Mardi 27 février 2024

ANOmalies CORonaires congénitales (ANOCOR) et chirurgie

Pierre Aubry
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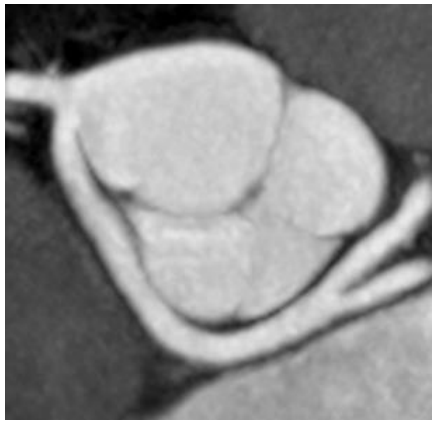
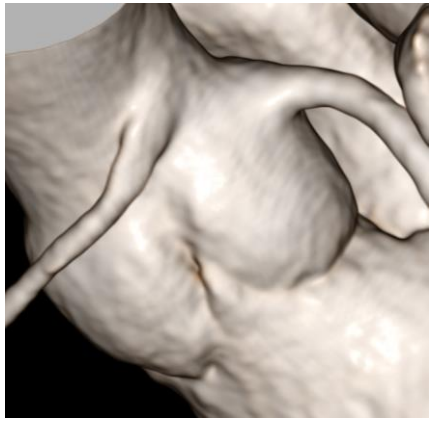
HÔPITAUX UNIVERSITAIRES PARIS NORD VAL DE SEINE
Bichat - Claude-Bernard

ASSISTANCE PUBLIQUE HÔPITAUX DE PARIS

Groupement Hospitalier de Territoire
Saint-Denis Gonesse
Plaine de France





- Embryologie et anatomie
- Classification
- Prévalence
- Imagerie
- Ischémie myocardique
- Mort subite
- Prise en charge
- Chirurgie
- Angioplastie

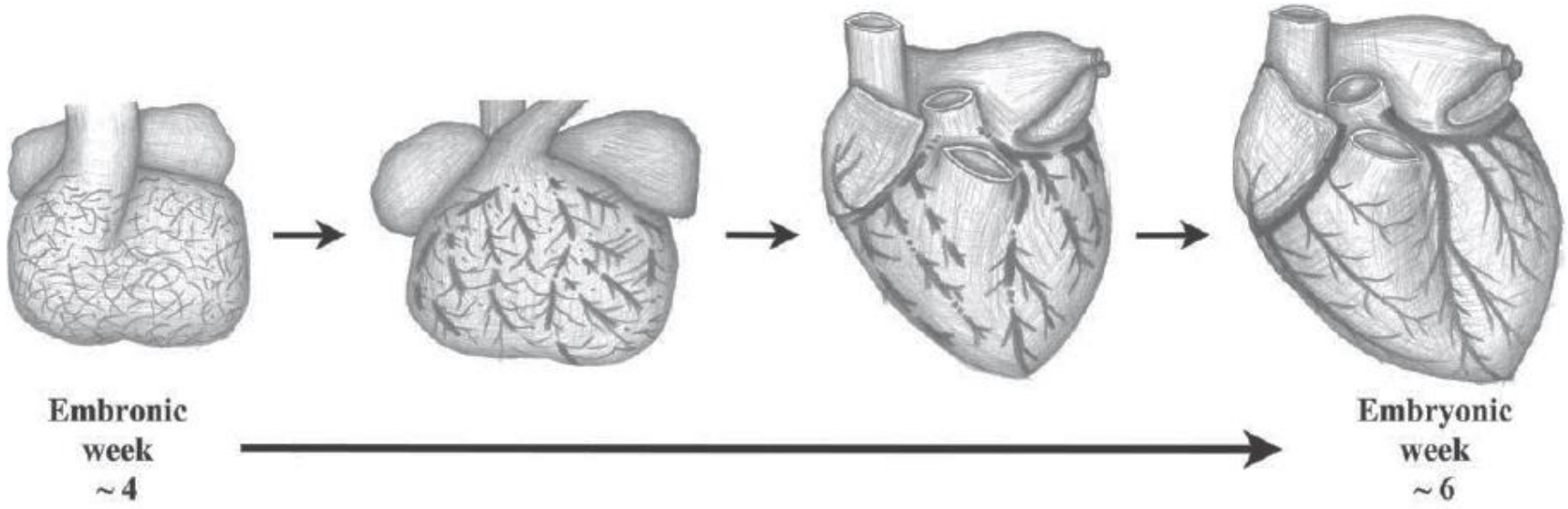
Origine anormale

Développement à partir de l'aorte

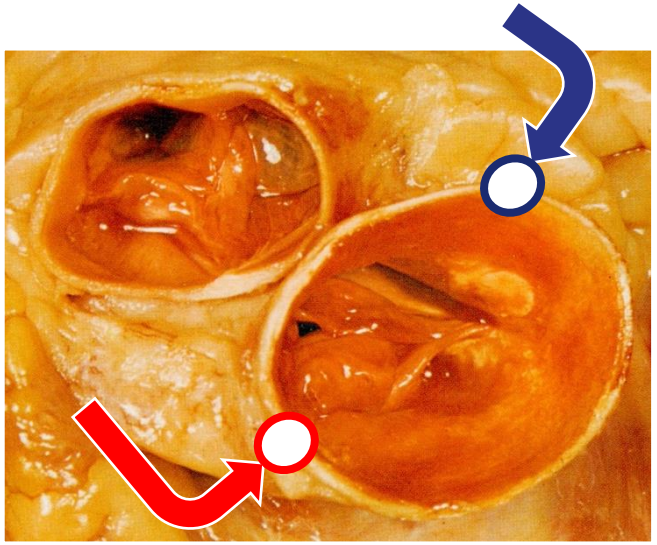
Connexion anormale

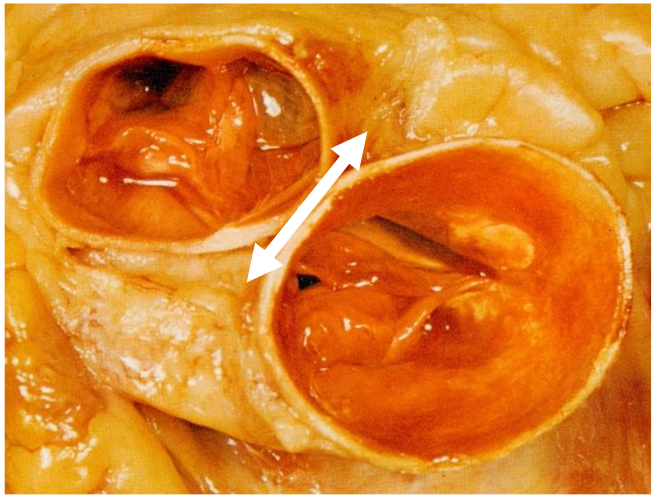
Développement vers l'aorte

Embryologie et anatomie



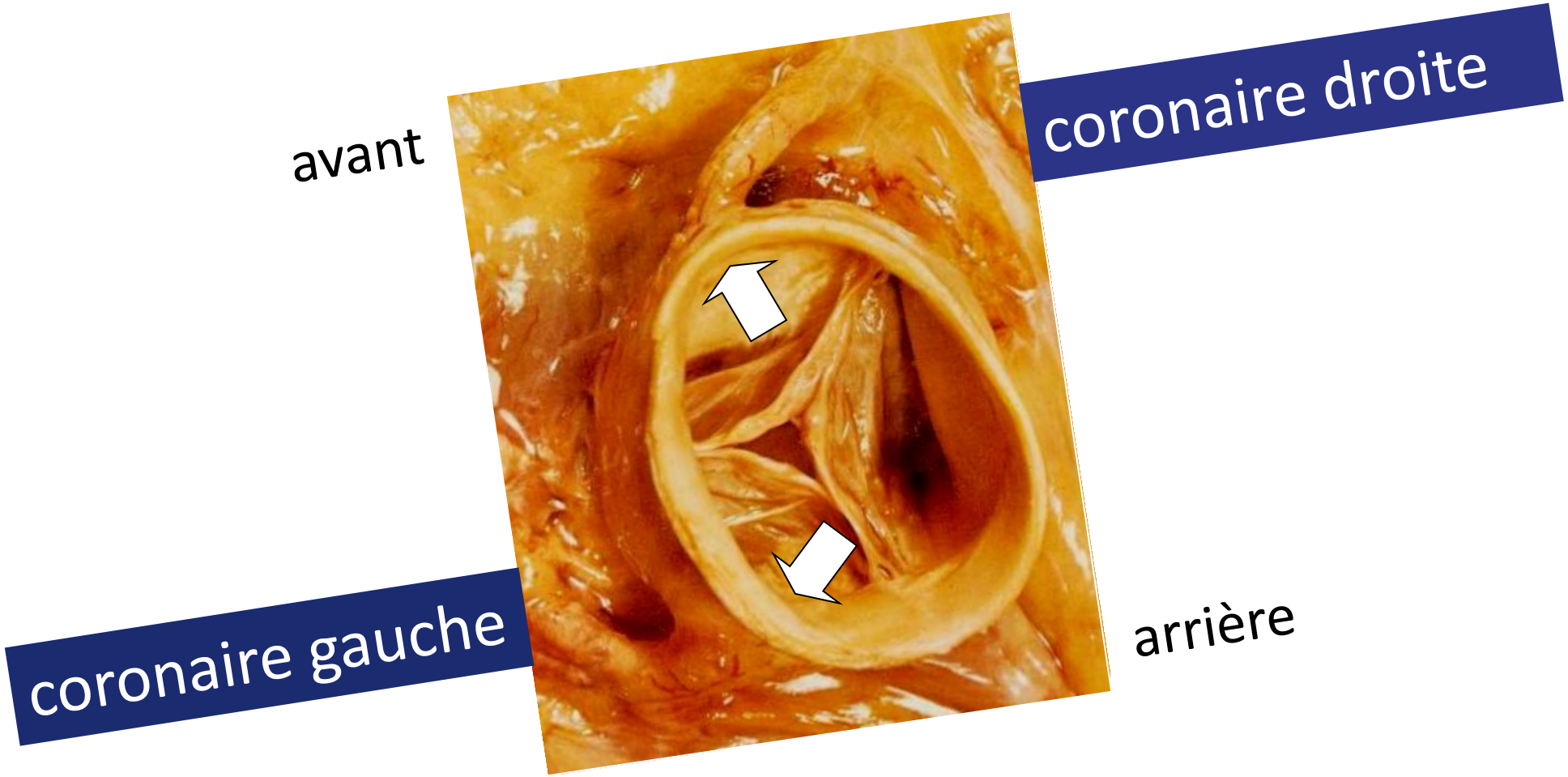
Development of coronary vessels during embryogenesis.





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

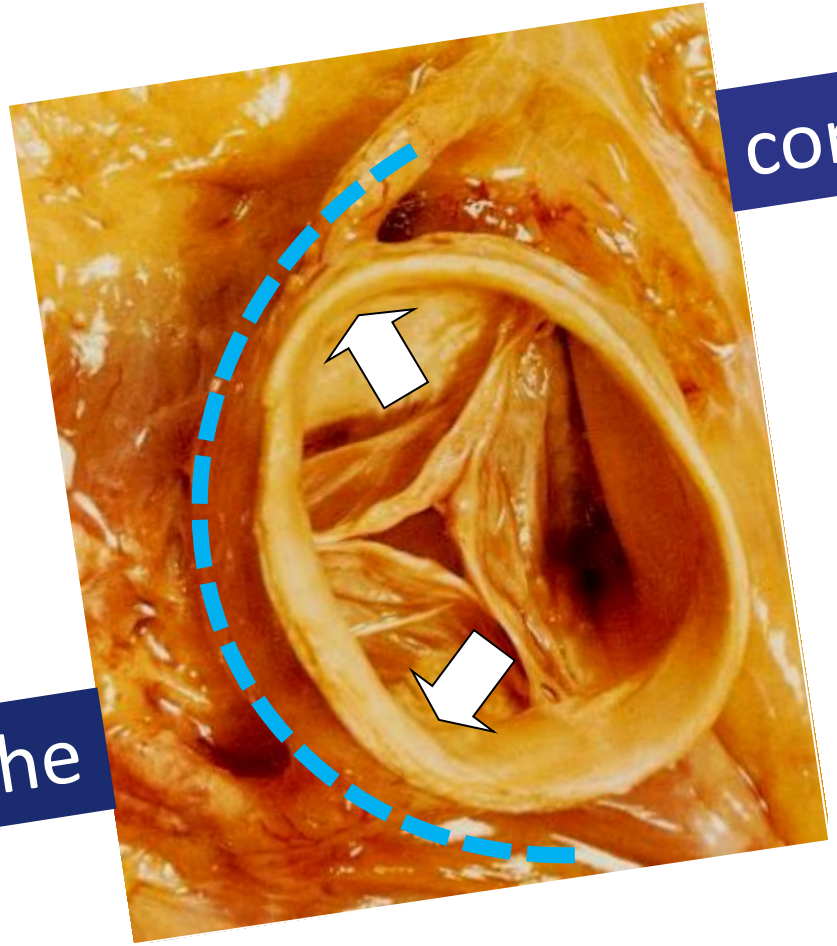
Connexions coronaires normales



Connexions coronaires anormales (- -)

avant

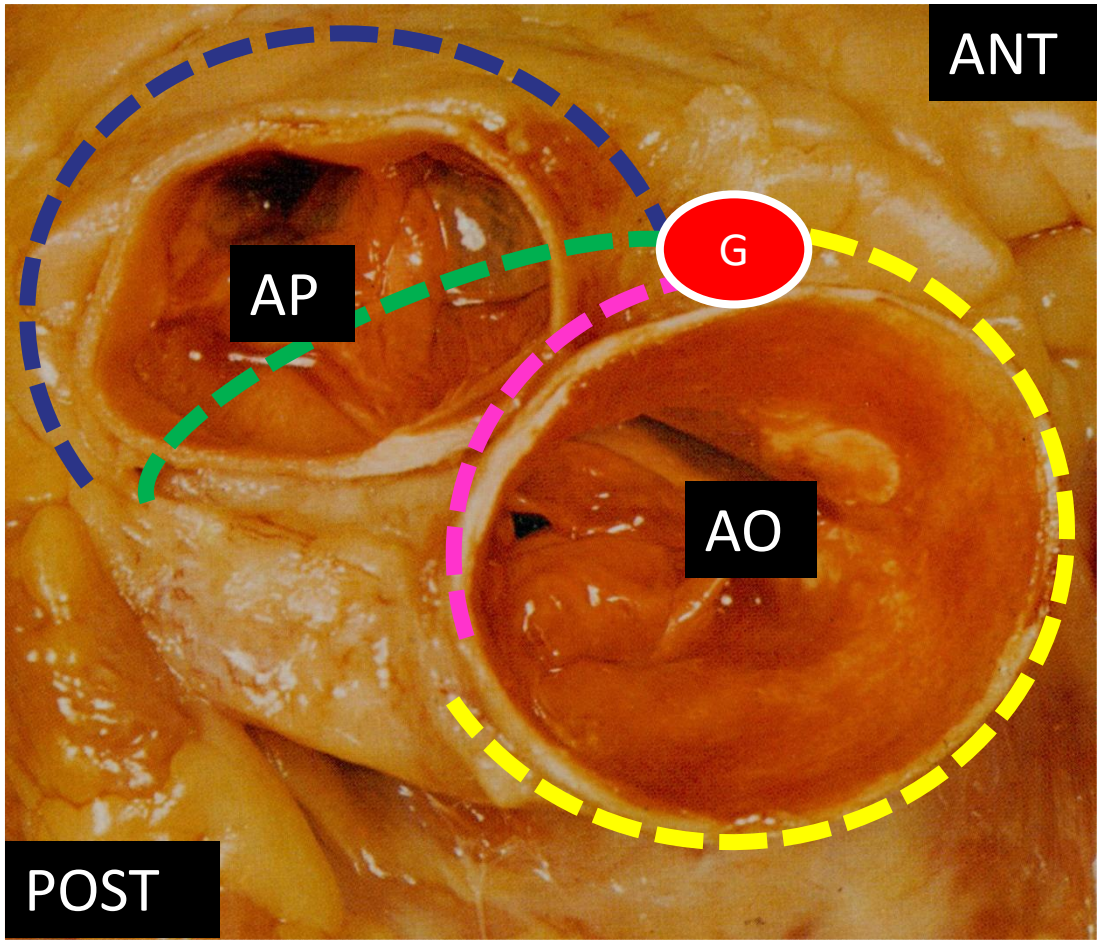
coronaire droite



coronaire gauche

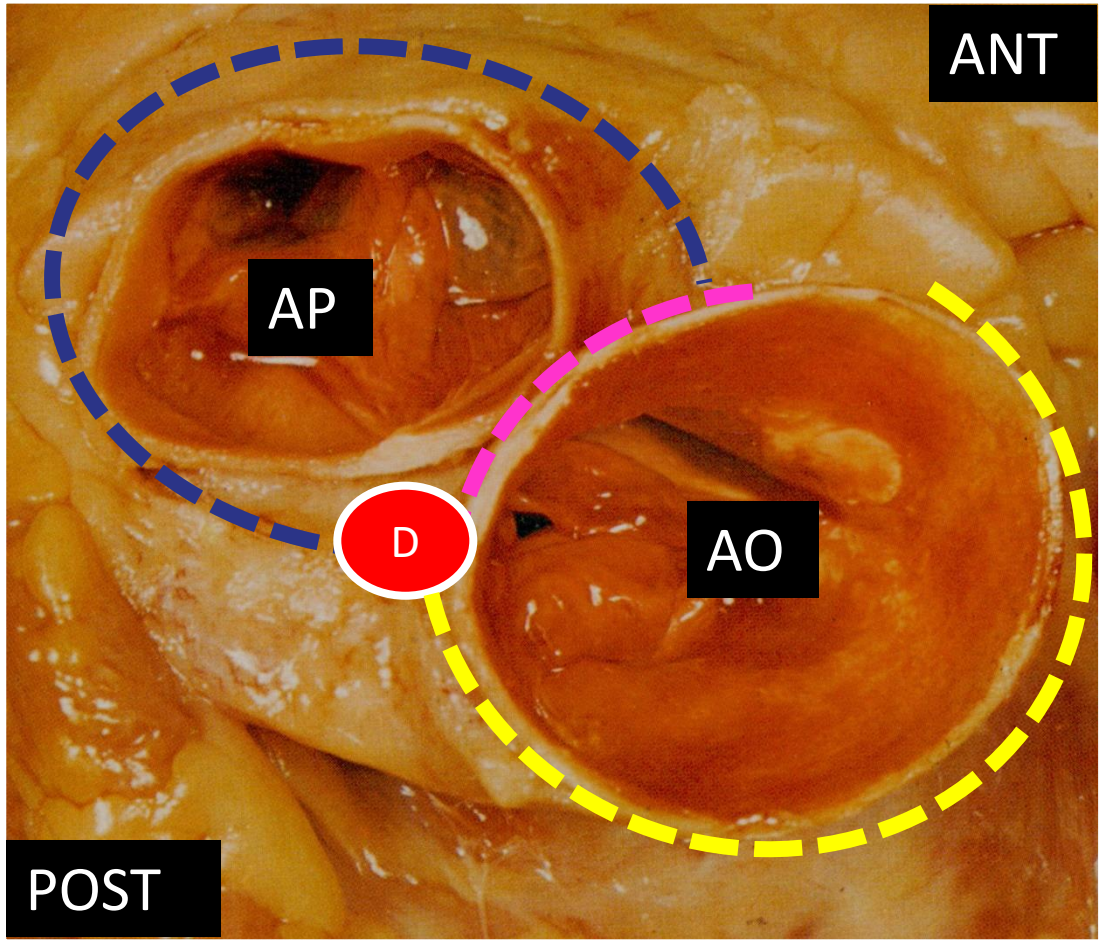
arrière

Trajets ectopiques pour la coronaire gauche



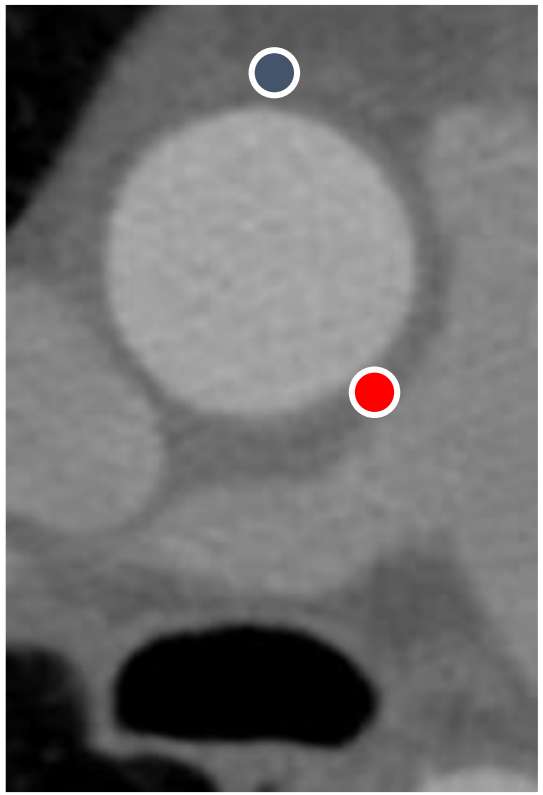
- prépulmonaire
- rétropulmonaire (intraseptal)
- interartériel (préaortique)
- rétroaortique

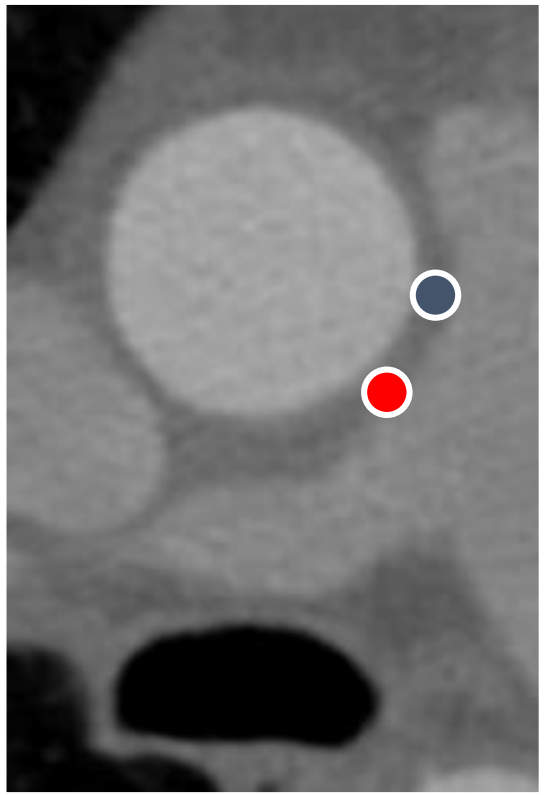
Trajets ectopiques pour la coronaire droite

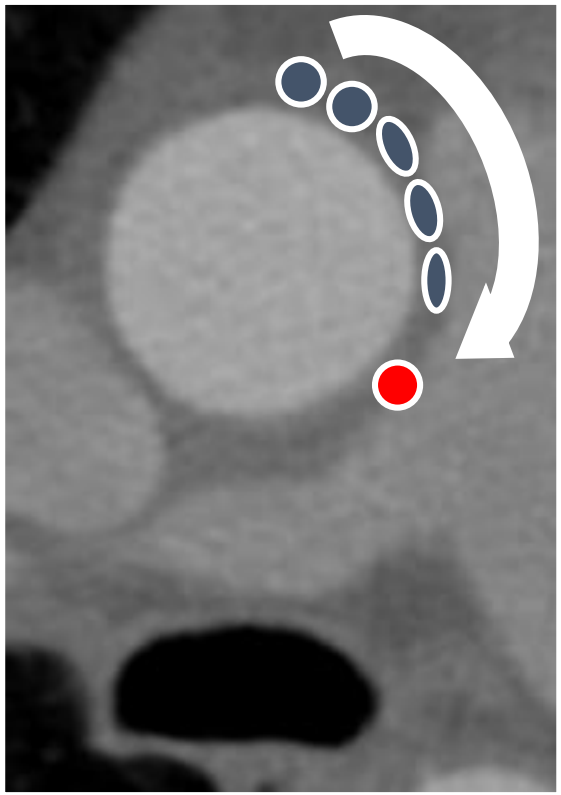


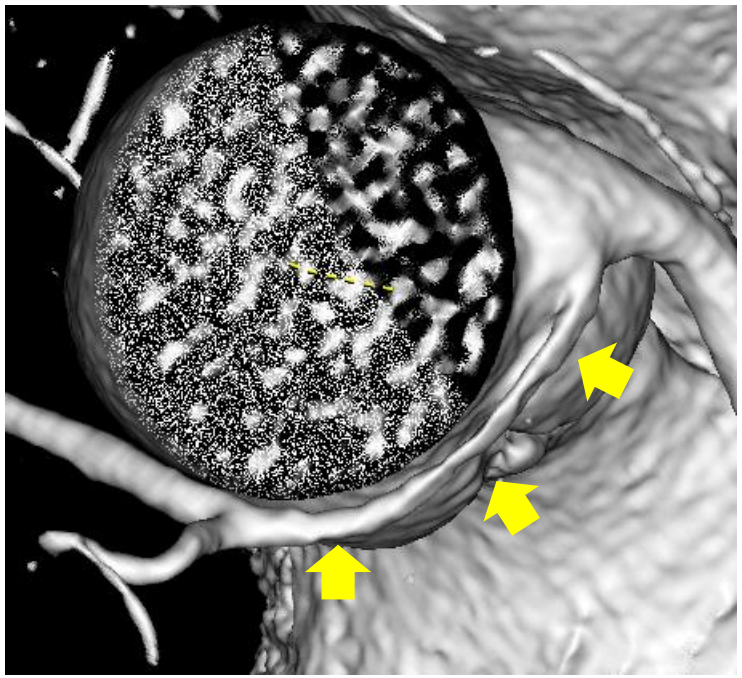
- prépulmonaire
- interartériel (préaortique)
- rétroaortique

Adaptation vasculaire

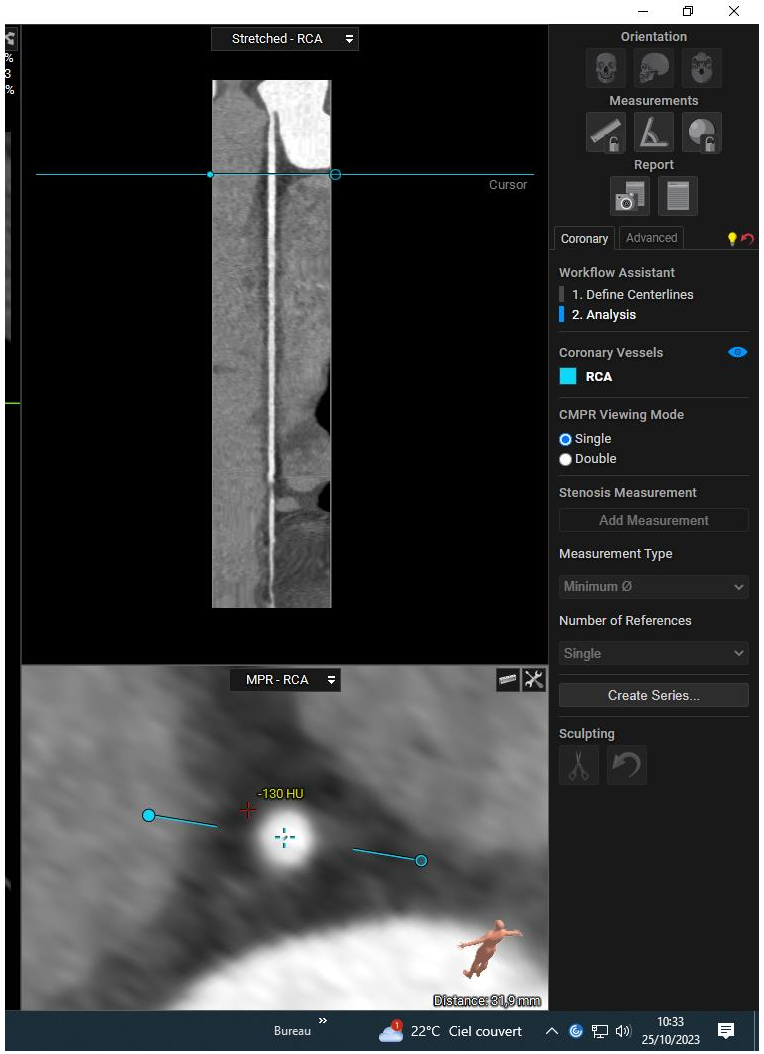


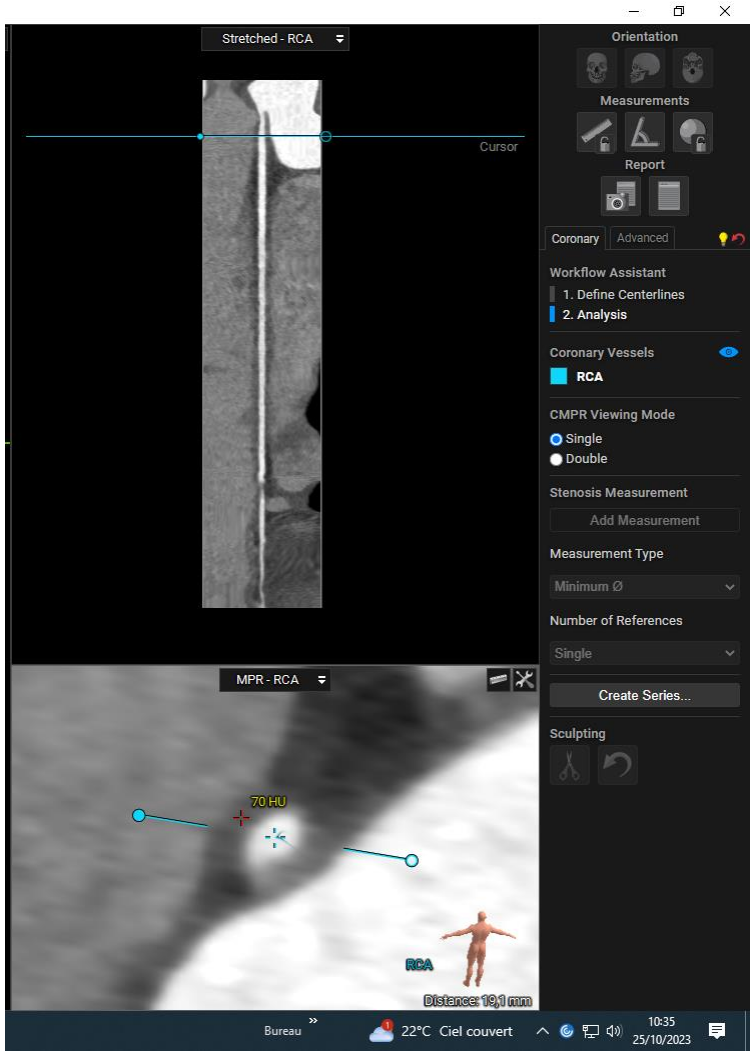


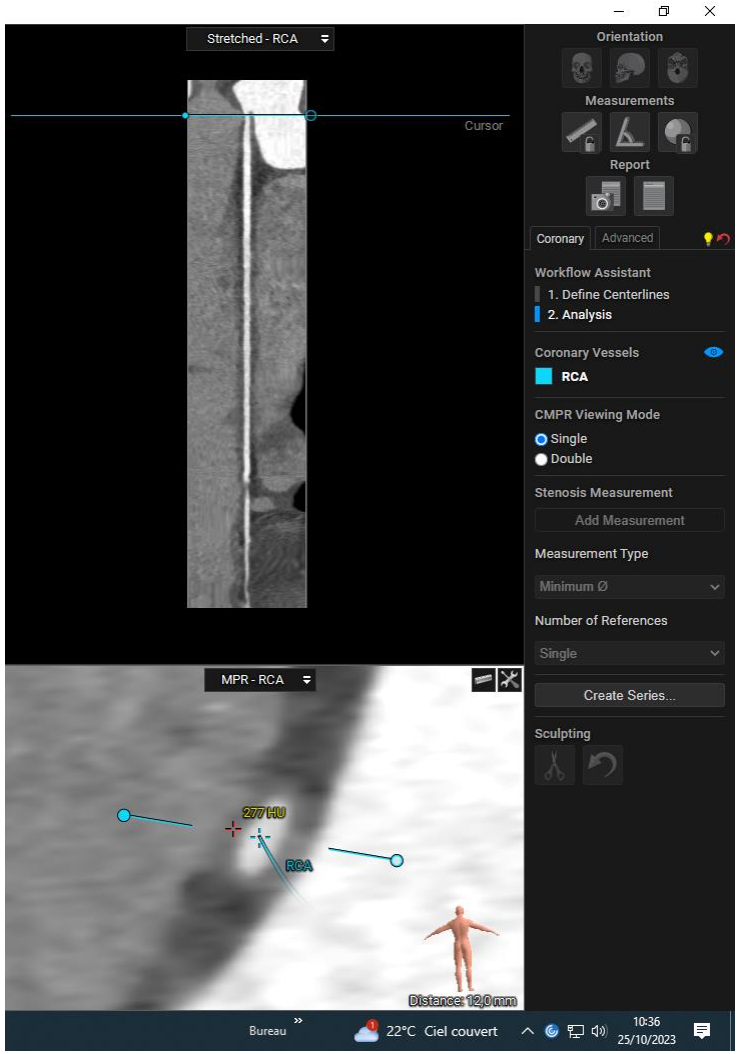




Adaptation vasculaire







- Embryologie et anatomie
- Classification
- Prévalence
- Imagerie
- Ischémie myocardique
- Mort subite
- Screening
- Prise en charge
- Chirurgie
- Angioplastie
- Activités sportives

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 ventriculaires
  - Ischémie myocardique
  - Absents

Classification

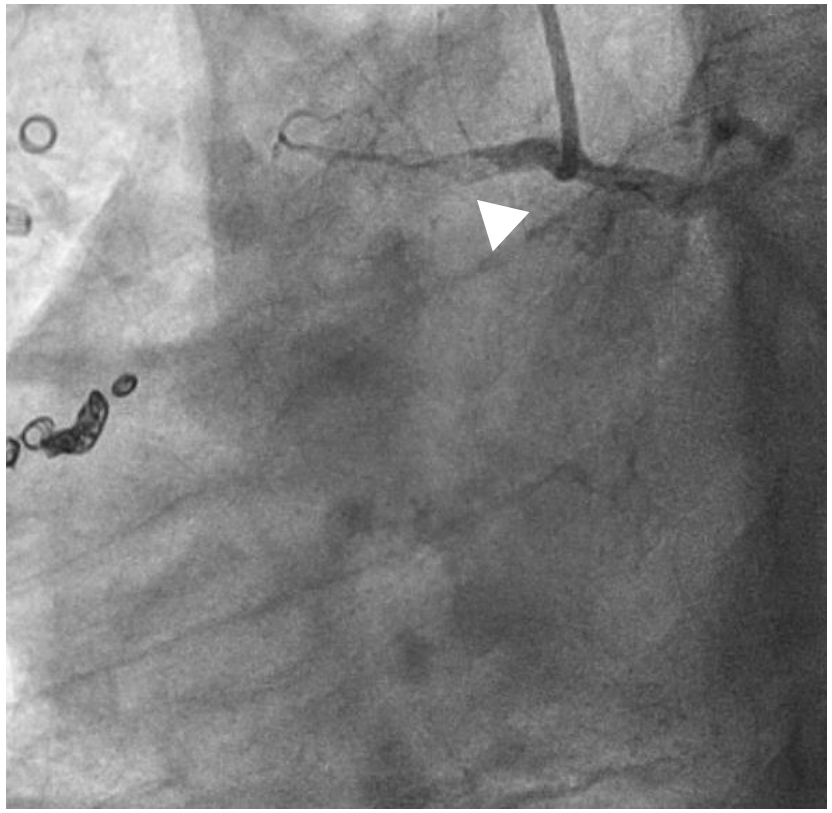
Liens de causalité :

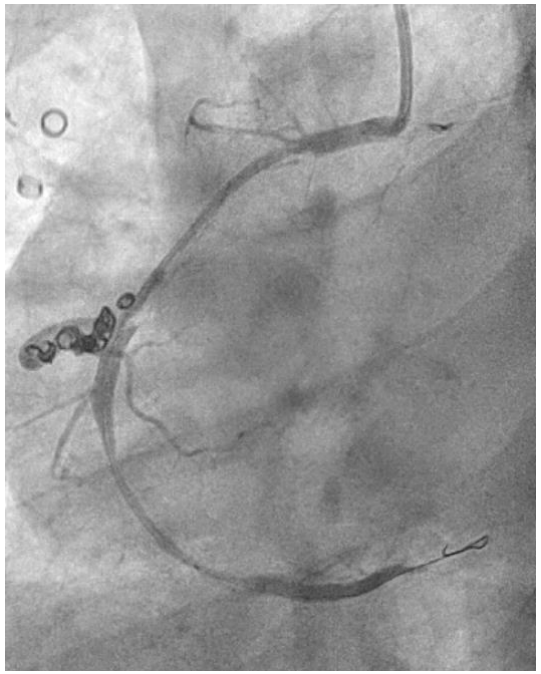
- entre anomalie coronaire et symptomatologie
- entre anomalie coronaire et ischémie myocardique
- entre anomalie coronaire et arythmie ventriculaire
- entre anomalie coronaire et arrêt cardiaque

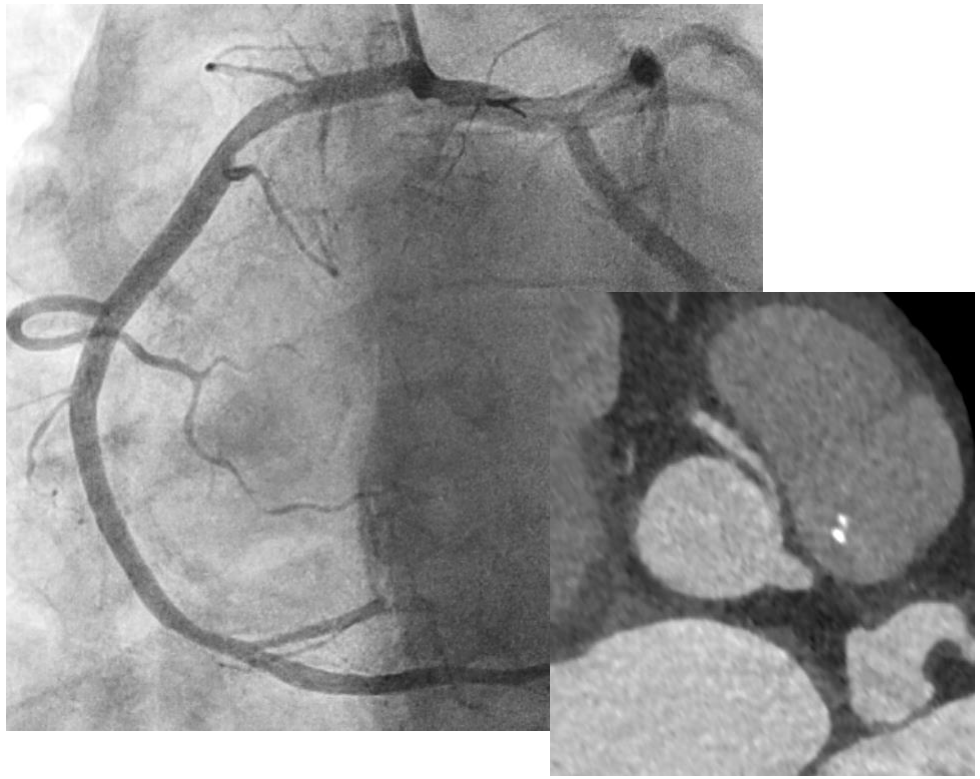
Absent | Possible/Probable | Certain

Classification

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







- Embryologie et anatomie
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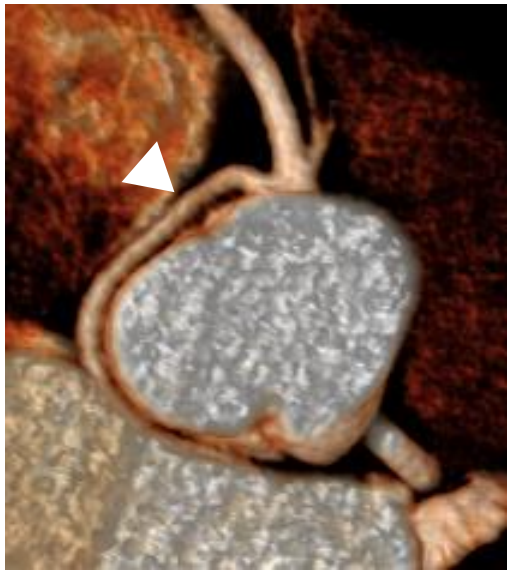
Prévalence selon l'artère coronaire **50%**

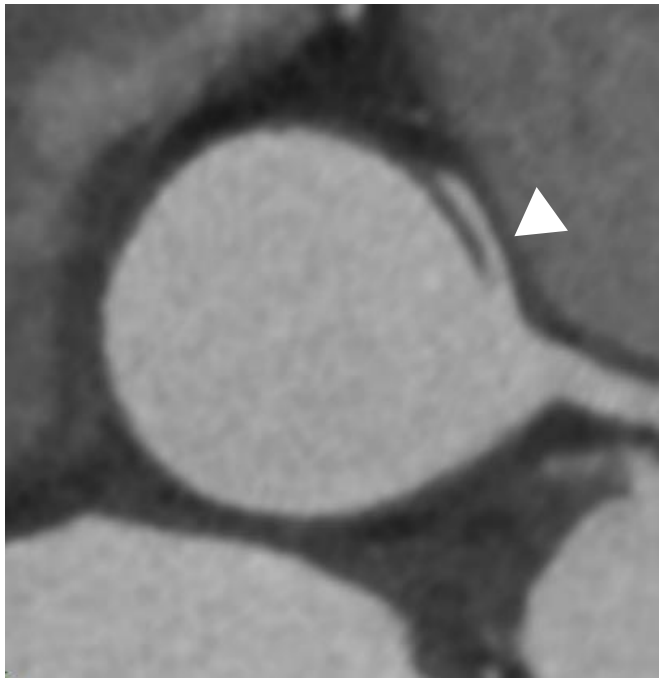
Circonflexe

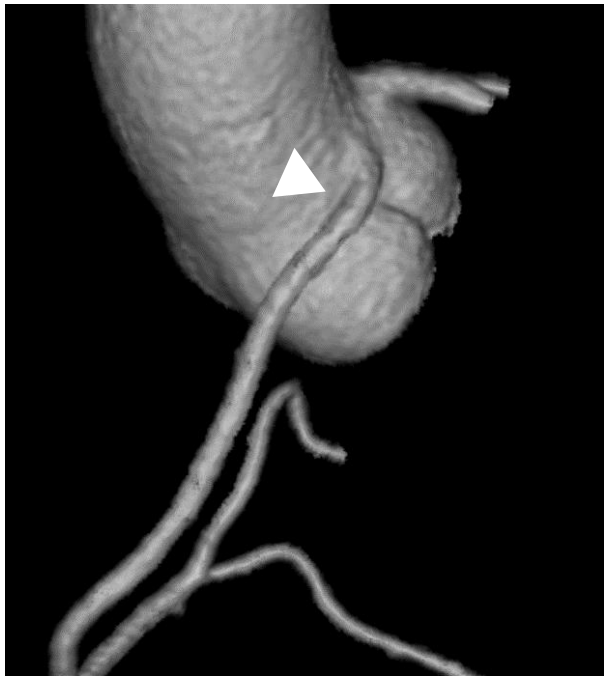


Prévalence selon le trajet ectopique : rétroaortique **99%**

Prévalence selon l'artère coronaire **30%**

Droite

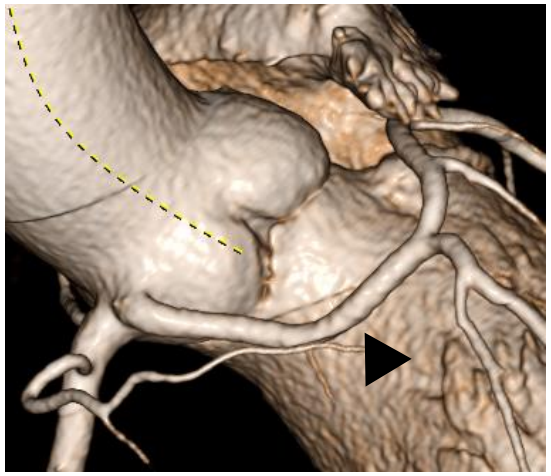




Prévalence selon le trajet ectopique : interartérielle **95%**

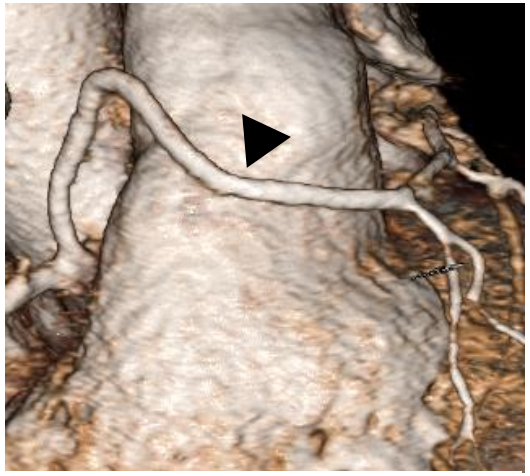
Prévalence selon l'artère coronaire 20%

Tronc IVA



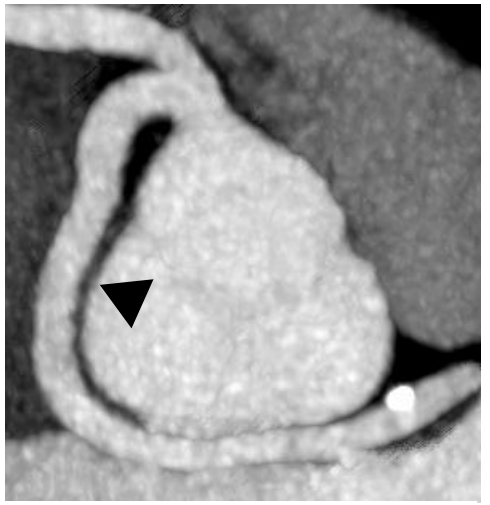
Rétropulmonaire

45%



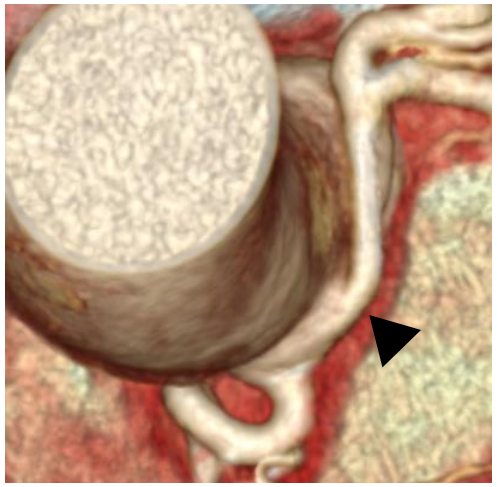
Prépulmonaire

30%



Rétroaortique

15%



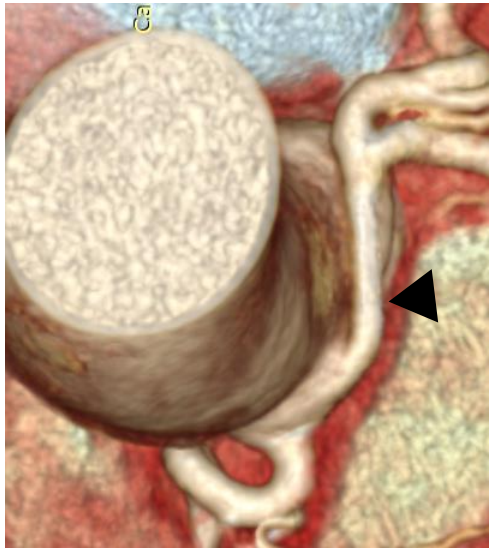
Interartériel

10%

Prévalence selon le trajet ectopique : variable

- Embryologie et anatomie
- Classification
- Prévalence
- **Imagerie**
- Ischémie myocardique
- Mort subite
- Prise en charge
- Chirurgie
- Angioplastie

Piège à éviter

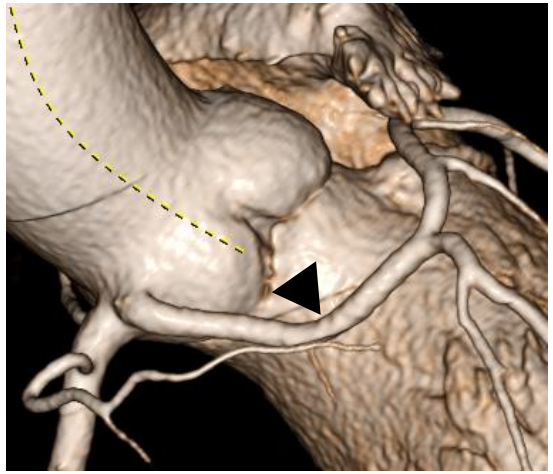


Trajet prépulmonaire

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

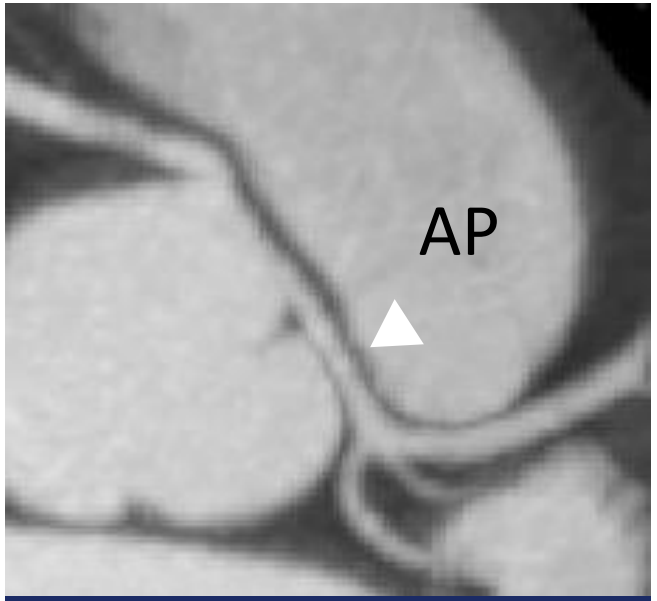
WILEY Congenital Heart Disease

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

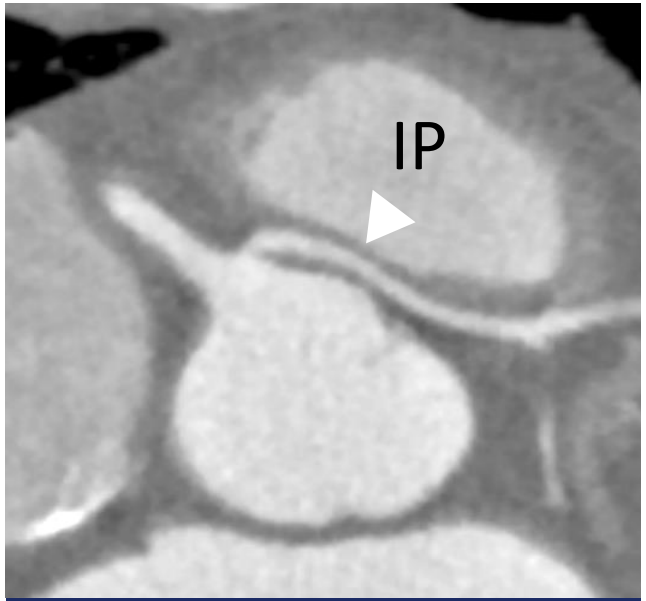
Athanasios Koutsoukis, MD[1] | Xavier Halna du Fretay, MD[2] | Patrick Dupouy, MD[3] | Phalla Ou, MD, PhD[4] | Jean-Pierre Laissy, MD, PhD[4] | Jean-Michel Juliard, MD[5] | Fabien Hyafil, MD[6] | Pierre Aubry, MD[5] | on behalf of the ANOCOR Investigators*

Congenital Heart Disease 2017

Formes anatomiques gauches à ne pas confondre

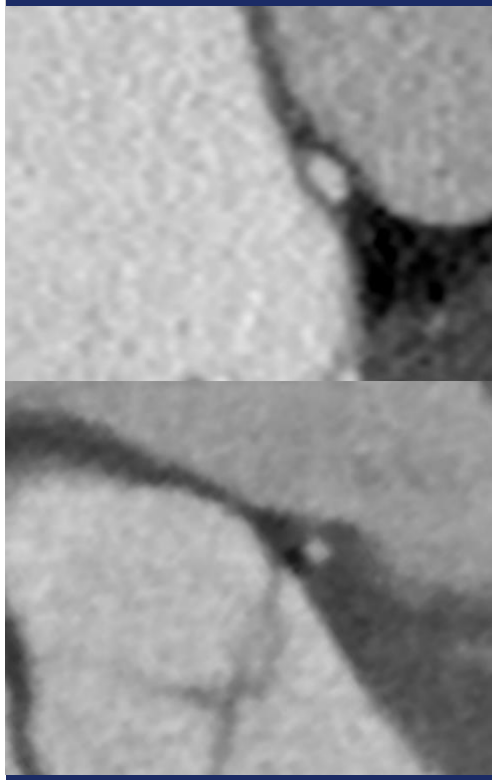


Trajet interartériel



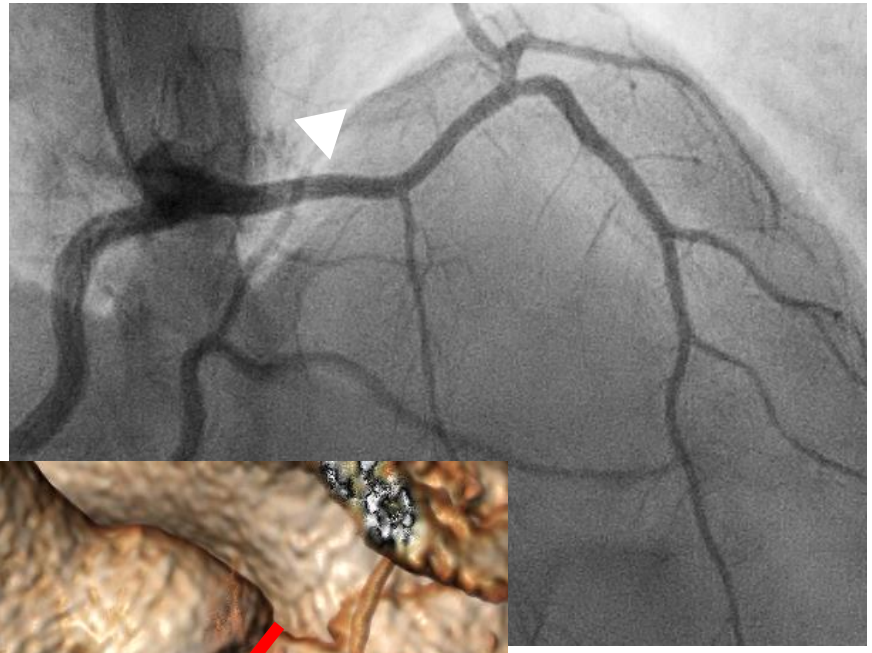
Trajet rétropulmonaire

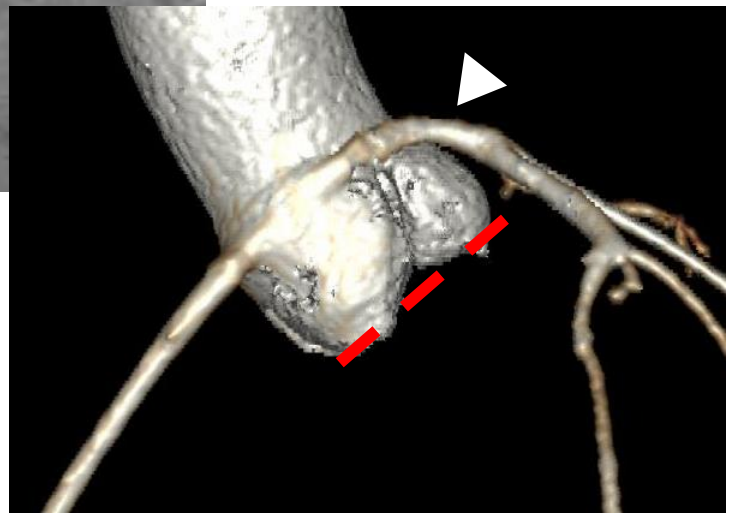
Interartériel



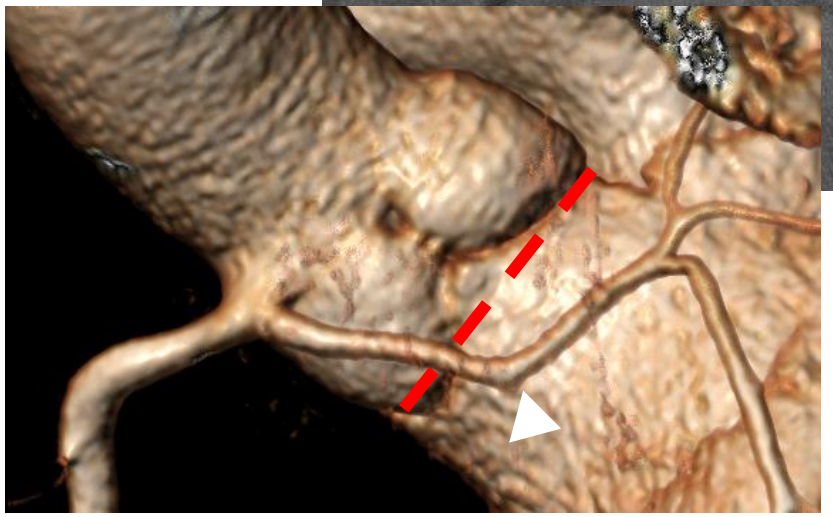
Rétropulmonaire

ANOCOR gauches





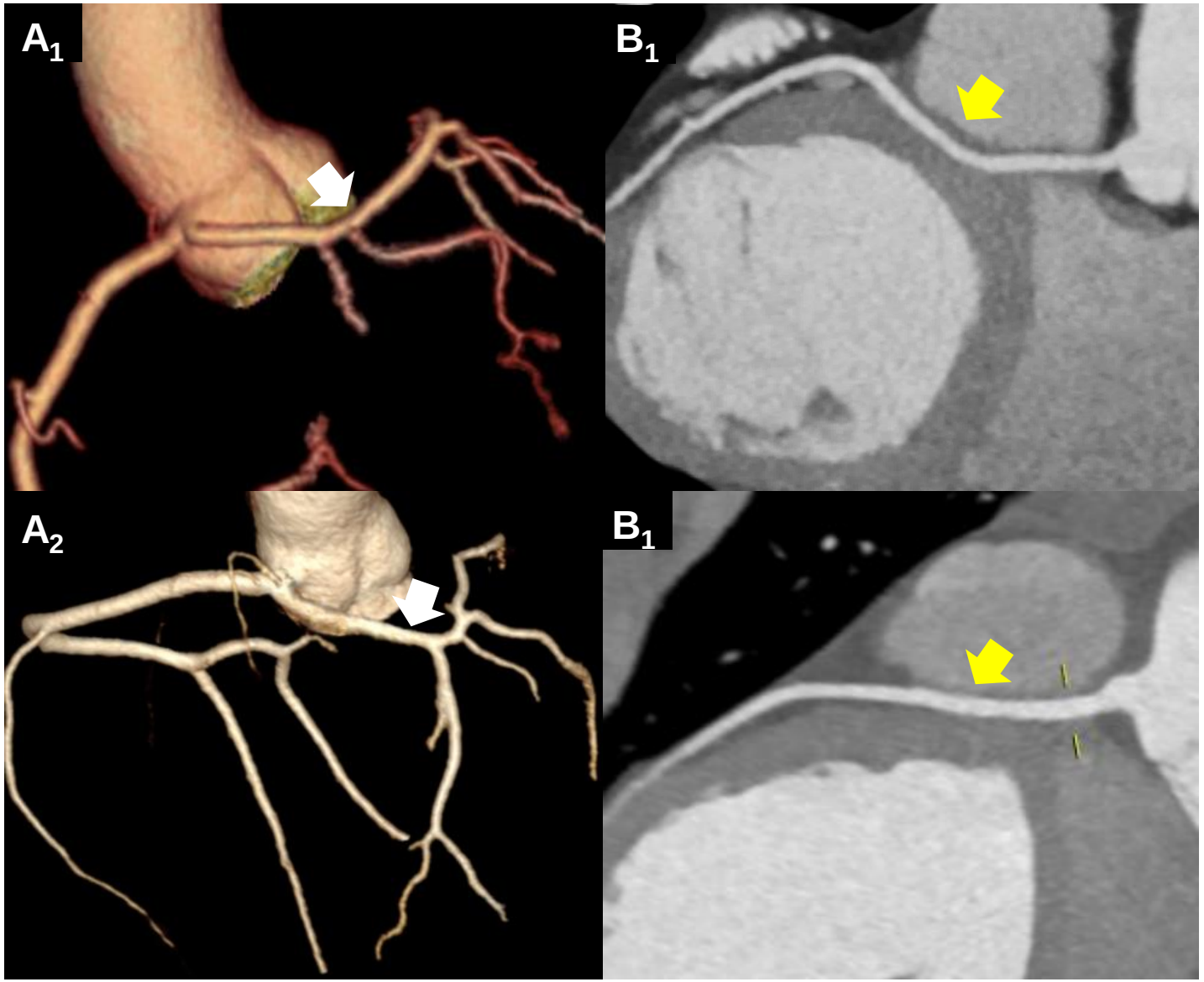
Trajet interartériel



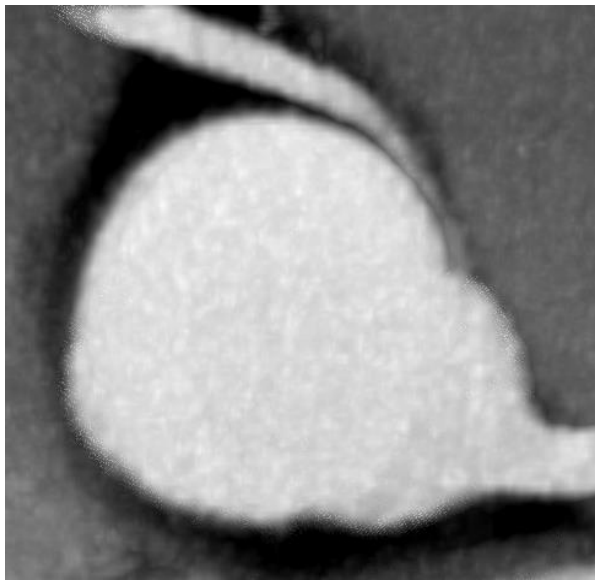
Trajet rétropulmonaire

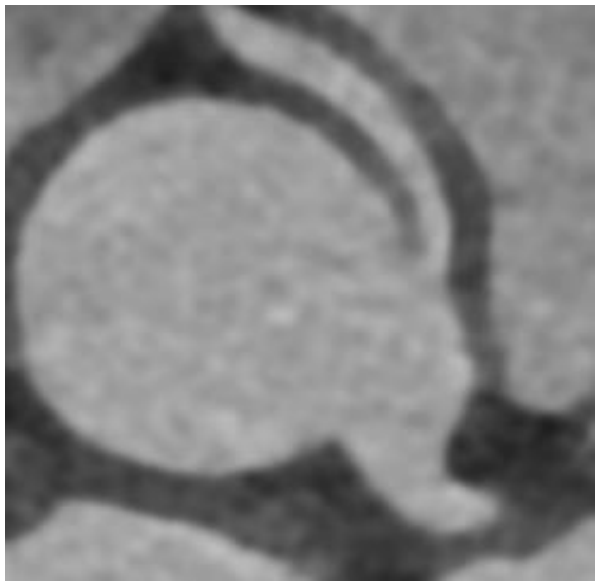
ANOCOR gauches

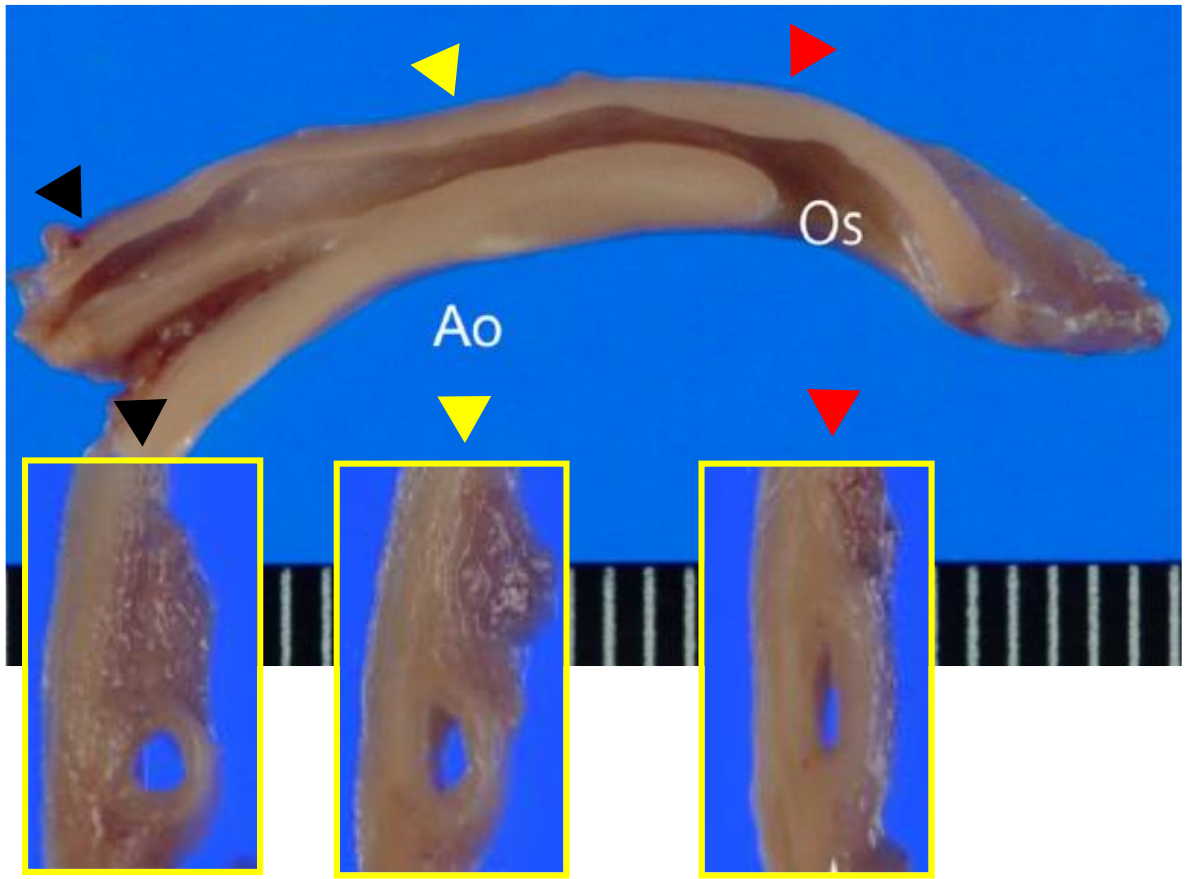
Trajet rétropulmonaire



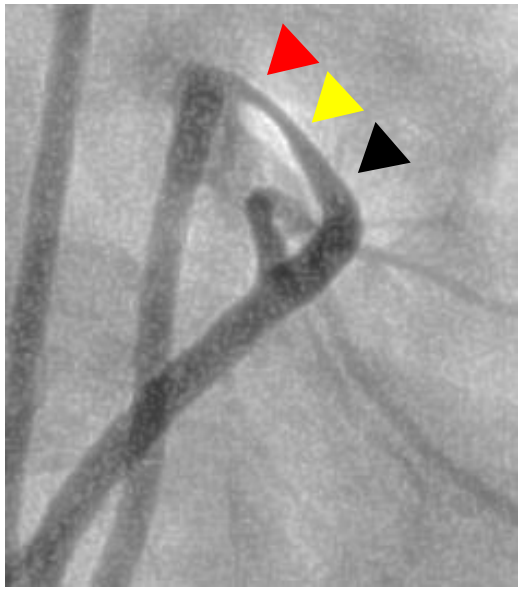
Passage aortique intramural

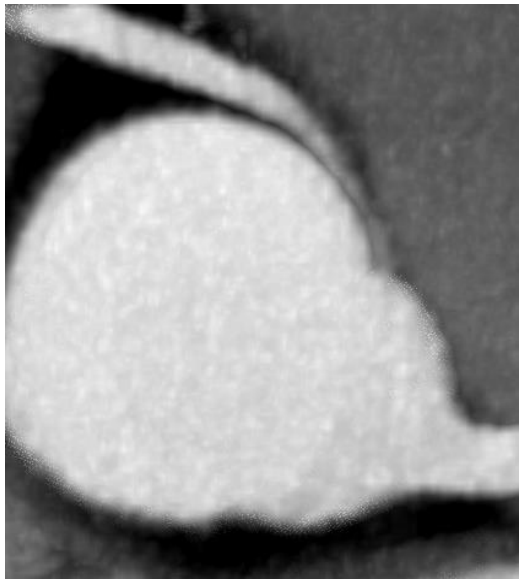




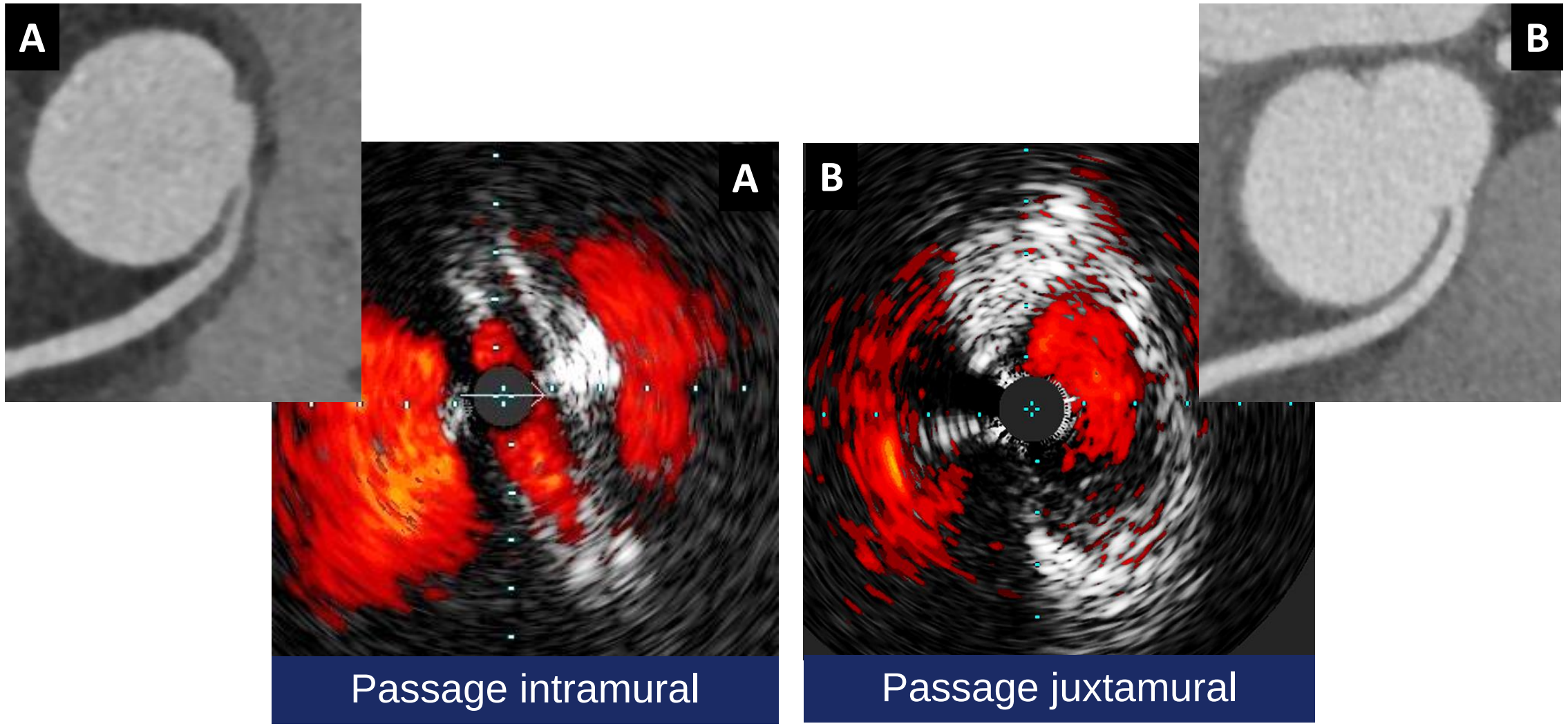


Right ANOCOR with an intramural course
Hata Y et al. Cardiovasc Pathol. 2014.



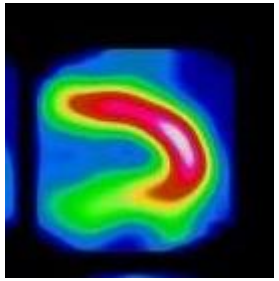


Echographie endocoronaire



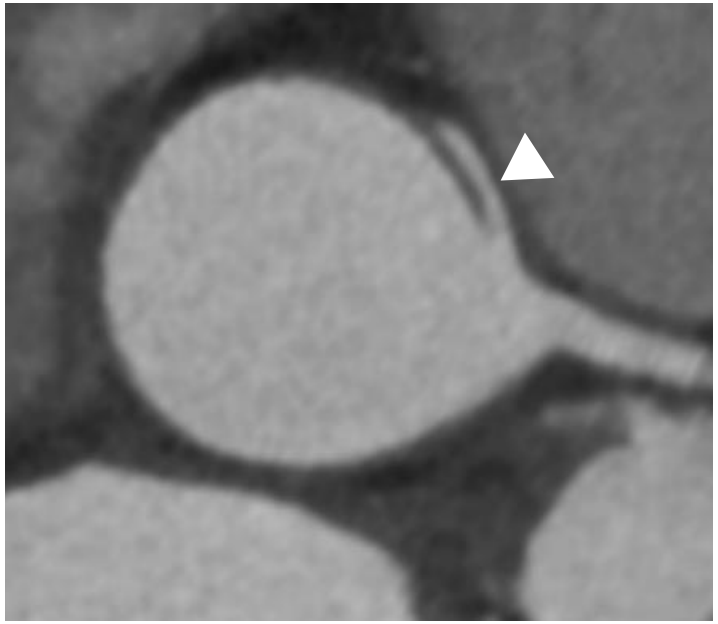
- Mort subite/arrêt cardiaque récupéré
- Symptômes d'allure ischémique (angor/syncope/dyspnée)
- Ischémie myocardique (test avec imagerie)

- Embryologie et anatomie
- Classification
- Prévalence
- Imagerie
- Ischémie myocardique
- Mort subite
- Prise en charge
- Chirurgie
- Angioplastie

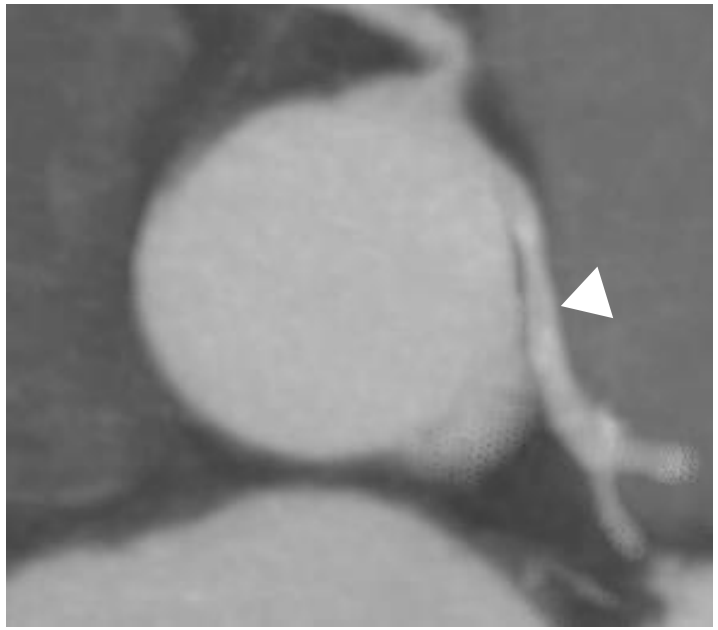


ANOCOR à risques

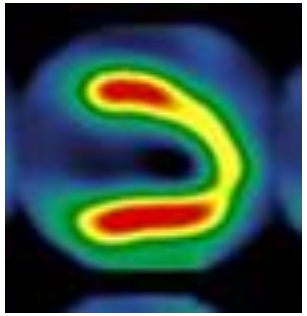
Trajet interartériel



ANOCOR droite

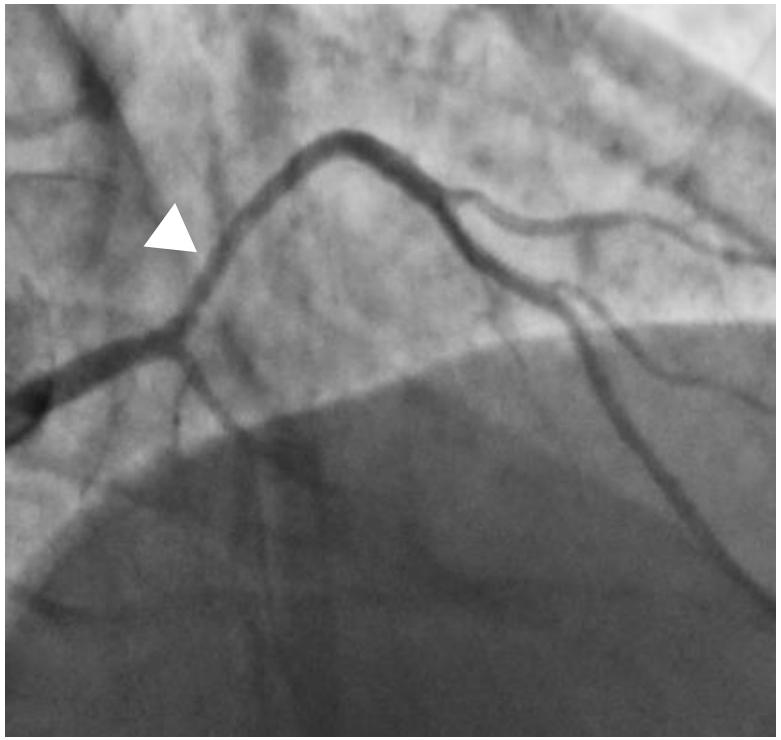


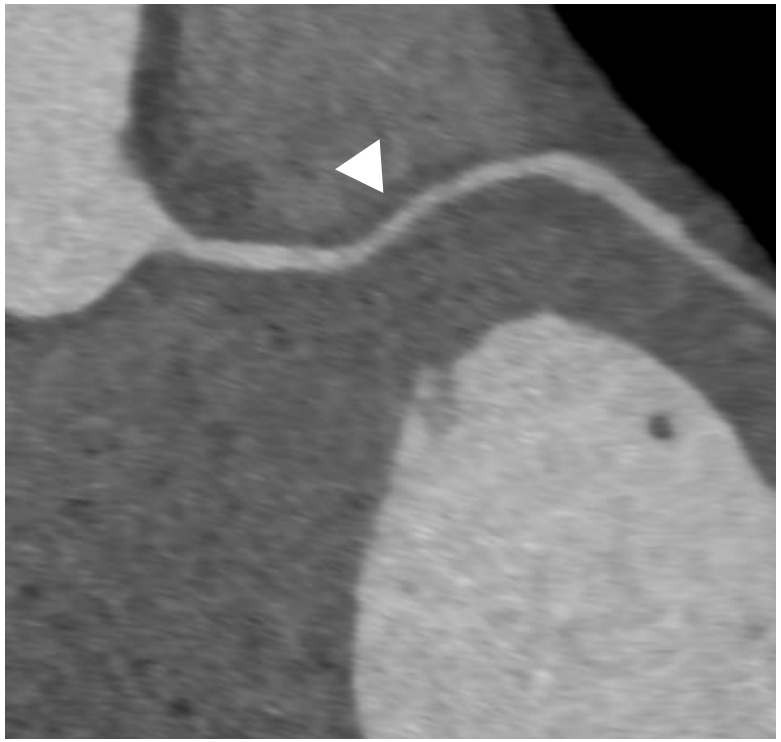
ANOCOR gauche



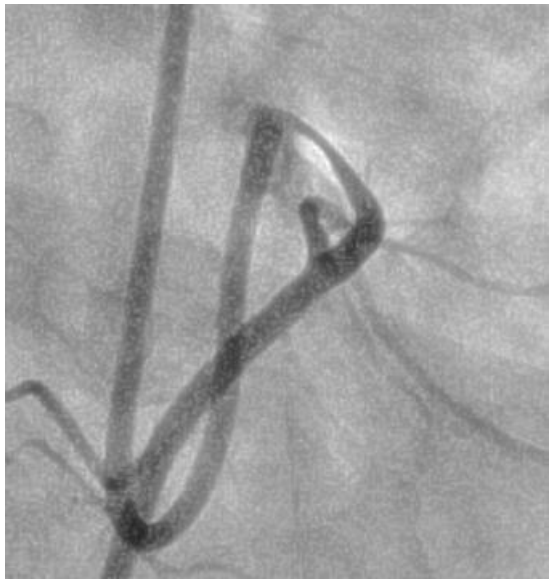
ANOCOR à risque

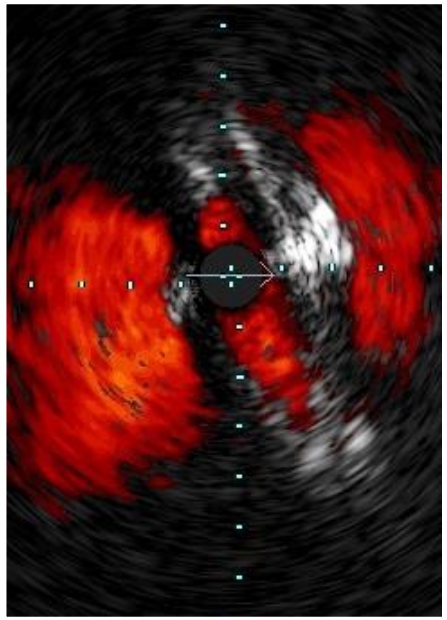
Trajet rétropulmonaire avec passage intramyocardique

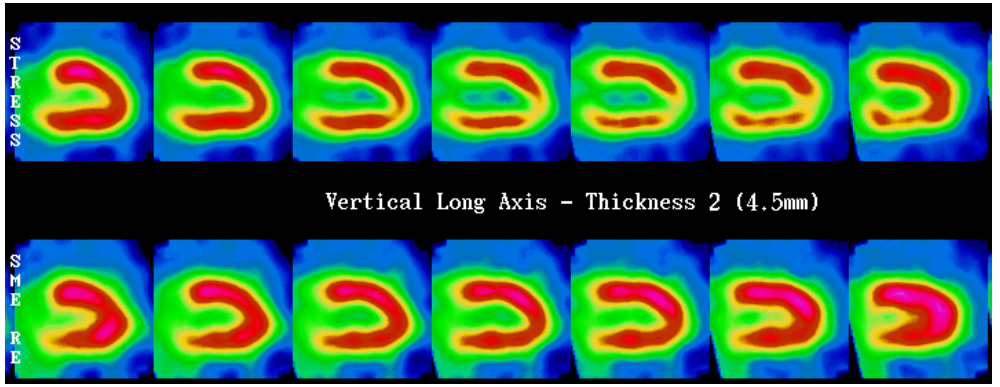




Ischémie myocardique documentée



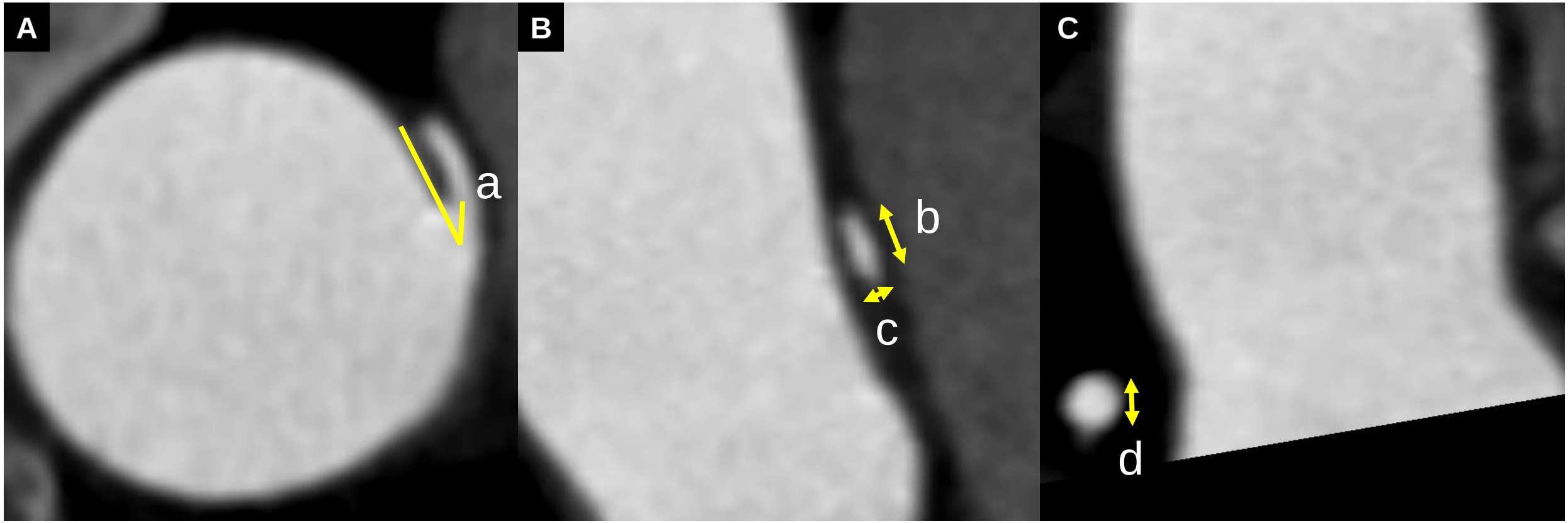




Prévalence ≈ 15%

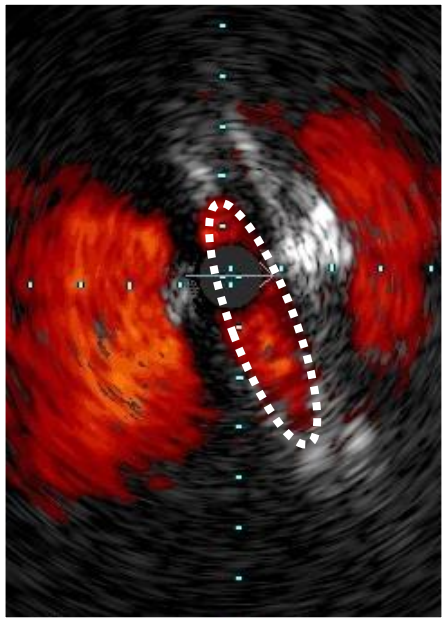
Réduction de diamètre : (1 – c/d) x 100 = 40-70%

Réduction de surface : (1 – surface proximale/surface distale) x 100 = 40-70%

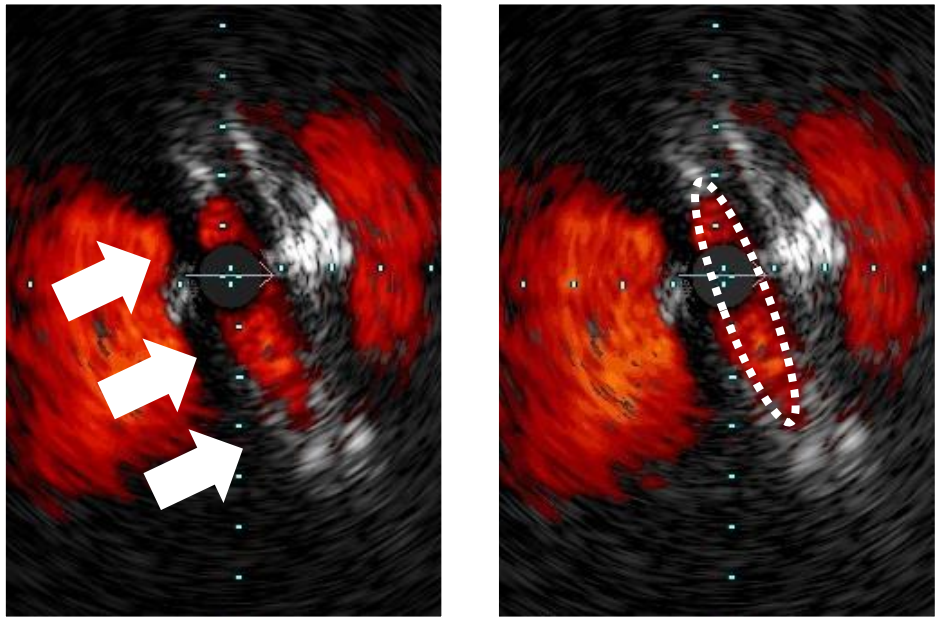


Two-Tier Concept

Fixed Component



Dynamic Component



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

Recherche d'ischémie myocardique

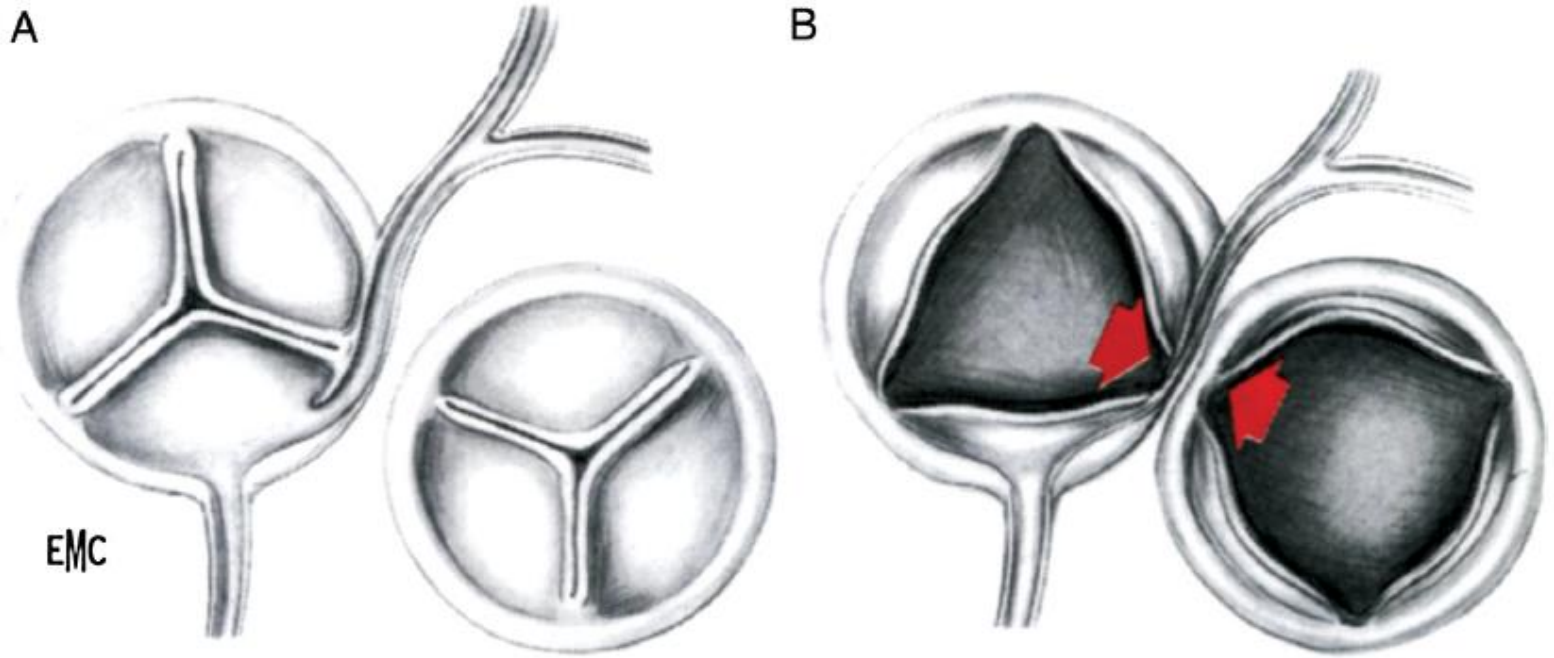
TABLE 3 | Overview of possible stress protocols in assessing patients with ACAOS.

	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.

Exertional dynamic compression



Raisky O, Vouhé P. EMC 2007

Never demonstrated

External compression

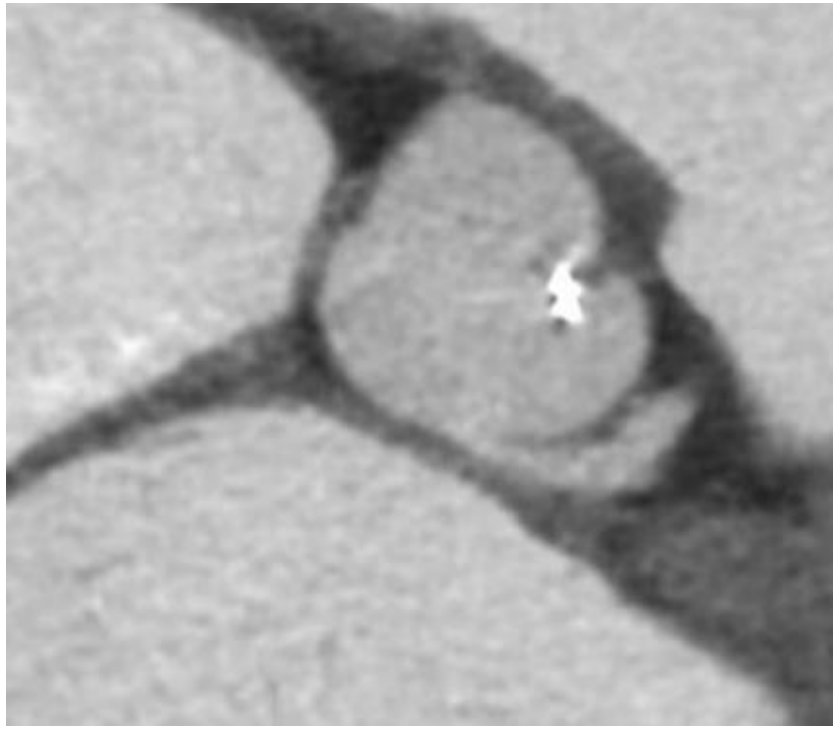
Aortic valve surgery

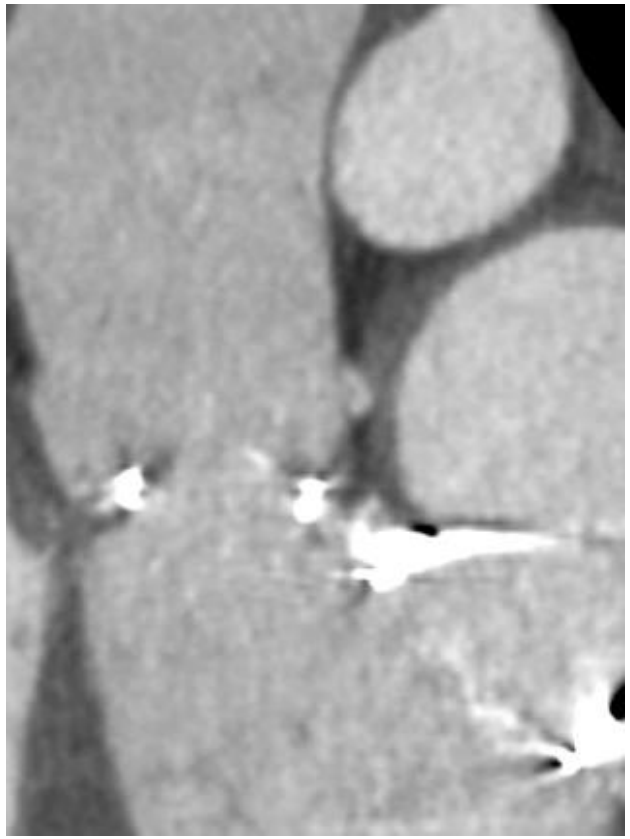
Transcatheter aortic valve implantation

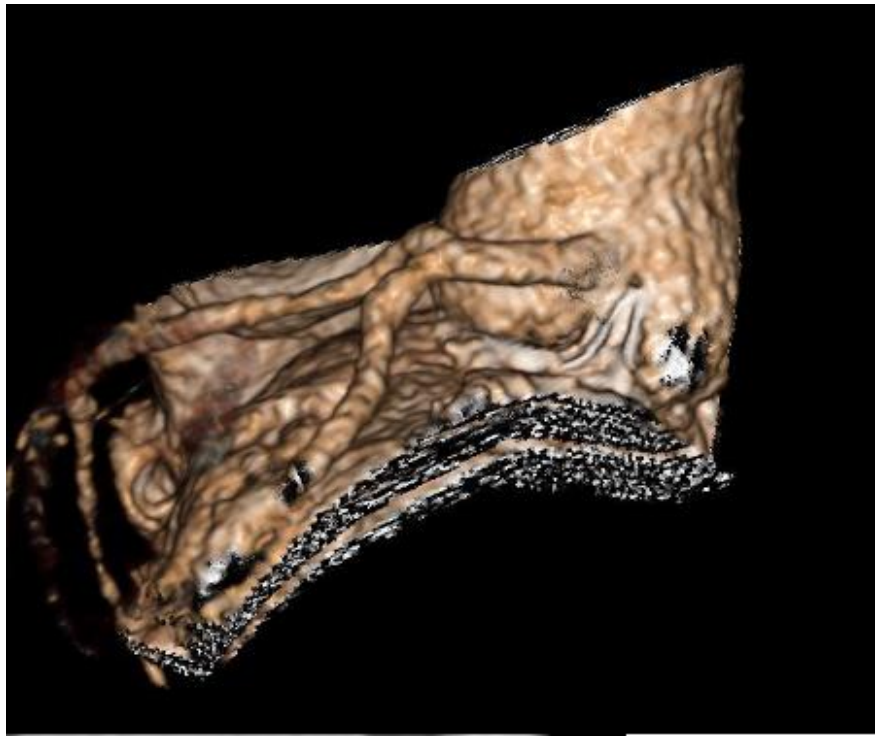
Cas clinique 1
Mme P.

- Femme de 28 ans
- Valvulopathie mitro-aortique post RAA : IM 3/4, IA 3/4
- VG dilaté, FEVG 60%
- Pas de coronarographie/scanner coronaire pré opératoire
- Staff médicochirurgical : remplacement aortique/mitral avec bioprothèses (2015)
- TDR ventriculaires sortie de CEC : reprise avec nouvelle bioprothèse aortique
- ECMO
- Evolution favorable : FEVG 50%

Scanner coronaire



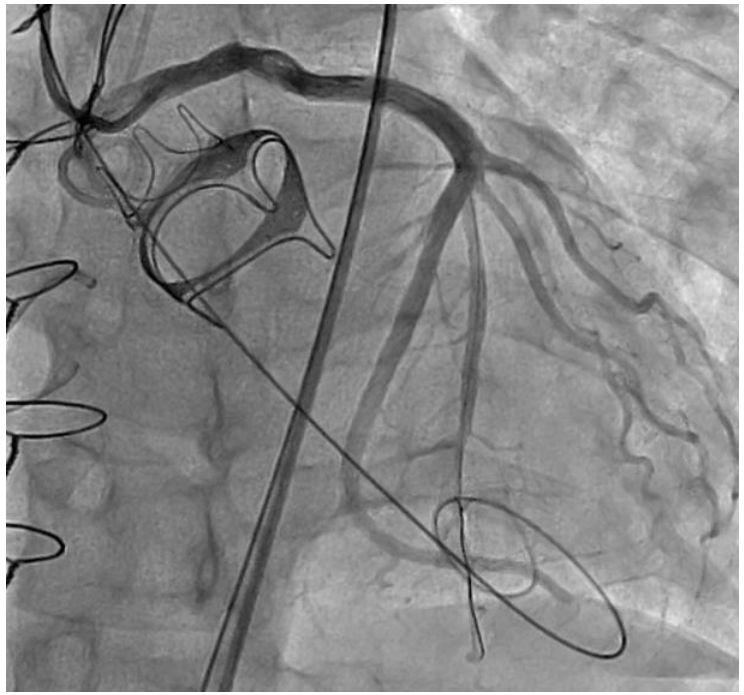




Cas clinique 1
Mme P.

- Dégénerence deux bioprothèses (sténoses serrées)
- Staff médicochirurgical : TAVI/TMVI

TAVI



- Embryologie et anatomie
- Classification
- Prévalence
- Imagerie
- Ischémie myocardique
- **Mort subite**
- Prise en charge
- Chirurgie
- Angioplastie

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%

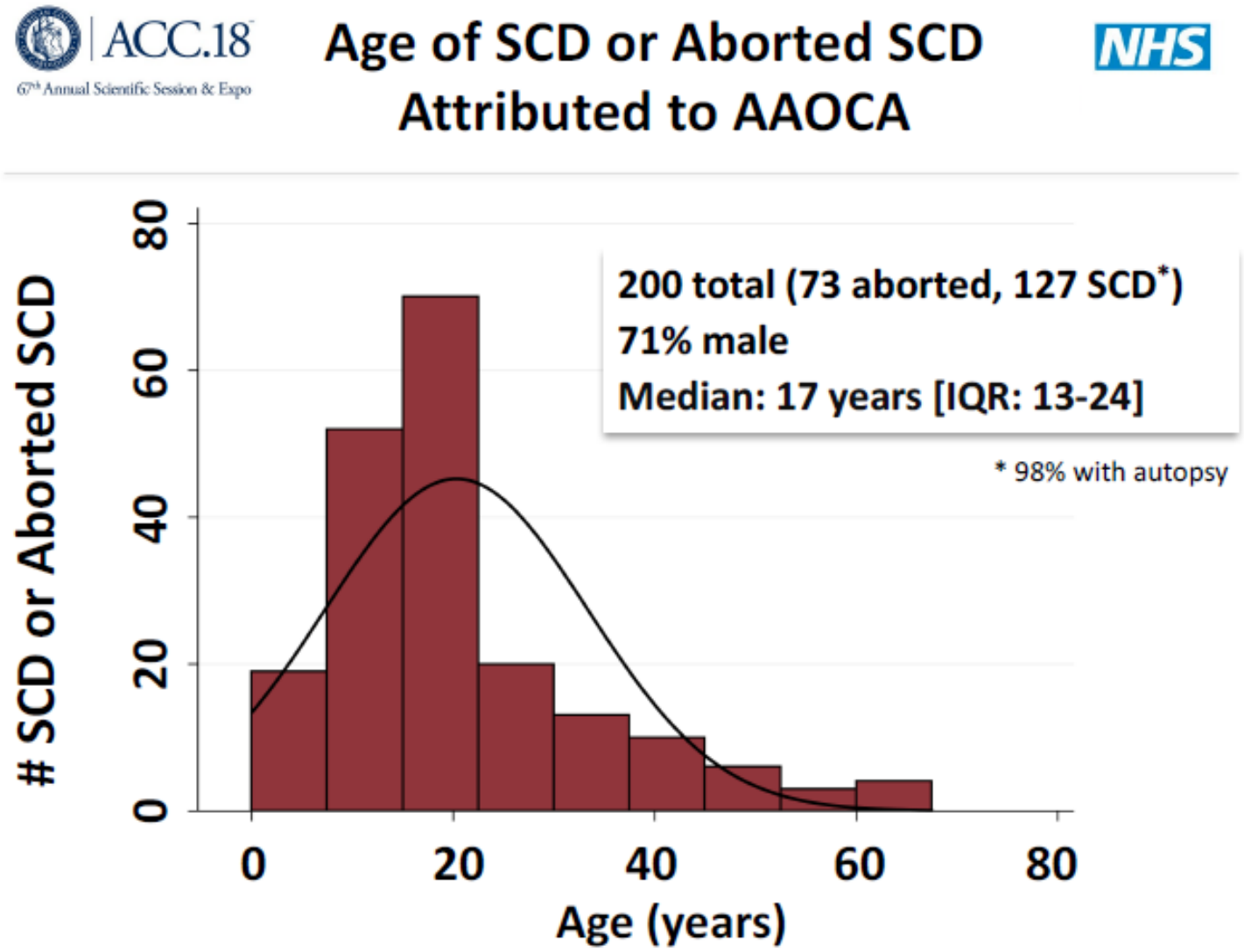
* Anomalie de connexion avec trajet interartériel

** 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%

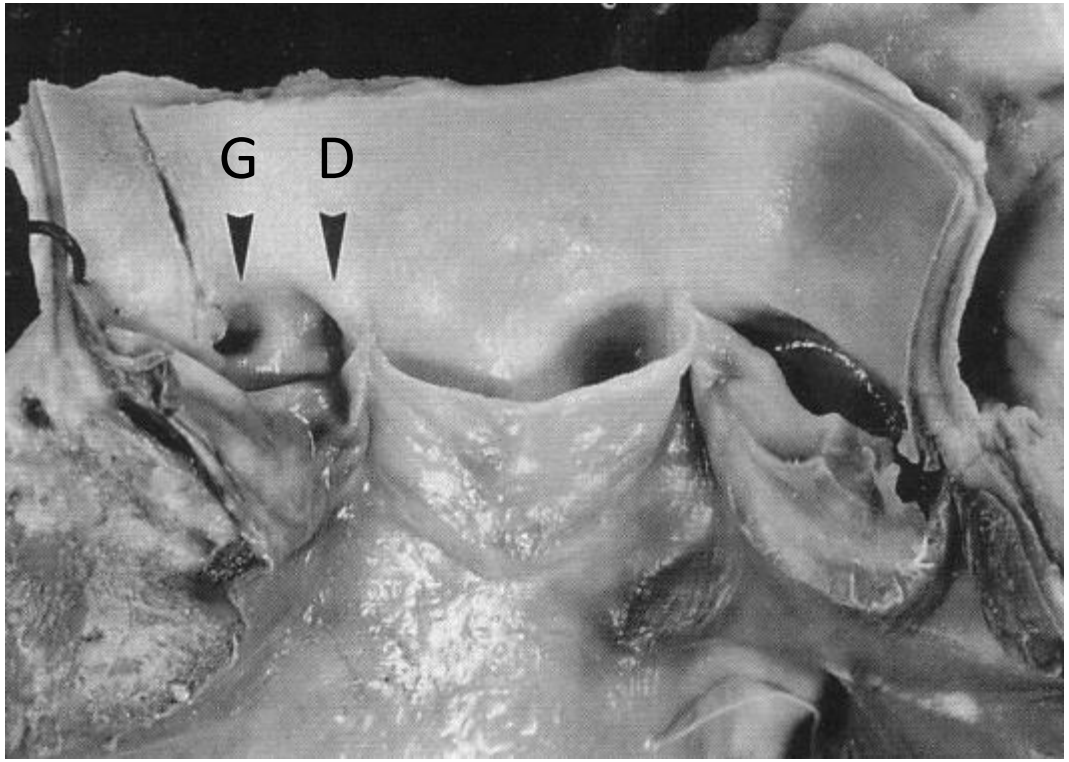
* Anomalie de connexion avec trajet interartériel

** Incidence annuelle de mort subite (estimations)



Shiwani H. ACC 2018

1990 Mort subite



Corrado et al. Br Heart J. 1992.

2010 Arrêt cardiaque récupéré

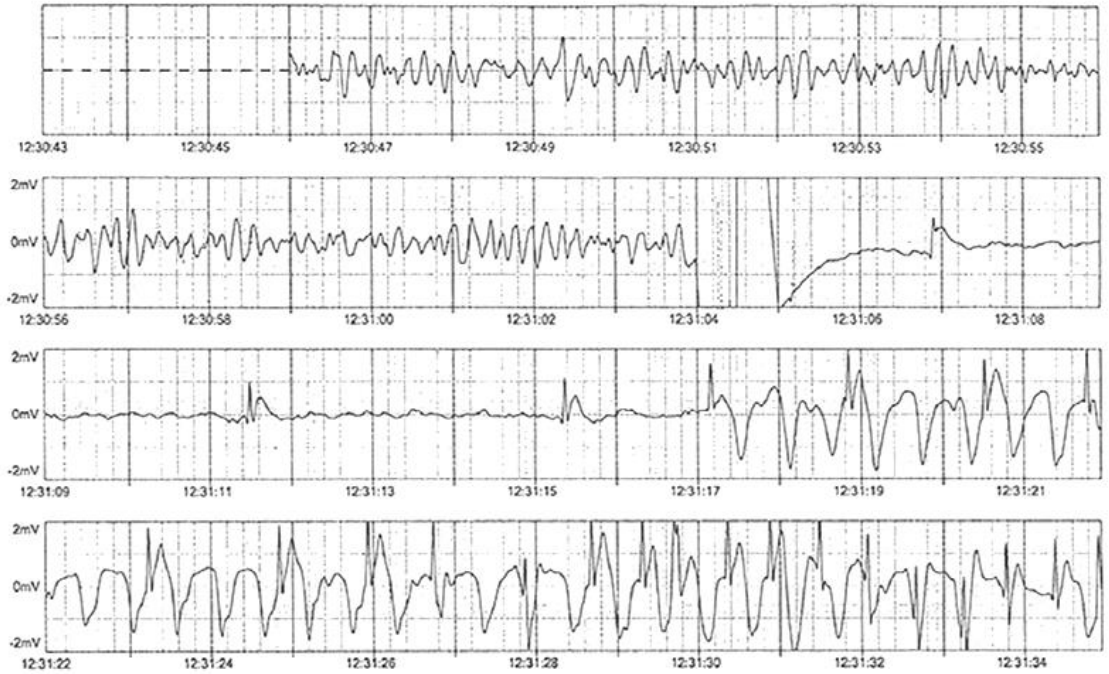
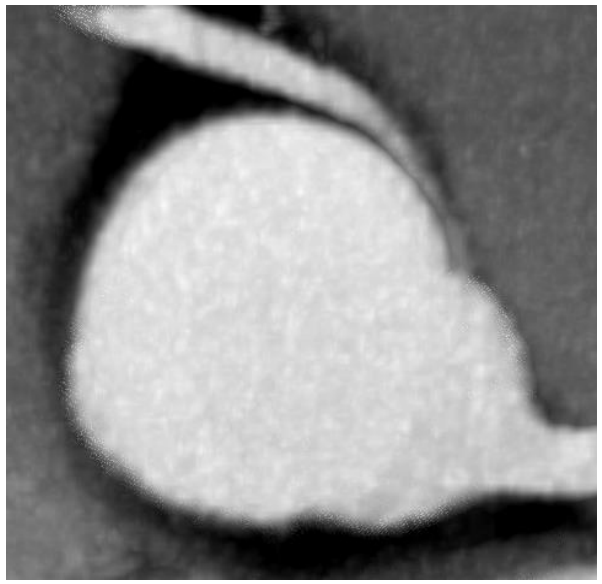


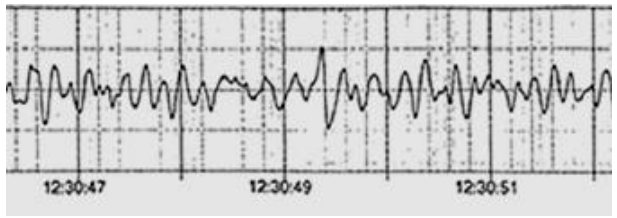
Figure 1. ECG recording from an automated external defibrillator

Mécanisme(s) de la fibrillation ventriculaire

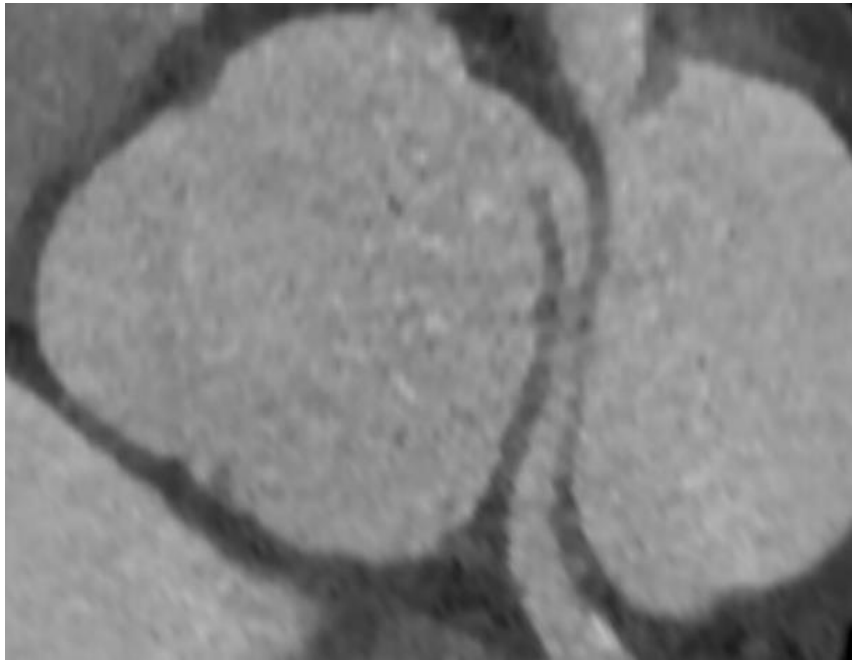


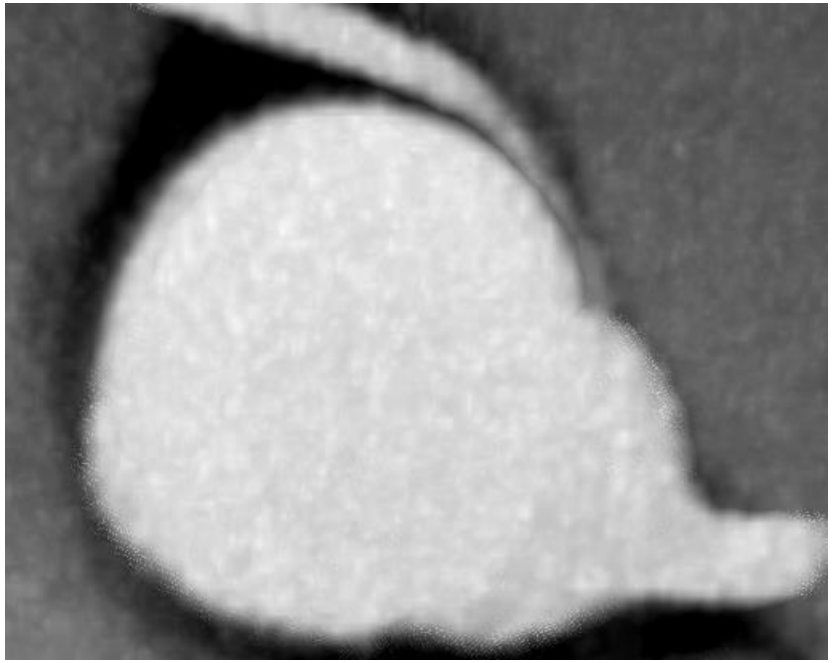
?

24/07/2022
vers 12.20



Sur risque de mortalité pour les formes gauches (x 10)





- Embryologie et anatomie
- Classification
- Prévalence
- Imagerie
- Ischémie myocardique
- Mort subite
- Prise en charge
- Chirurgie
- Angioplastie

Management of AAOCA at risk

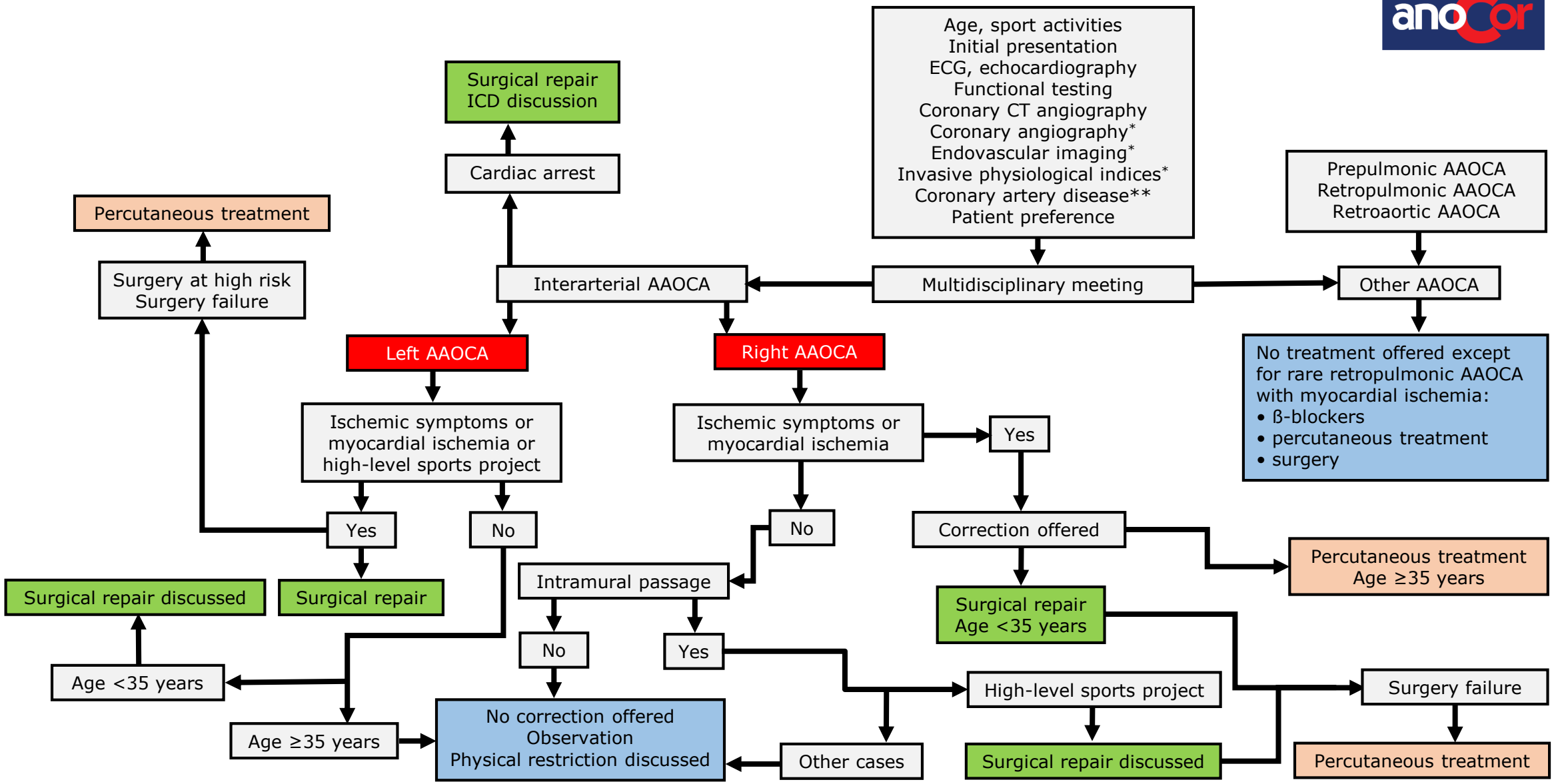
No AAOCA risk-SCD score

Decision-making

- Age < 35 or ≥ 35 years
- Left AAOCA vs. Right AAOCA
- History of aborted cardiac arrest
- Ischemic symptoms/relationship with exertion
- Induced myocardial ischemia with imaging
- Anatomic characteristics (CT scan/angio/IVUS/OCT)
- Physiological assessment (iFR, FFR)
- Sports profile/Patient choice

Surgery/PCI/Medical/Observation/Physical restriction

Algorithm for people ≥12 year-old with AAOCA



Guidelines

2018 AHA/ACC Guideline for the Management of Adults With Congenital Heart Disease: Executive Summary

COR	LOE	Recommendations
Therapeutic		
I	B-NR	1. Surgery is recommended for AAOCA from the left sinus or AAOCA from the right sinus for symptoms or diagnostic evidence consistent with coronary ischemia attributable to the anomalous coronary artery.[S4.4.5.2-1–S4.4.5.2-3]
IIa	C-LD	2. Surgery is reasonable for anomalous aortic origin of the left coronary artery from the right sinus in the absence of symptoms or ischemia.[S4.4.5.2-4–S4.4.5.2-6]
IIa	C-EO	3. Surgery for AAOCA is reasonable in the setting of ventricular arrhythmias.
IIb	B-NR	4. Surgery or continued observation may be reasonable for asymptomatic patients with an anomalous left coronary artery arising from the right sinus or right coronary artery arising from the left sinus without ischemia or anatomic or physiological evaluation suggesting potential for compromise of coronary perfusion (eg, intramural course, fish-mouth-shaped orifice, acute angle).[S4.4.5.2-4–S4.4.5.2-6]

Stout KK. et al. Circulation. 2019.

2020 ESC Guidelines for the management of adult congenital heart disease

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

Baumgartner H. et al. Eur Heart J. 2020.

Guidelines

2017 AHA/ACC/HRS Guideline for Management of Patients With Ventricular Arrhythmias and the Prevention of Sudden Cardiac Death: Executive Summary

4.3. Surgery and Revascularization Procedures in Patients With Ischemic Heart Disease

Recommendations for Surgery and Revascularization Procedures in Patients With Ischemic Heart Disease References that support the recommendations are summarized in Online Data Supplement 11.		
COR	**LOE**	**Recommendations**
I	B-NR	1. Patients with sustained VA and survivors of SCA should be evaluated for ischemic heart disease, and should be revascularized as appropriate (1-4).
I	C-EO	2. In patients with anomalous origin of a coronary artery suspected to be the cause of SCA, repair or revascularization is recommended.

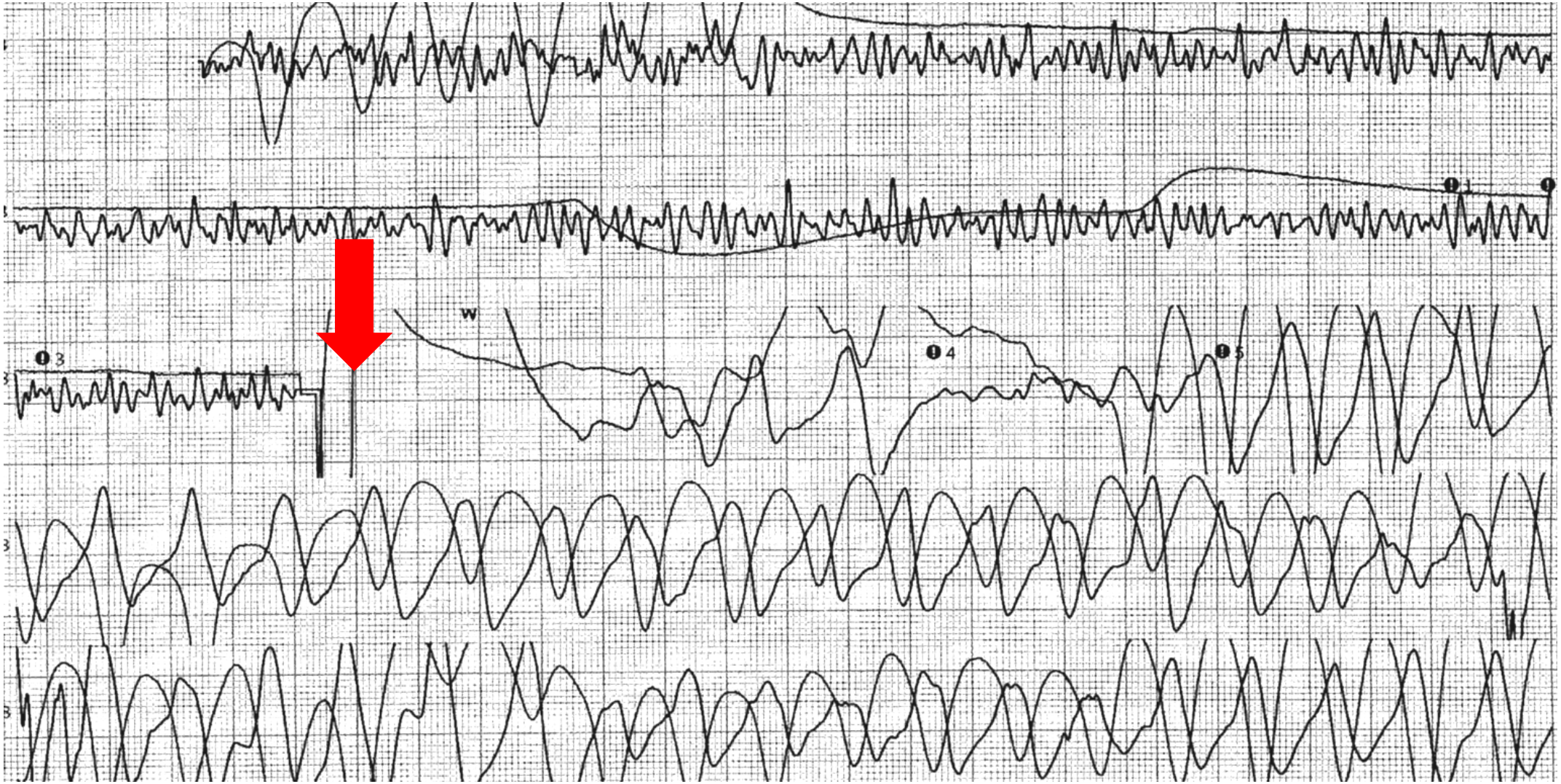
SCA: sudden cardiac arrest

Al-Khatib et al. Circulation. 2018.

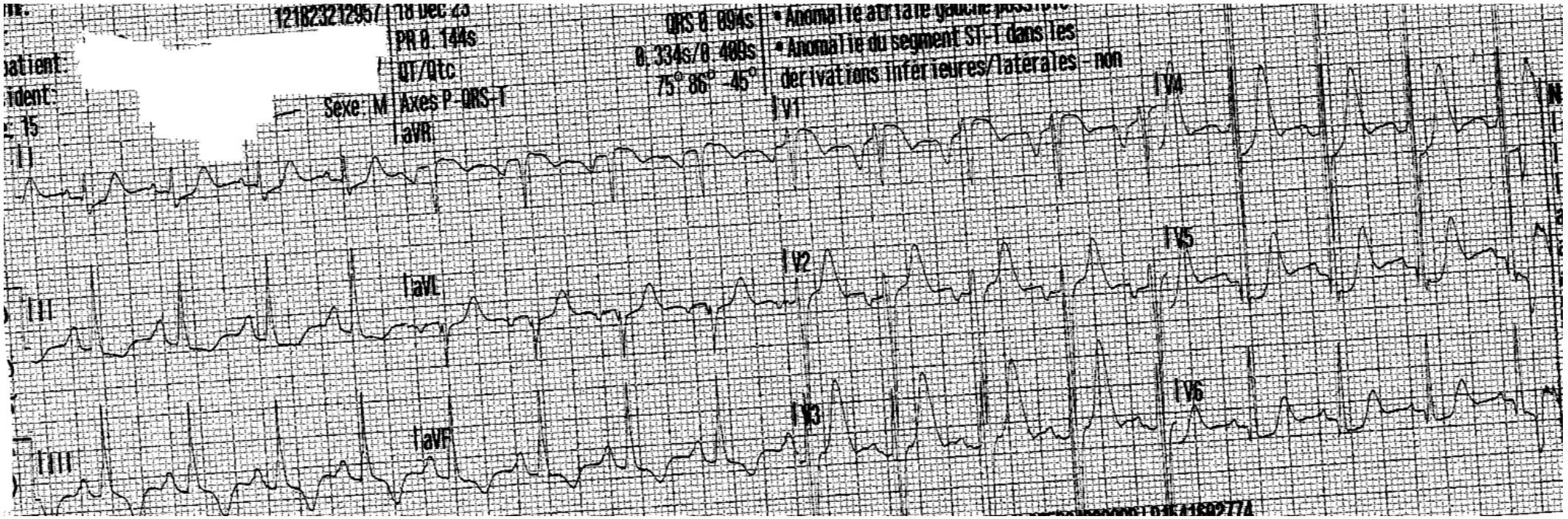
Cas clinique 2
Jeune N.

- Jeune garçon de 15 ans
- Pas d'antécédents cardiovasculaires
- Pratique sportive régulière
- Basket-ball niveau départemental
- Arrêt cardiaque 18/12/2023 début match de basket
- Aucun prodrome
- Rythme choquable
- No flow > 1 min , low flow < 15 min
- Rythme sinusal, sous-décalage ST inférolatéral
- Pic troponine à 6.000 ng/L
- Coronarographie

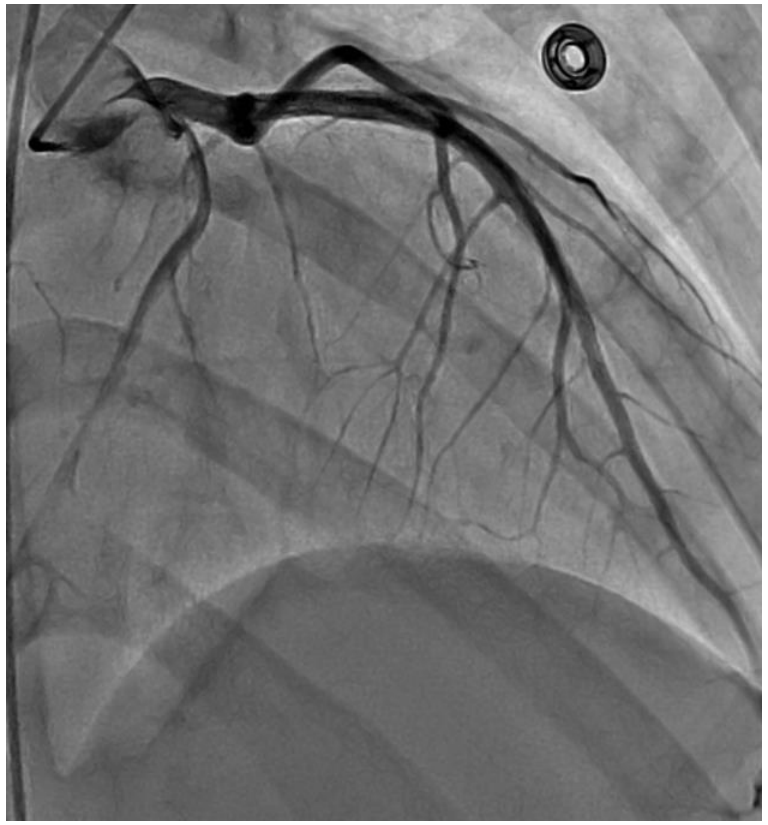
Tracé DAE



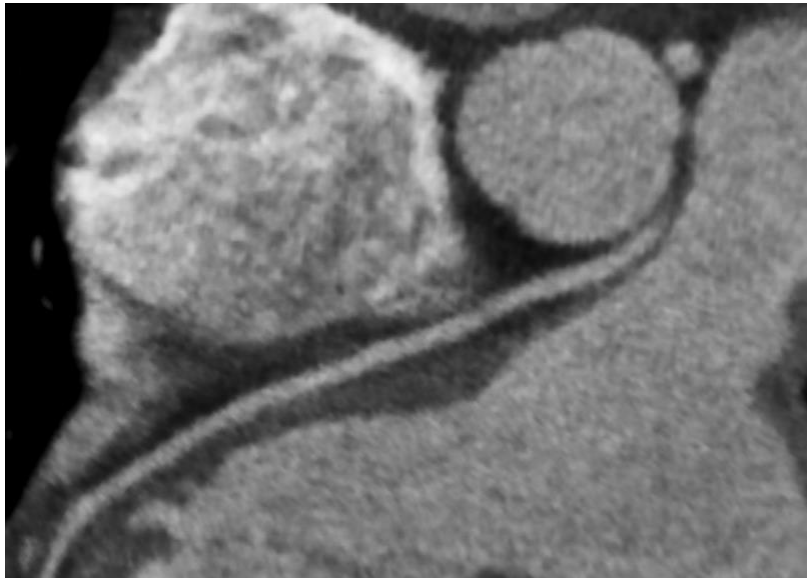
Tracé ECG post ACR



Coronarographie



Scanner coronaire



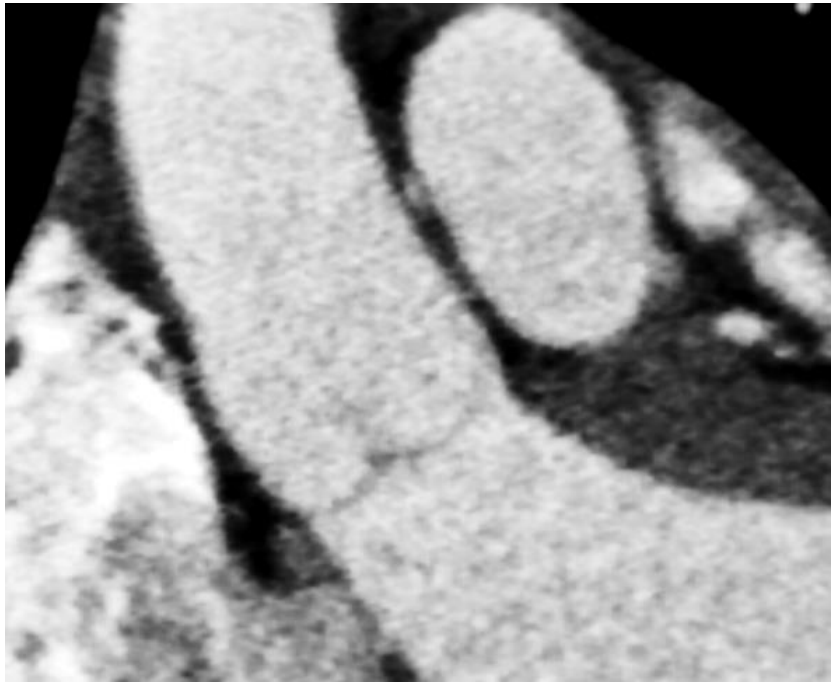
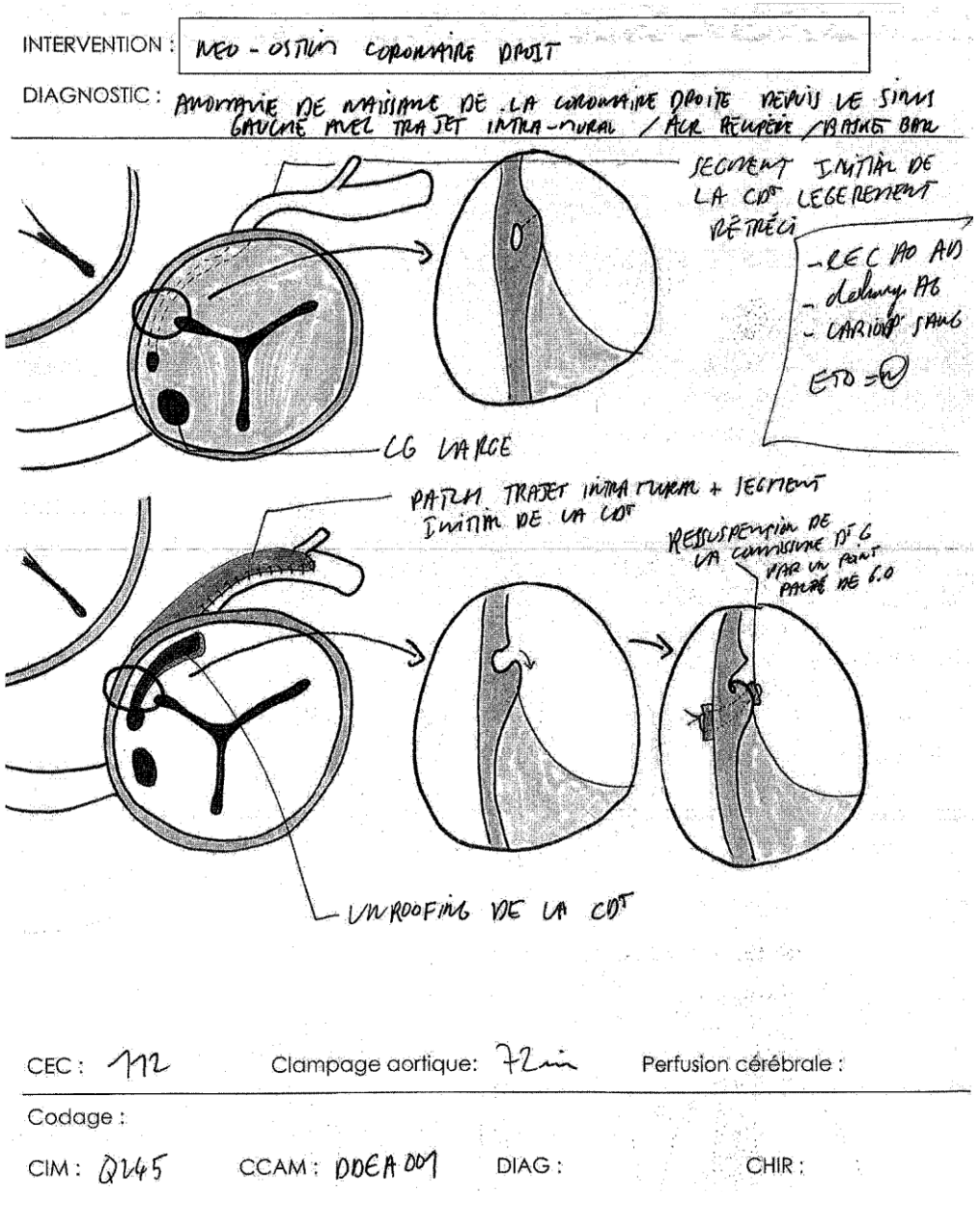
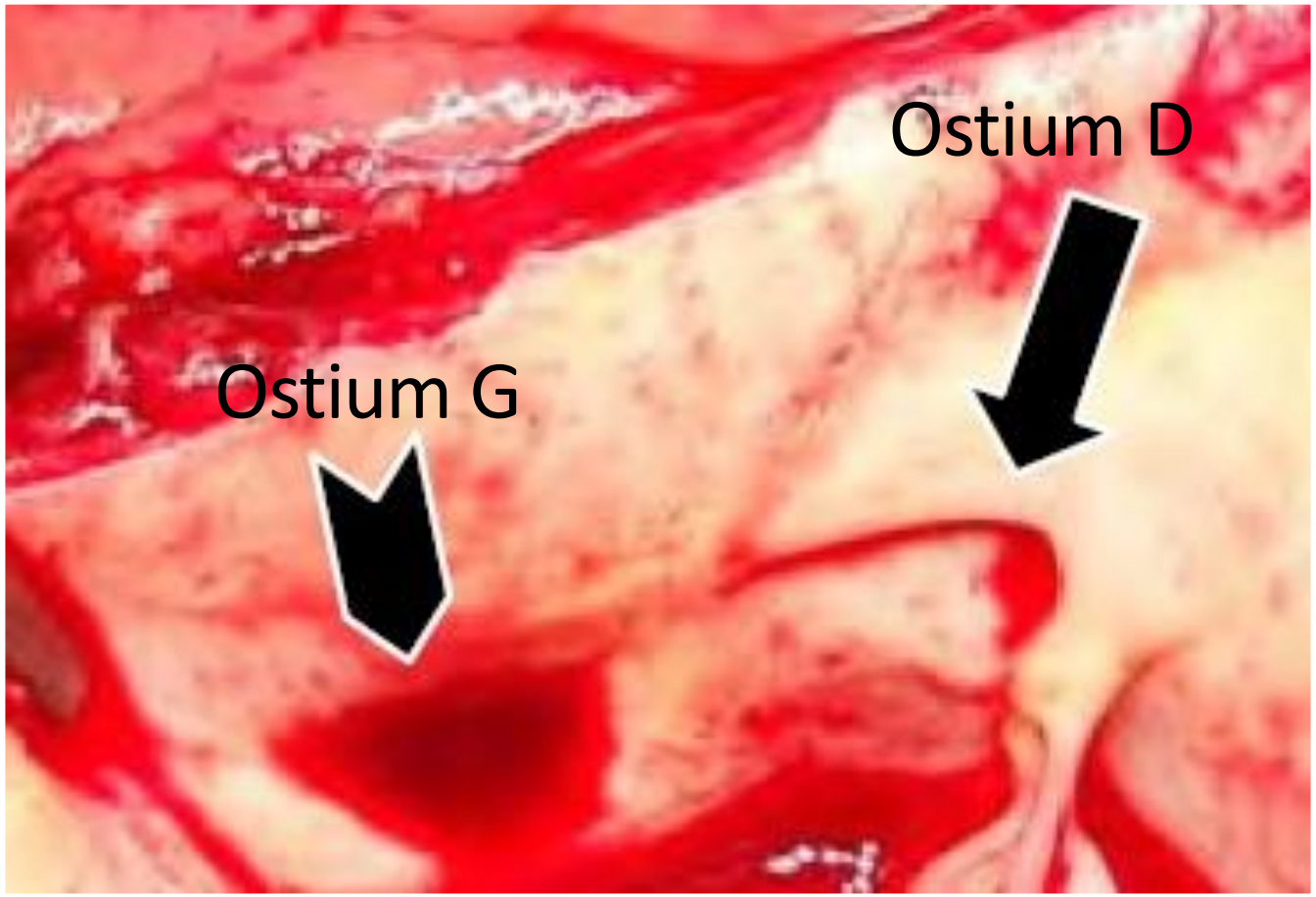


Schéma opératoire

Docteur Gaudin
CHU NECKER

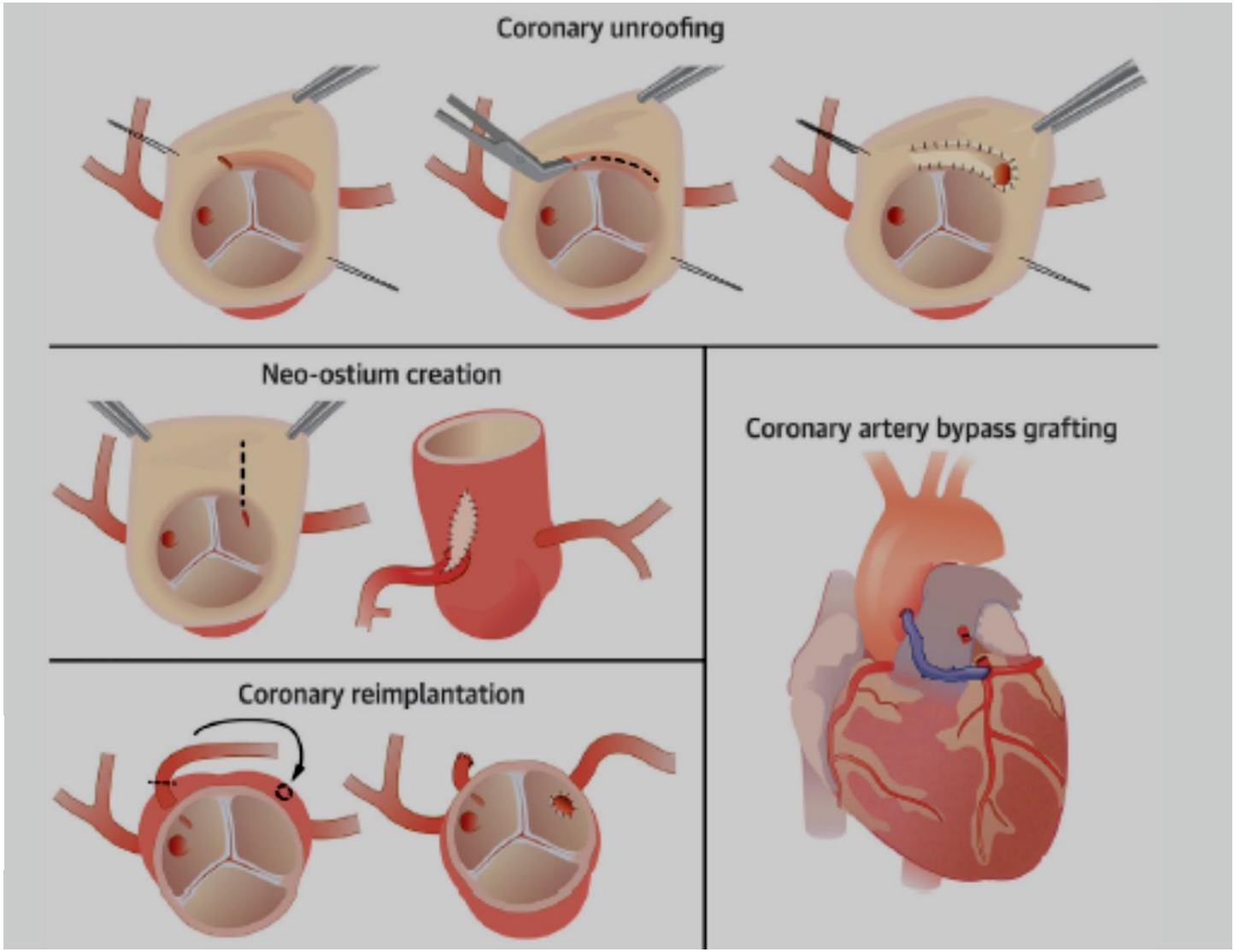


ANOCOR droite



Techniques chirurgicales

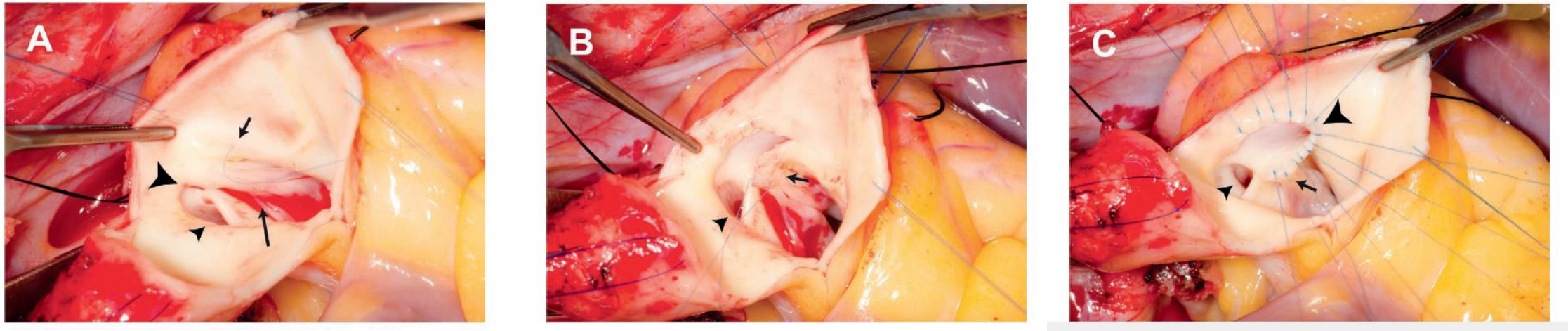
ANOCOR avec trajet interartériel



Gaudino M. et al. Ann Thorac Surg. 2023.

ANOCOR avec trajet interartériel

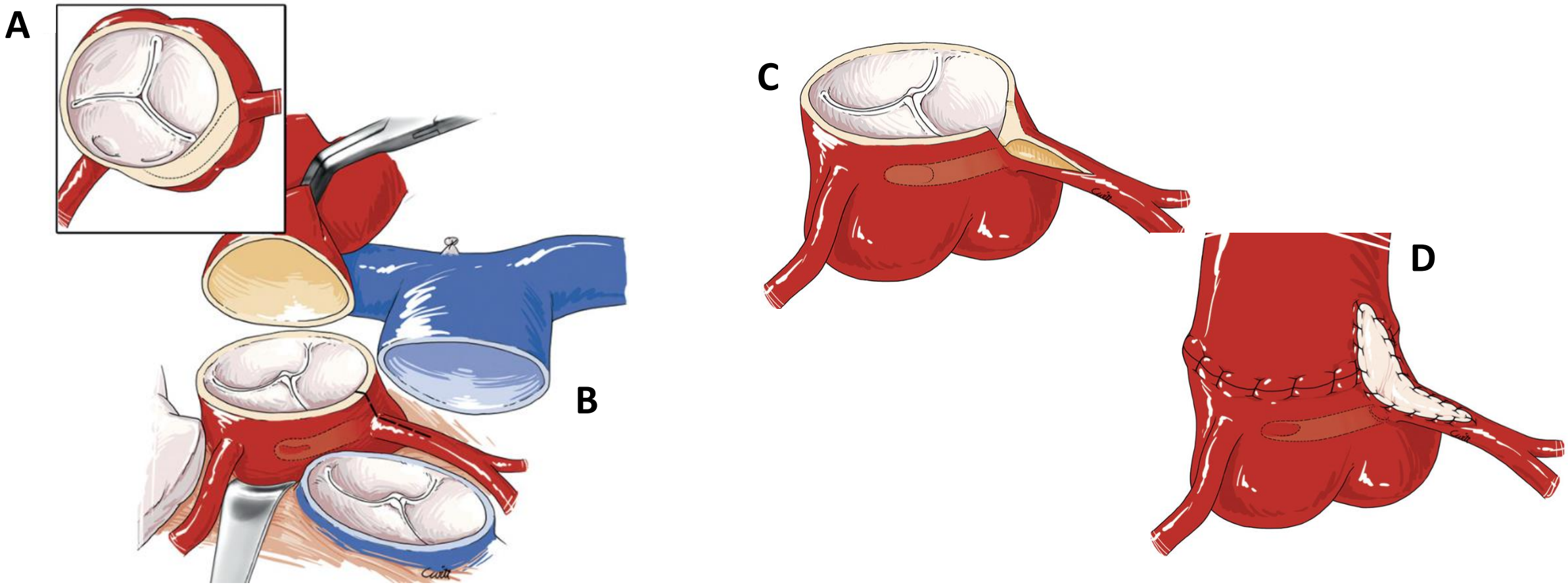
Unroofing technique



Molossi S. et al. MD Cardiovasc J. 2019.

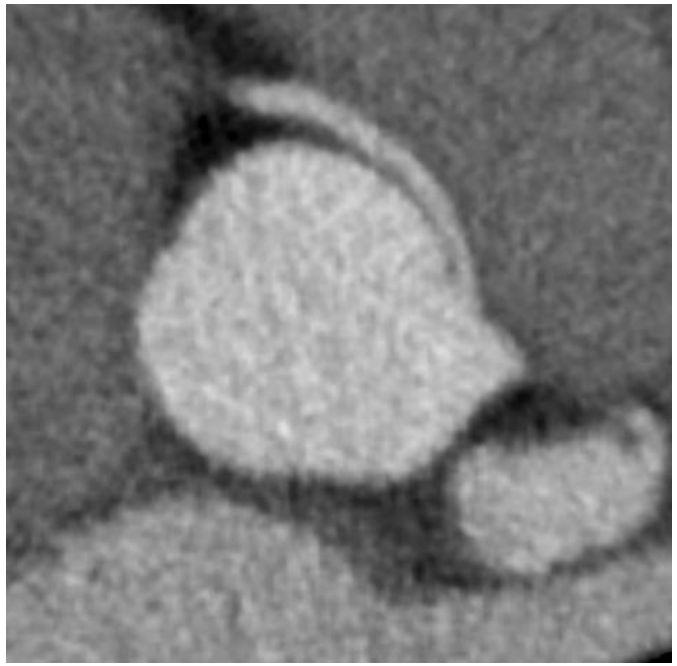
ANOCOR avec trajet interartériel

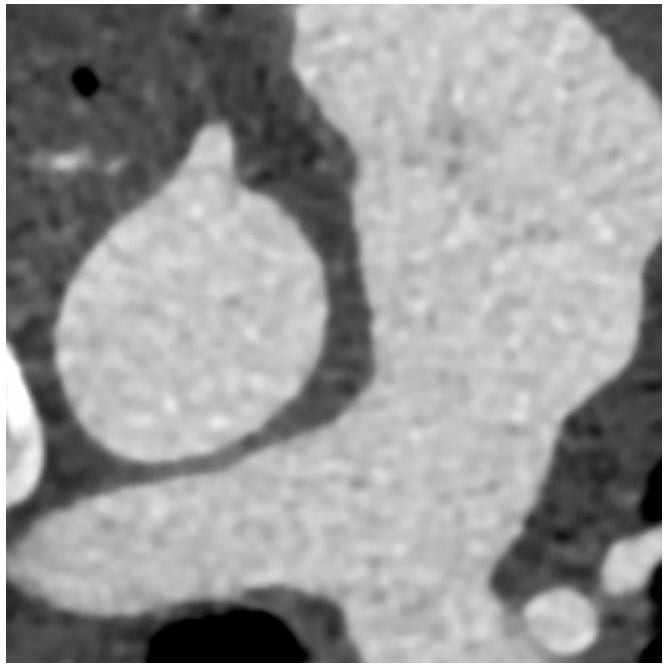
Création nouvel ostium



Vouhé P. Bulletin Académie Nationale Médecine. 2014.

Scanner coronaire post chirurgie



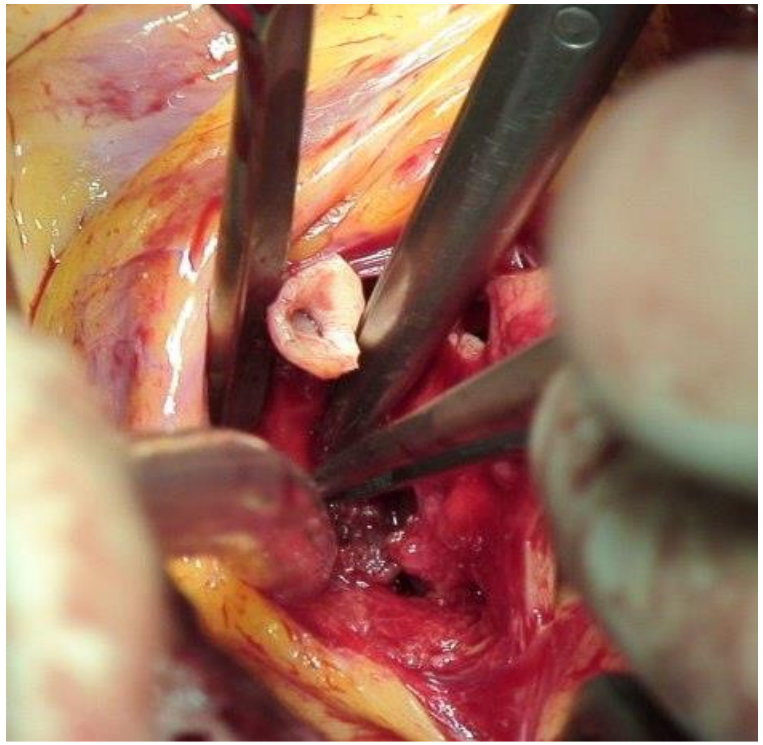


Création nouvel ostium

ANOCOR avec trajet interartériel

Réimplantation coronaire

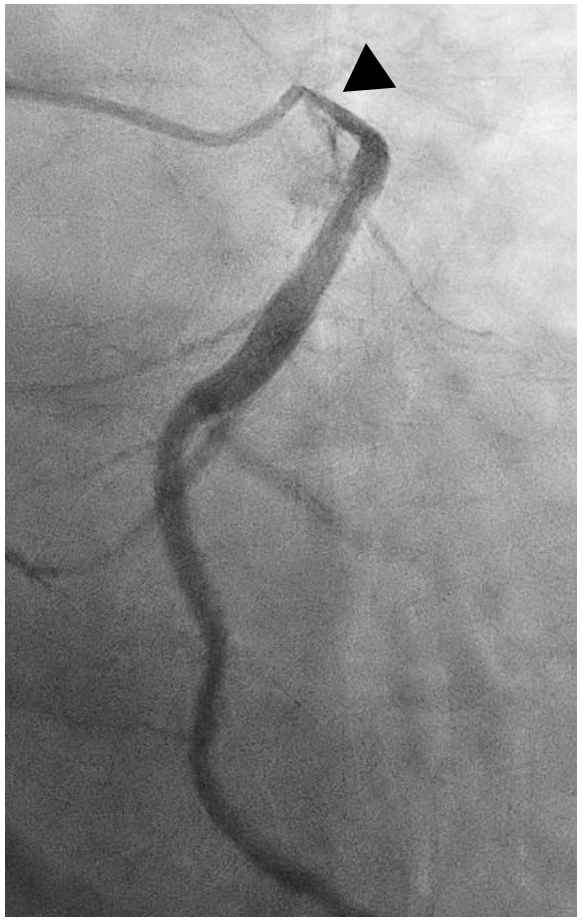
Rarement adapté



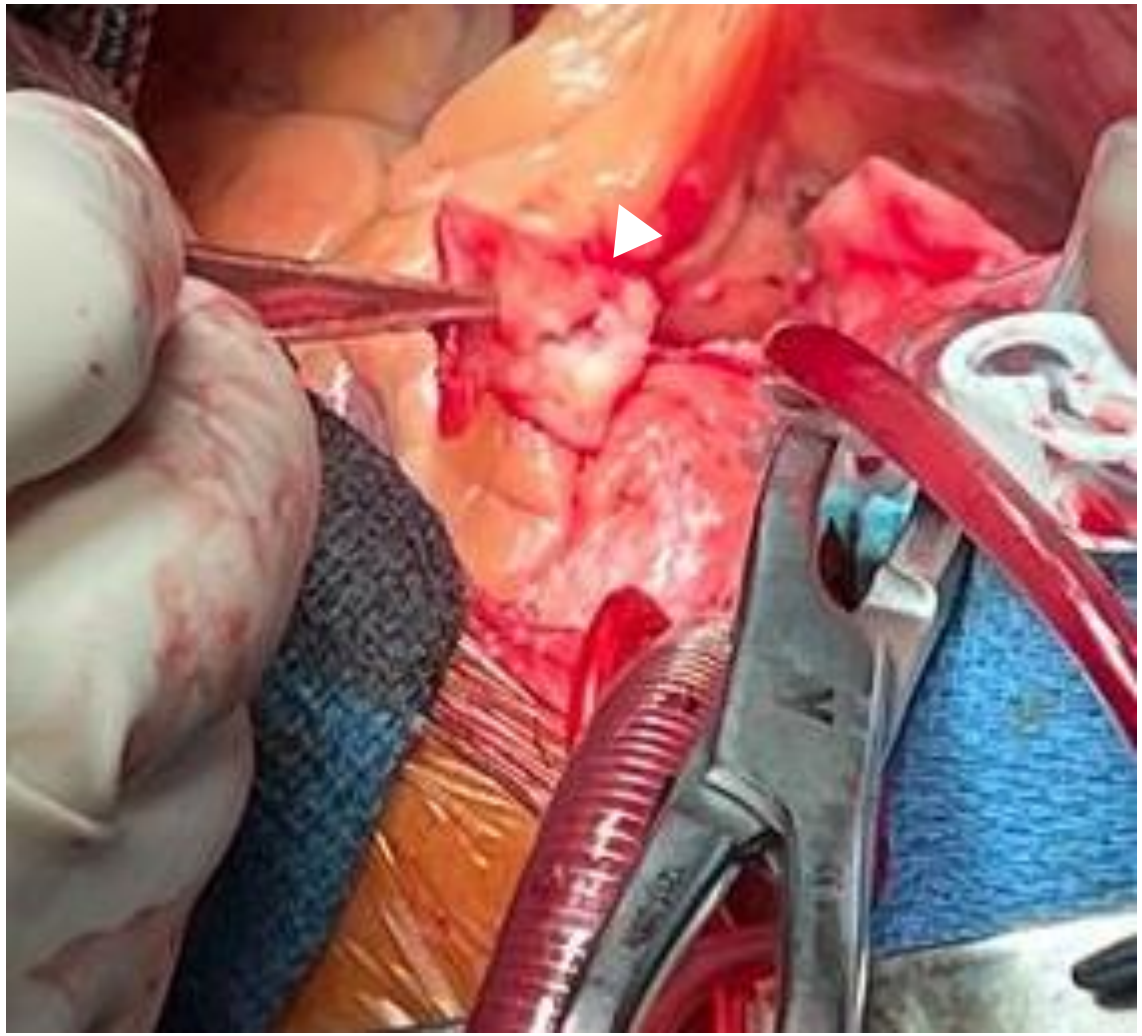
Cas clinique 3
Mme P.

- Femme de 59 ans
- SCA ST- troponine +
- Dilatation aortique : 55 mm (sinus), junction (46 mm), tube (48 mm)
- FEVG 45%
- Coronarographie/scanner coronaire : ANOCOR droite
- IRM cardiaque : rehaussement tardif inférieur
- Staff médicochirurgical : remplacement aortique/reimplantation coronaire/VMA

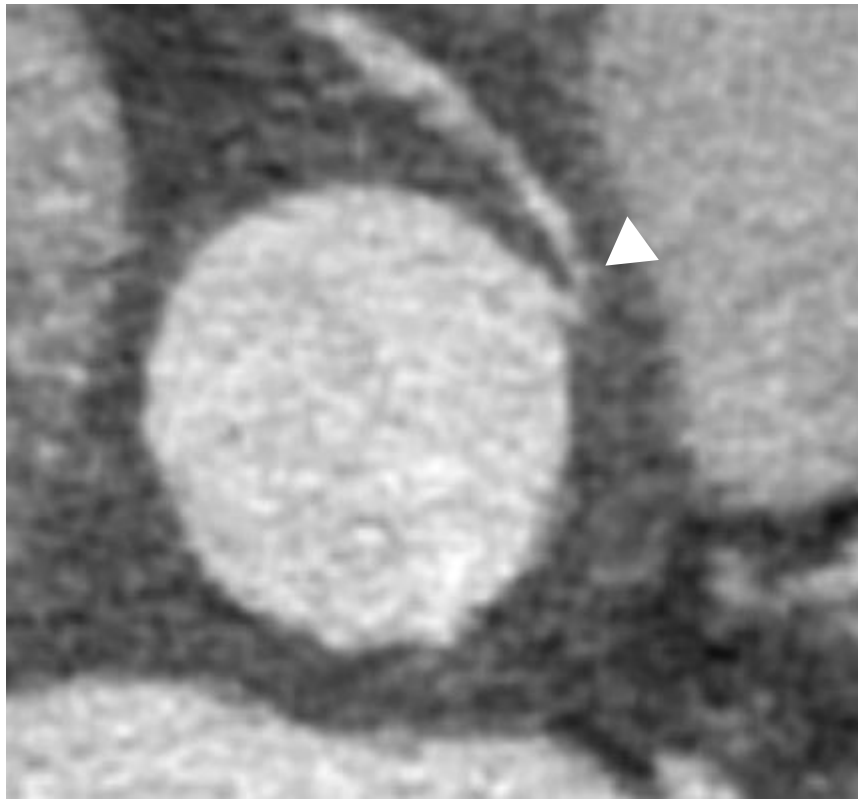
ANOCOR droite

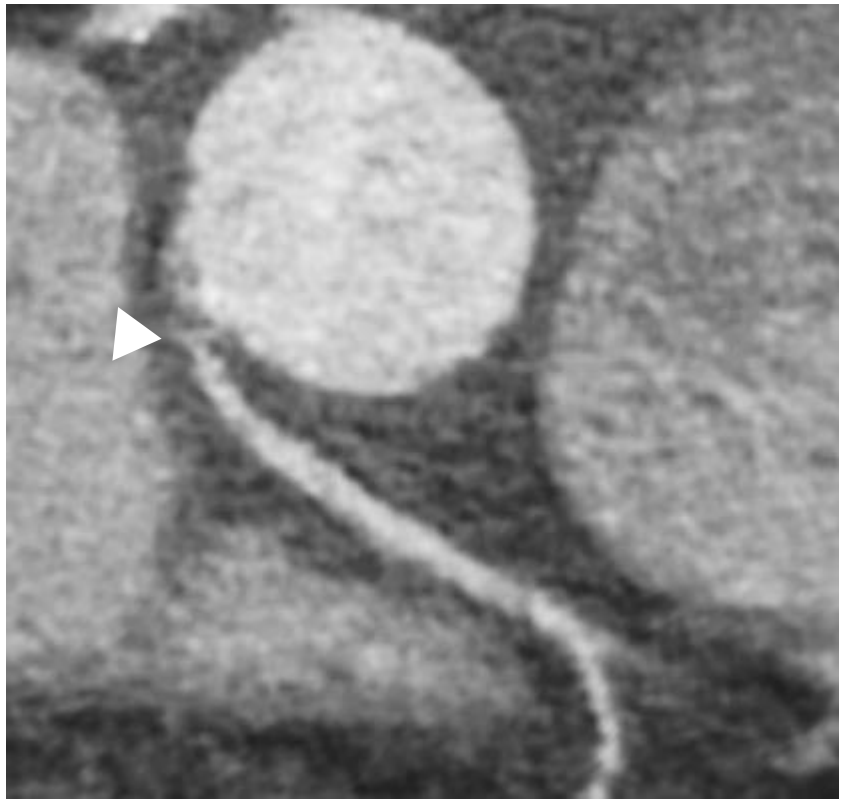


Intervention



Scanner coronaire post opératoire





Techniques chirurgicales

ANOCOR avec trajet rétropulmonaire

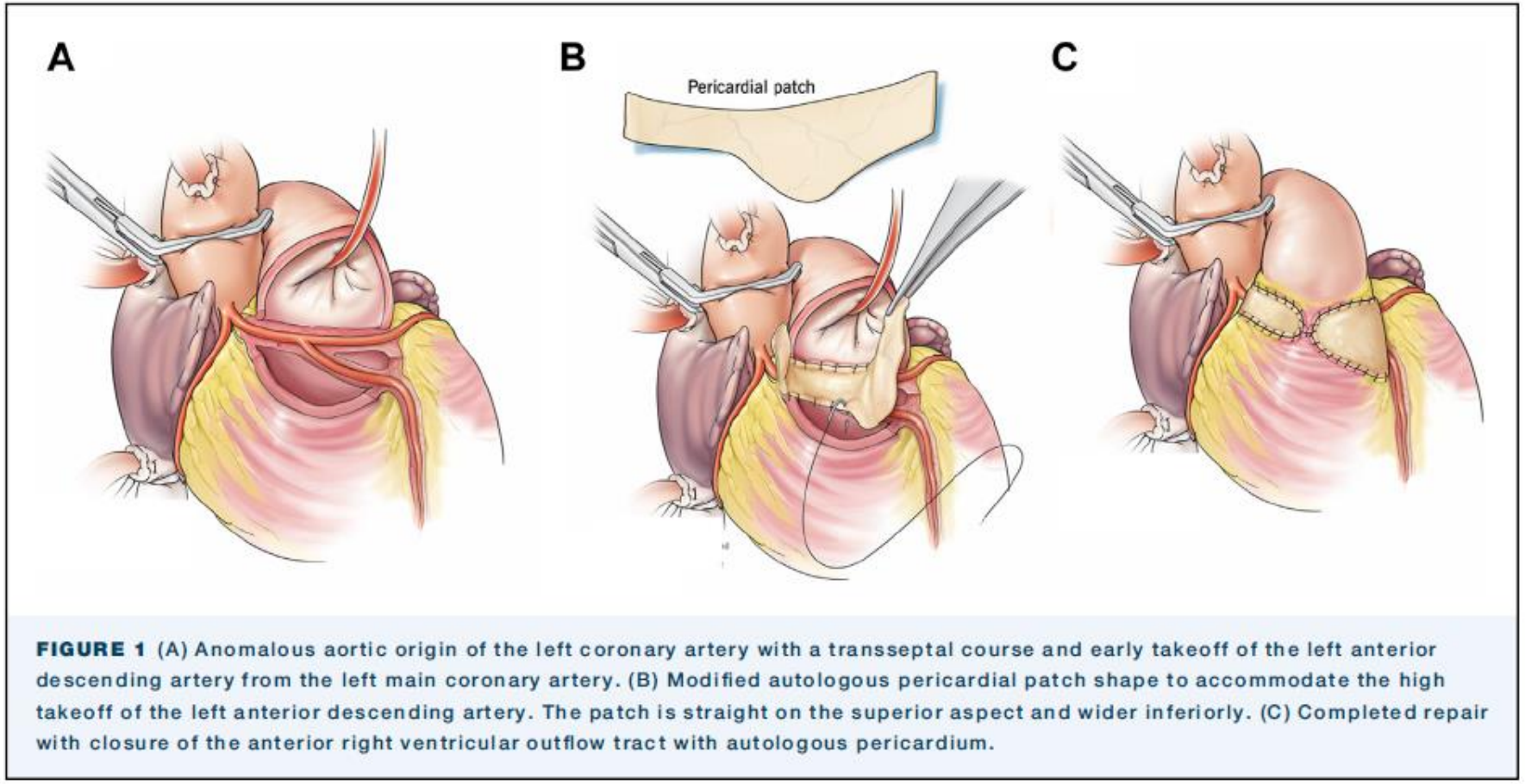


FIGURE 1 (A) Anomalous aortic origin of the left coronary artery with a transseptal course and early takeoff of the left anterior descending artery from the left main coronary artery. (B) Modified autologous pericardial patch shape to accommodate the high takeoff of the left anterior descending artery. The patch is straight on the superior aspect and wider inferiorly. (C) Completed repair with closure of the anterior right ventricular outflow tract with autologous pericardium.

Najm HK. et al. Ann Thorac Surg. 2023.

ANOCOR et chirurgie

European Journal of Cardio-Thoracic Surgery 58 (2020) 975–982
doi:10.1093/ejcts/ezaa129 Advance Access publication 23 June 2020

ORIGINAL ARTICLE

Cite this article as: Gaillard M., Pontailler M, Danial P, Moreau de Bellaing A, Gaudin R, du Puy-Montbrun L *et al*. Anomalous aortic origin of coronary arteries: an alternative to the unroofing strategy. Eur J Cardiothorac Surg 2020;58:975–82.

Anomalous aortic origin of coronary arteries: an alternative to the unroofing strategy

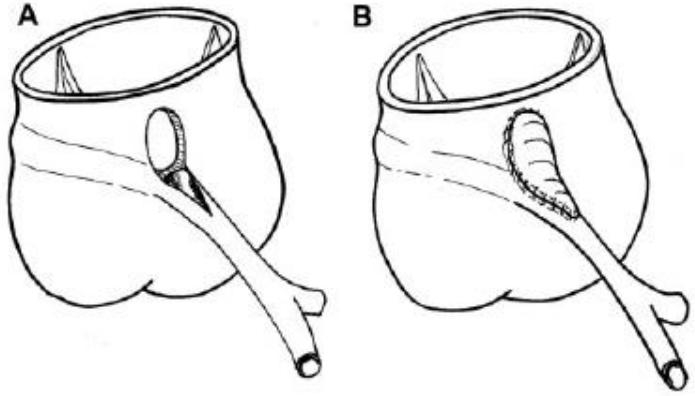
Maïra Gaillard[a], Margaux Pontailler [a], Pichoy Danial[a], Anne Moreau de Bellaing[a], Régis Gaudin [a], Leonora du Puy-Montbrun[a], Bari Murtuza[a], Ayman Haydar[a], Sophie Malekzadeh-Milani [b], Damien Bonnet [b], Pascal Vouhé[a] and Olivier Raisky[a,*]

- N = 61
- 2005-2019
- Age (years - median) : 14.7 (3.7 – 66.1)
- AAOCA right : 40 (66%) – AAOCA left : 21 (34%)
- Interarterial course : 56 (92%) – subpulmonic course : 5 (8%)
- Aborted sudden cardiac death : 5 (8%)

ANOCOR et chirurgie

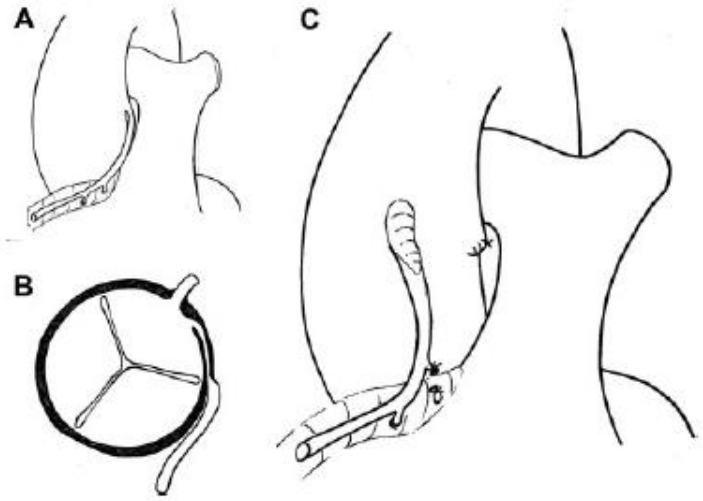
Anomalous aortic origin of coronary arteries: an alternative to the unroofing strategy

Anatomical repair



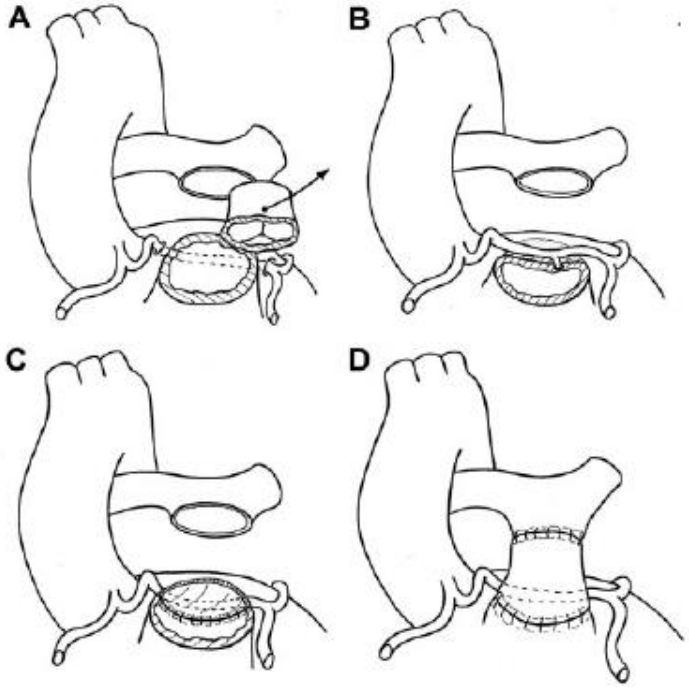
N=37 (60.7%)

Reimplantation



N=19 (31.1%)

Intraseptal relief



N=5 (8.2%)

Gaillard M. et al. Eur J Cardio Thorac Surg. 2020.

ANOCOR et chirurgie

Anomalous aortic origin of coronary arteries: an alternative to the unroofing strategy

Early outcomes

Postoperative death : 0

PCI : 2 (3%) : 1 coronary thrombosis, 1 patch plication

Redo surgery : 1 (1.5%) : cardiac arrest/coronary thrombosis/ECMO

Late outcomes

Mean follow-up (years) : 38 months (1-15 years)

Death : 0

PCI : 2 (3%) : 1 recurrent restenosis, 1 scar stenosis

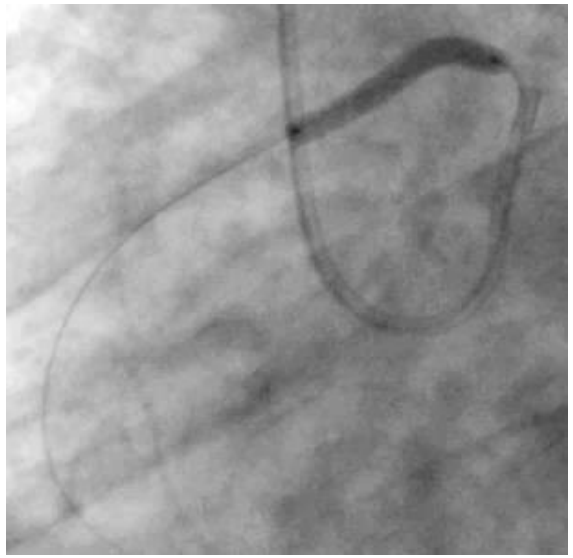
Redo surgery : 2 (3.5%) : 1 CABG, 1 surgical revision (patch aneurysm)

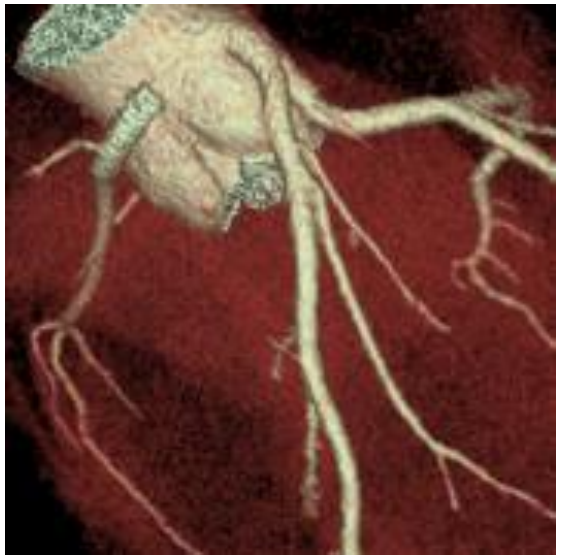
- PCI : 3 patients (5%)
- Redo surgery : 3 patients (5%)

Gaillard M. et al. Eur J Cardio Thorac Surg. 2020.

- Embryologie et anatomie
- Classification
- Prévalence
- Imagerie
- Ischémie myocardique
- Mort subite
- Prise en charge
- Chirurgie
- Angioplastie

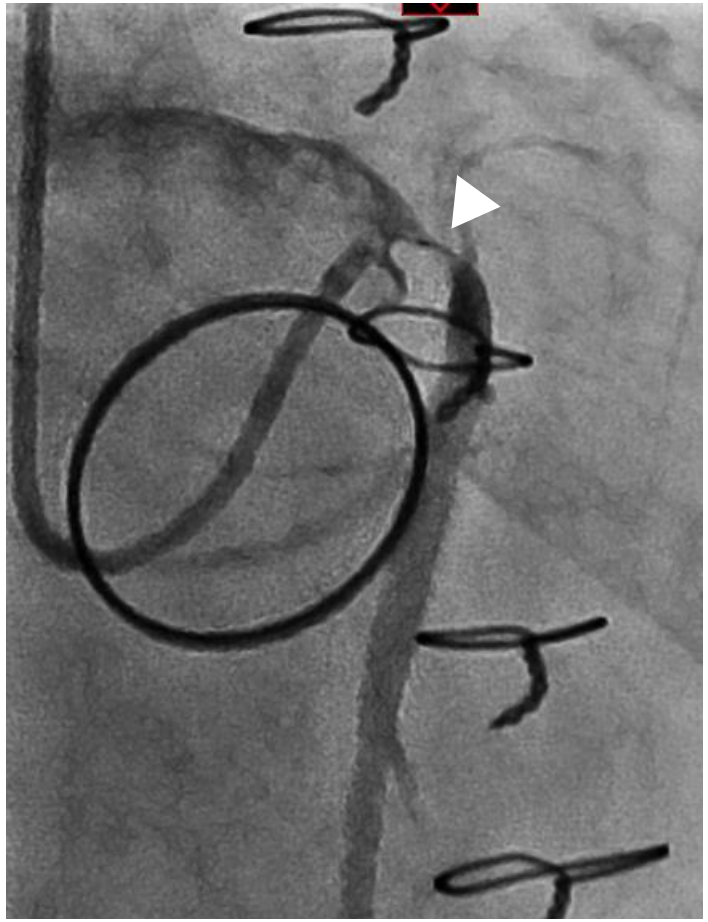
Angioplastie coronaire droite ectopique

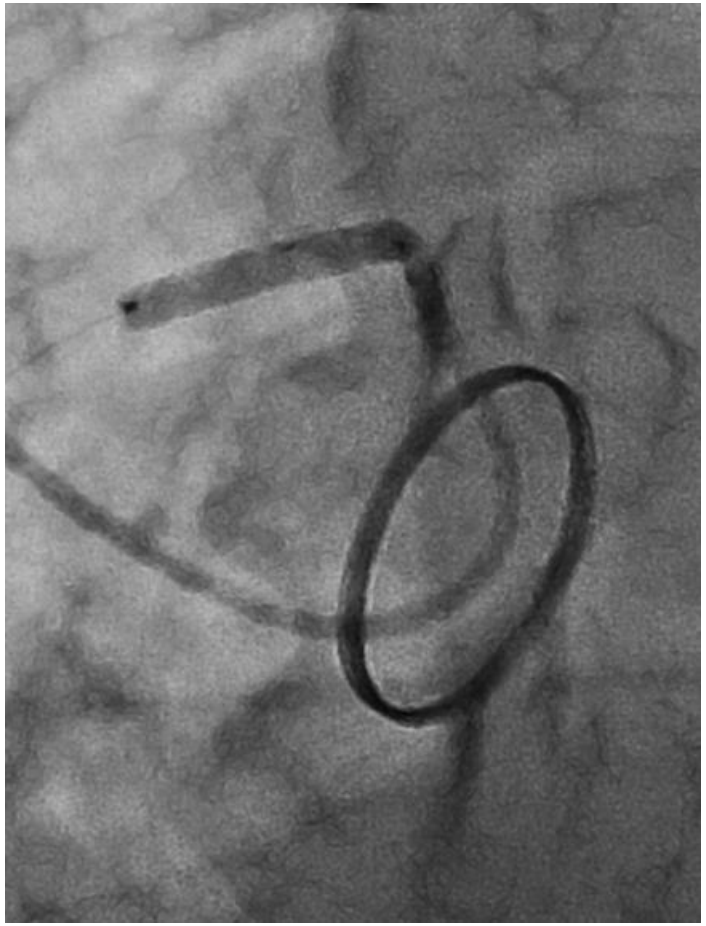




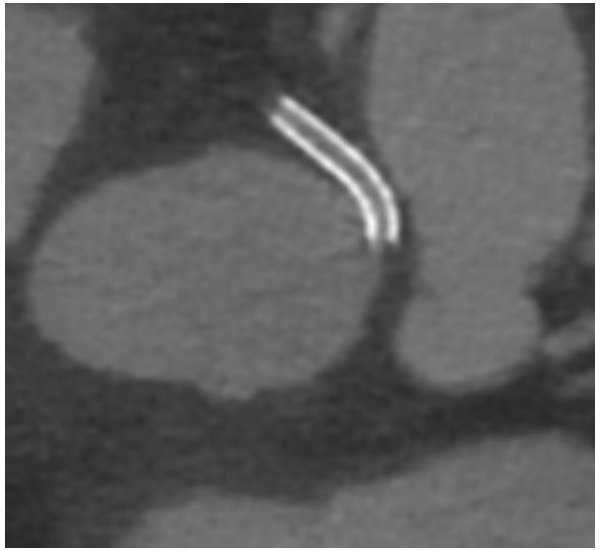
Est-ce possible ?

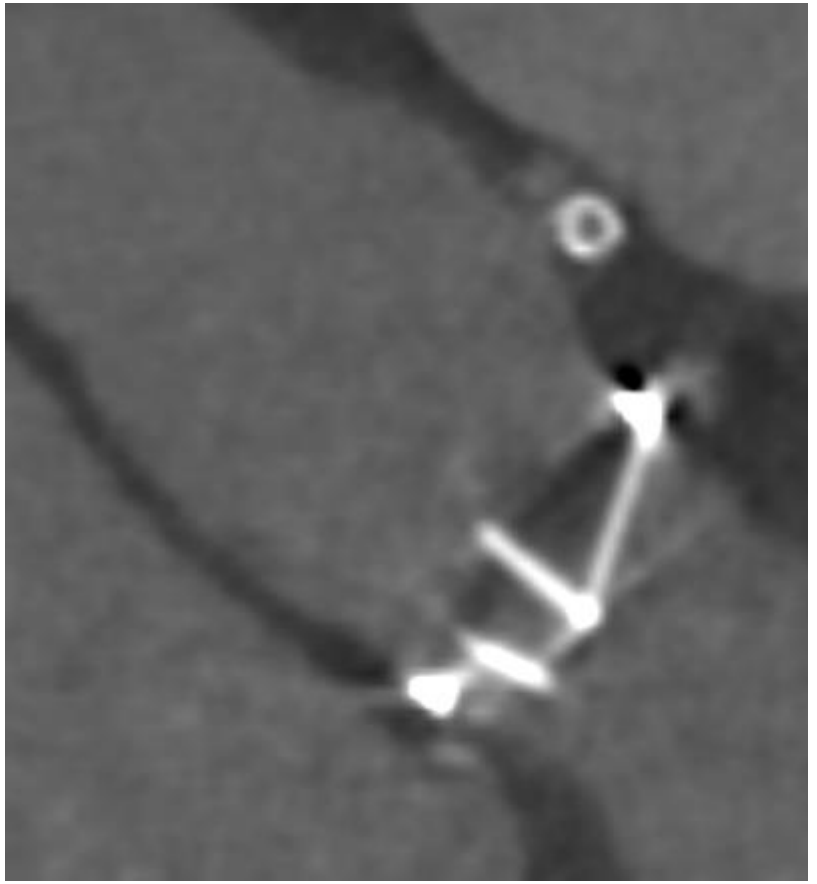
Cas clinique 3
Angioplastie coronaire





Scanner coronaire post angioplastie





ANOCOR et chirurgie

- Recommandations : souvent ciblées sur une population jeune
- Décisions thérapeutiques : indiquées sans tenir compte de l'âge
- Etudes randomisées contrôlées : aucune
- Histoire naturelle et corrigée : mal connue à long terme
- Effet sur le risque de mort subite : ?
- Correction chirurgicale : techniques spécialisées
- Quelques échecs : thrombose précoce, sténose cicatricielle, anévrisme, insuffisance aortique

Groupe de travail multidisciplinaire sur les ANOmalies congénitales des artères CORonaires

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Ouvert février 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.