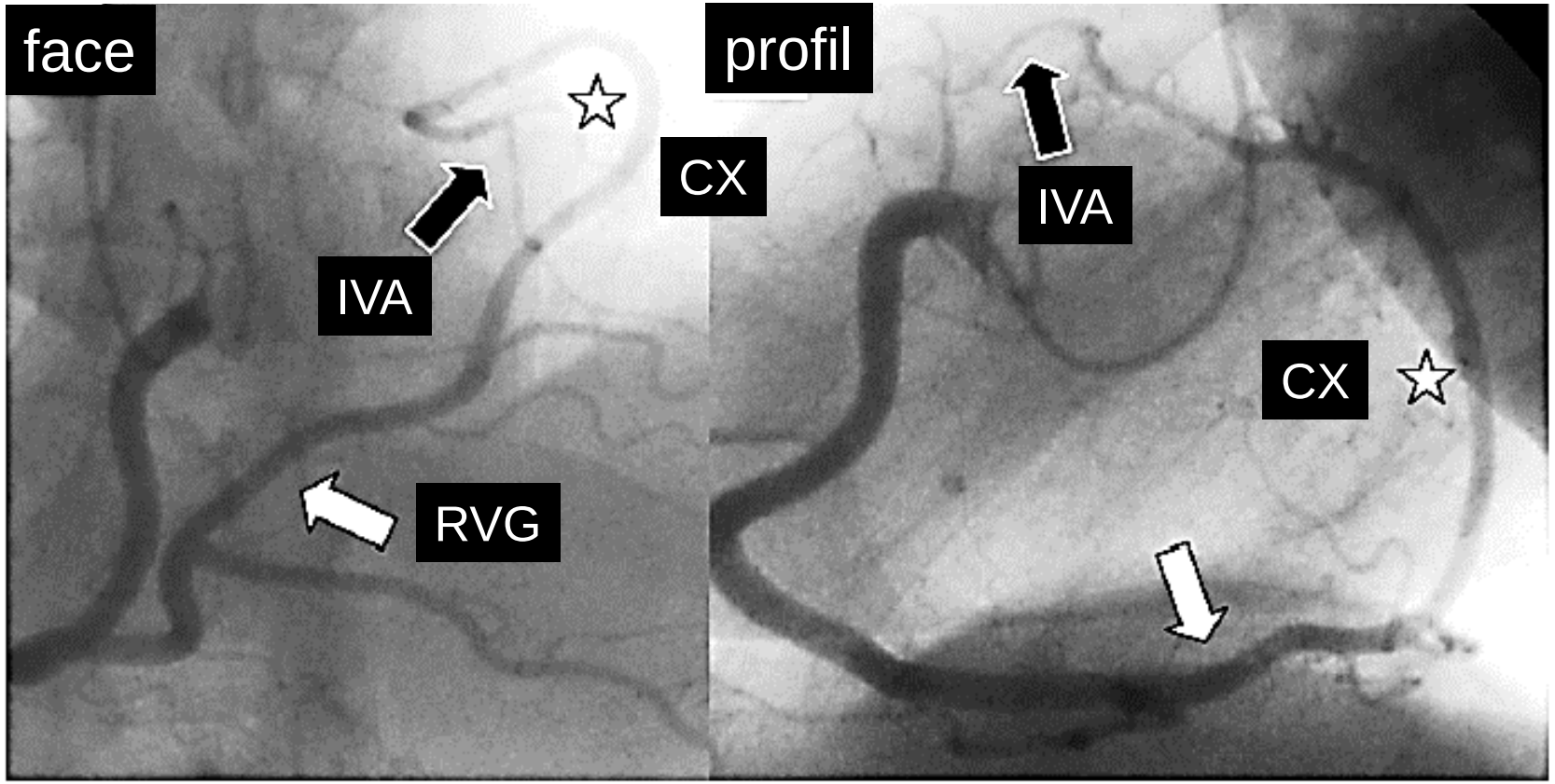

CD


CD


TC


TC

Artère coronaire unique



- Embryologie et anatomie
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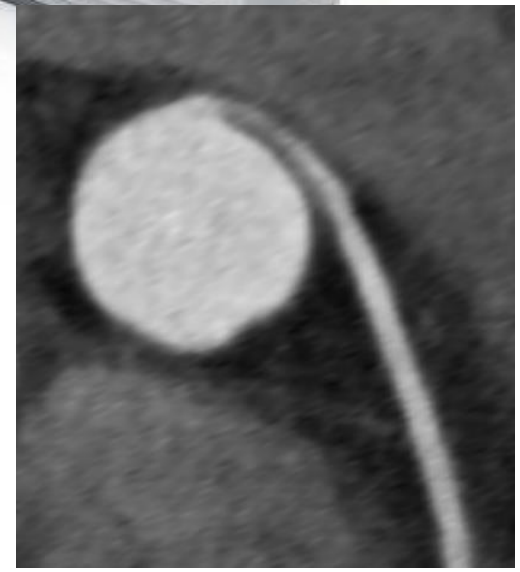
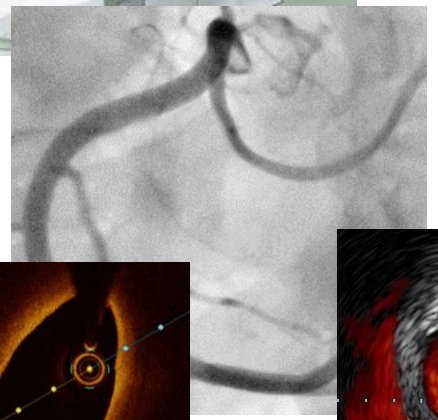
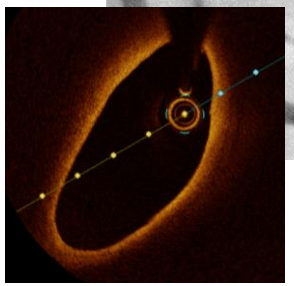
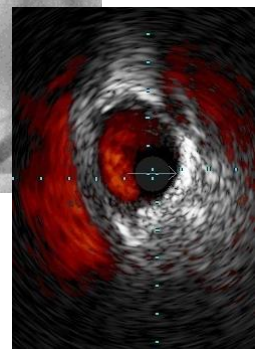
- Prévalence
- **Imagerie**
- Ischémie myocardique
- Mort subite

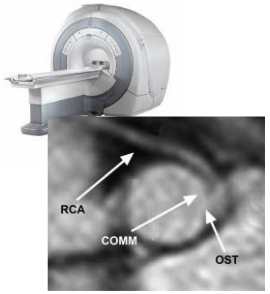
Outils d'imagerie





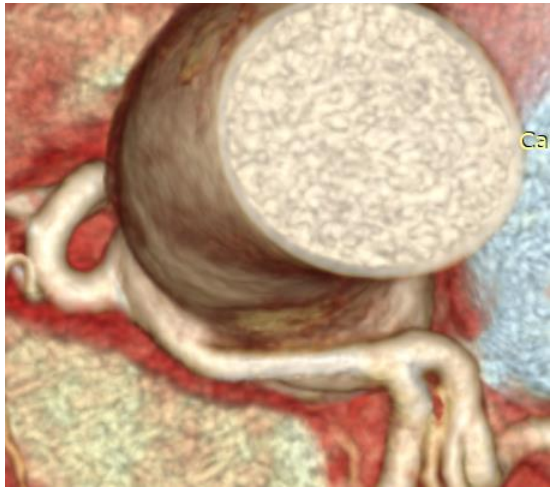






DIU cardiologie interventionnelle

Piège à éviter

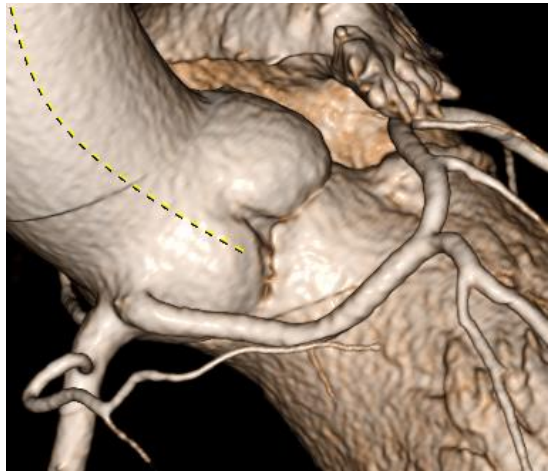


Trajet prépulmonaire

Trajet rétroaortique

Trajet interartériel

Trajet rétropulmonaire



Received: 11 October 2016 | Revised: 21 February 2017 | Accepted: 28 May 2017
DOI: 10.1111/chd.12504

ORIGINAL ARTICLE

WILEY Congenital Heart Disease

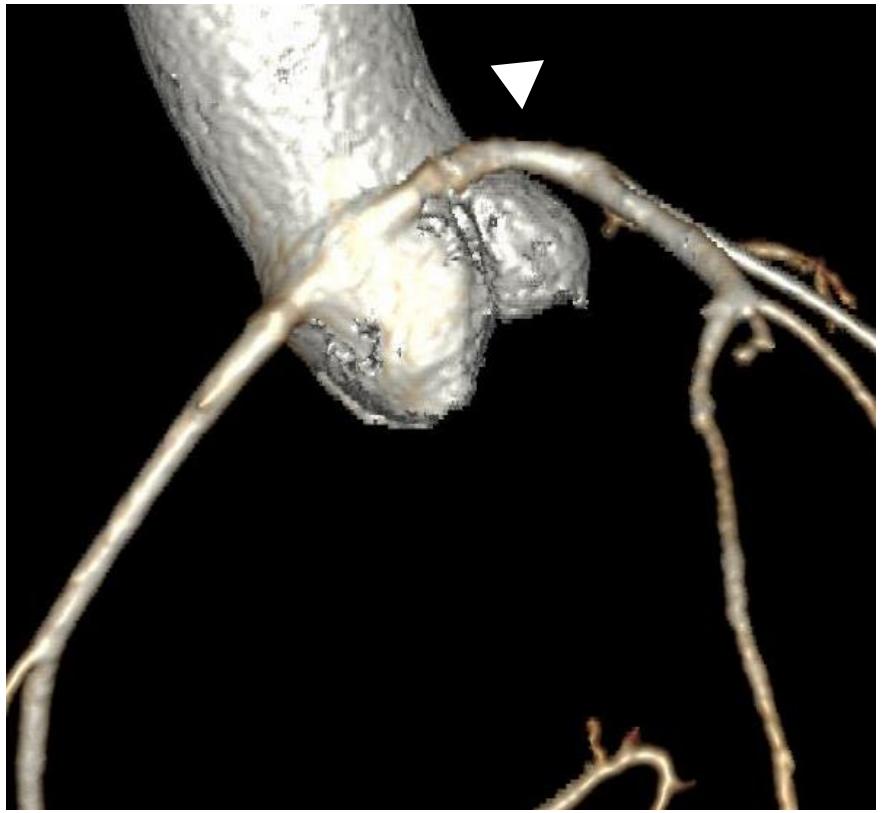
Interobserver variability in the classification of congenital coronary abnormalities: A substudy of the anomalous connections of the coronary arteries registry

Athanasios Koutsoukis, MD[1] | Xavier Halna du Fretay, MD[2] | Patrick Dupouy, MD[3] | Phalla Ou, MD, PhD[4] | Jean-Pierre Laissy, MD, PhD[4] | Jean-Michel Juliard, MD[5] | Fabien Hyafil, MD[6] | Pierre Aubry, MD[5] | on behalf of the ANOCOR Investigators*

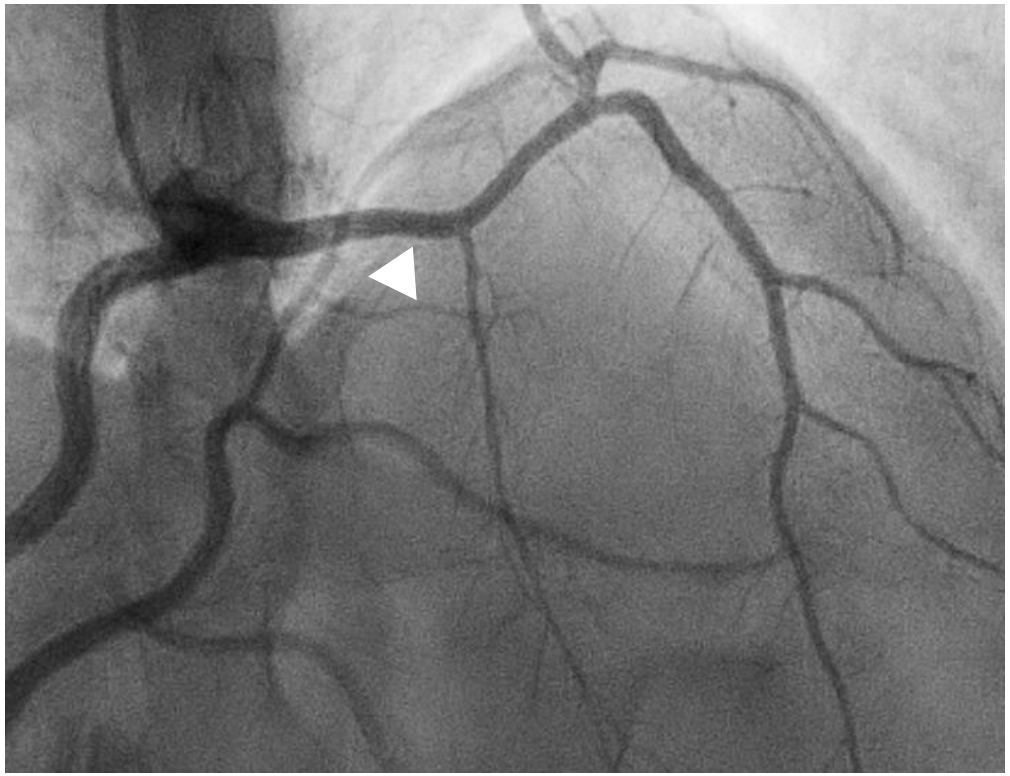
Congenital Heart Disease 2017

DIU cardiologie interventionnelle

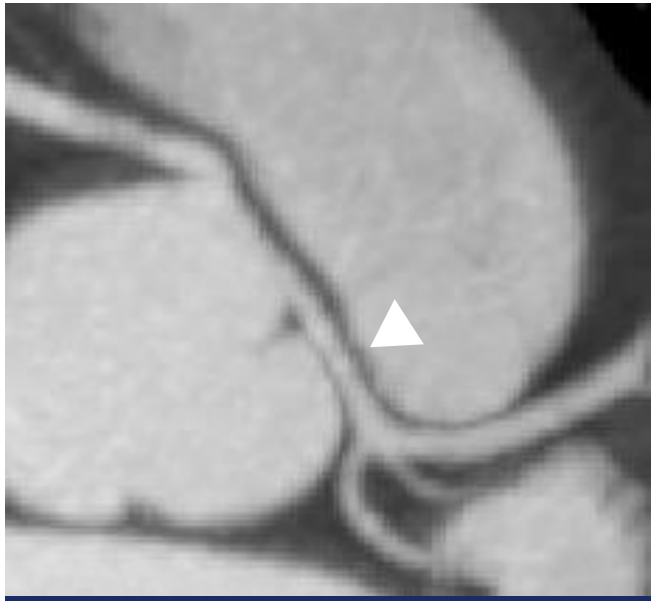
ANOCOR gauche avec trajet interartériel



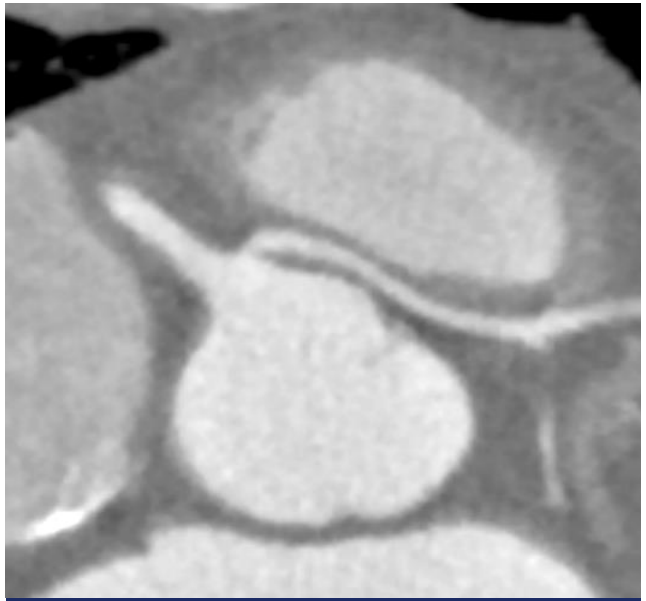
ANOCOR gauche avec trajet rétropulmonaire



Formes anatomiques gauches à ne pas confondre

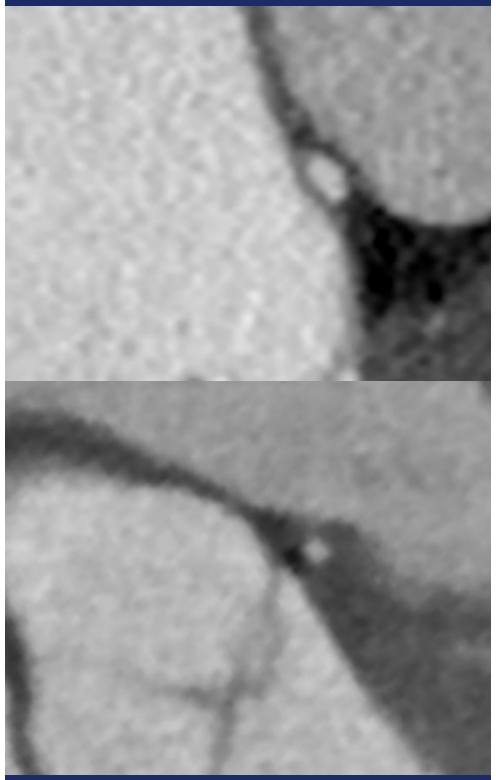


Trajet interartériel



Trajet rétropulmonaire

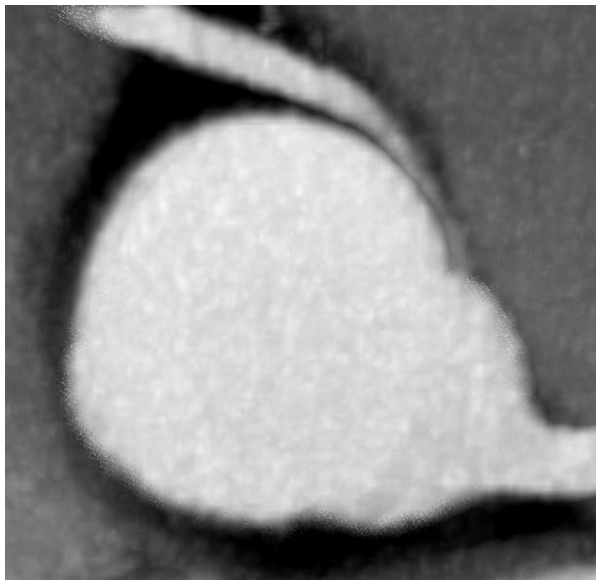
Interartériel

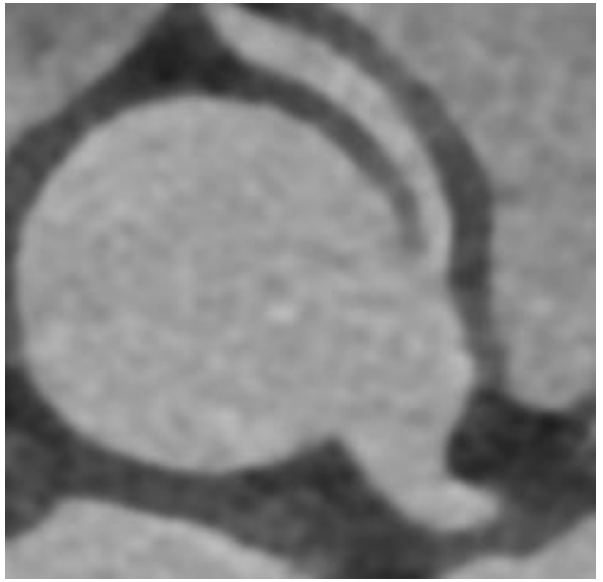


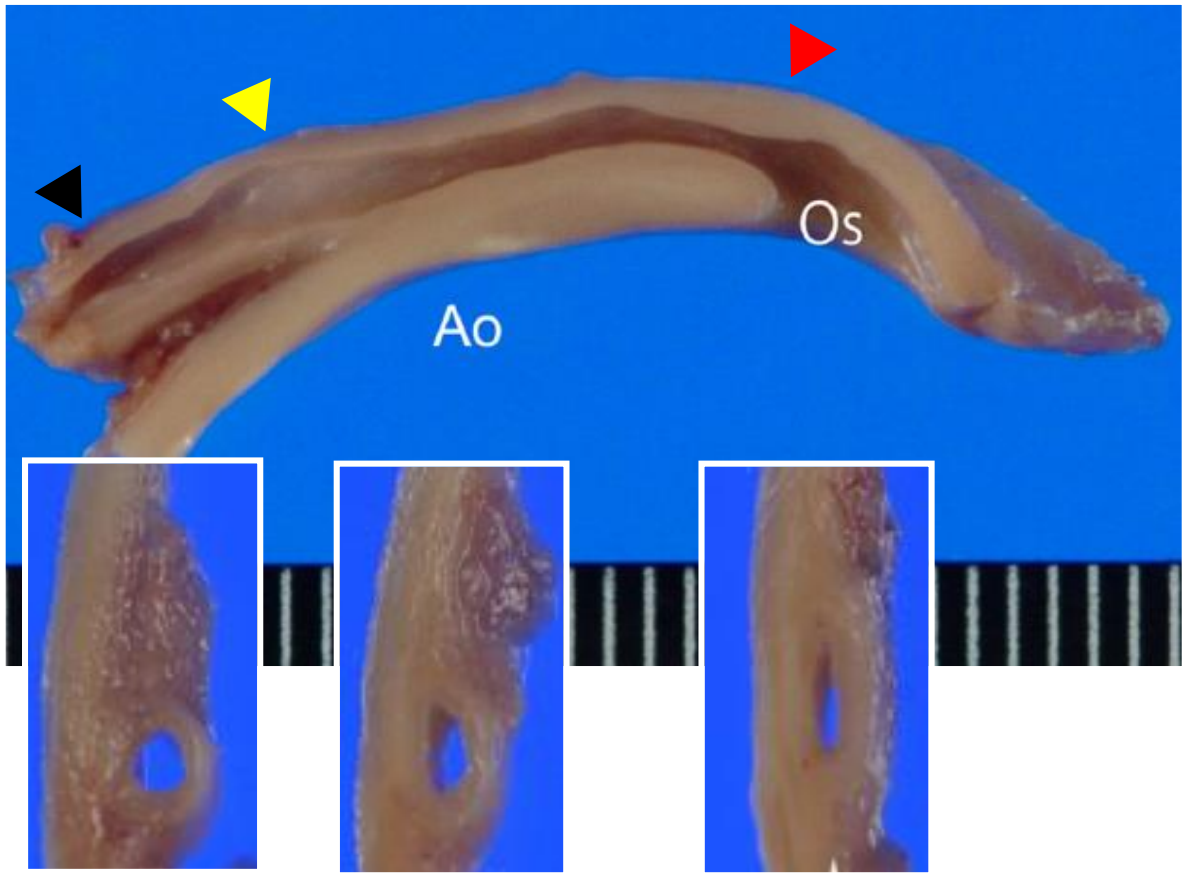
Rétropulmonaire

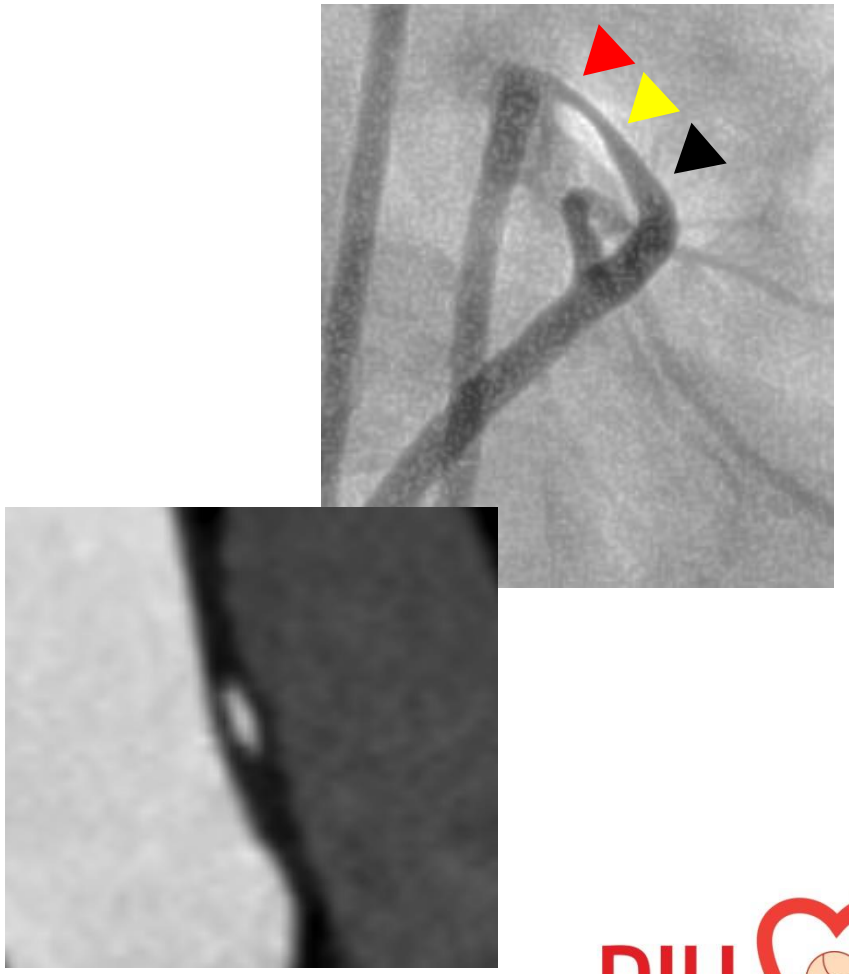
Passage aortique intramural

Passage aortique juxtamural





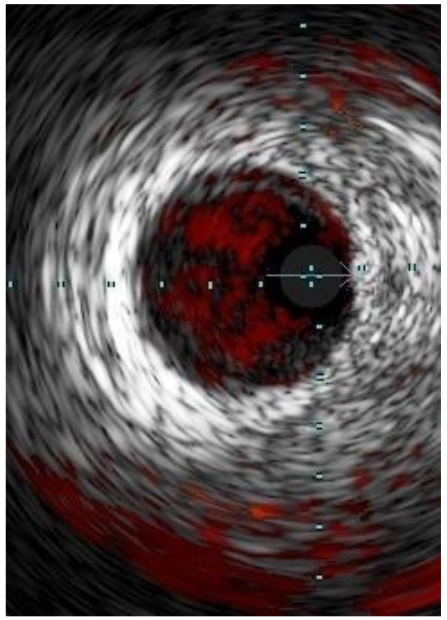




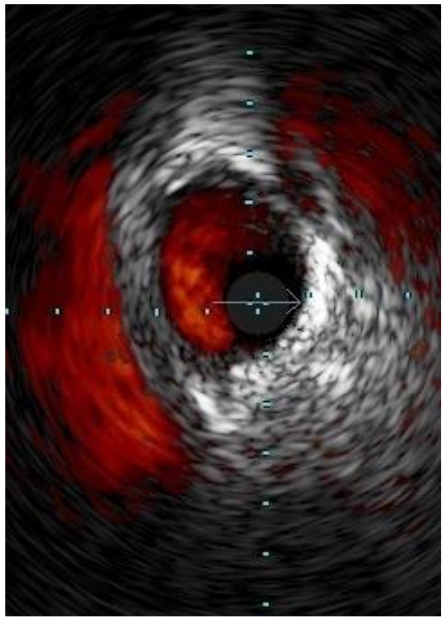
Right ANOCOR with an intramural course
Hata Y et al. Cardiovasc Pathol. 2014.

Echographie endocoronaire

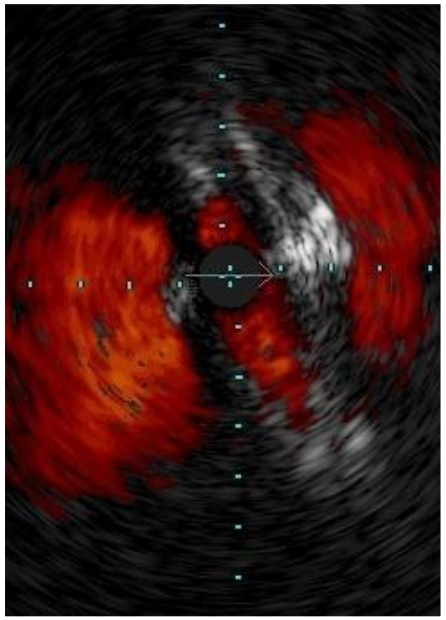
extramural



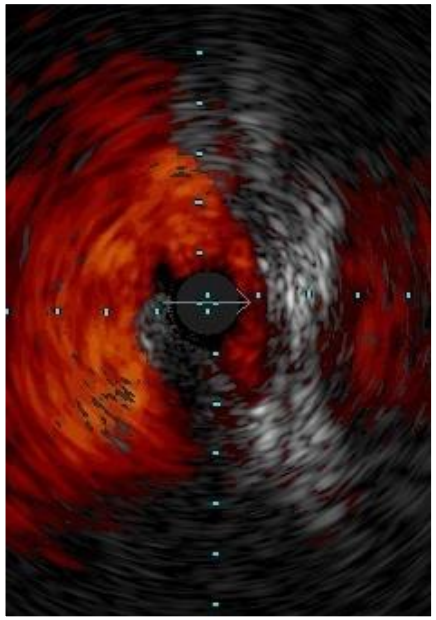
juxtamural



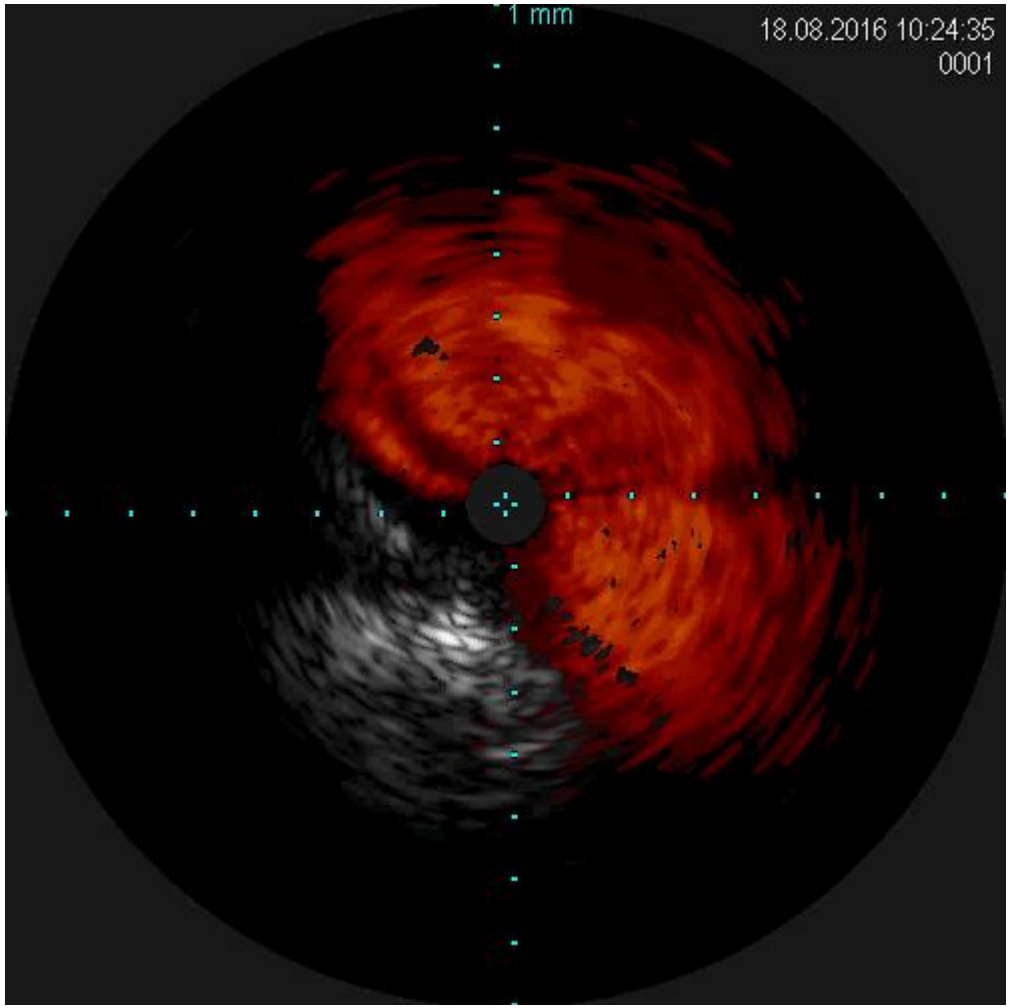
intramural



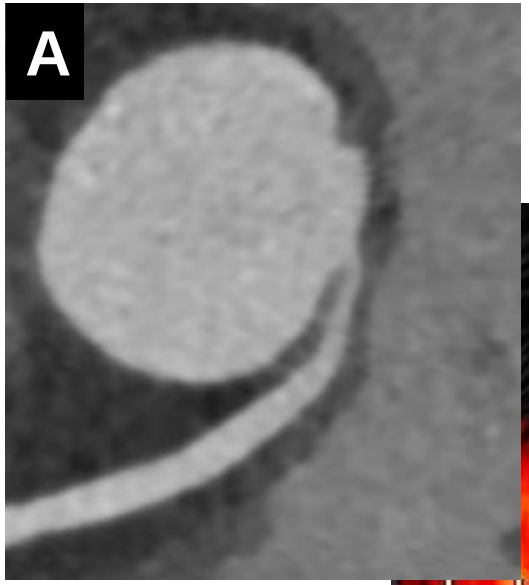
ostium

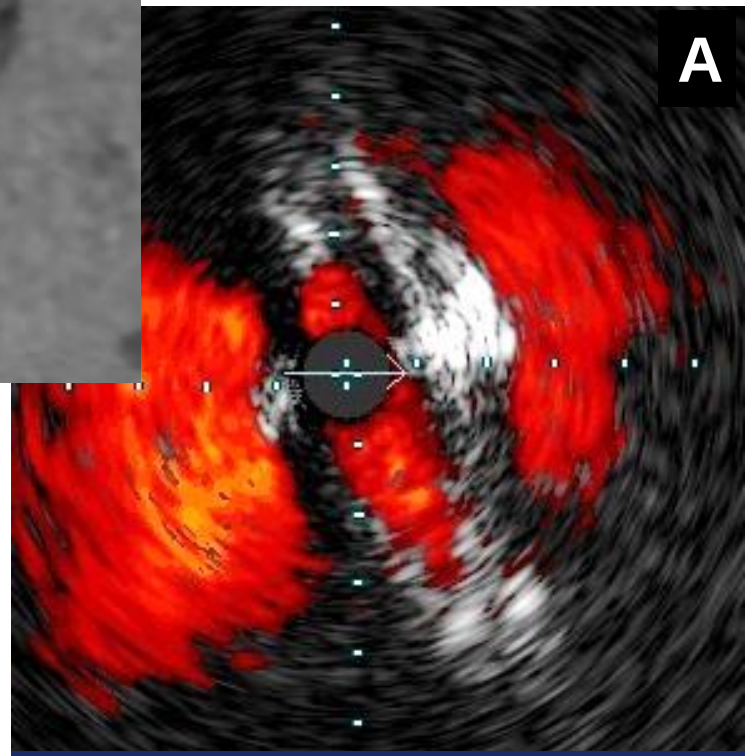


Echographie endocoronaire

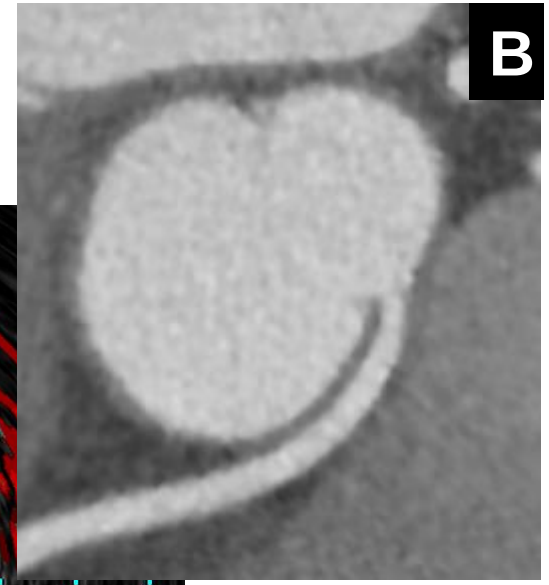


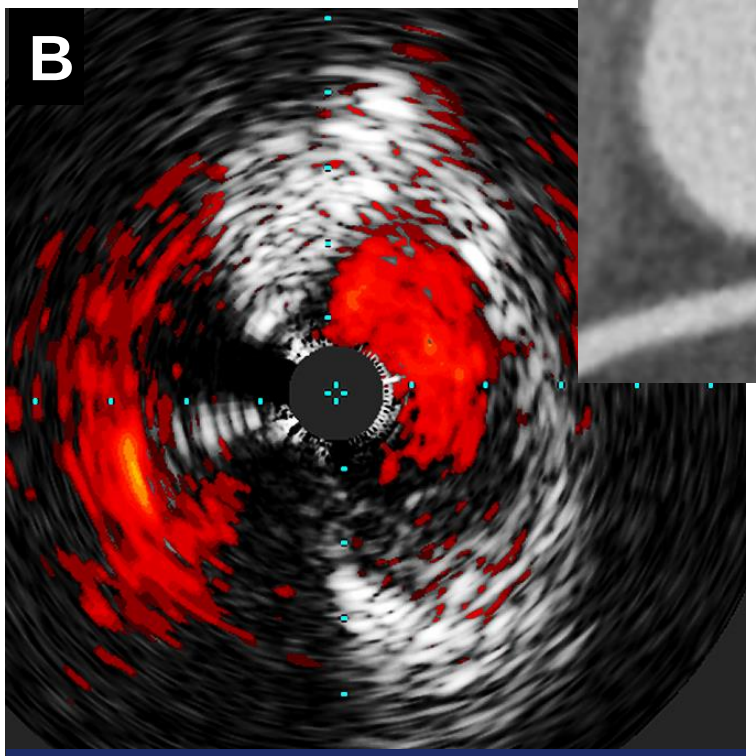
Echographie endocoronaire





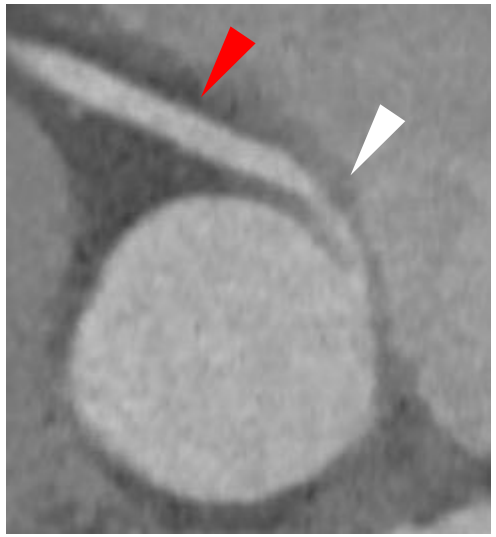
Passage intramural

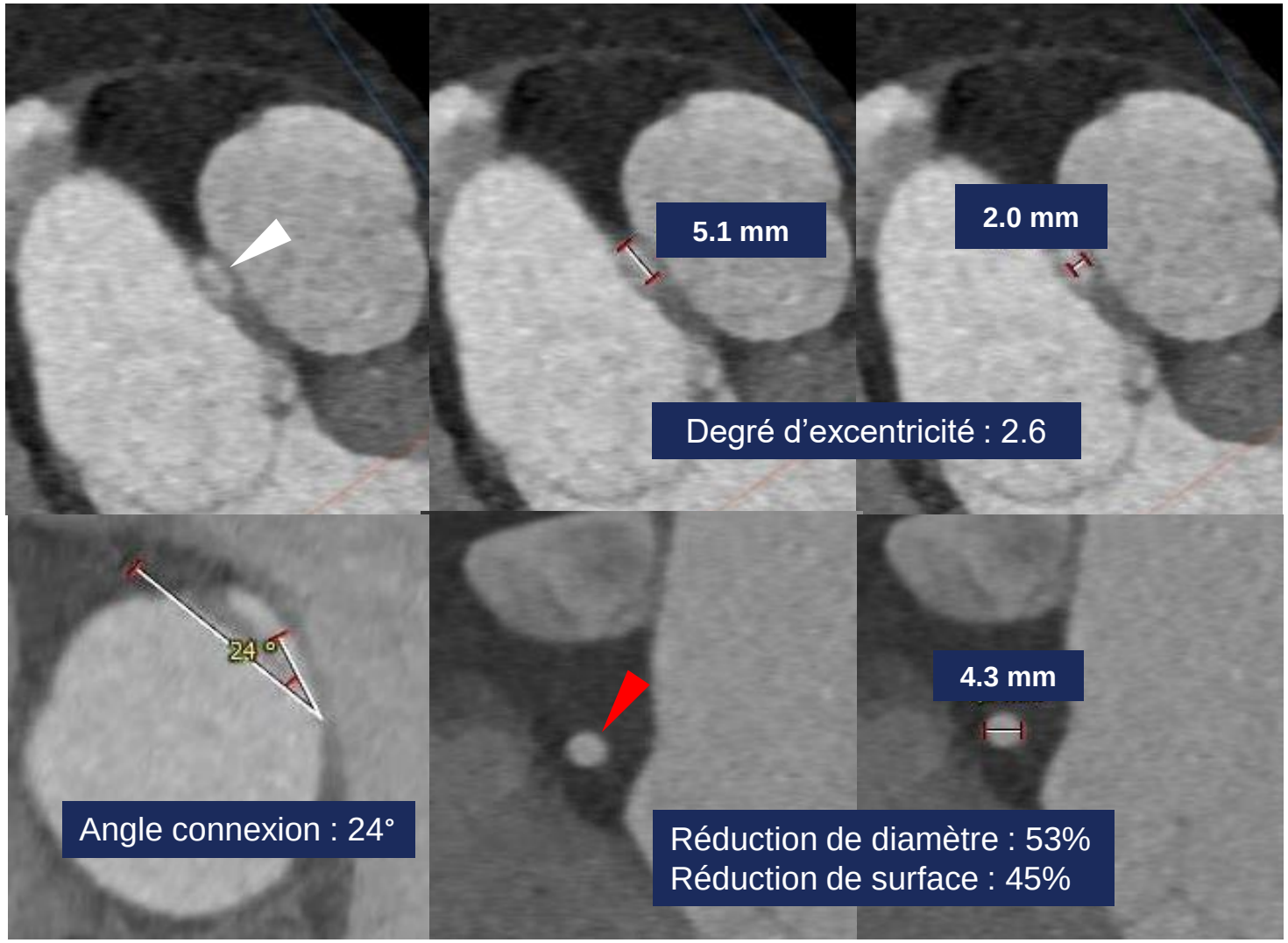




Passage juxtamural

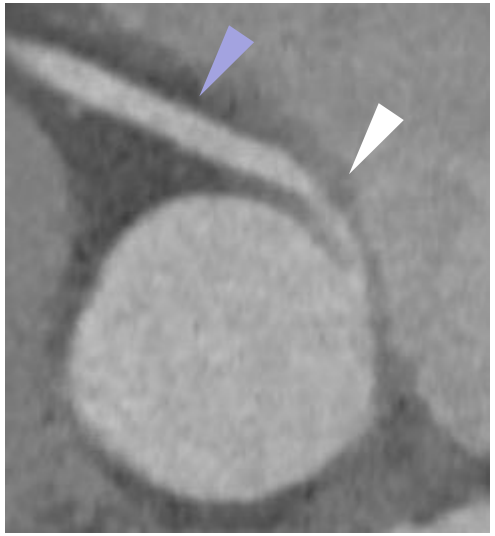
Analyse tomographique





DIU cardiologie interventionnelle

Définition tomographique d'un passage intramural aortique

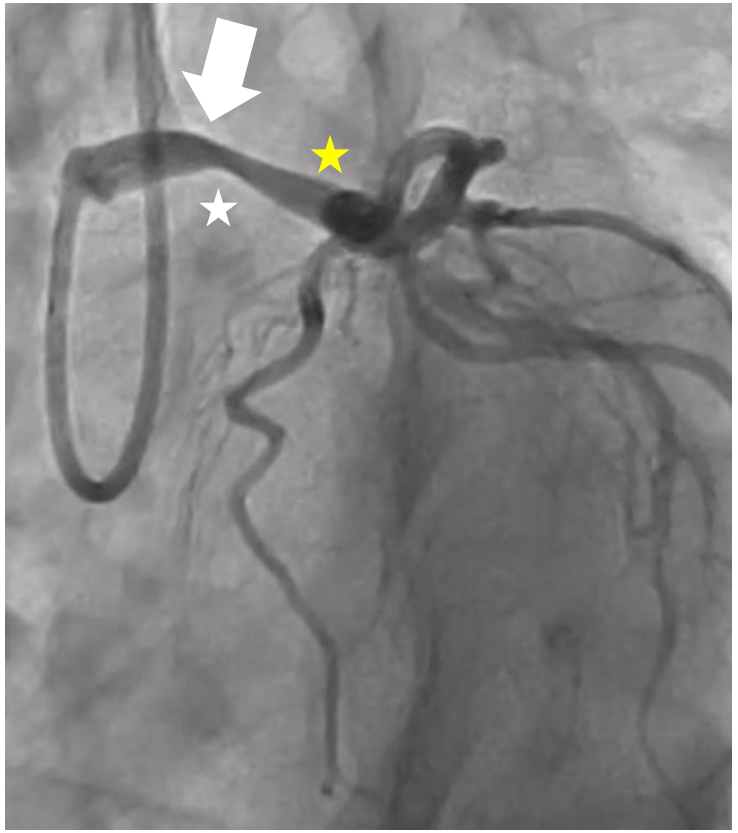


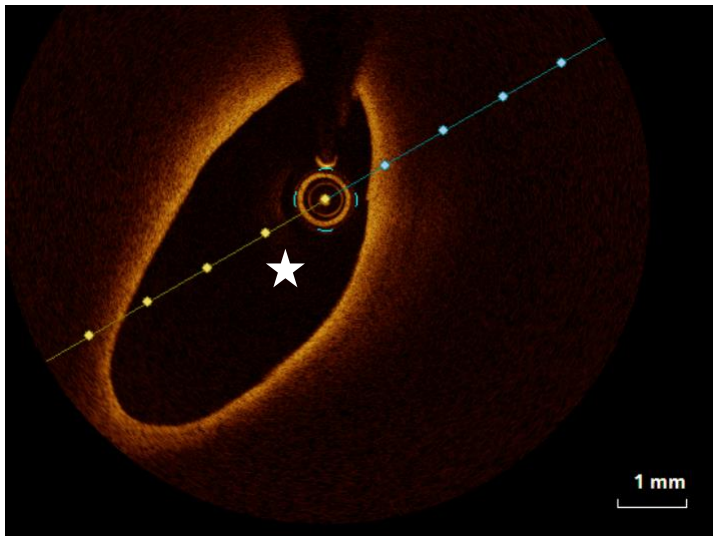
- Degré d'excentricité (grand axe/petit axe) ≥ 2.0
- Angle de connexion ≤ 30°
- Réduction de diamètre ≥ 50%

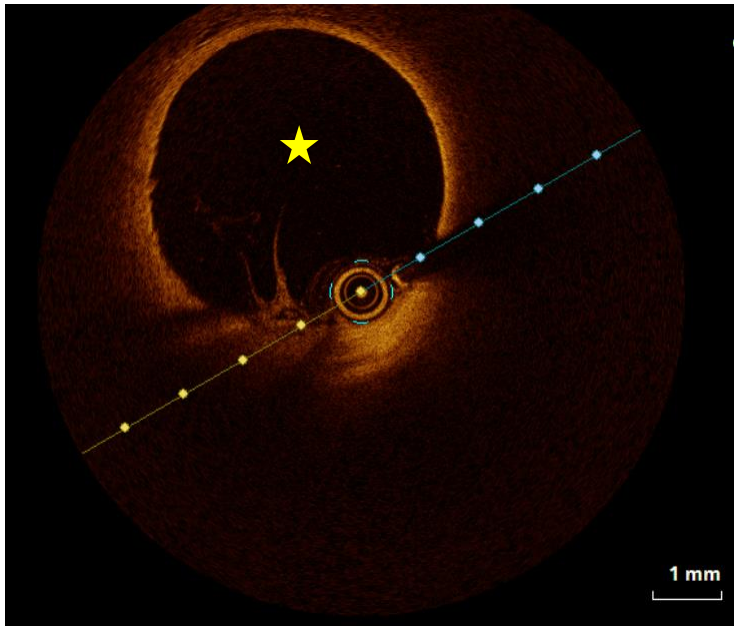
Trois critères présents* : passage intramural aortique certain
Deux critères présents* : passage intramural aortique incertain
Zéro ou un critère présent : passage intramural aortique absent

* Petit axe < 2.0 mm

Anomalies coronaires congénitales de l'adulte





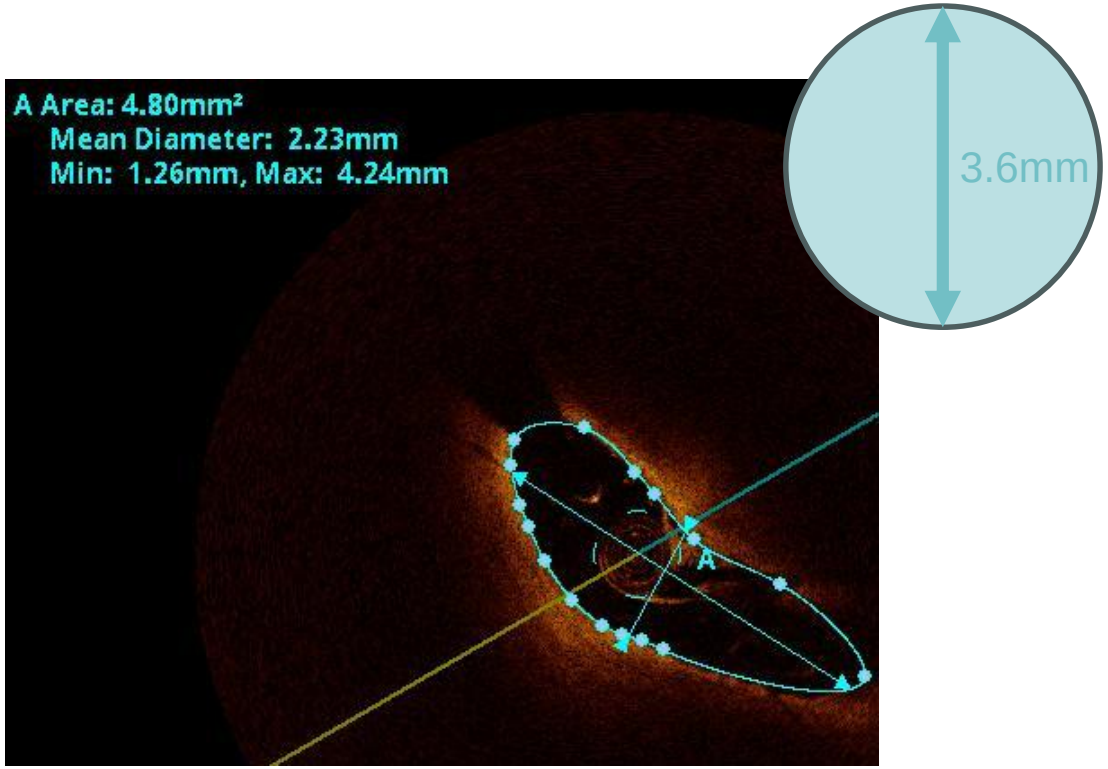


- Embryologie et anatomie
- Classification anatomique
- Prévalence
- Imagerie
- Ischémie myocardique
- Mort subite

Ischémie myocardique

- Mort subite/arrêt cardiaque récupéré
- Symptômes d'allure ischémique (angor/syncope/dyspnée)
- Ischémie myocardique (avec imagerie)

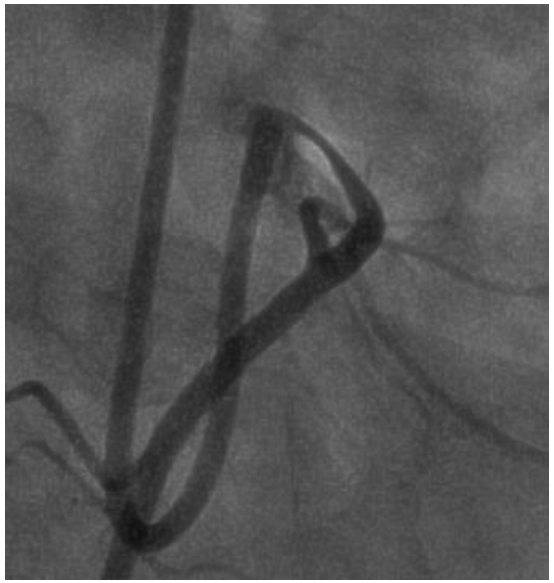
ANOCOR droites ou gauches avec trajet interartériel
Ischémie myocardique peu fréquemment documentée

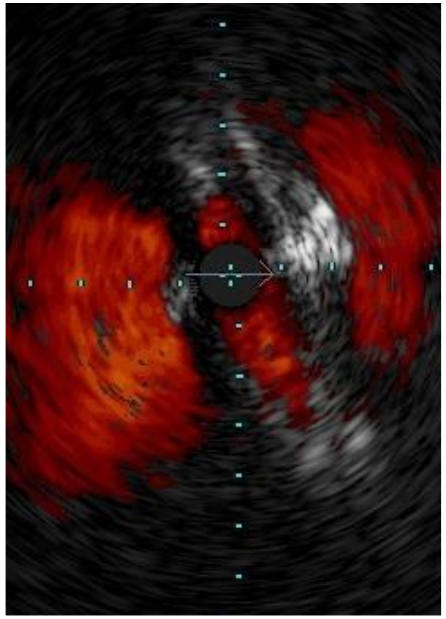


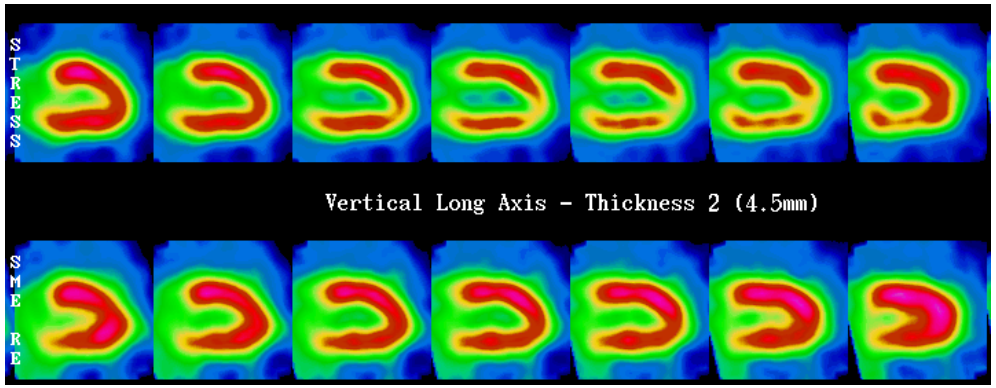
Diamètre luminal normal : 3.6 mm
Diamètre luminal minimal : 1.3 mm
Réduction de diamètre luminal : **64%**

Surface luminale normale : 10.2 mm^2
Surface luminale minimale : 4.8 mm^2
Réduction de surface luminale : **53%**

Ischémie myocardique documentée





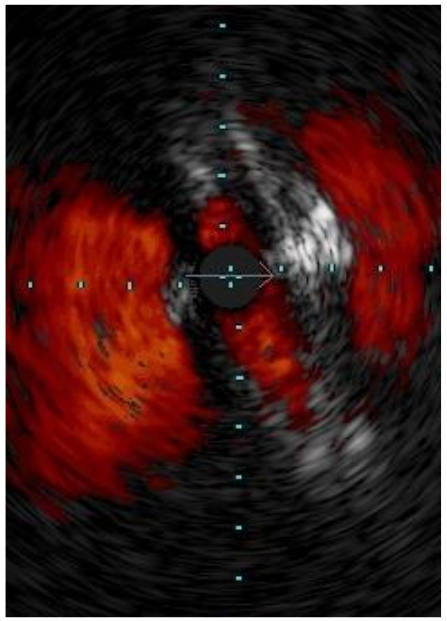


Prévalence ≈ 10%

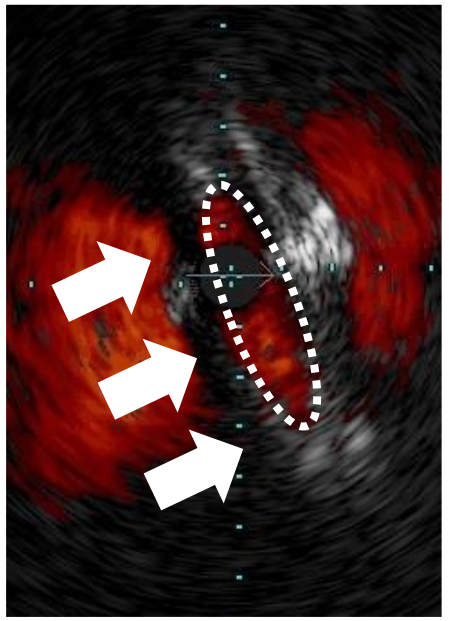
Ischémie myocardique

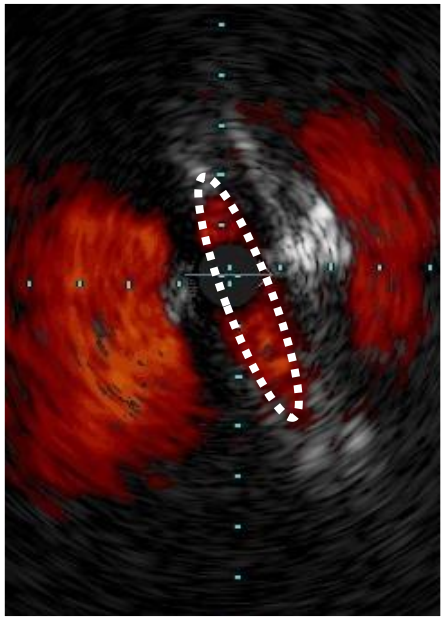
Two-Tier Concept

Fixed Component



Dynamic Component





Bigler MR. et al. Front Cardiovasc Med. 2021.

Recherche d'ischémie myocardique

TABLE 3 | Overview of possible stress protocols in assessing patients with ACAOS.

	Physical exercise		Adenosine	Regadenoson	Norepinephrine	Dobutamine	Dobutamine + volume challenge
Protocol/dose	85% of max. HR	100% of max. HR	140 μg/kg/min	Bolus: 400 μg	0.01 μg/kg/min	40 μg/kg/min	40 μg/kg/min + saline: 1.5–3 l+ atropine: 1 mg
Applied in	Non-invasive testing	Non-invasive testing	Non-invasive / invasive testing	Non-invasive testing	Invasive testing	Non-invasive / invasive testing	Invasive testing
Increase in coronary blood flow to detect relevant fixed stenosis	+++	+++++	+++	+++	++	++++	++++
Increased heart minute volume to provoke dynamic lateral compression	++	+++++	-	-	+++	++	++++
Reproducibility of symptoms	+++	+++++	-	-	++	++	+++
Tolerability	++++	++++	++	+++	++	++	++

HR, heart rate.

Bigler MR. et al. Front Cardiovasc Med. 2021.

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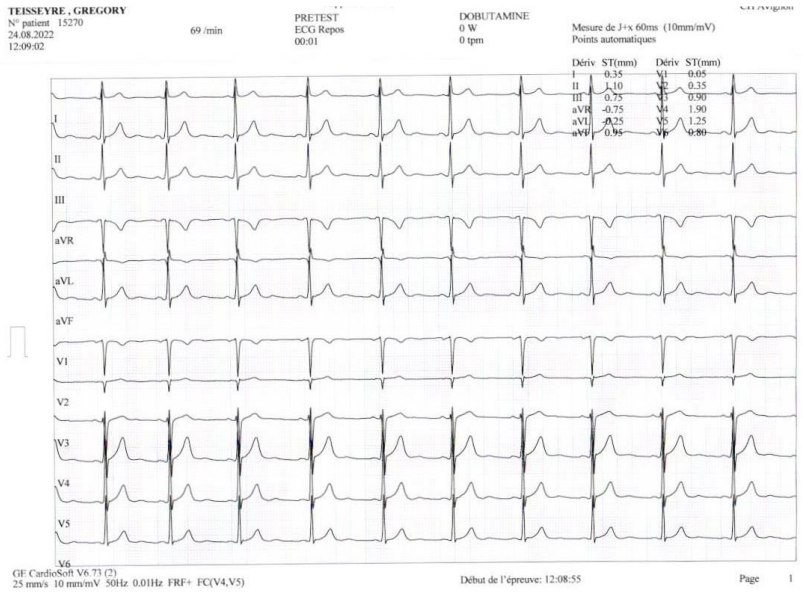
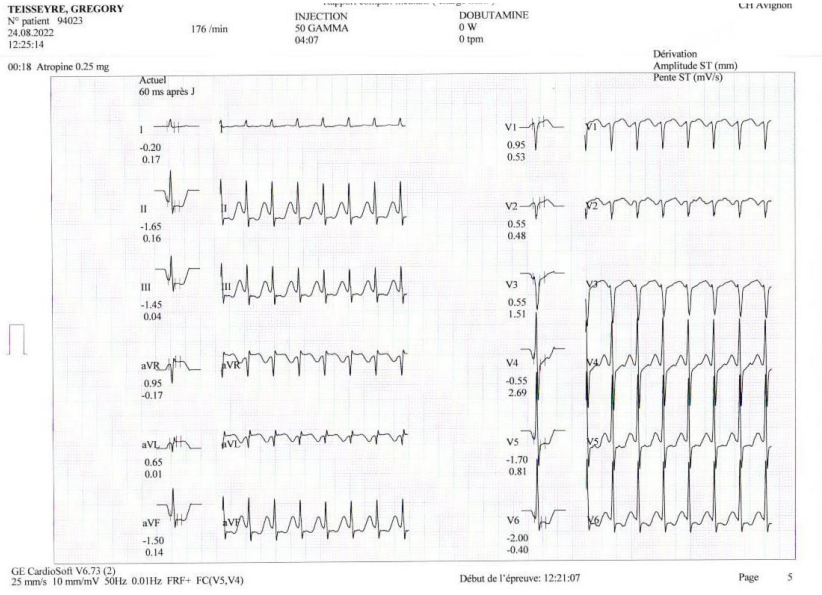
Recherche d'ischémie myocardique

Homme de 40 ans
Sportif +
Pas d'antécédents cardiaques
Découverte fortuite ANOCOR gauche avec trajet interartériel
Scintigraphie myocardique d'effort : normale à 100% FMT
Echocardiogramme d'effort : normale à 80% FMT
Echocardiogramme sous dobutamine : lipothymie sans angor à 50 gamma/kg/min





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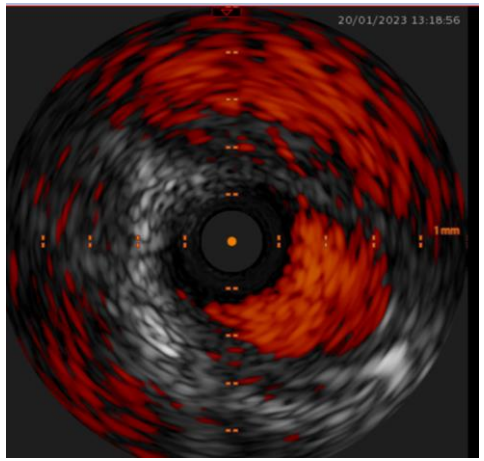


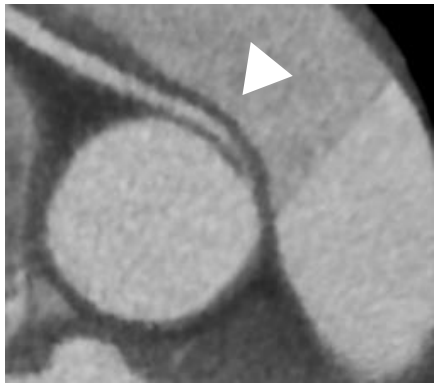
ANOCOR droite

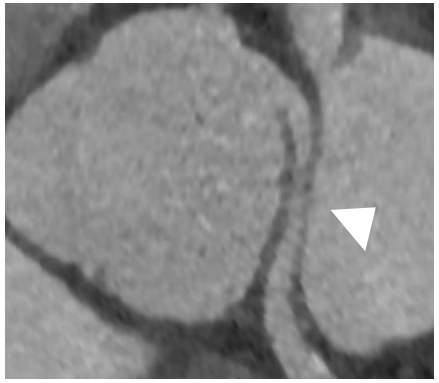
FFR sous dobutamine

ANOCOR à risque d'ischémie myocardique

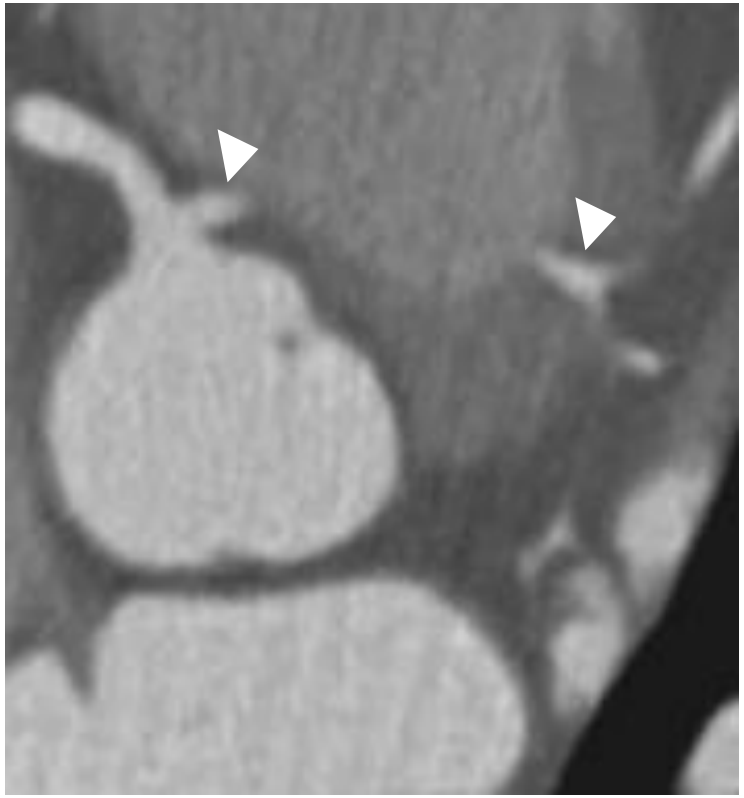
Connexions aortiques

Trajet interartériel

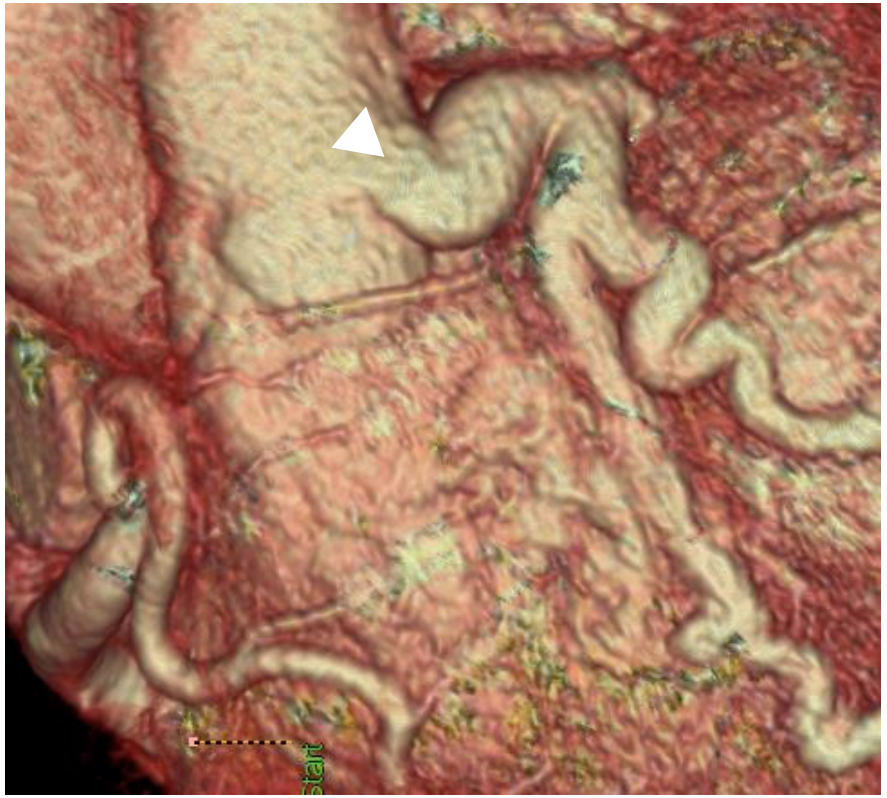




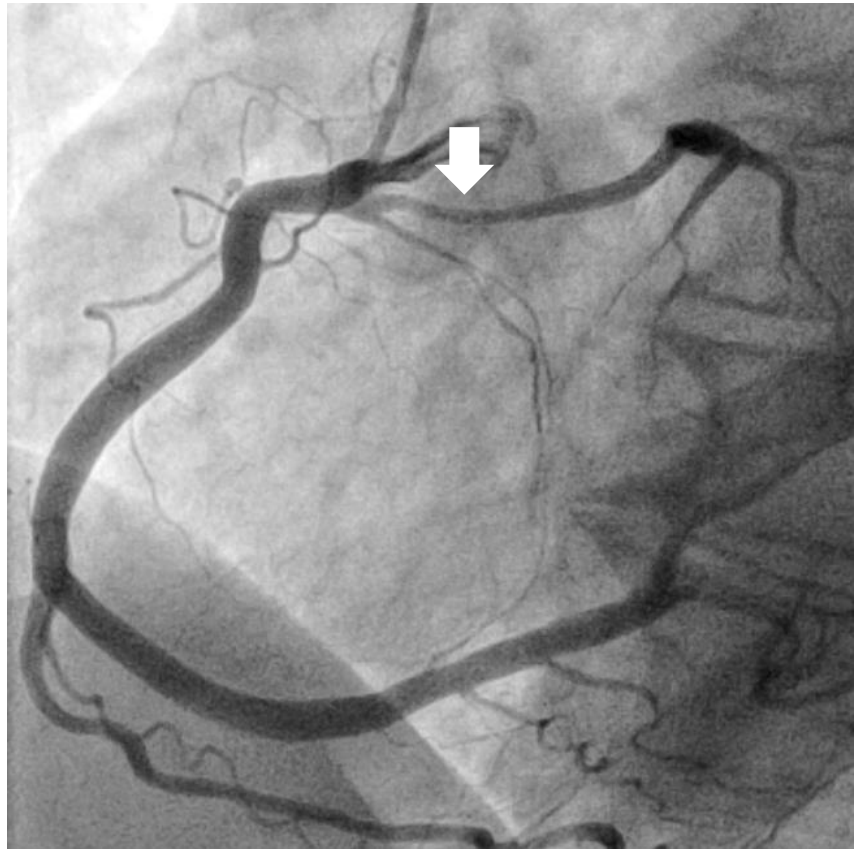
Trajet rétropulmonaire



Connexions pulmonaires

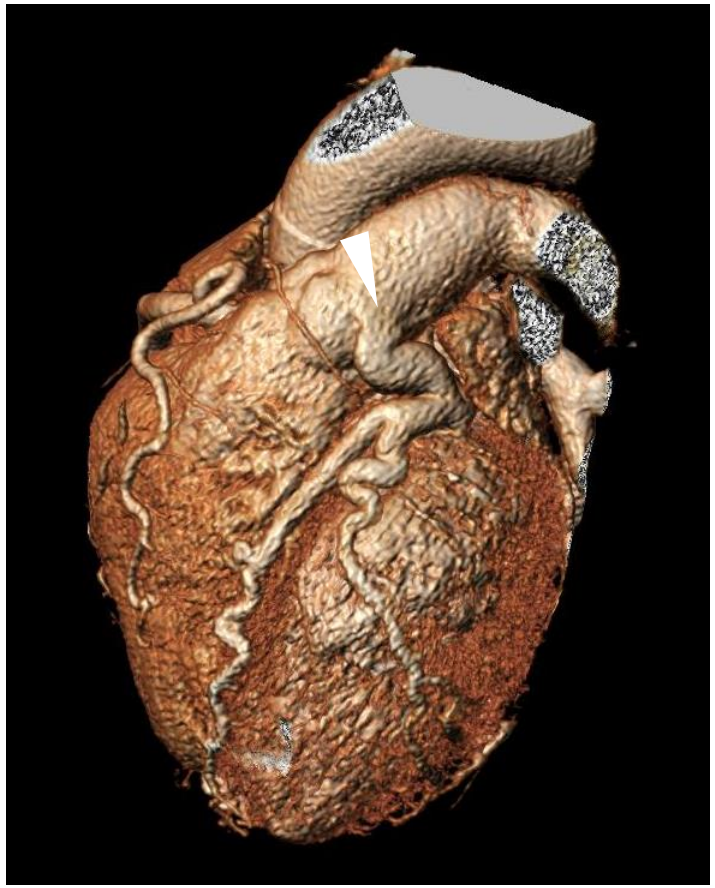


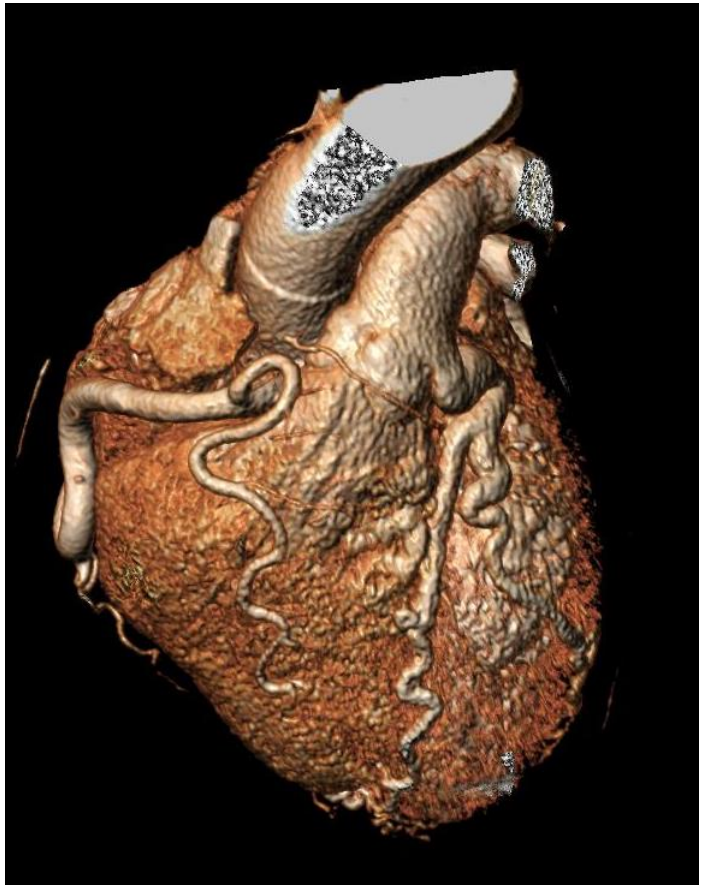
Trajet rétropulmonaire du tronc gauche



ANOCOR à risque d'ischémie myocardique

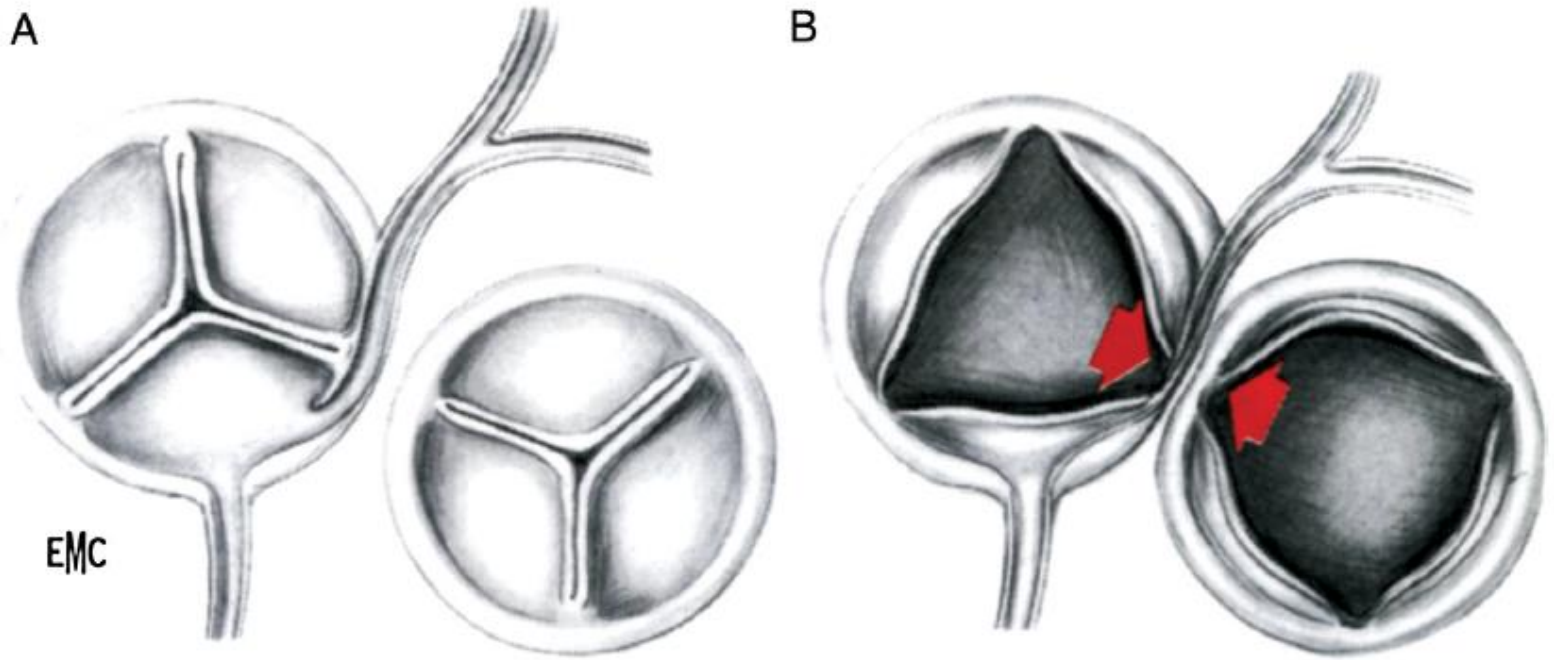
Connexions pulmonaires





- Découverte très rare chez l'adulte
- Droite > IVA > Tronc commun > Circonflexe
- Cardiomyopathie ischémique
- VG dilaté et hypokinétique
- Insuffisance mitrale possible
- Séquelle possible de nécrose
- Hypoperfusion myocardique chronique

Exertional dynamic compression

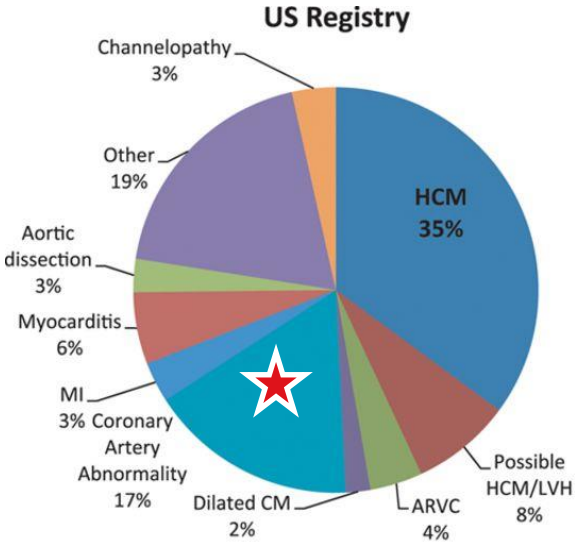


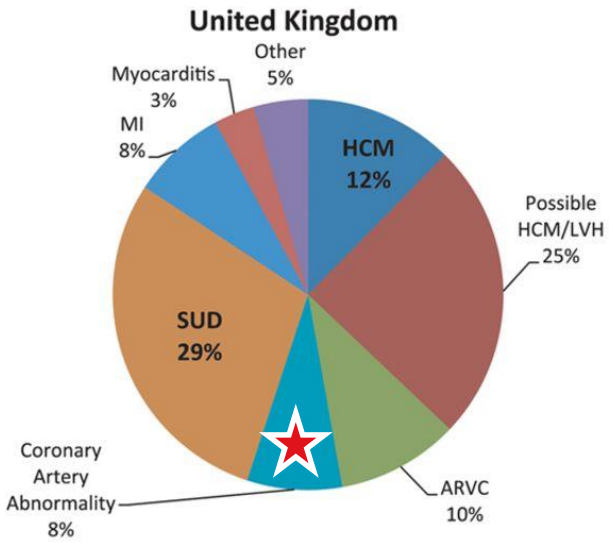
Raisky O, Vouhé P. EMC 2007

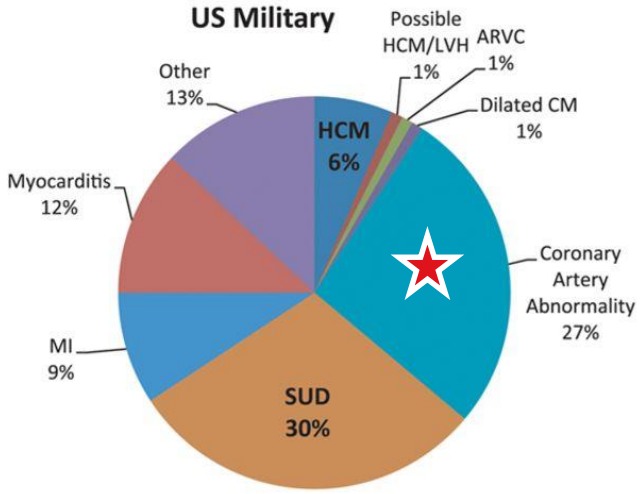
Never demonstrated

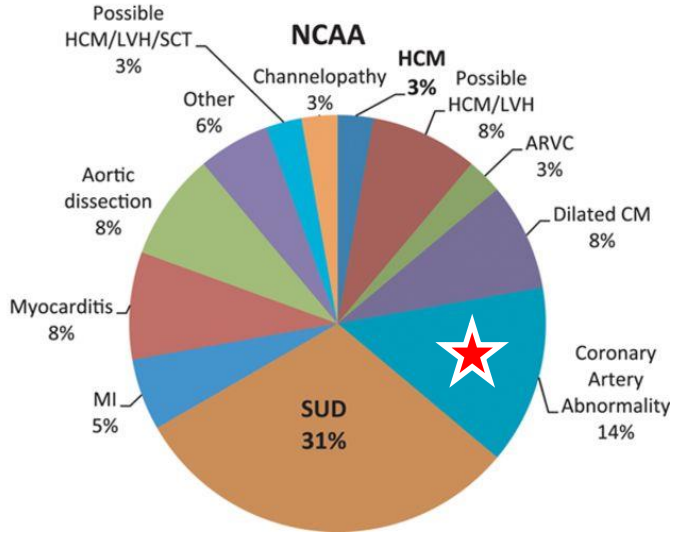
- Embryologie et anatomie
- Classification
- Prévalence
- Imagerie
- Ischémie myocardique
- Mort subite

Sudden death
in 0-35 years of age







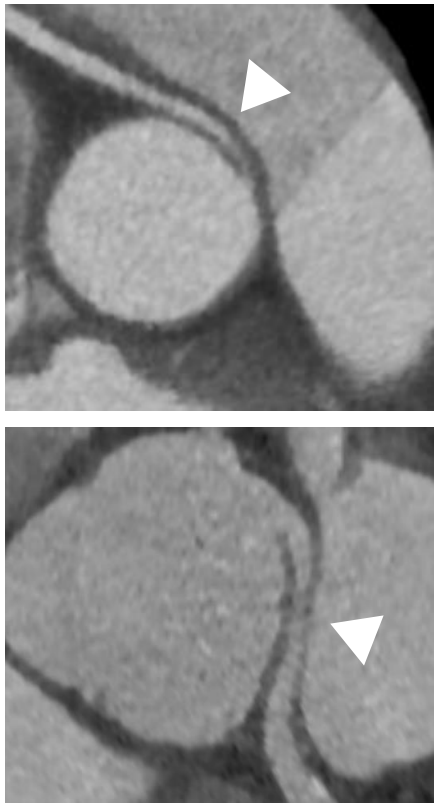


Meyer L. Circulation. 2012.

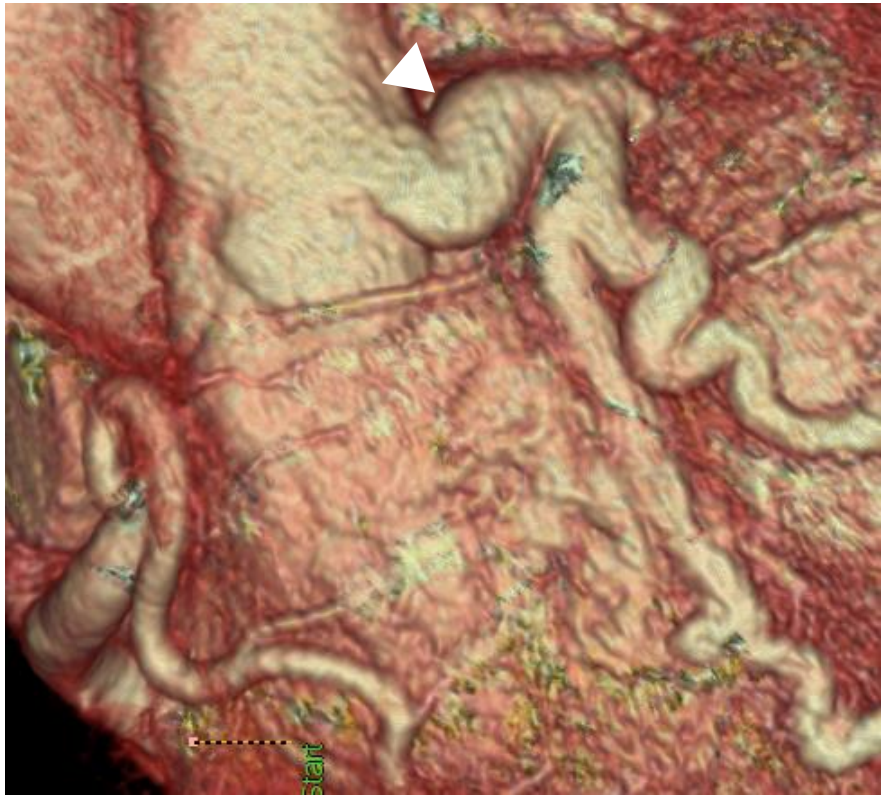
ANOCOR à risque de mort subite

Connexions aortiques

Trajet interartériel



Connexions pulmonaires



Cardiopathie congénitale à risque de mort subite	Prévalence**
ANOCOR* droite	0.3%
Cardiomyopathie hypertrophique	0.2%
Syndrome pré-excitation ventriculaire	0.15%
Syndrome de QT long	0.05%
Cardiomyopathie dilatée idiopathique	0.04%
Dysplasie ventriculaire droite arythmogène	0.04%
ANOCOR* gauche	0.03%
Syndrome de Brugada	0.02%
Tachycardie ventriculaire catécholergique	0.01%

* Anomalie de connexion avec trajet interartériel
** Nombre de cas à la naissance (estimations)

Cardiopathie congénitale à risque de mort subite	Incidence annuelle**
Tachycardie ventriculaire catécholergique	1.5%
Cardiomyopathie hypertrophique	1-2%
Syndrome de Brugada	1%
Syndrome de QT long	0.5-1%
Cardiomyopathie dilatée idiopathique	0.5-1%
Dysplasie ventriculaire droite arythmogène	0.5-1%
ANOCOR* gauche	0.2%
Syndrome pré-excitation ventriculaire	0.1%
ANOCOR* droite	0.02%

* Anomalie de connexion avec trajet interartériel
** Incidence annuelle de mort subite (estimations)

2020 Guidelines for adult congenital heart disease

ESC European Society of Cardiology

Anomalous aortic origin of the coronary artery		
Surgery is recommended for AAOCA in patients with typical angina symptoms who present with evidence of stress-induced myocardial ischaemia in a matching territory or high-risk anatomy.[c]	I	C
Surgery should be considered in *asymptomatic* patients with AAOCA (right or left) and evidence of myocardial ischaemia.	IIa	C
Surgery should be considered in *asymptomatic* patients with AAOLCA and no evidence of myocardial ischaemia but a high-risk anatomy.[c]	IIa	C
Surgery may be considered for symptomatic patients with AAOCA even if there is no evidence of myocardial ischaemia or high-risk anatomy.[c]	IIb	C
Surgery may be considered for *asymptomatic* patients with AAOLCA without myocardial ischaemia and without high-risk anatomy[c] when they present at young age (<35 years).	IIb	C
Surgery is not recommended for AAORCA in asymptomatic patients without myocardial ischaemia and without high-risk anatomy.[c]	III	C

[c]High-risk anatomy includes features such as an intramural course and orifice anomalies (slit-like orifice, acute-angle take-off, orifice >1 cm above the sinotubular junction).

Baumgartner H et al. Eur Heart J. 2020.

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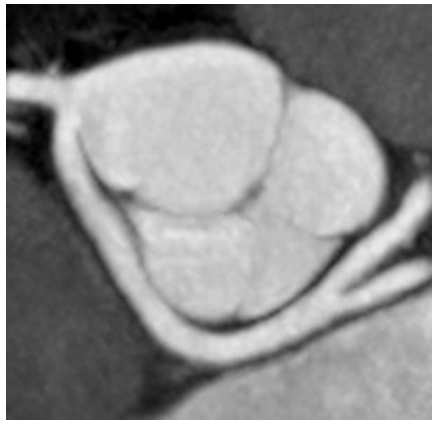
Informations dans le compte-rendu de coronarographie

- Connexions anormales proximales
  - artère concernée
  - site de connexion
  - trajet probable par rapport à AO/AP
  - athérome coronaire associé

- Connexions anormales distales
  - artère concernée
  - type proximal (A) ou distal (B)
  - site de connexion
  - taille : petite/intermédiaire/large
  - unique/multiple
  - morphologie (tortuosités/calcifications)

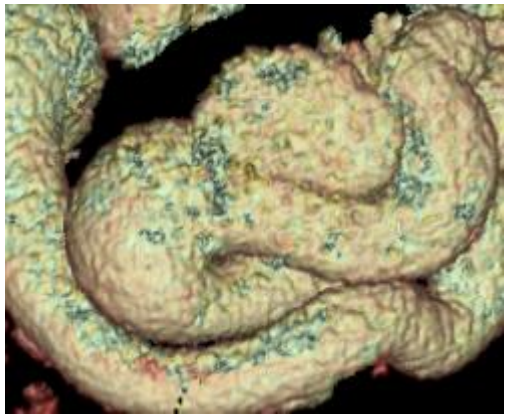
- Trajet intramyocardique
  - artère concernée
  - présent/possible
  - écrasement systolique < ou > 50%

Conclusions

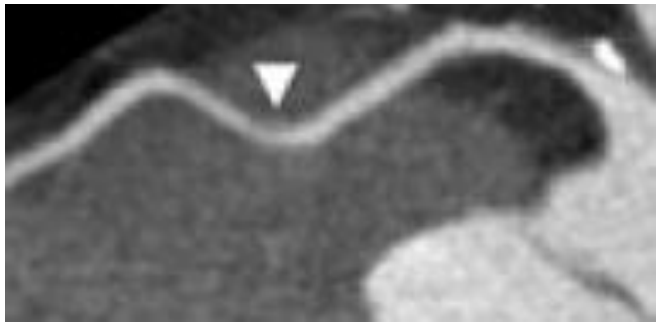


- Connexions anormales proximales
  - nombreuses formes anatomiques
  - trajet interartériel à reconnaître
  - aide de l'imagerie en coupe

- Connexions anormales distales
  - très rares
  - hétérogénéité anatomique
  - retentissement très variable
  - aide de l'imagerie en coupe



- Anomalies sur le trajet
  - ponts musculaires
  - prévalence élevée
  - généralement bénignes



DIU cardiologie interventionnelle

Groupe de travail multidisciplinaire sur les ANOmalies congénitales des artères CORonaires

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http://anocor.fr
Ouverture début 2024
Groupe multidisciplinaire ANOCOR
Anomalies Coronaires Congénitales
Ce site est destiné aux professionnels de santé et aux patients, ainsi qu'à leur entourage, souhaitant obtenir des informations sur les Anomalies Coronaires Congénitales (ANOCOR). Les formes anatomiques sont très nombreuses, allant de la banale anomalie sans conséquence clinique aux anomalies pouvant être responsables de symptômes cardiaques graves dont l'arrêt cardiaque. Même si les techniques d'imagerie, surtout radiologiques, permettent le diagnostic de ces anomalies rares, leur compréhension reste incomplète et leur prise en charge n'est pas encore parfaitement codifiée. Le site ANOCOR a pour objectifs d'aider les professionnels de santé dans leur démarche de recherche et de transmettre aux patients nos connaissances actuelles. Bonne navigation.