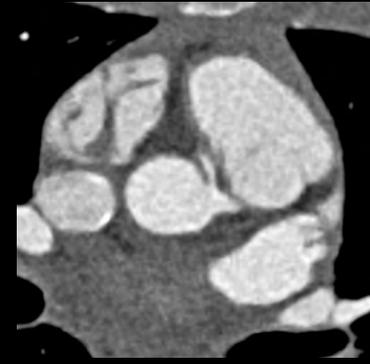




# Scanner des cardiopathies congénitales



*Dr Volodia Dangouloff-Ros*

*Service de Radiopédiatrie  
du Pr Boddaert  
Hôpital Necker, Paris, France*



# Programme



- Avantages, Inconvénients → Indications
- Technique de réalisation et d'interprétation
- Exemples



Avantages, Inconvénients → Indications

- Comparaison à l'échographie:
  - Avantages:
    - Pas gêné par les poumons
    - Visualisation 3D
    - Résolution spatiale
    - Relecture aisée (moins opérateur dépendant)
  - Inconvénients:
    - Besoin d'immobilité (quelques minutes)
    - Pas d'image de flux
    - Etude limitée des valves et des CIA/CIV
    - Rayonnements ionisants



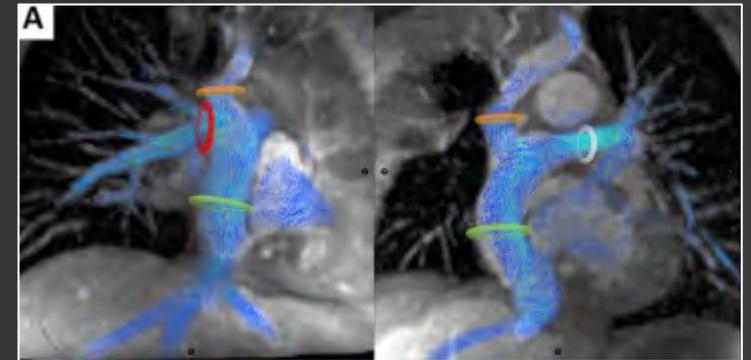
- Comparaison à l'IRM:

- Avantages:

- Résolution spatiale (petits vaisseaux)
- Rapidité d'acquisition
- Disponibilité
- Moins artéfacté par le matériel chirurgical

- Inconvénients:

- Pas d'imagerie dynamique (ciné, flux)
- Pas d'image de rehaussement
- Rayonnements ionisants



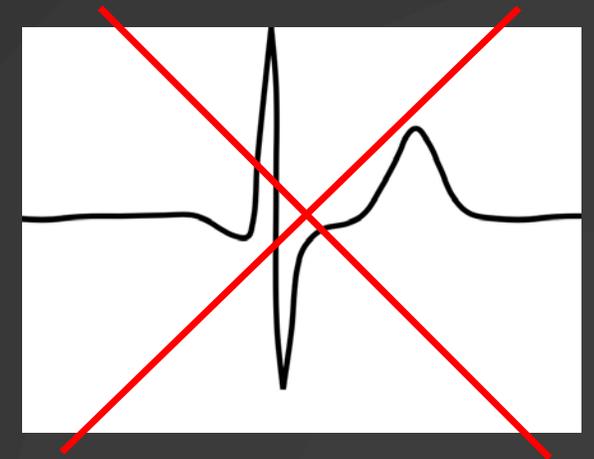
- Indications:
  - Imagerie vasculaire:
    - Coronaires
    - Artères pulmonaires, aorte, veines caves et pulmonaires
    - Montages chirurgicaux
  - Cardiopathies complexes:
    - Anatomie vasculaire
    - Rapports anatomiques
  - Extracardiaque:
    - Collections médiastinales, péri-valvulaires
    - Retentissement pulmonaire, trachéal

# Technique de réalisation

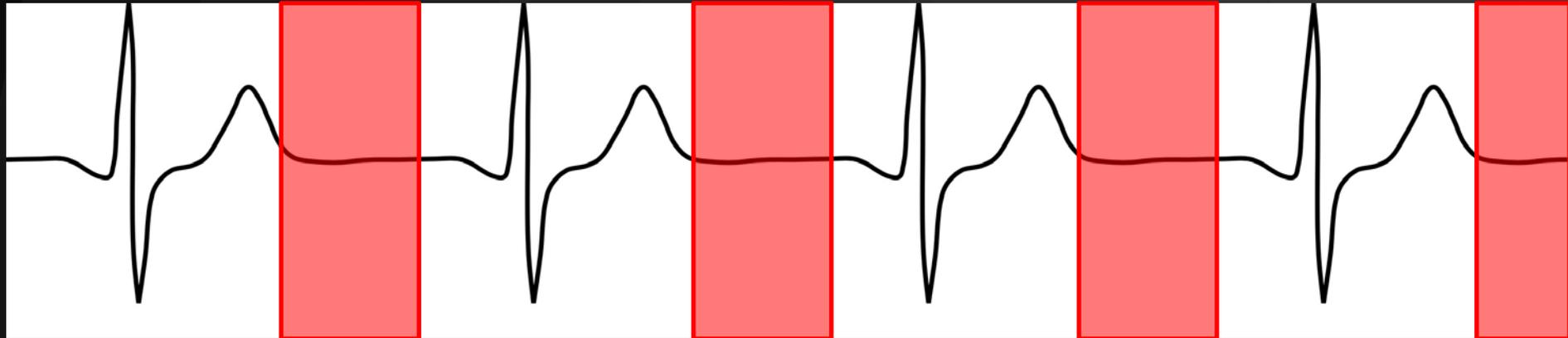
- Où ?
  - Où les manipulateurs ont l'habitude de la pédiatrie
  - Où les manipulateurs / radiologues savent faire
- Sur quel scanner ?
  - La majorité... si les manipulateurs connaissent
  - Différences de rapidité d'acquisition, de « boîtes », de qualité

- Synchronisation
- Injection
- Apnée
- Sédation

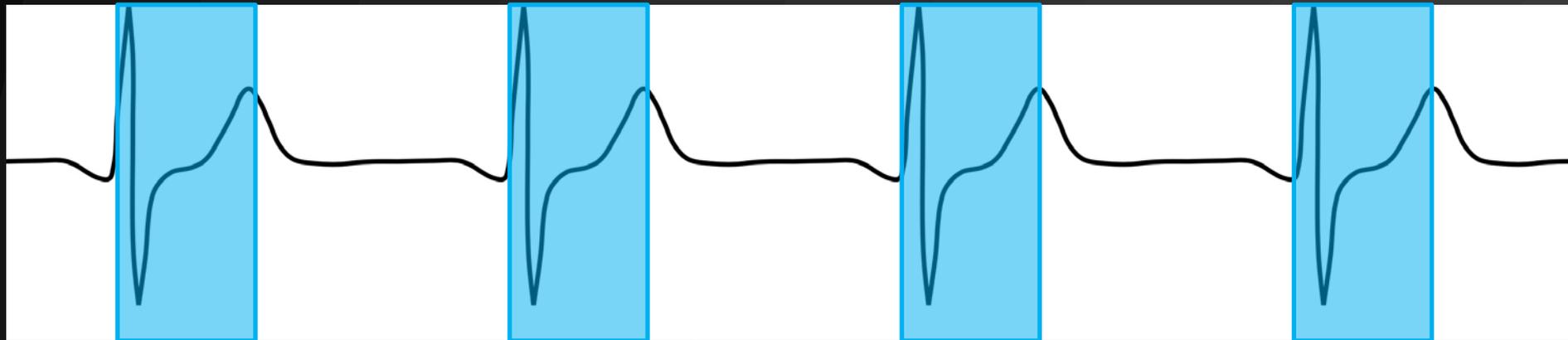
- Quelle acquisition : Gating ou sans gating ?
  - Gating = Synchronisation à l'ECG ( $\approx$  coroscanner)
    - Avec des électrodes reliées au scanner
    - Pour les structures très mobiles
    - Nécessite un savoir-faire paramédical
  - Sans gating = Angioscanner « standard »
    - Sans électrodes
    - Pour structures peu mobiles
    - Faisable partout



- Acquisition avec gating cardiaque
  - Synchronisation à l'ECG
  - Acquisition pendant une partie du cycle cardiaque
    - 35-74 bpm : diastole



- Acquisition avec gating cardiaque
    - Synchronisation à l'ECG
    - Acquisition pendant une partie du cycle cardiaque
      - 35-74 bpm : diastole
      - > 74 bpm : systole
- (pour remplissage coronaire optimal)

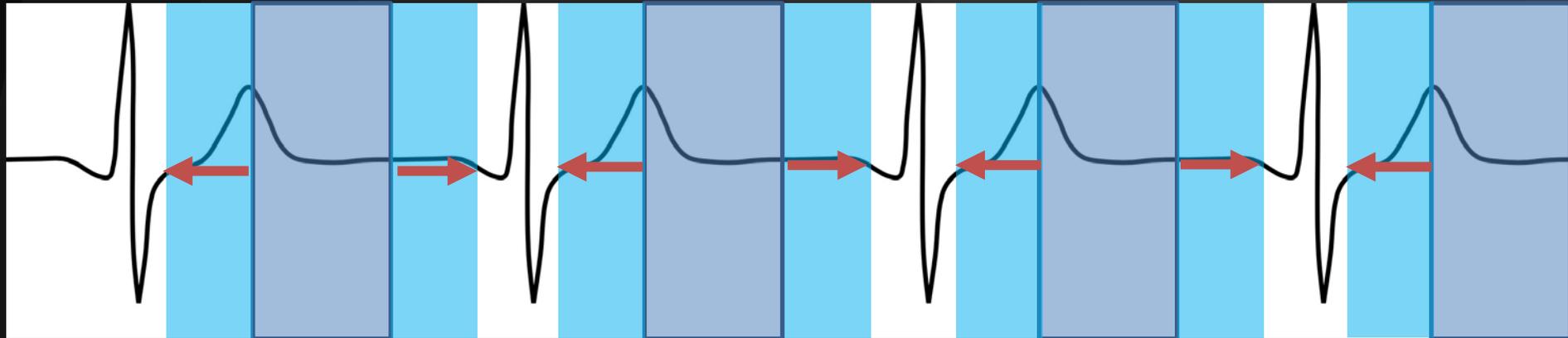


- Acquisition avec gating cardiaque

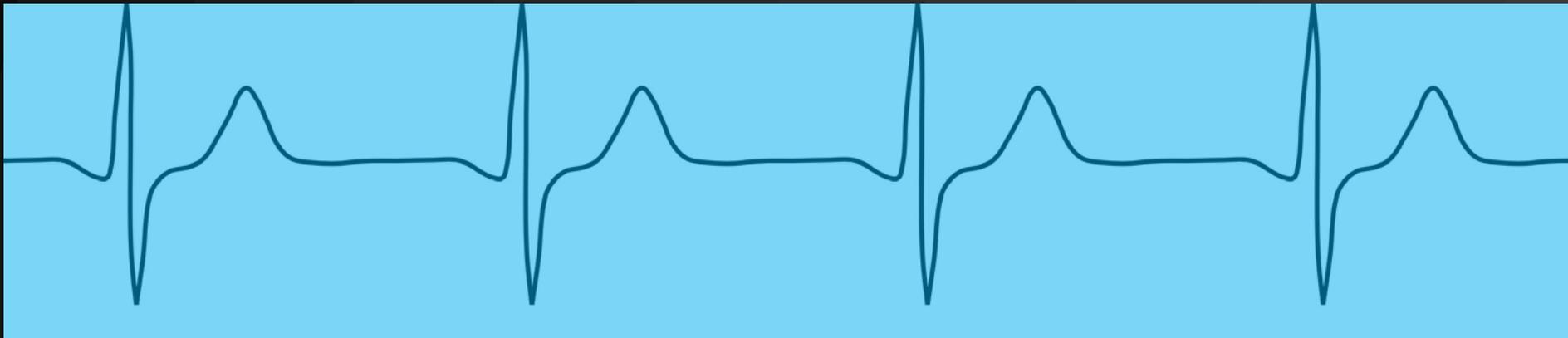
- Padding :

- = Remplissage dynamique

- Extension de l'acquisition aux phases adjacentes
    - Permet de reconstruire des phases intermédiaires entre systole et diastole
    - Utile si on a peur de rater l'acquisition : plusieurs chances



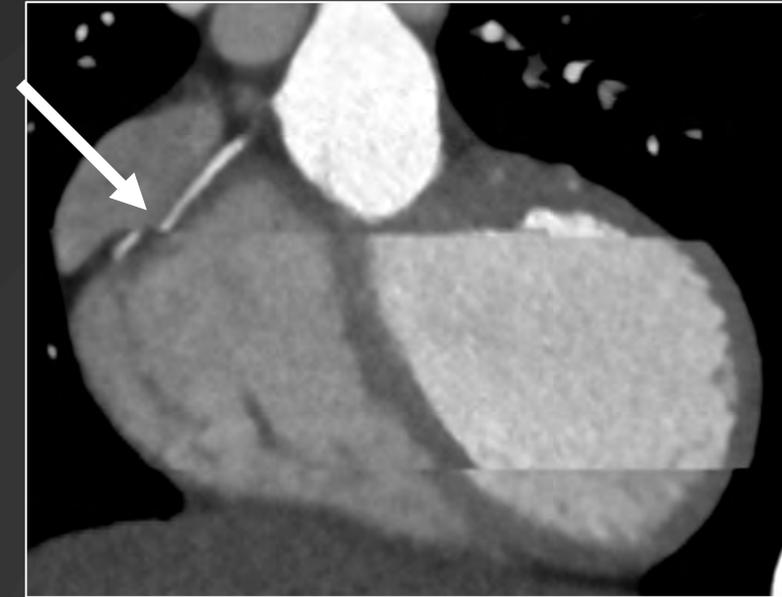
- Acquisition avec gating cardiaque
  - Padding « extrême » = Acquisition « rétrospective »
    - = Acquisition de tout le cycle cardiaque
    - Permet de reconstruire toutes les phases
    - Donc permet de mesurer les volumes et fonctions cardiaques
    - MAIS : très irradiant, donc EXCEPTIONNEL chez l'enfant



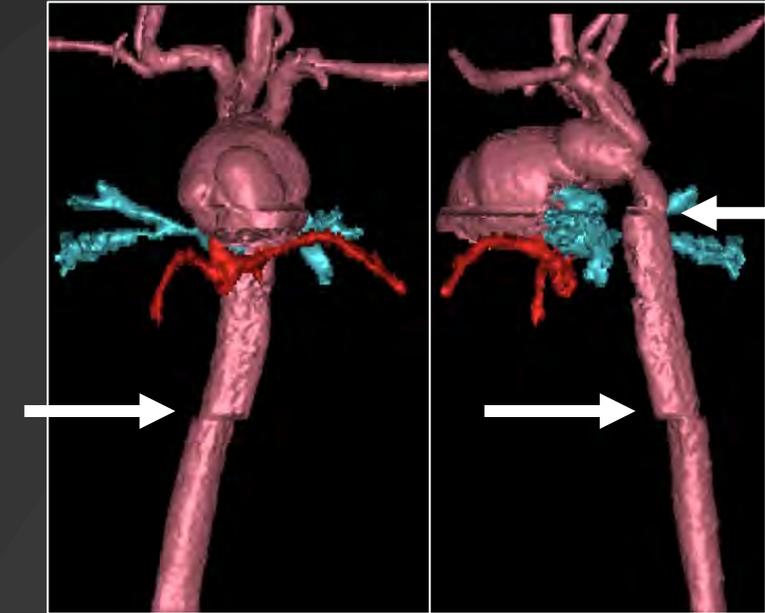
- Acquisition avec gating cardiaque

- Problèmes:

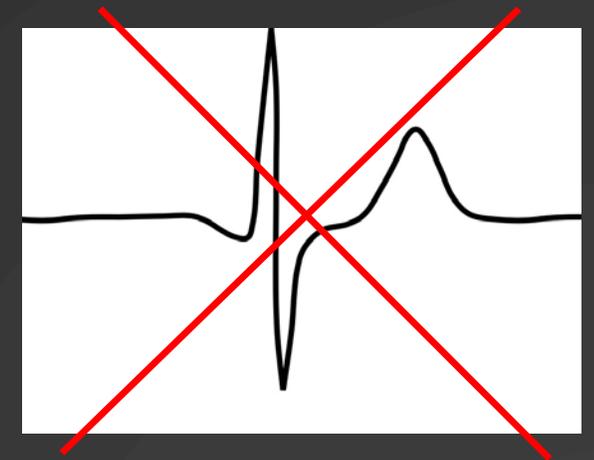
- Acquisition pendant une partie du cycle cardiaque
  - Fonctionne si rythme cardiaque régulier
  - Si irrégulier : se trompe sur le moment de la diastole
- Rythme rapide : pas un problème si régulier
- Ne peut pas acquérir tout le cœur en une fraction de cycle cardiaque (quelques ms) → plusieurs « boîtes »
  - Densité du produit de contraste variable
  - Mouvements entre les boîtes



- Acquisition avec gating cardiaque
  - Problèmes:
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- Acquisition SANS gating cardiaque
  - Angioscanner standard
- Quand on ne s'intéresse pas au cœur lui-même ni au coronaires
  - Aorte, artères pulmonaires, retours veineux...
- En cas de risque d'échec avec gating:
  - Rythme cardiaque irrégulier
  - Respiration ample



- Synchronisation
- **Injection**
- Apnée
- Sédation

## Injection de produit de contraste iodé

- Besoin d'une opacification vasculaire intense
  - Dose plus élevée (comme abdomen)
  - **Débit le plus élevé possible** pour avoir un bolus dense
    - Facteur de qualité ++
    - Besoin d'une « grosse » perfusion
- Cardiopathie : vitesse de circulation imprévisible → intérêt du **smart prep**
- Temps d'acquisition:
  - Le plus souvent mixte : AP et Aorte
  - Parfois: temps veineux cave nécessaire (anomalie de veine cave, DCPT...)
    - acquisition tardive ou biphasique



- Synchronisation
- Injection
- Apnée
- Sédation

## Apnée

- Peut être longue (10-30 s)
- Facteur clé pour éviter les « marches »
- Pas besoin d'une grande inspiration: que « bloquer »
- Donc dépend:
  - Du degré de compréhension de l'enfant
  - De sa capacité respiratoire à tenir l'apnée
  - ... du manipulateur radio



## Apnée

- Bébés
  - Respiration libre pas trop gênante car petite amplitude
  - Mais: pas d'agitation ! : une seule chance



- Synchronisation
- Injection
- Apnée
- **Sédation**

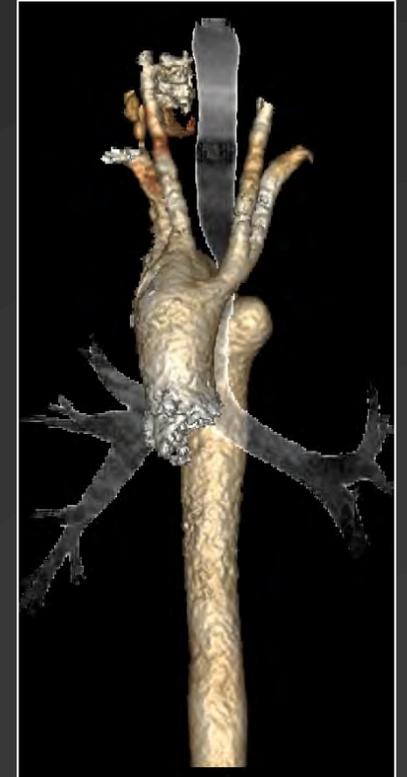
## Sédation ?

- Besoin d'immobilité thoracique pendant  $\approx$  10 minutes
- $< 5$  kgs: après biberon  $\rightarrow$  sommeil
- $< 5$  ans: dépend le degré de coopération
  - Installation « libre »
  - « Planchage » uniquement
  - Sédation (pentobarbital ou autre) et « planchage »
- $> 5-6$  ans: devient trop grand pour sédation habituelle
  - Sédation « médicalisée »
  - Anesthésie générale

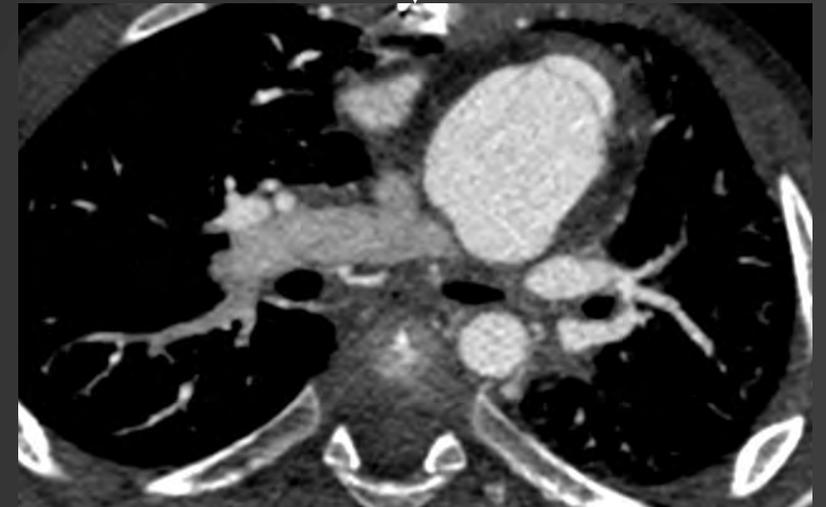
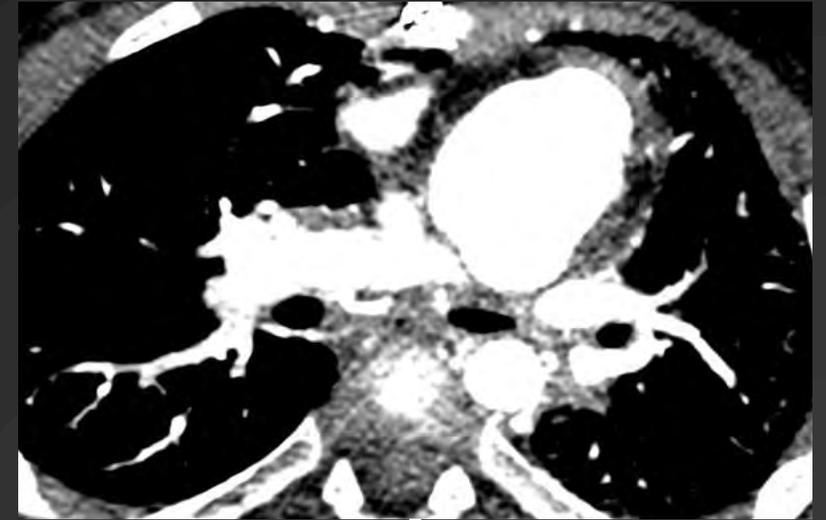


# Technique d'interprétation et exemples

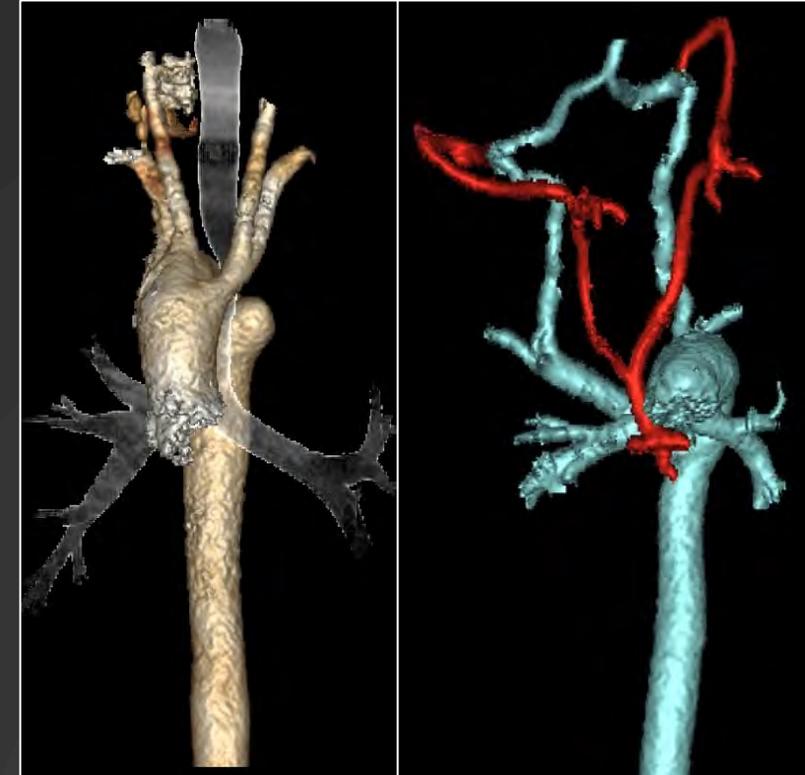
- Affichage
  - Peut être anormal selon le type de PACS
  - PACS Carestream (APHP):
    - « Afficher comme » MPR
    - Regroupe les différentes « boîtes » d'acquisition
  - Parfois mélange de reconstructions → flou ou bruit
    - Charger uniquement une reconstruction
  - Sur console d'interprétation des constructeurs de scanner
    - Multiphase
    - Reconstructions: 3D, curviligne, lumière...



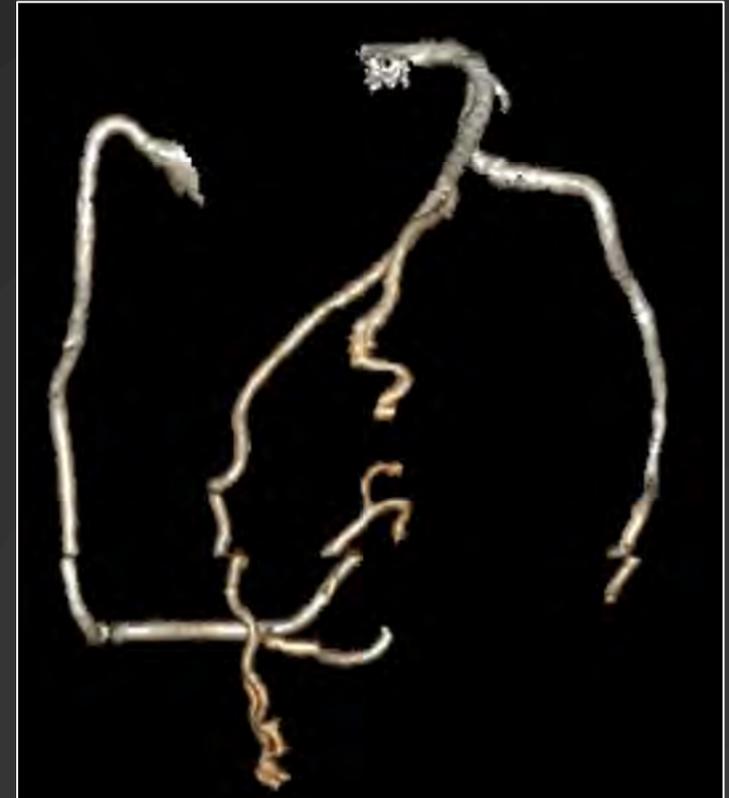
- Filtre et Fenêtre
  - Choisir filtre « mou »  
(pas parenchyme pulmonaire)
  - Fenêtrage:
    - Elargir la fenêtre par rapport au fenêtrage médiastinal standard
    - Adapter manuellement au contraste souhaité



- Reconstructions
  - Moyen de communiquer un résultat
  - Comprendre les rapports anatomiques
  - ⚠ Choix de l'opérateur ! ⚠
- Reconstructions
  - 3D: choix des structures et de leur représentation



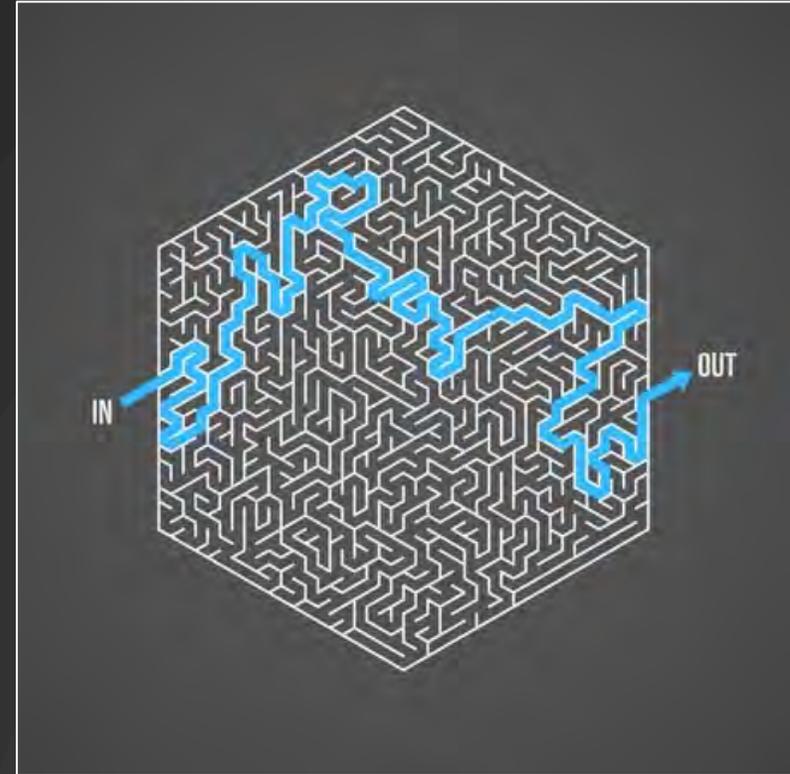
- Reconstructions
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- Reconstructions
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  - Comprendre les rapports anatomiques
  - ⚠ Choix de l'opérateur ! ⚠
- Reconstructions
  - 3D: choix des structures et de leur représentation
  - Curviligne: plan irrégulier qui suit une structure

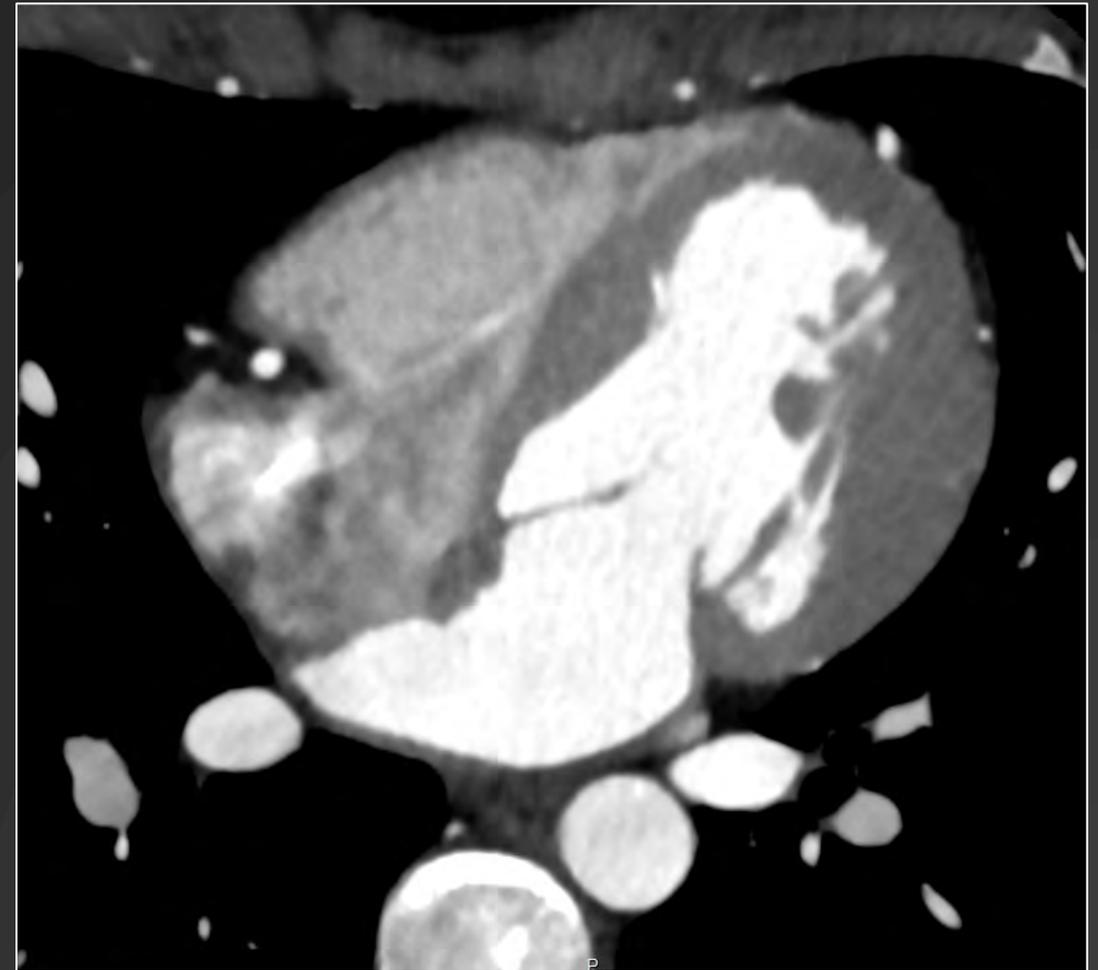


- Analyse
  - Il suffit de suivre le chemin !
  - Analyse structurée
    - Vaisseaux
    - Cavités cardiaques

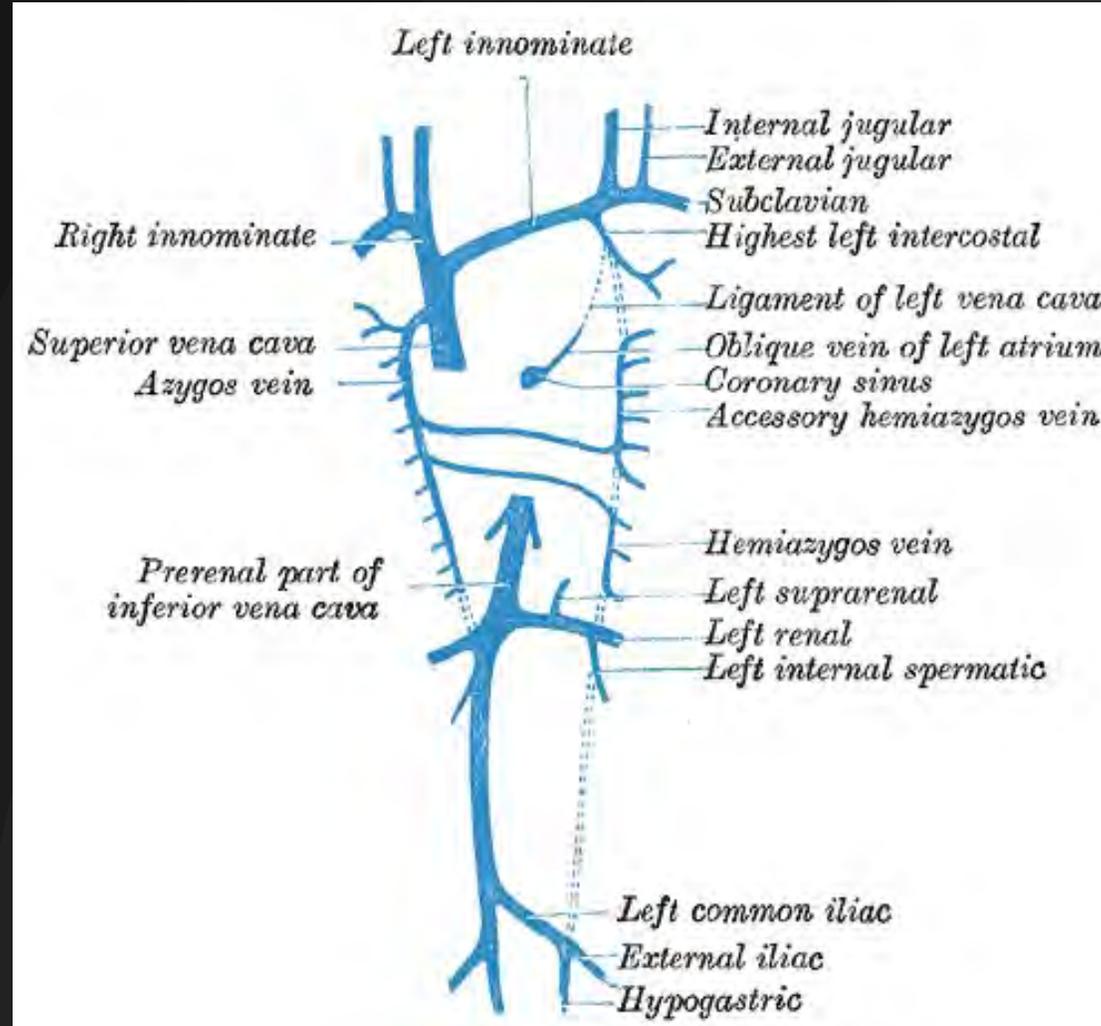


# Technique d'interprétation

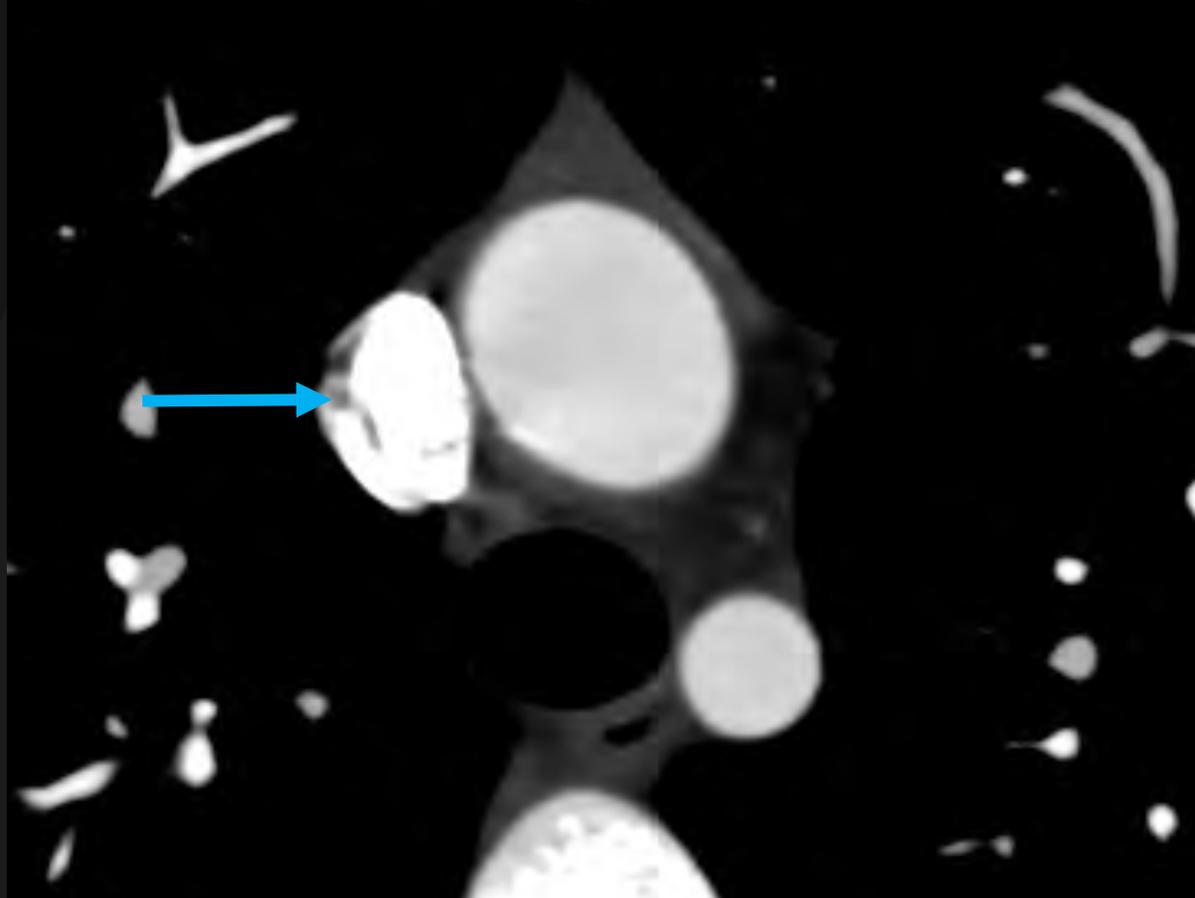
- Analyse
  - Entrées :
    - 2 veines caves (supérieure et inférieure)
    - 4 veines pulmonaires
  - Sorties :
    - Aorte
    - Artère pulmonaire (AP)
  - Vascularisation :
    - 2 artères coronaires
    - Sinus coronaire
  - Cavités :
    - 2 atria
    - 2 ventricules

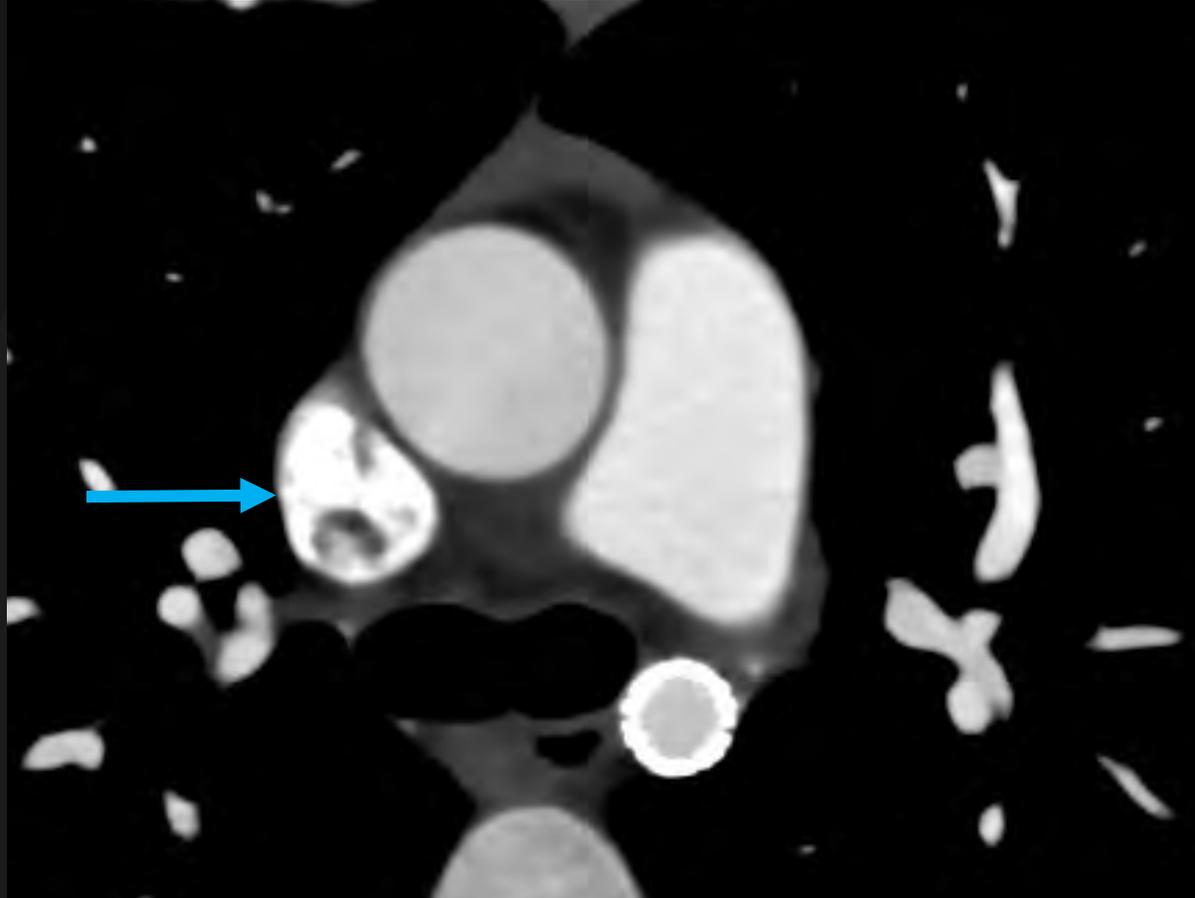


# Veines caves

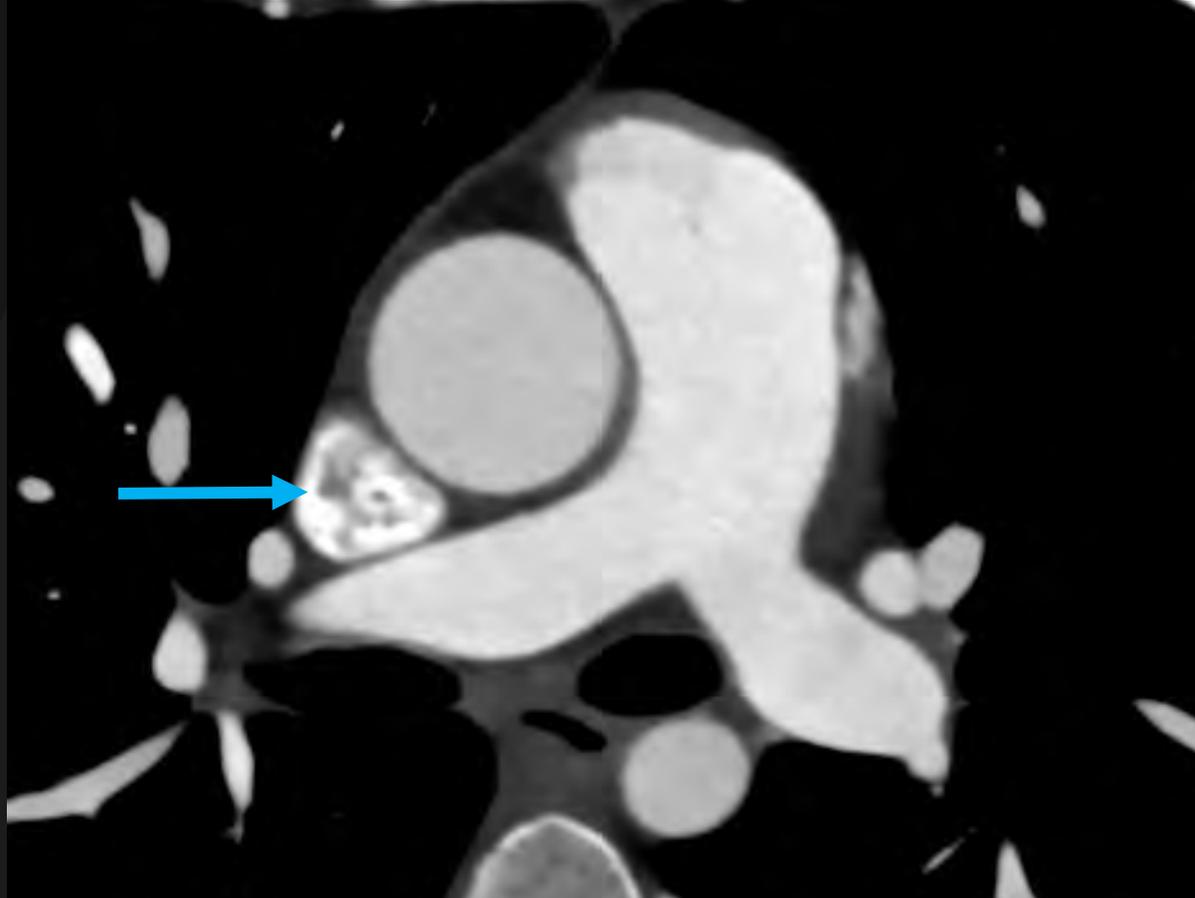


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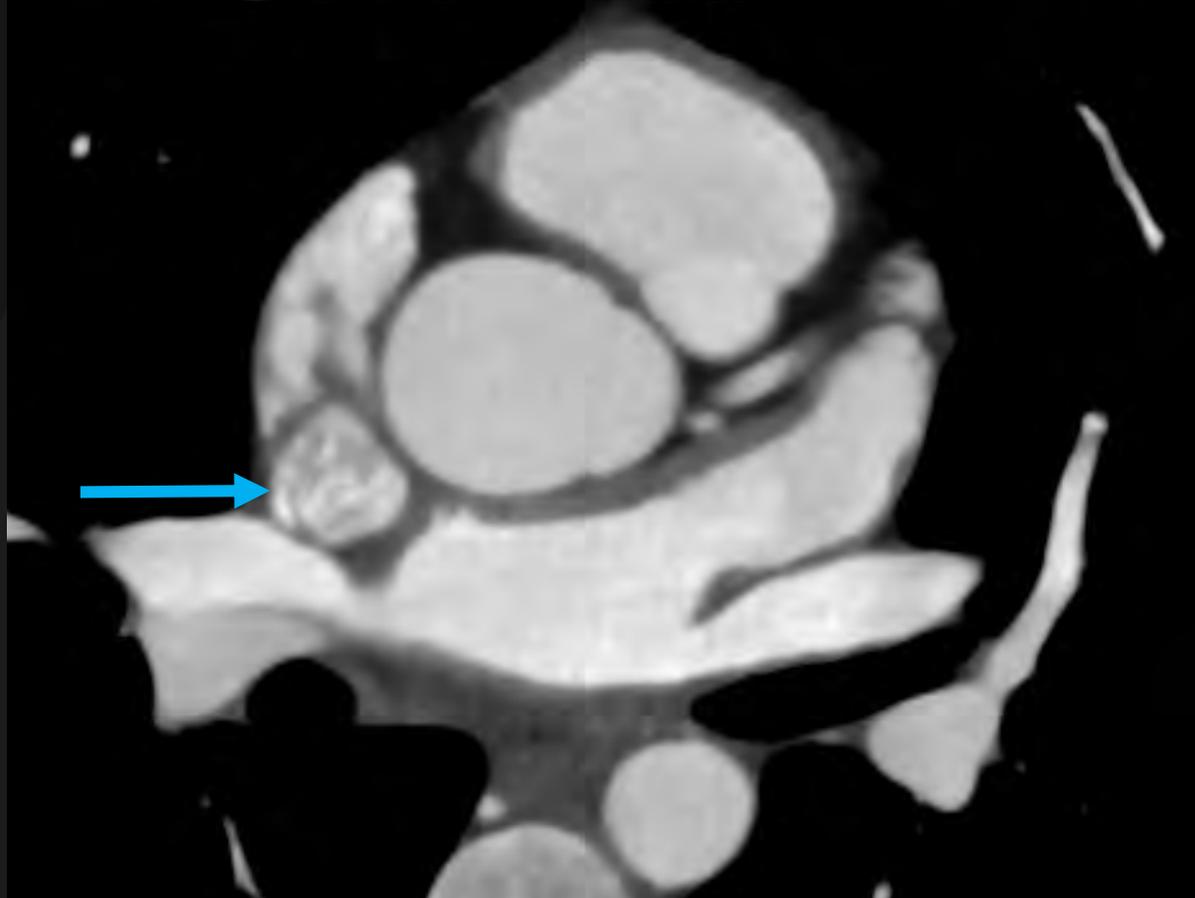




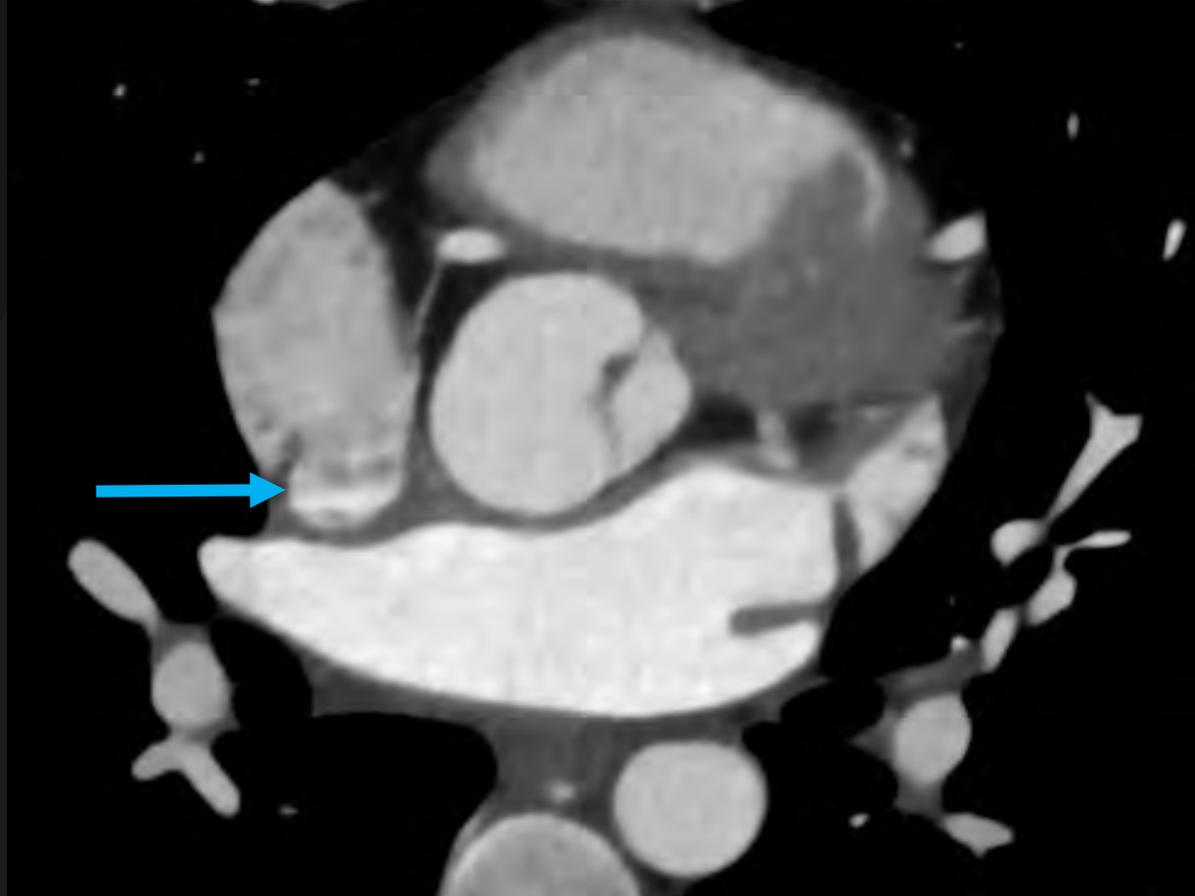
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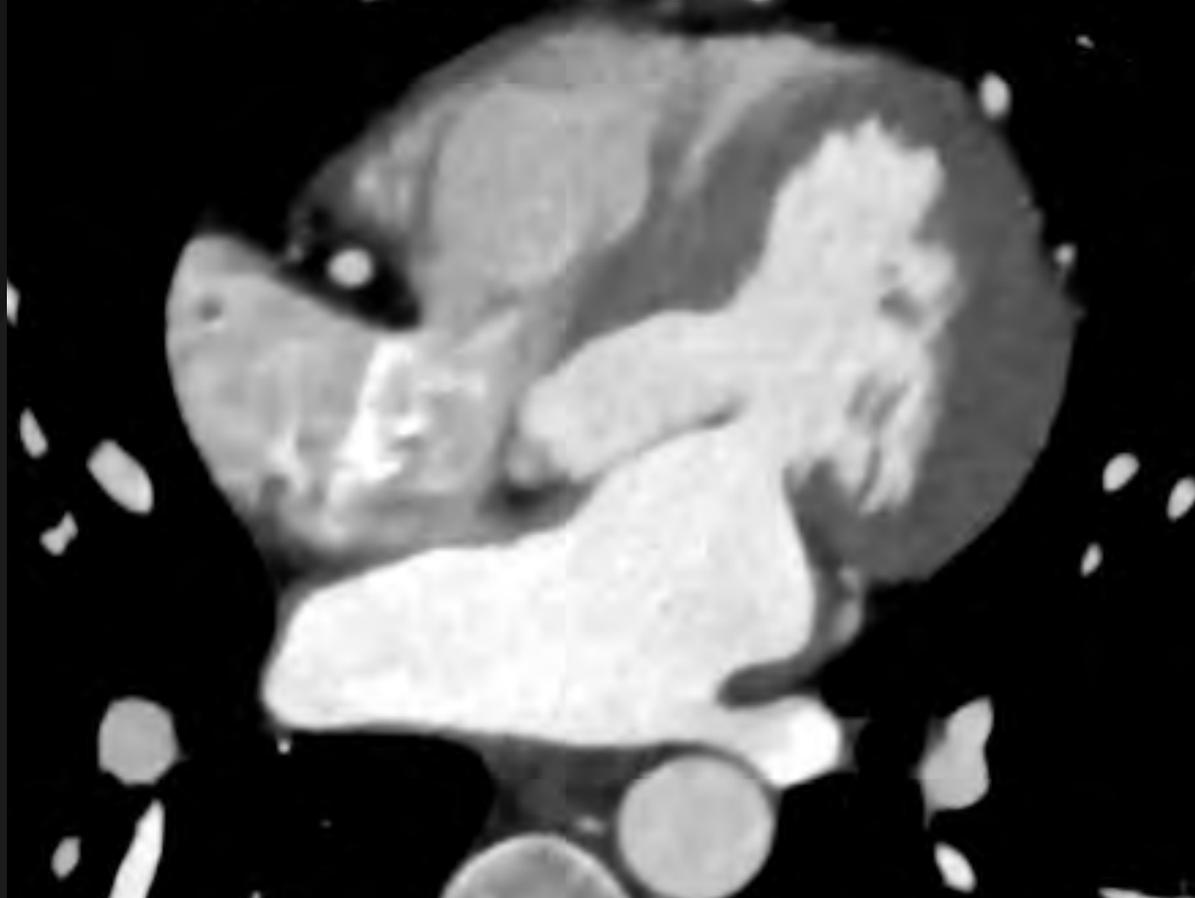
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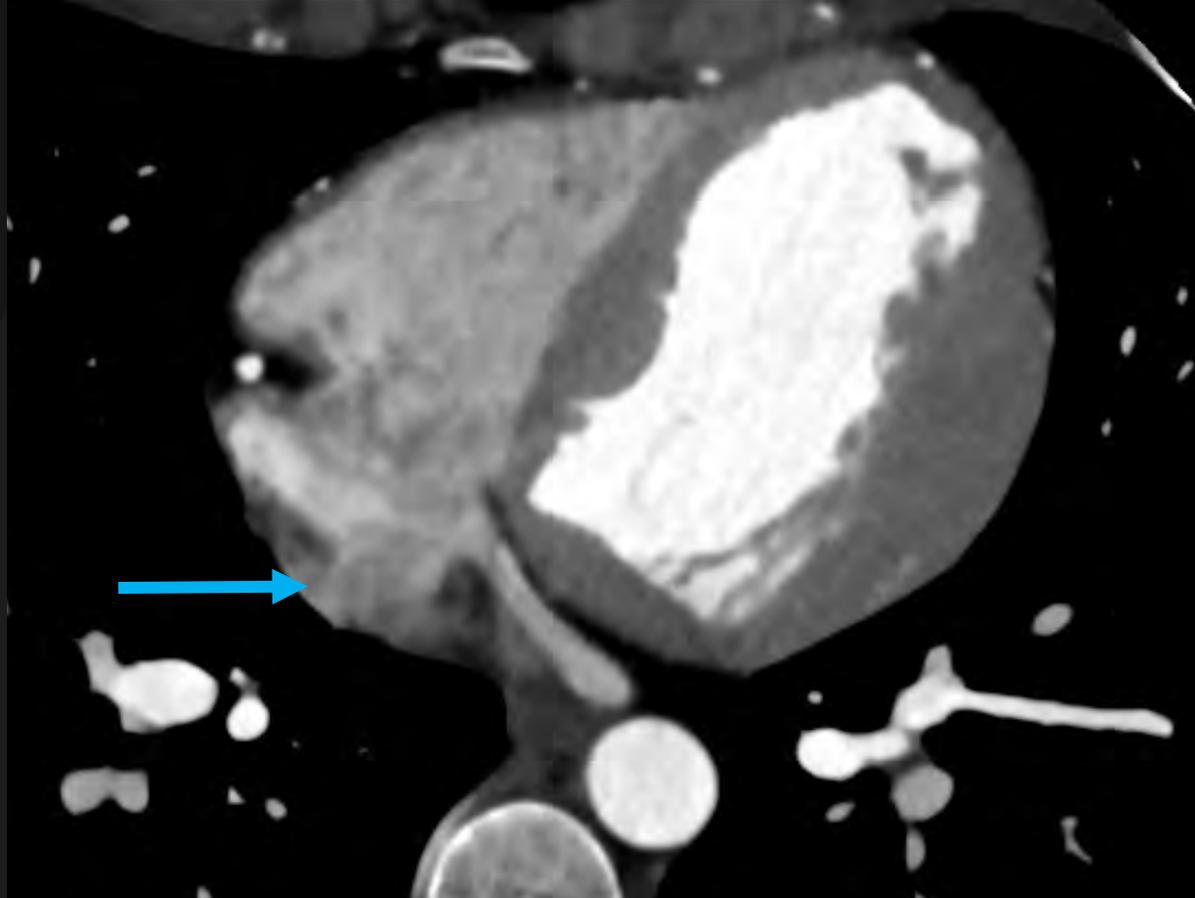
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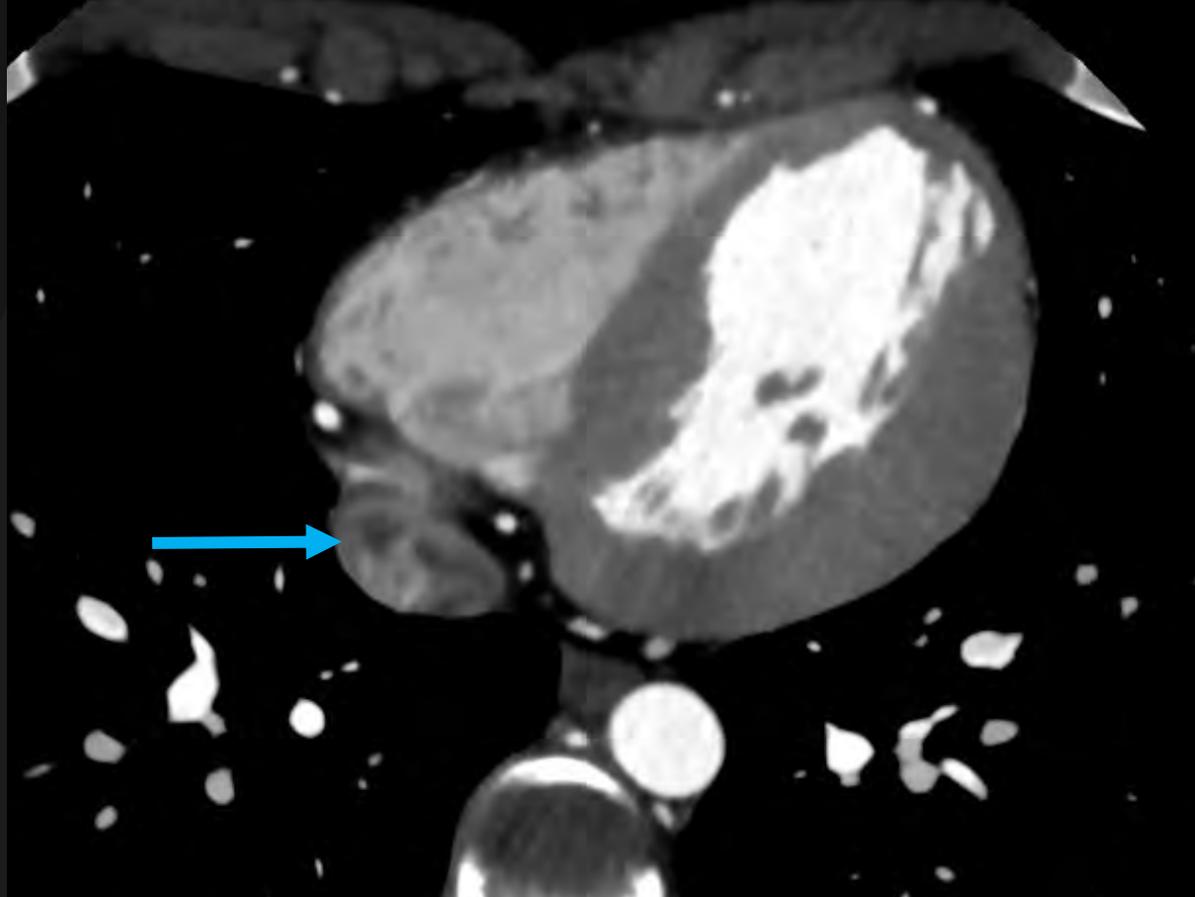
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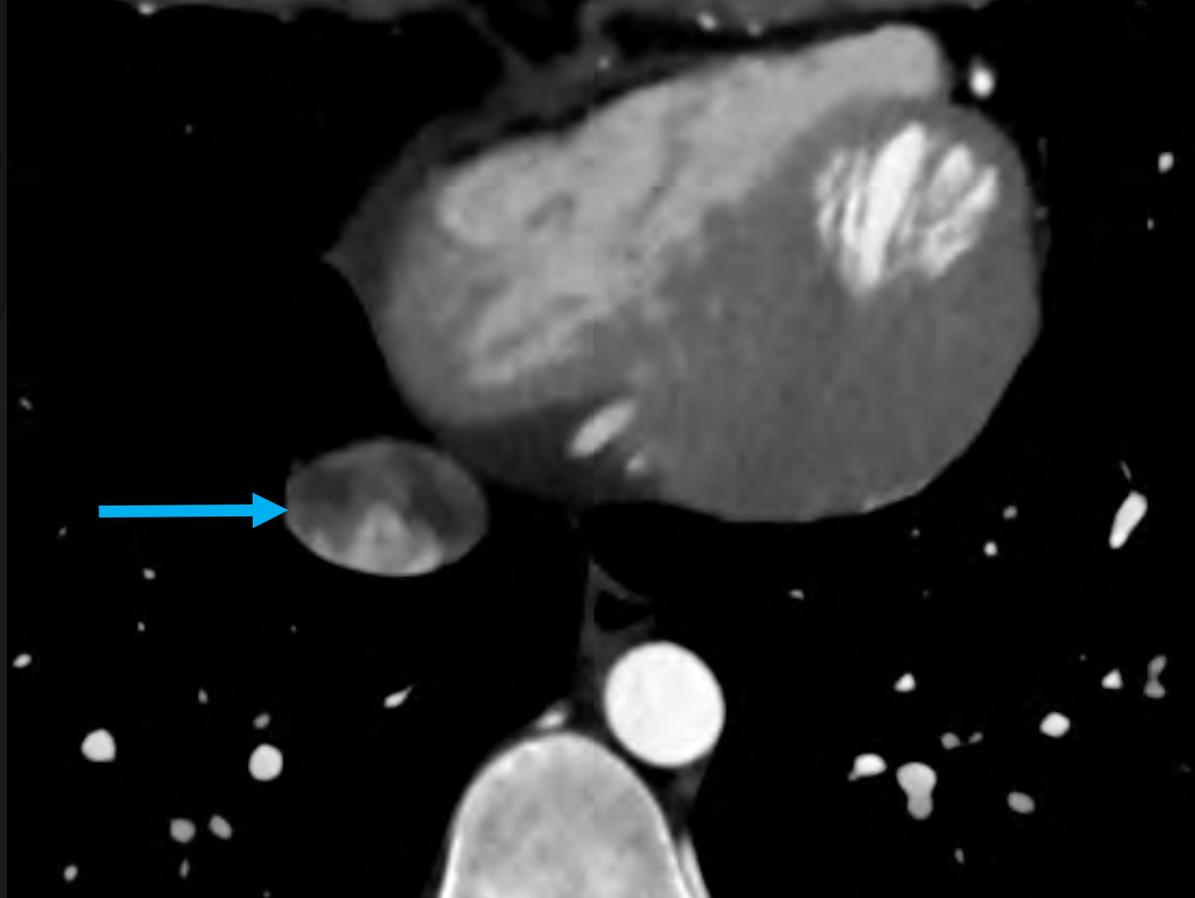
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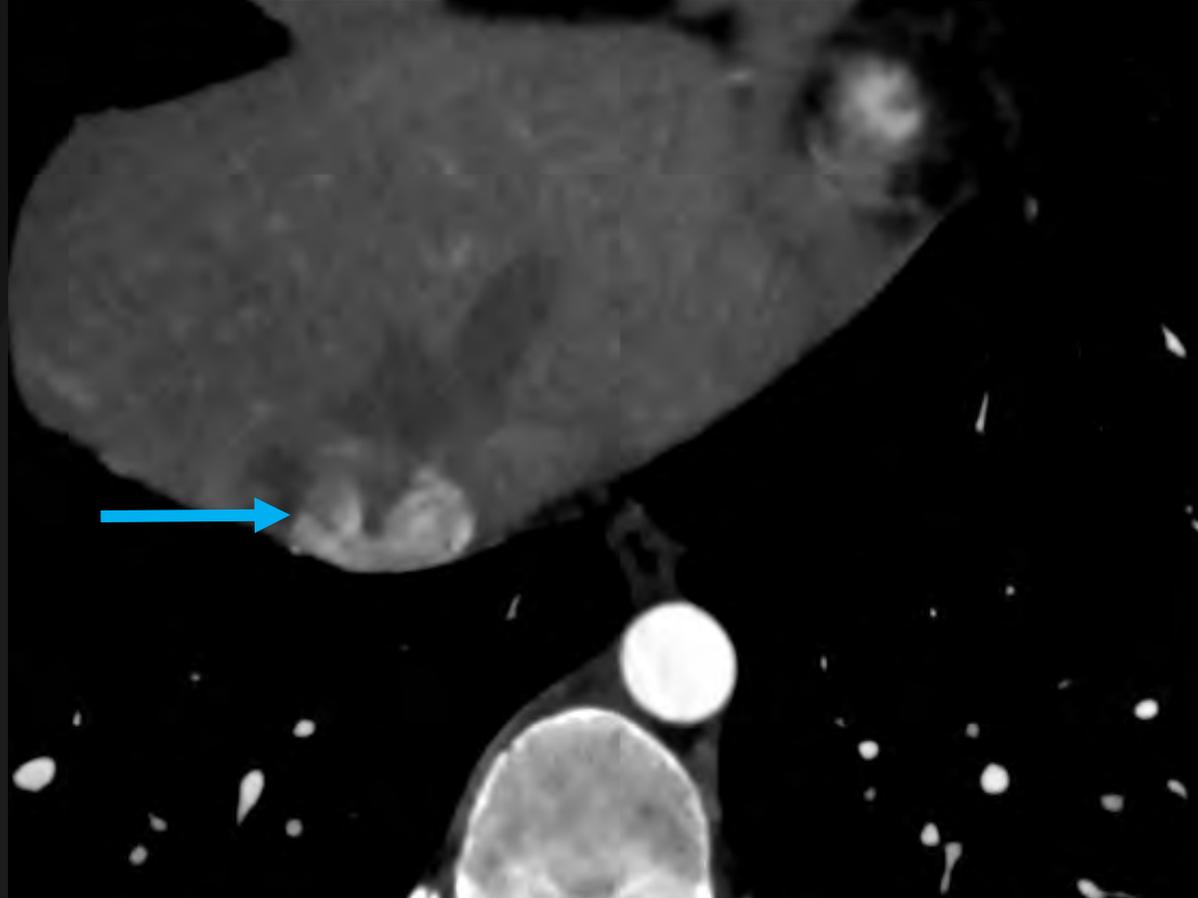
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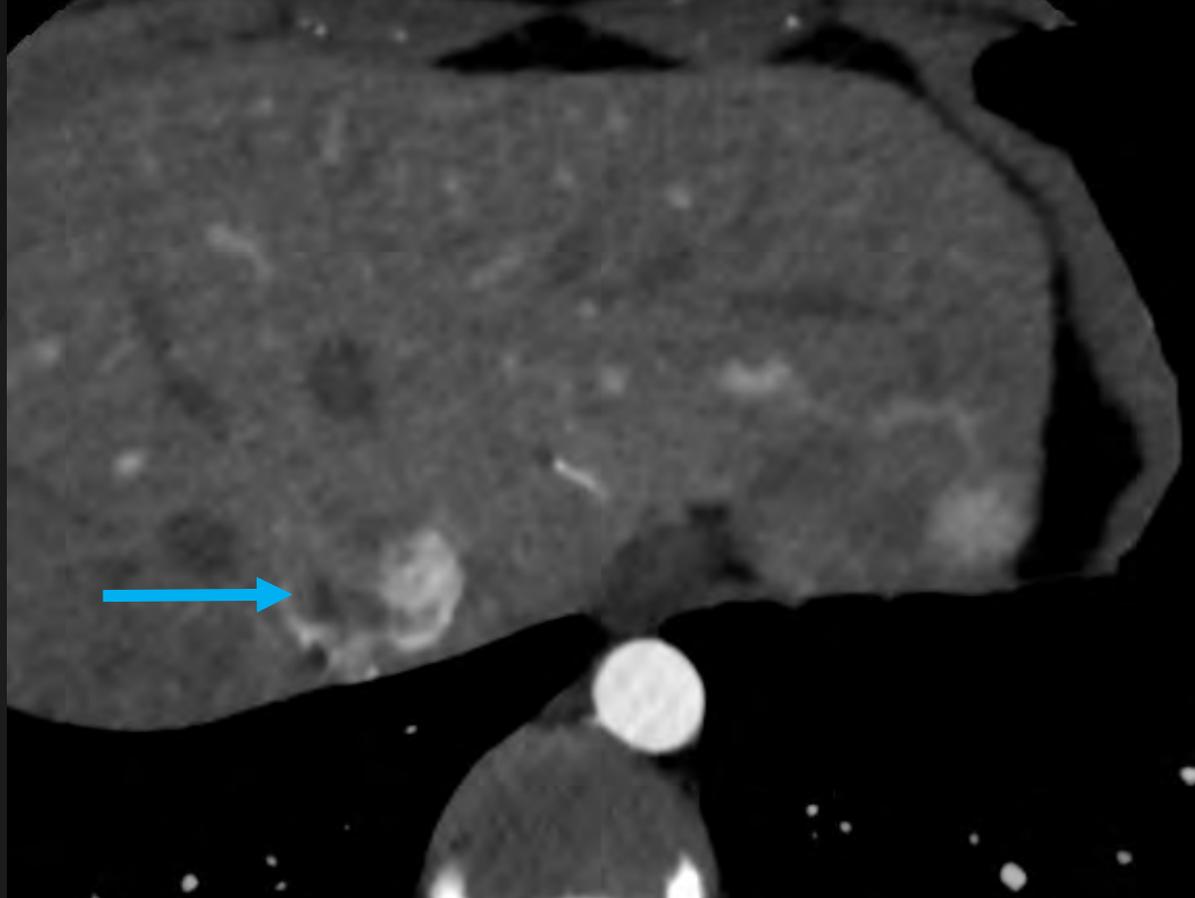
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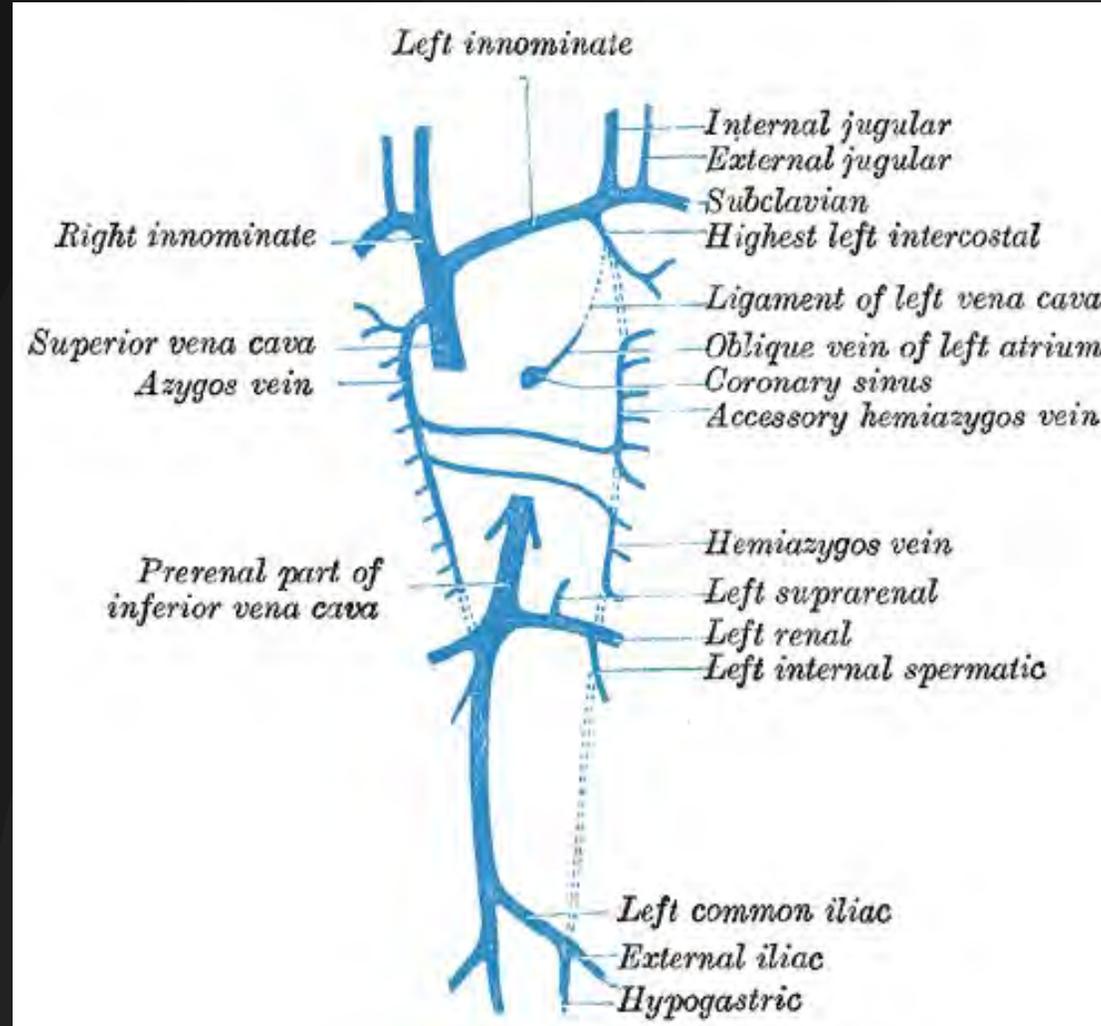
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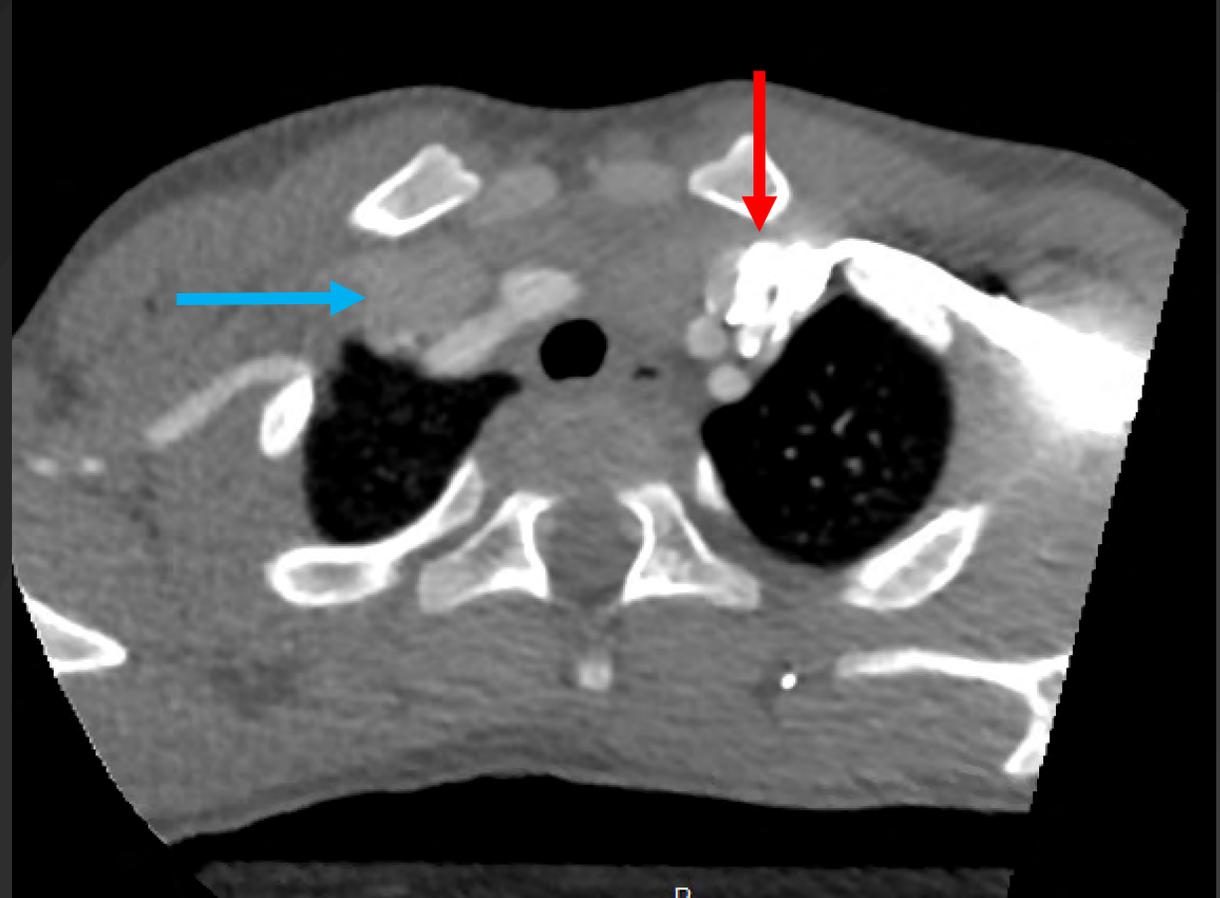
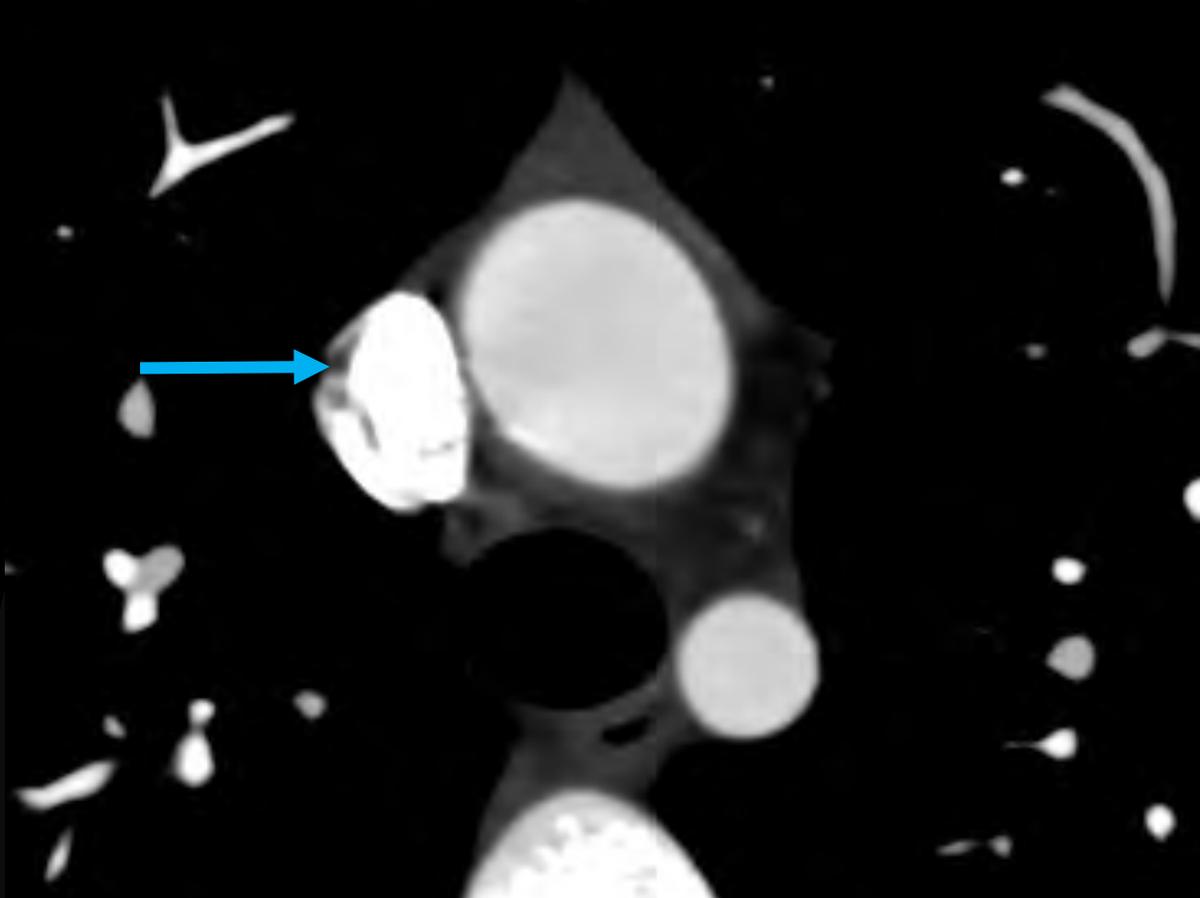
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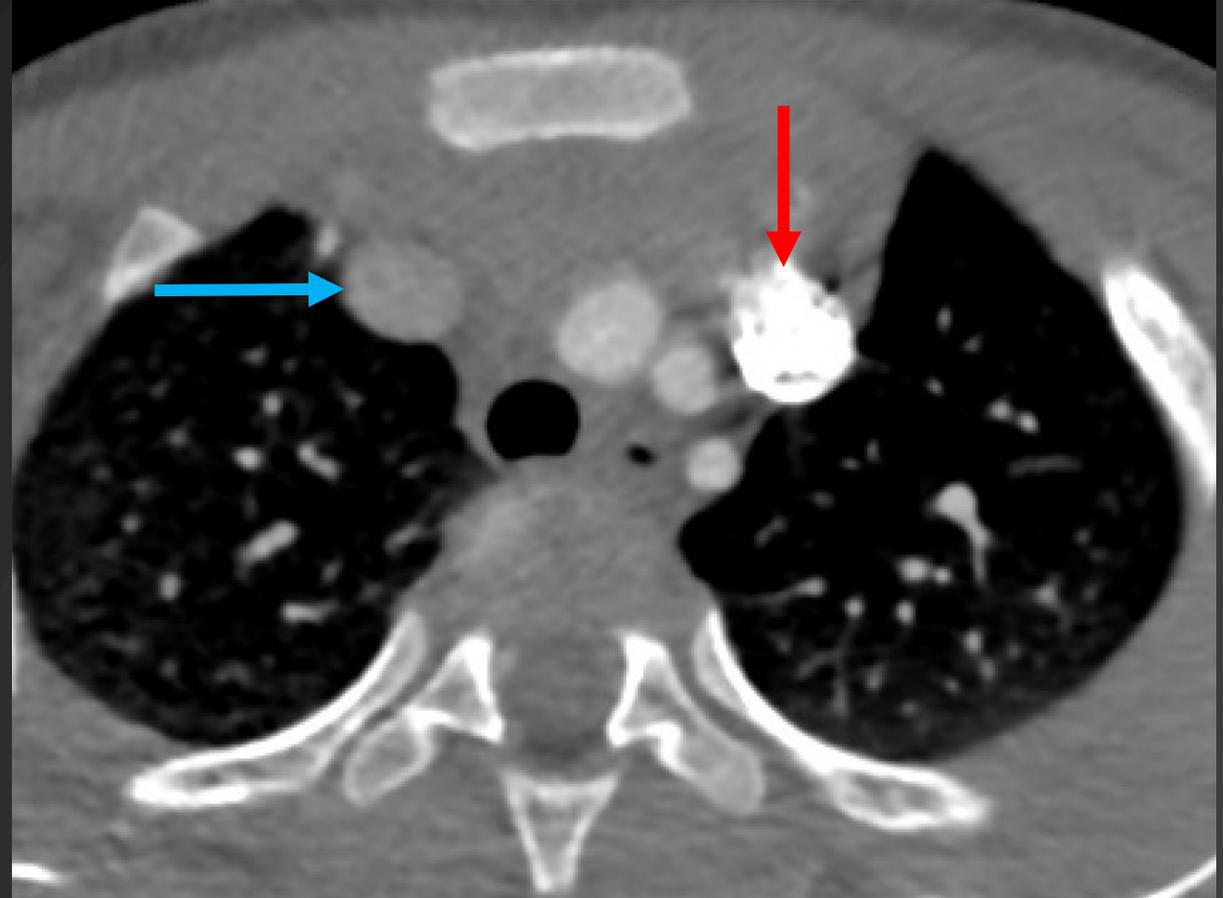
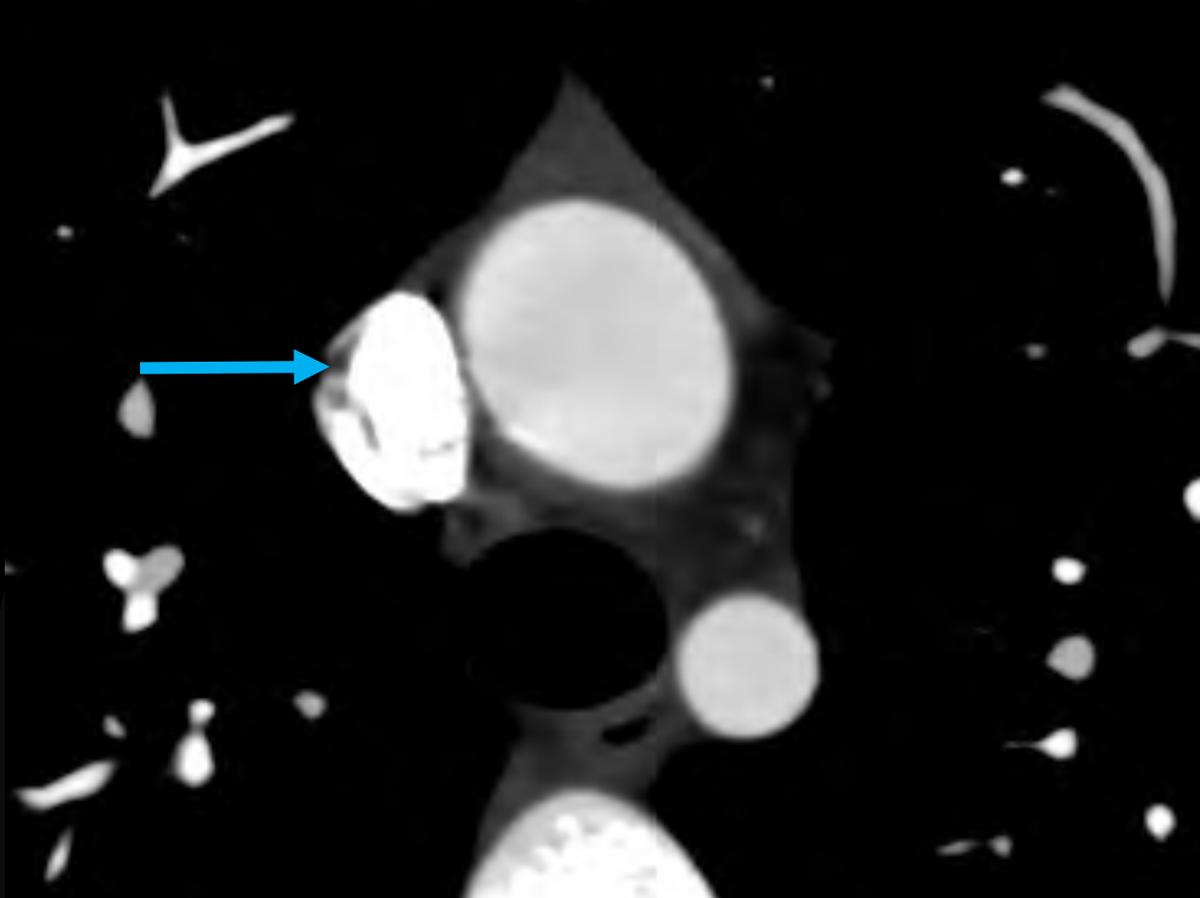
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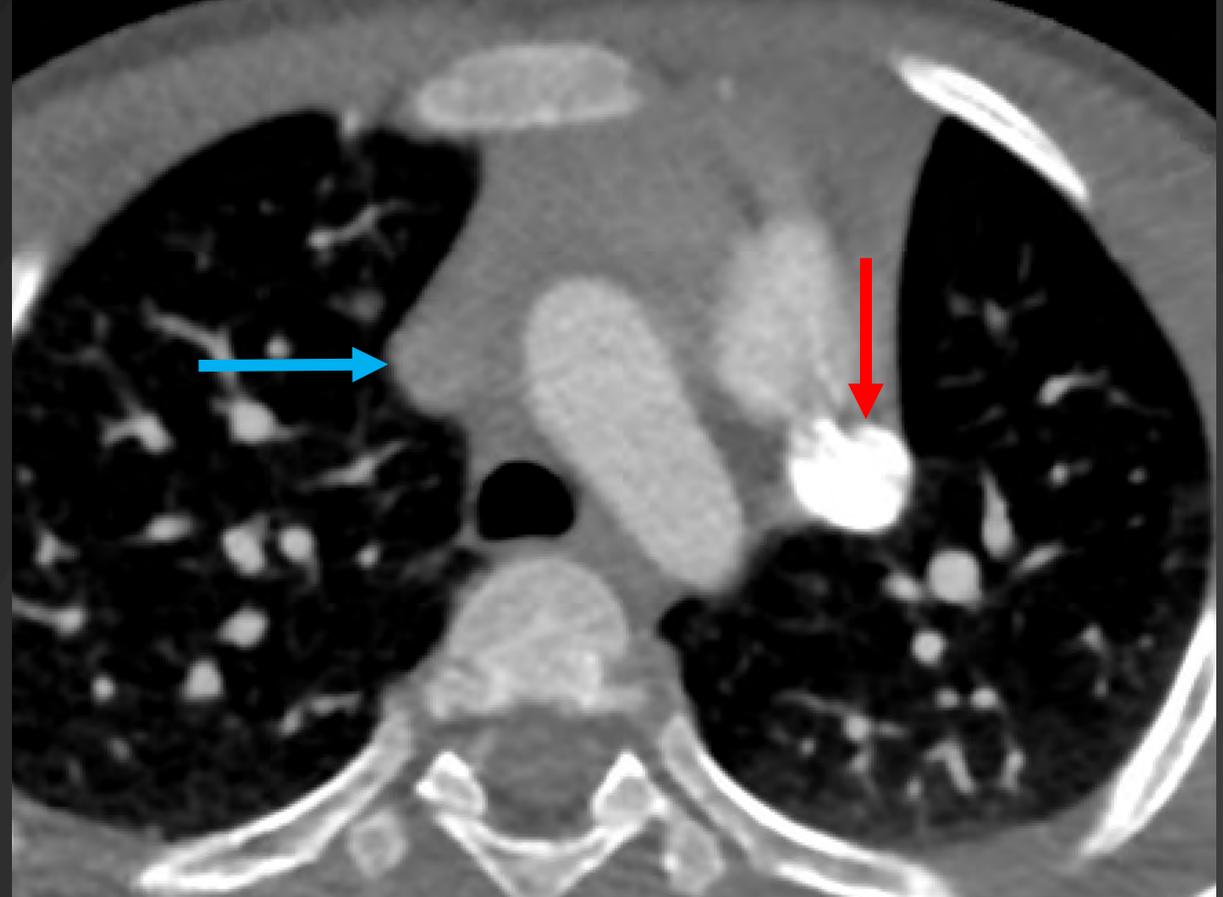
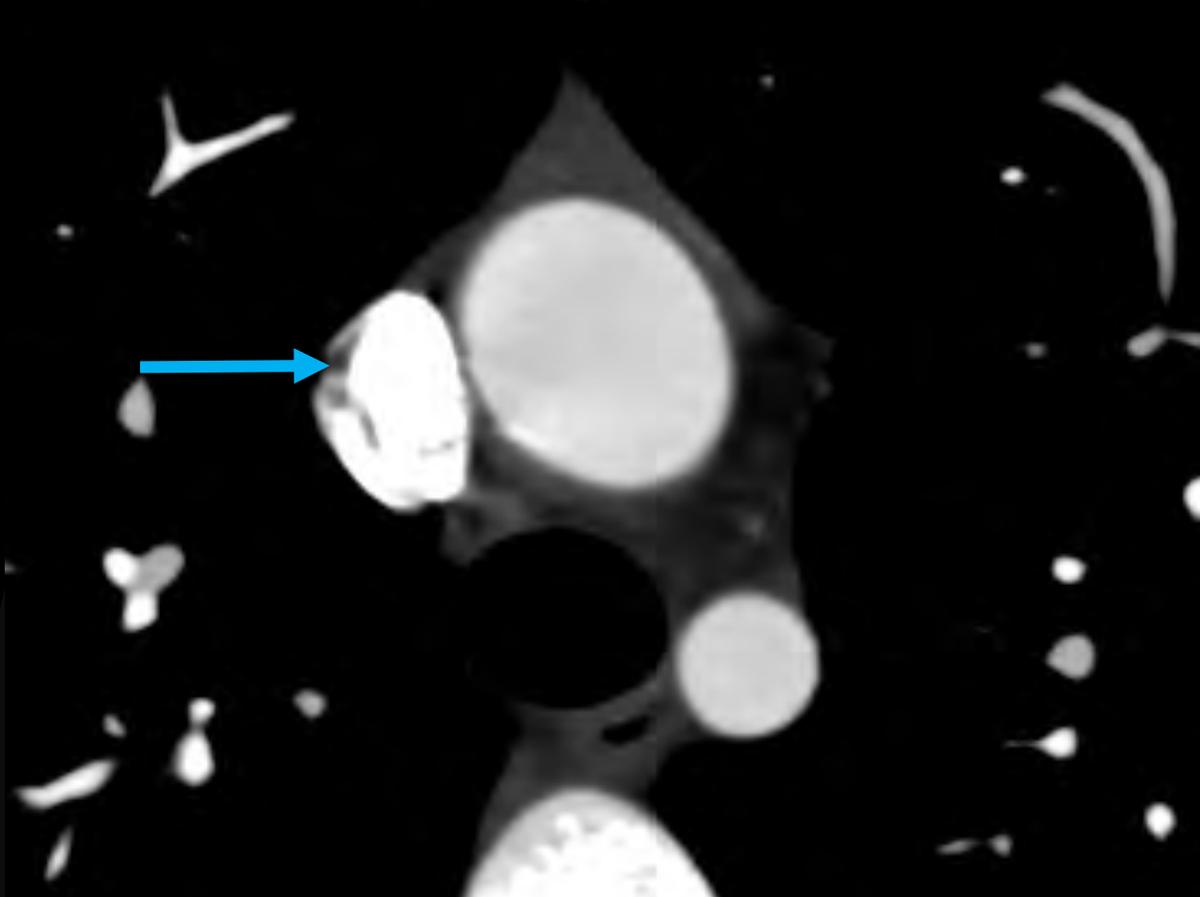
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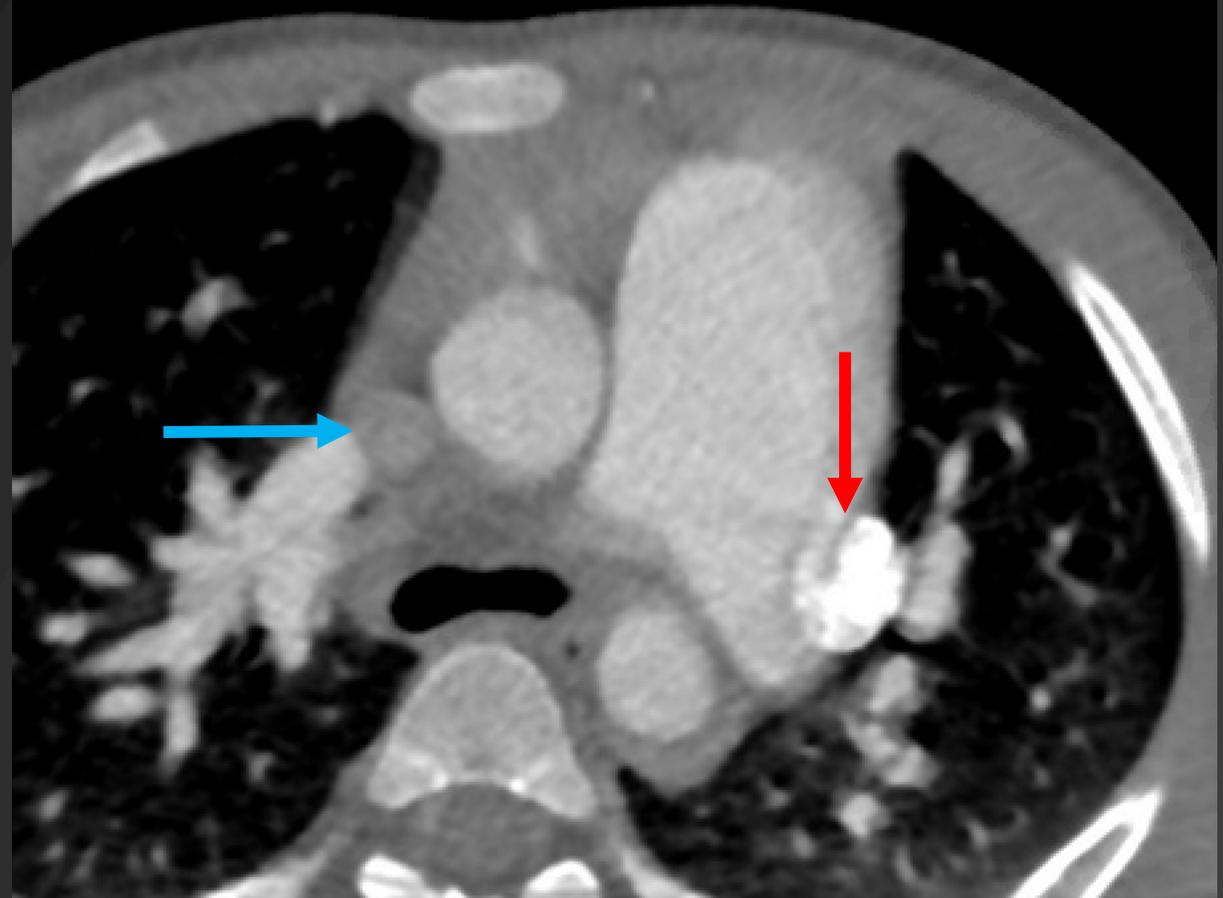
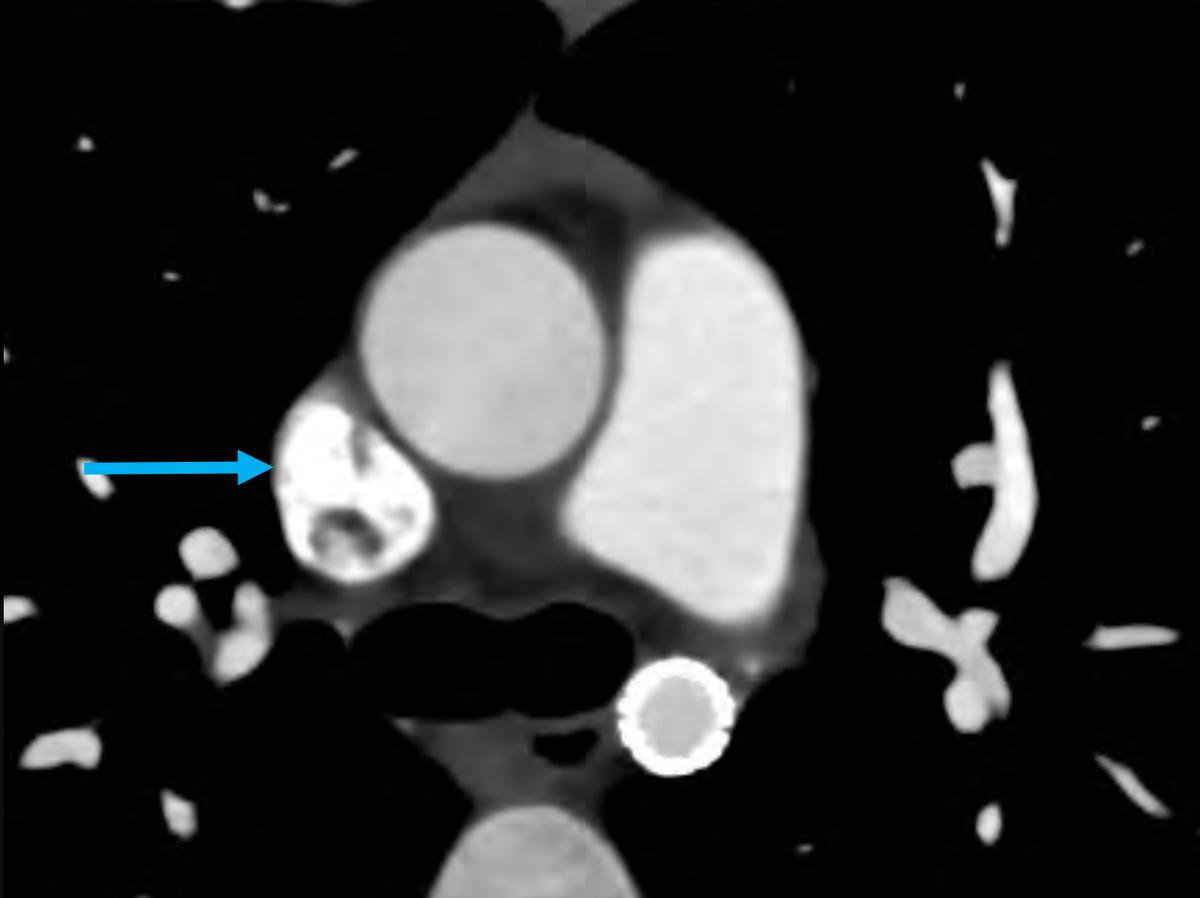
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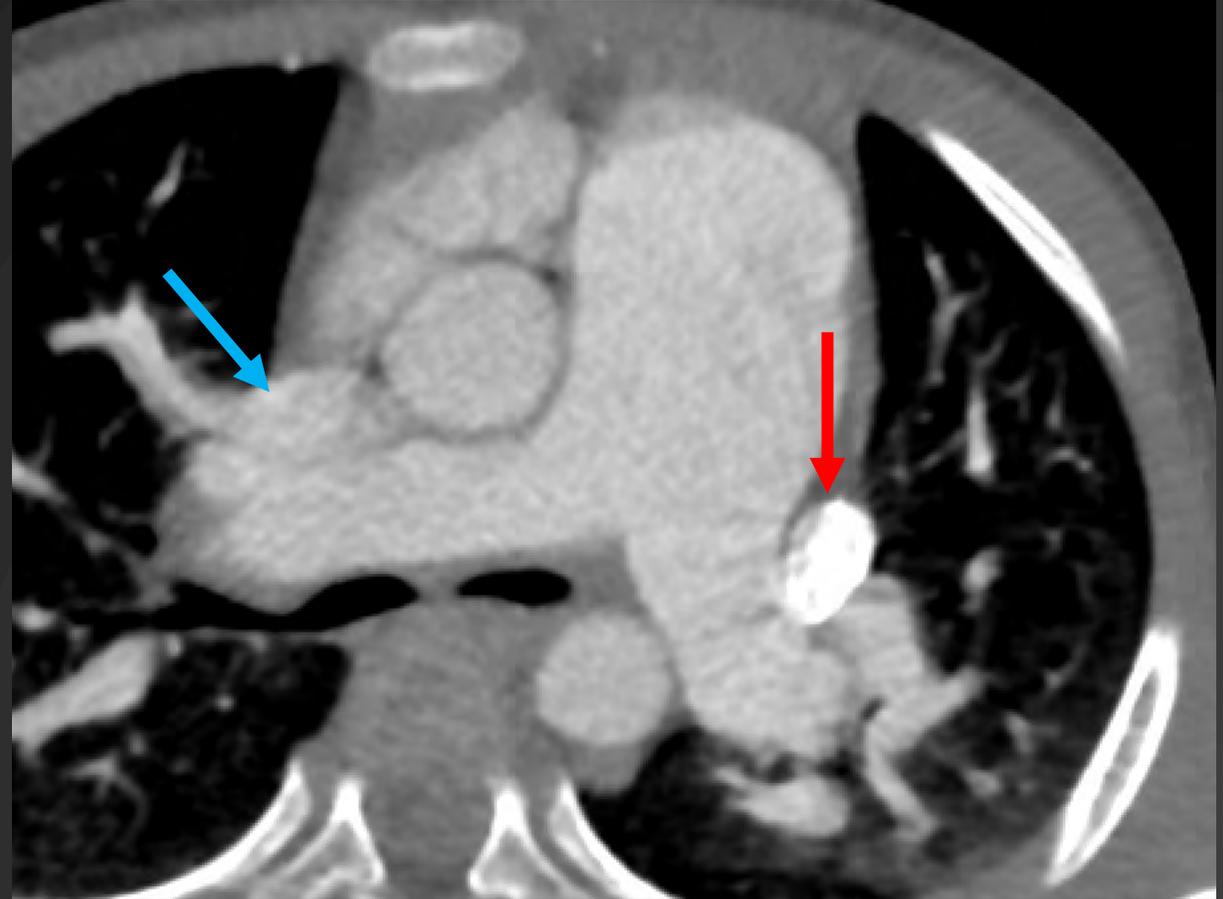
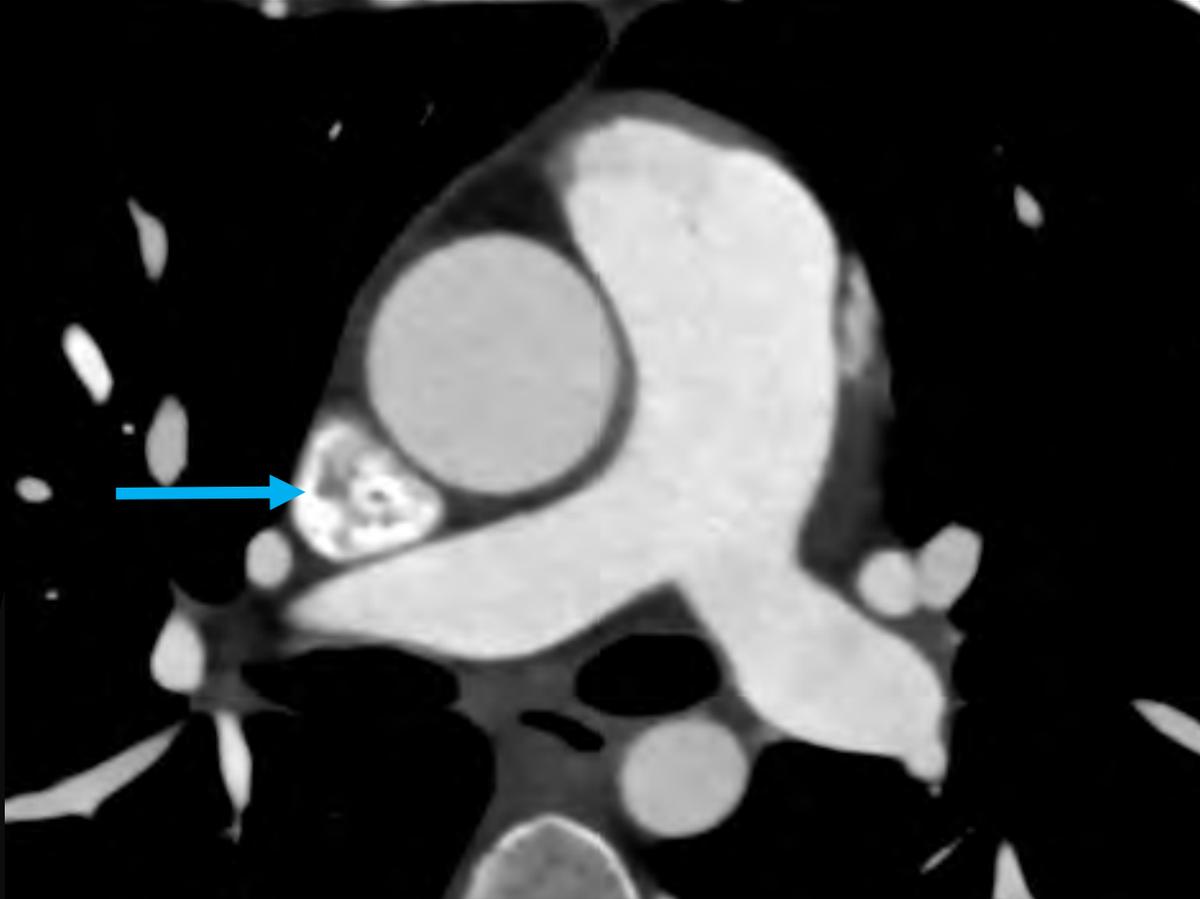
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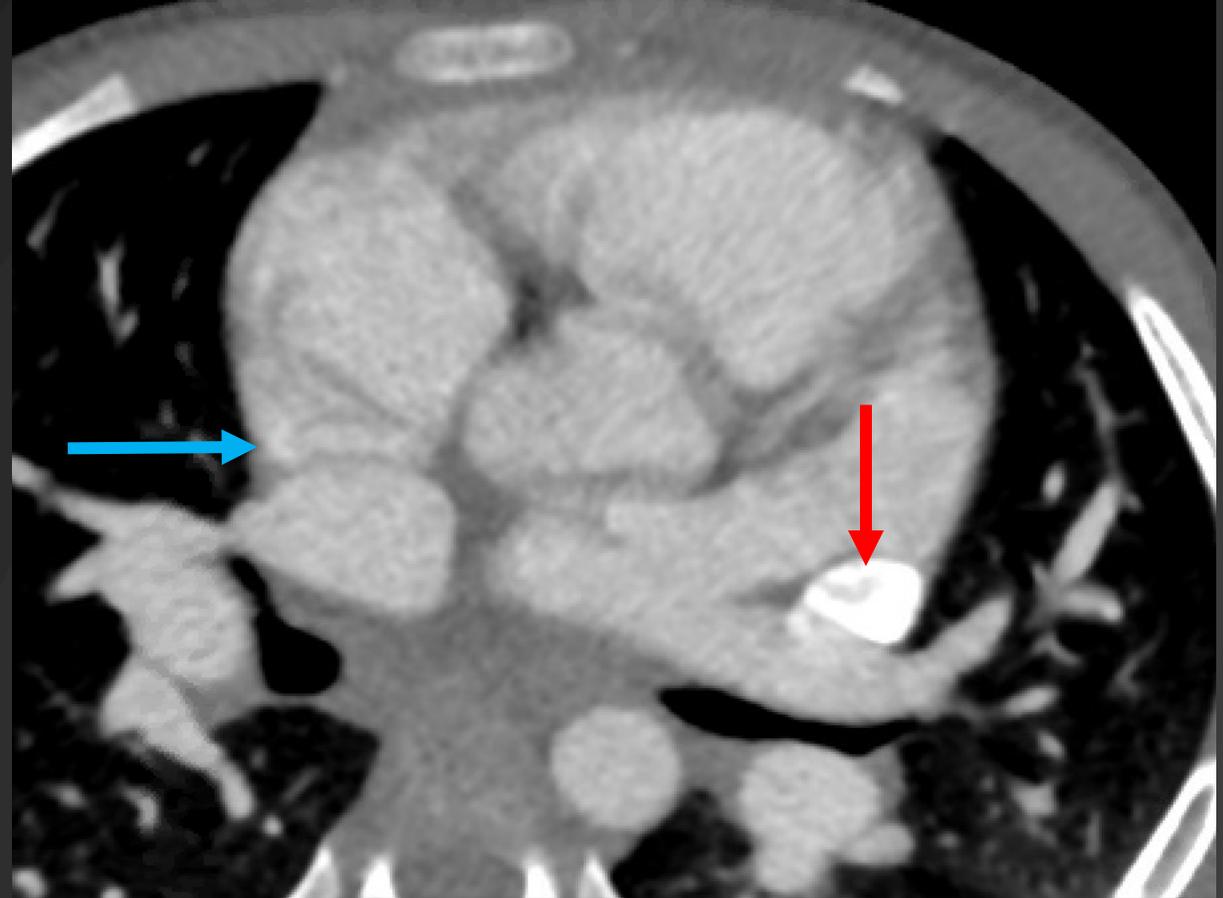
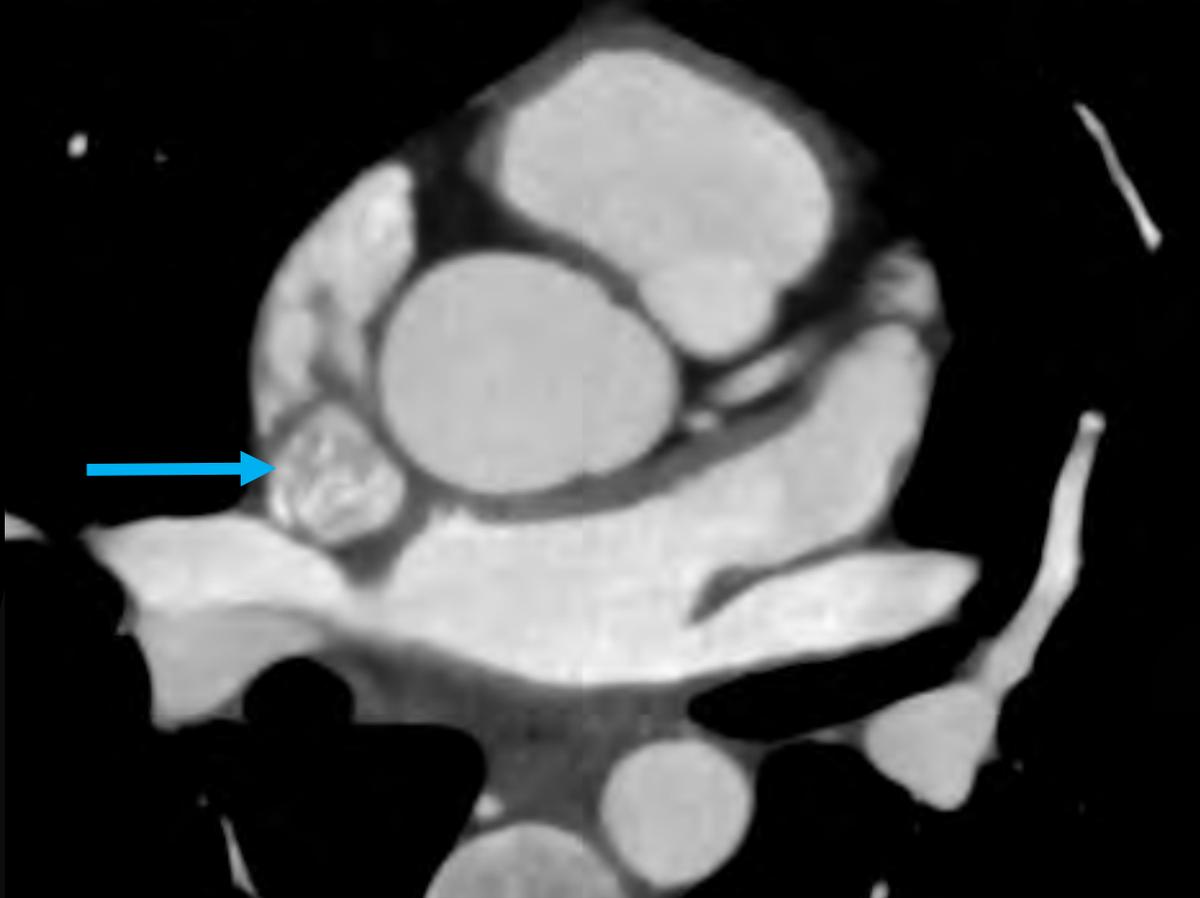
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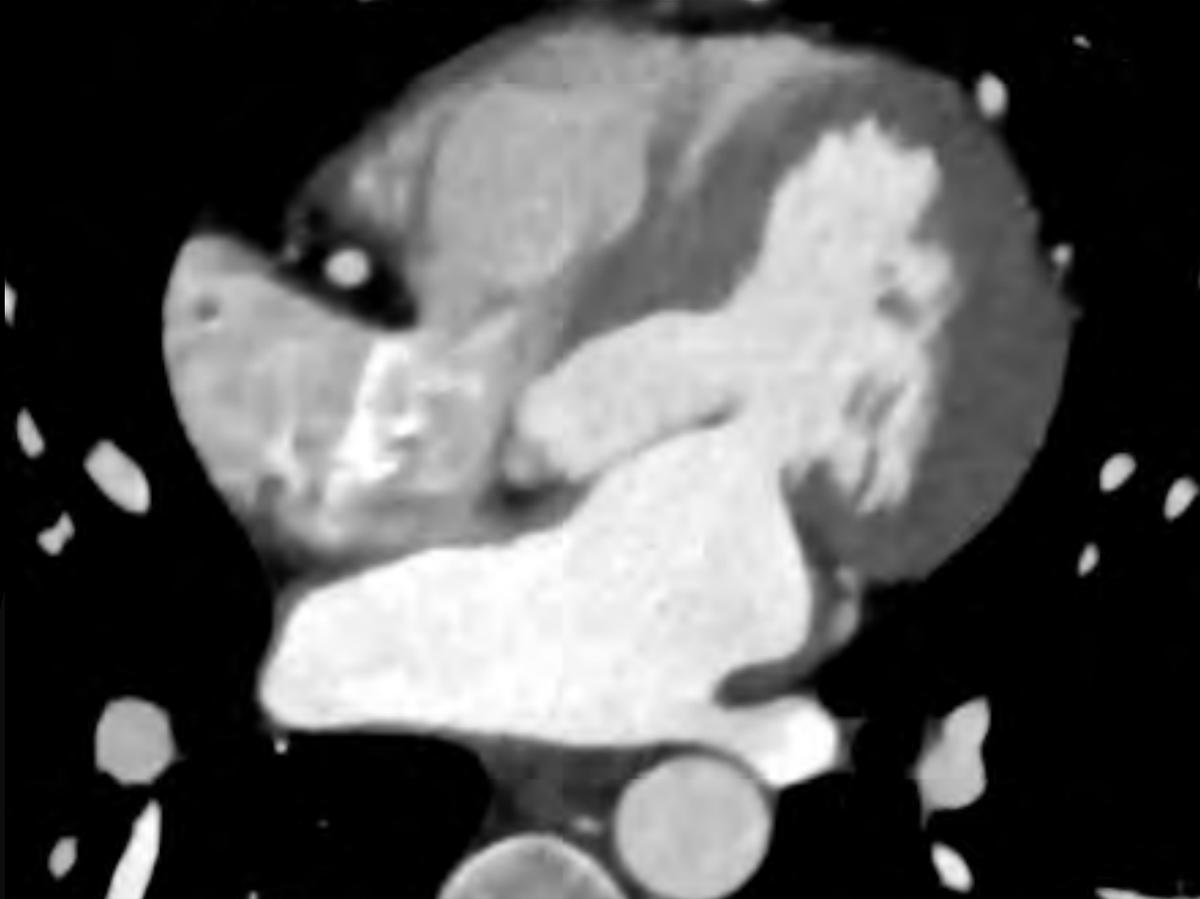
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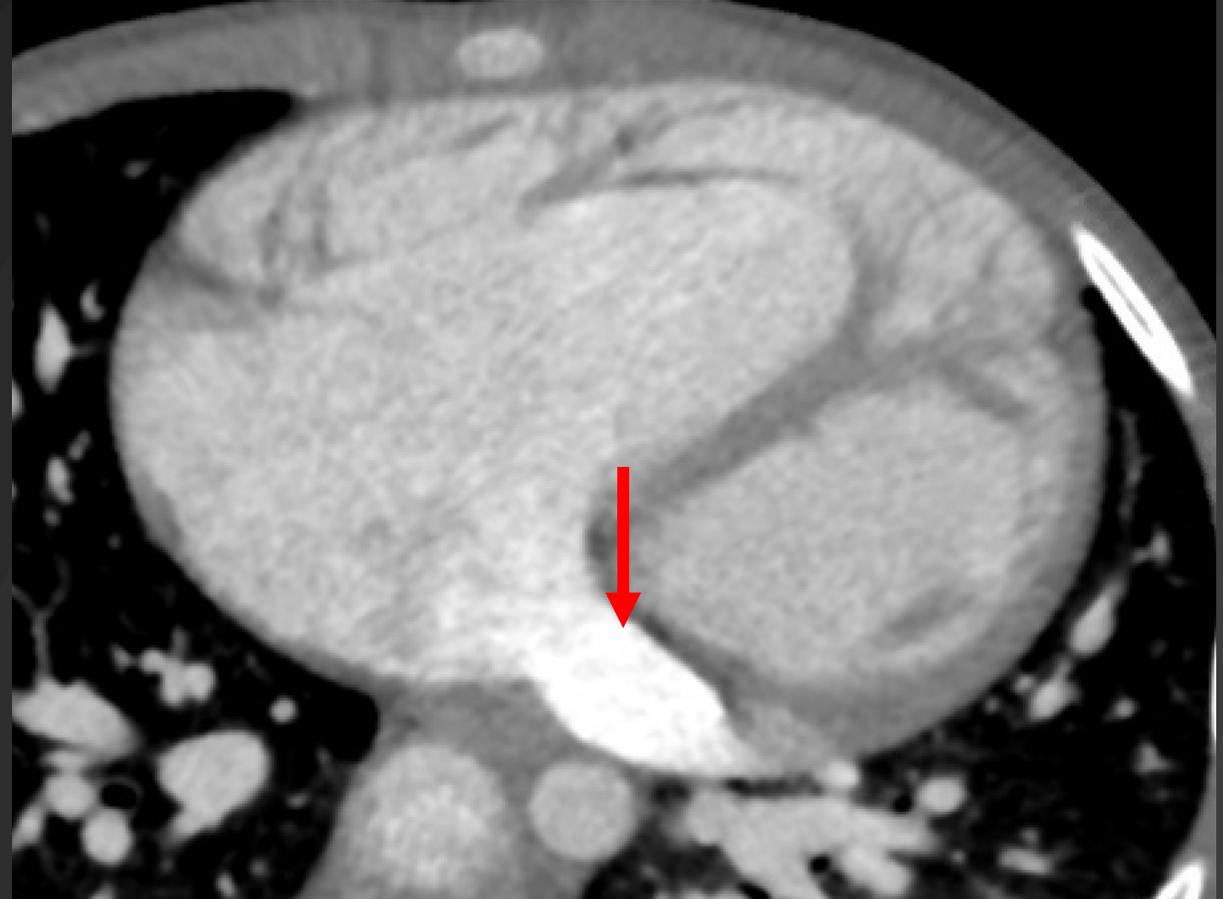
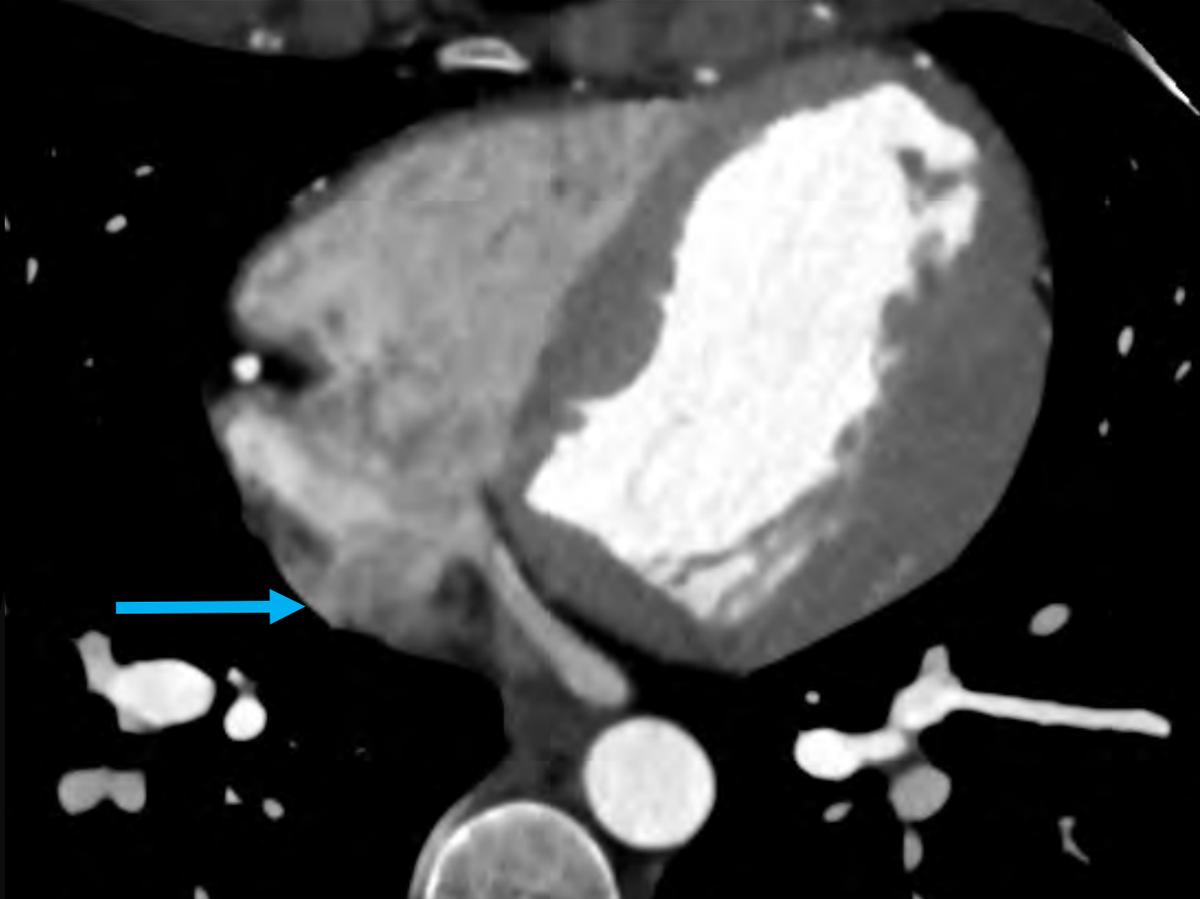
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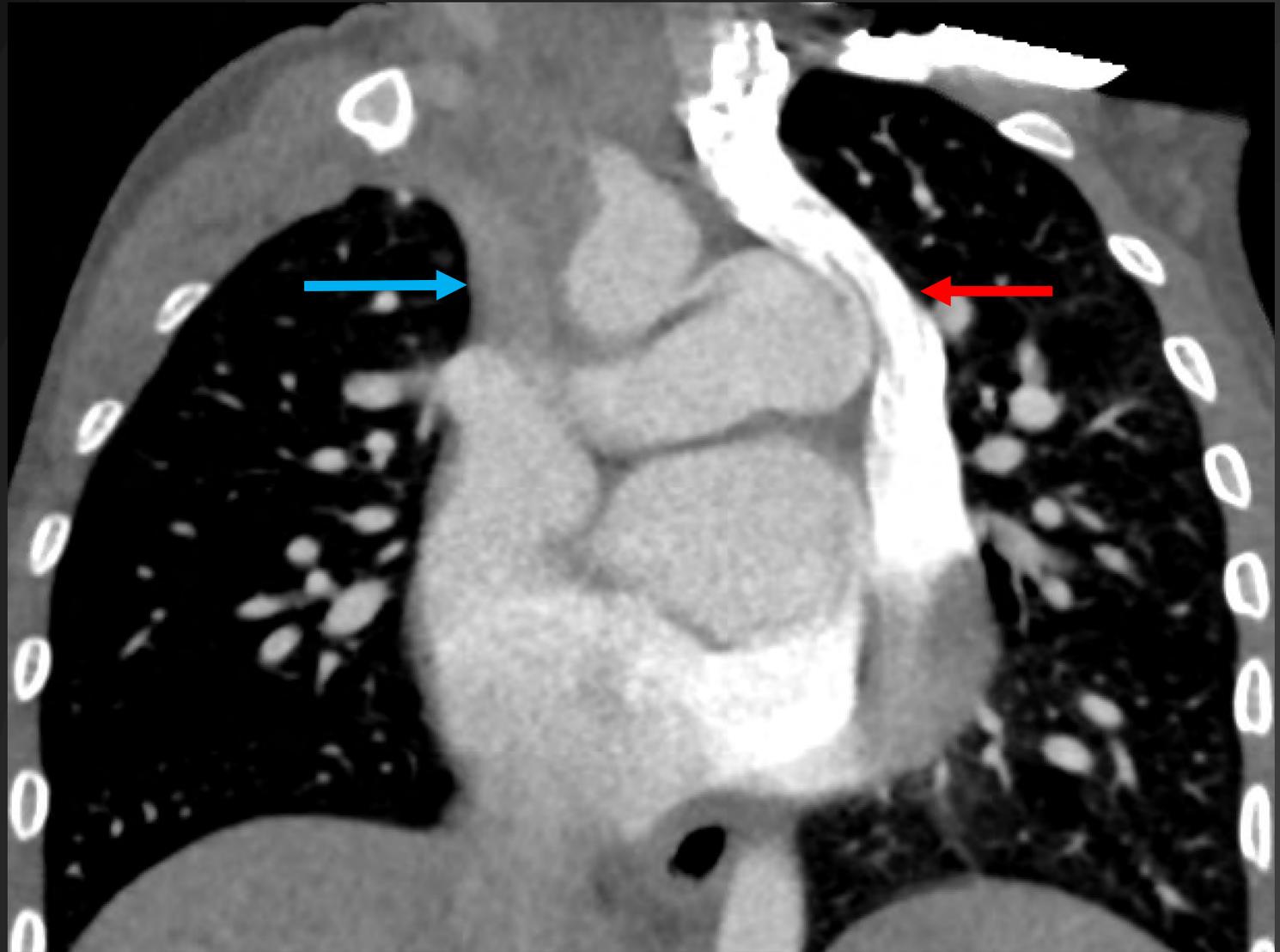
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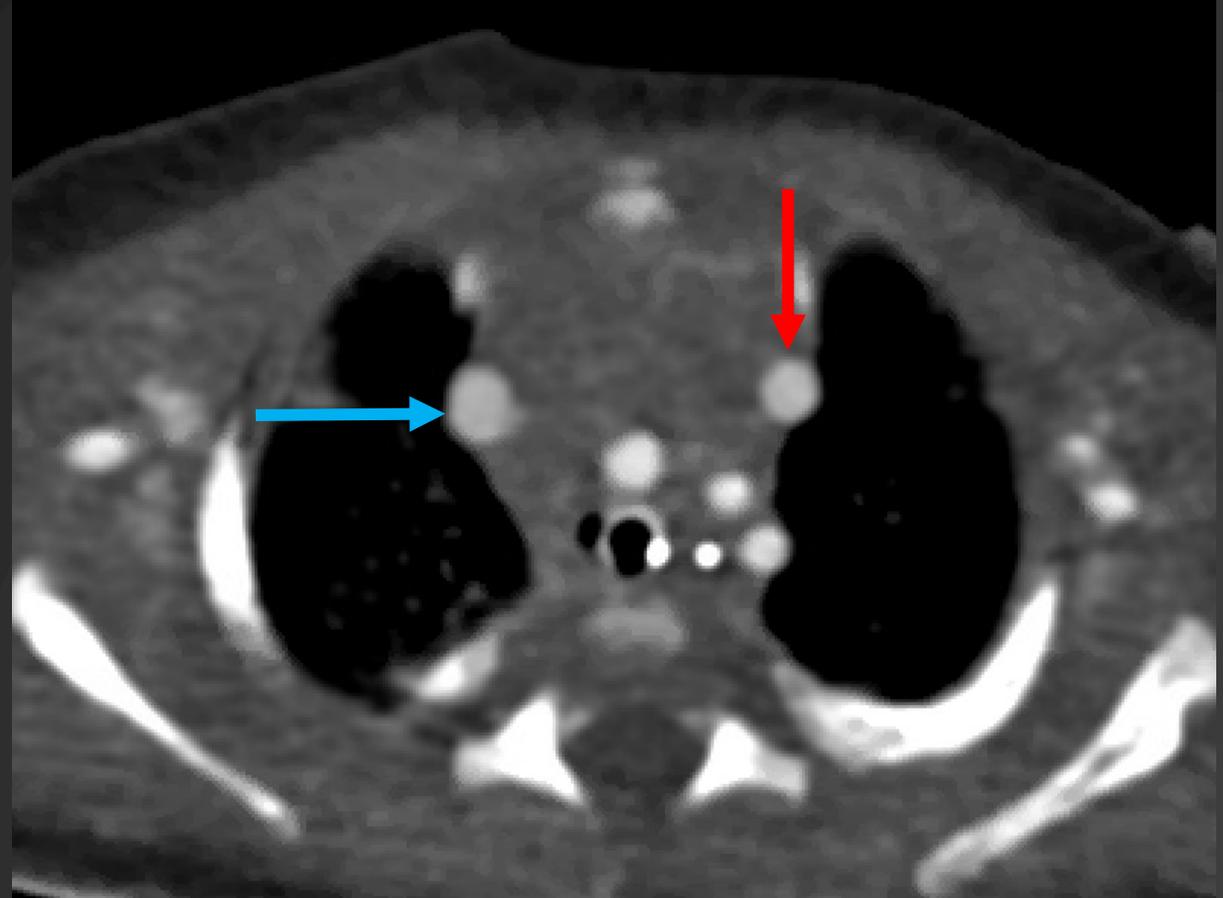
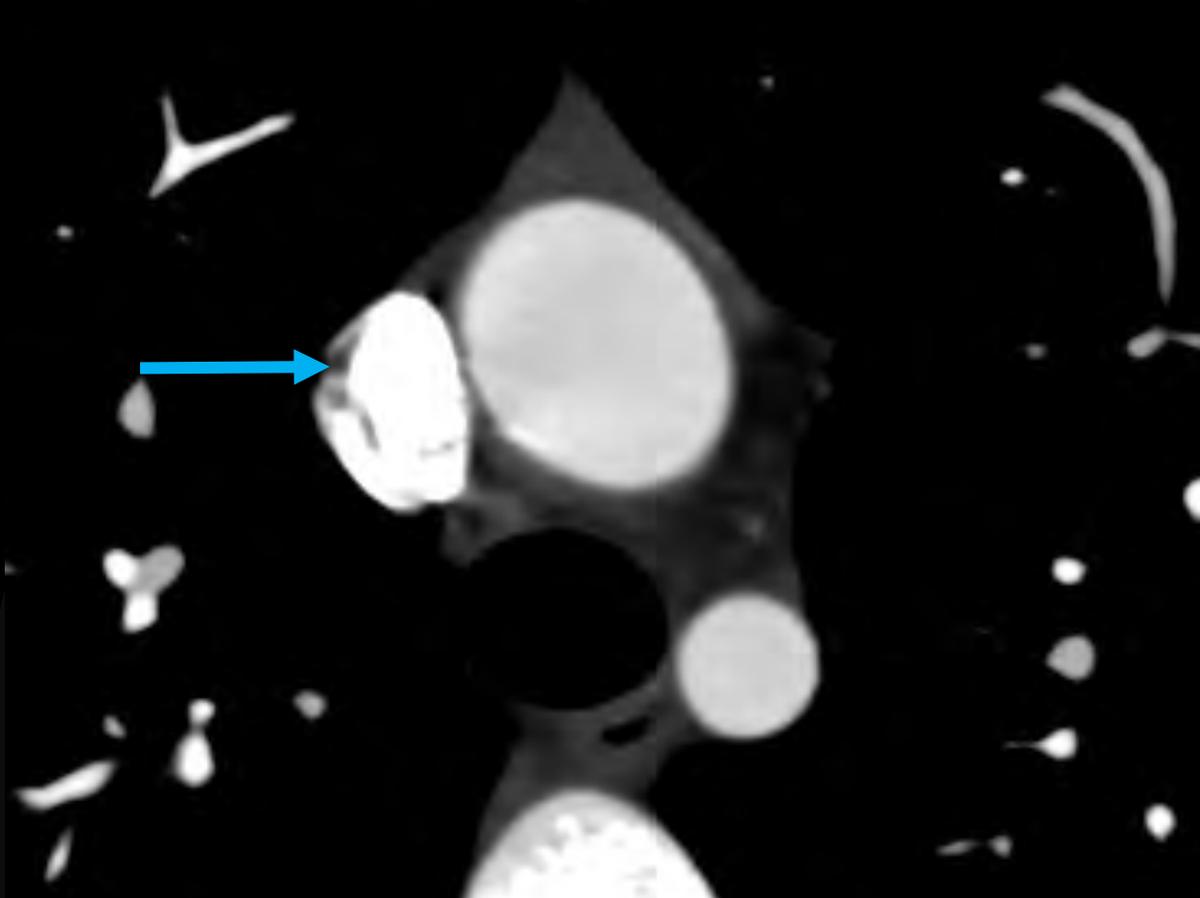


Veine cave  
supérieure gauche  
(CIA sinus venosus)

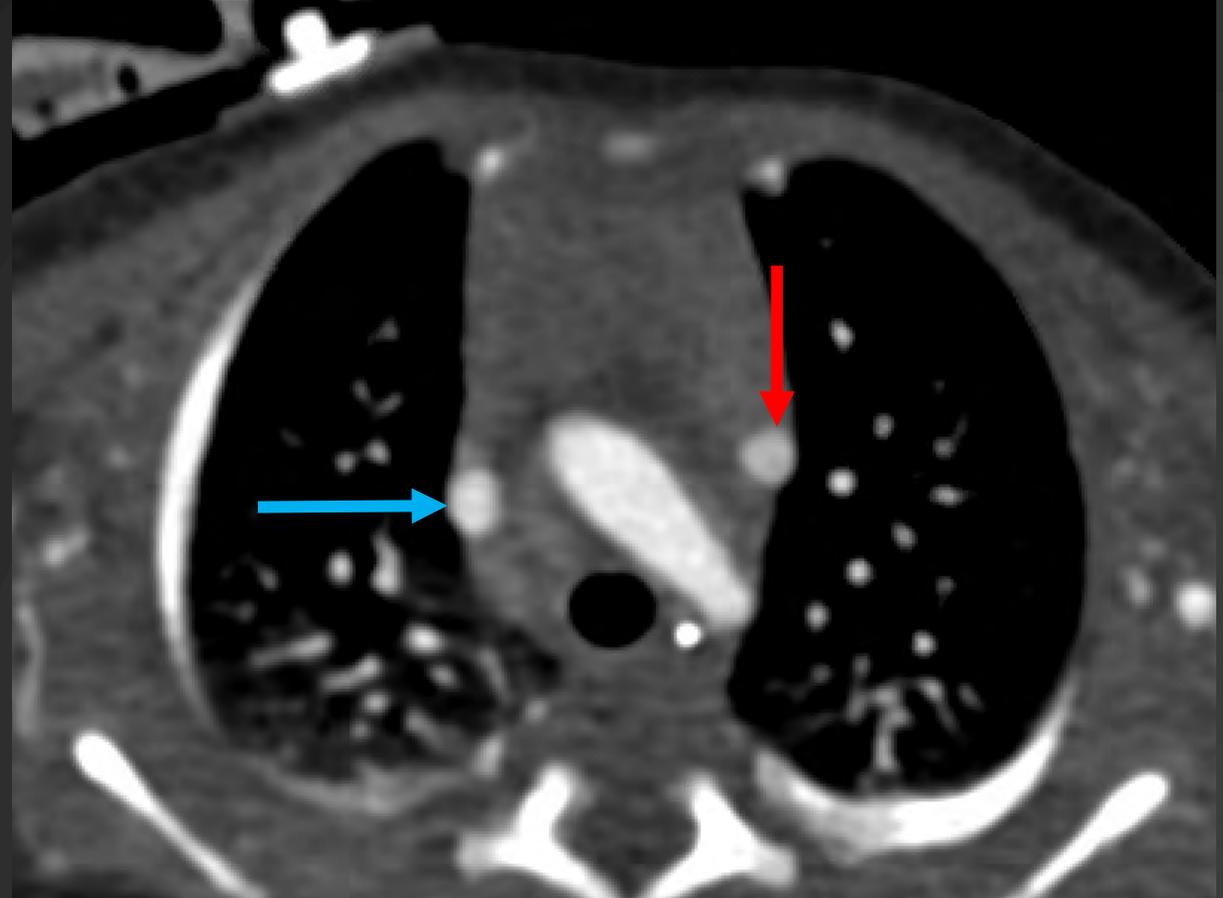
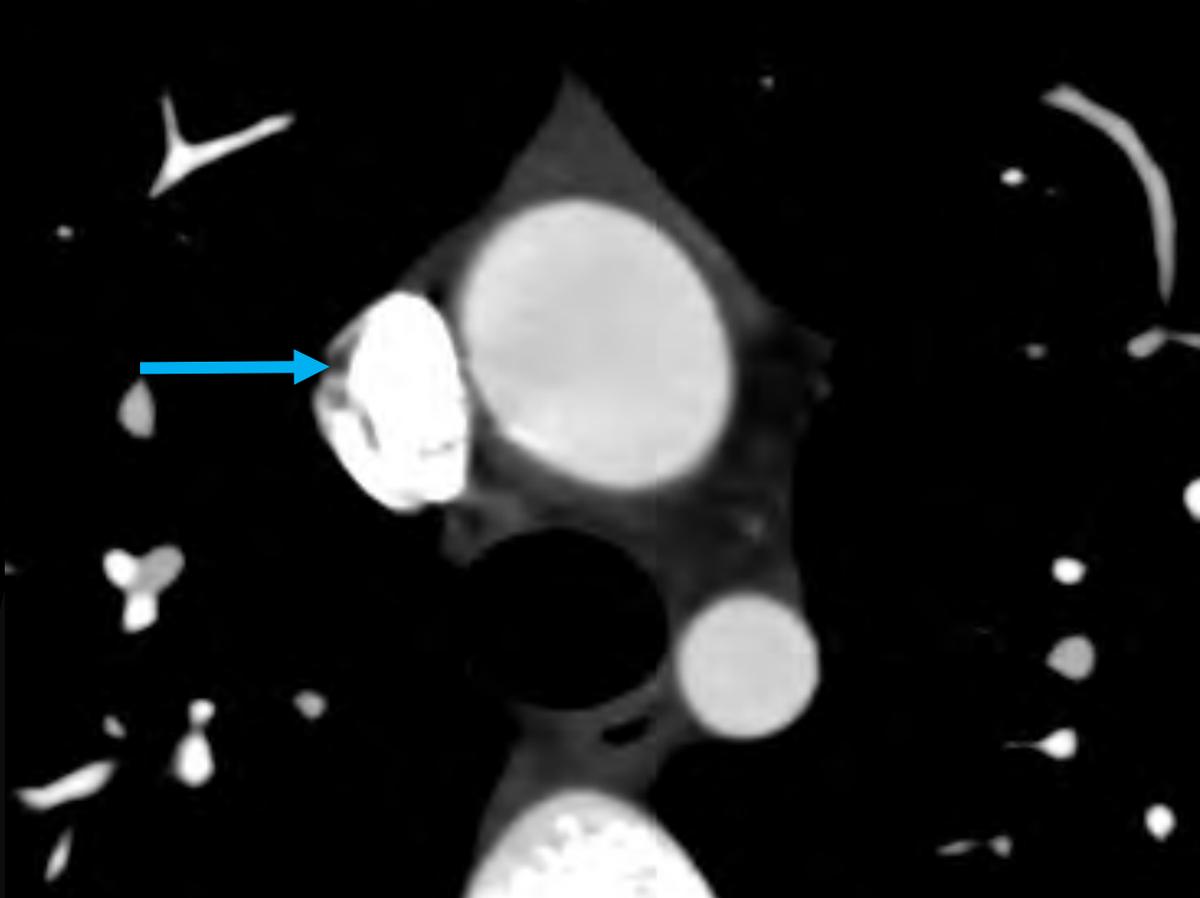




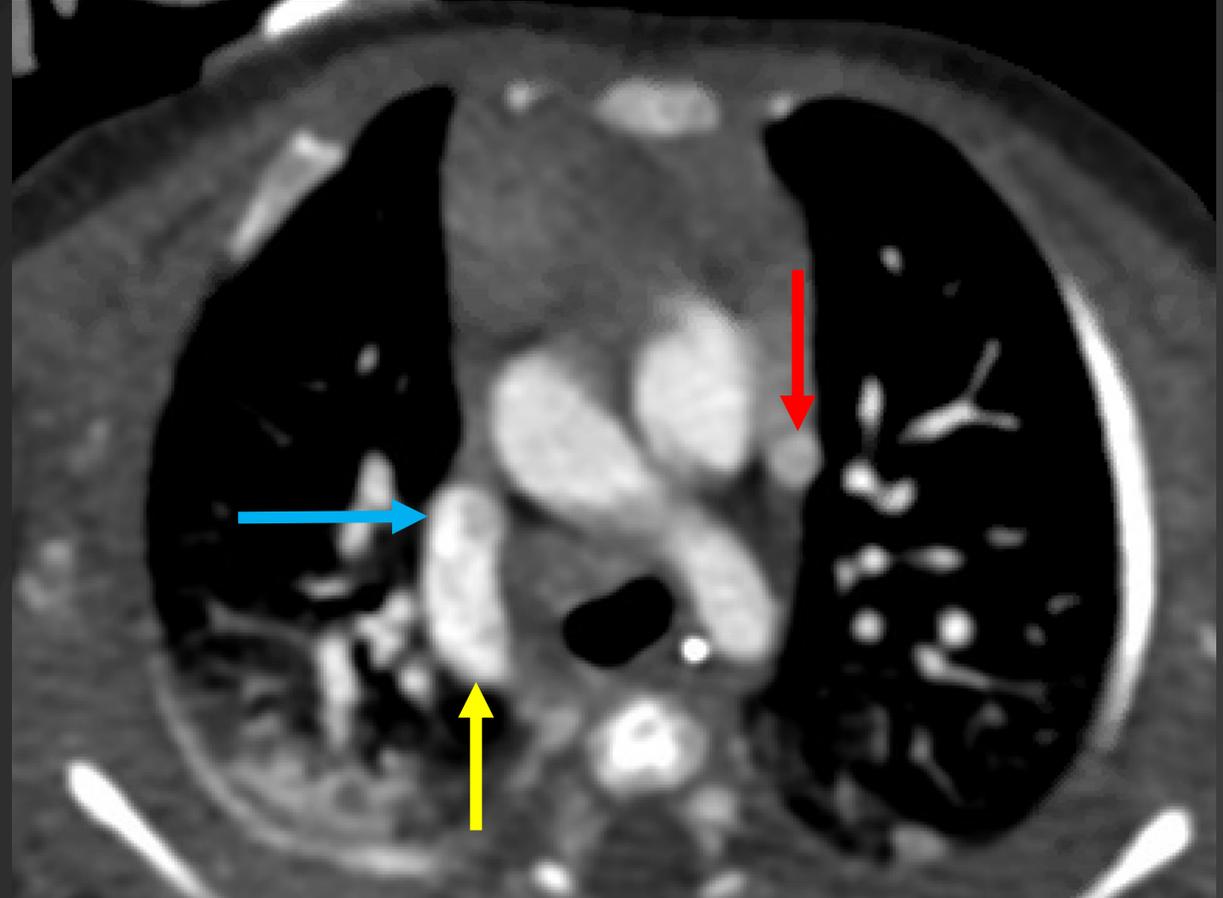
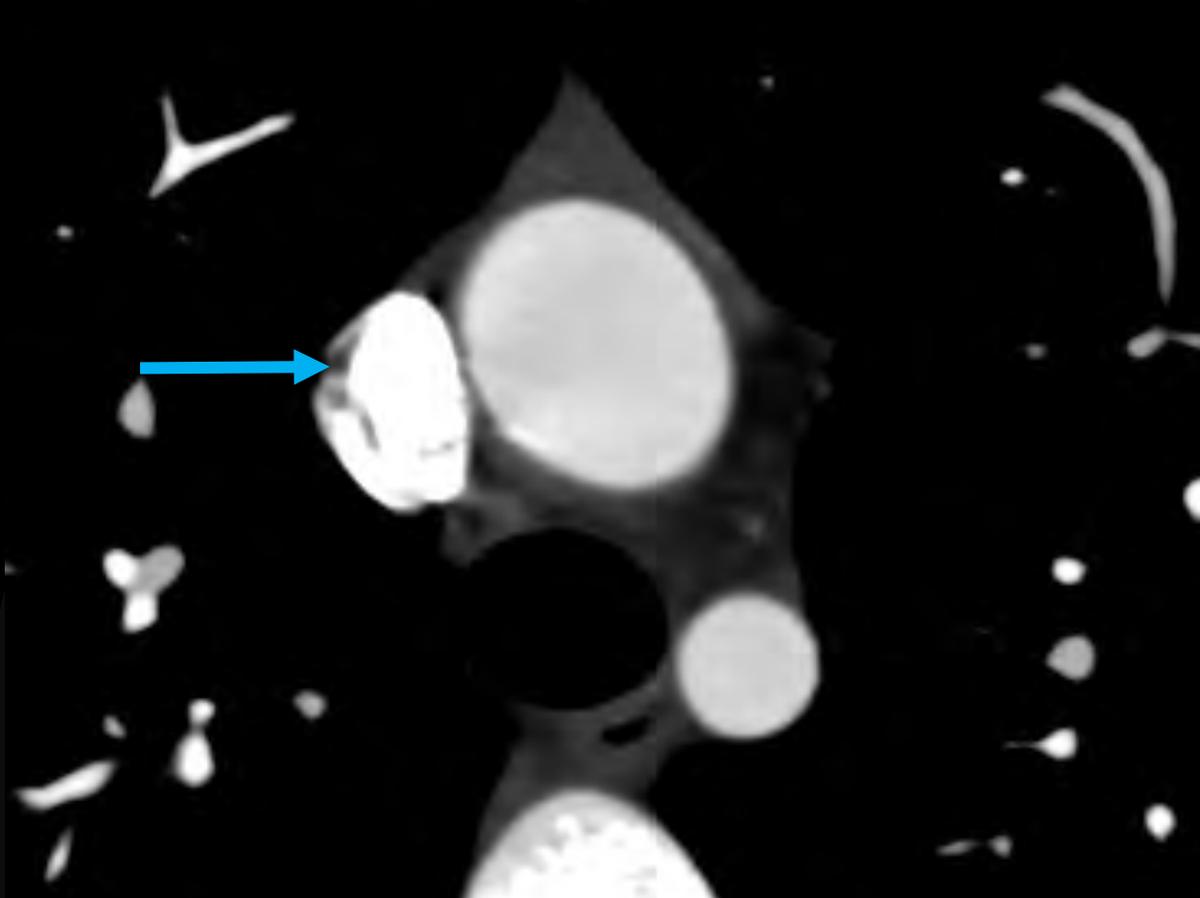
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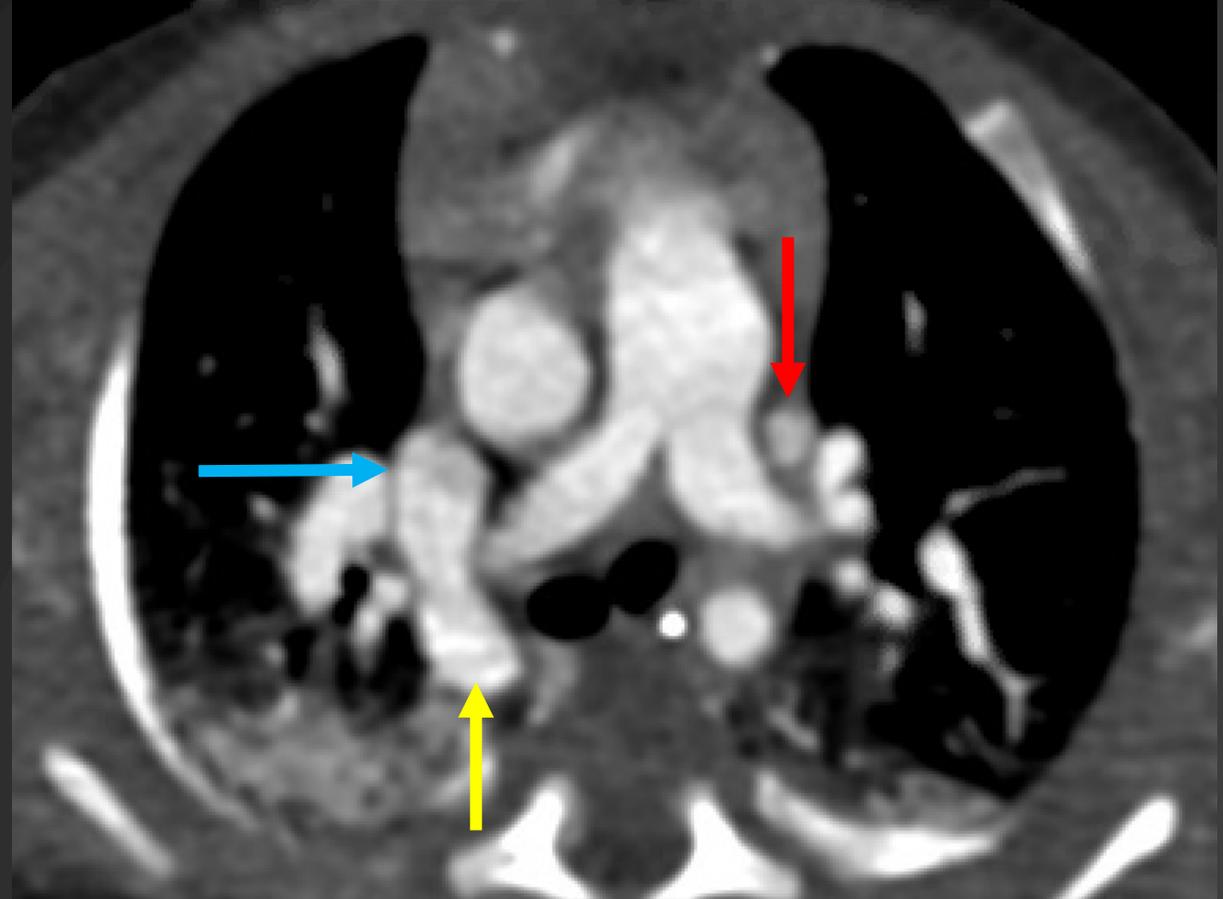
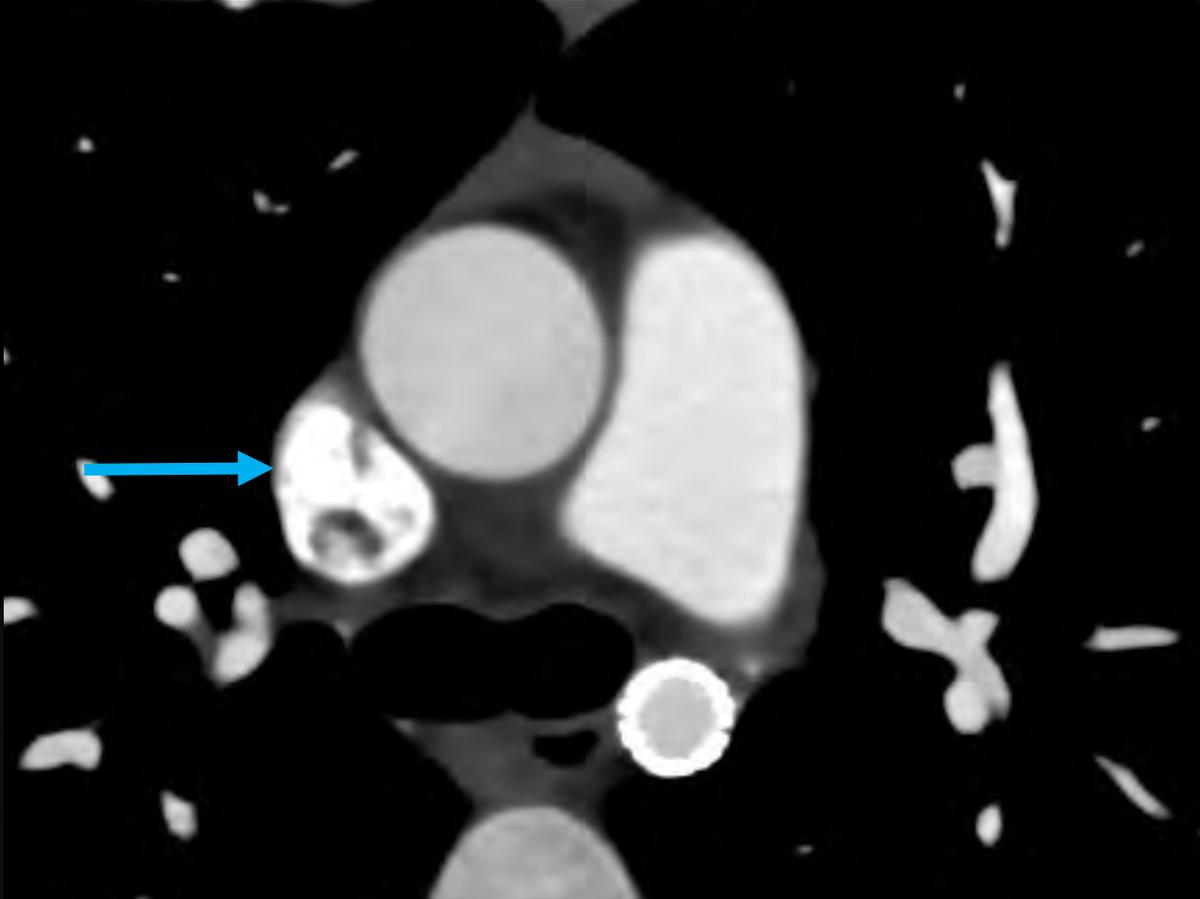
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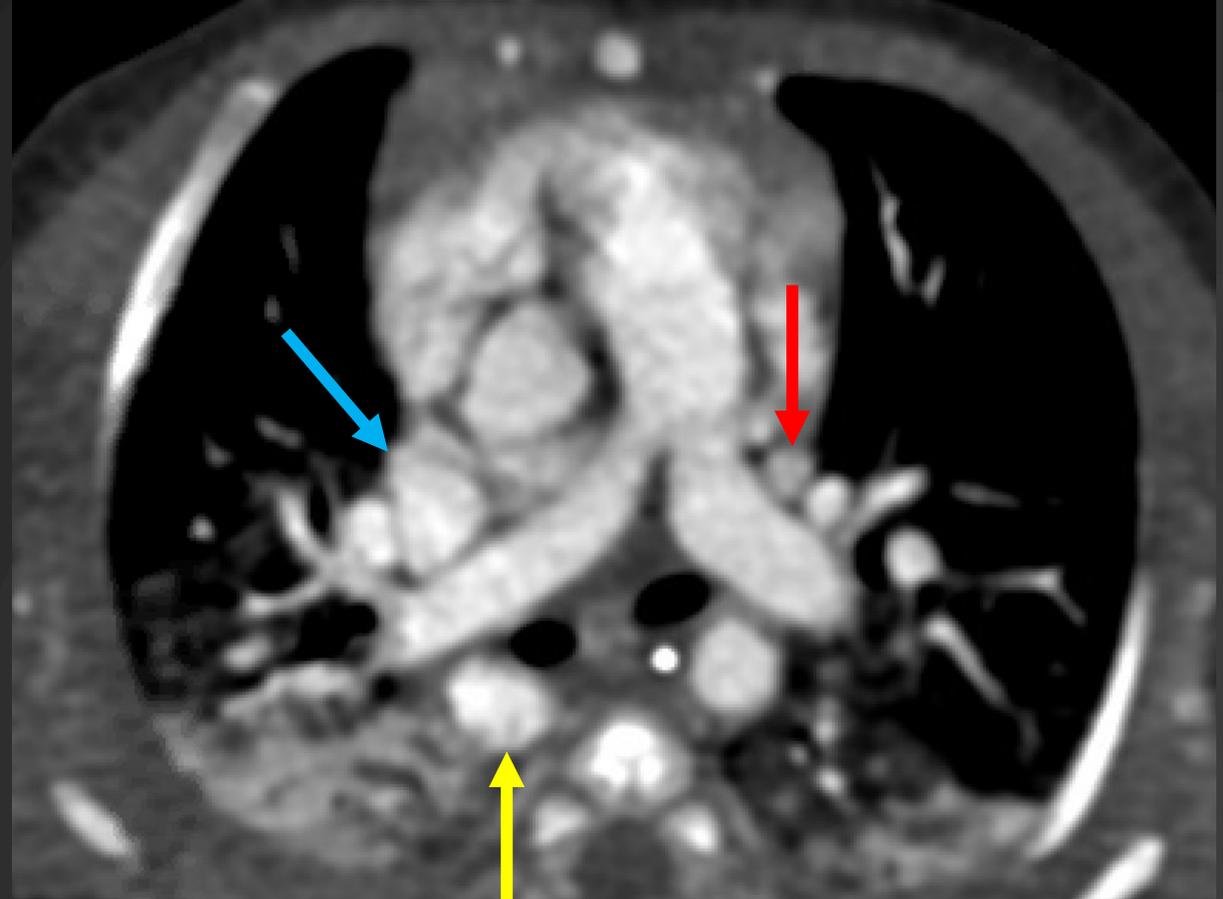
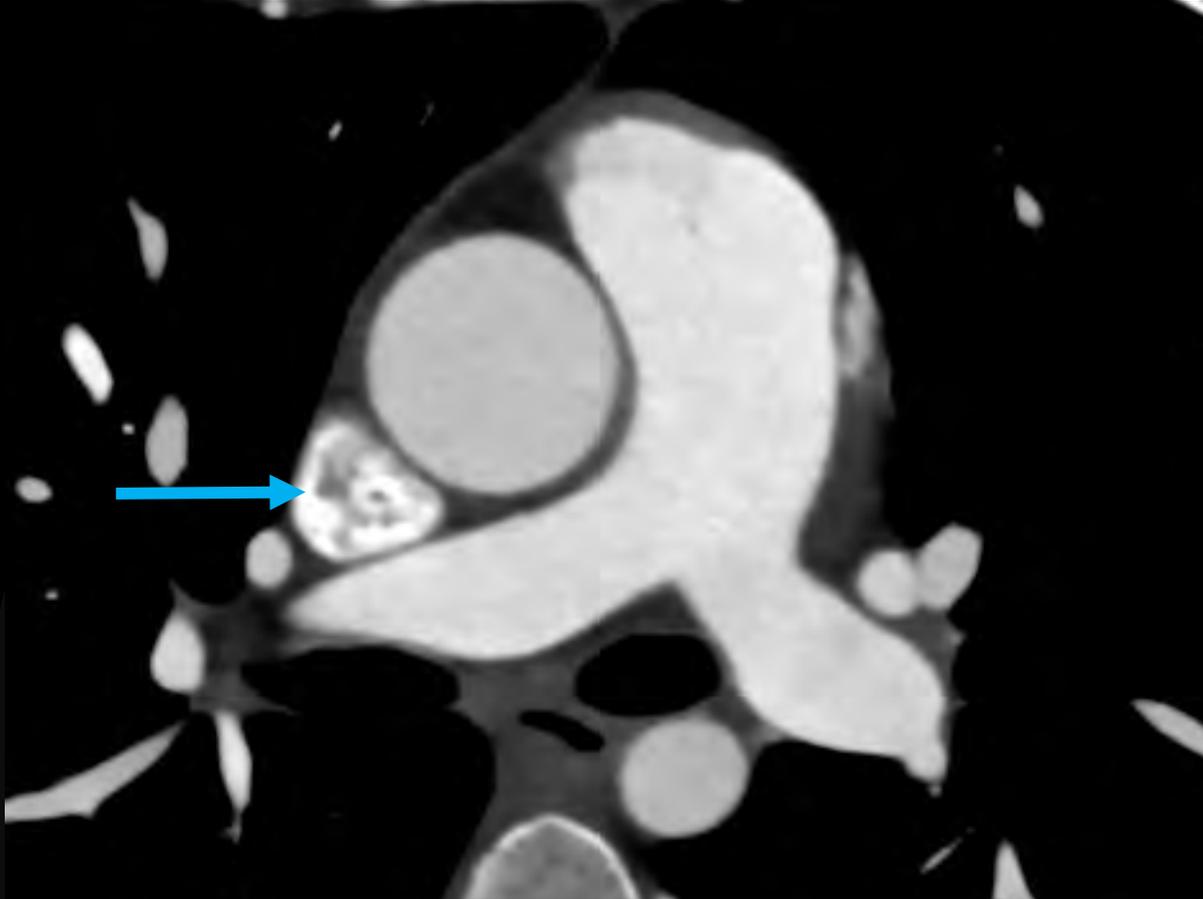
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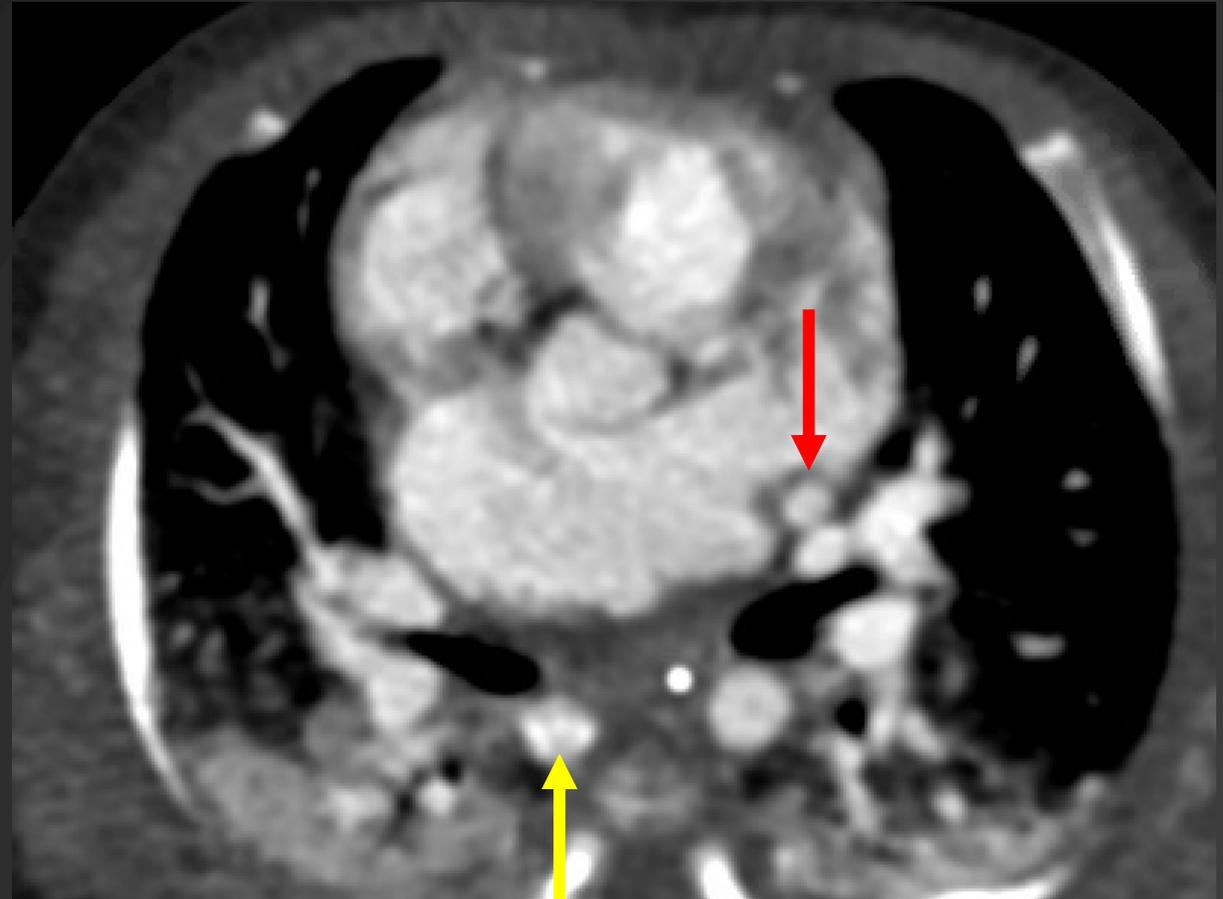
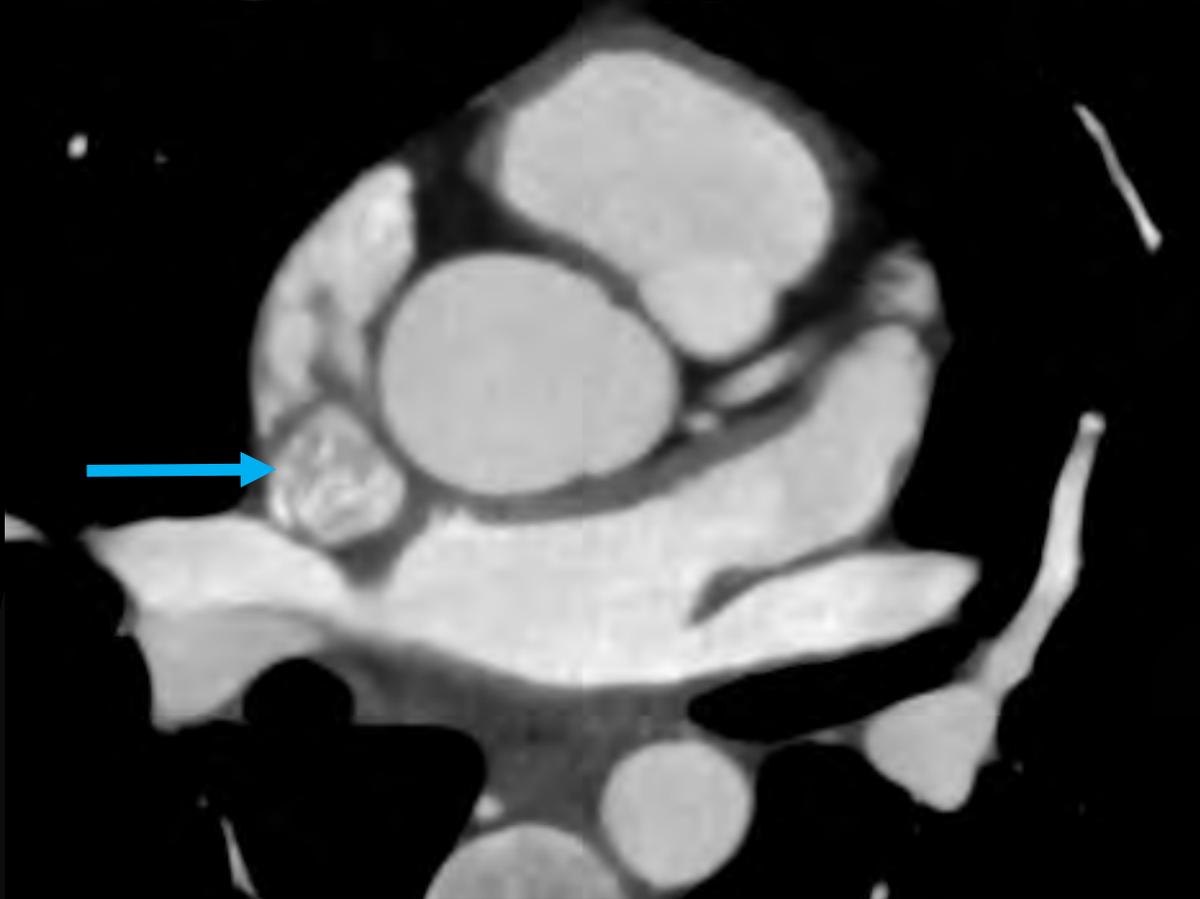
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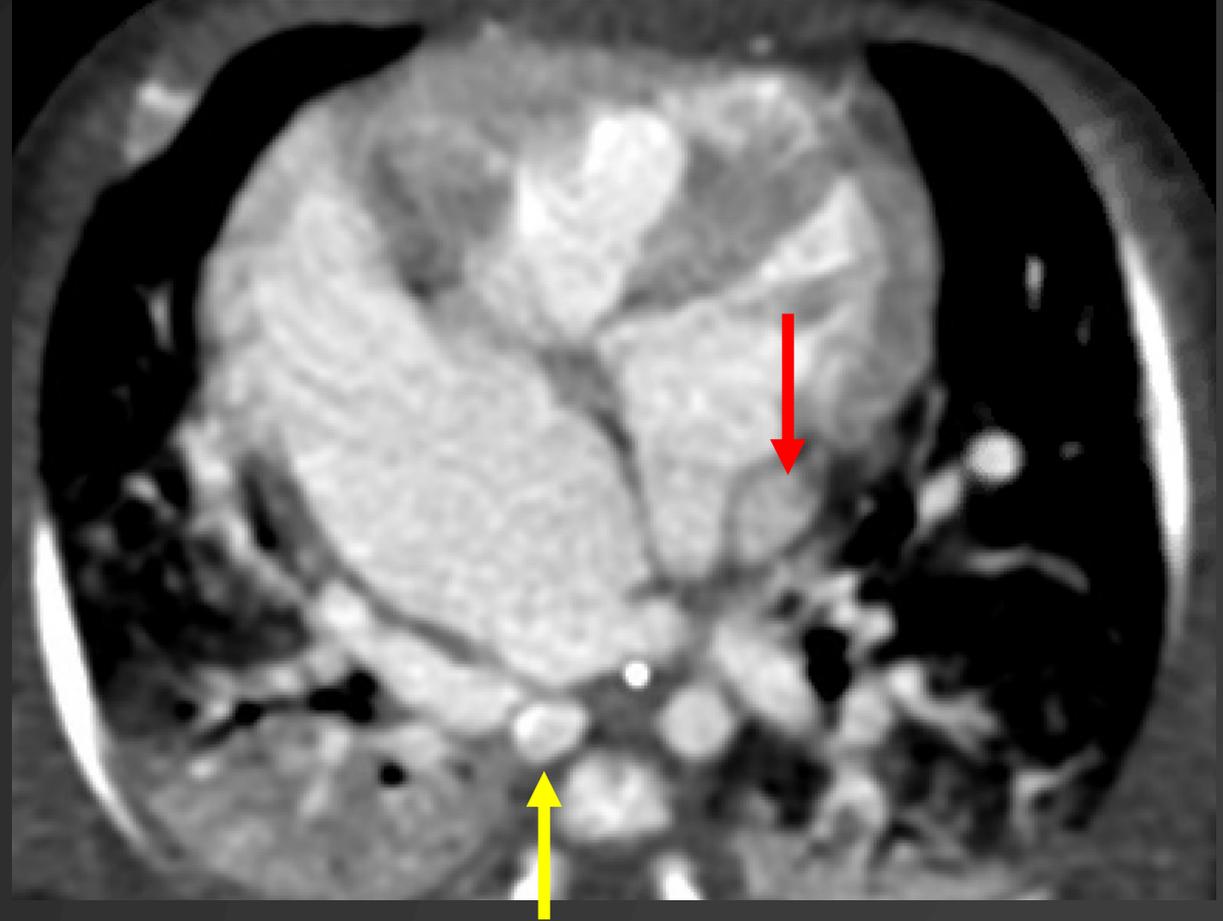
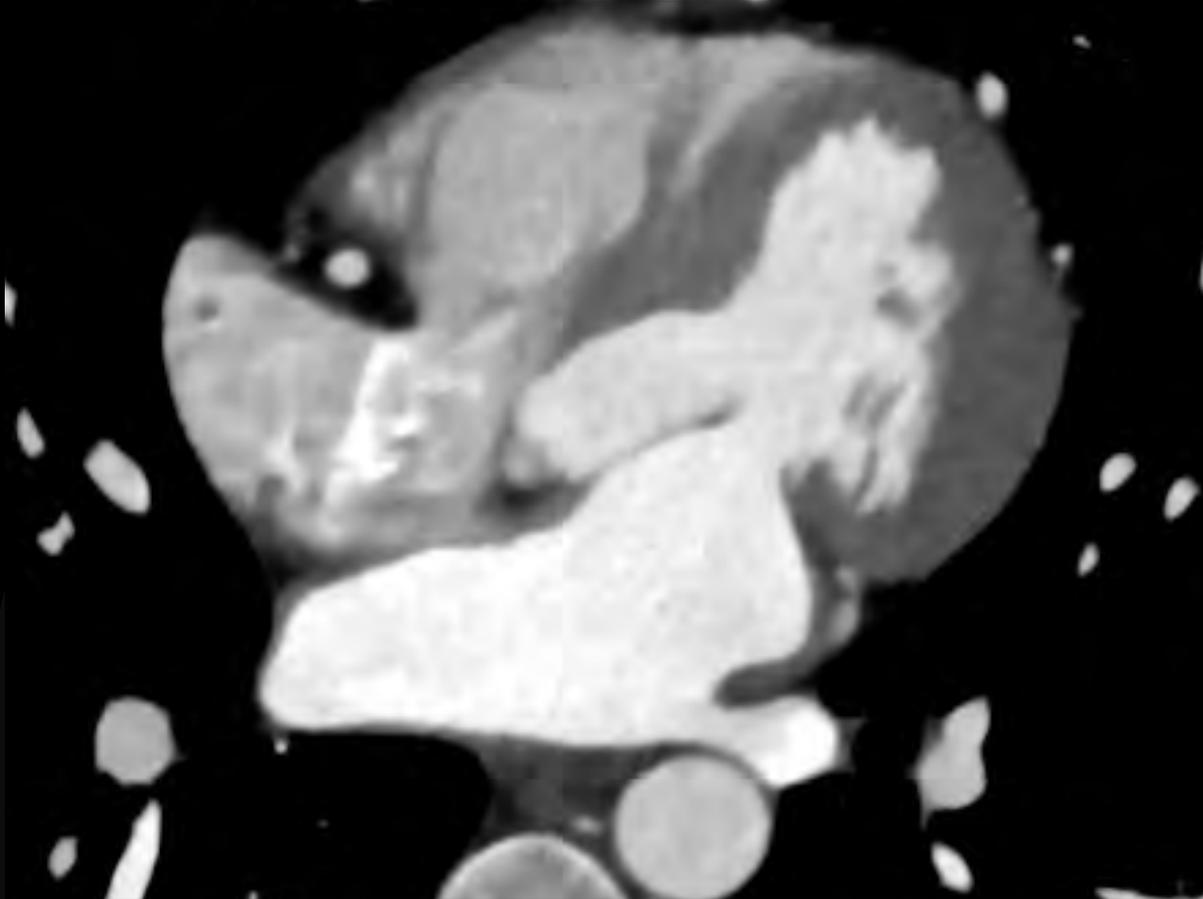
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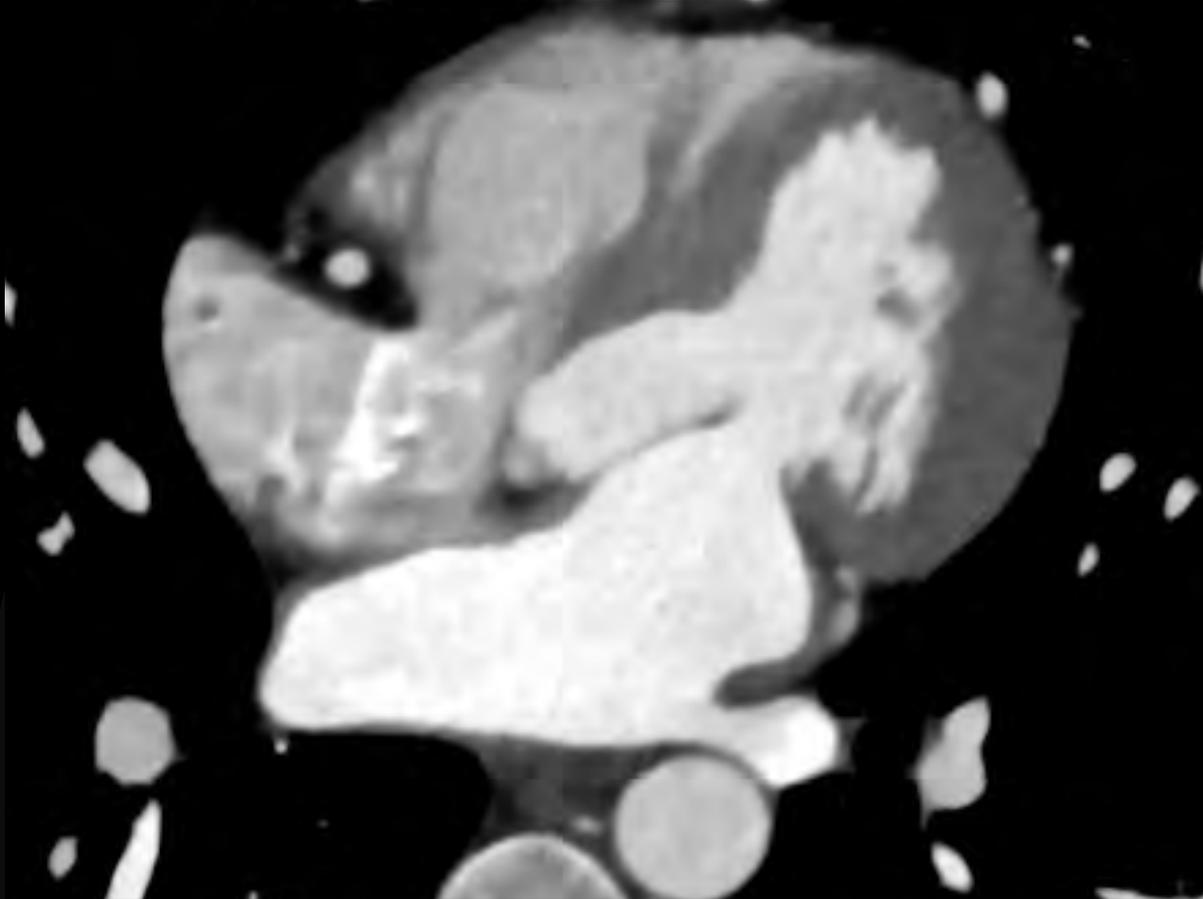
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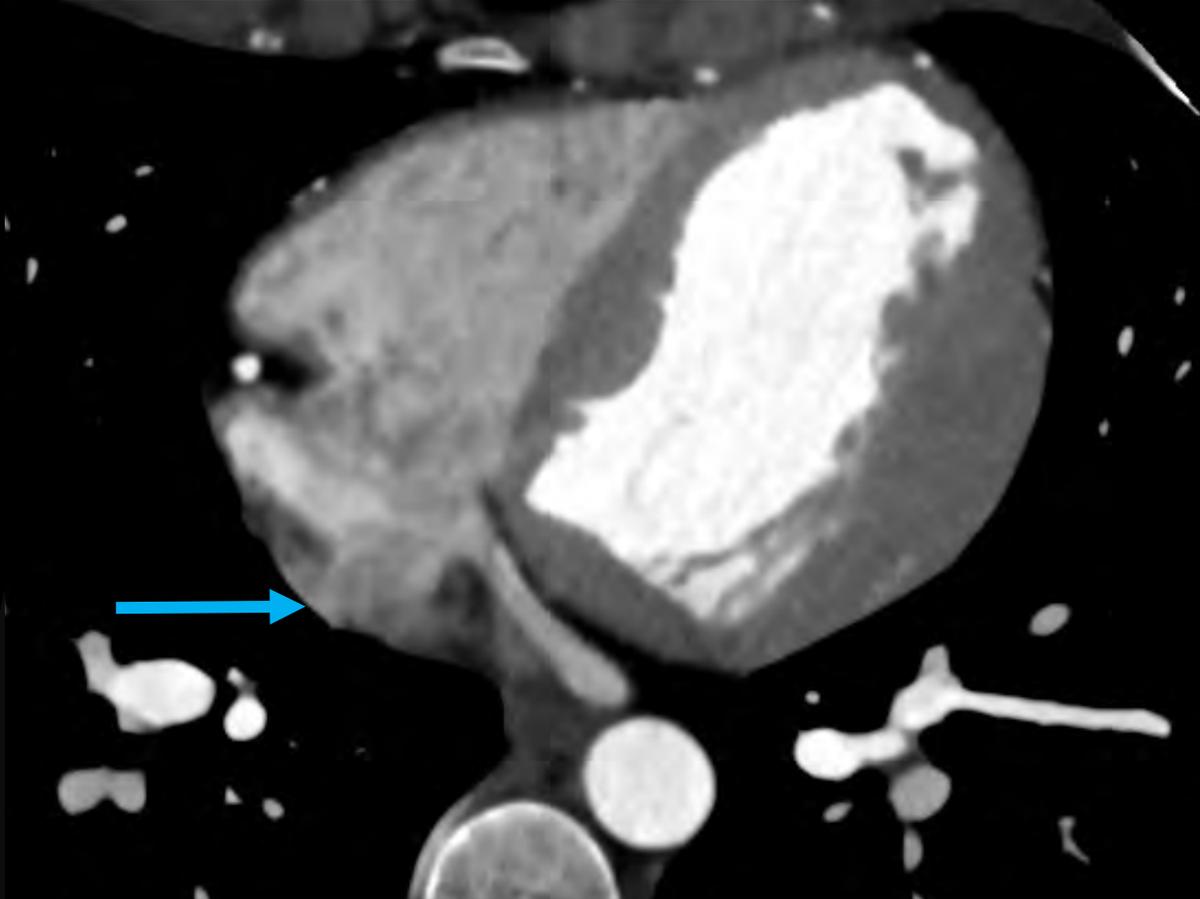
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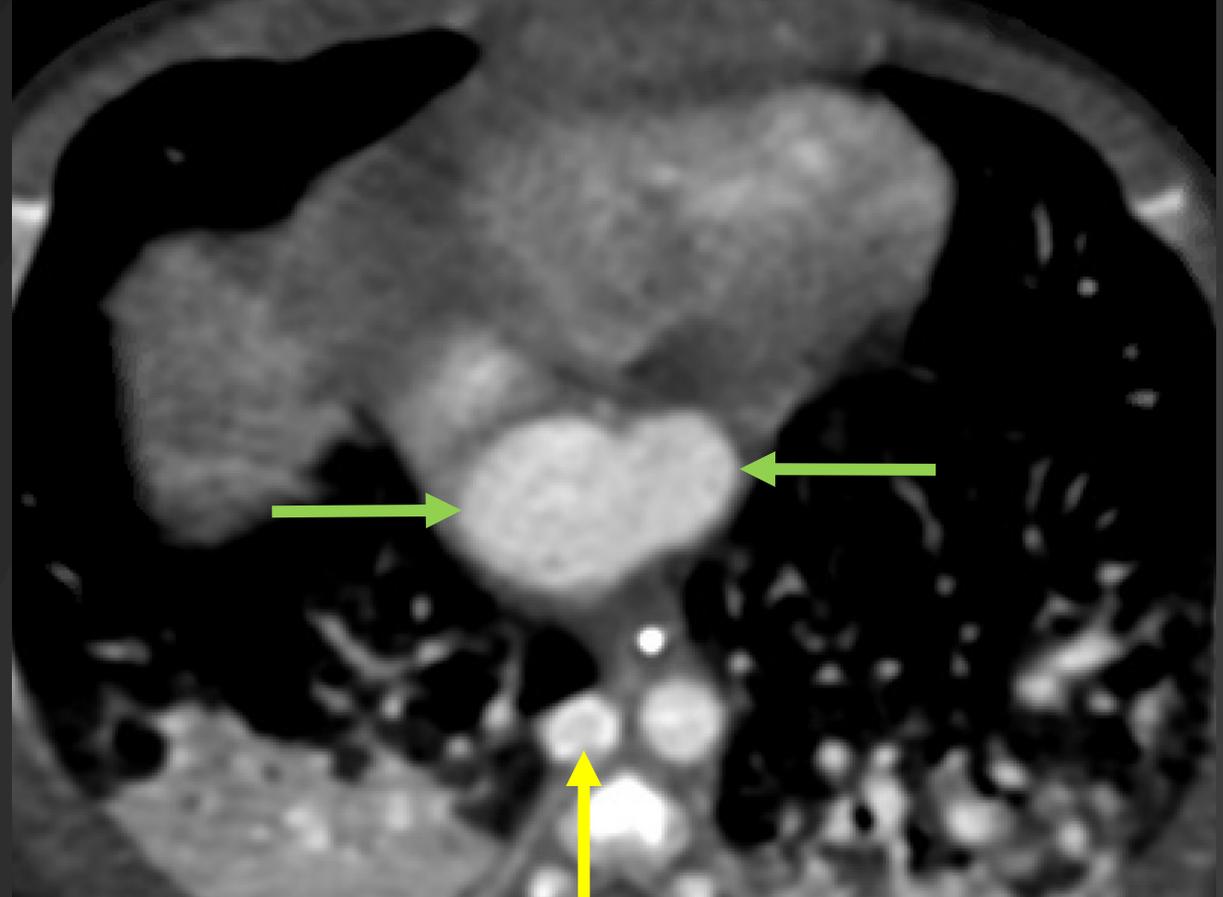
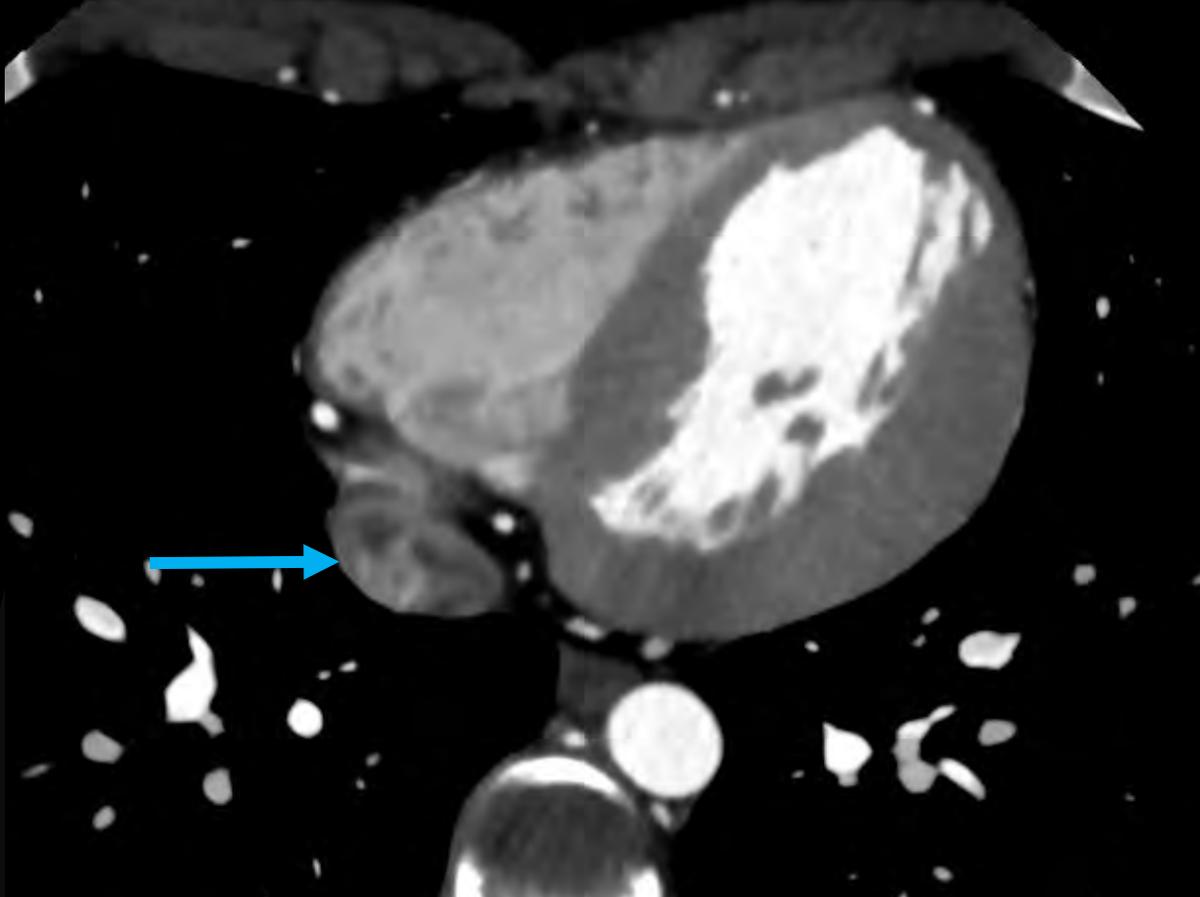
# Veines caves



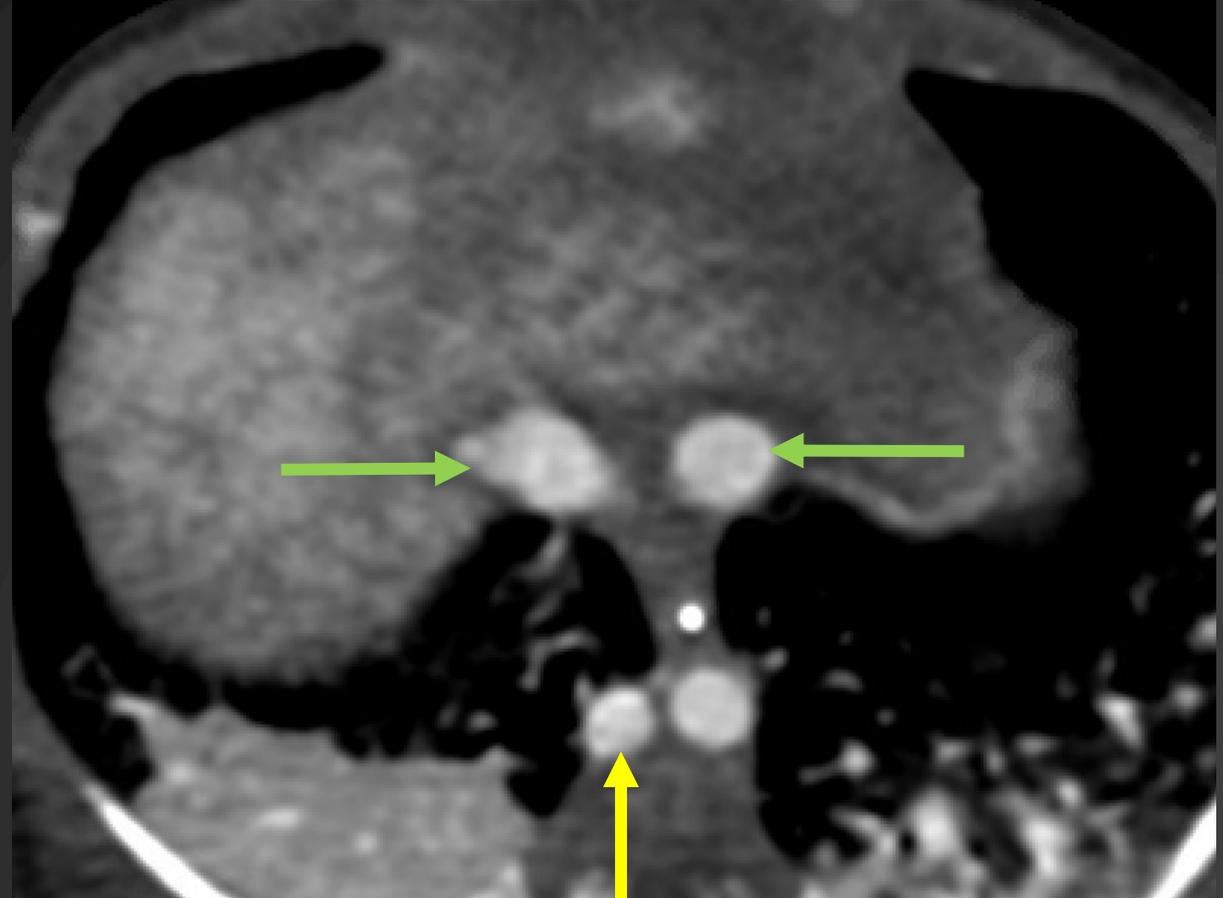
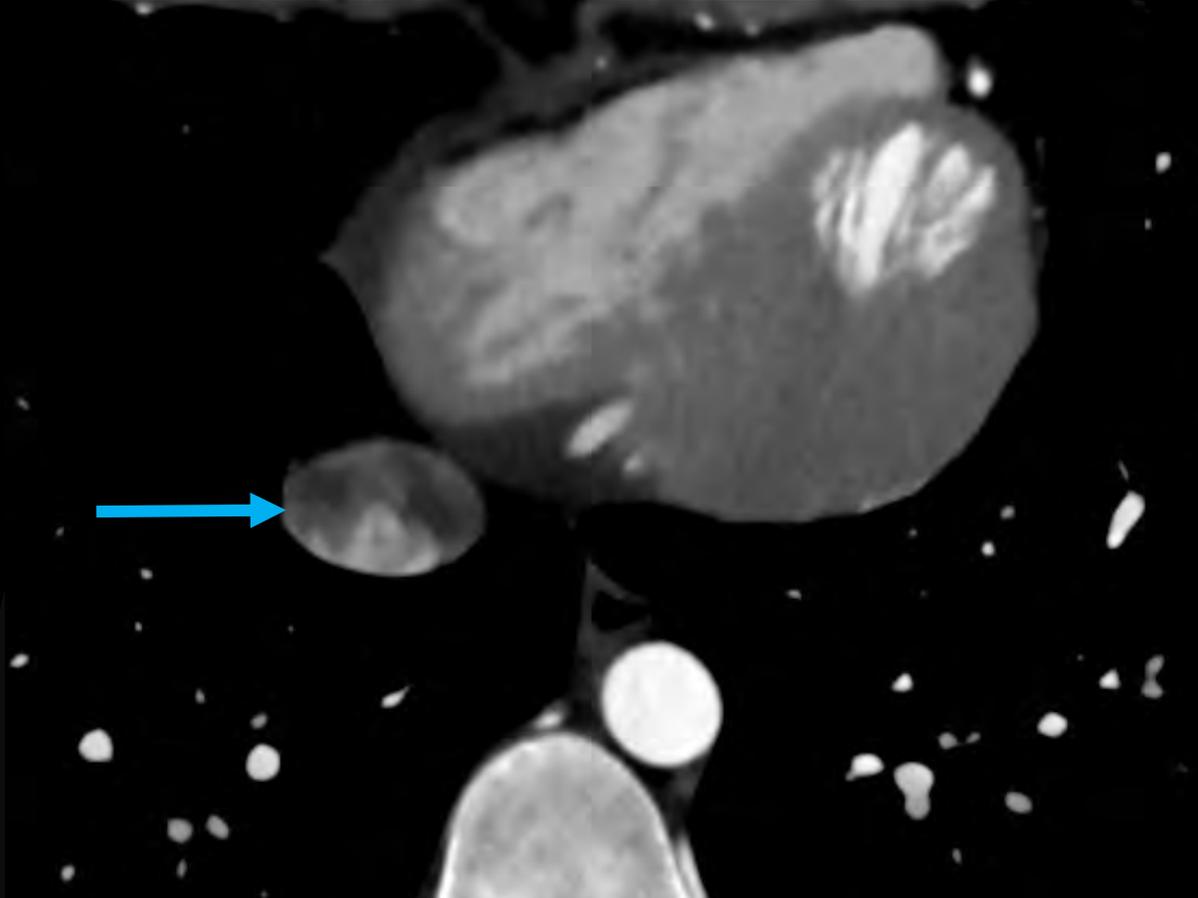
# Veines caves



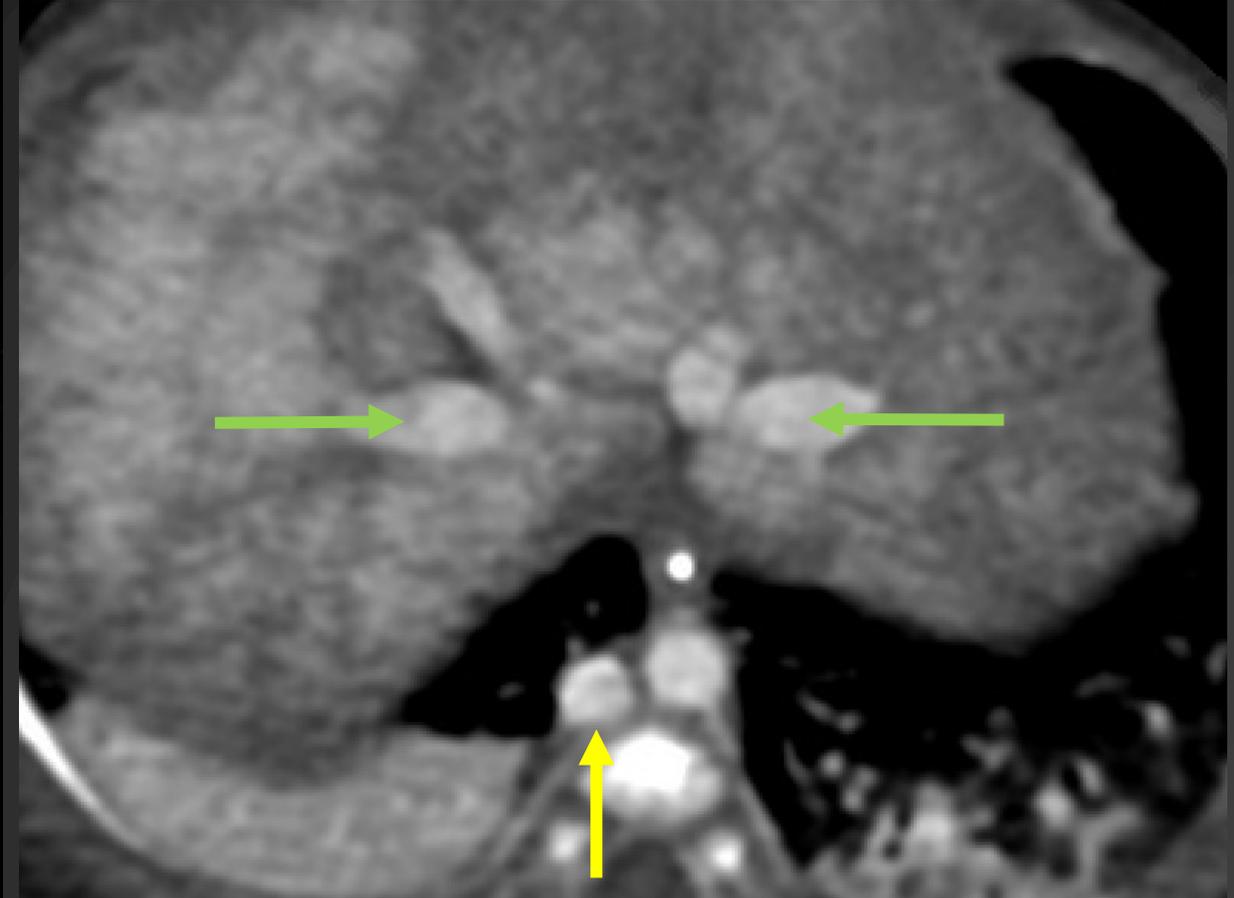
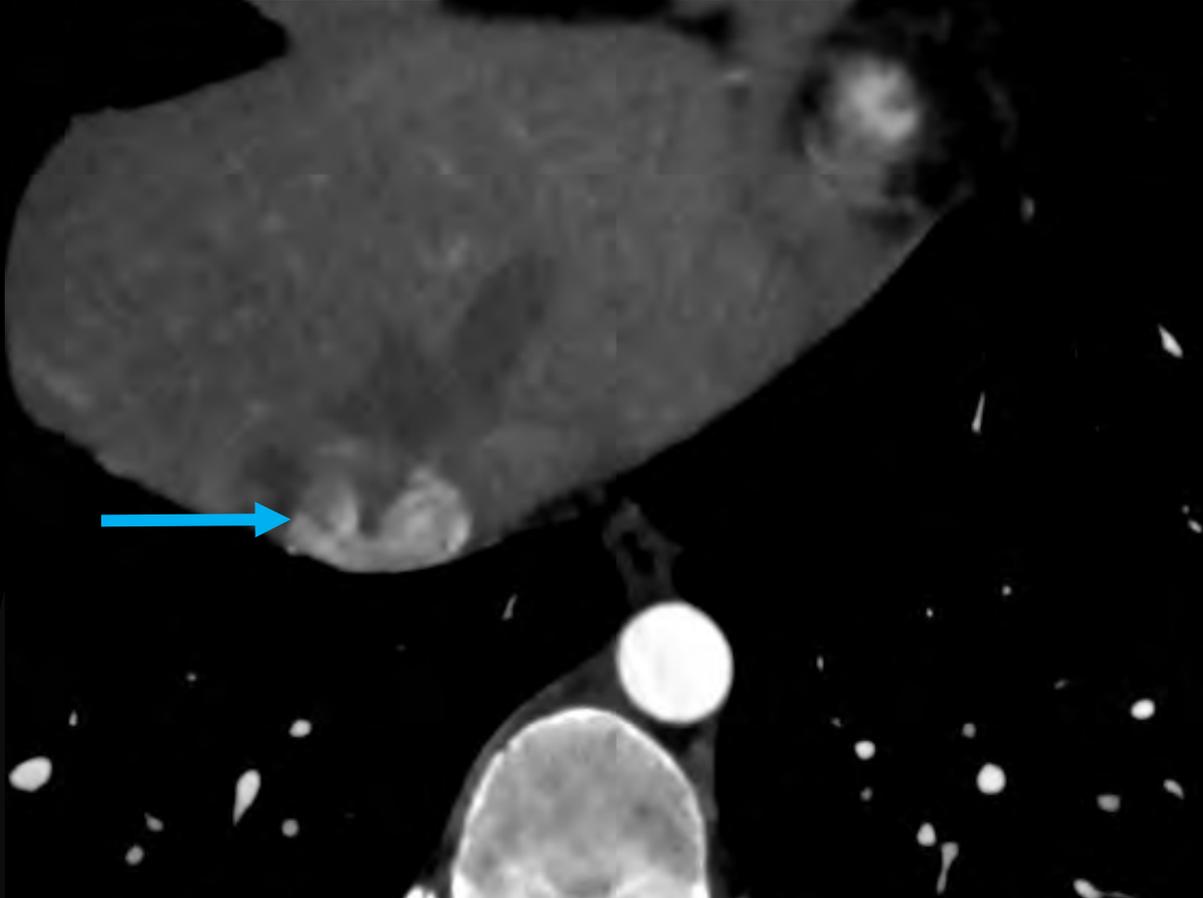
# Veines caves



# Veines caves



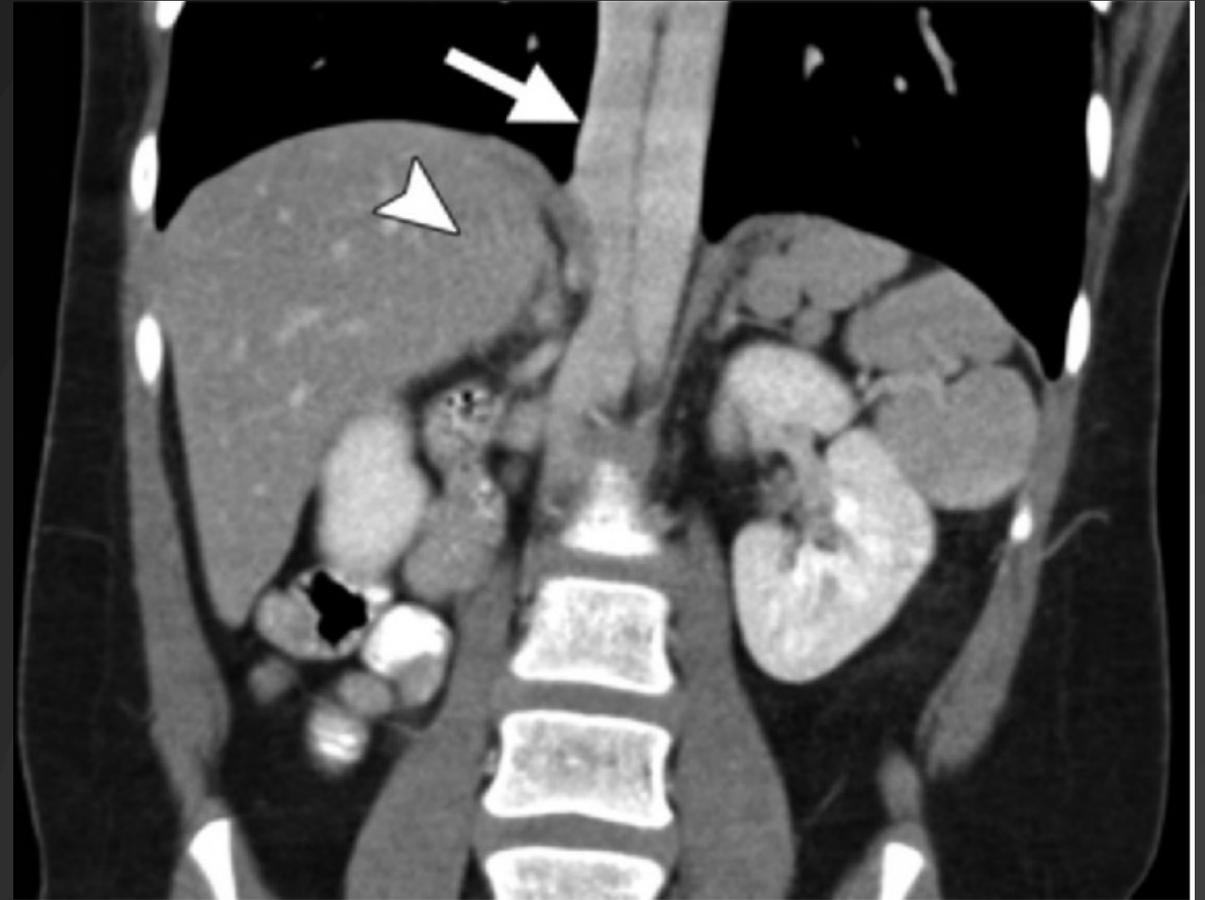
# Veines caves



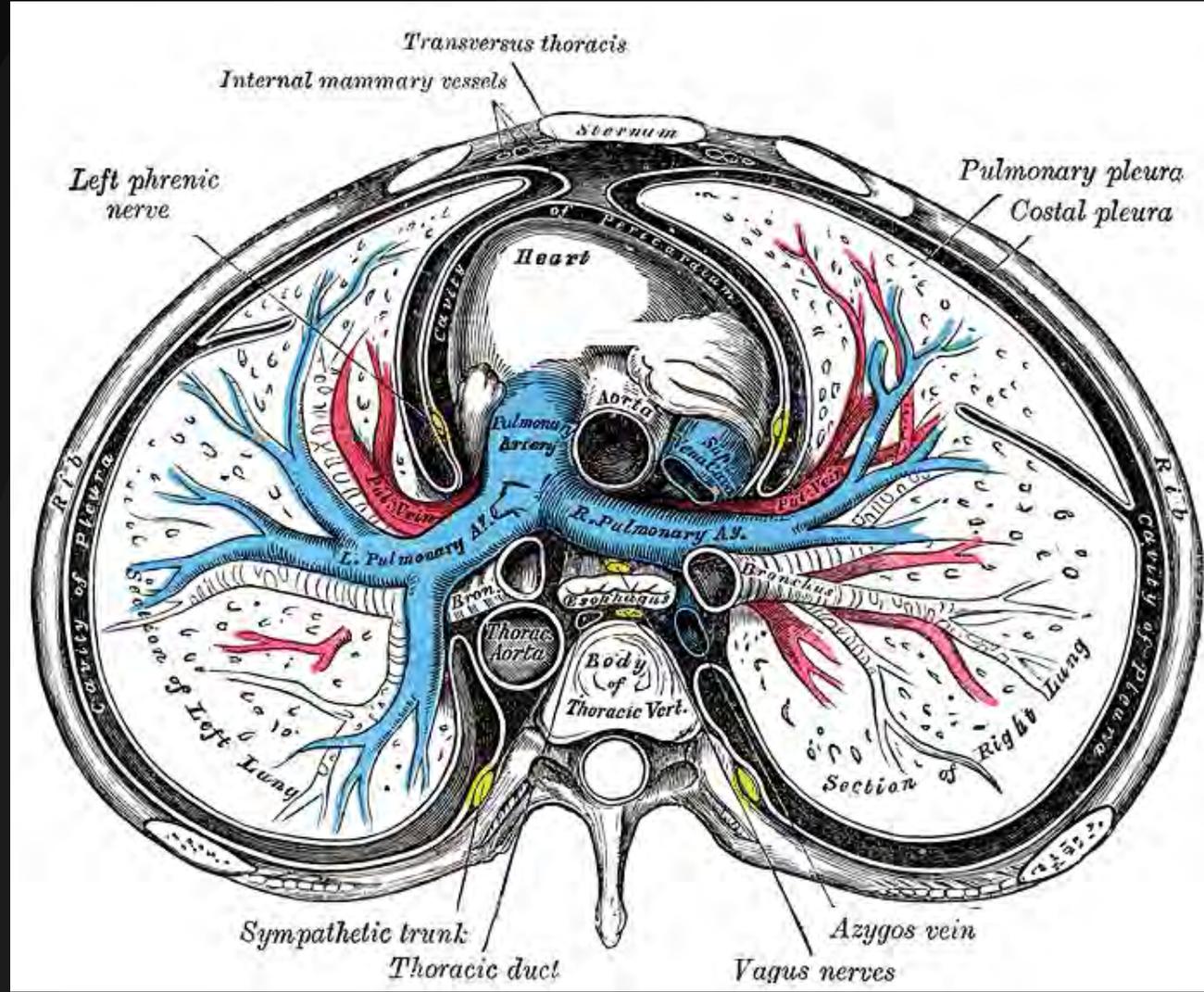
## Retour veineux azygos

- Agénésie de la VCI rétro-hépatique
- Veines hépatiques se drainent dans l'oreillette
- Dilatation azygos

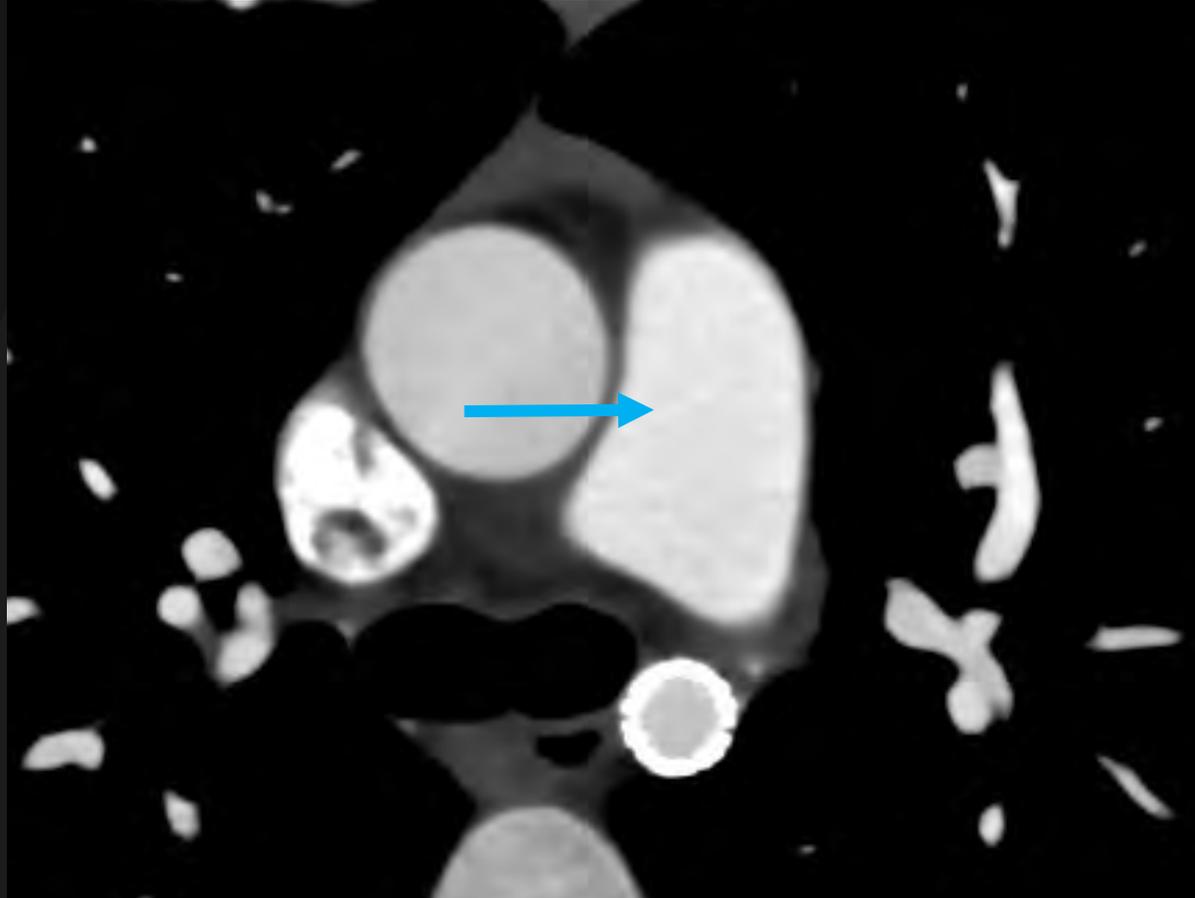
(Isomérisme gauche)



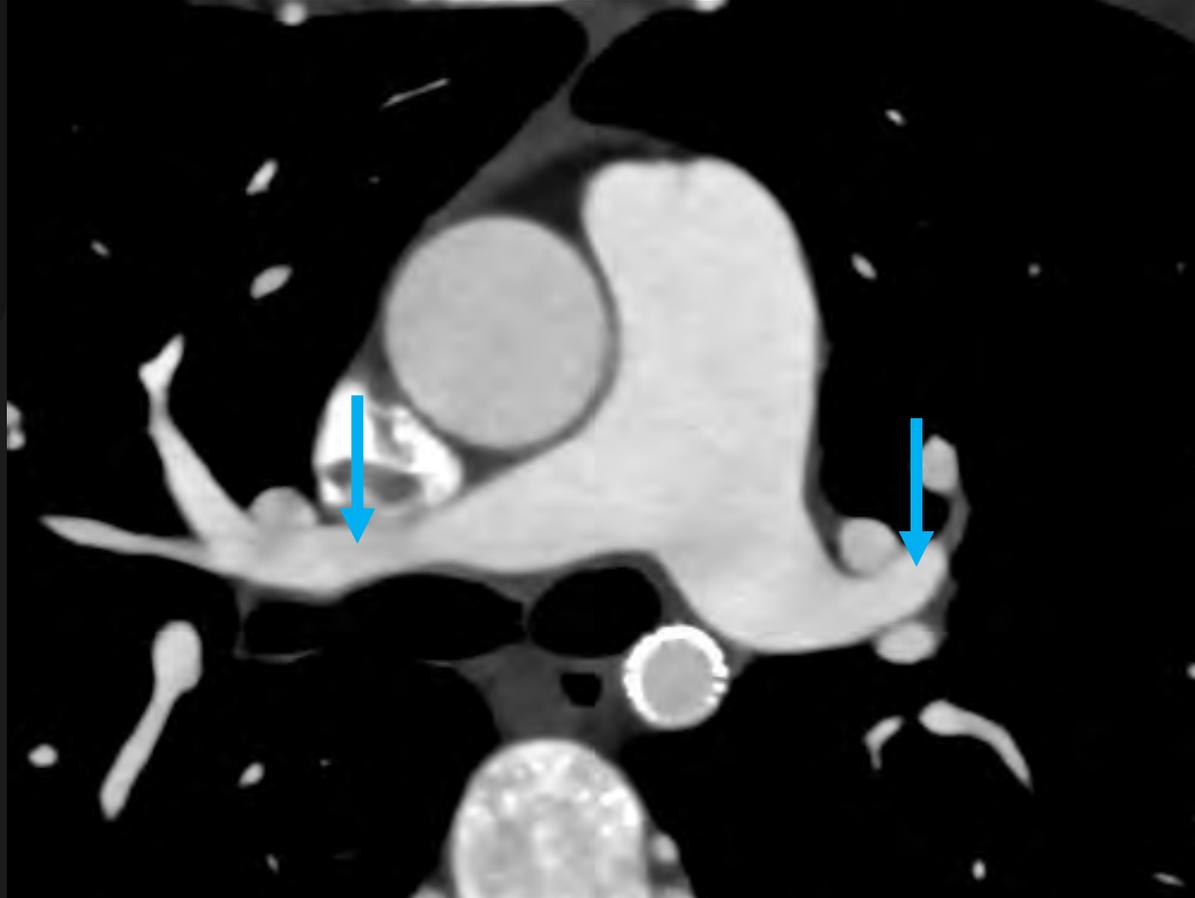
# Artères pulmonaires



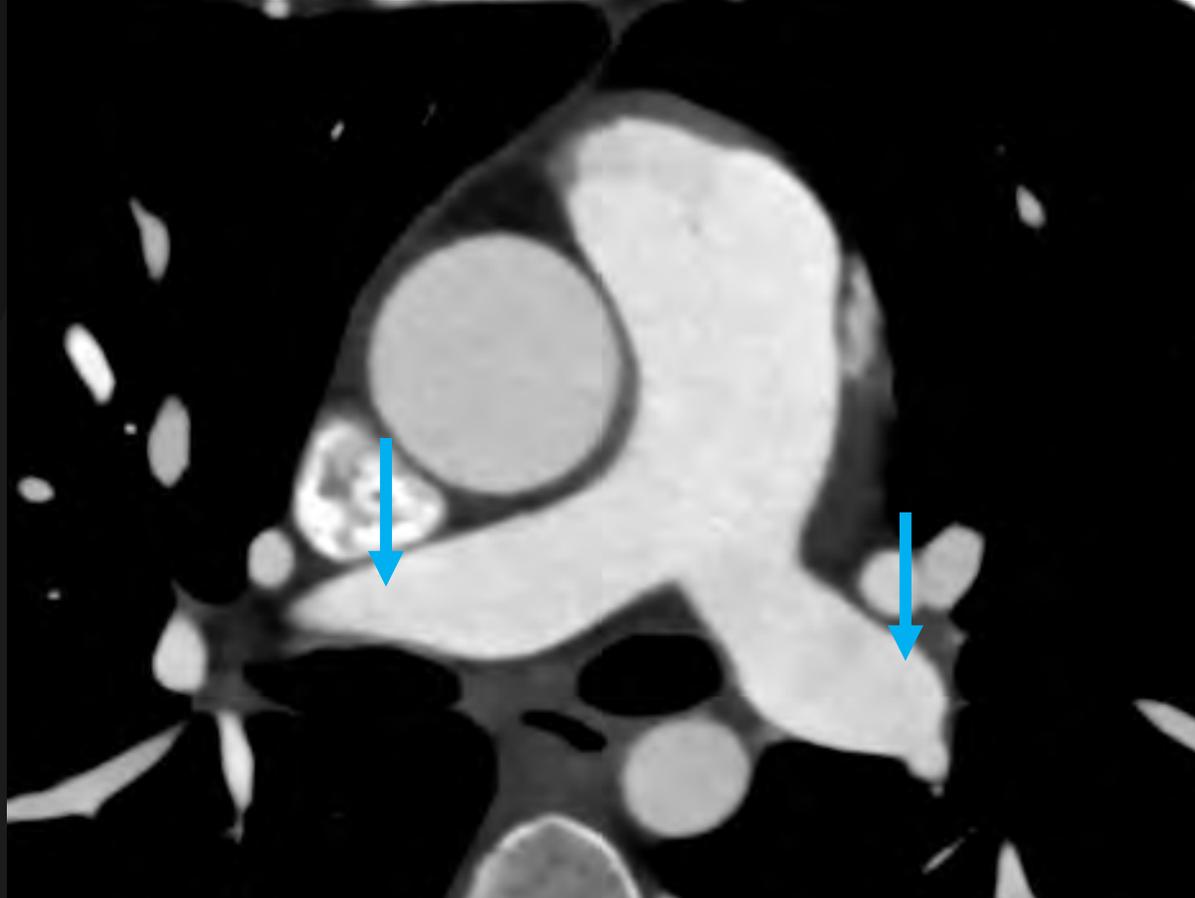
# Artères pulmonaires



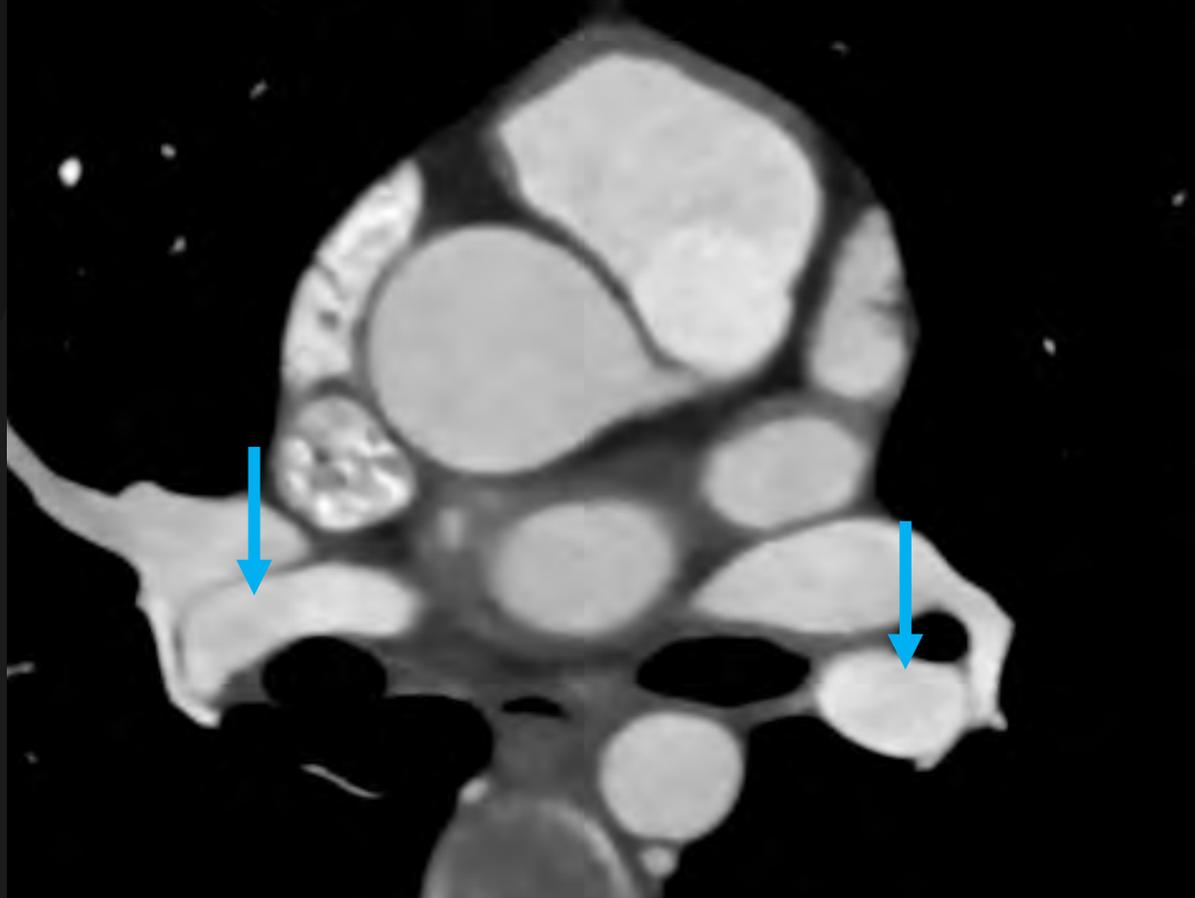
# Artères pulmonaires



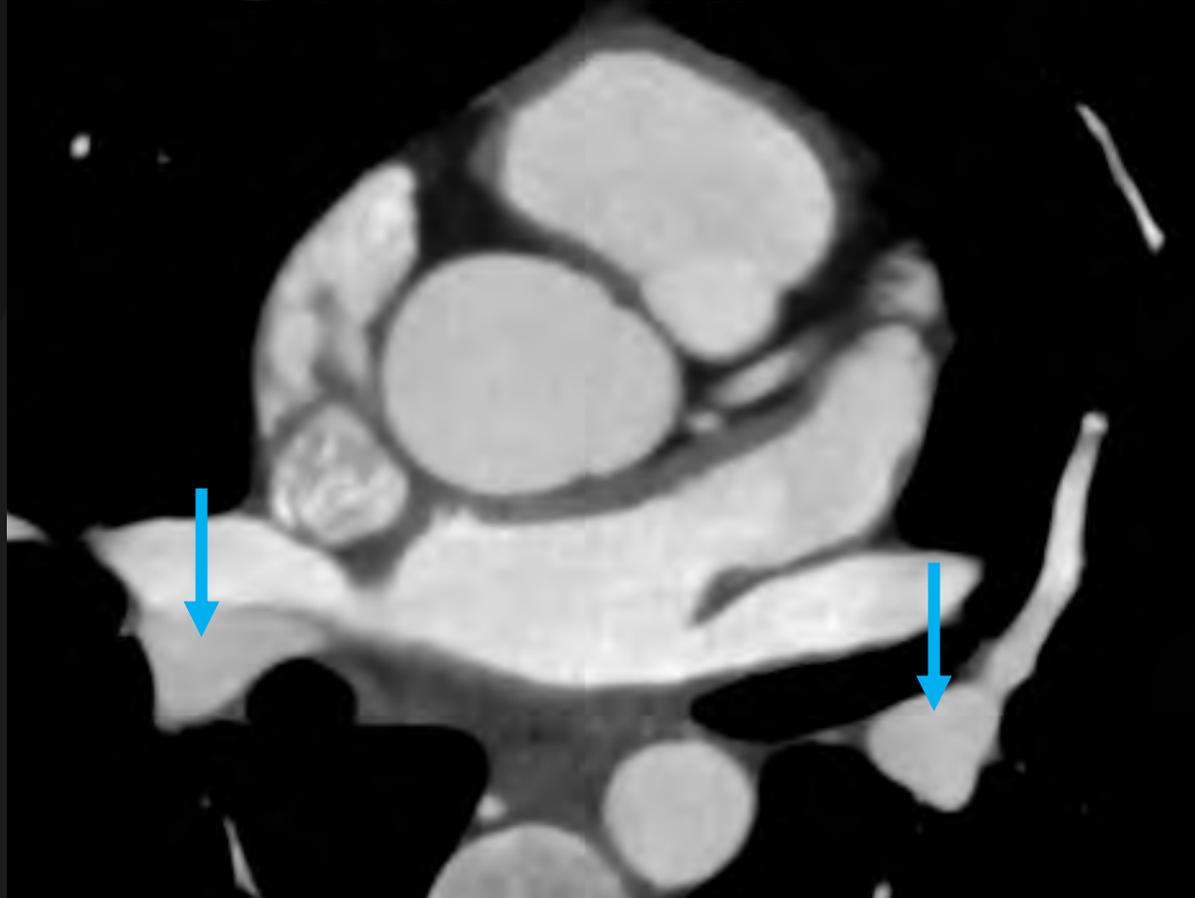
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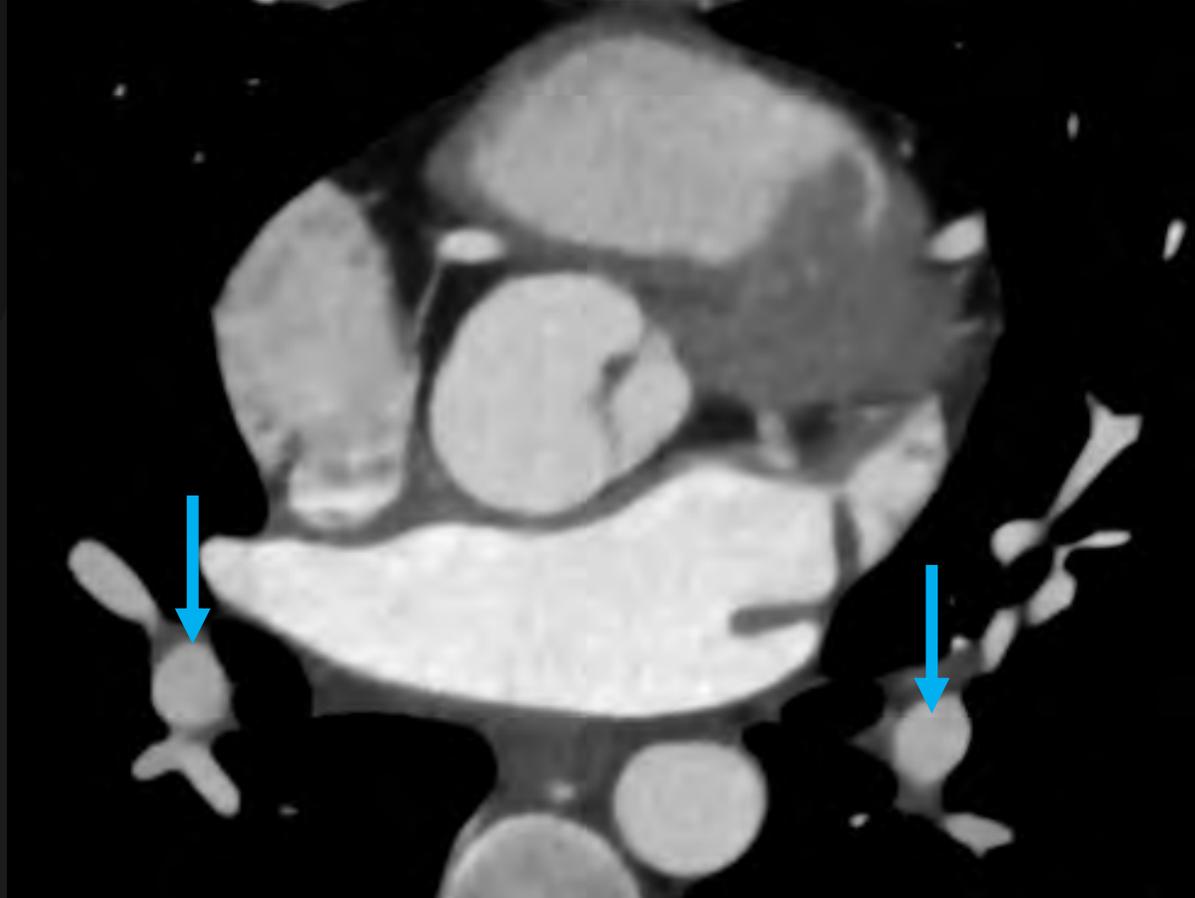
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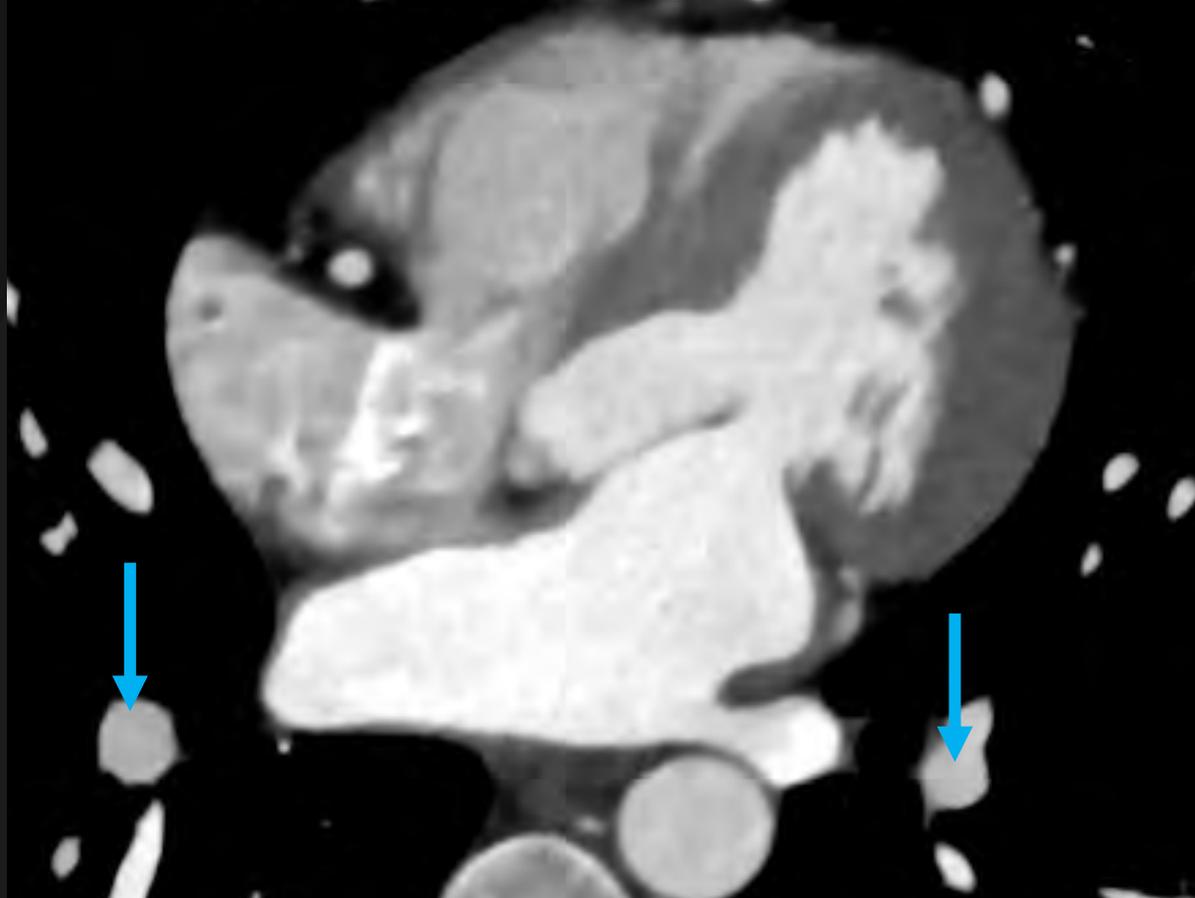
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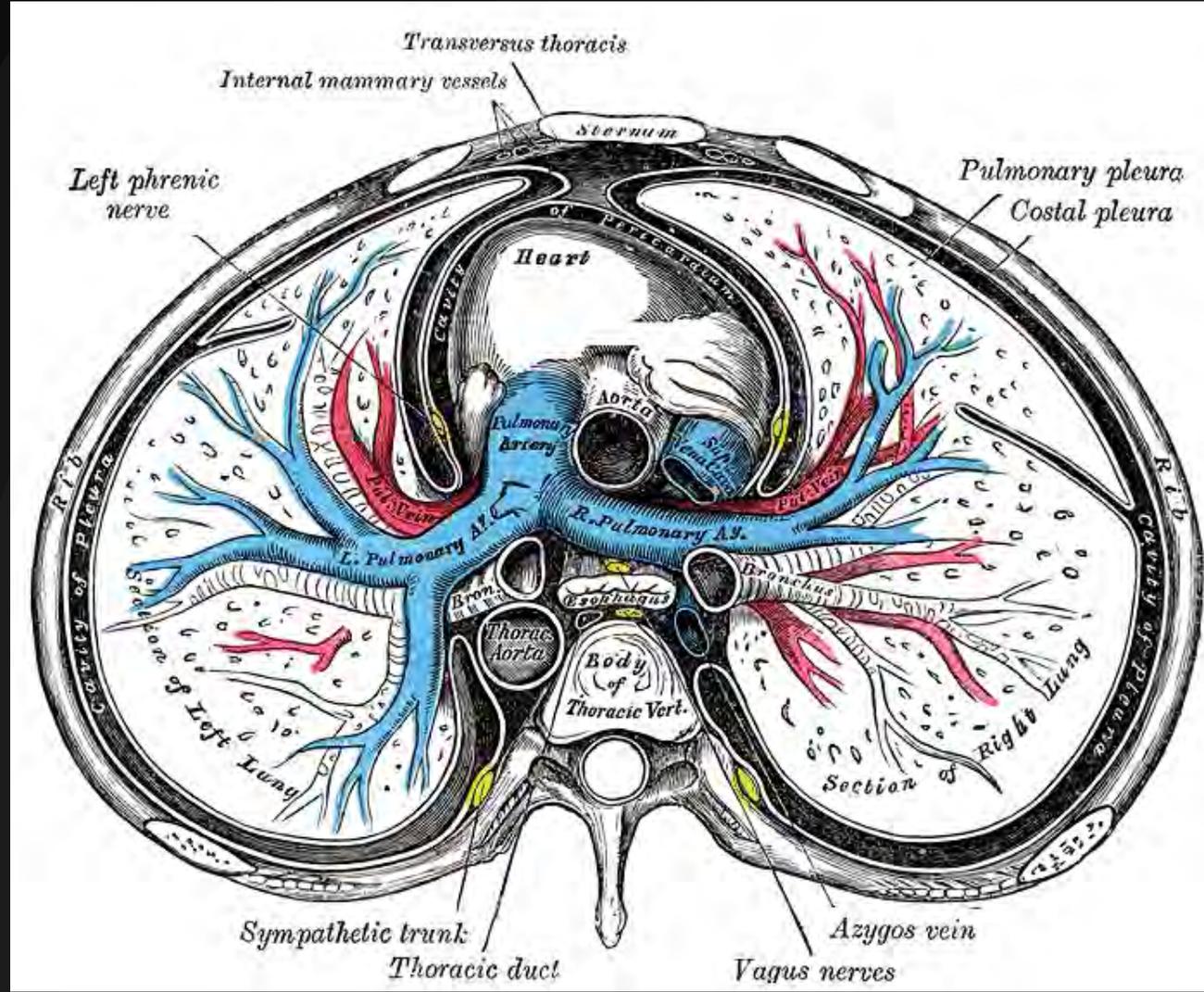
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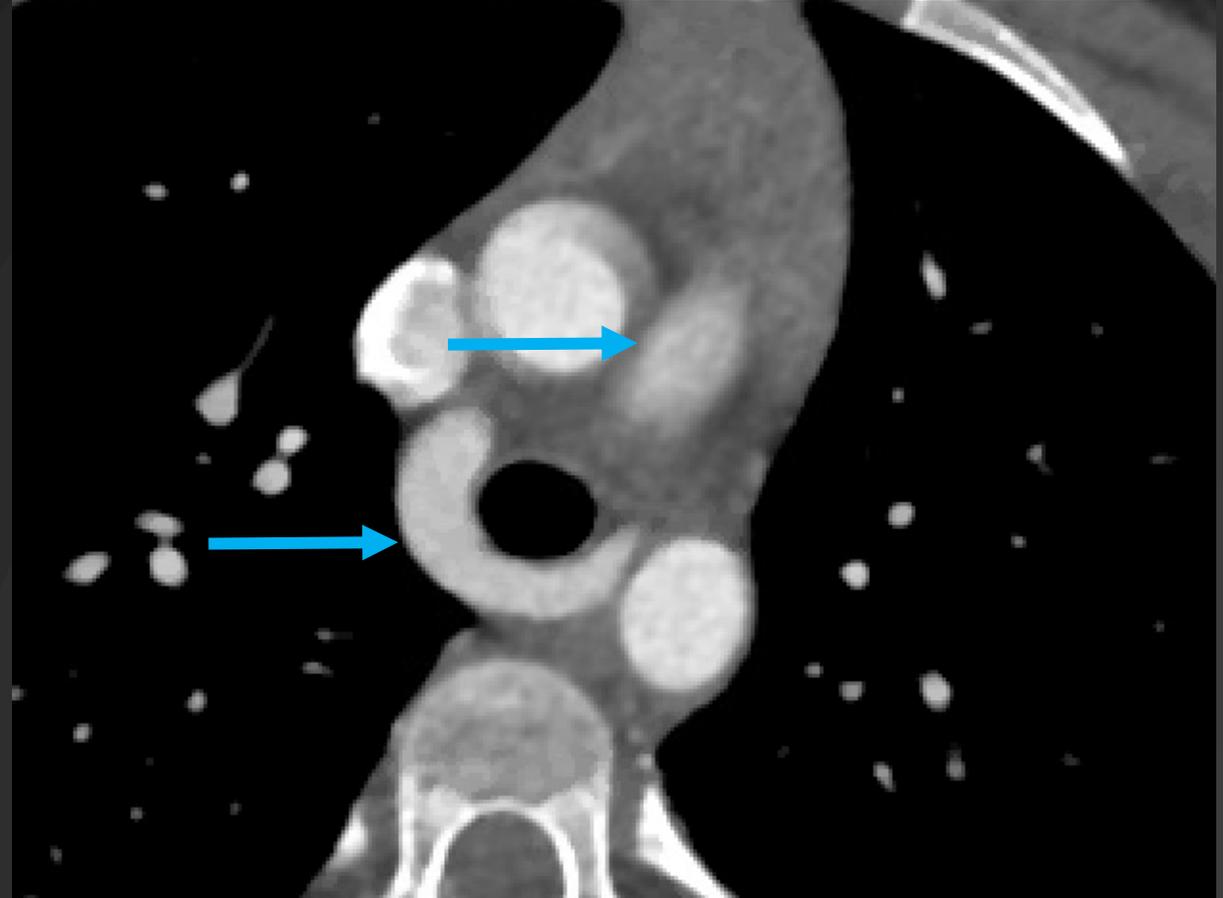
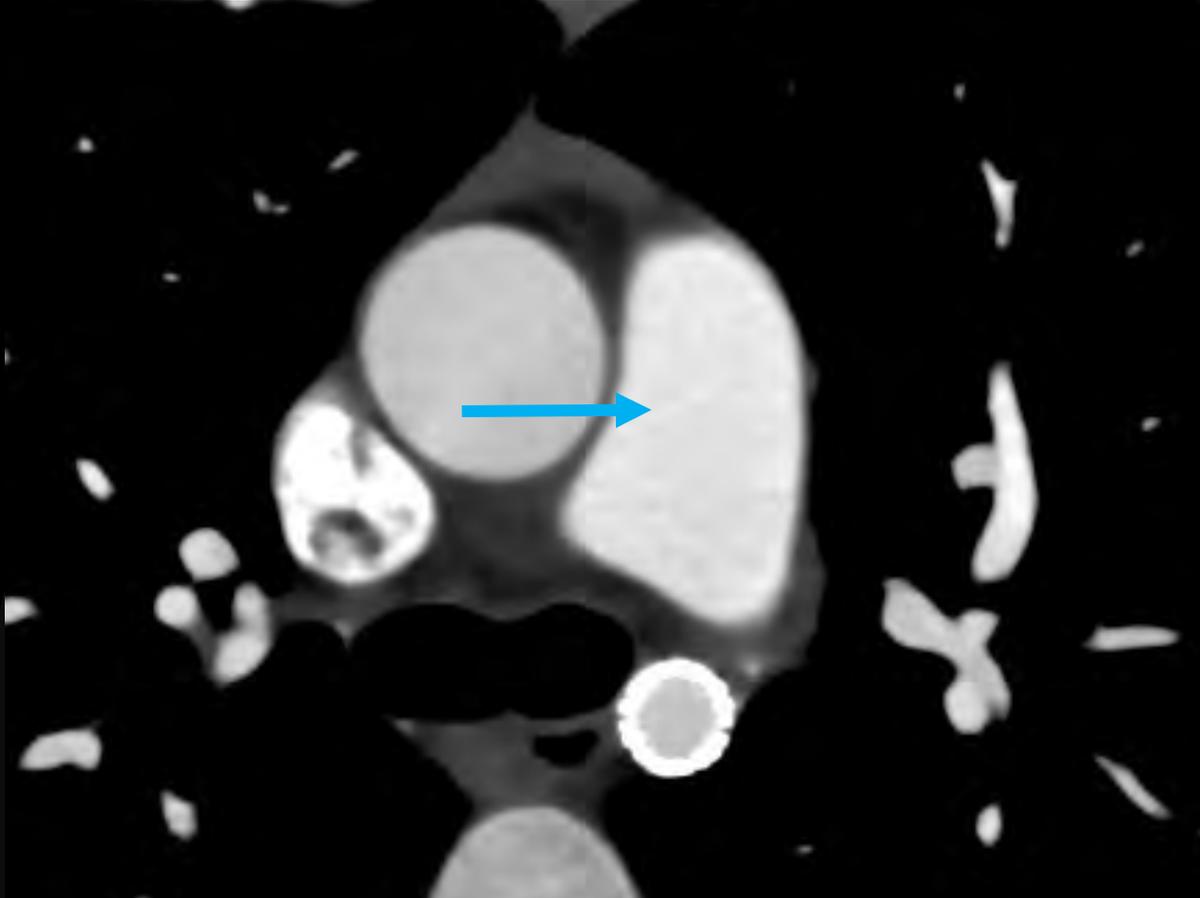
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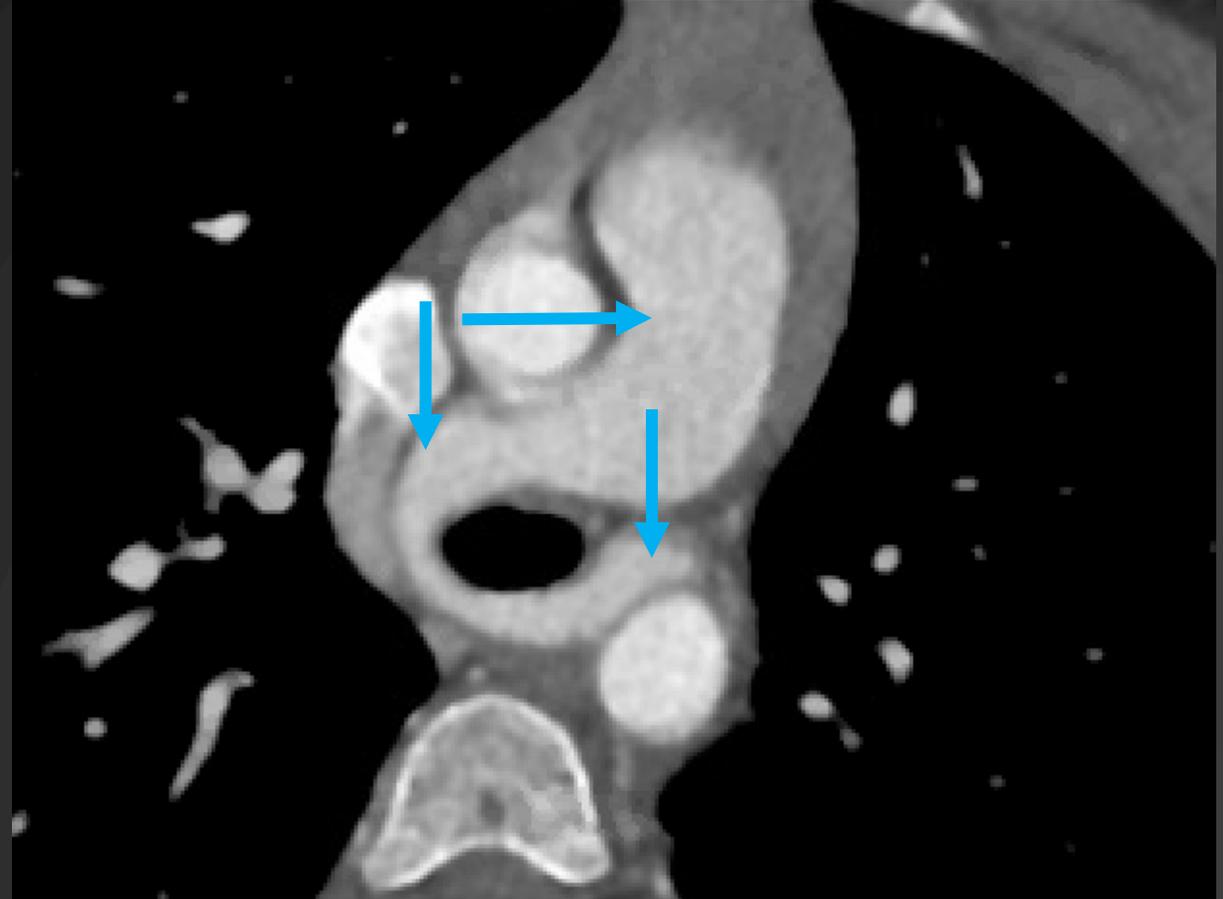
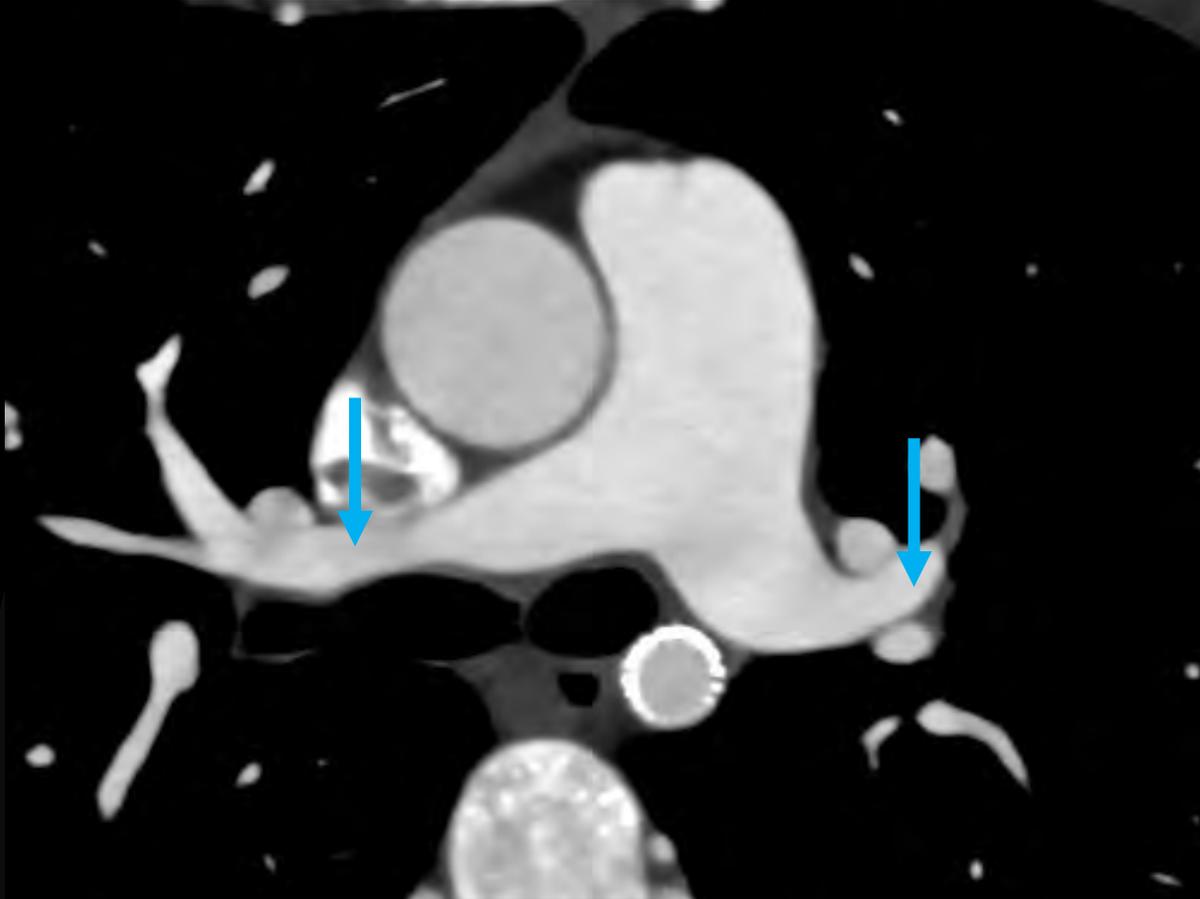
# Artères pulmonaires



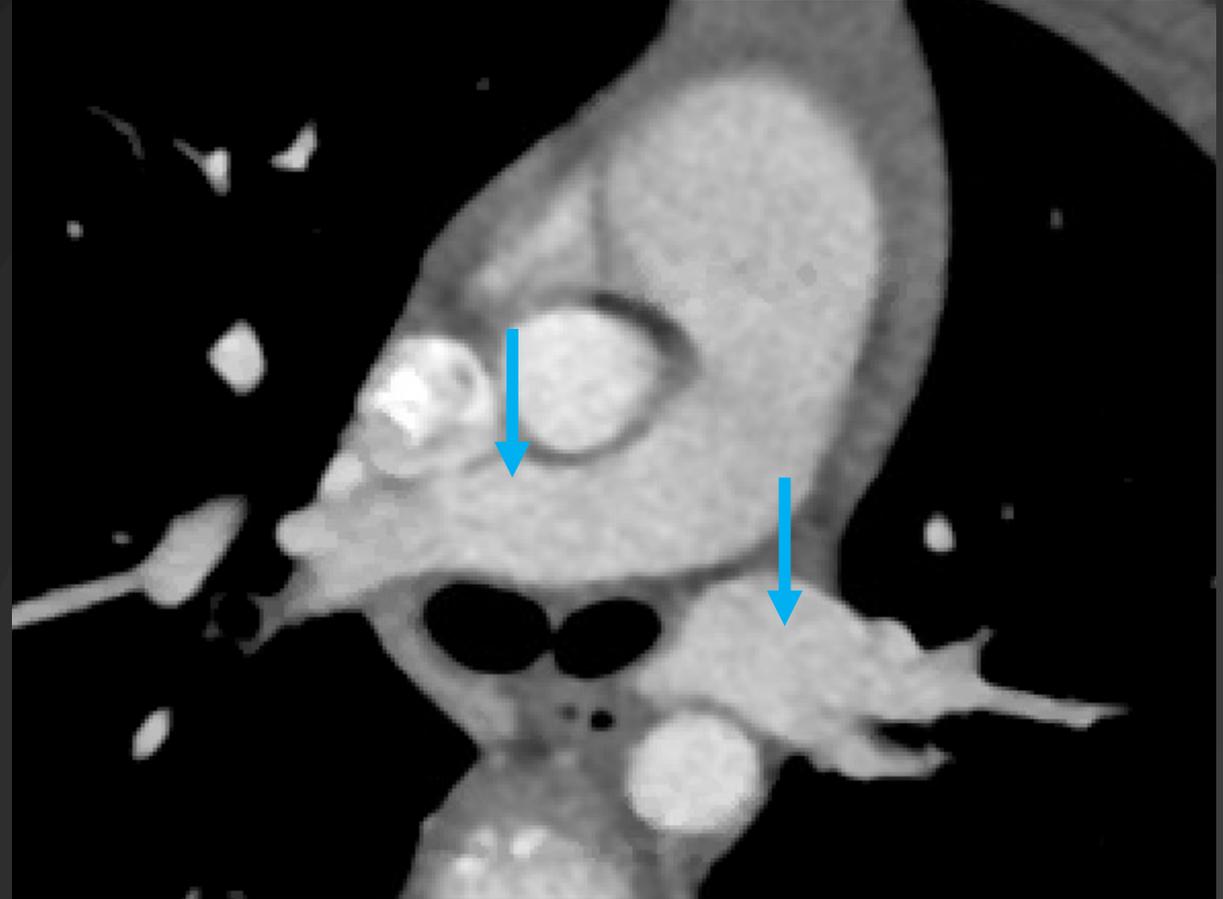
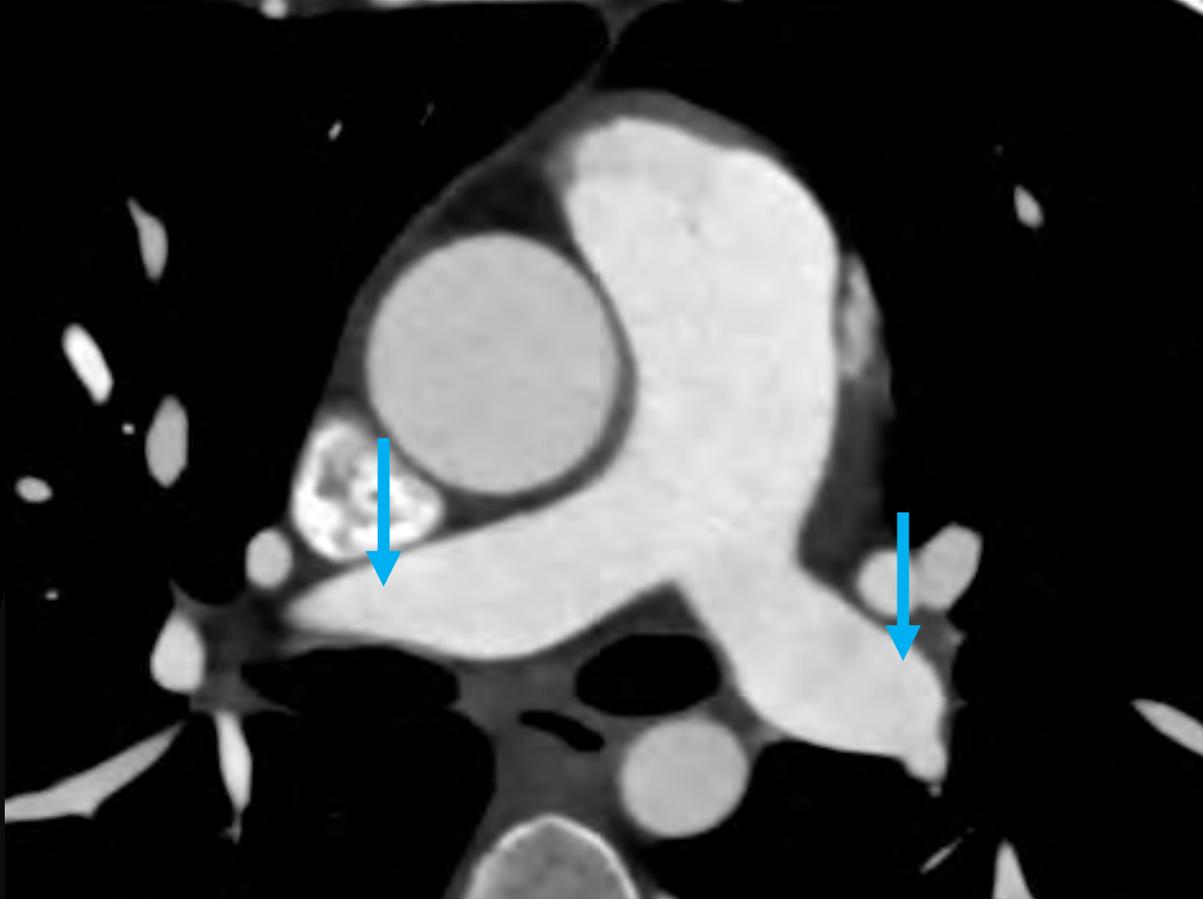
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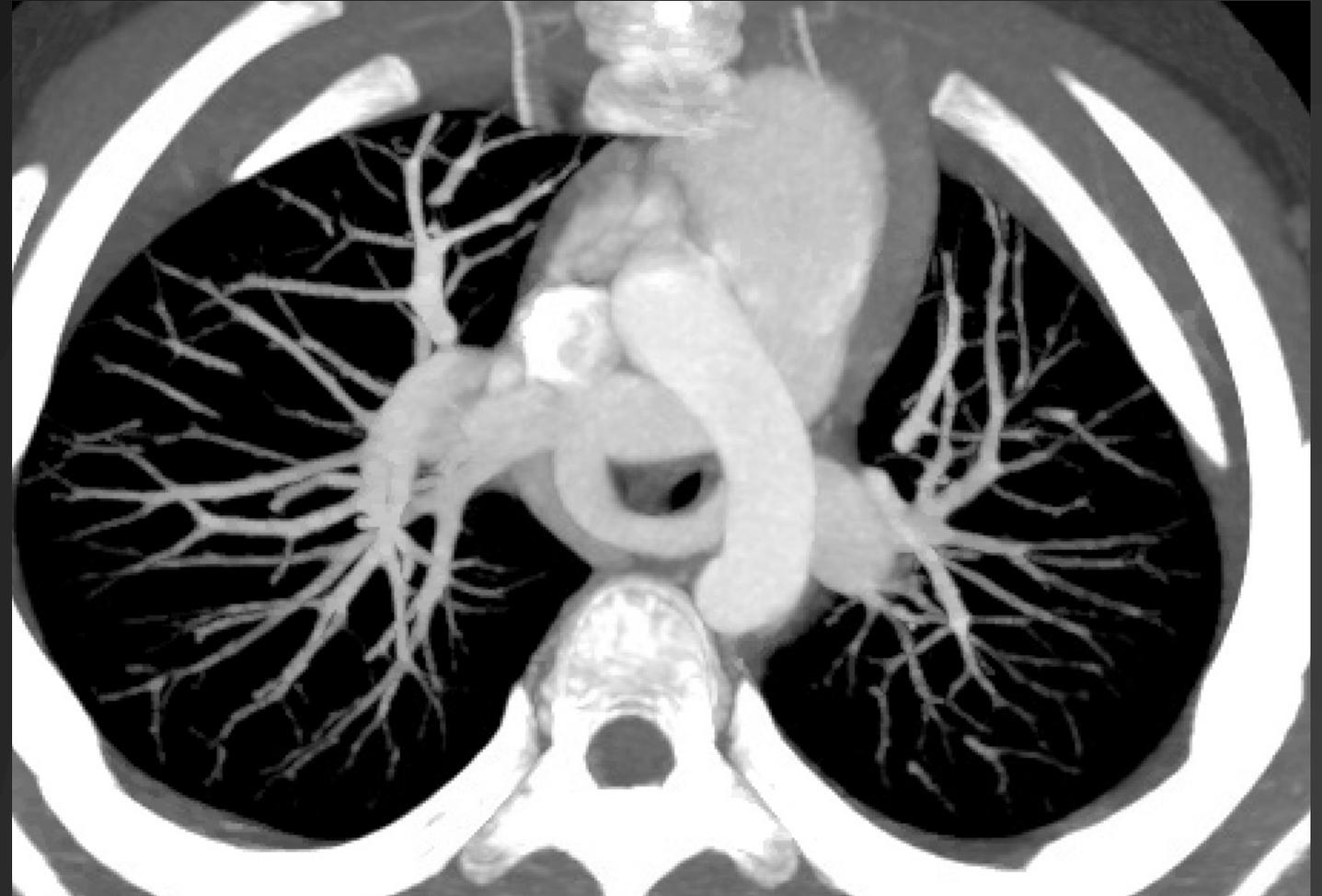
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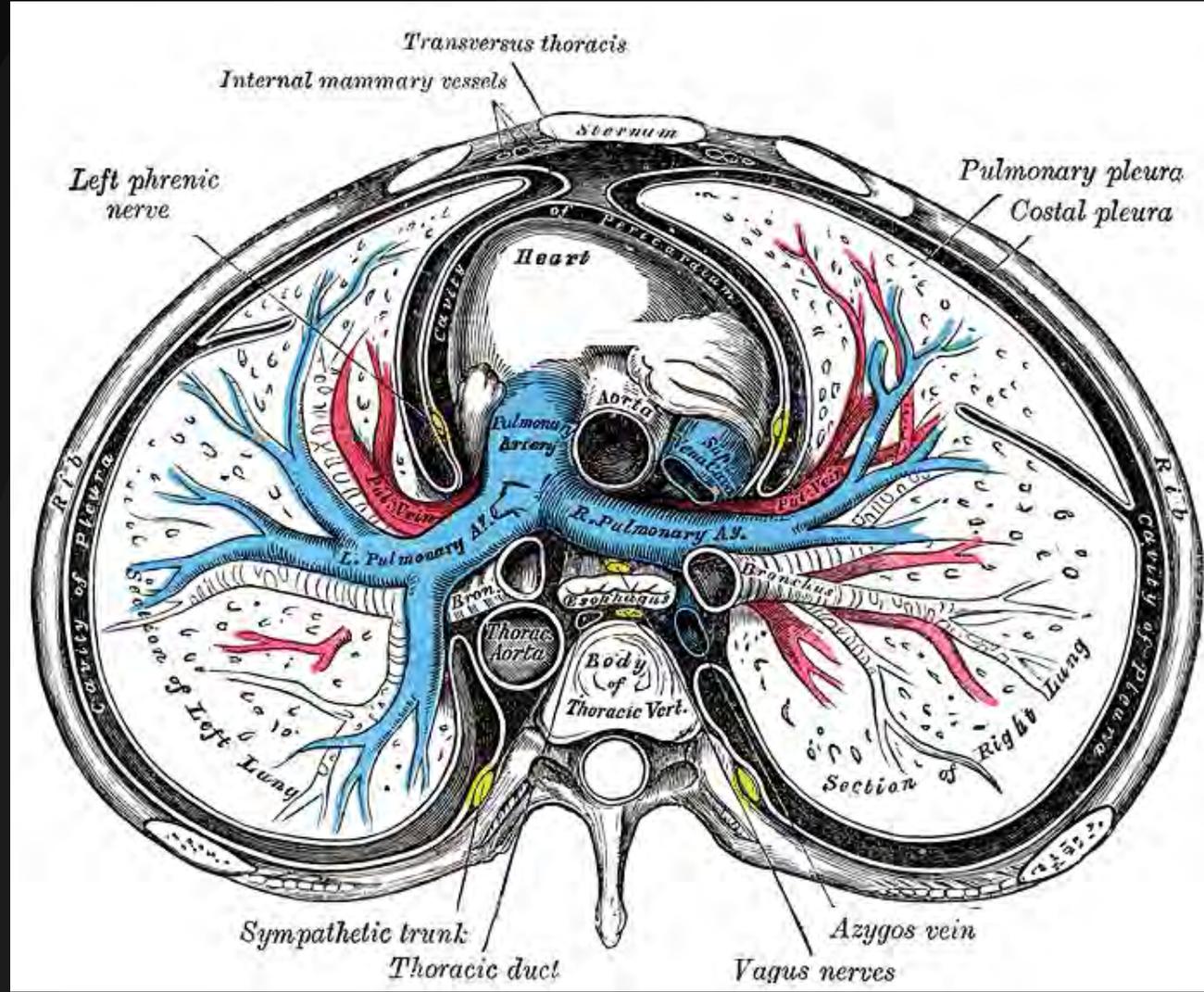
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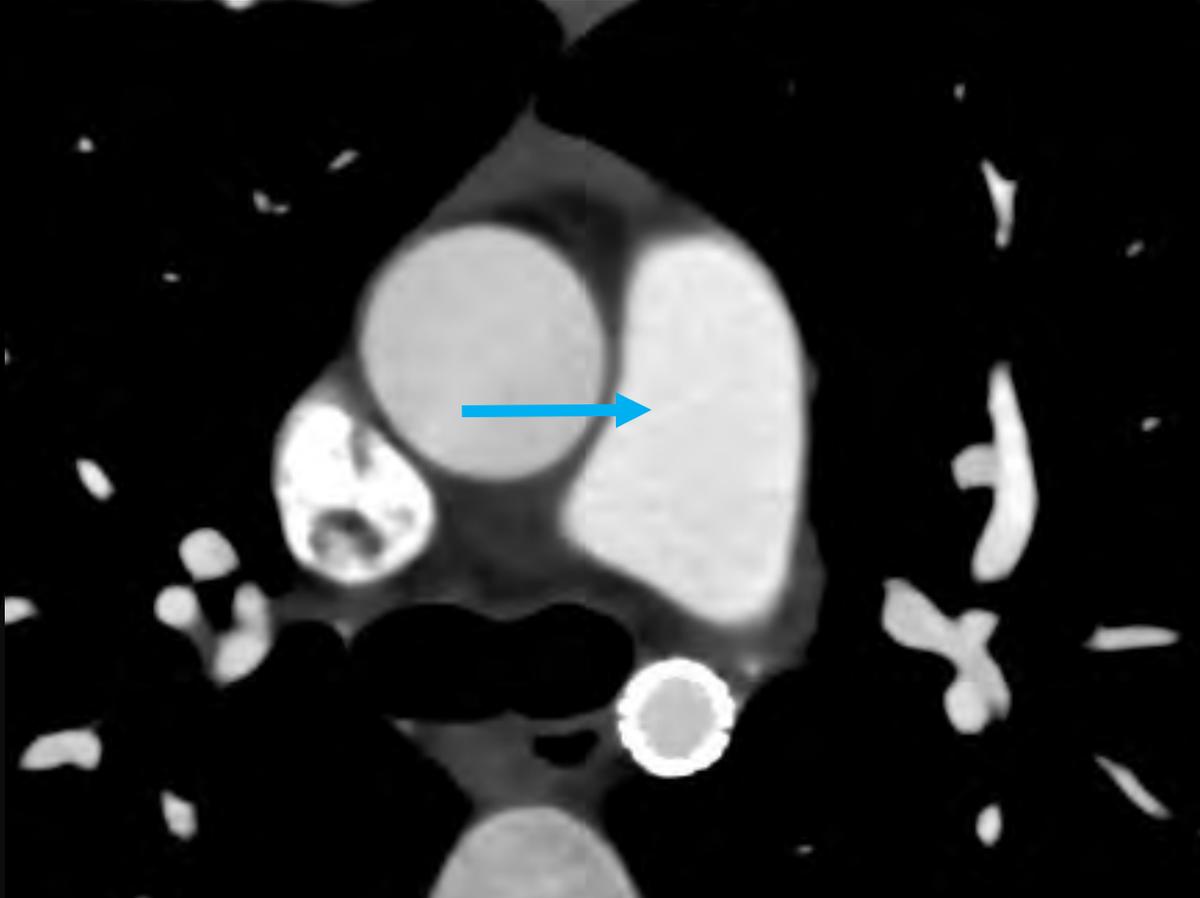
Sling de l'artère pulmonaire gauche



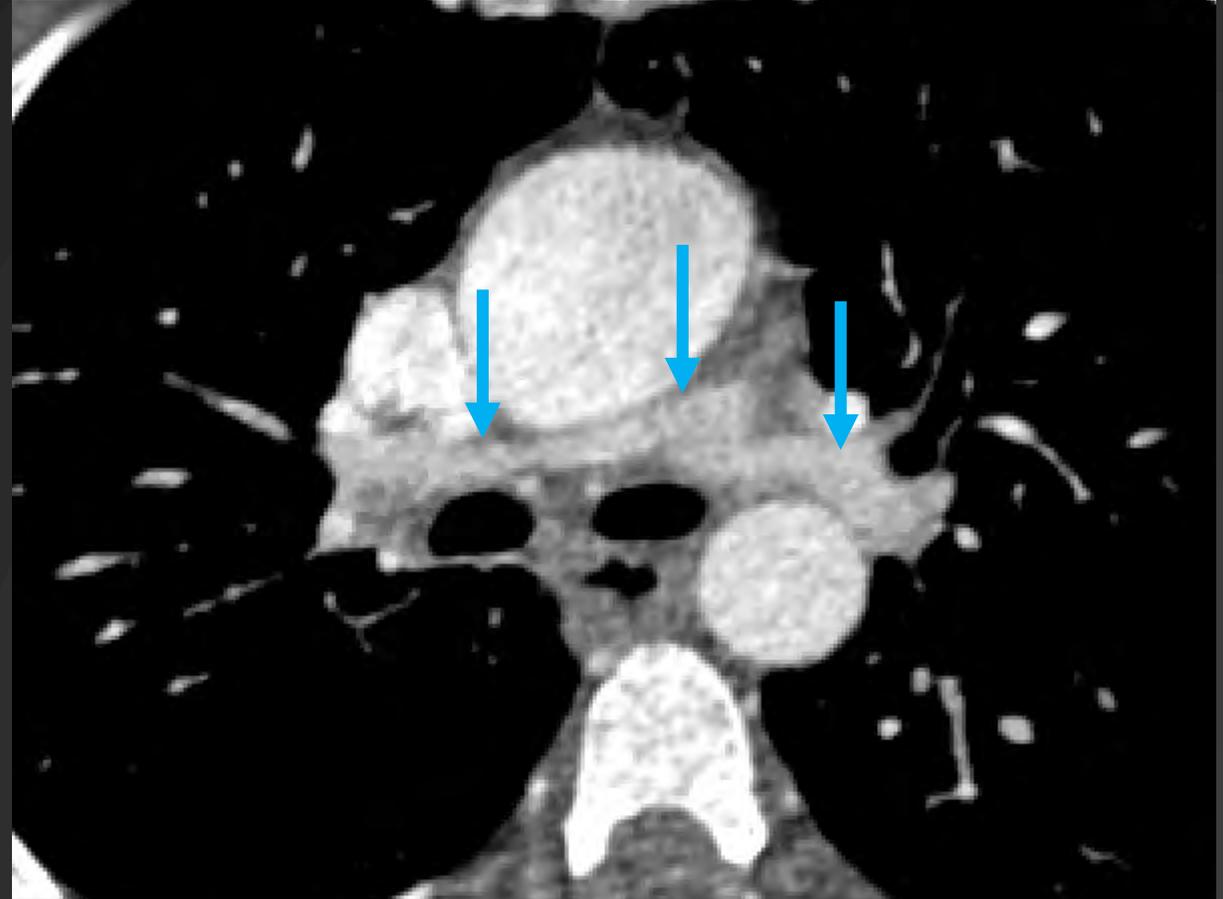
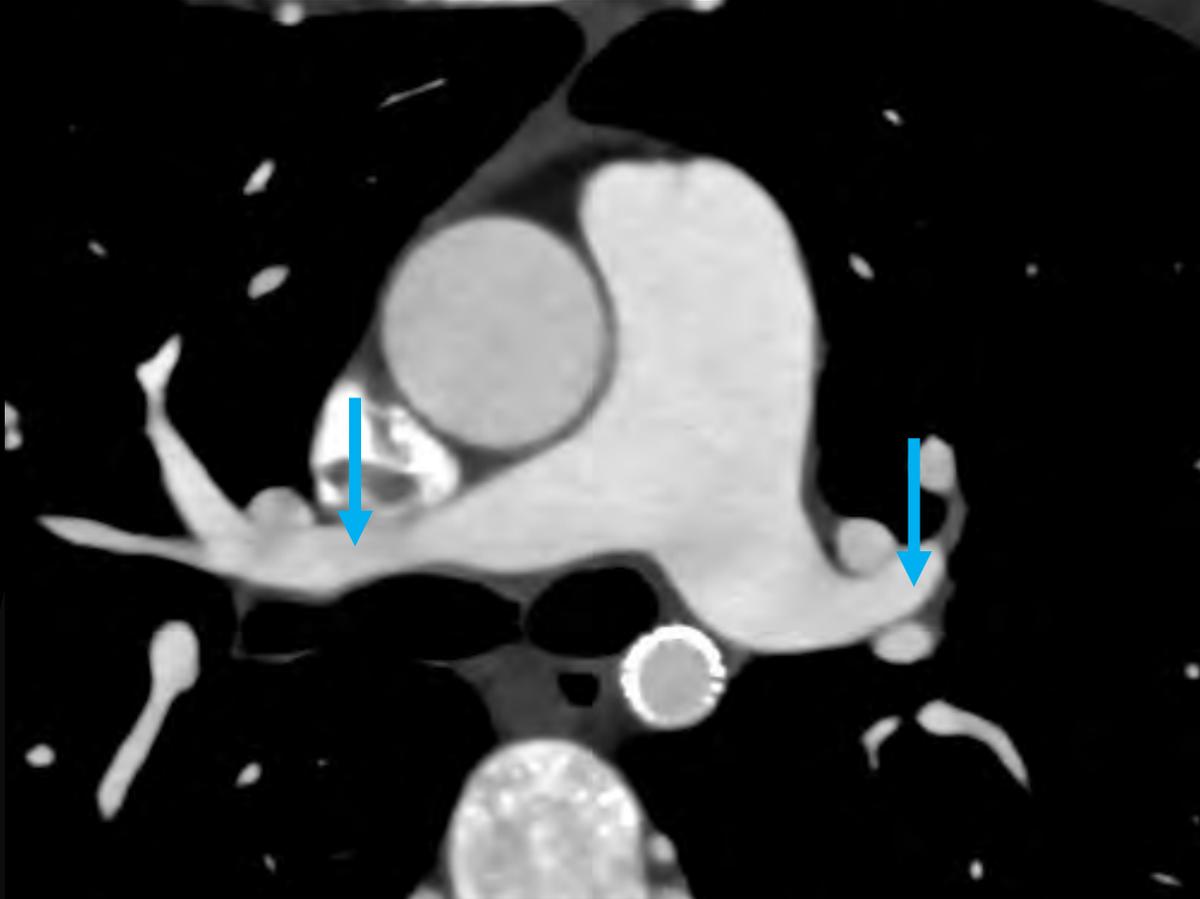
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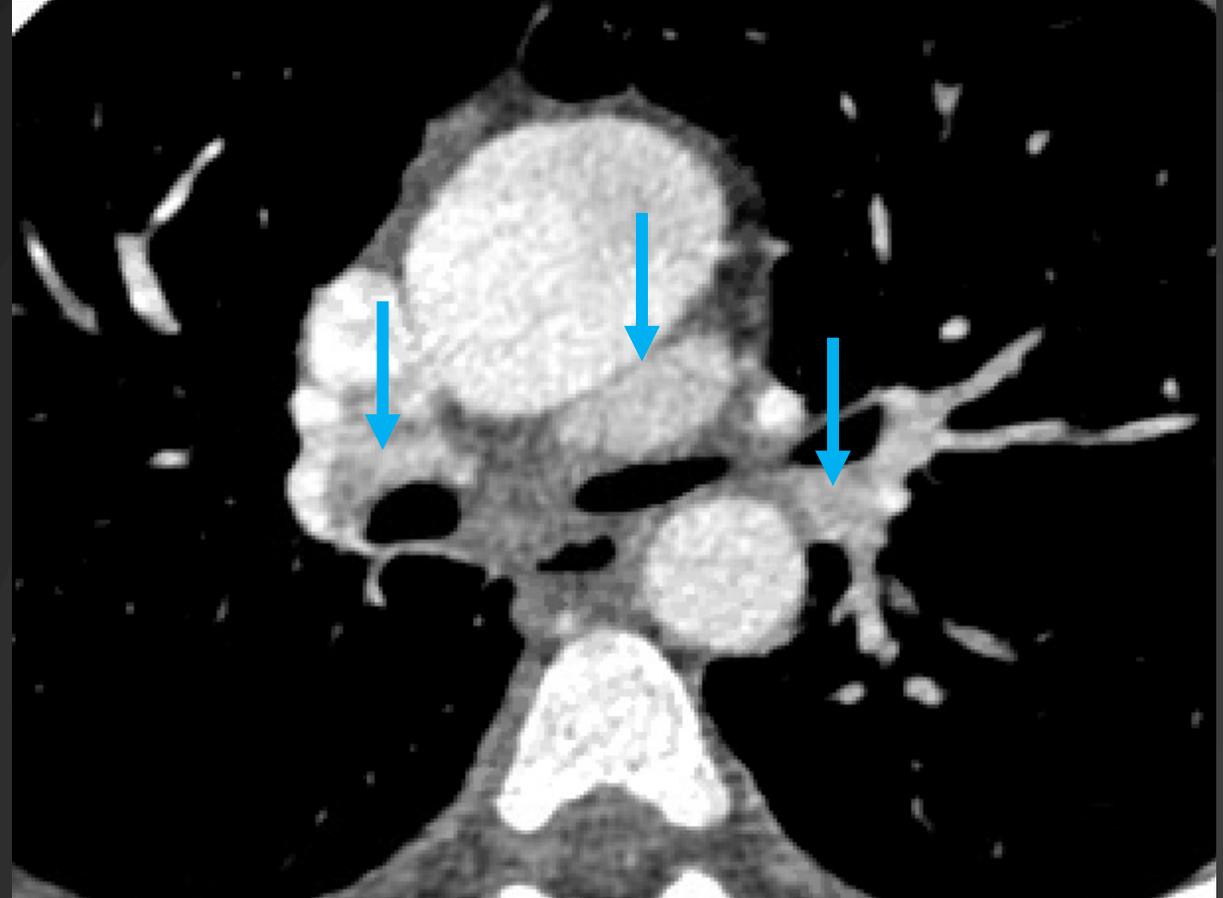
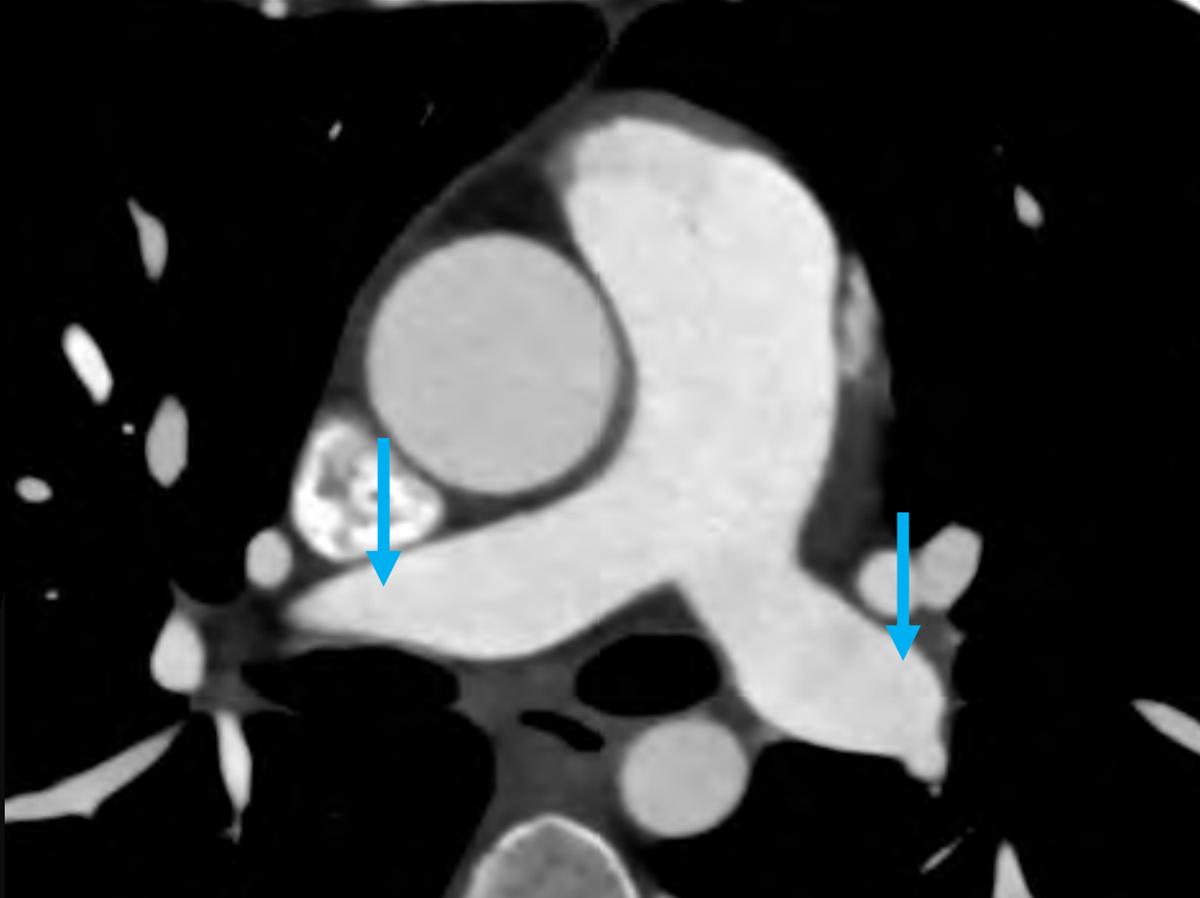
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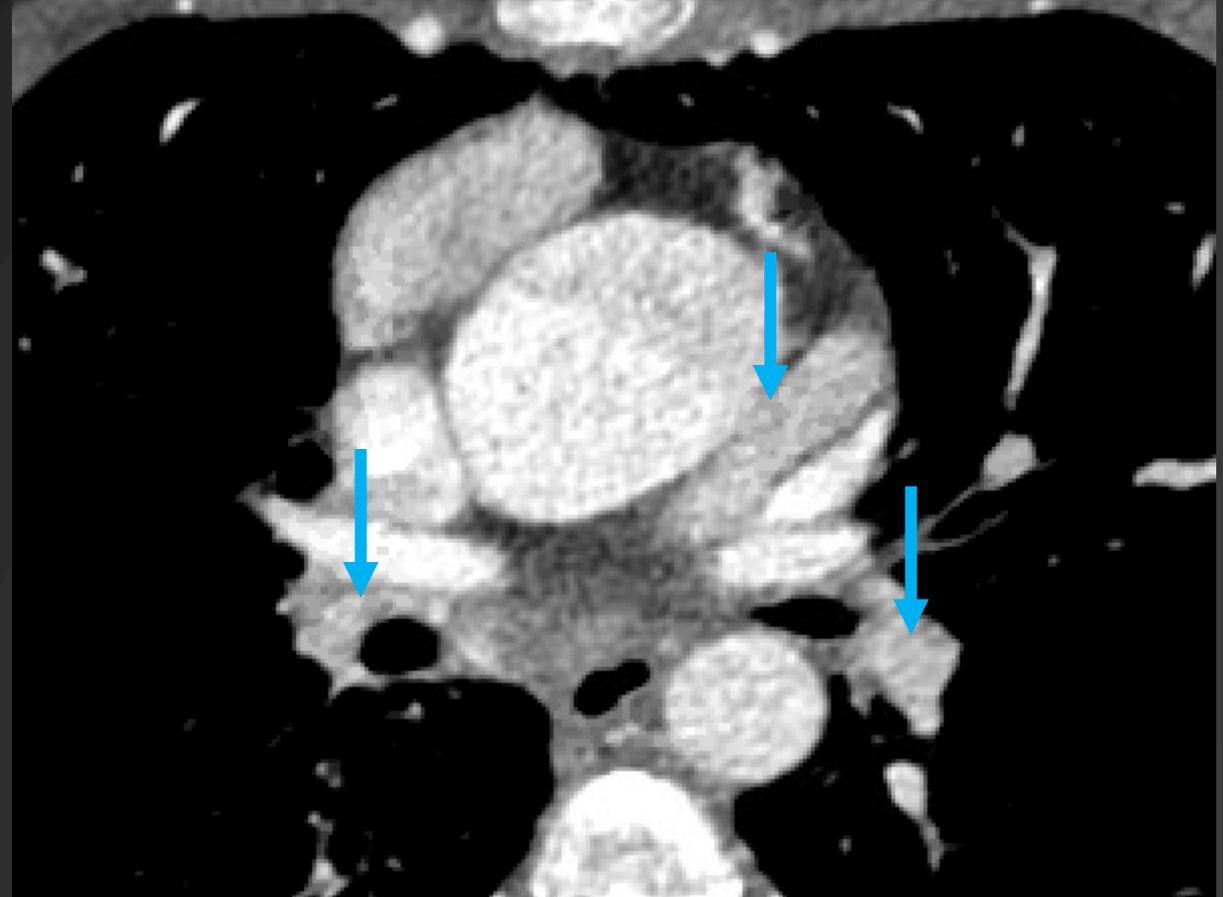
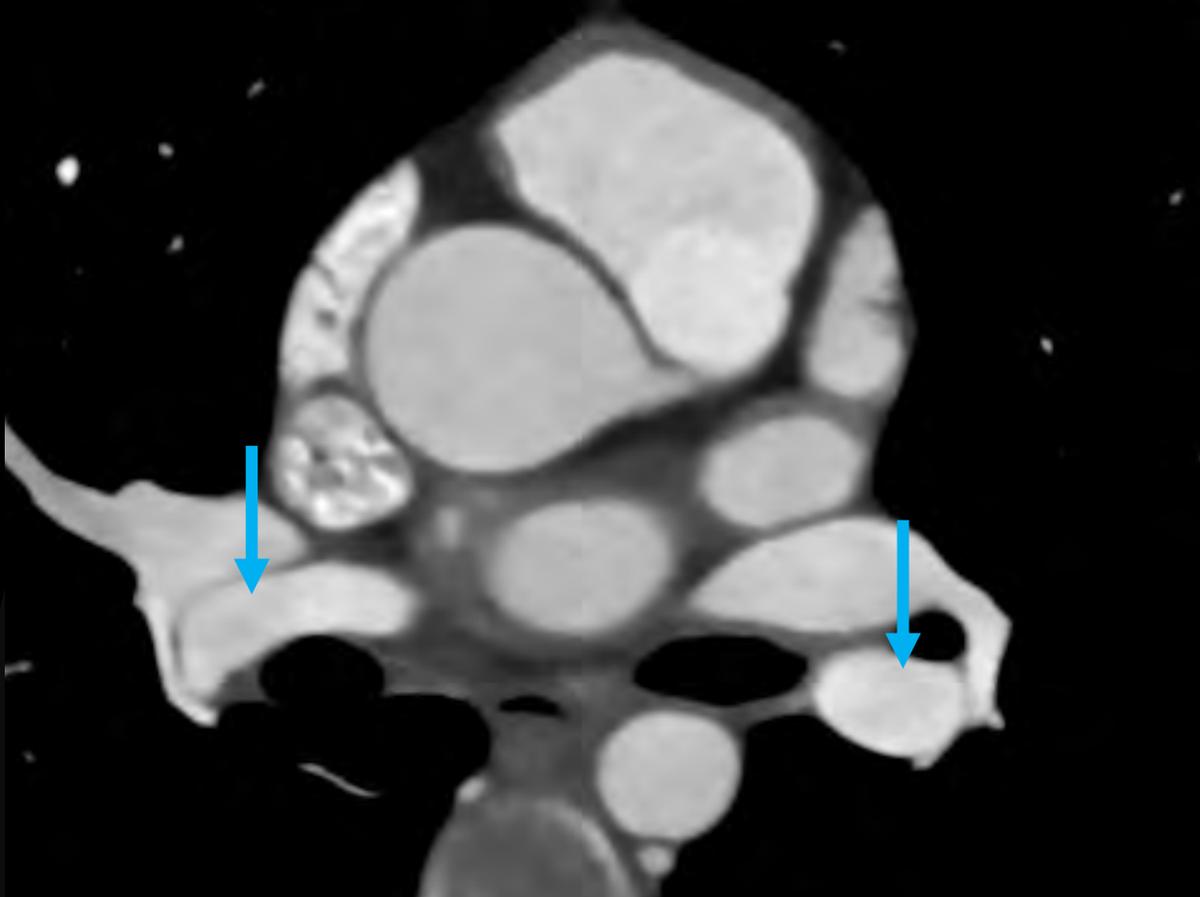
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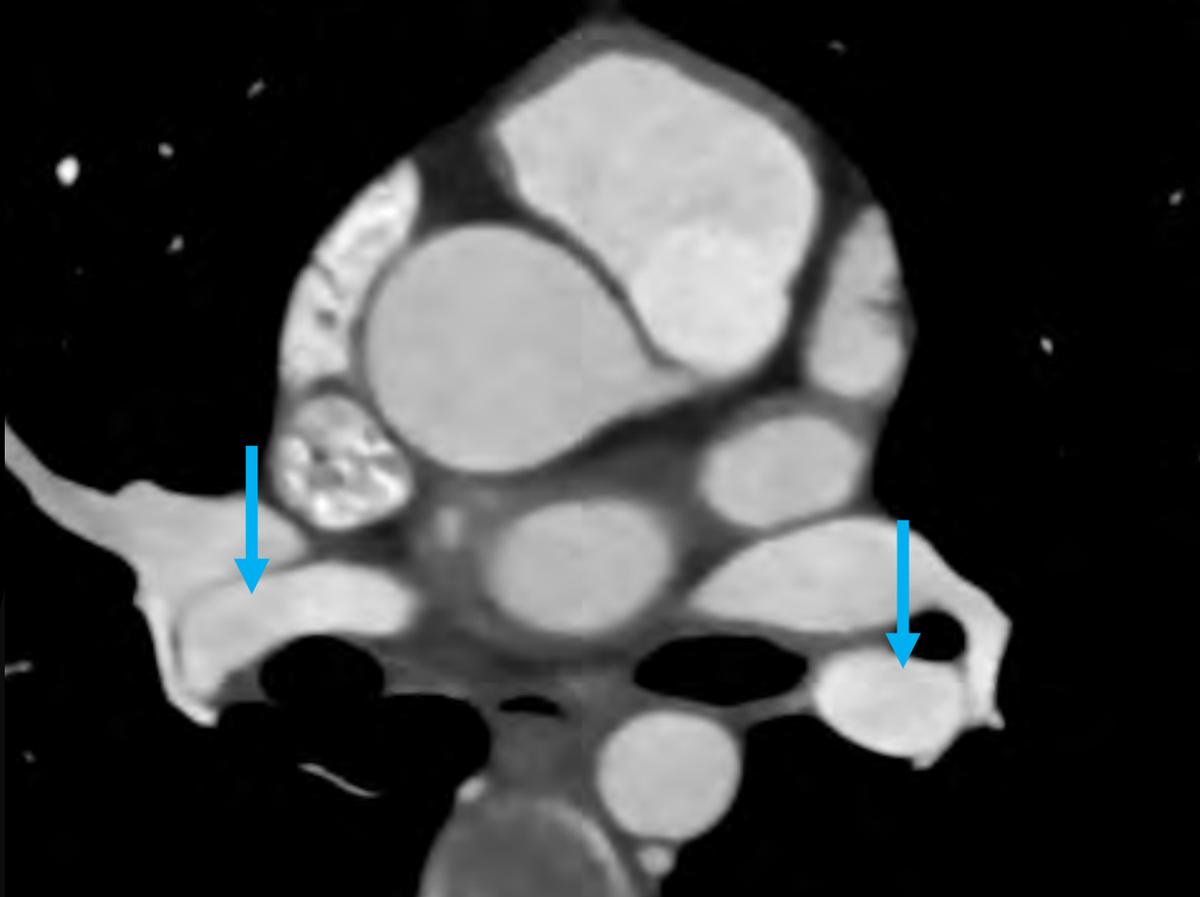
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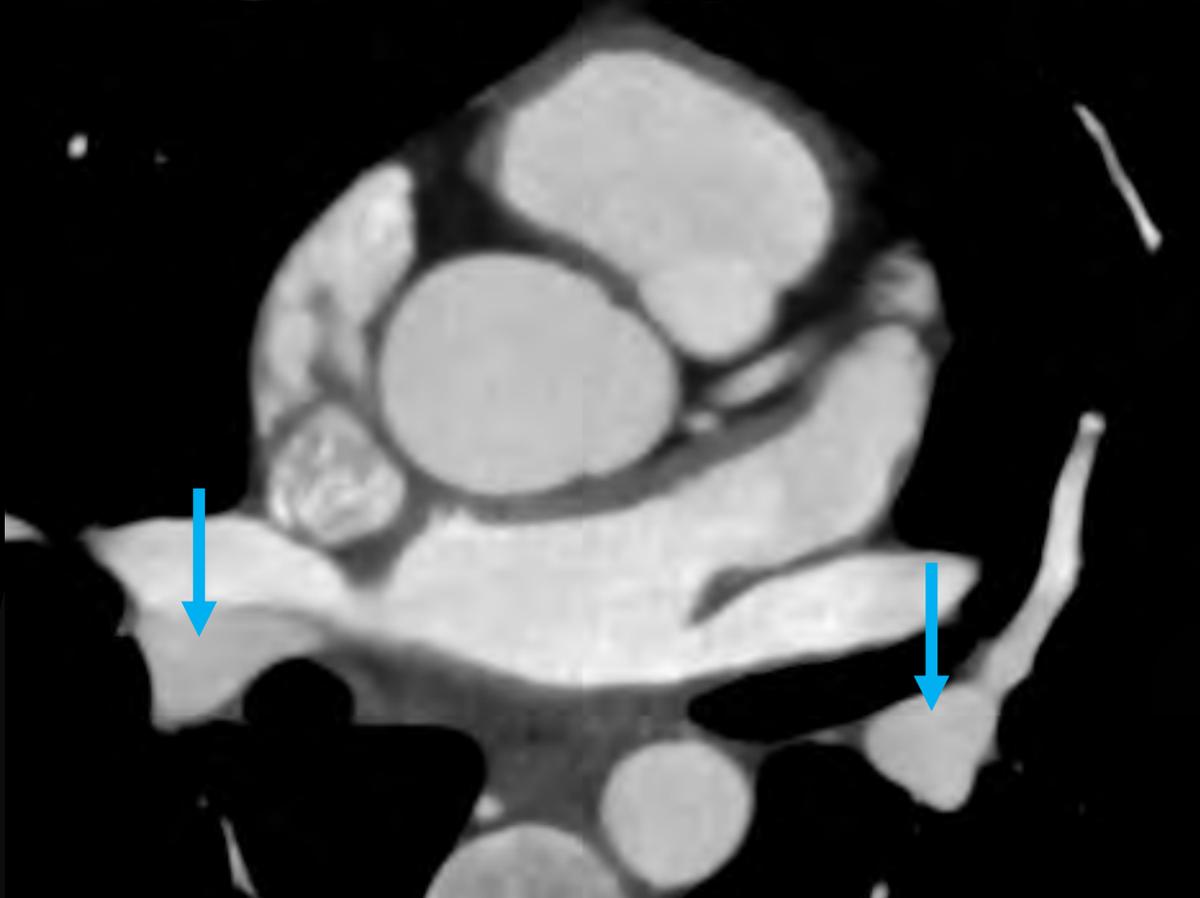
# Artères pulmonaires



# Artères pulmonaires



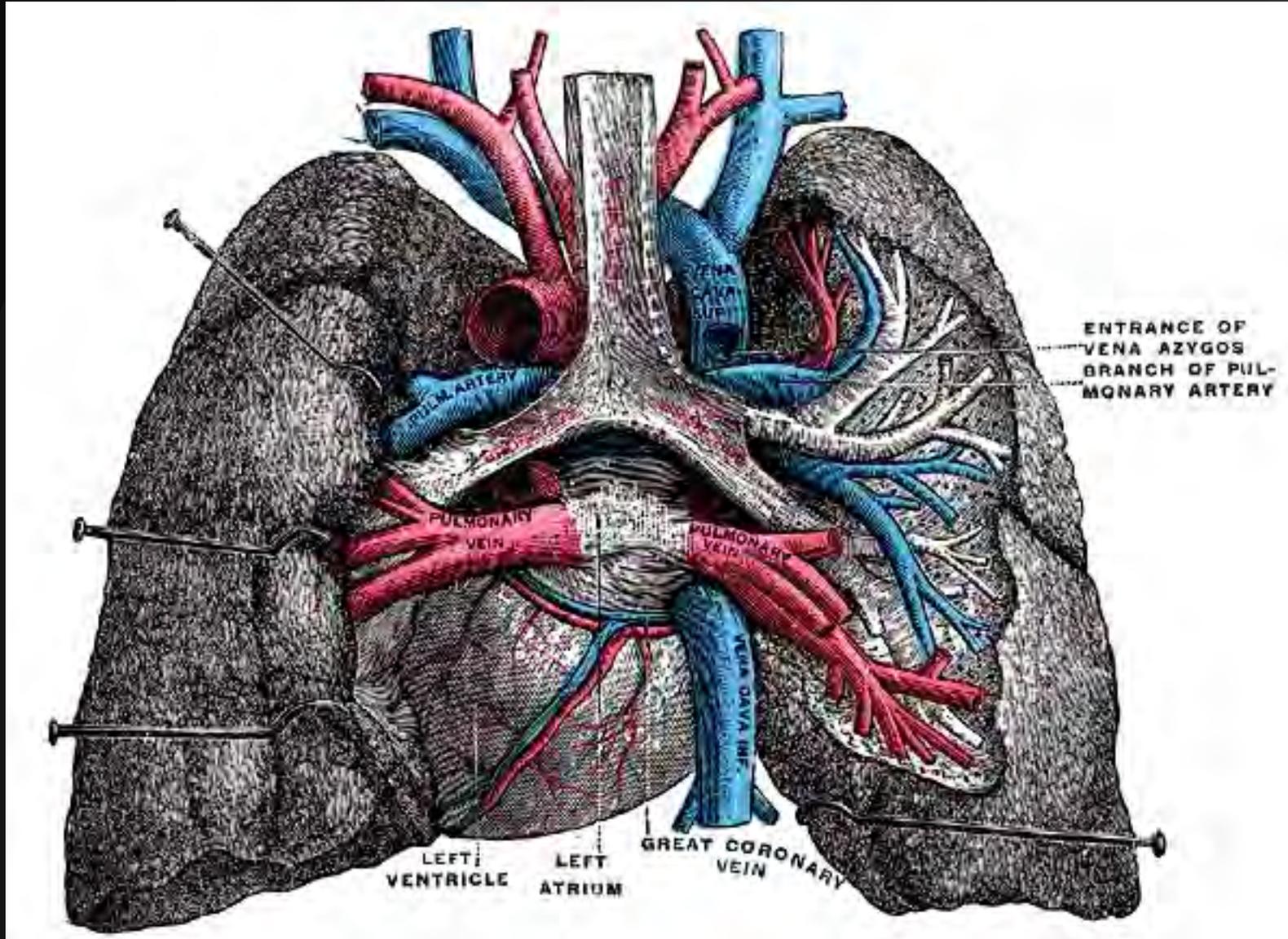
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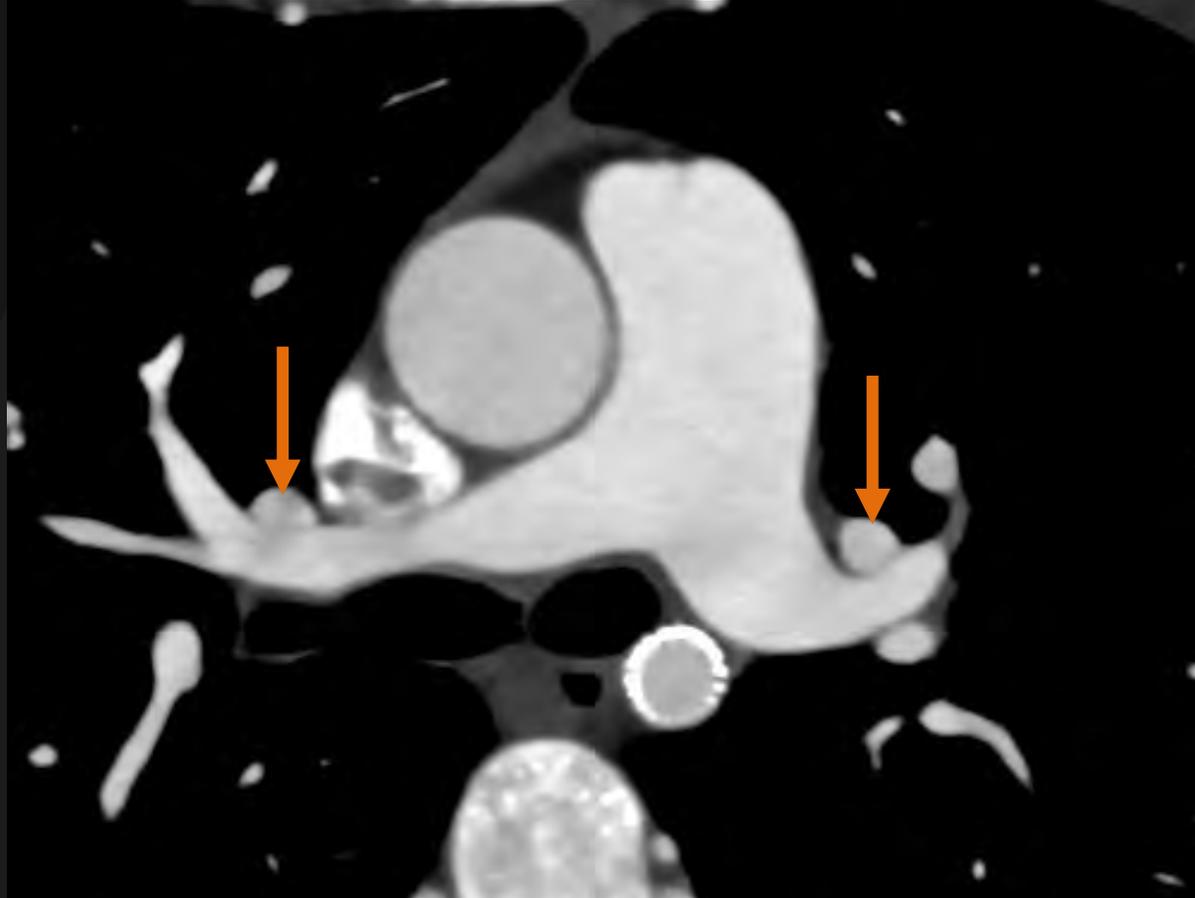
Atrésie pulmonaire à septum ouvert opérée



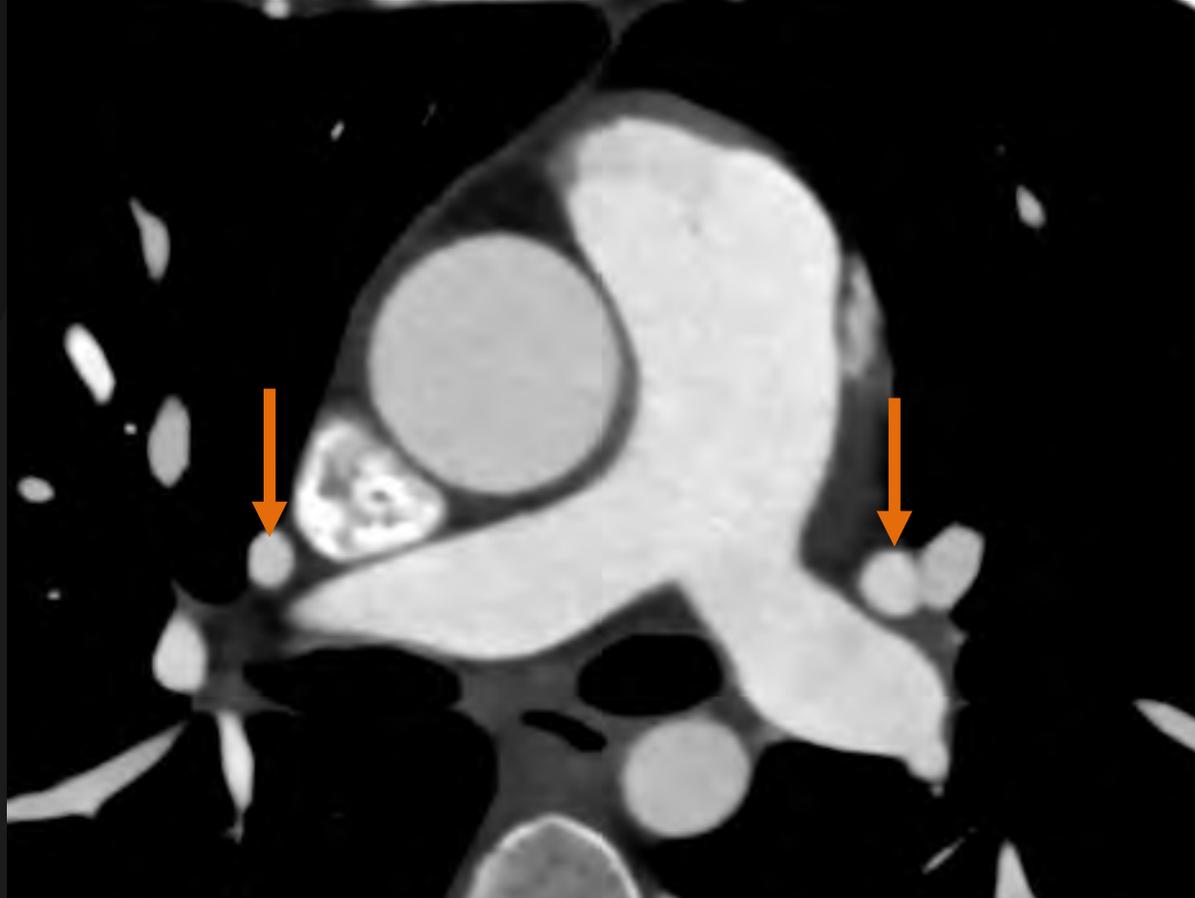
# Veines pulmonaires



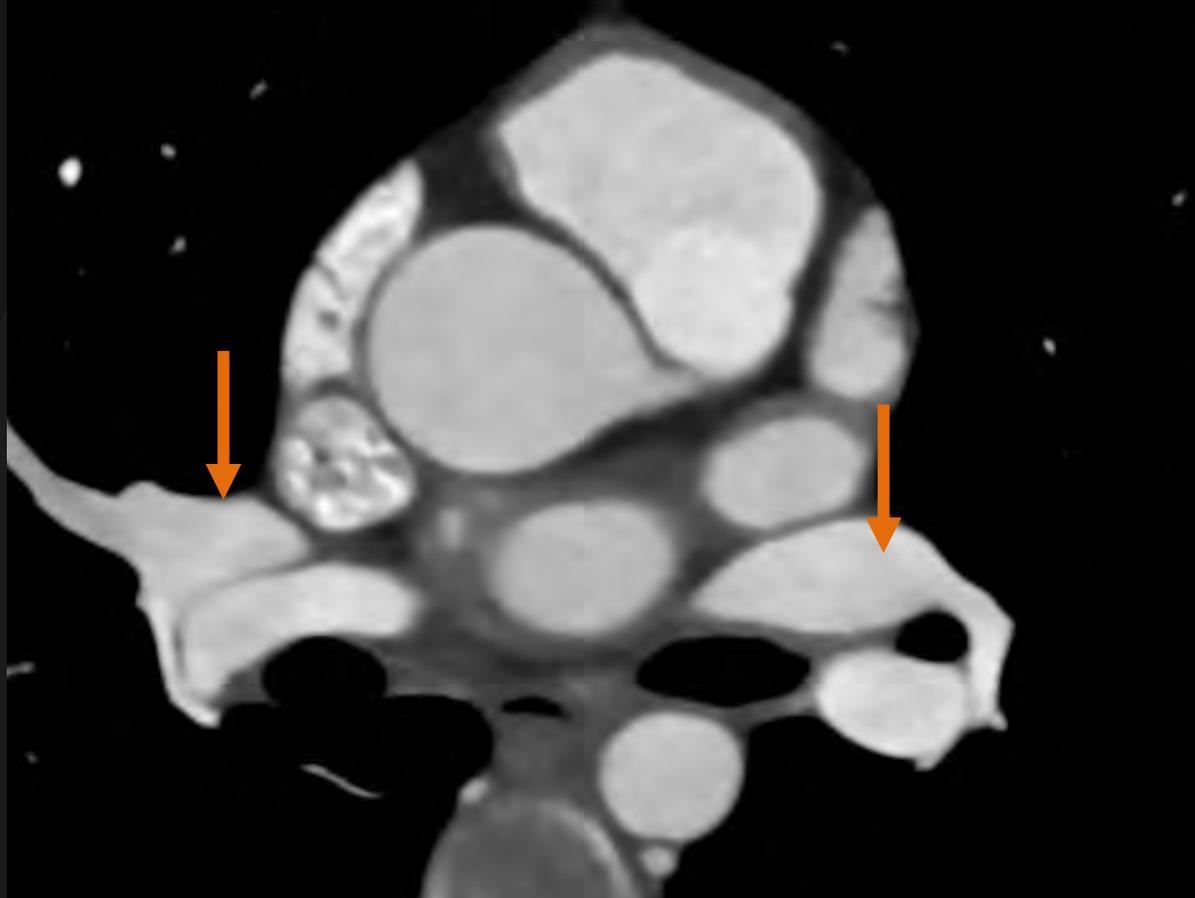
# Veines pulmonaires



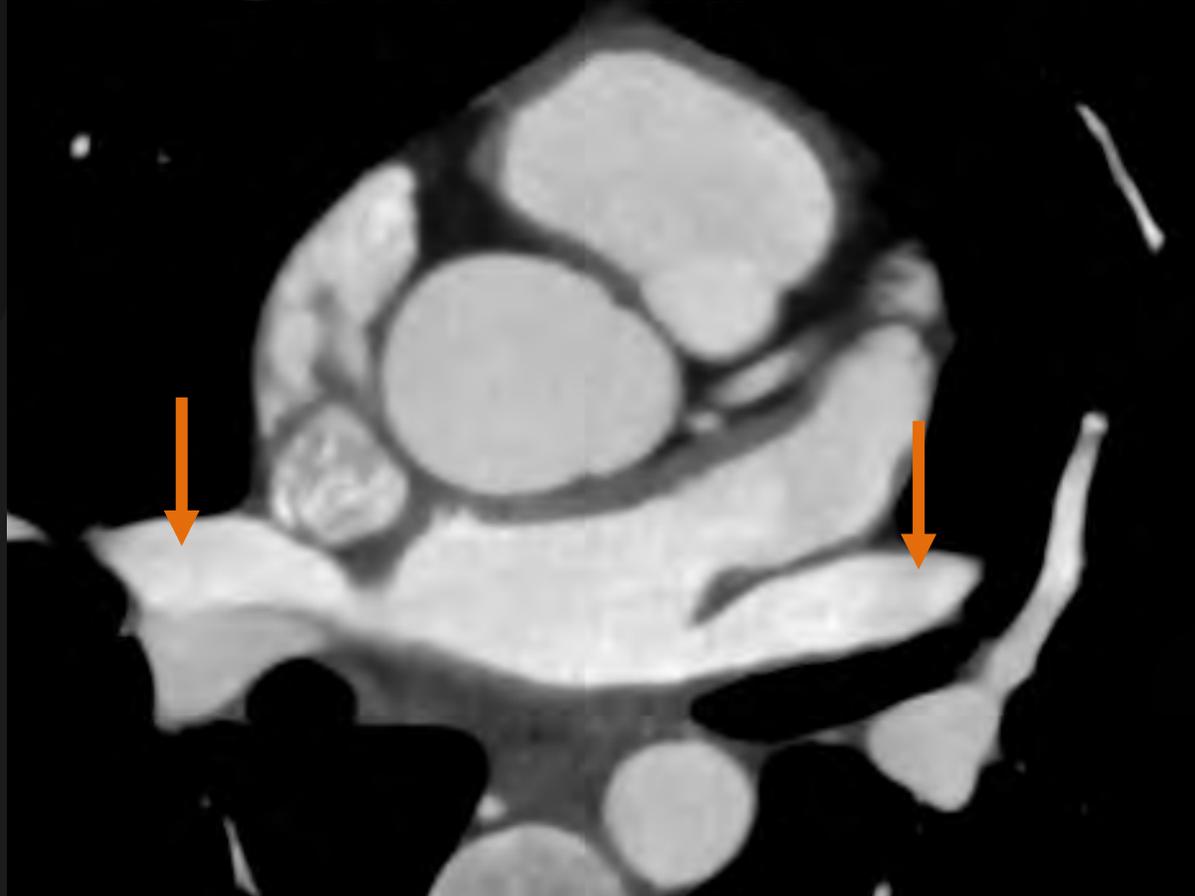
# Veines pulmonaires



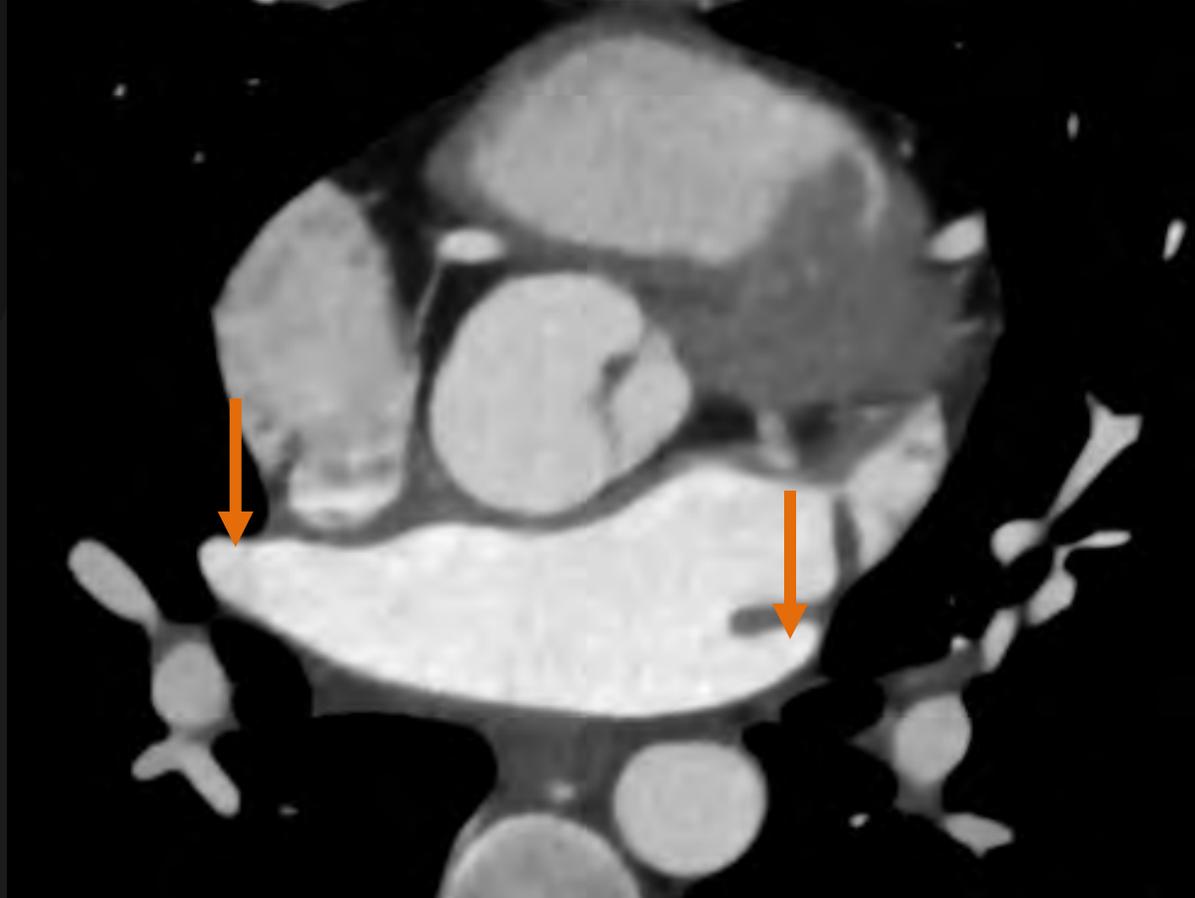
# Veines pulmonaires



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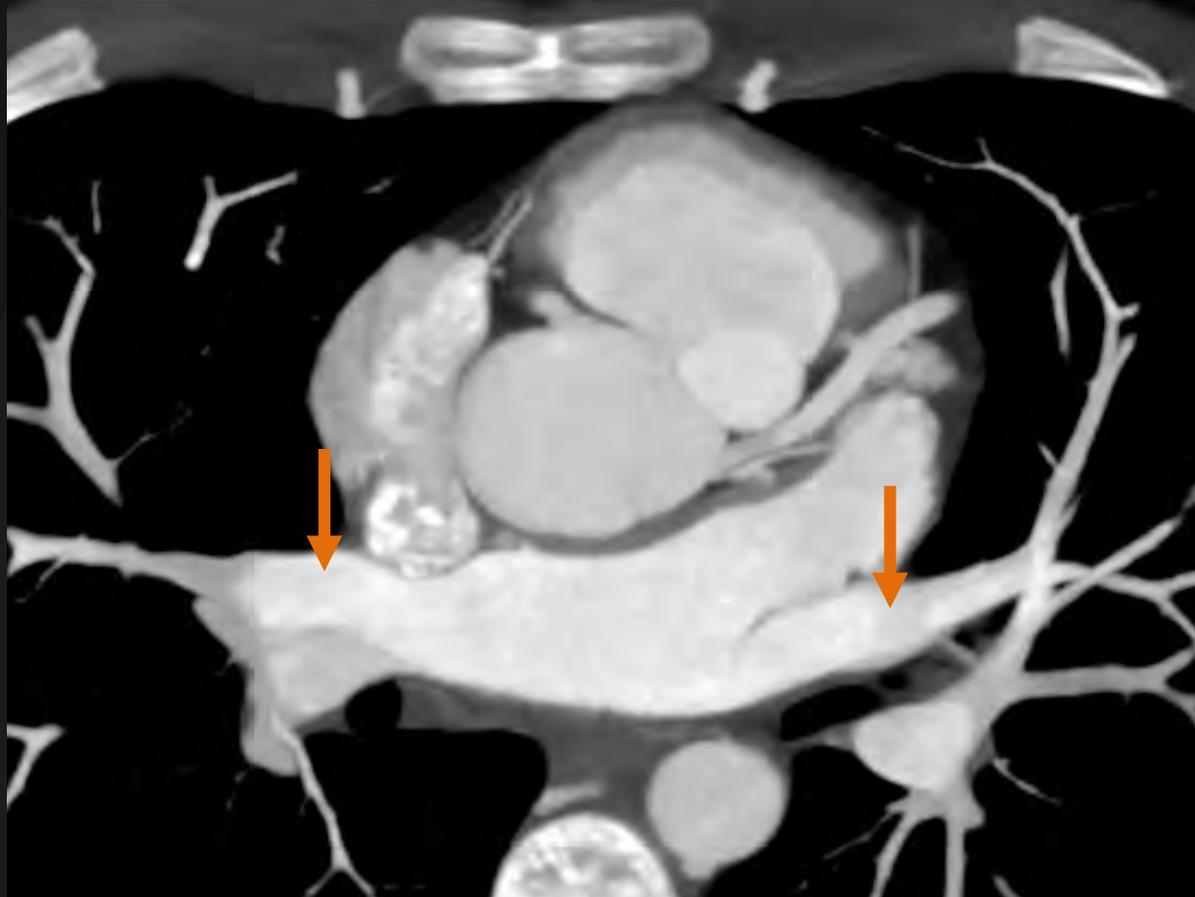
# Veines pulmonaires



# Veines pulmonaires



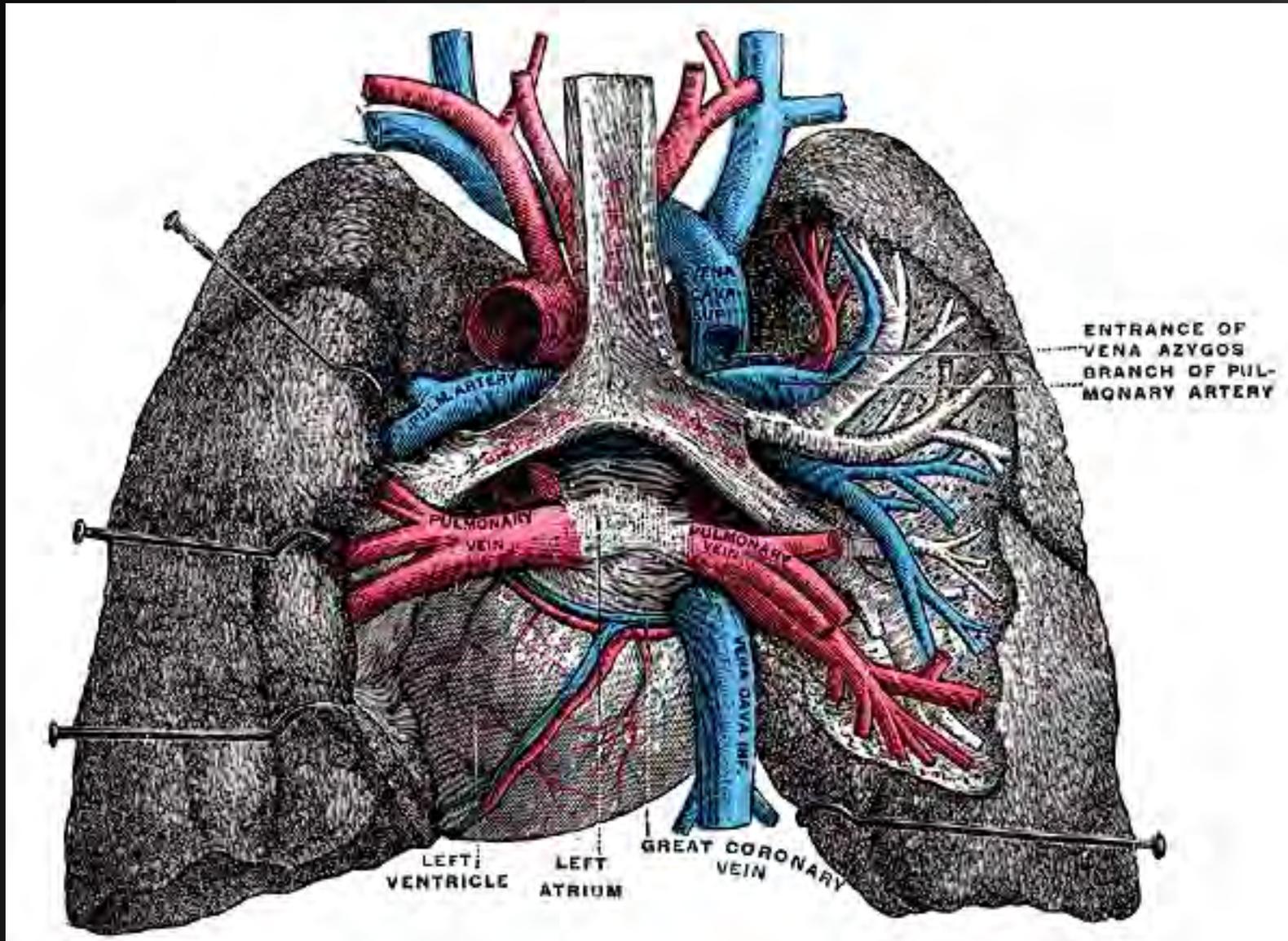
# Veines pulmonaires



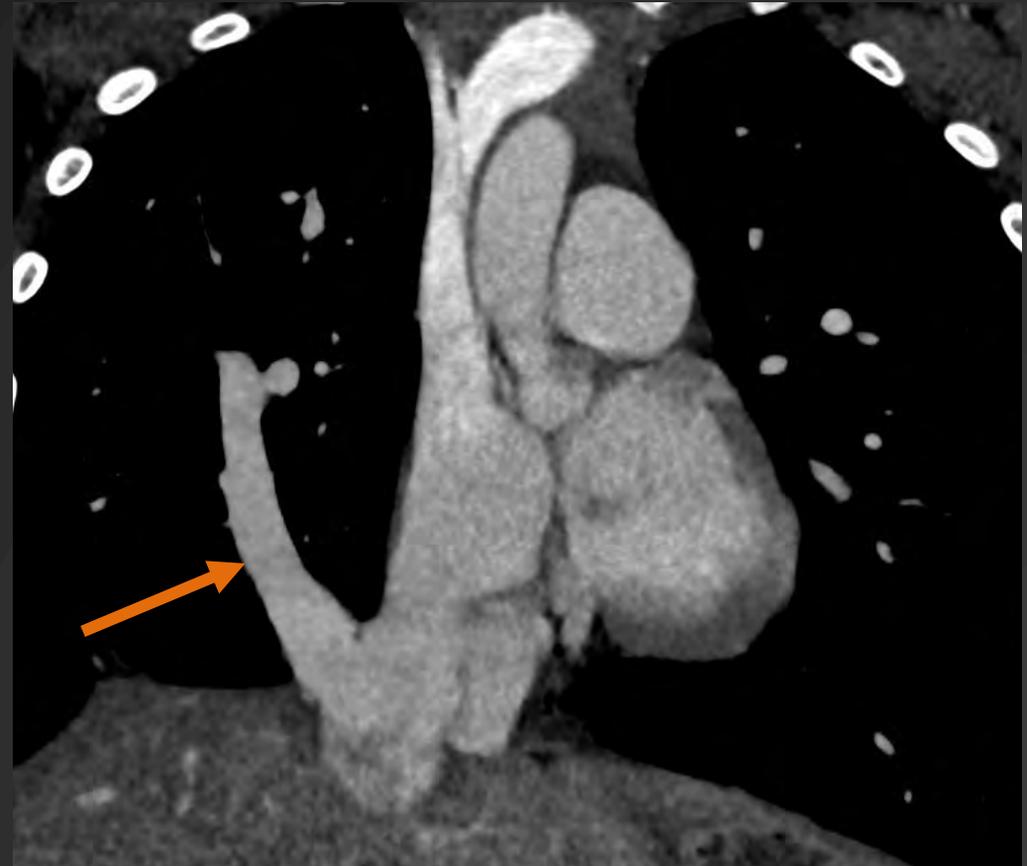
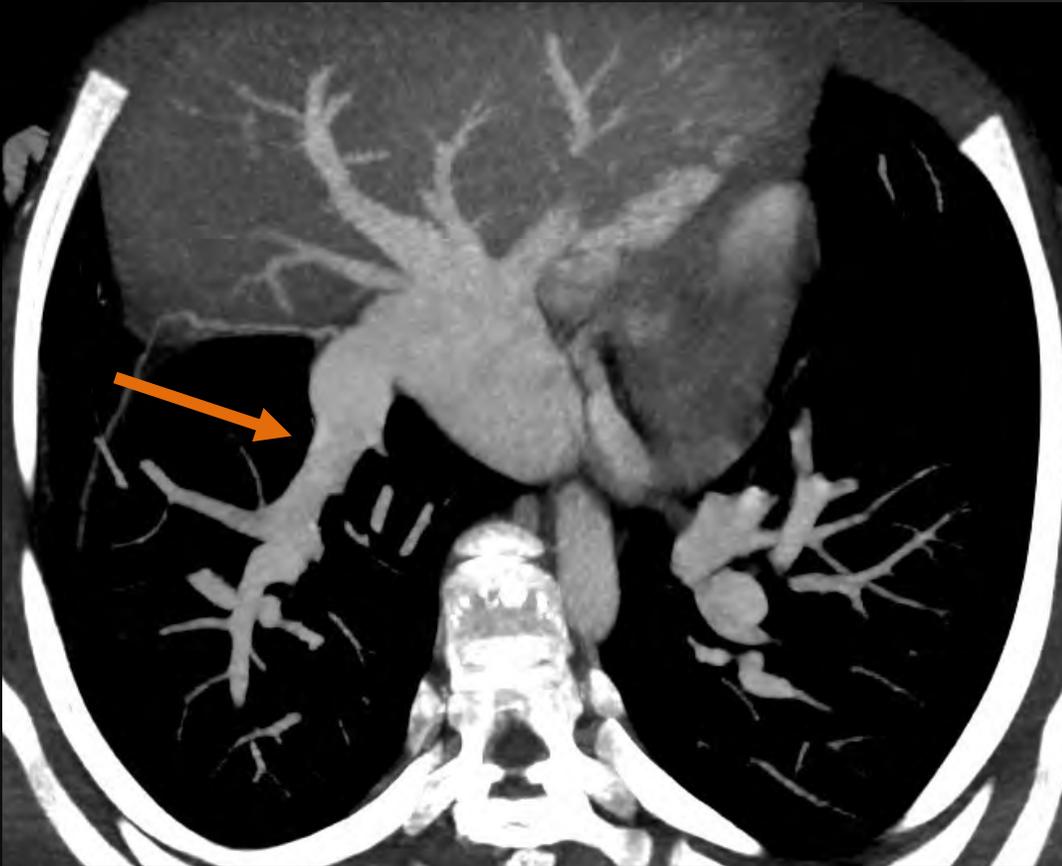
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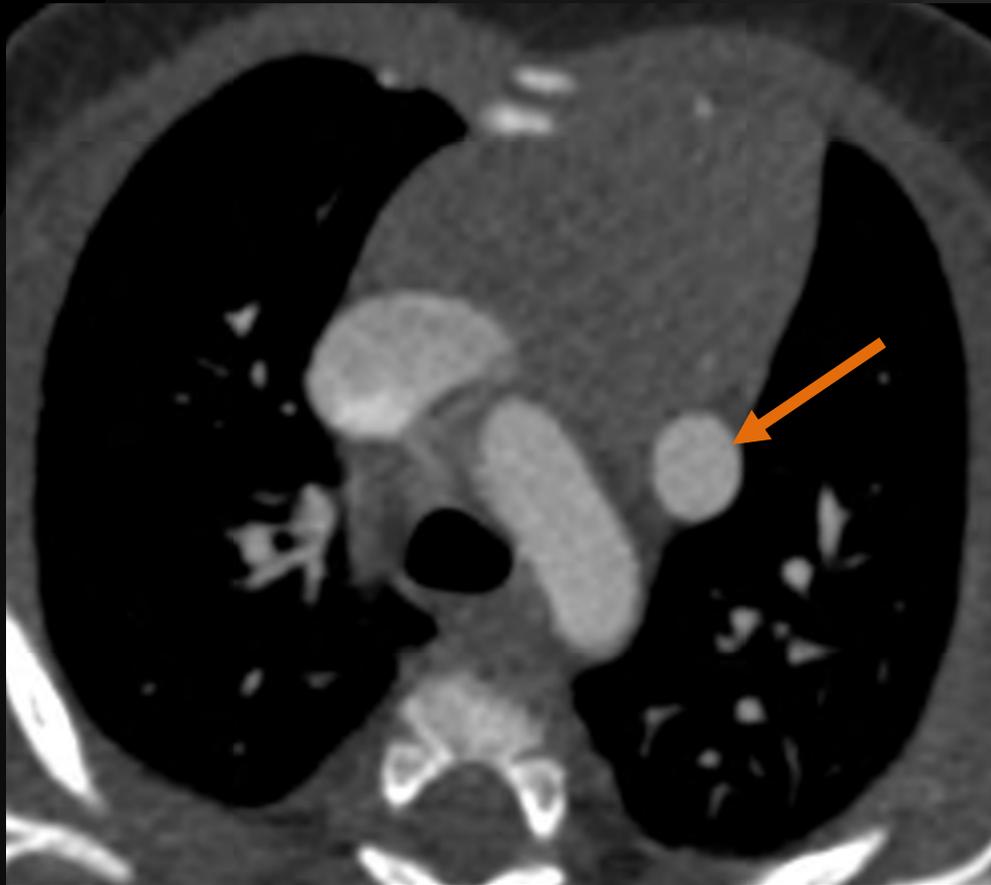
# Veines pulmonaires



# Veines pulmonaires

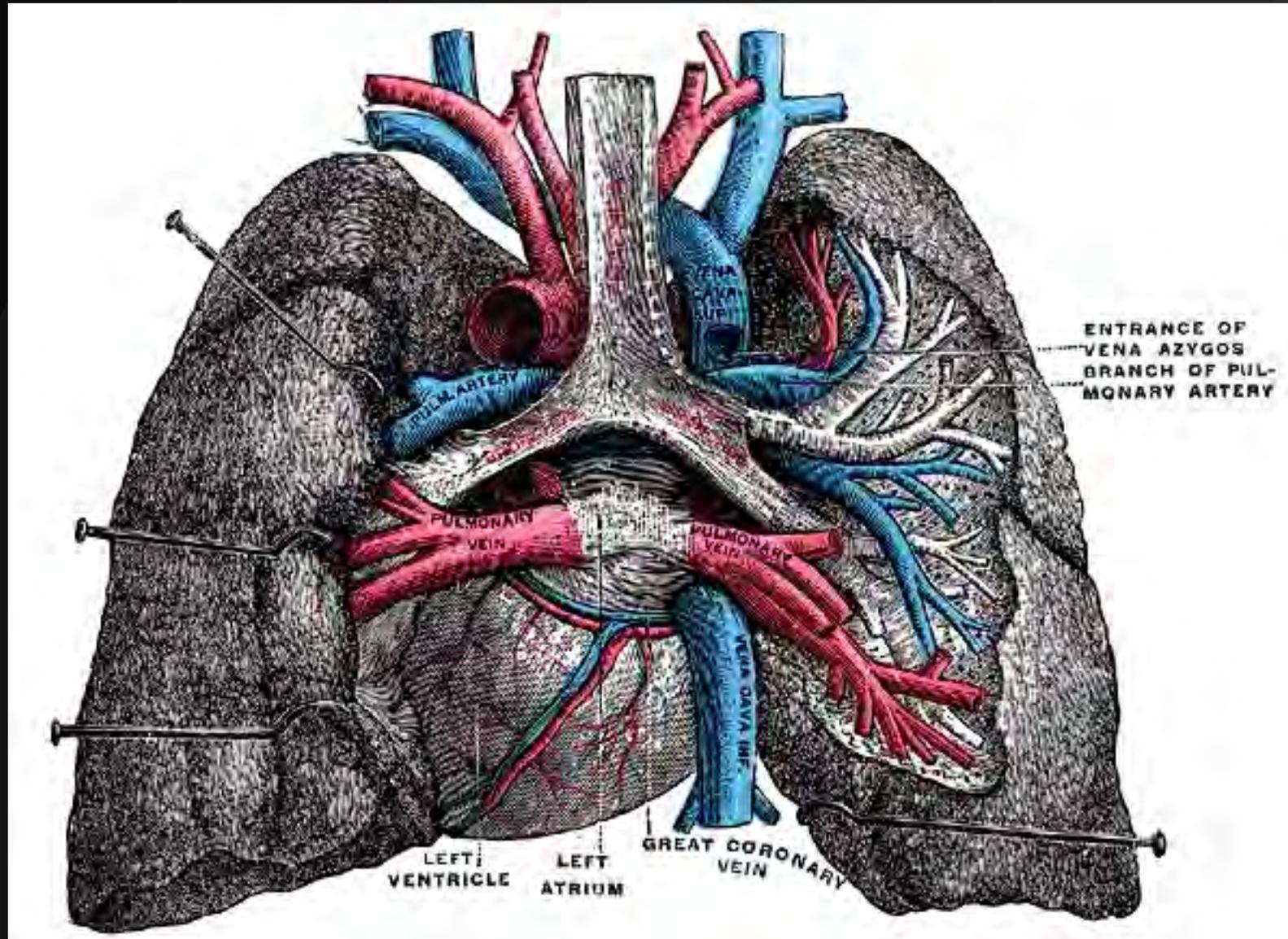


RVPA partiel

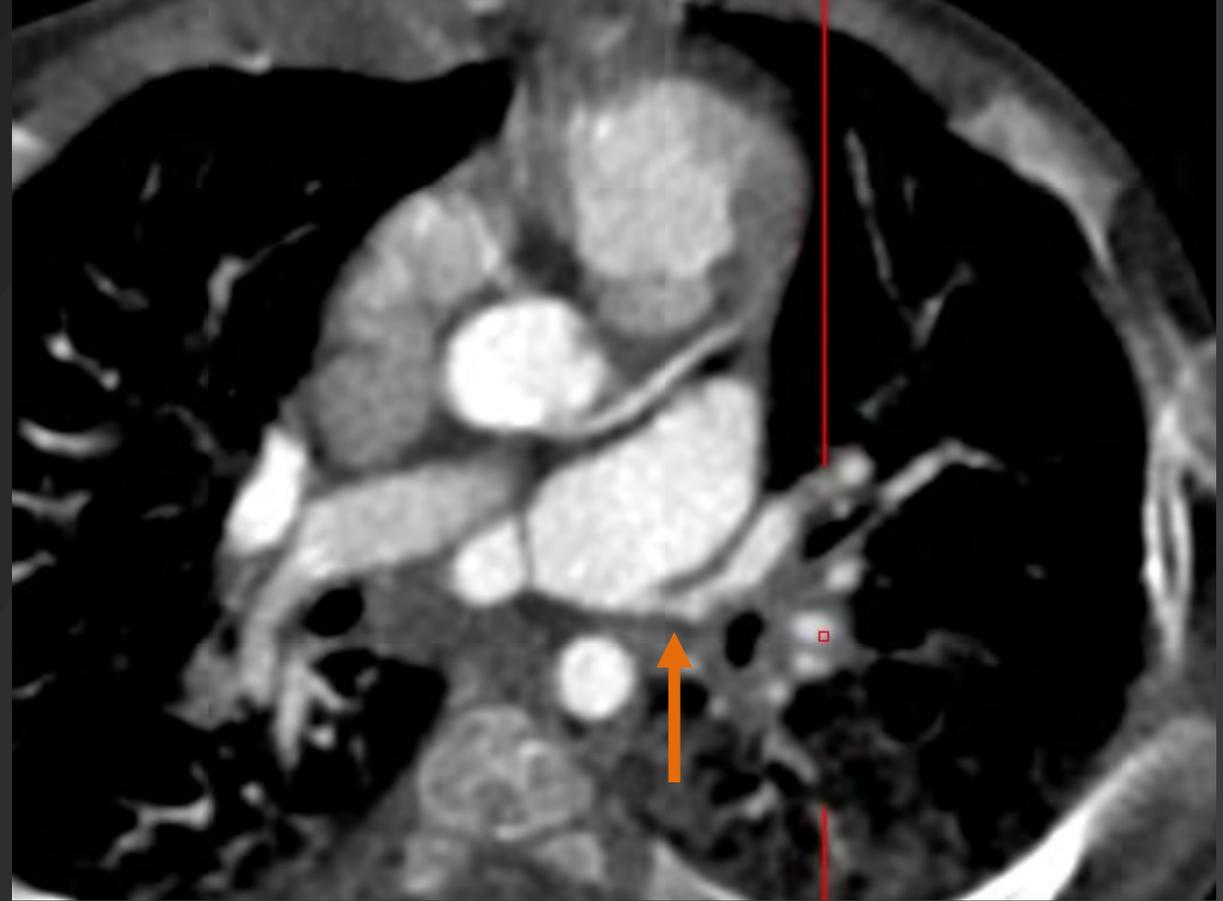
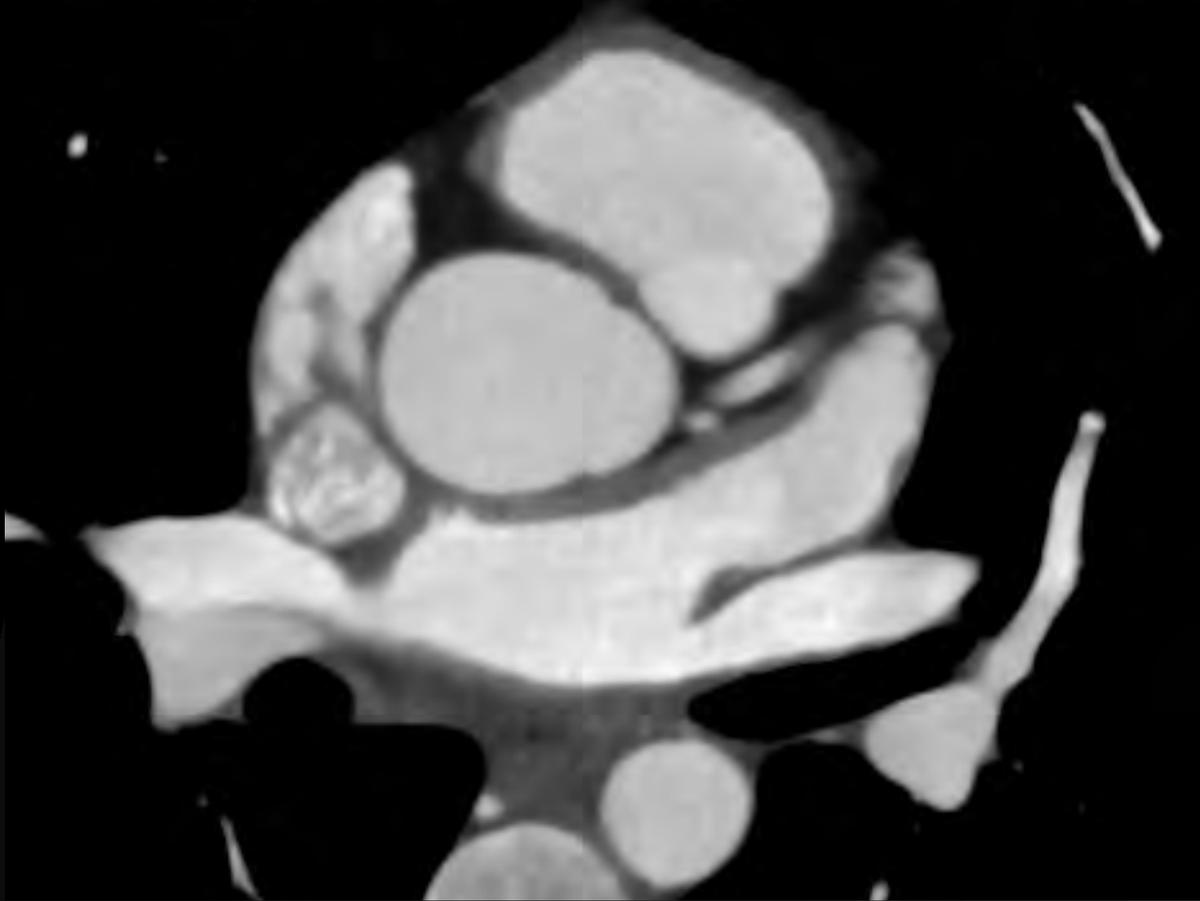


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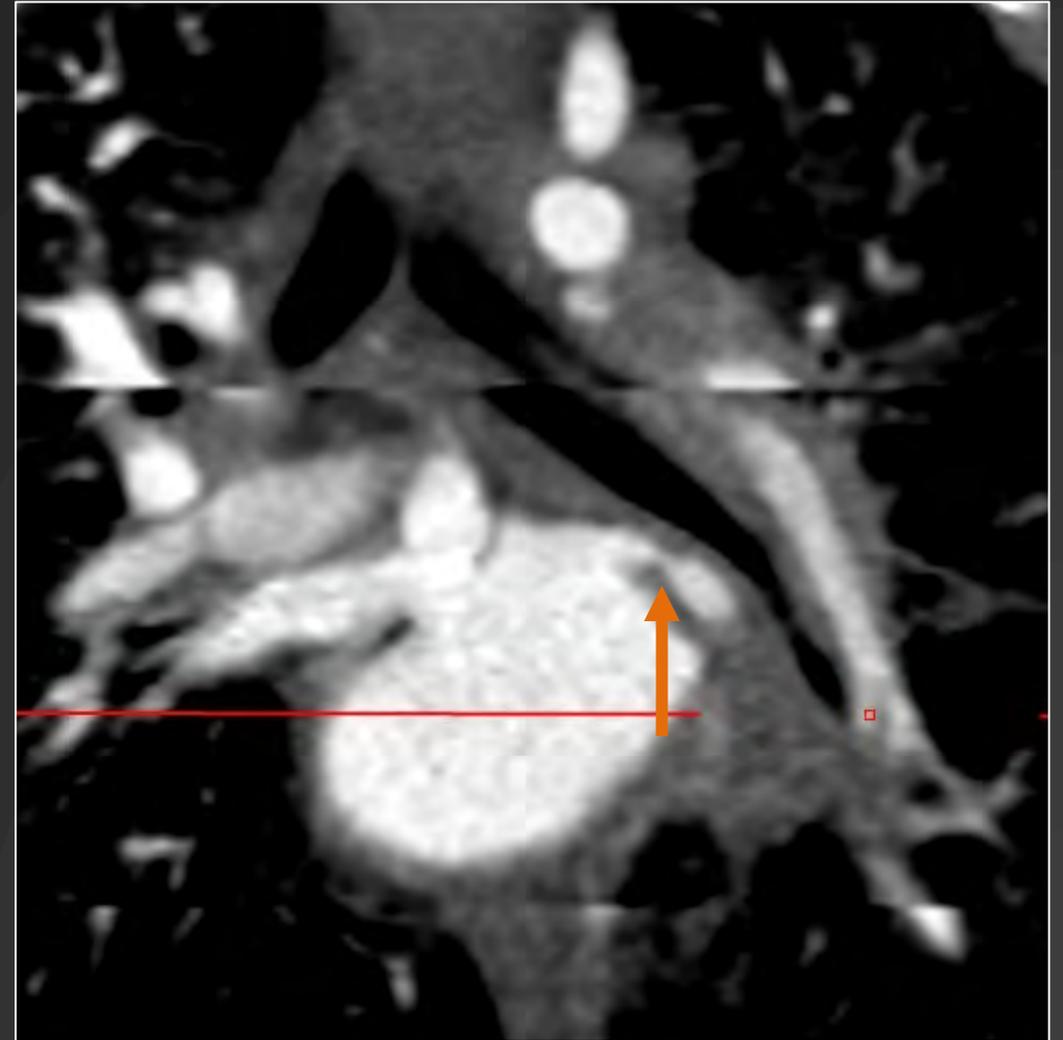
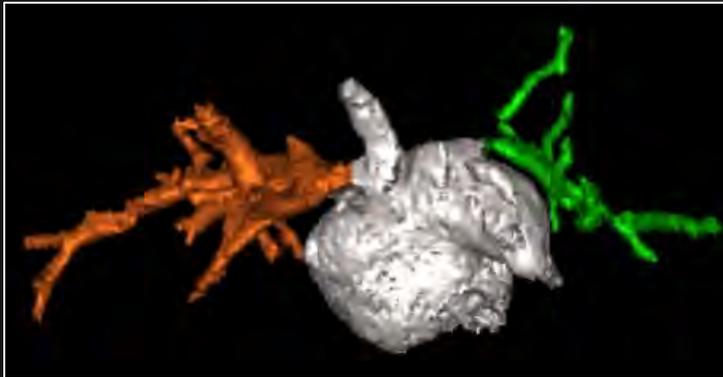
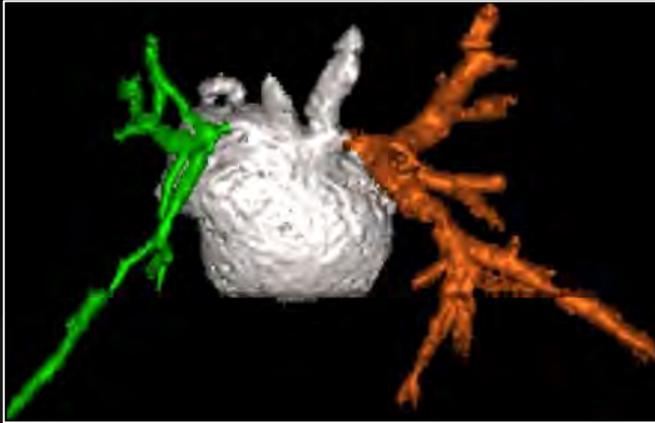
# Veines pulmonaires



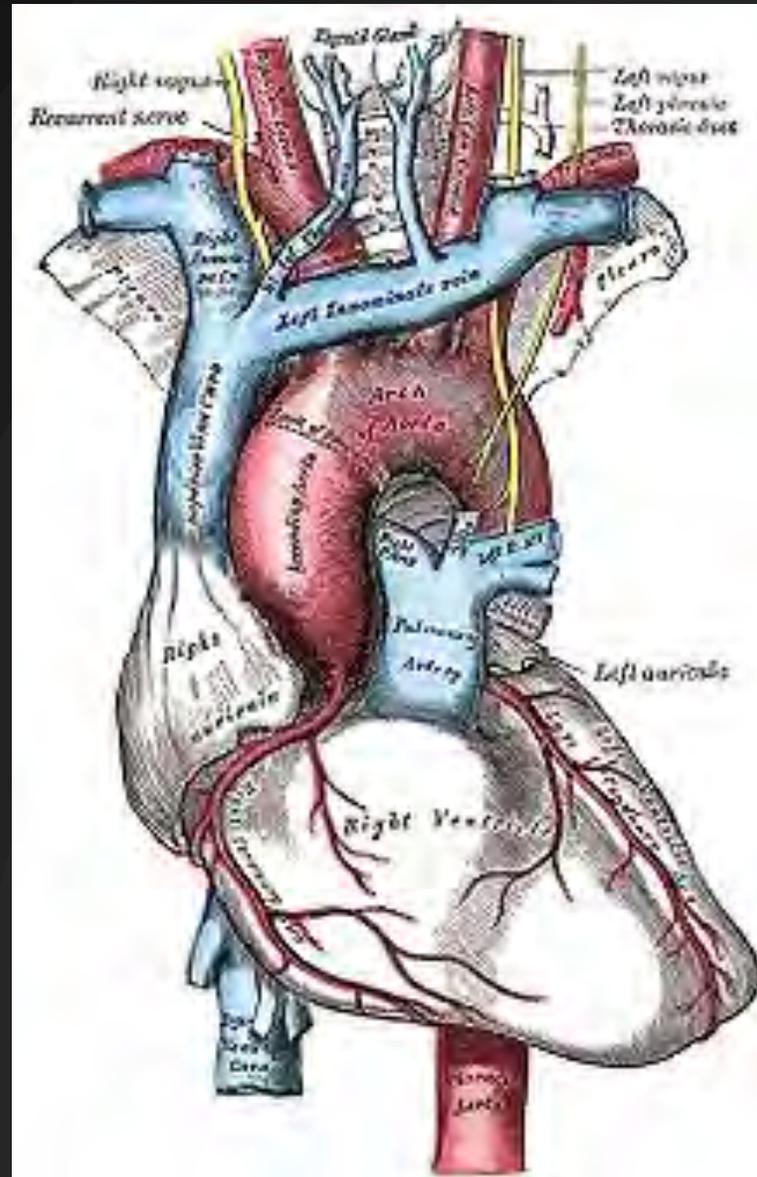
# Veines pulmonaires

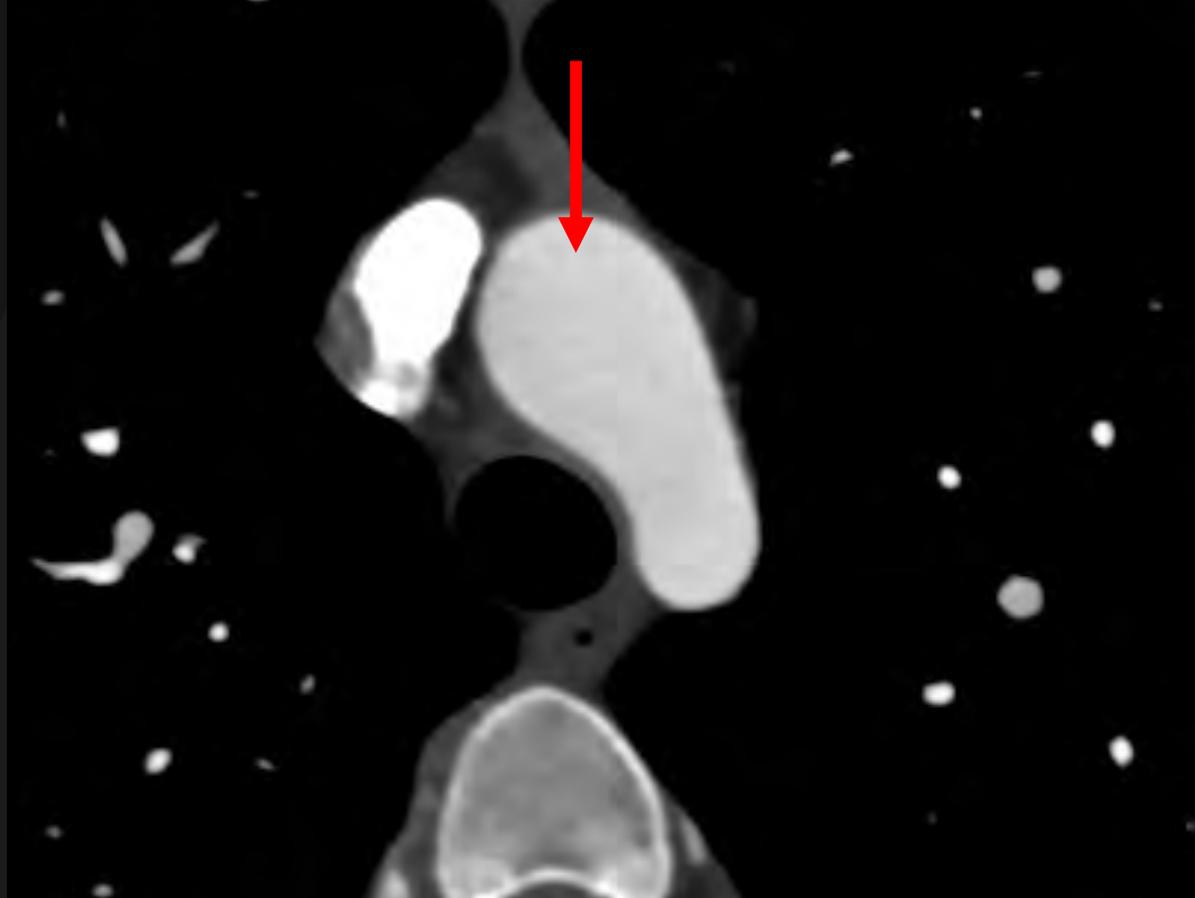


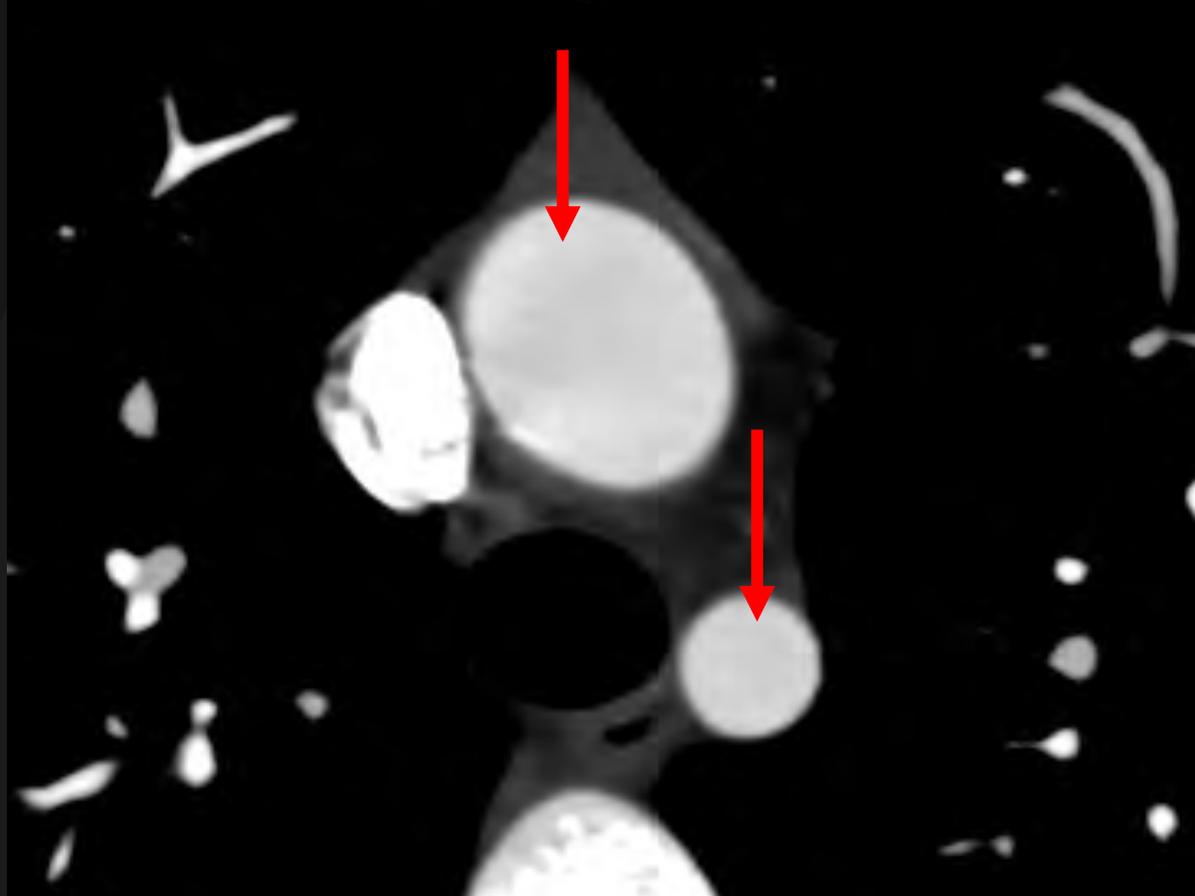
## Sténose de veine pulmonaire

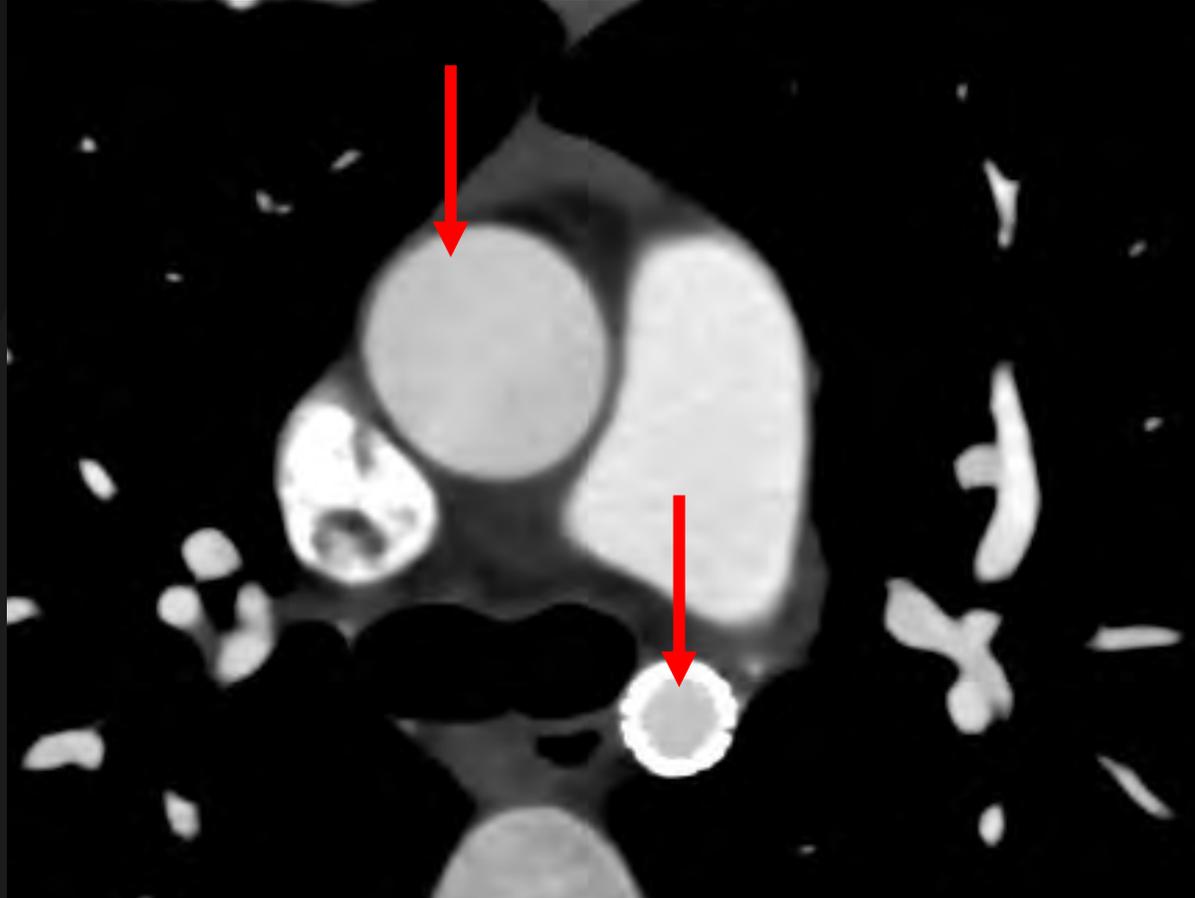


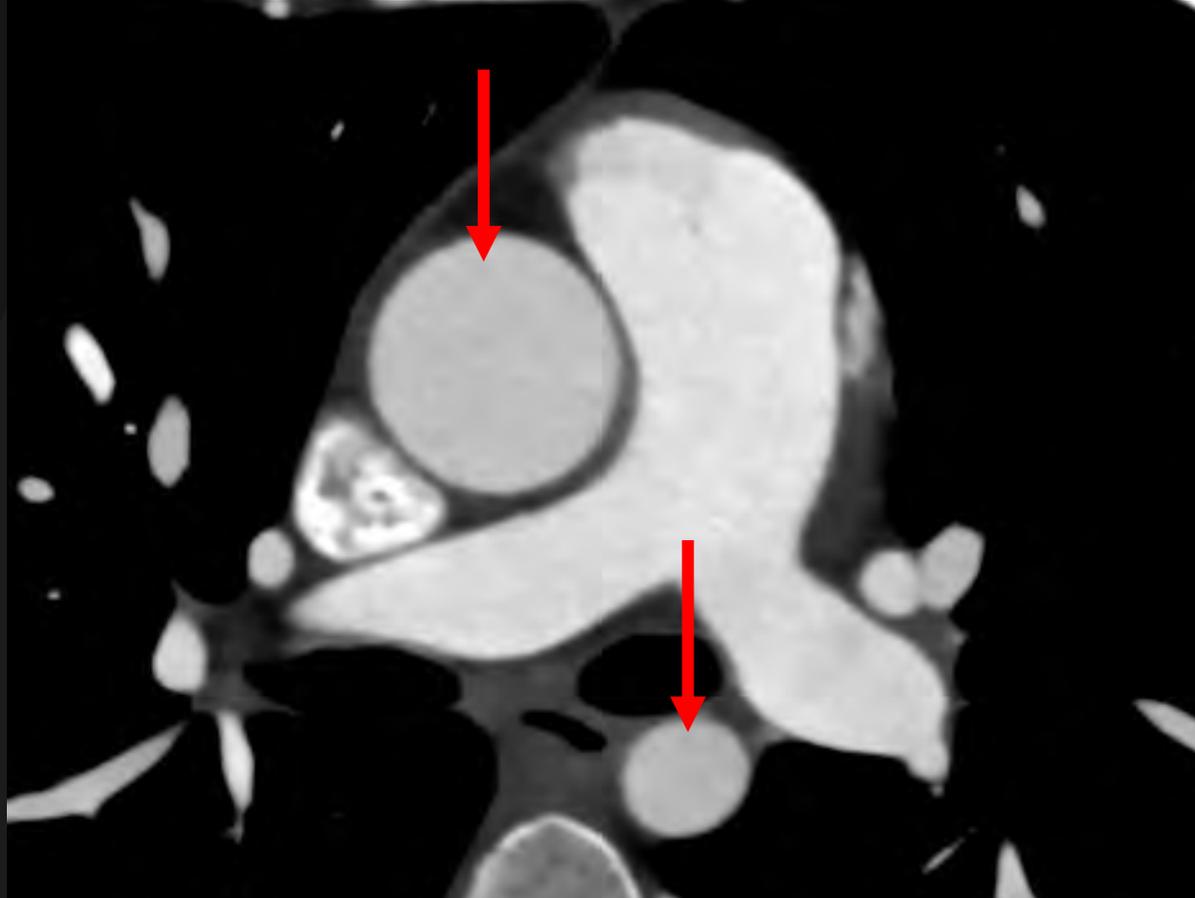
# Aorte

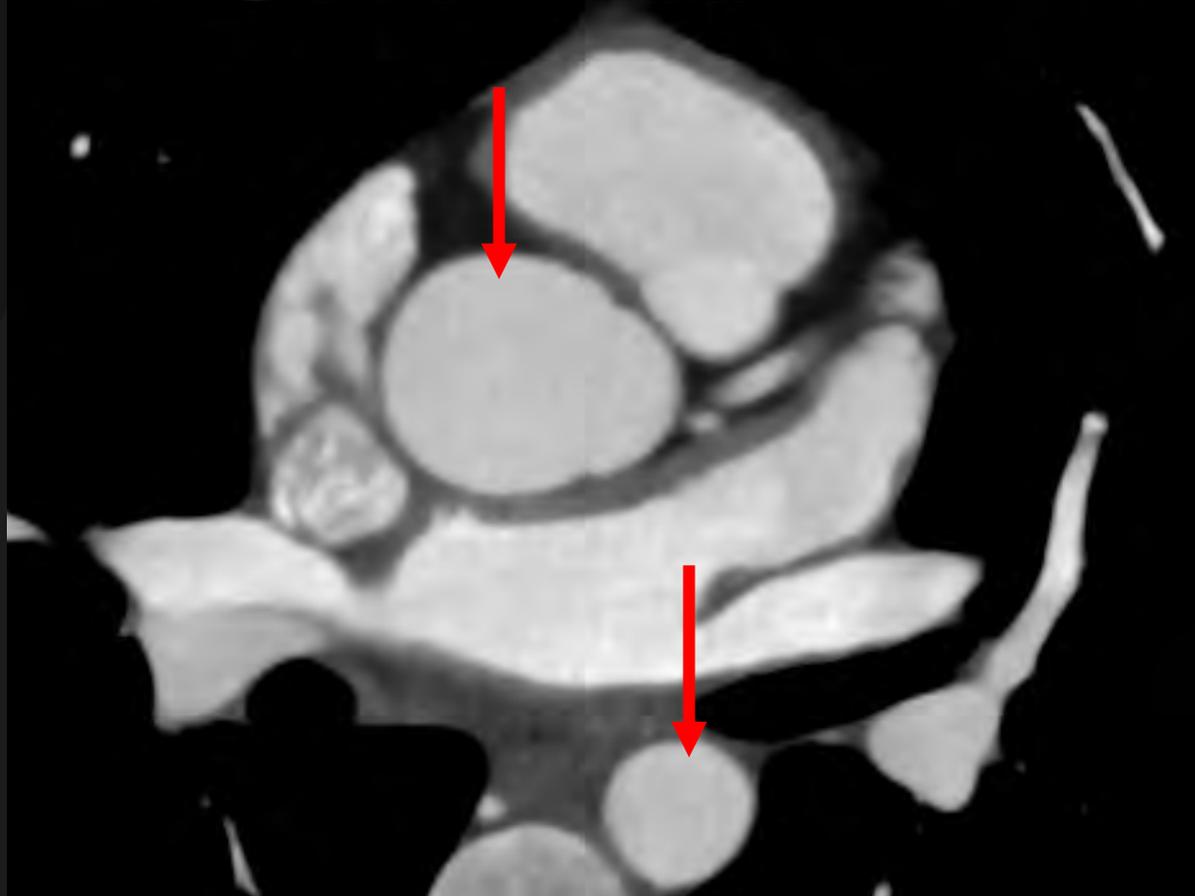


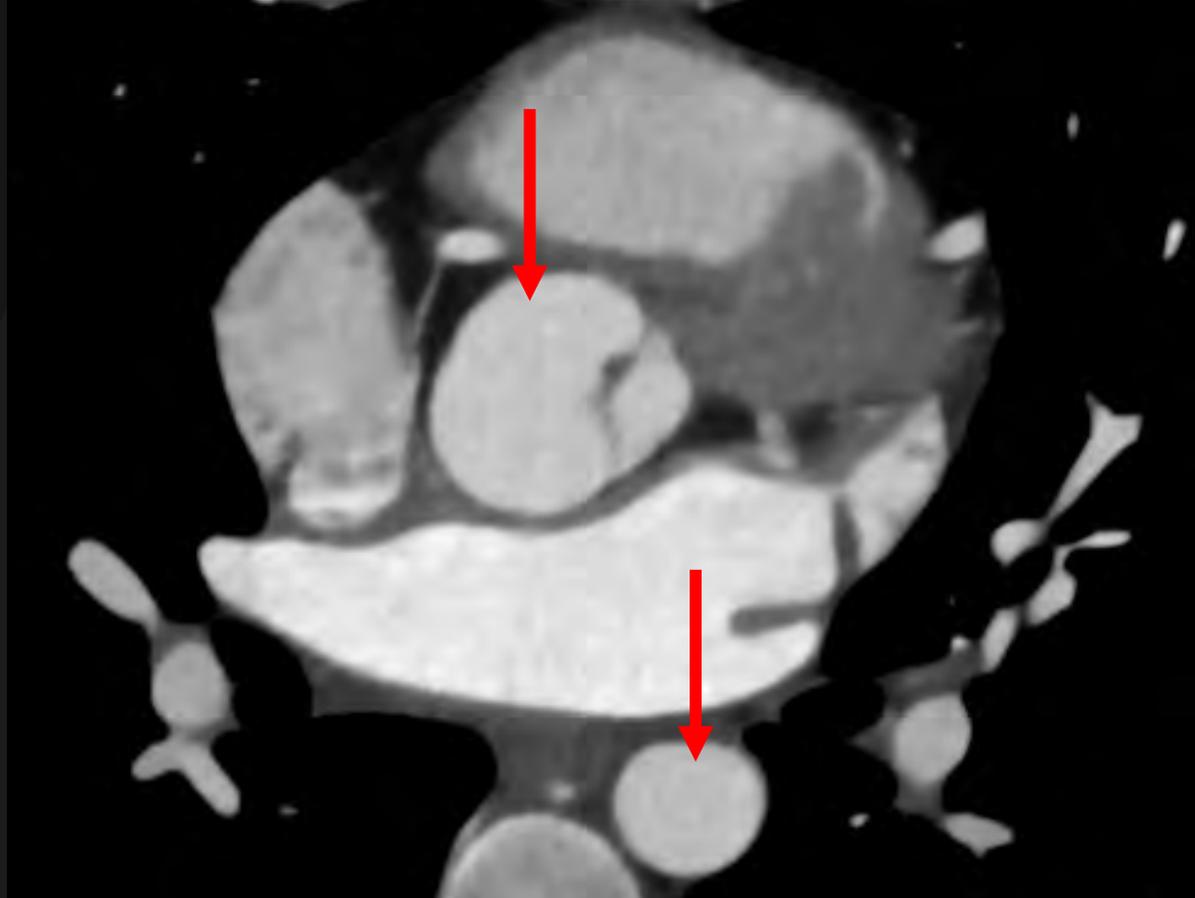




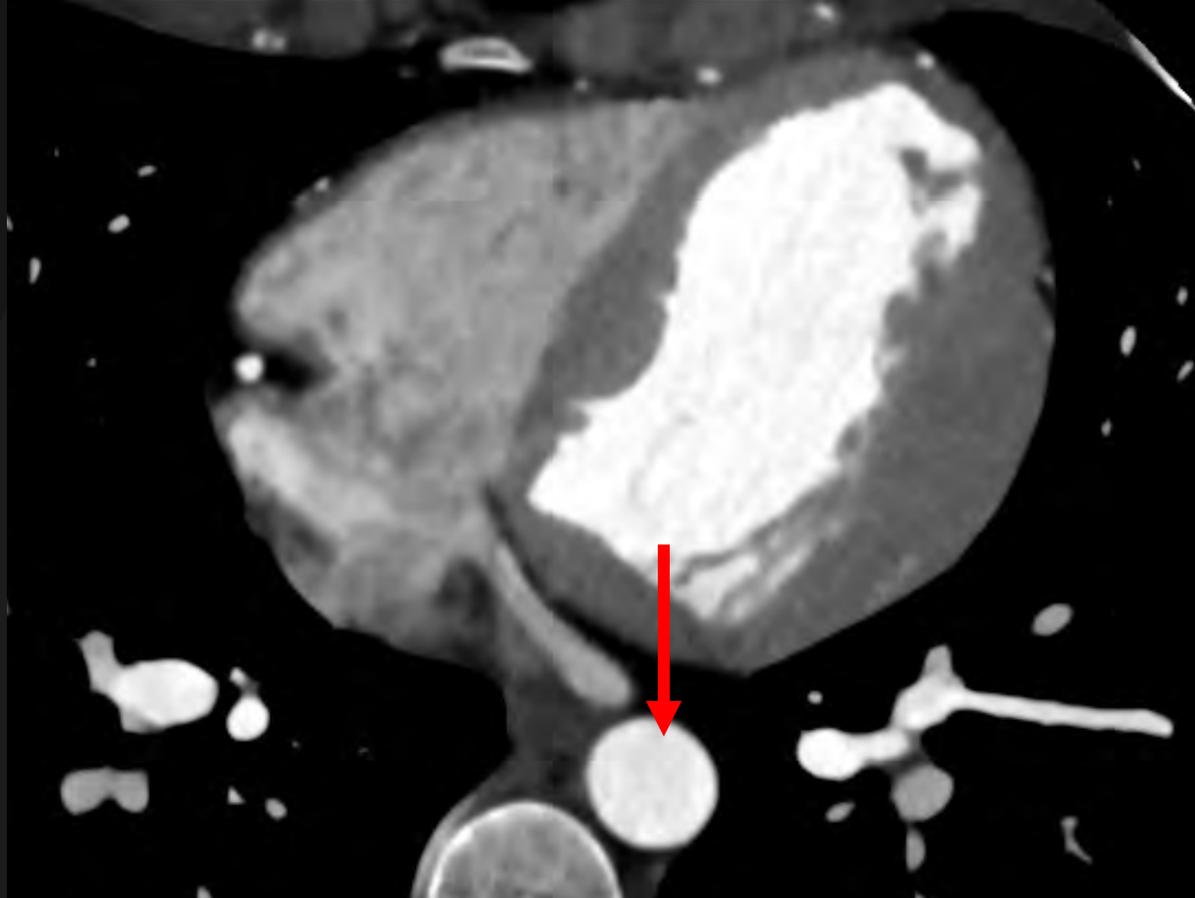




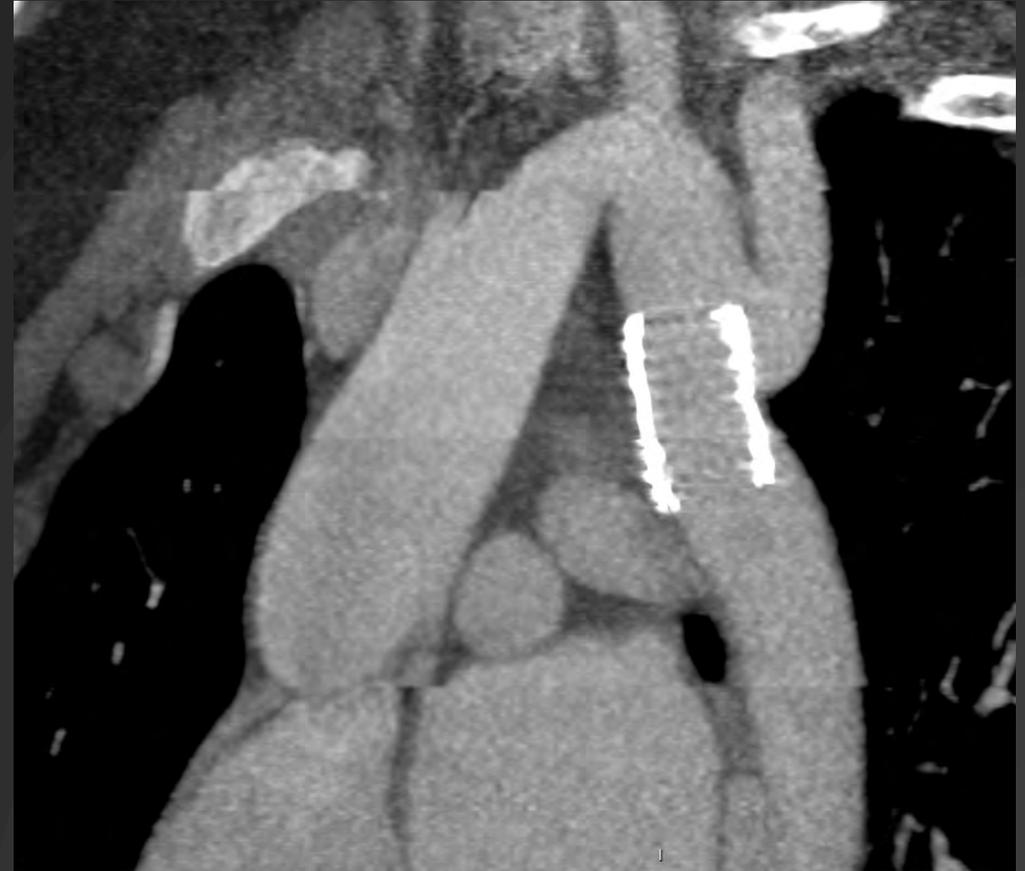
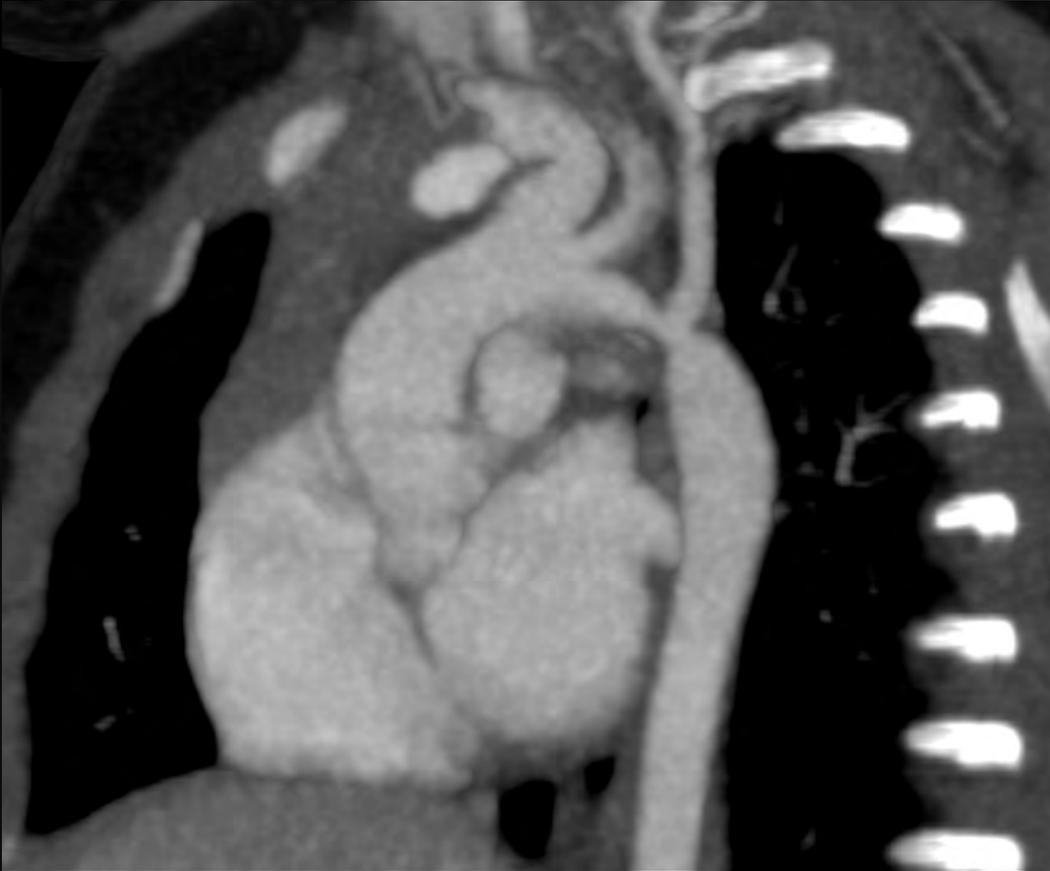




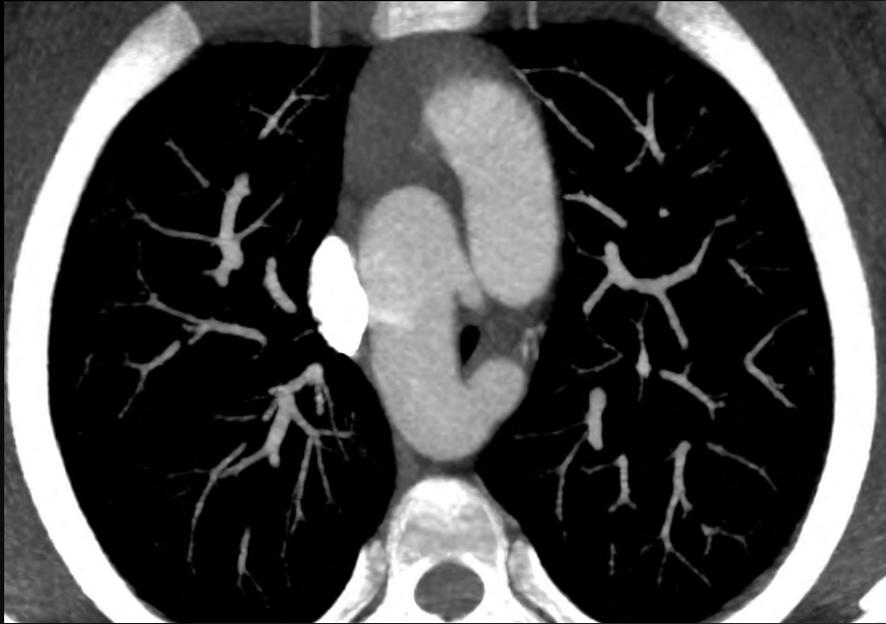




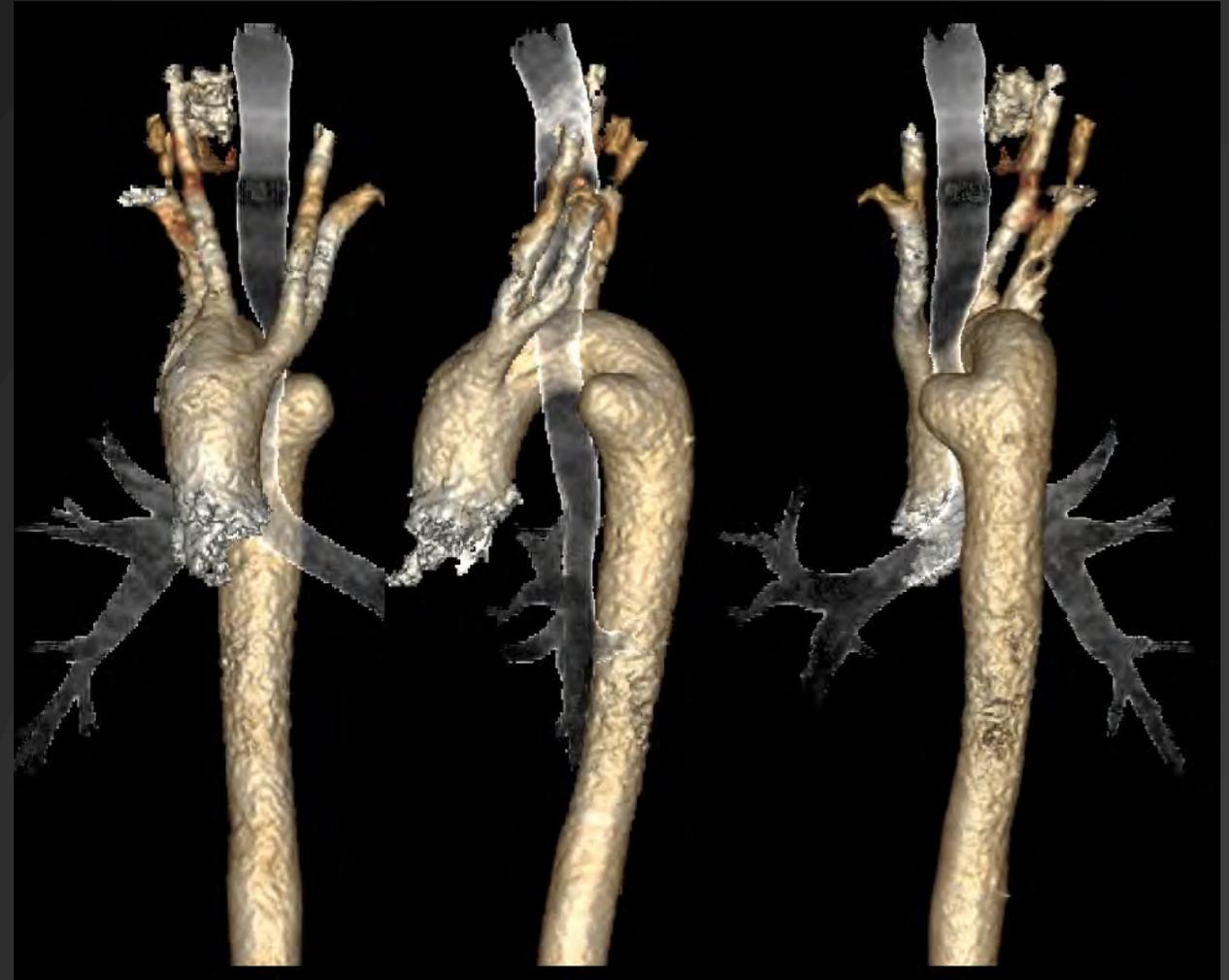




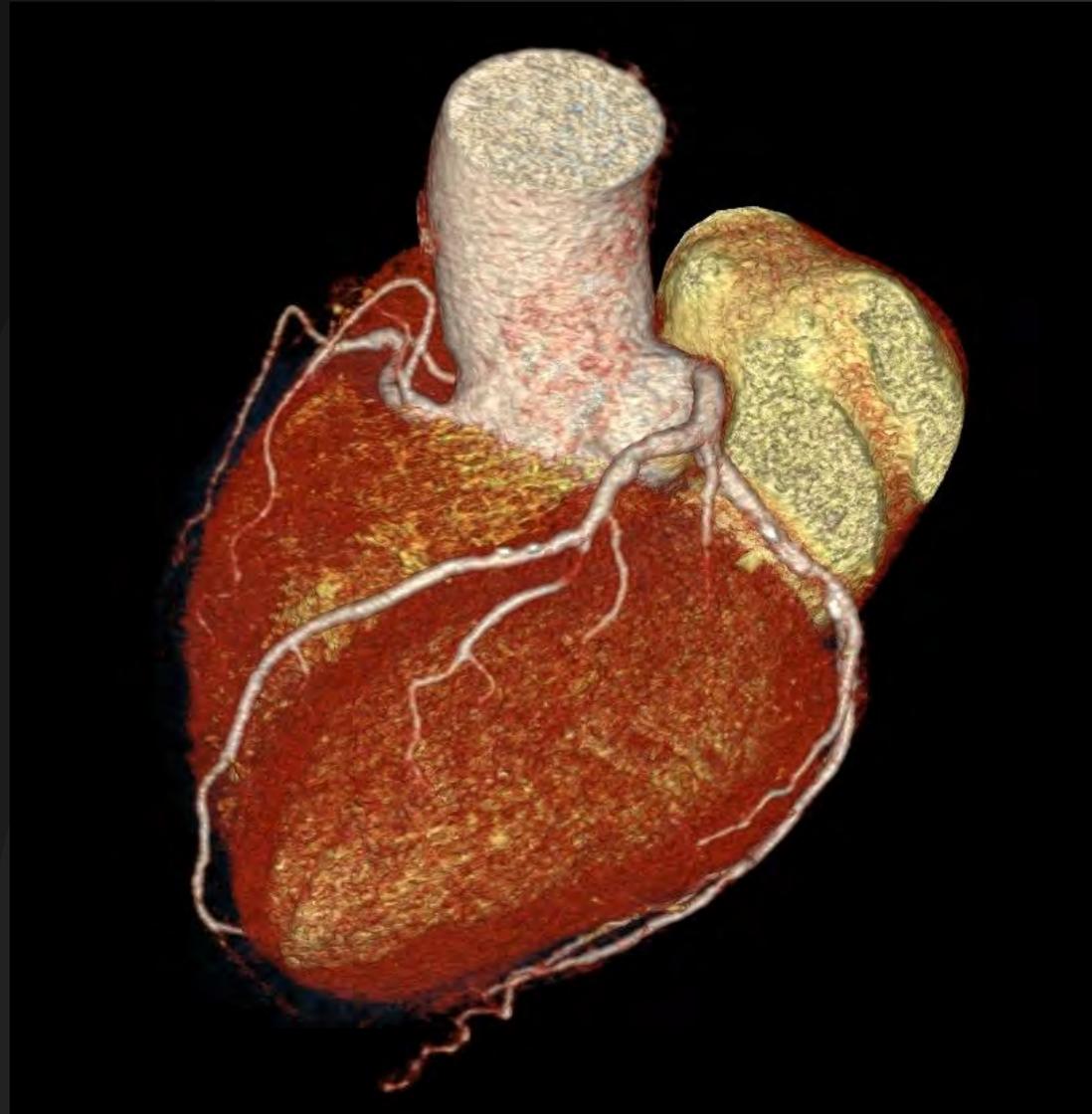
Coarctation aortique

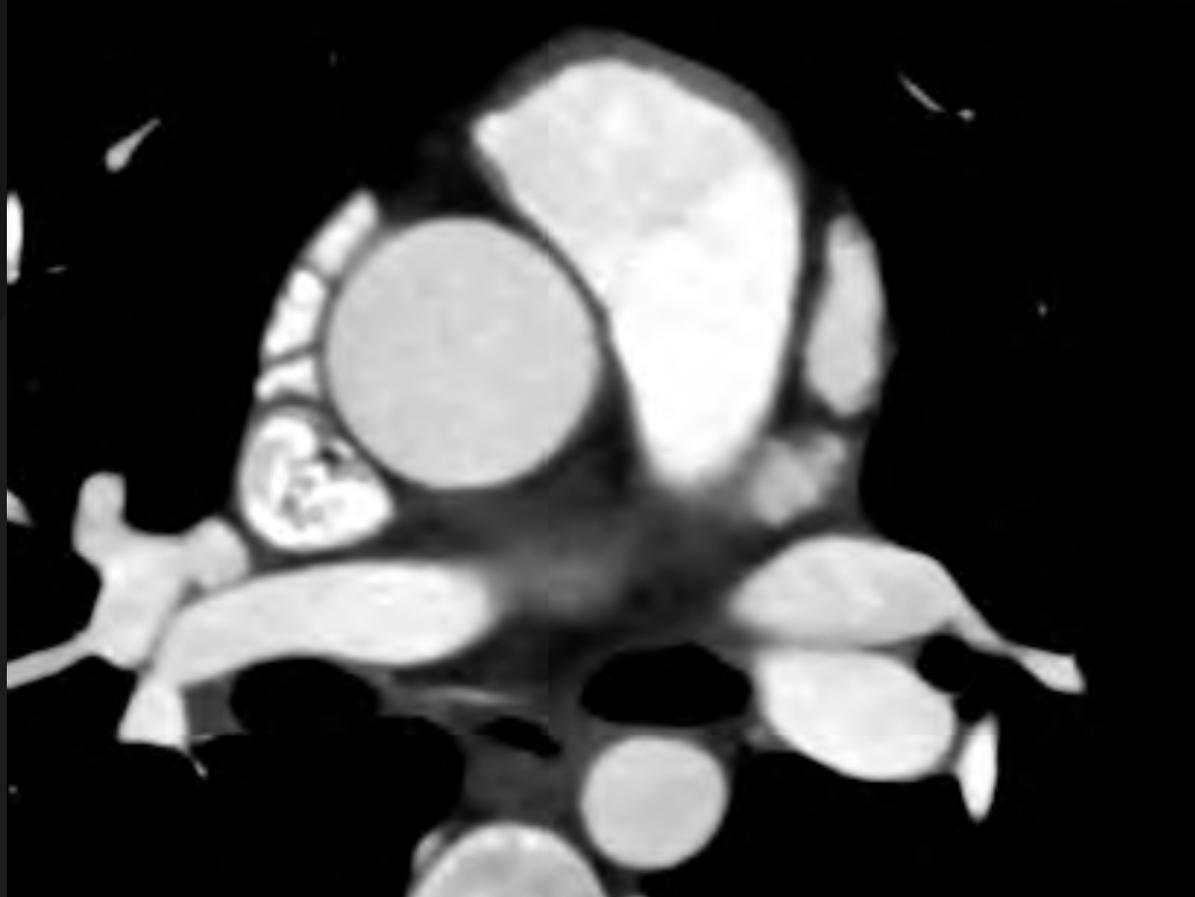


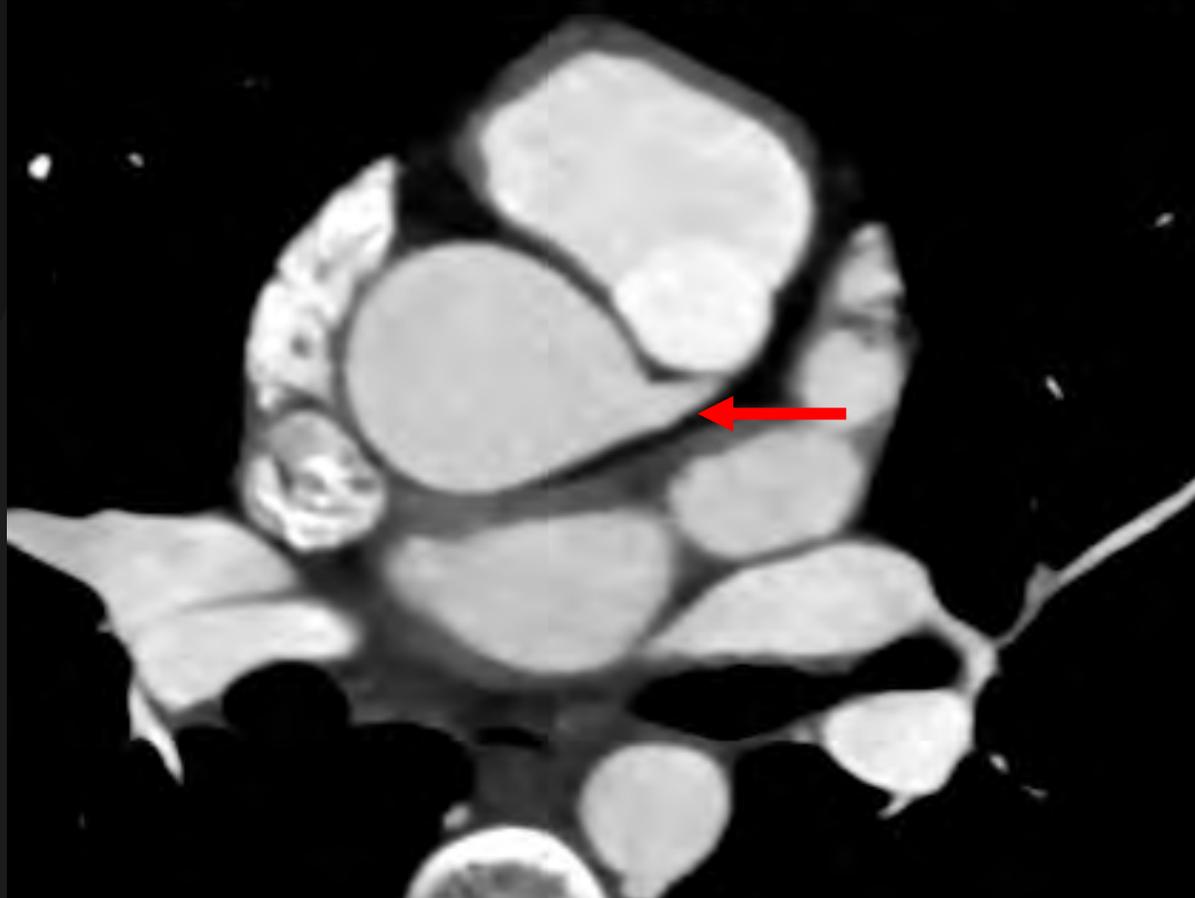
Anomalies d'arcs aortiques



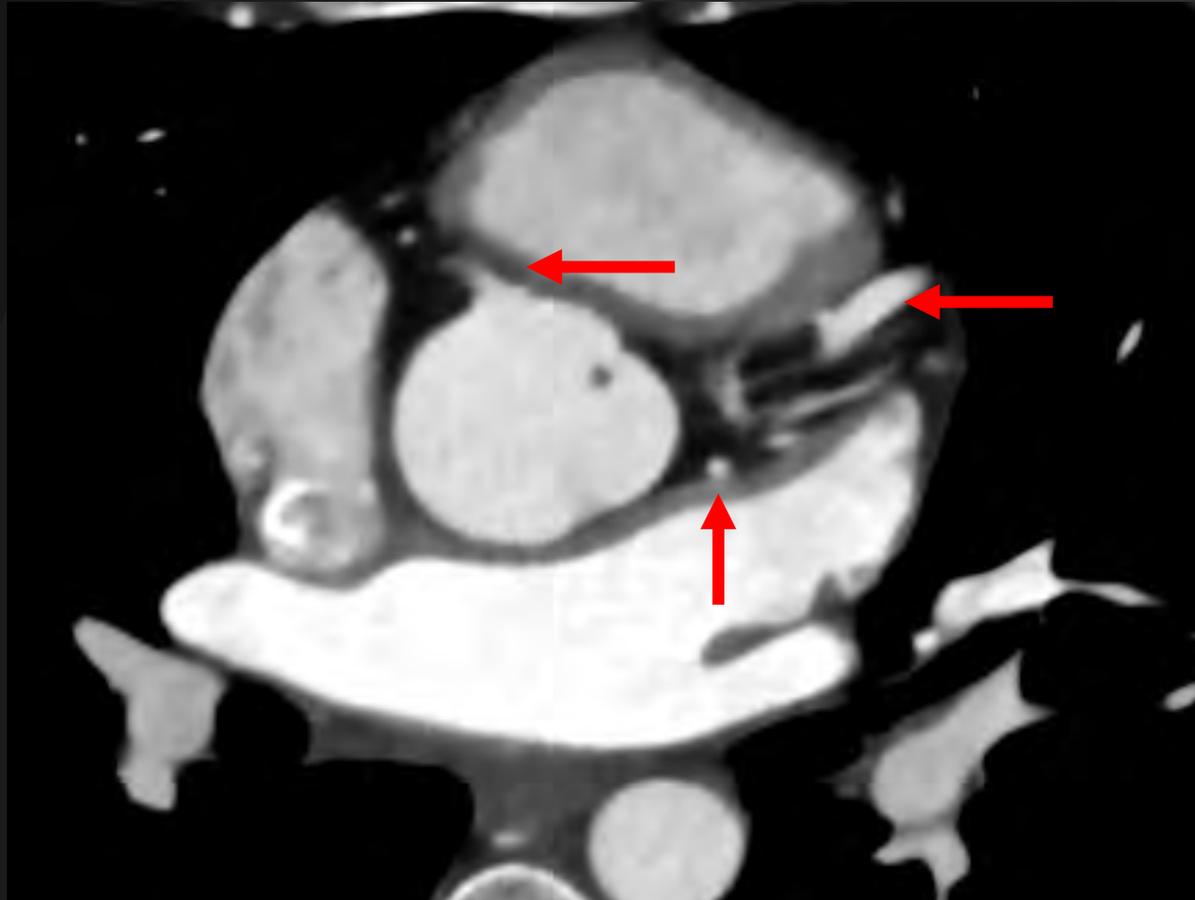
# Coronaires

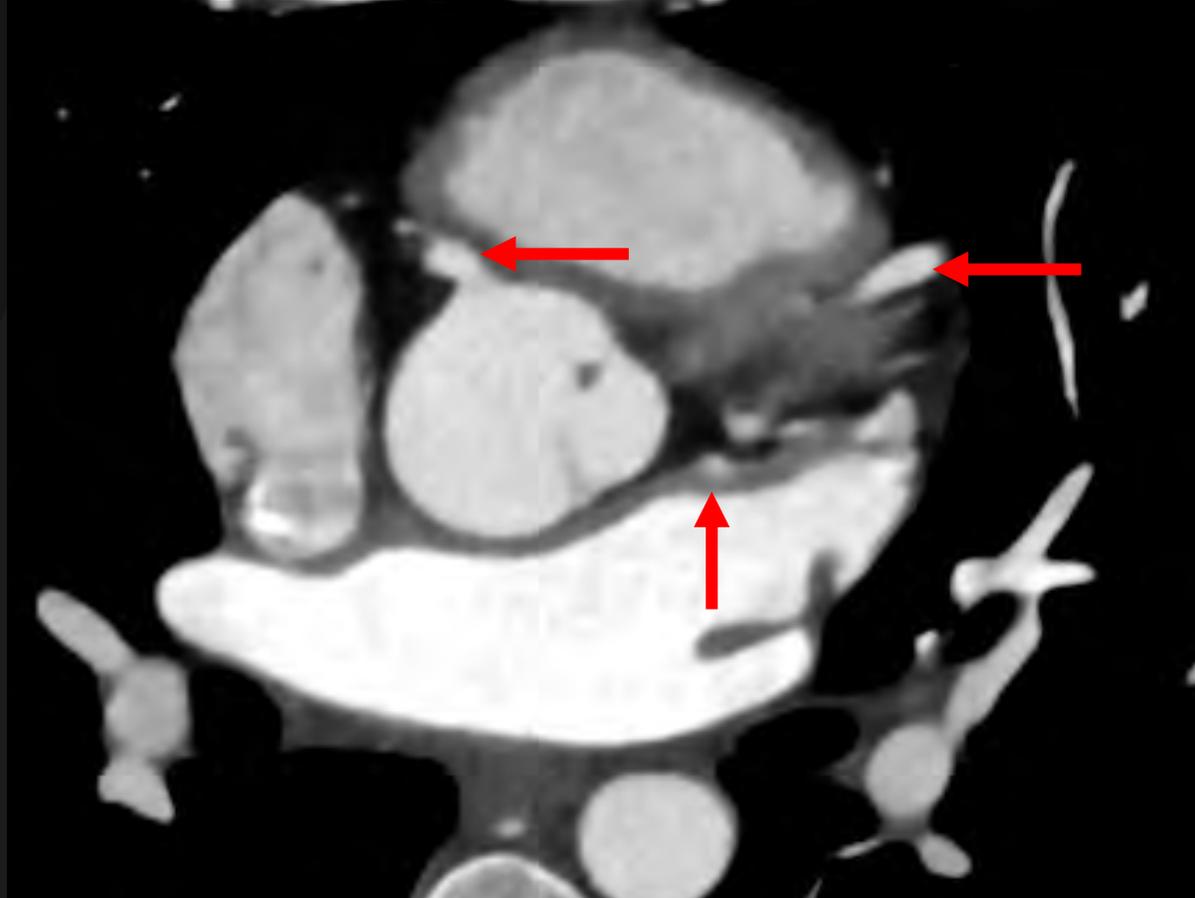


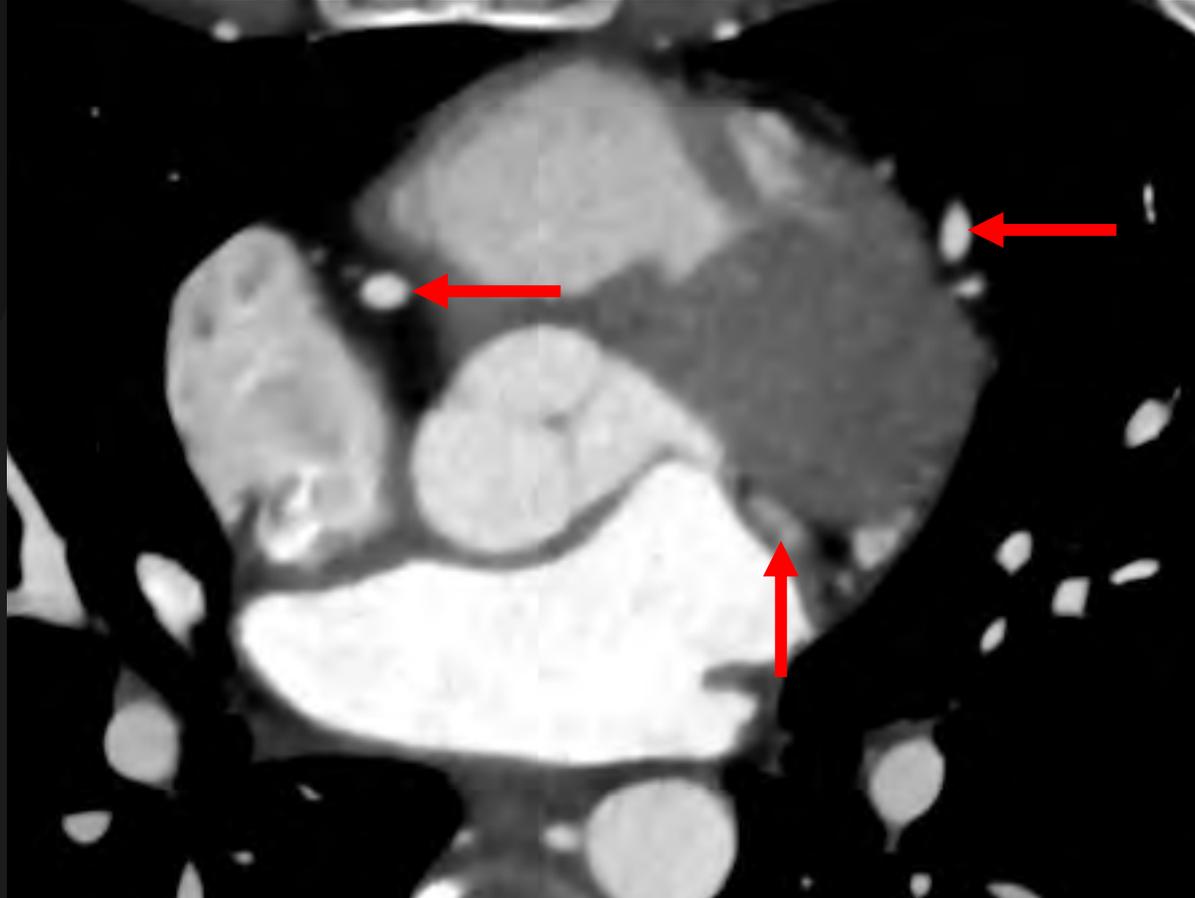


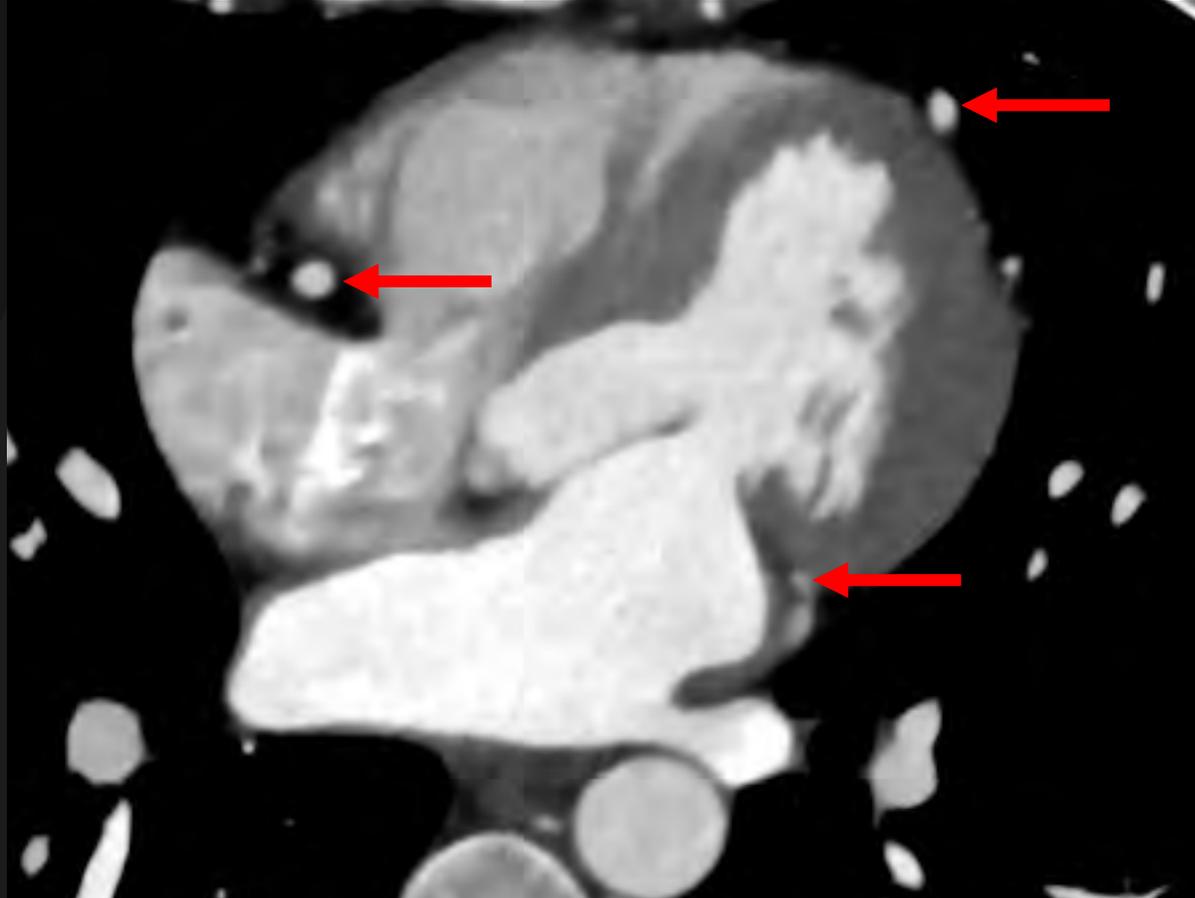


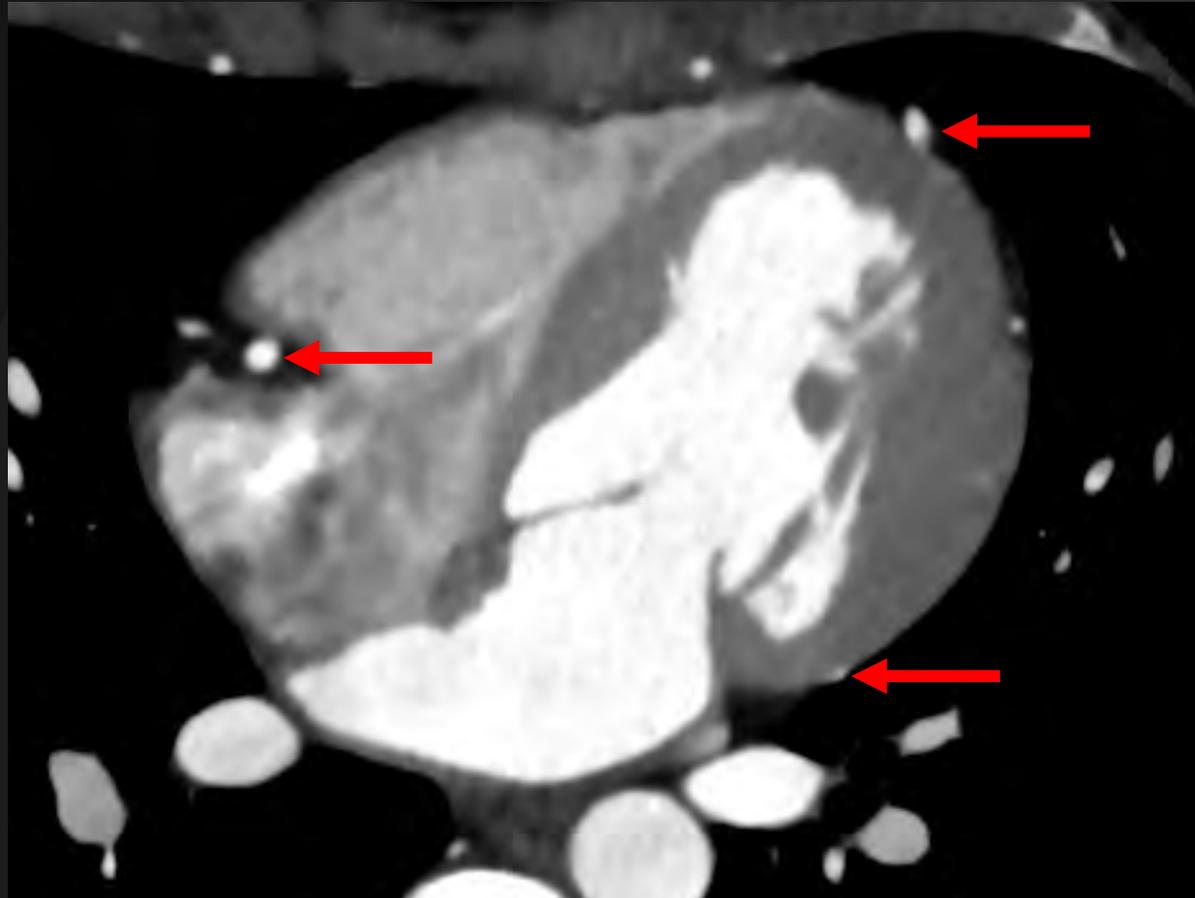


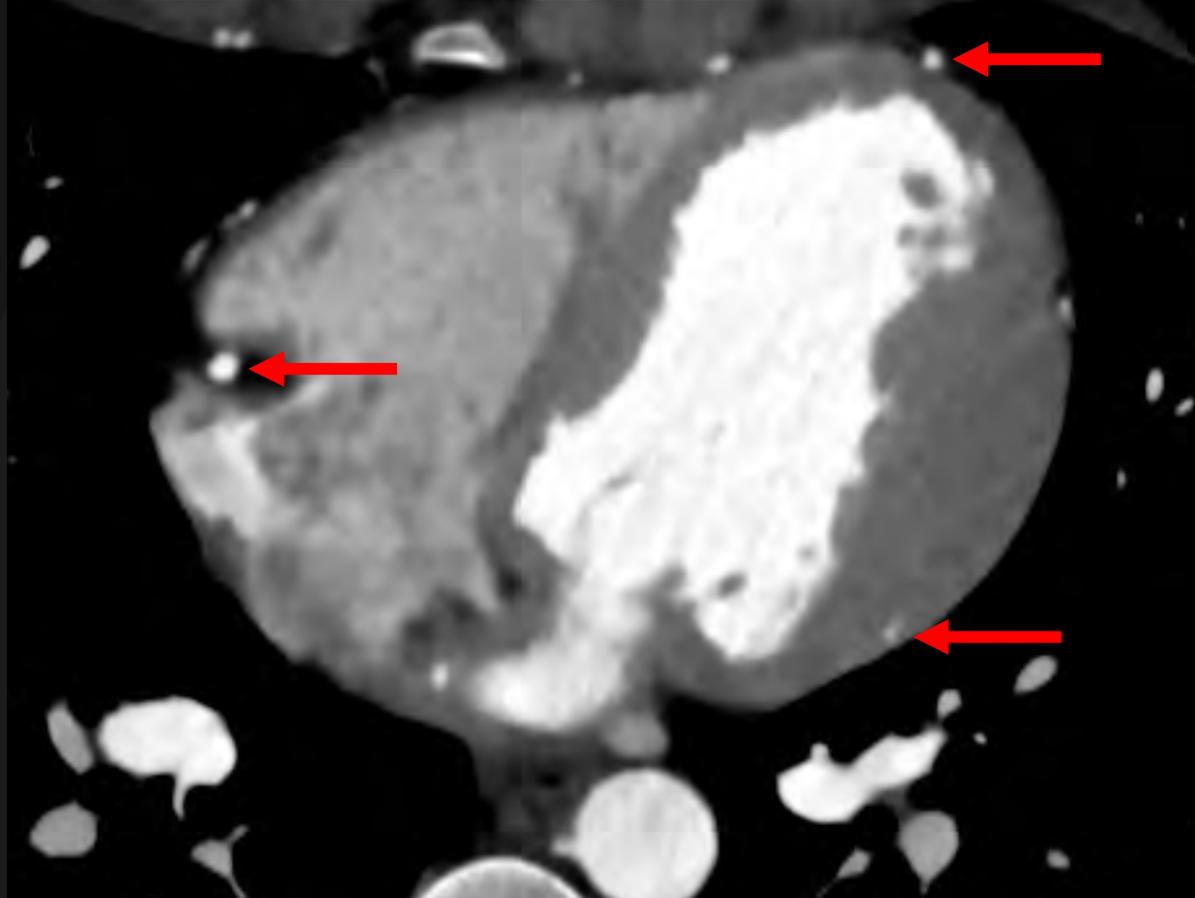


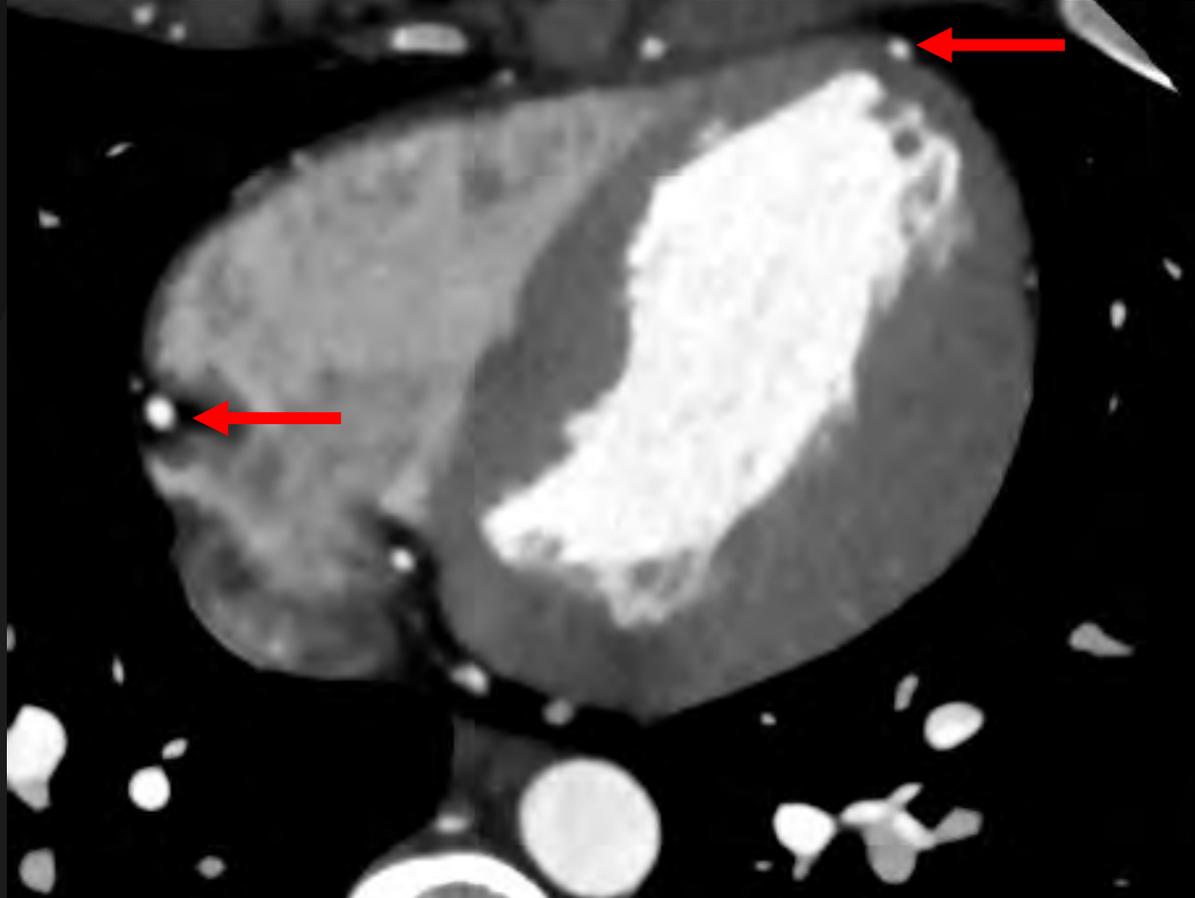


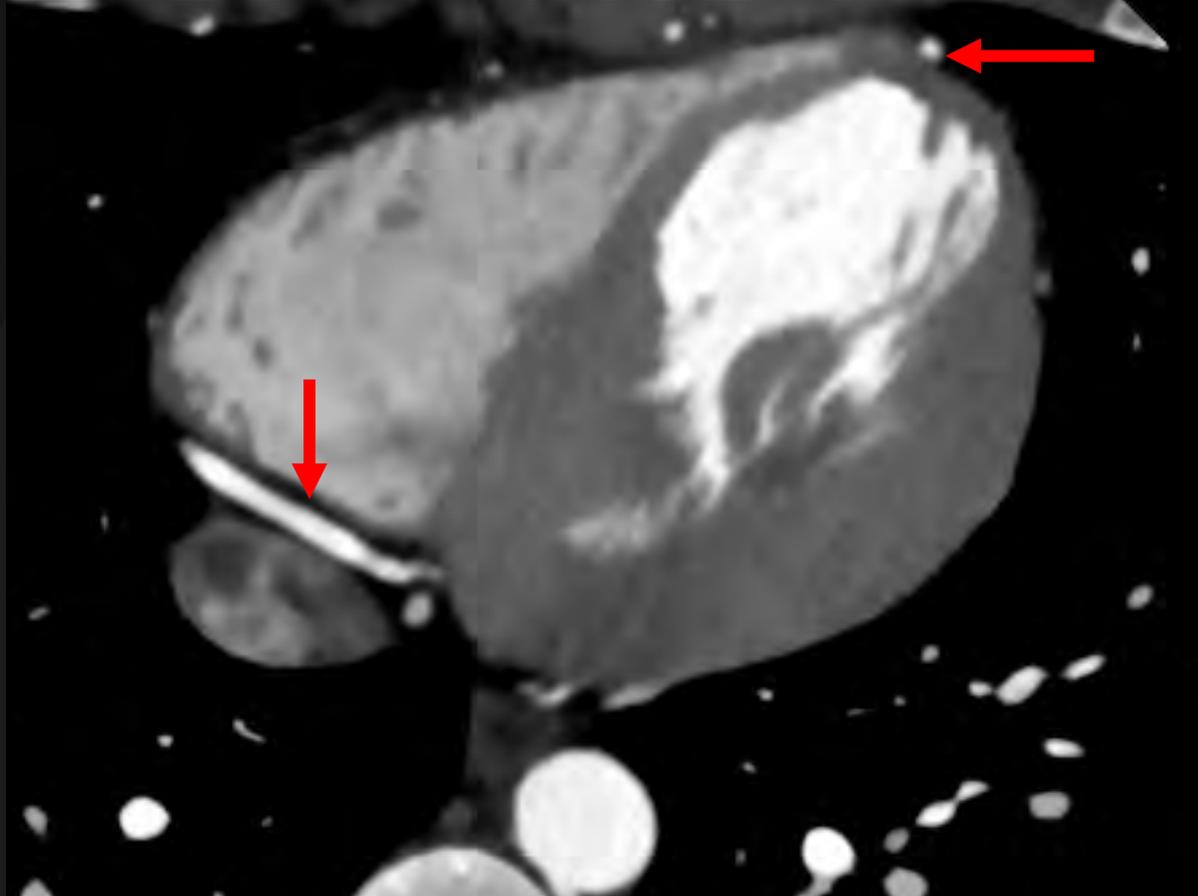


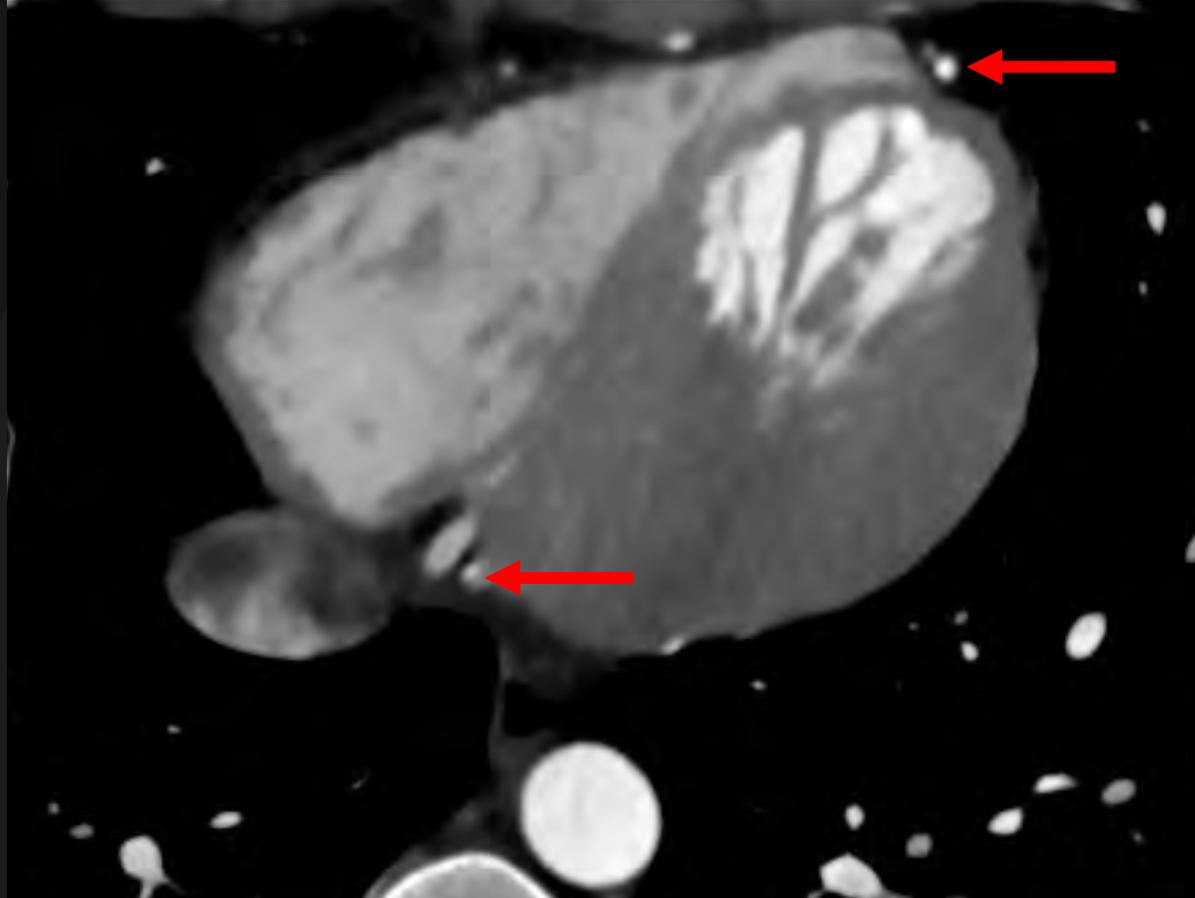


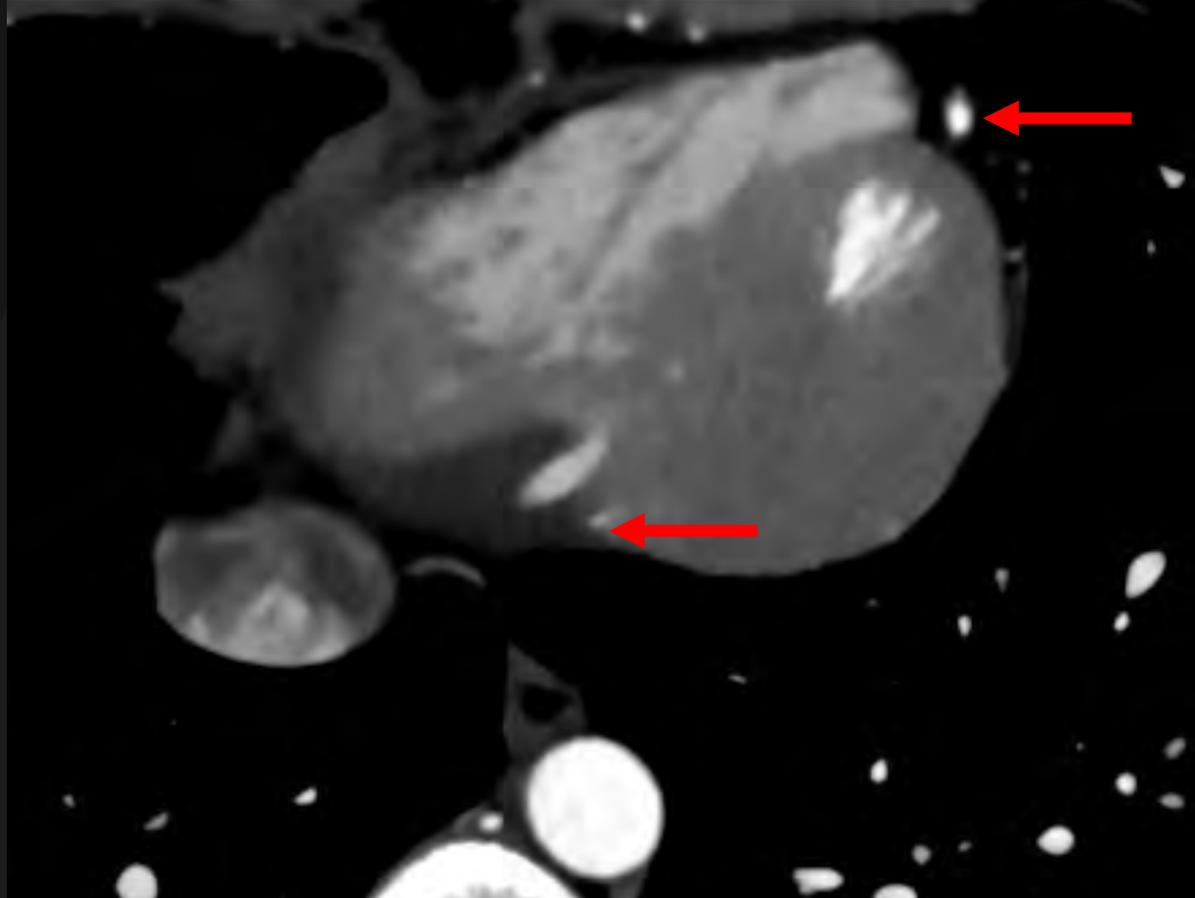


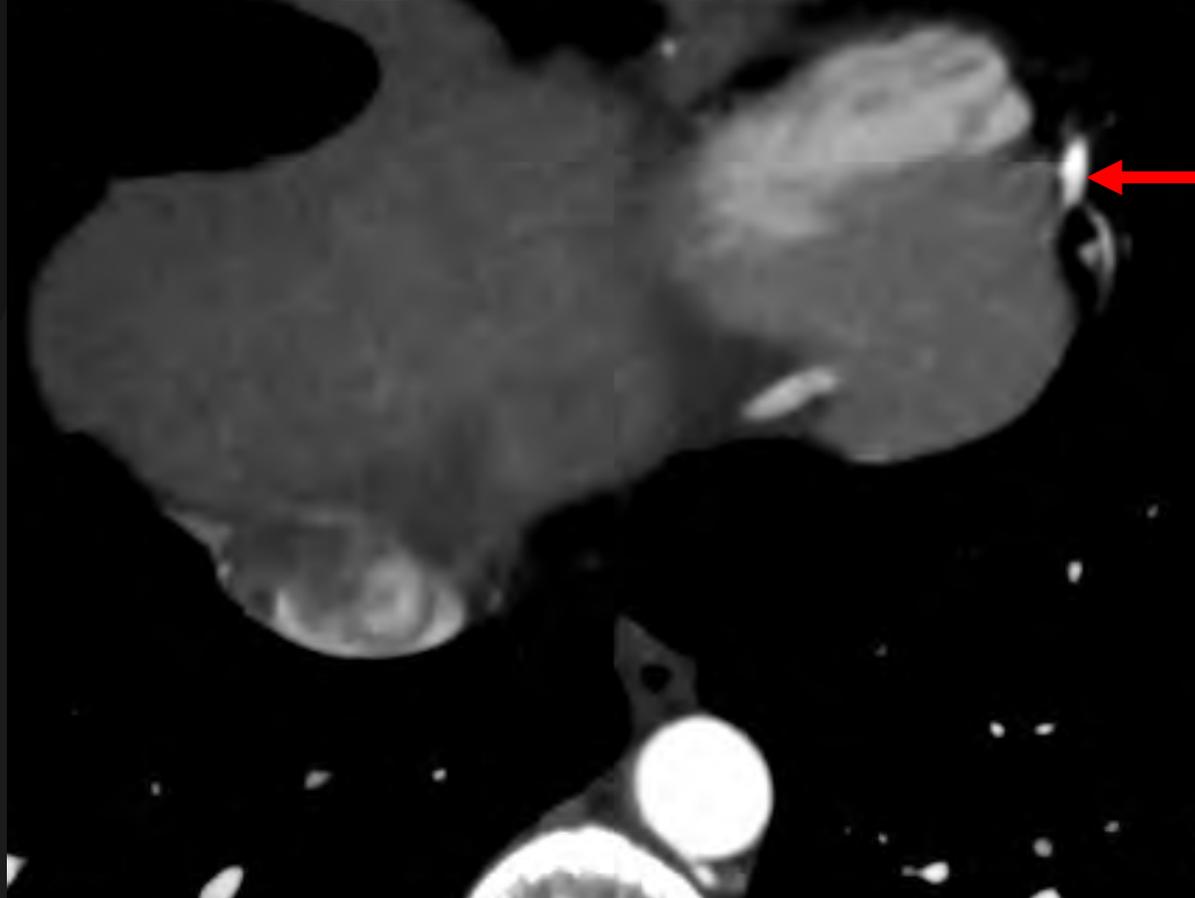


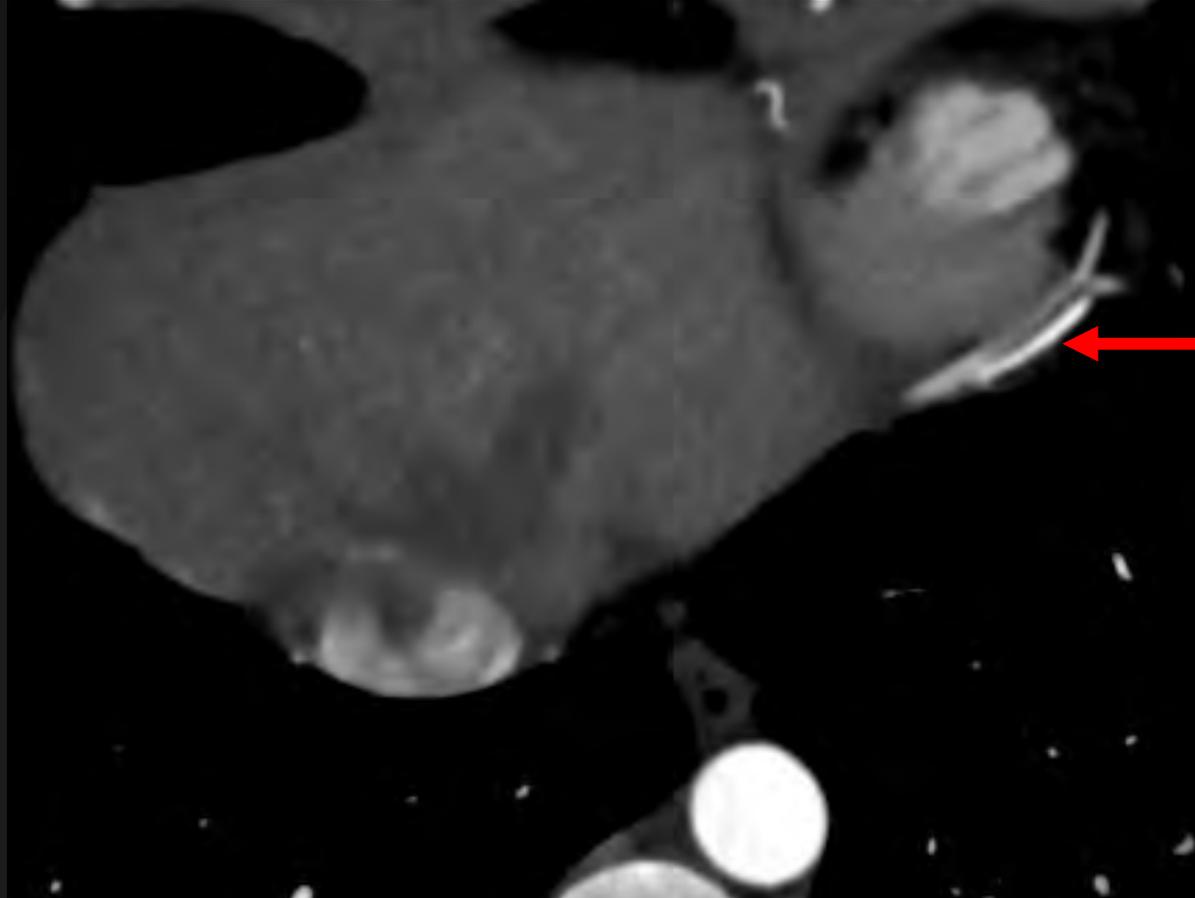




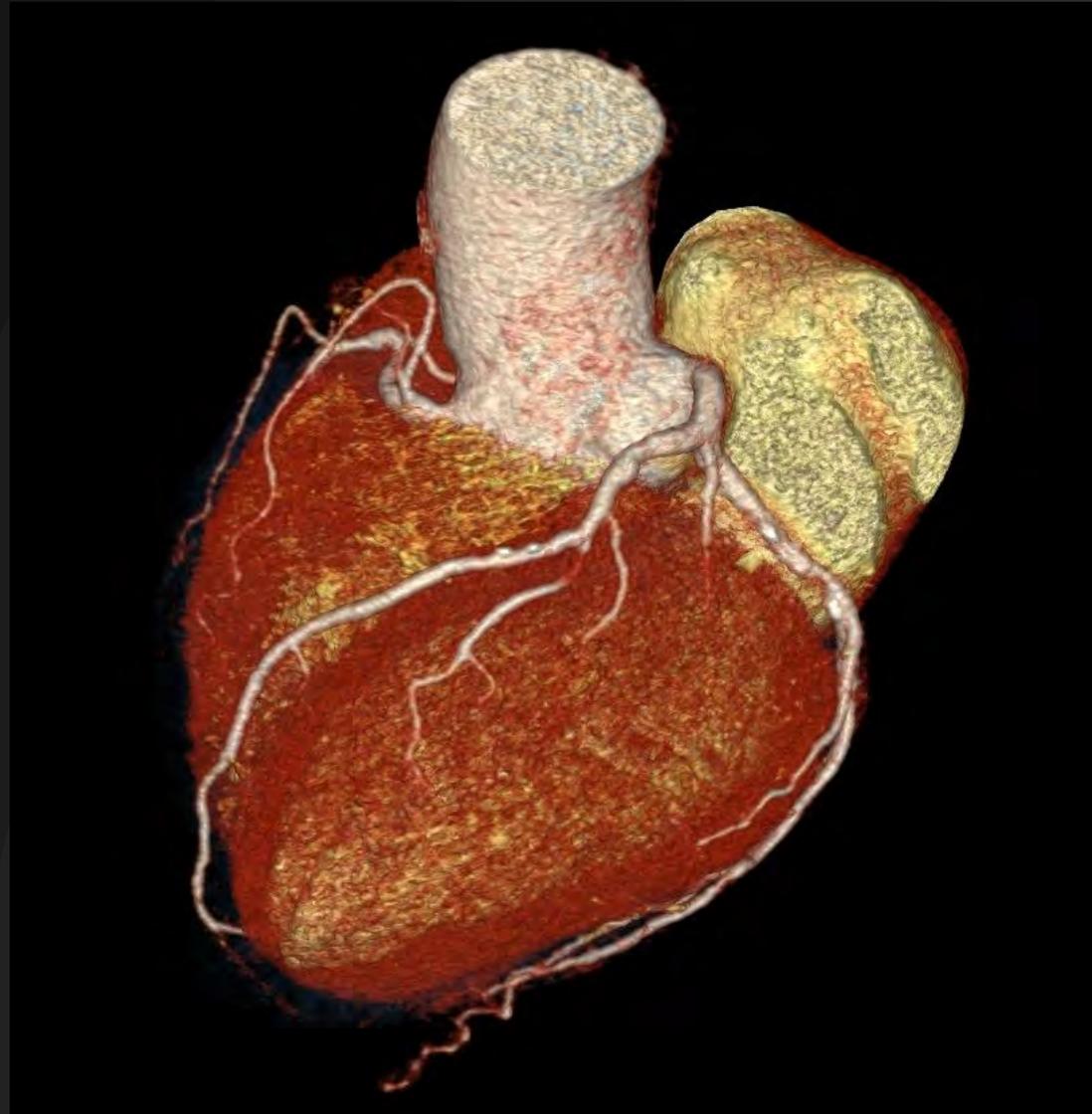


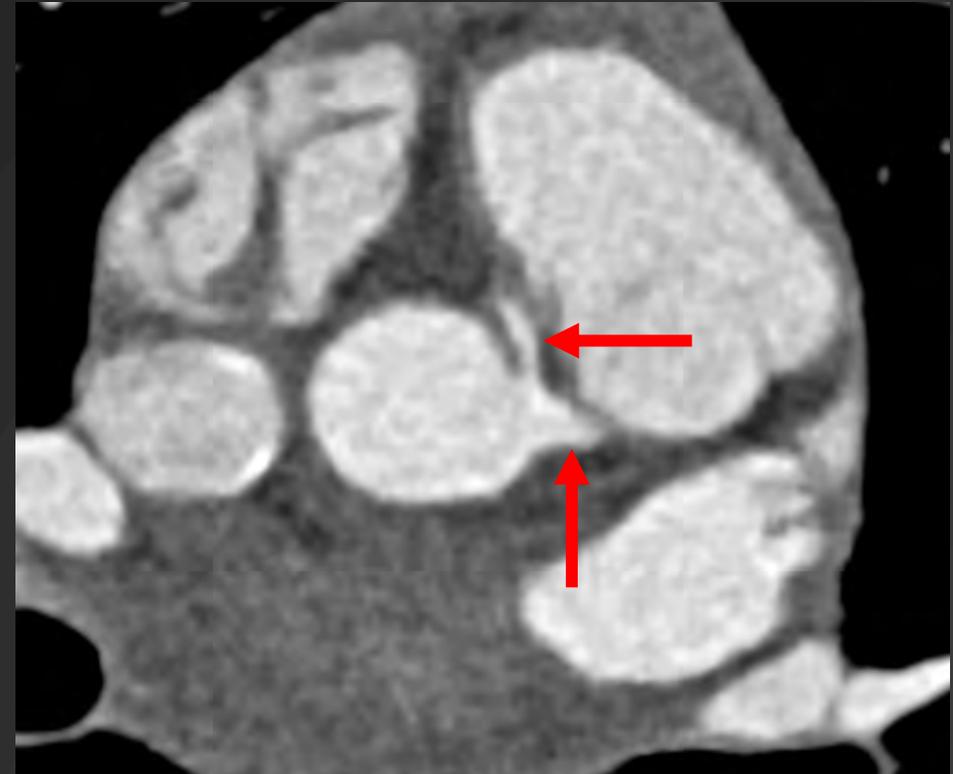
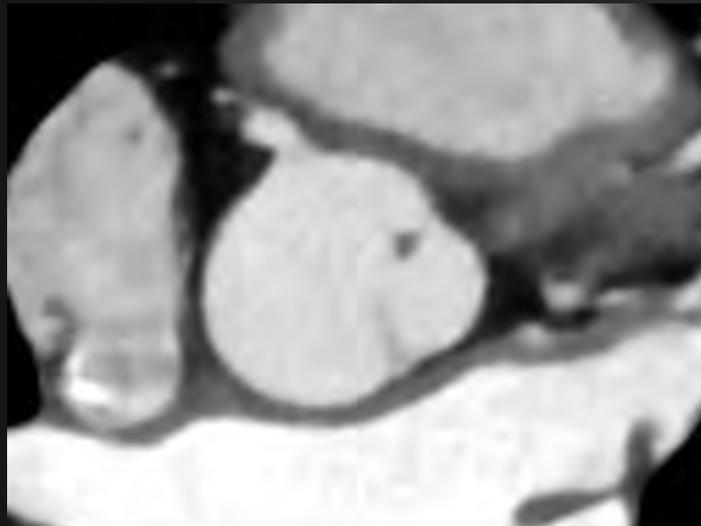
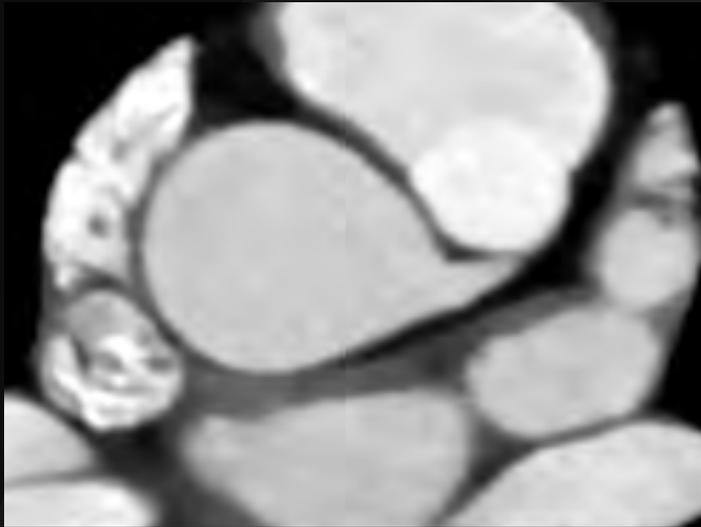




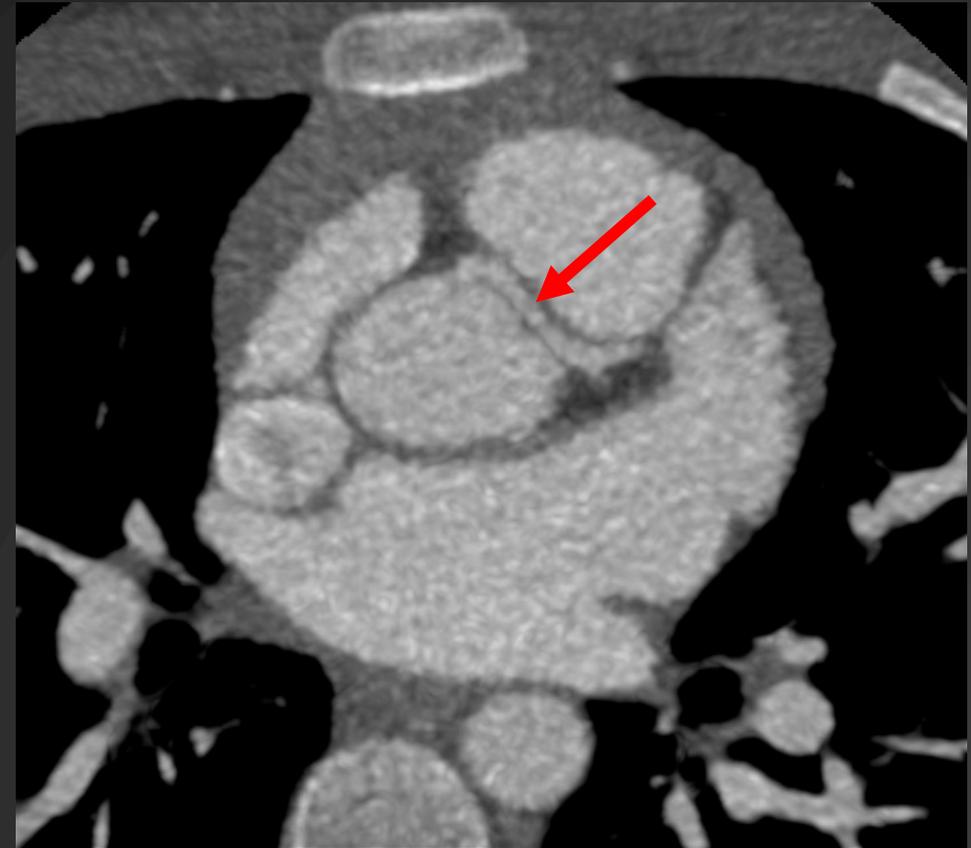
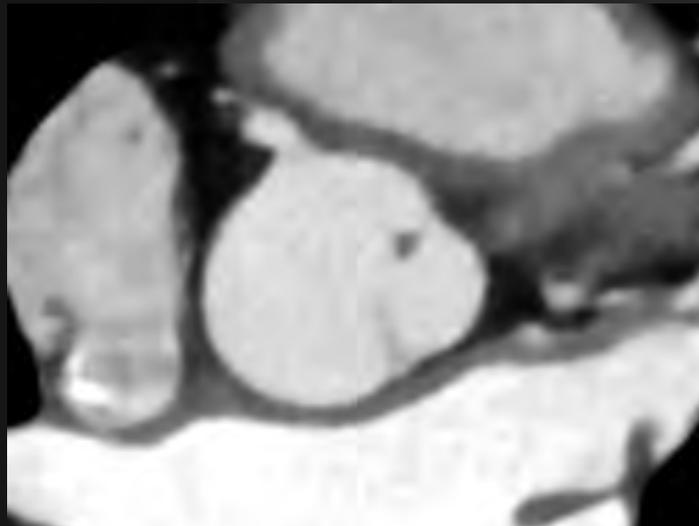
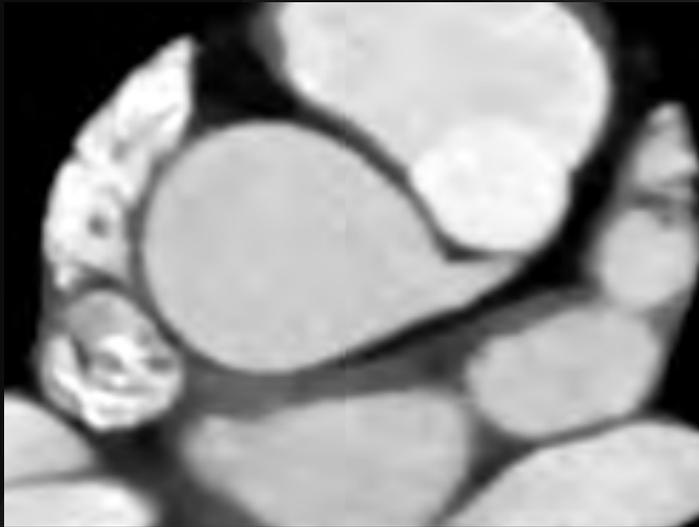


# Coronaires

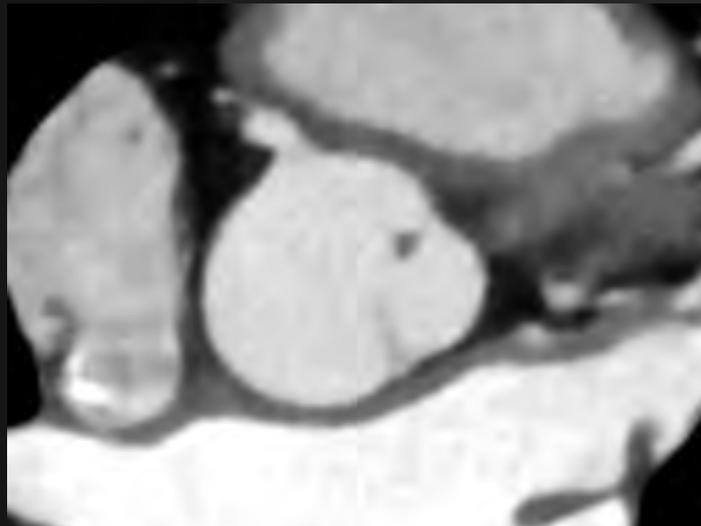
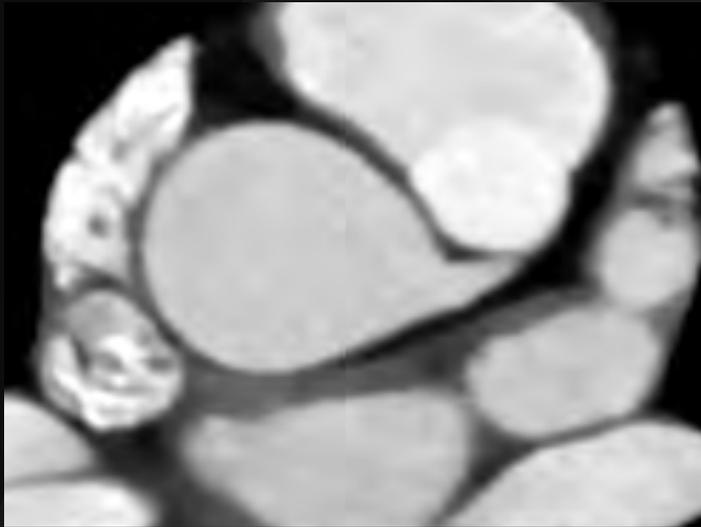




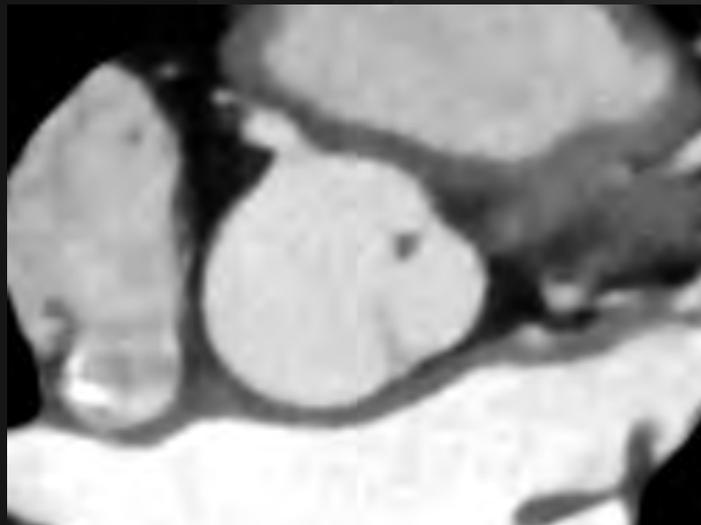
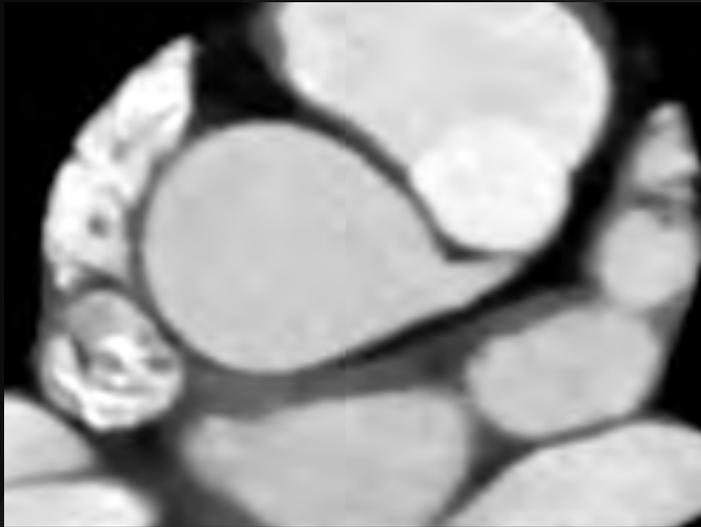
Coronaire D naissant de l'ostium gauche



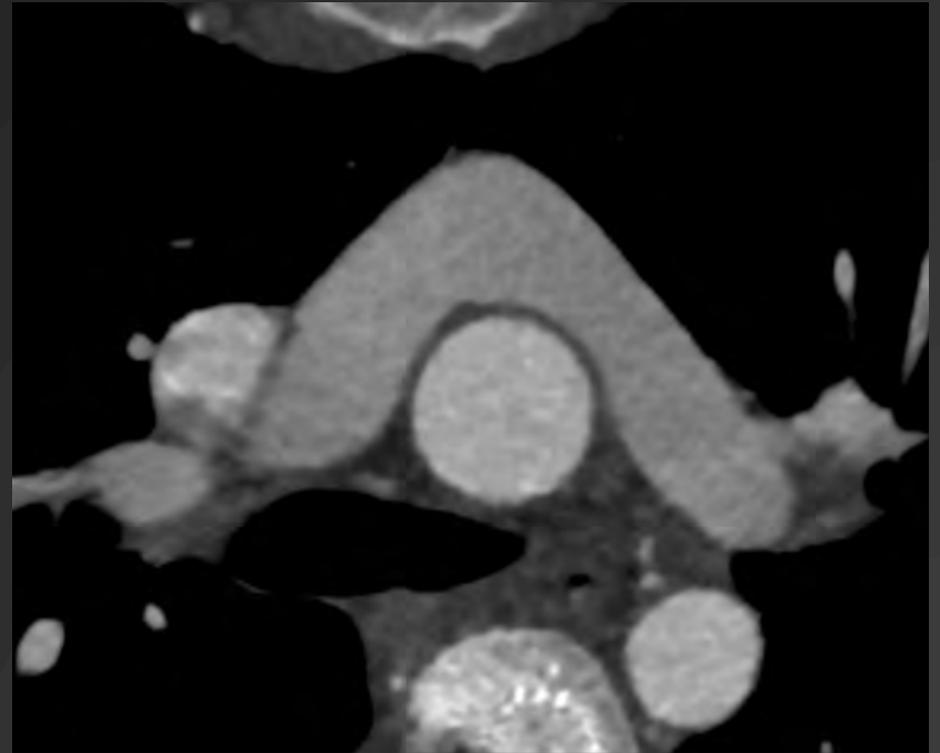
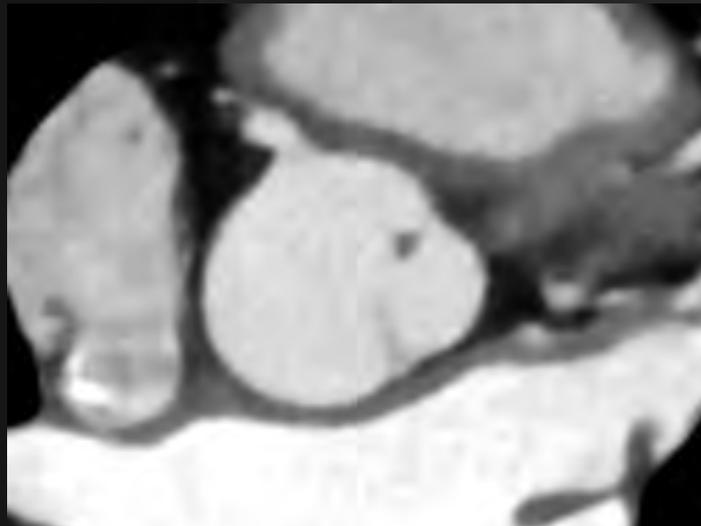
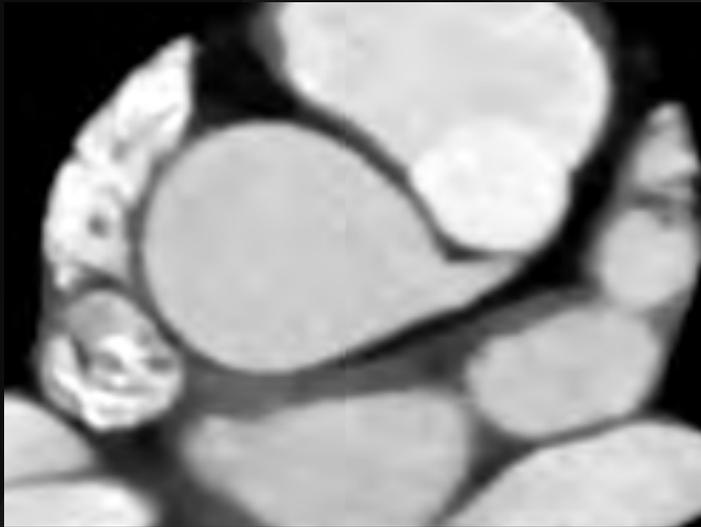
Coronaire G naissant de l'ostium droit



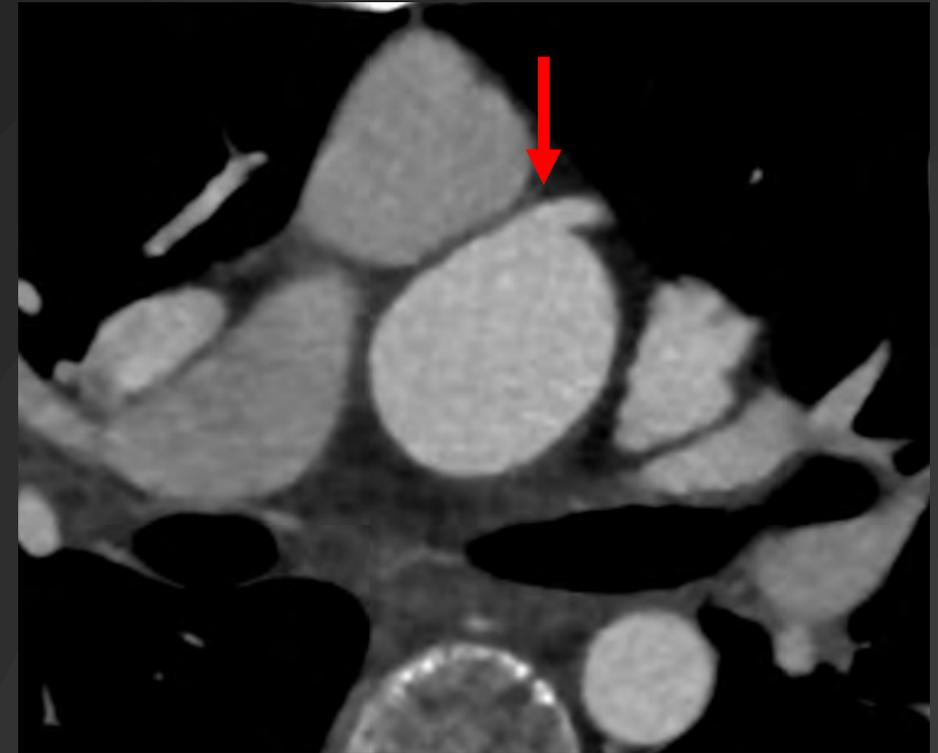
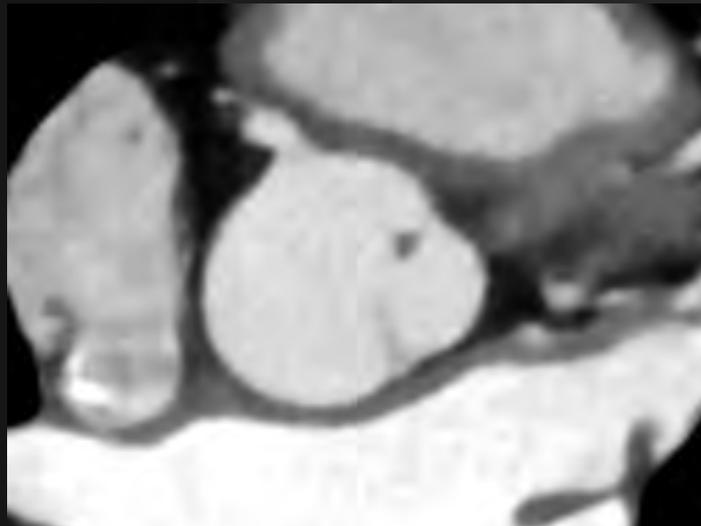
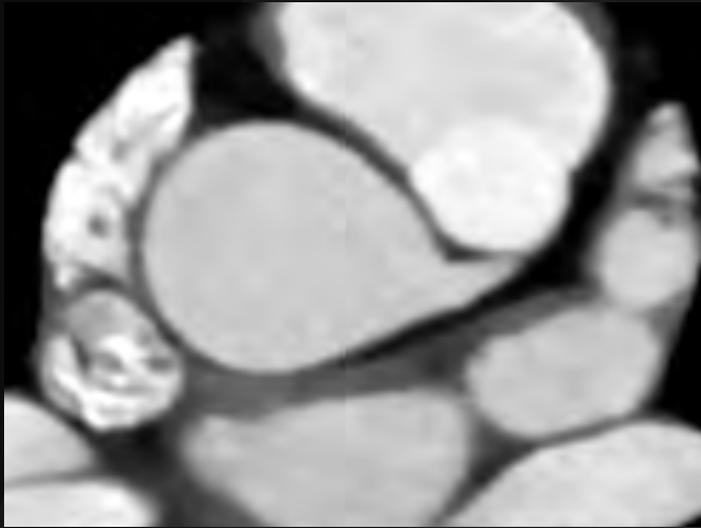
ALCAPA



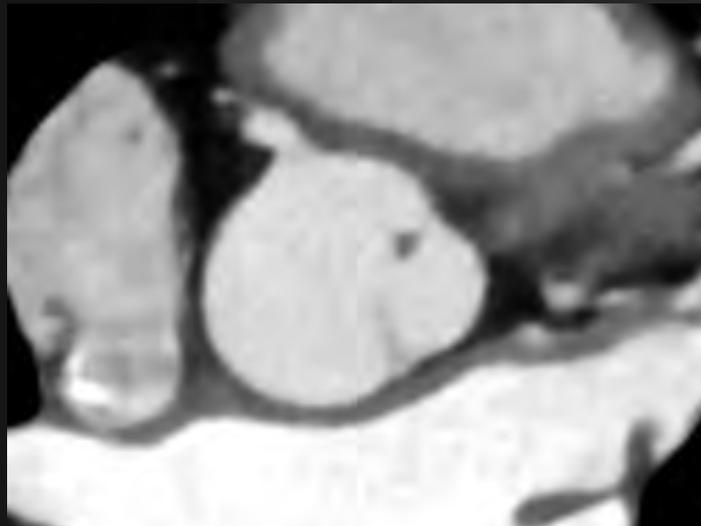
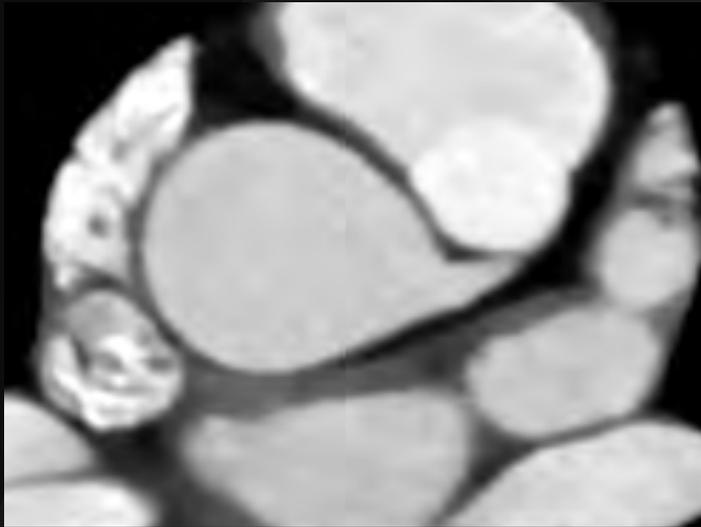
Anévrisme coronaire



TGV opérée

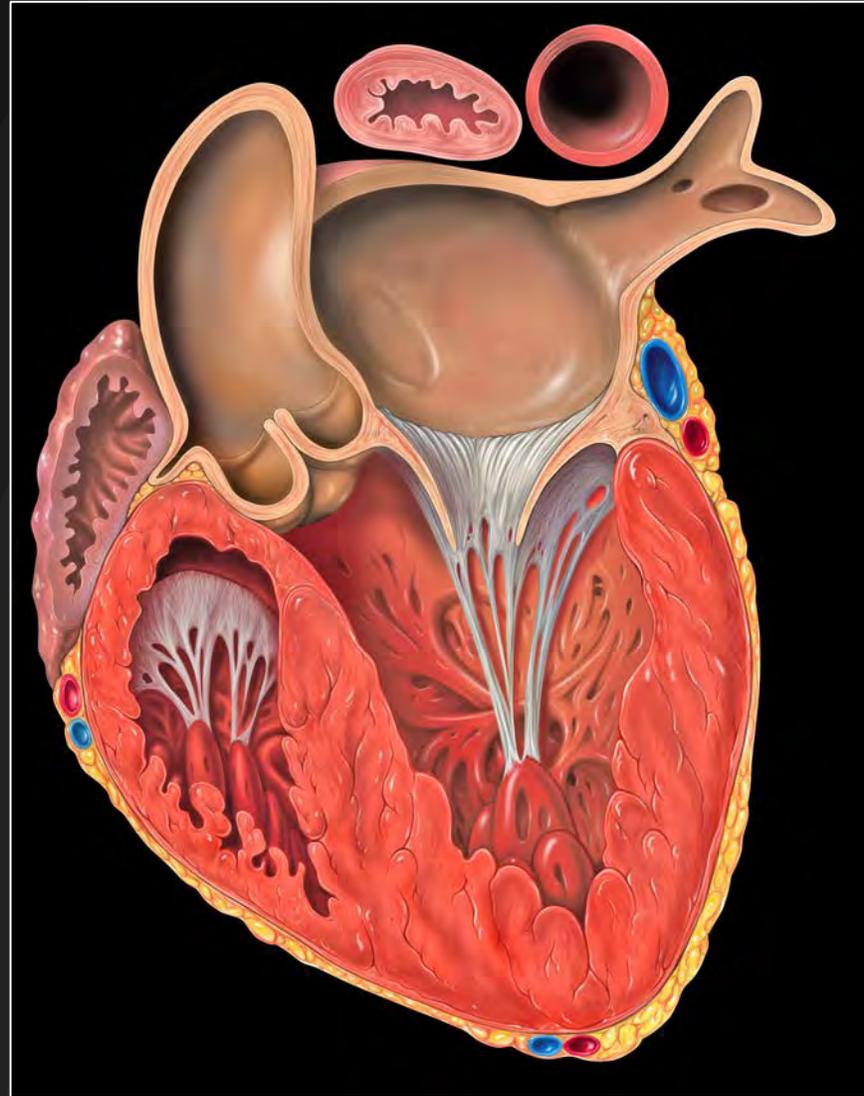


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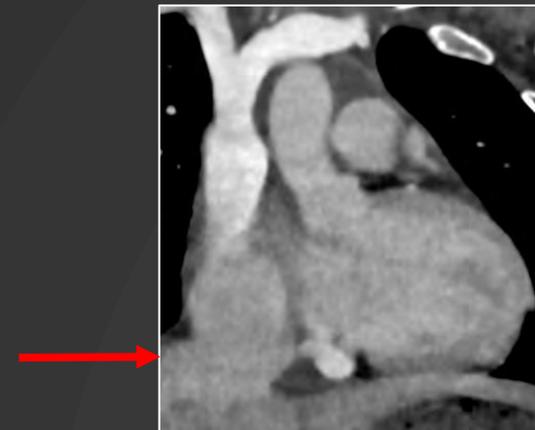
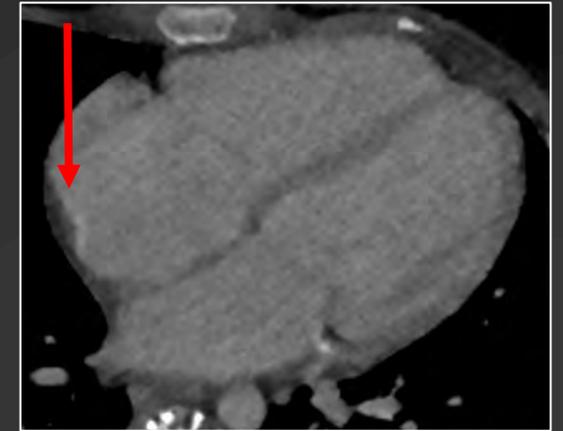
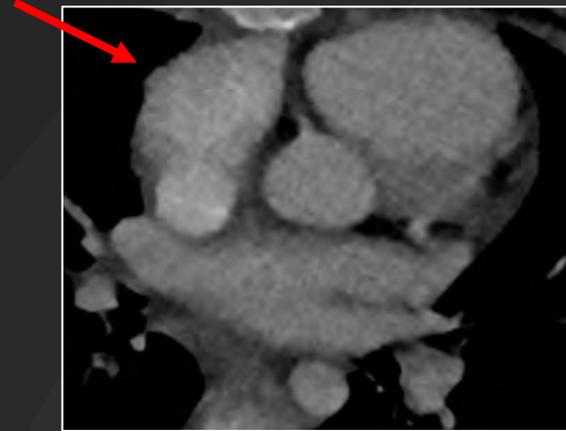


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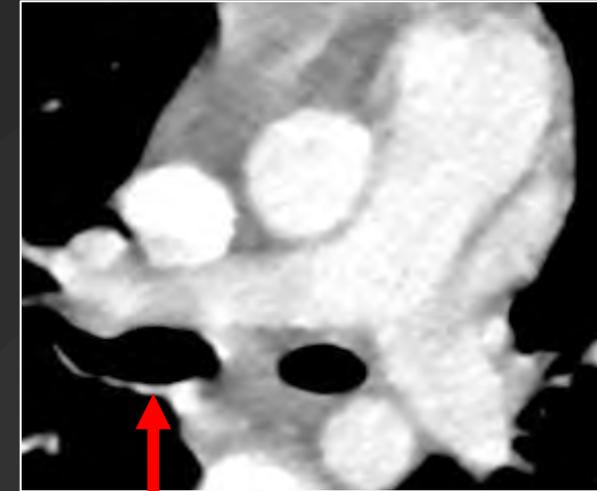
# Cavités cardiaques



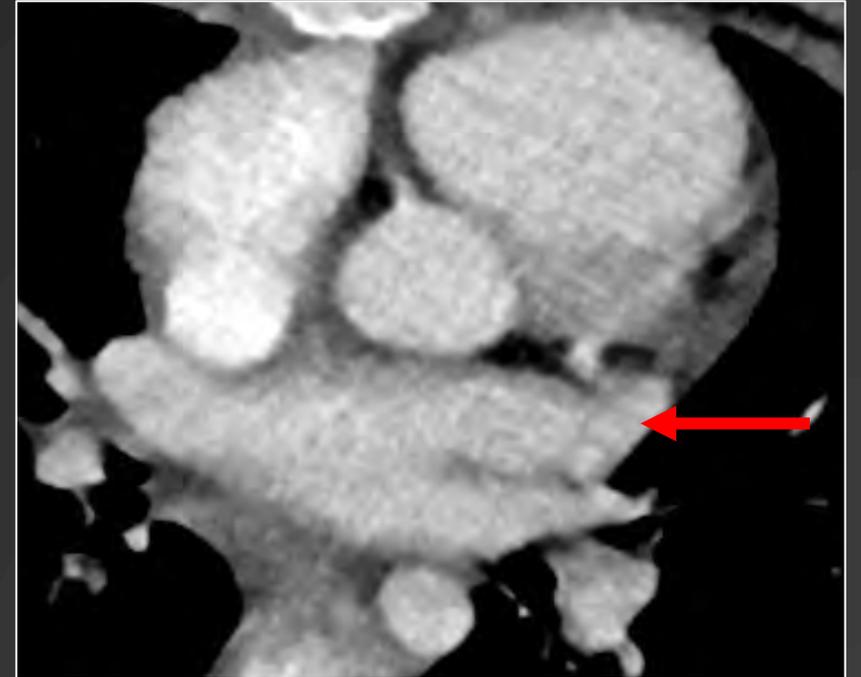
- *Atrium droit morphologique* :
  - Auricule large, triangulaire
  - Crista terminalis
  - Concordance veino-atriale



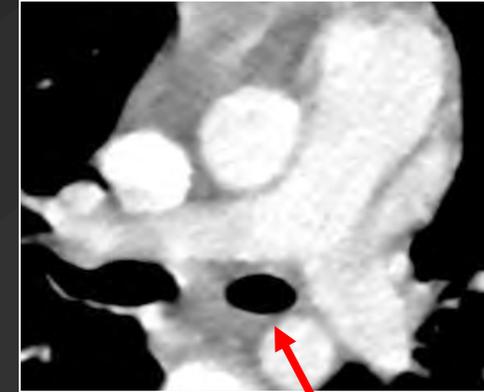
- *Atrium droit morphologique* :
  - Auricule large, triangulaire
  - Crista terminalis
  - Concordance veino-atriale
  - Du côté de la bronche et de l'AP droite :
    - Bronche en arrière de l'AP, 3 lobes
    - Naissance précoce de la bronche du LSD



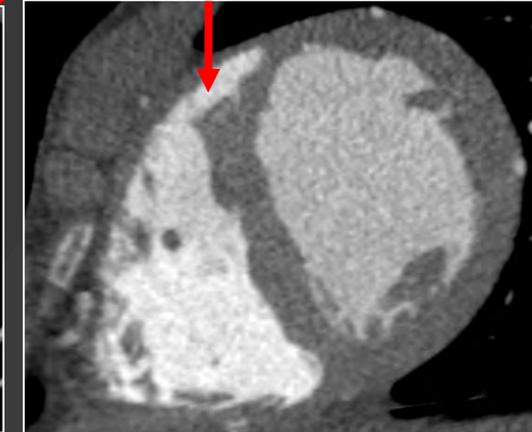
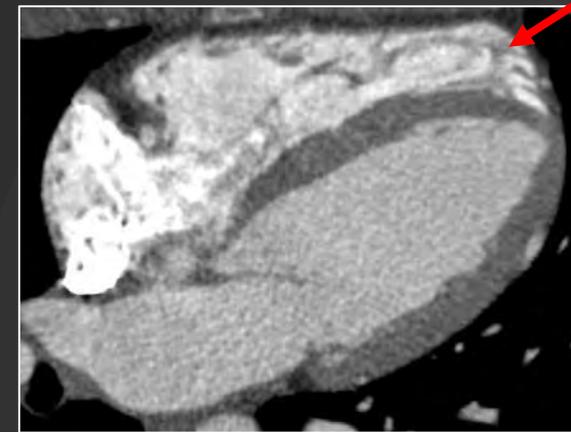
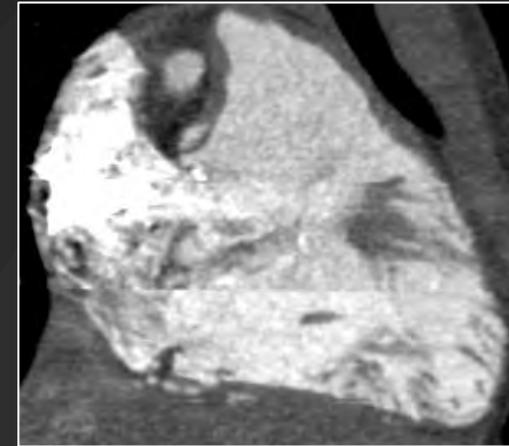
- Atrium gauche *morphologique* :
  - Auricule fin, tubulaire, en doigt de gant



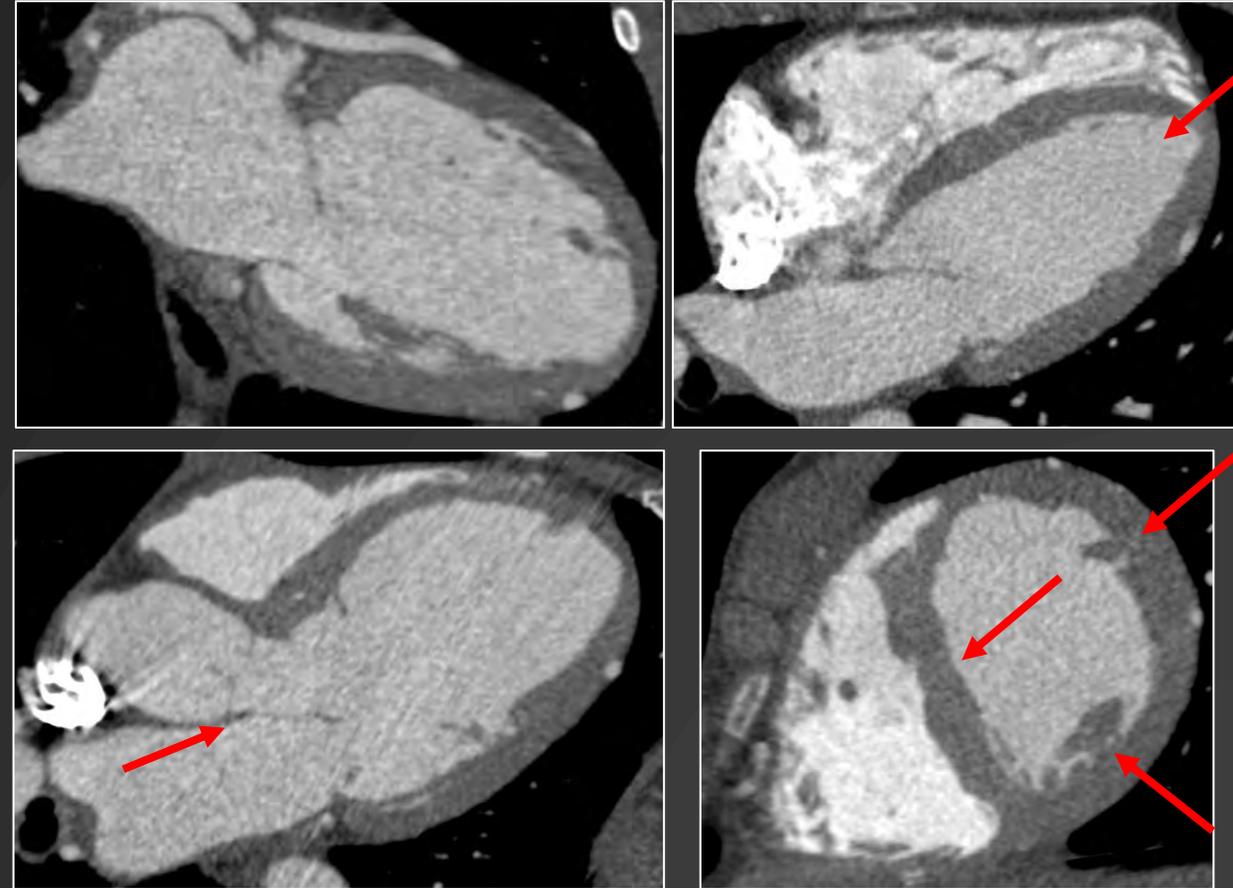
- Atrium gauche *morphologique* :
  - Auricule fin, tubulaire, en doigt de gant
  - Du côté de la bronche et de l'AP gauche :
    - Bronche sous l'AP, 2 lobes
    - Naissance tardive de la bronche du LSG



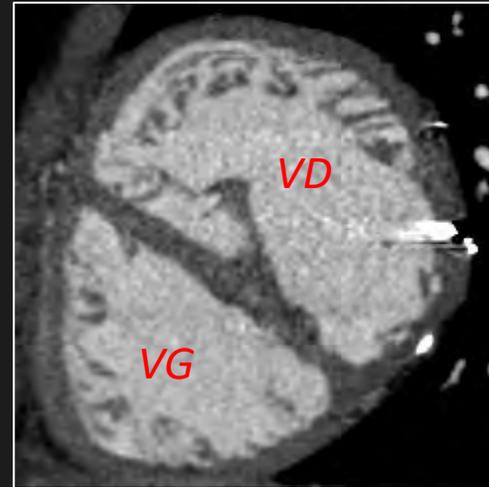
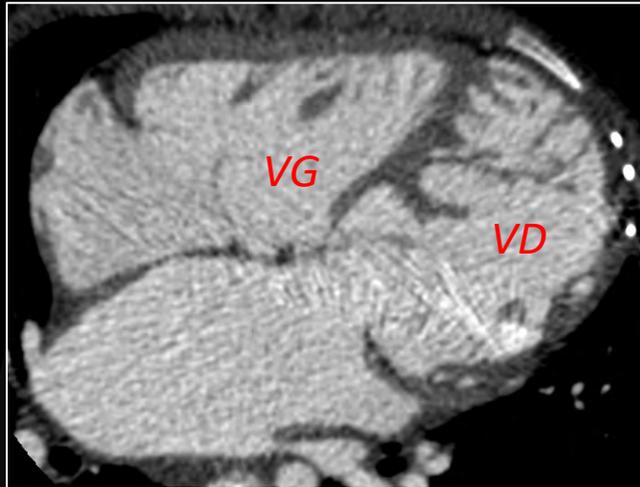
- Ventricule droit *morphologique*
  - Bande modératrice
  - Trabéculations épaisses
  - Muscles papillaires sur mur libre et septum
  - Valve tricuspide
  - Discontinuité tricuspide-pulmonaire (infundibulum)



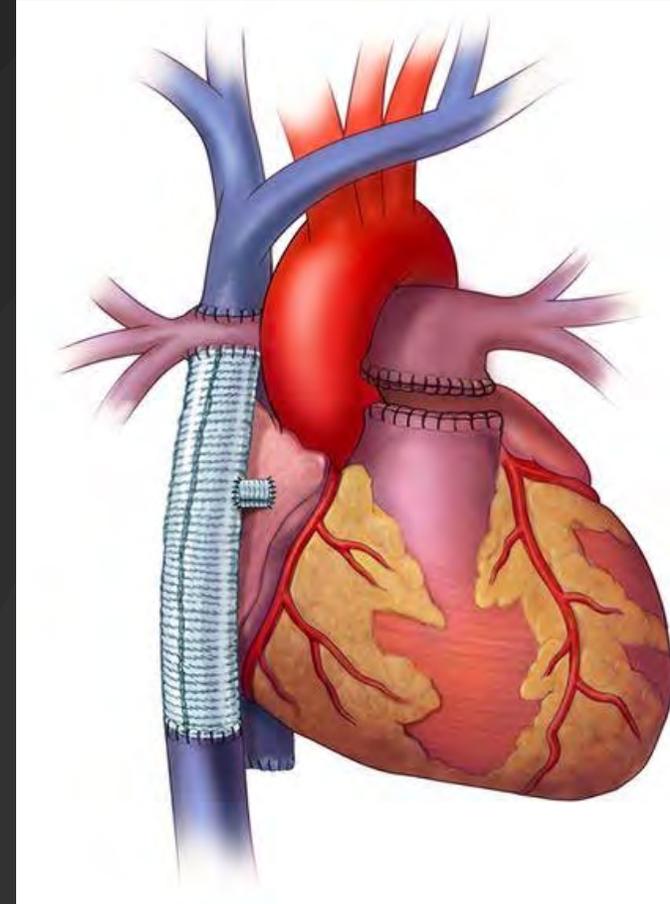
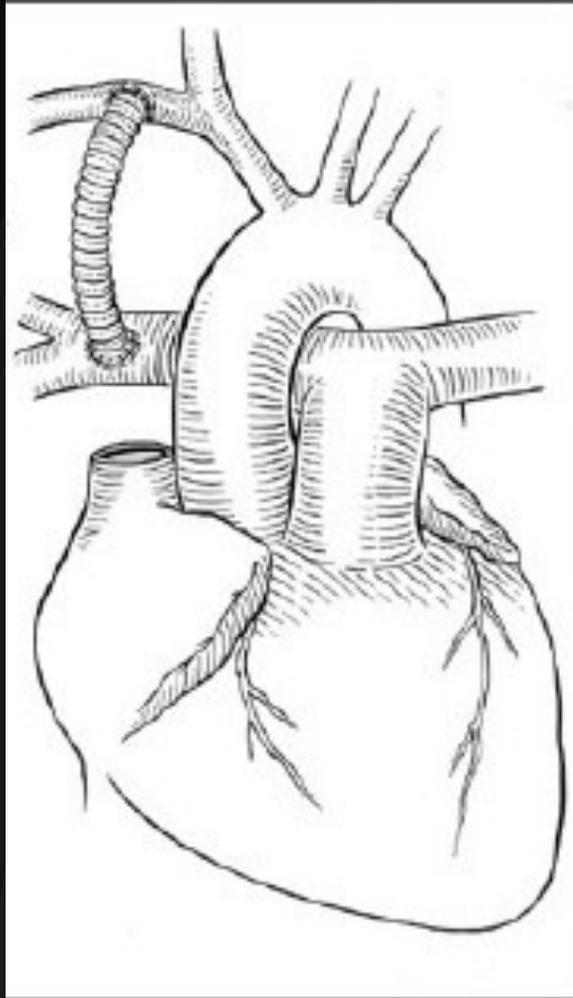
- Ventricule gauche *morphologique*
  - Trabéculations fines
  - Muscles papillaires uniquement sur paroi libre
  - Septum lisse
  - Valve mitrale bicuspide
  - Continuité mitro-aortique



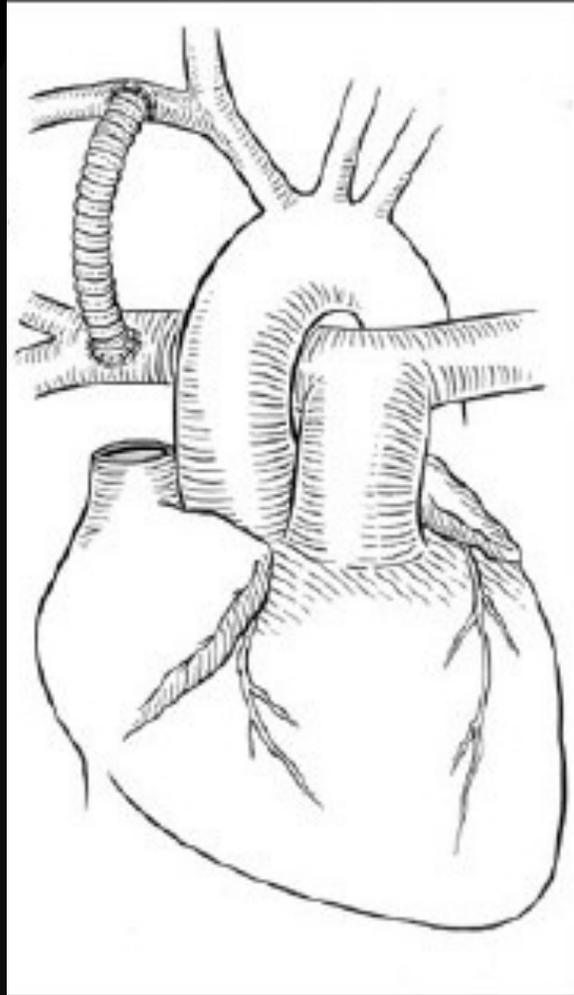
- Double discordance



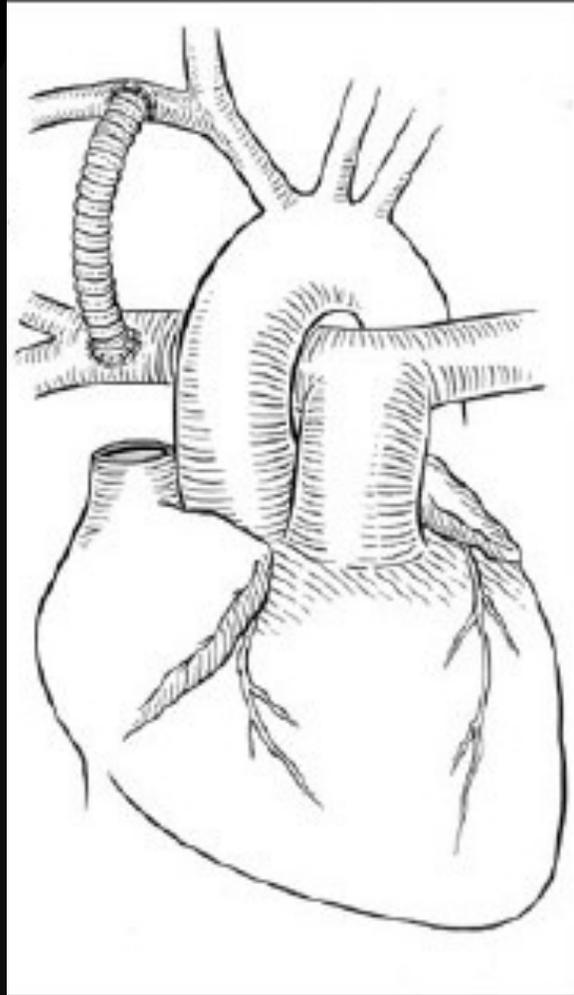
# Montages chirurgicaux



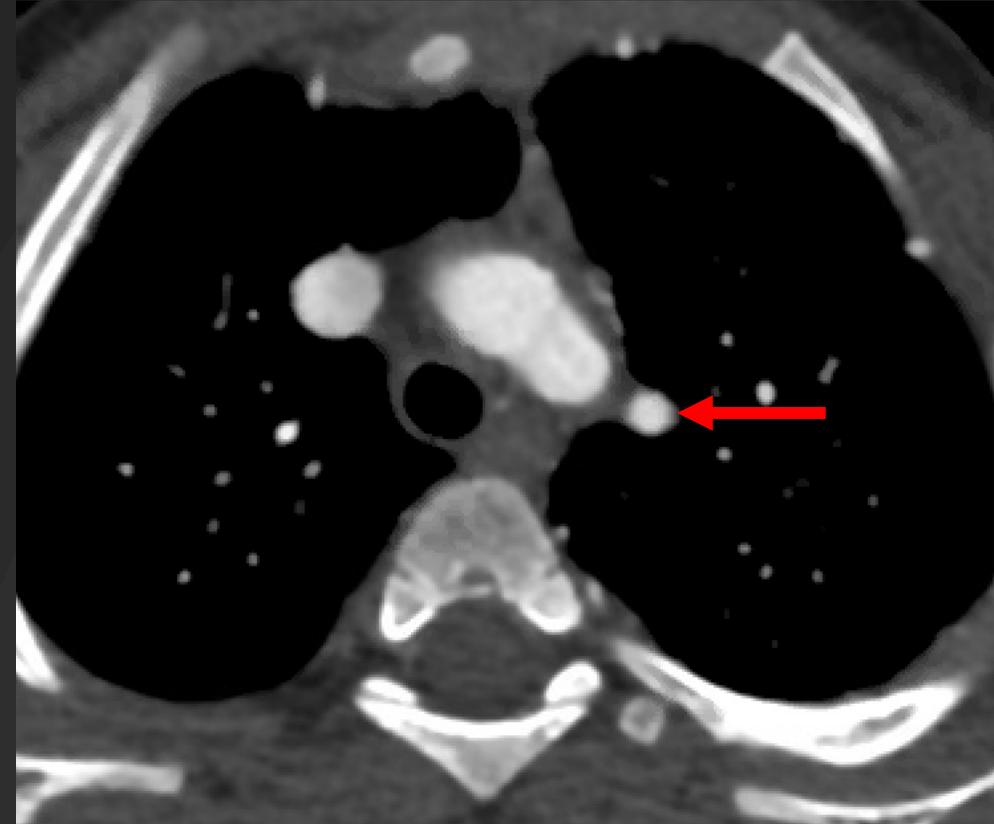
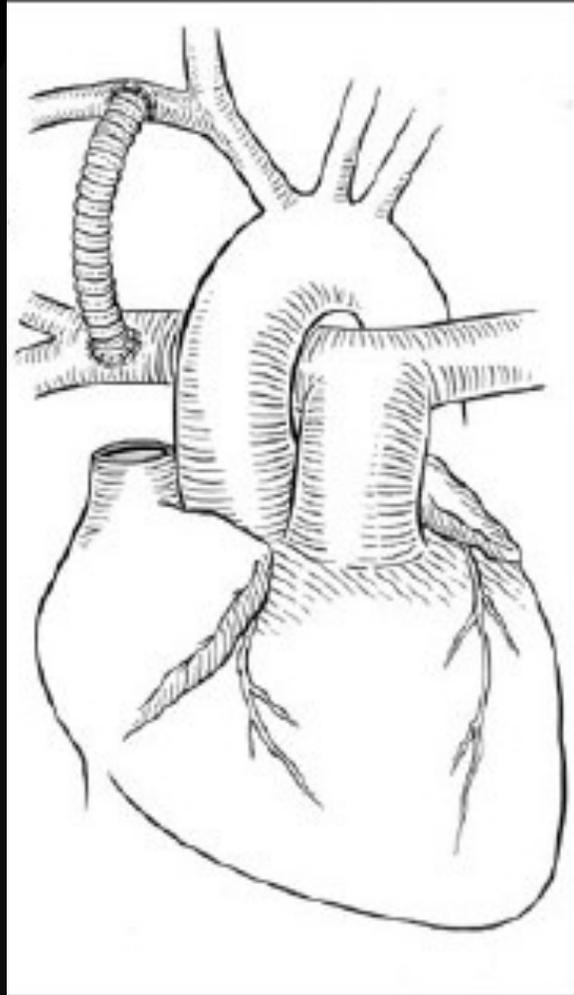
# Montages chirurgicaux



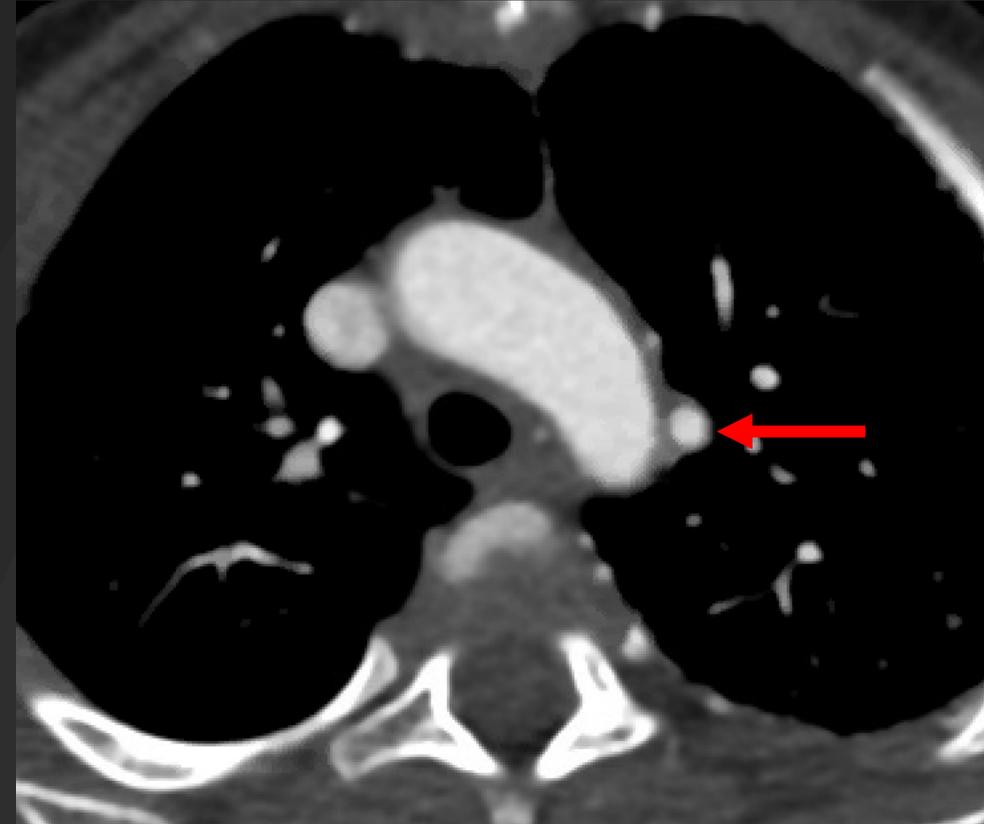
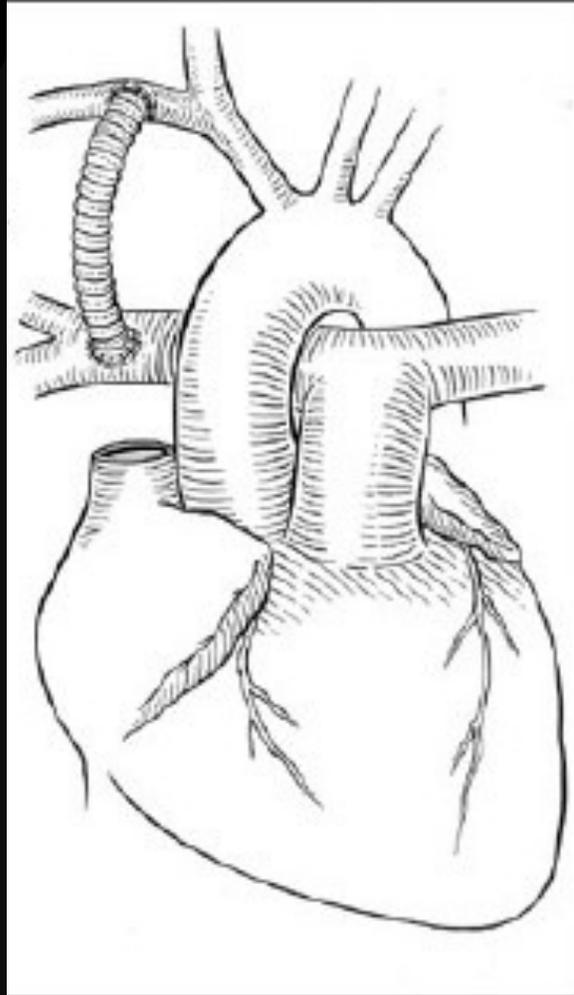
# Montages chirurgicaux



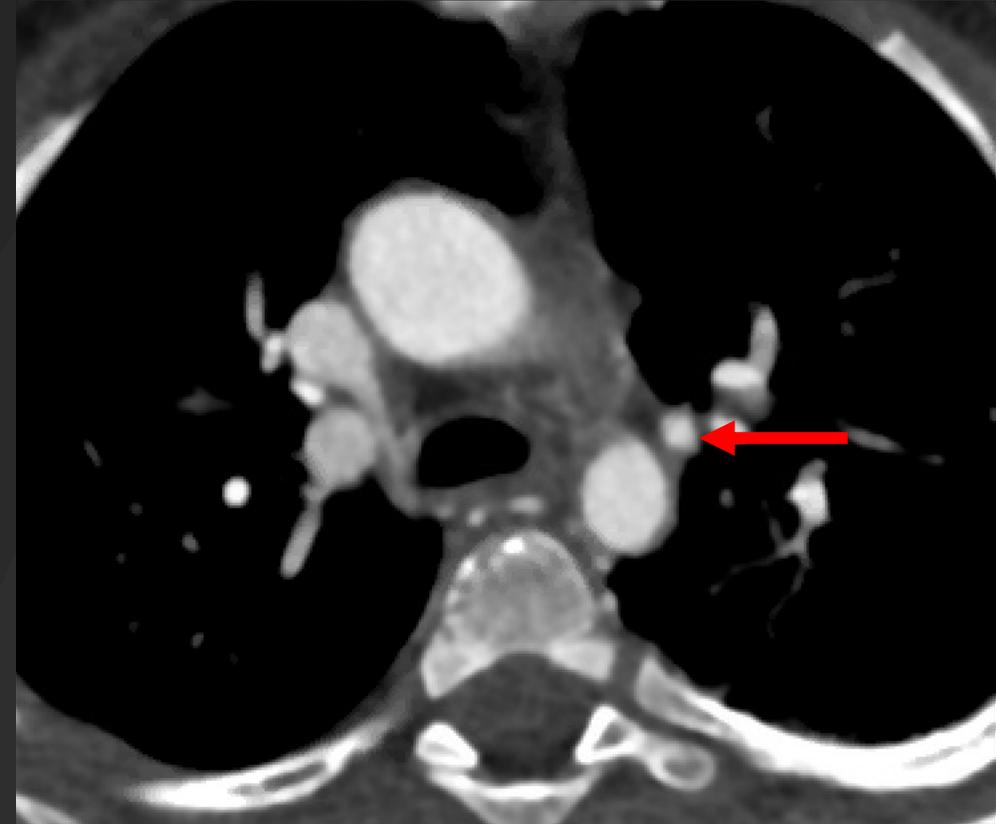
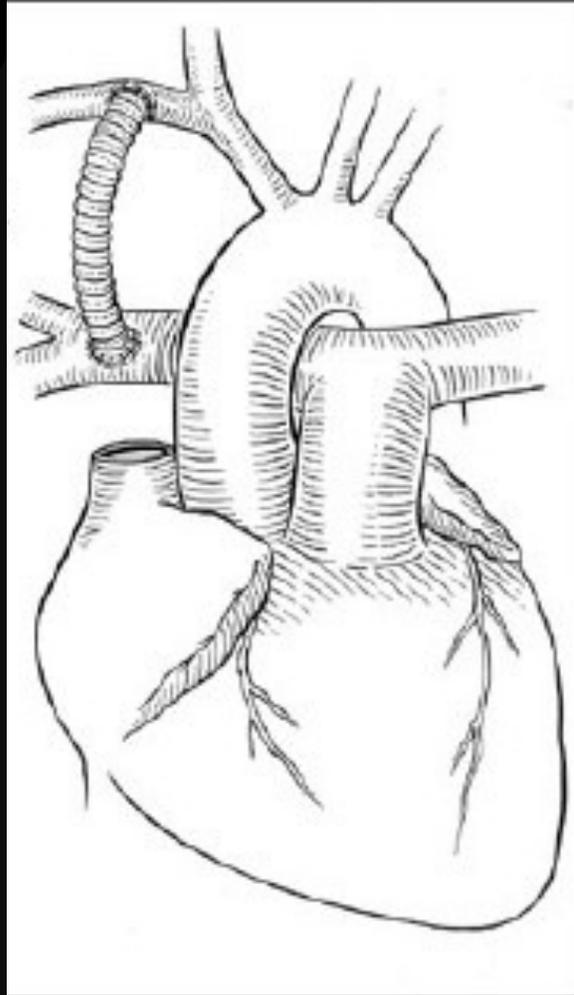
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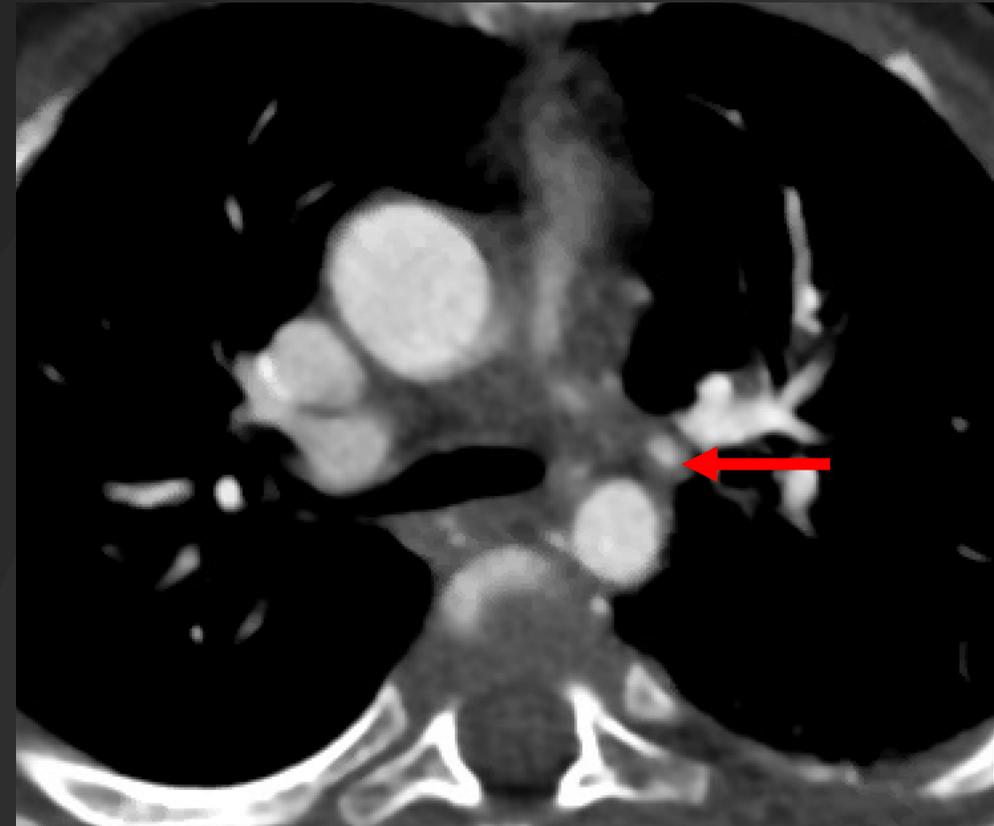
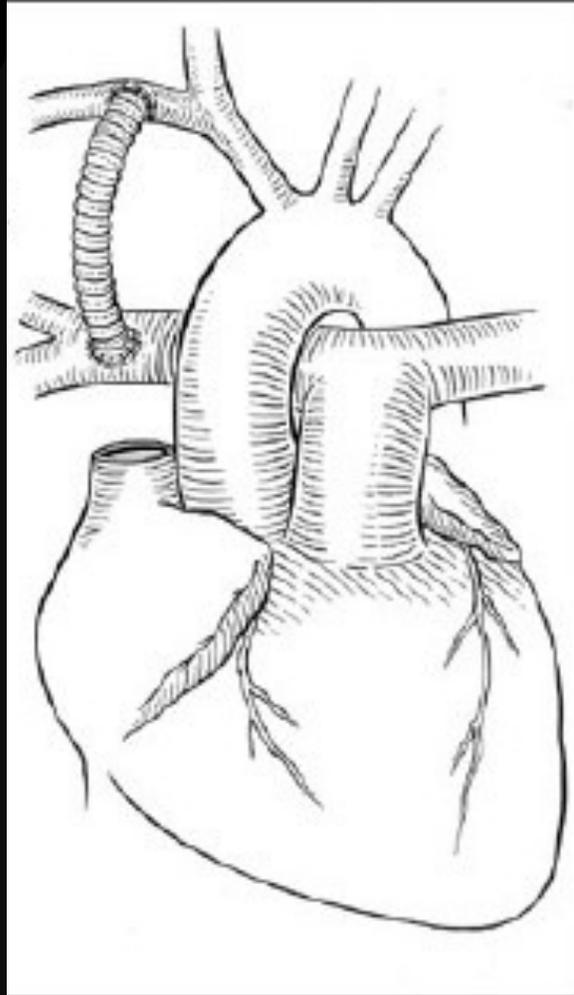
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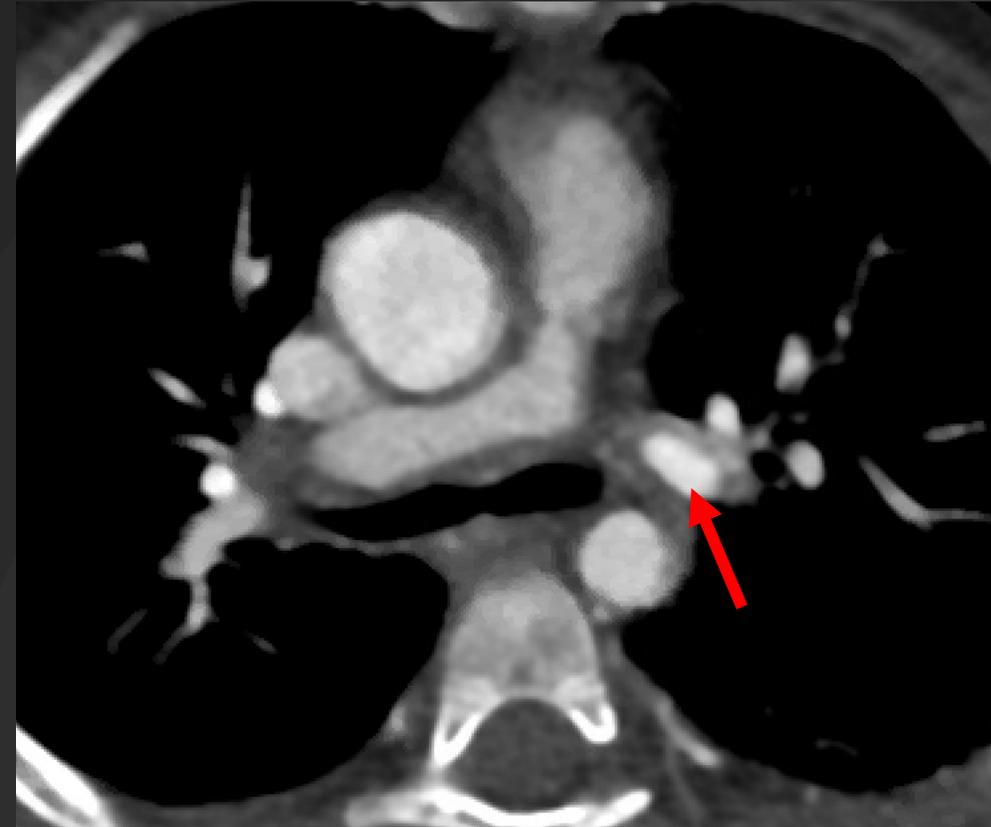
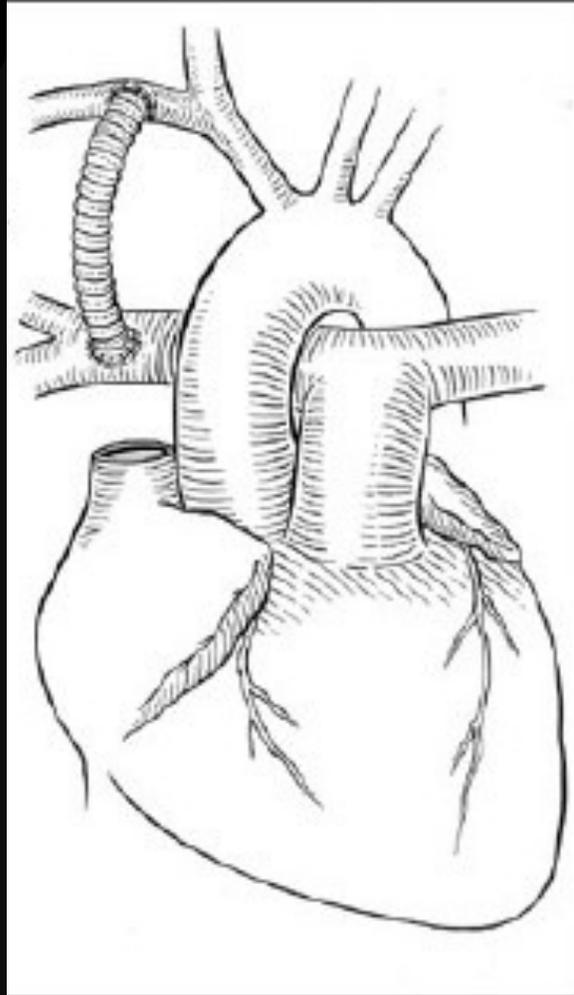
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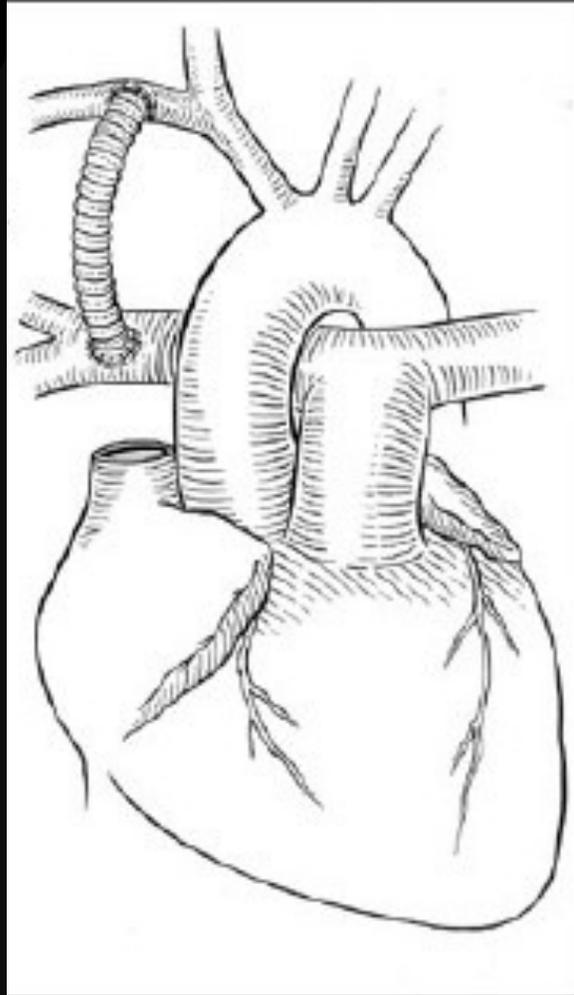
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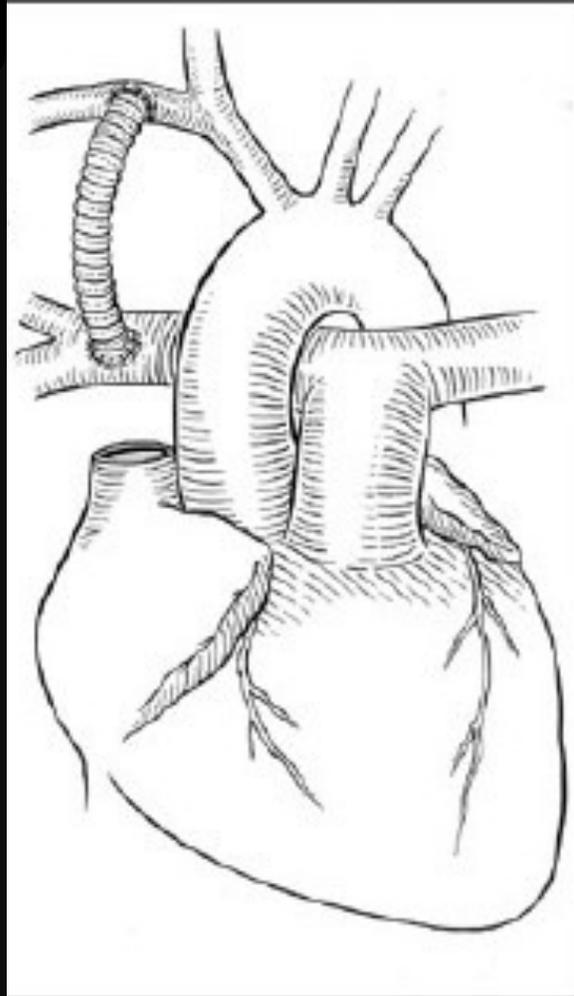
# Montages chirurgicaux



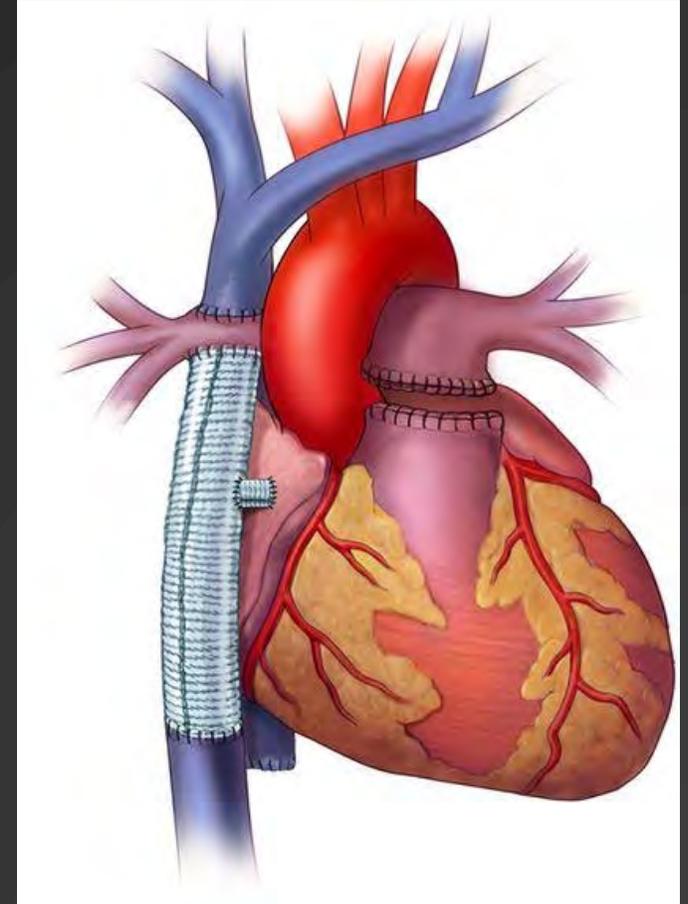
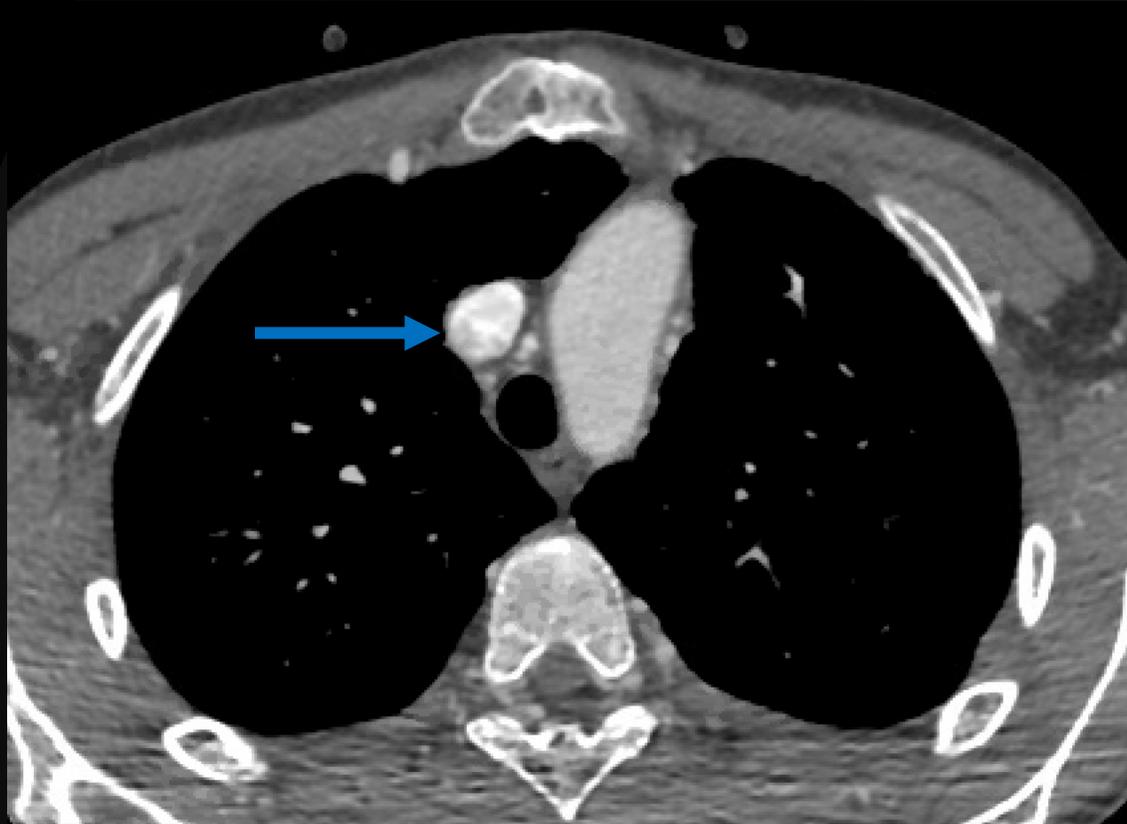
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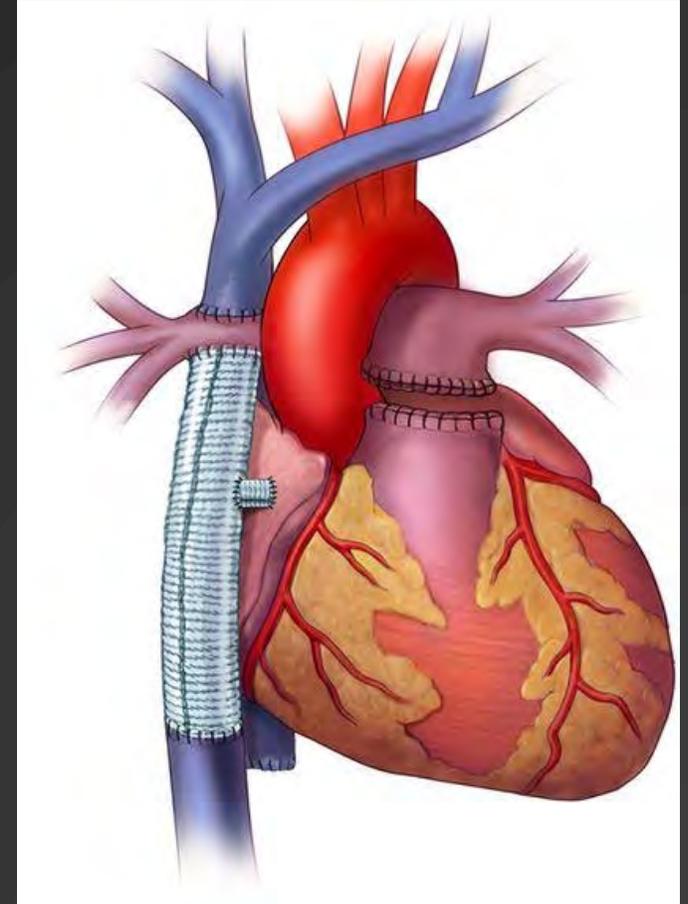
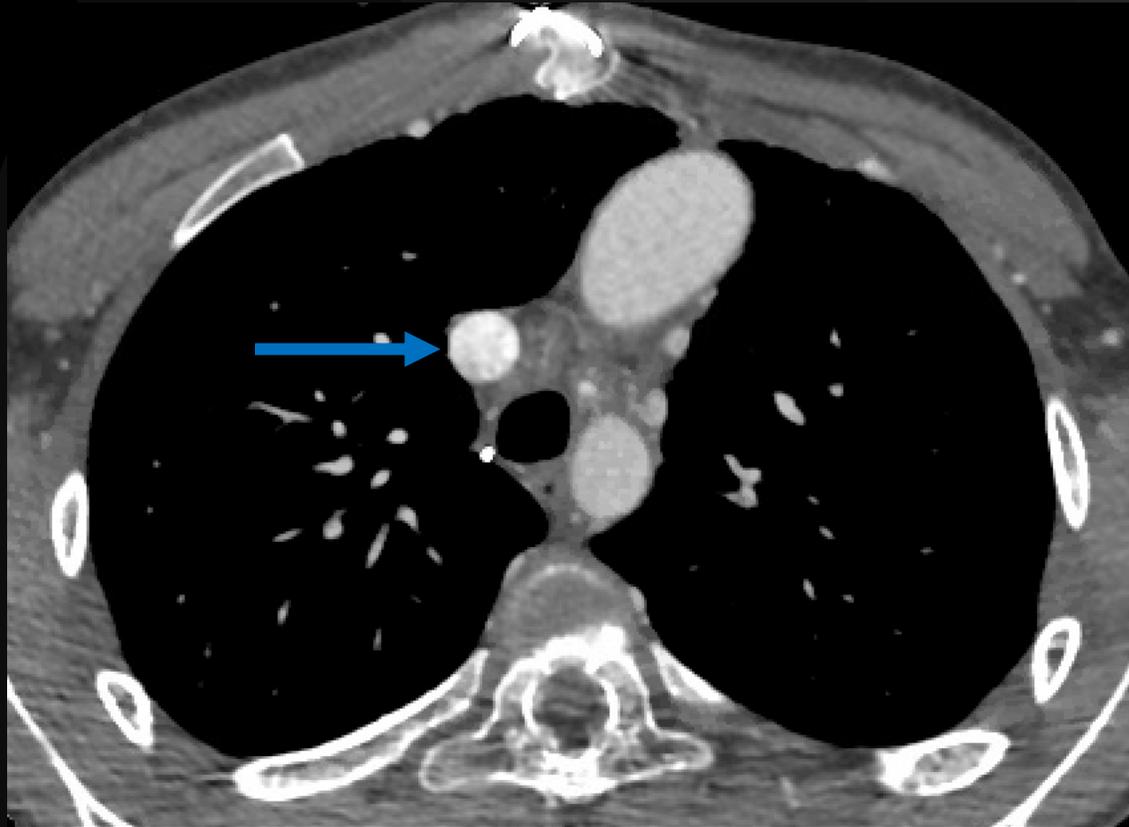
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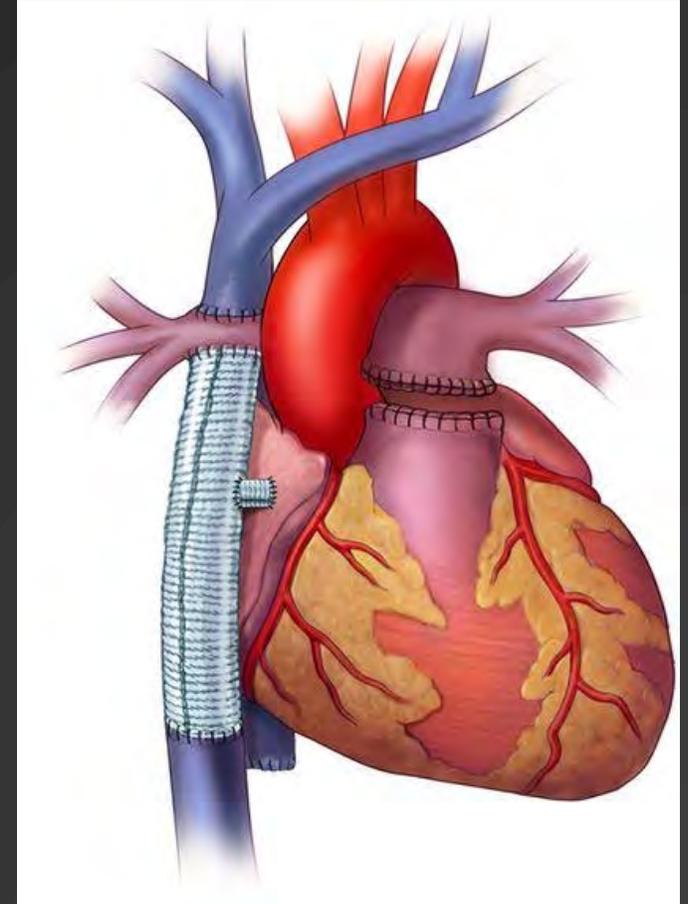
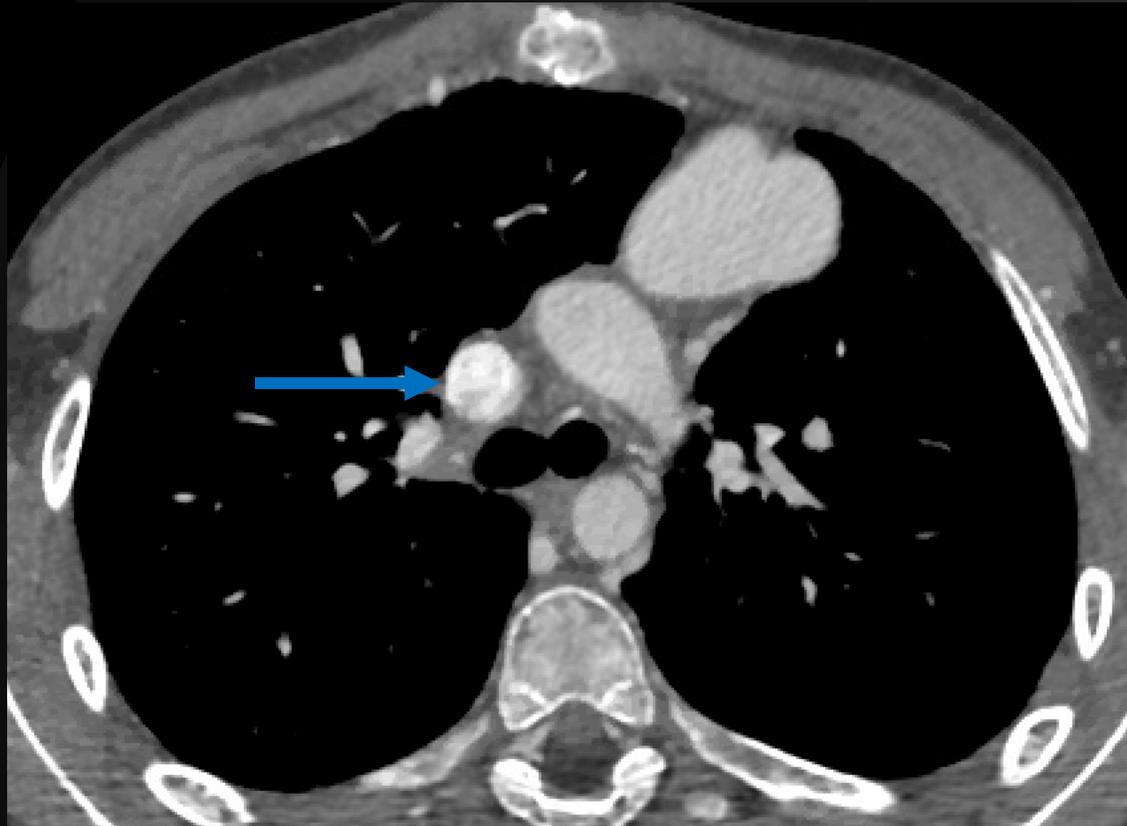
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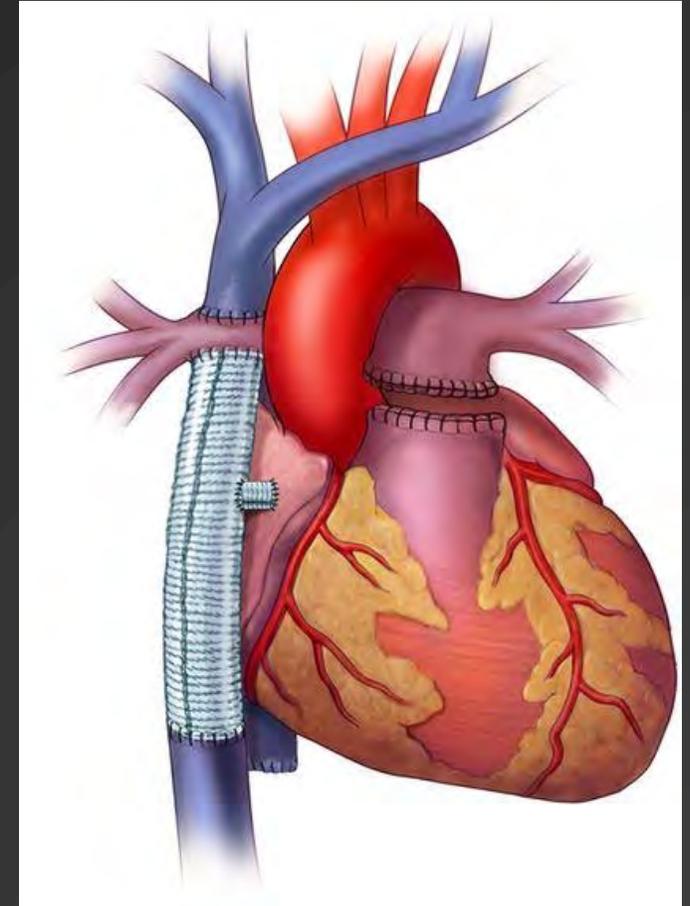
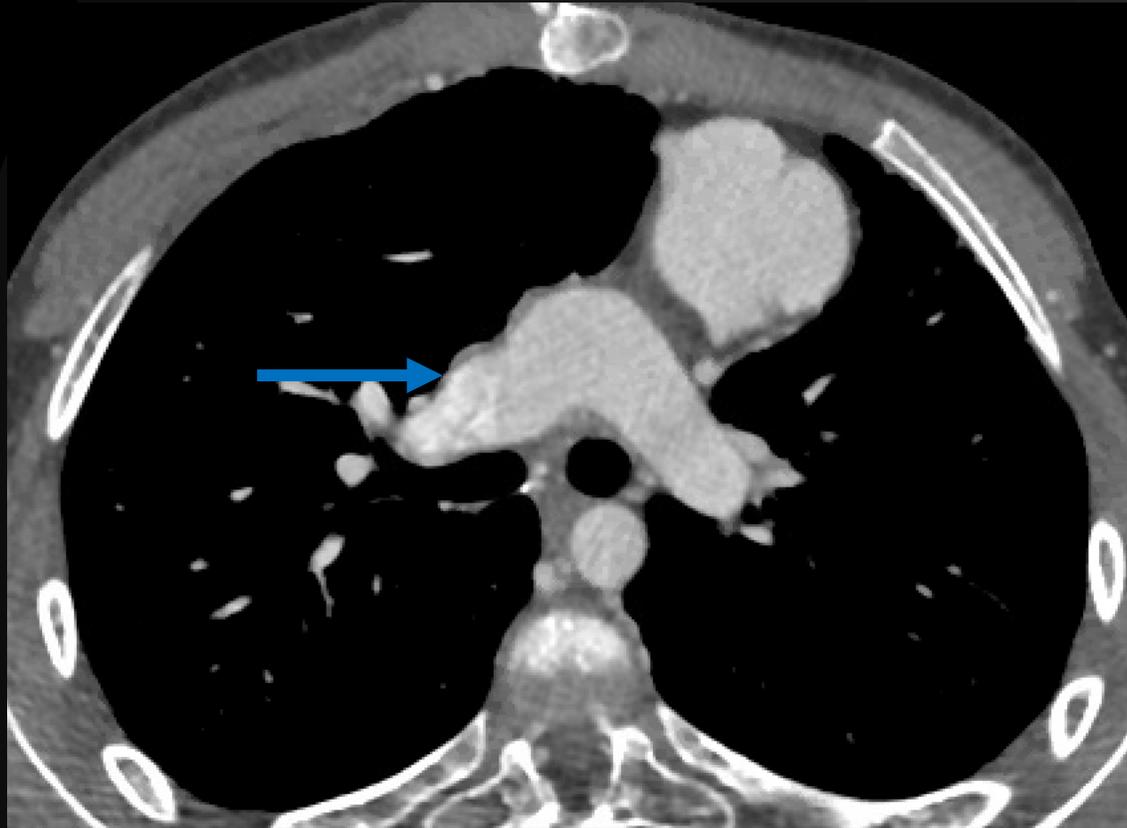
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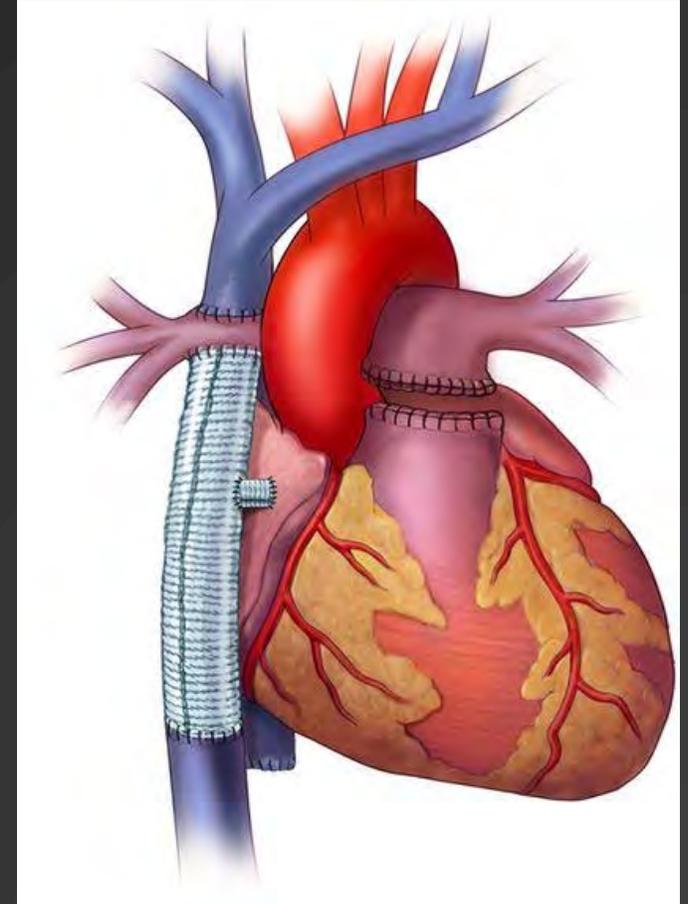
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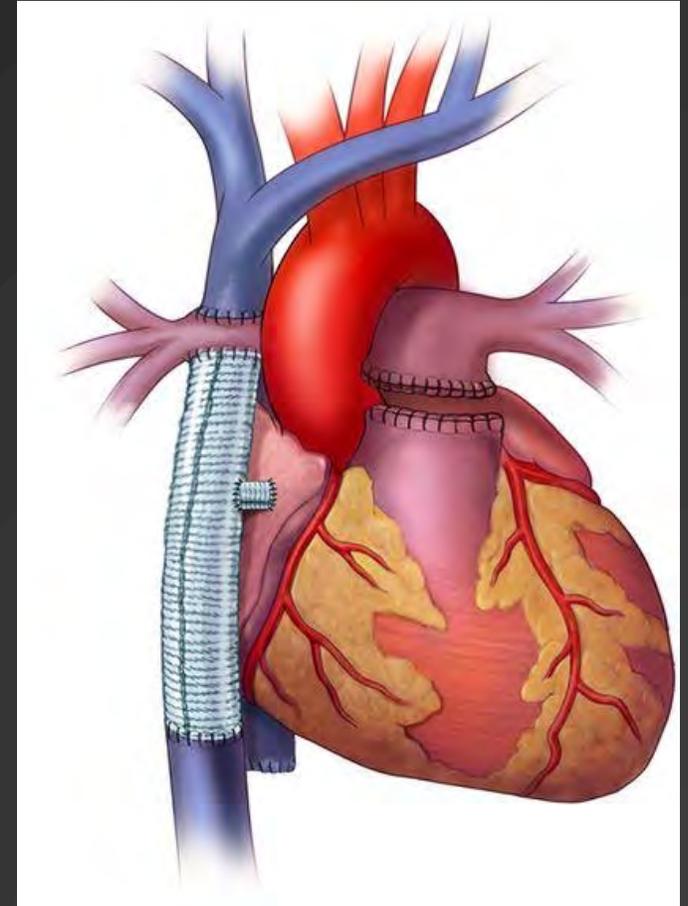
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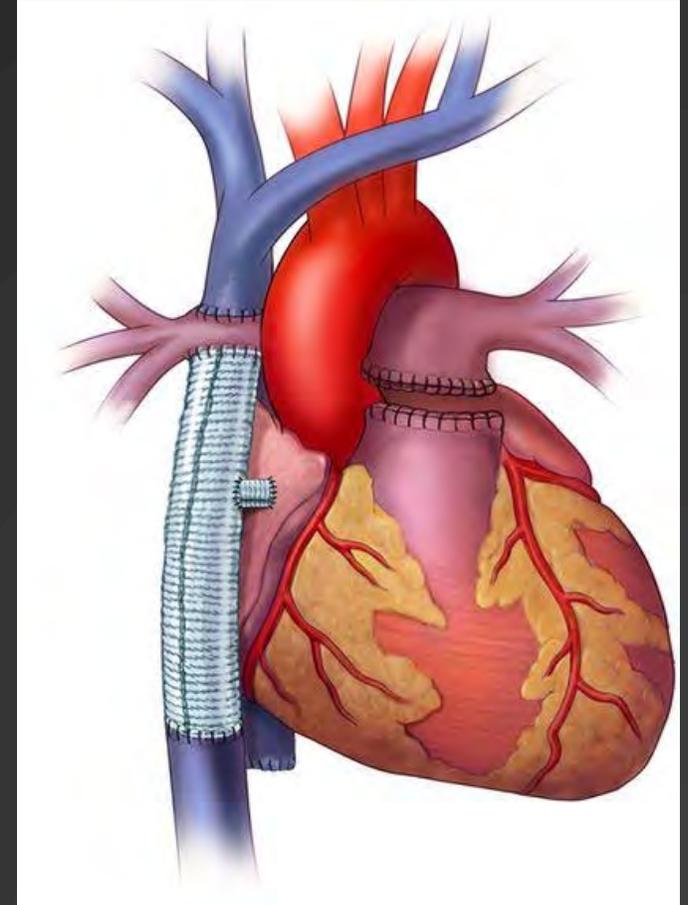
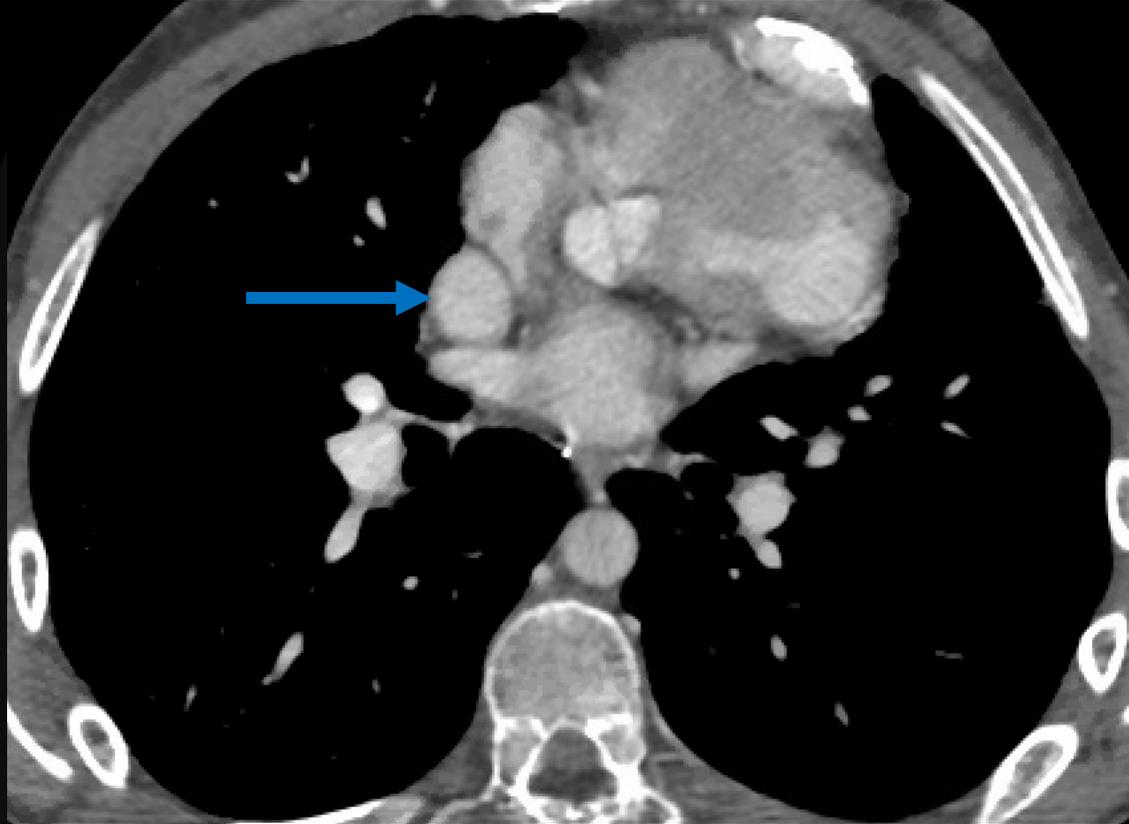
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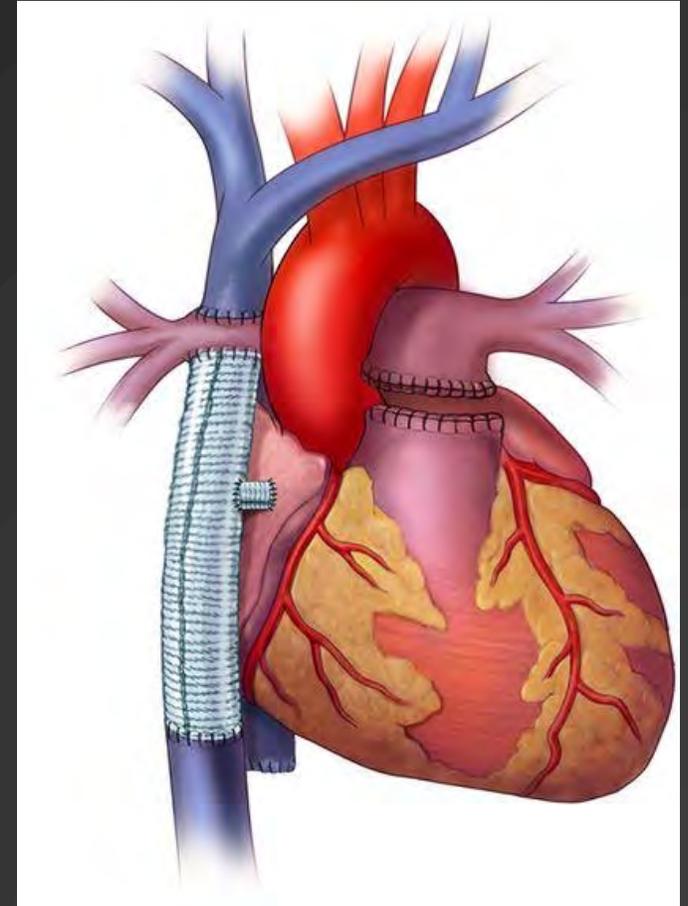
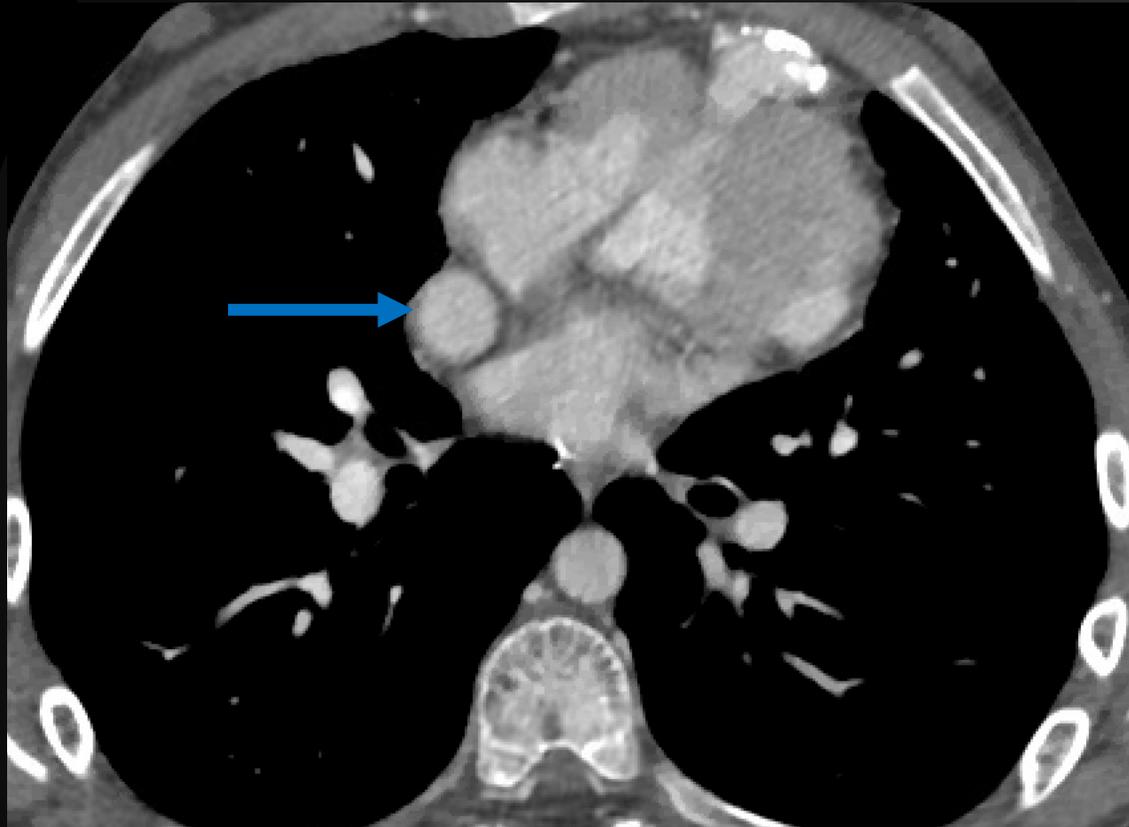
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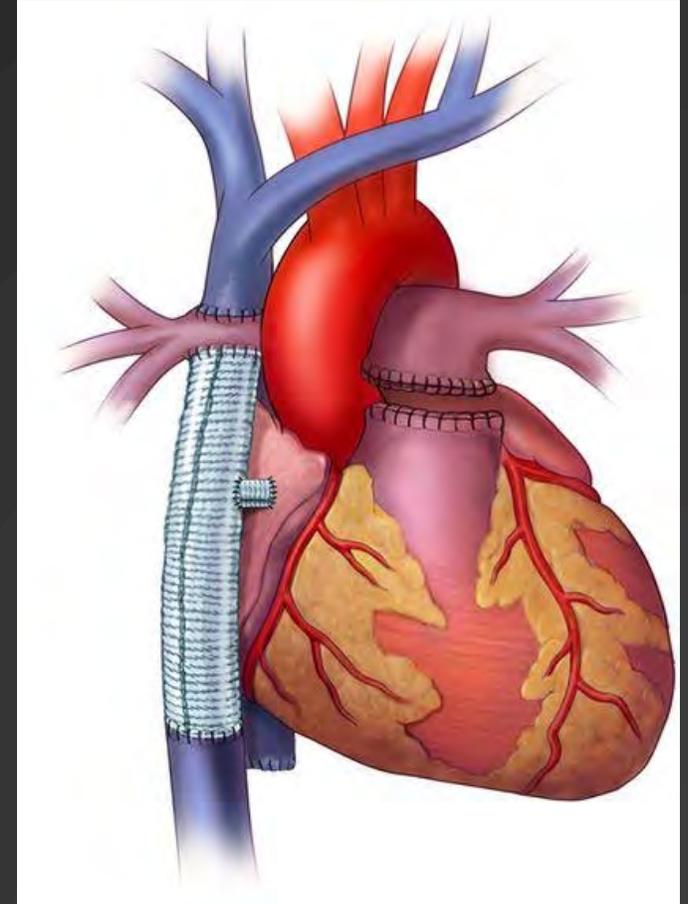
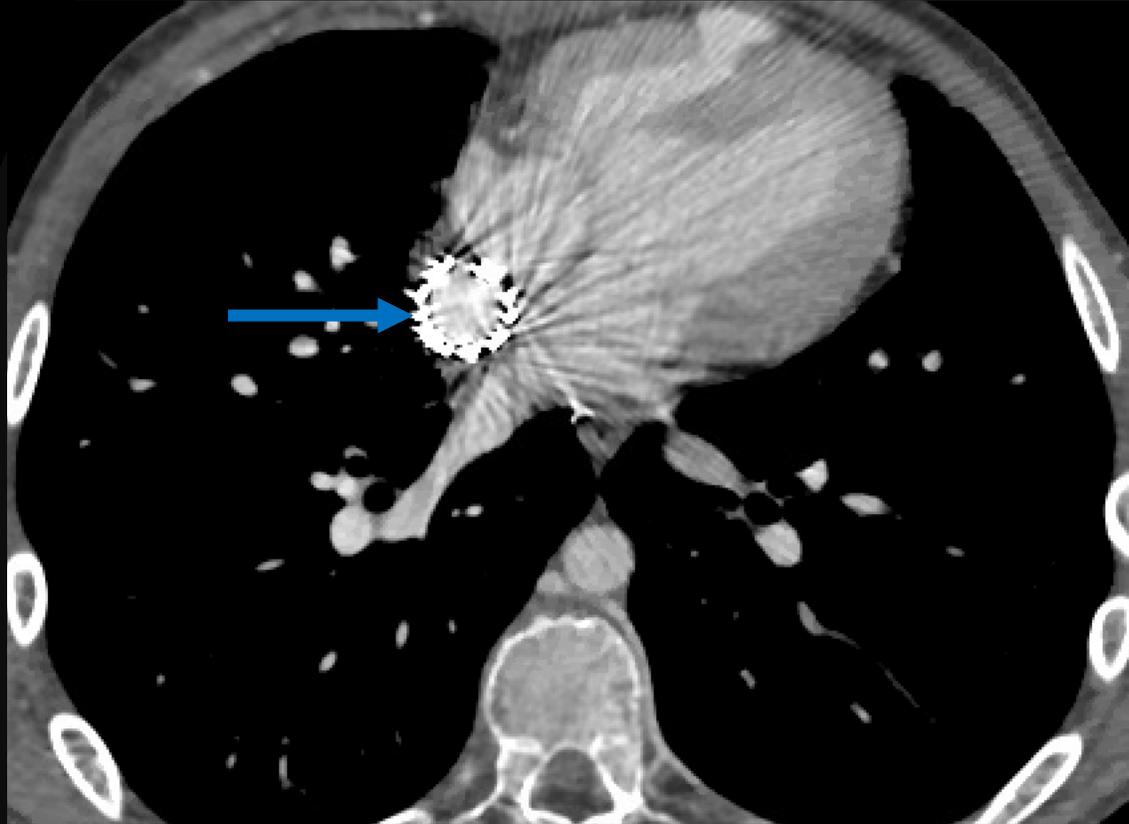
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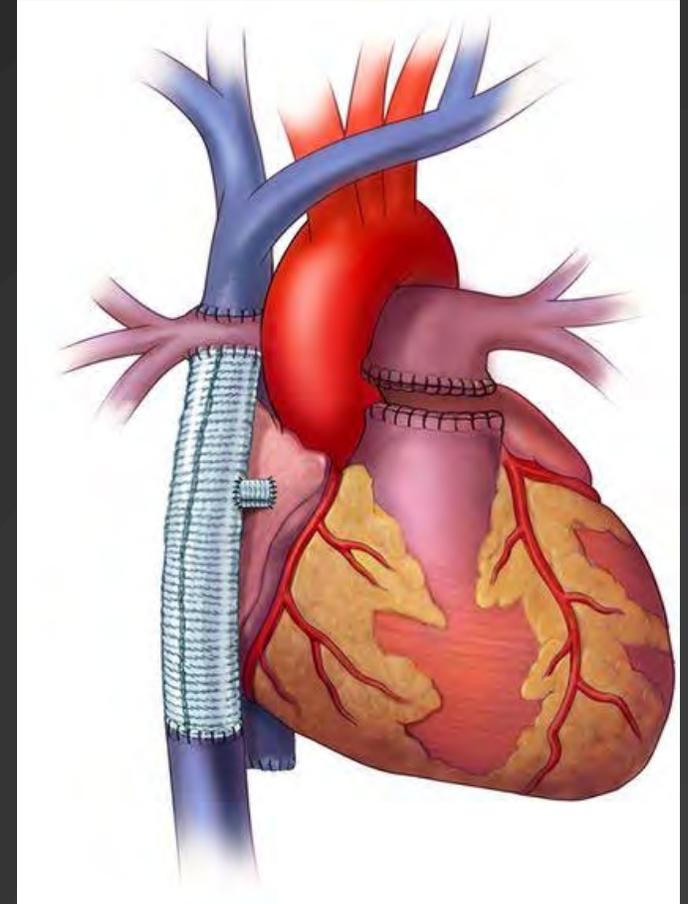
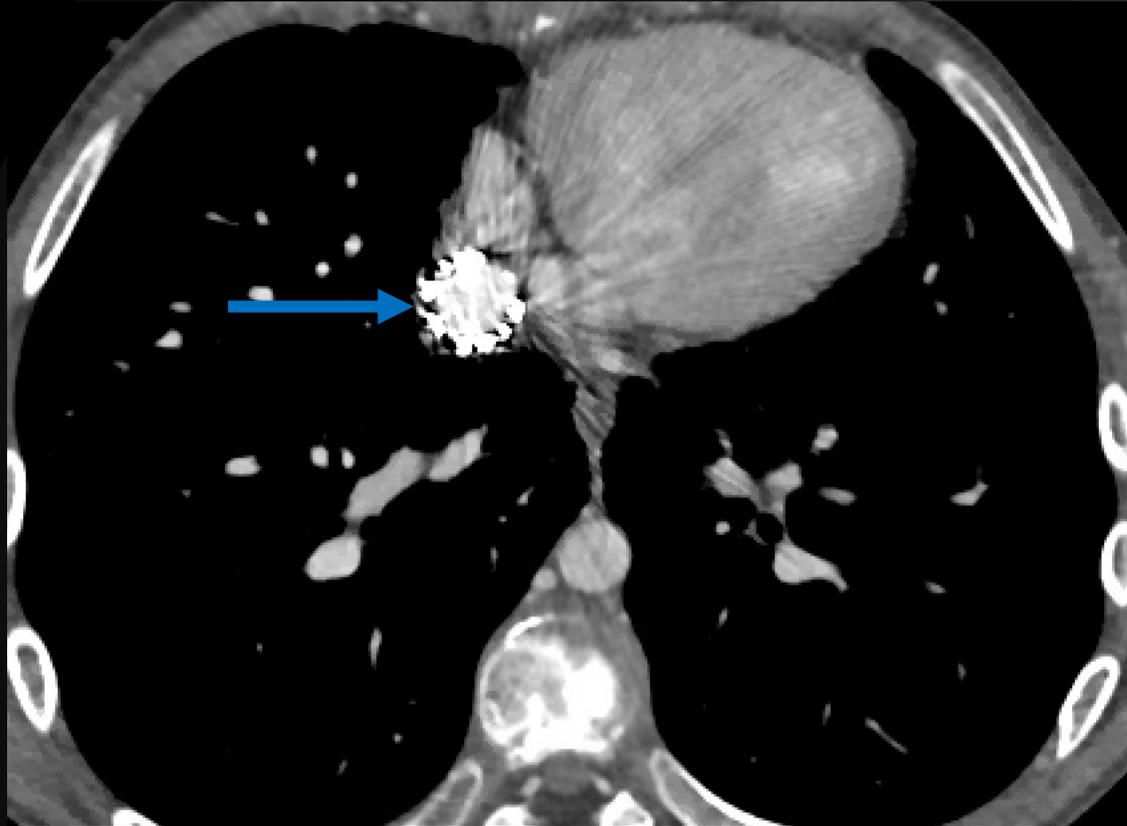
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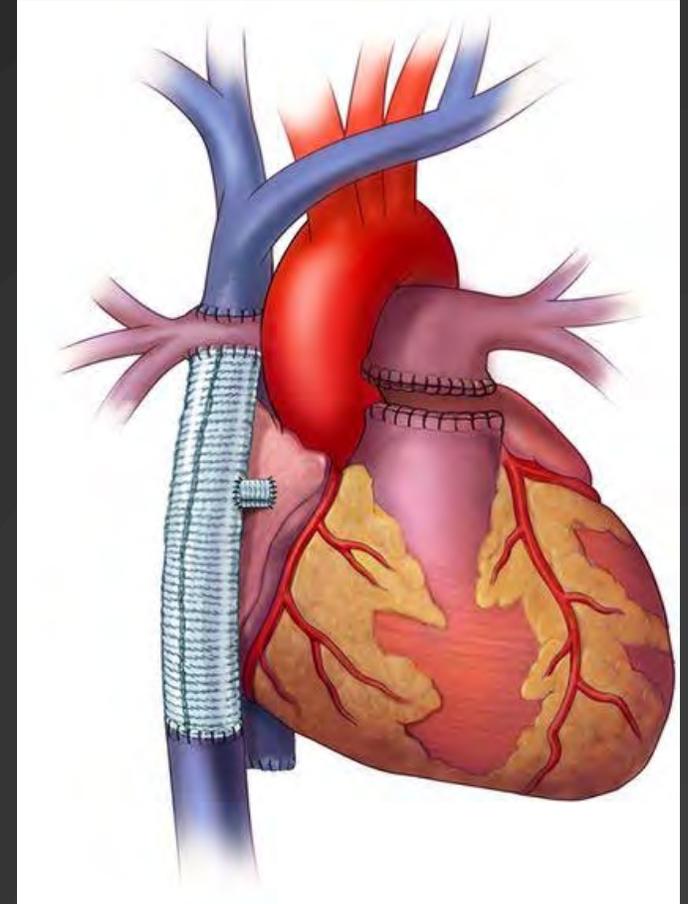
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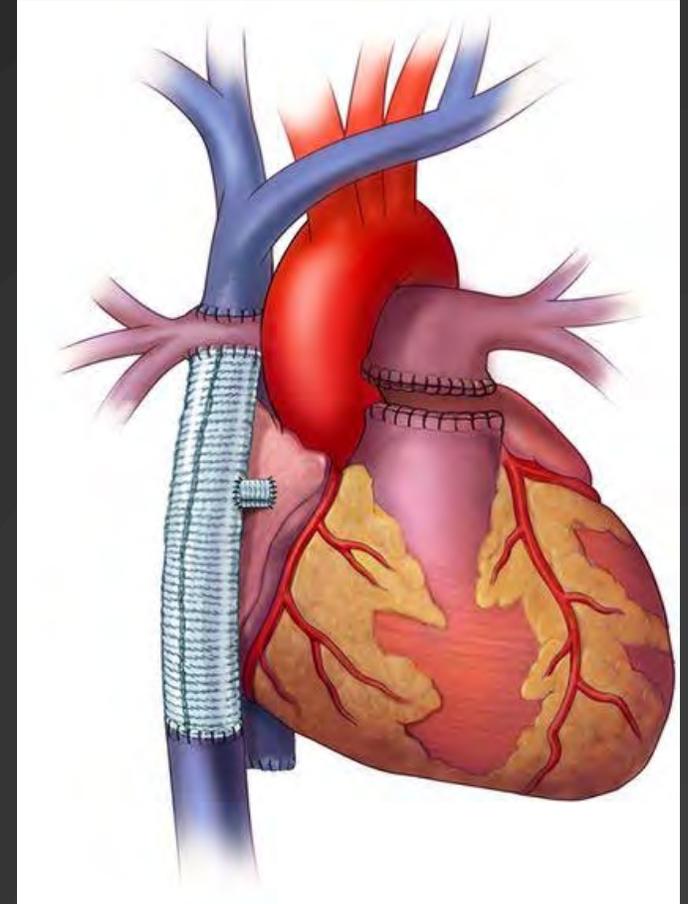
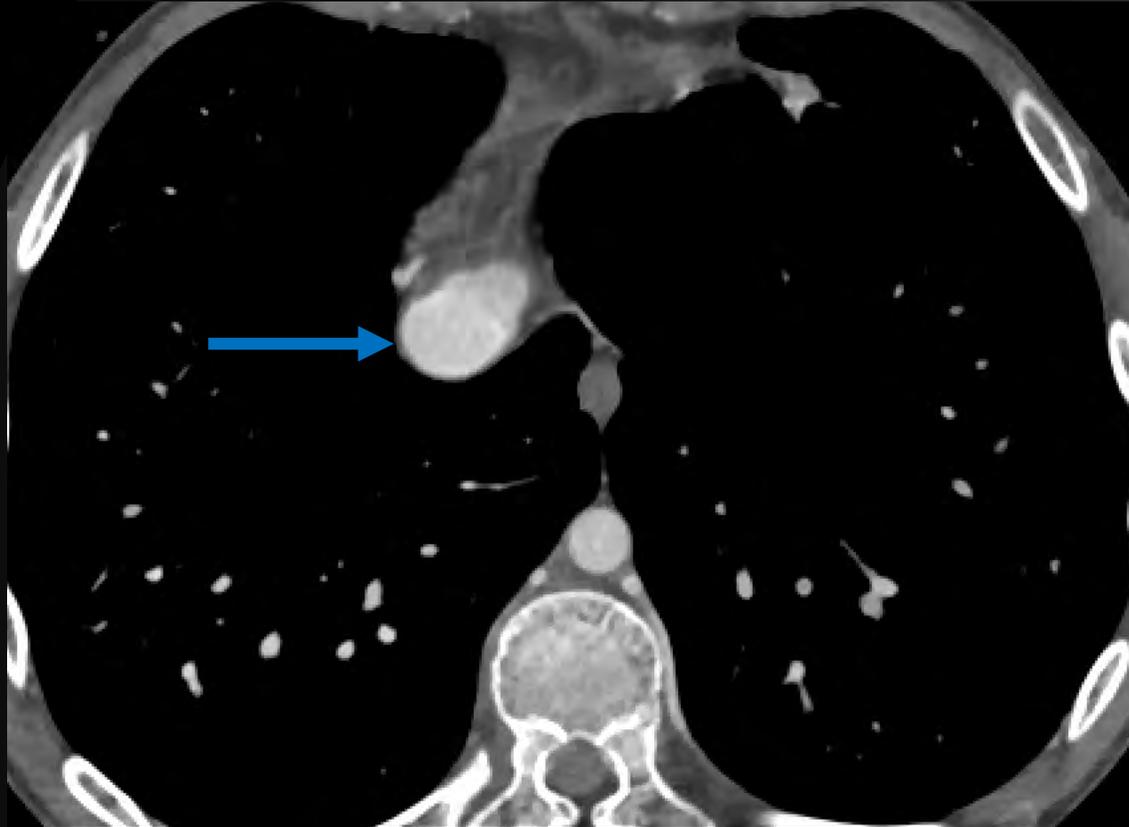
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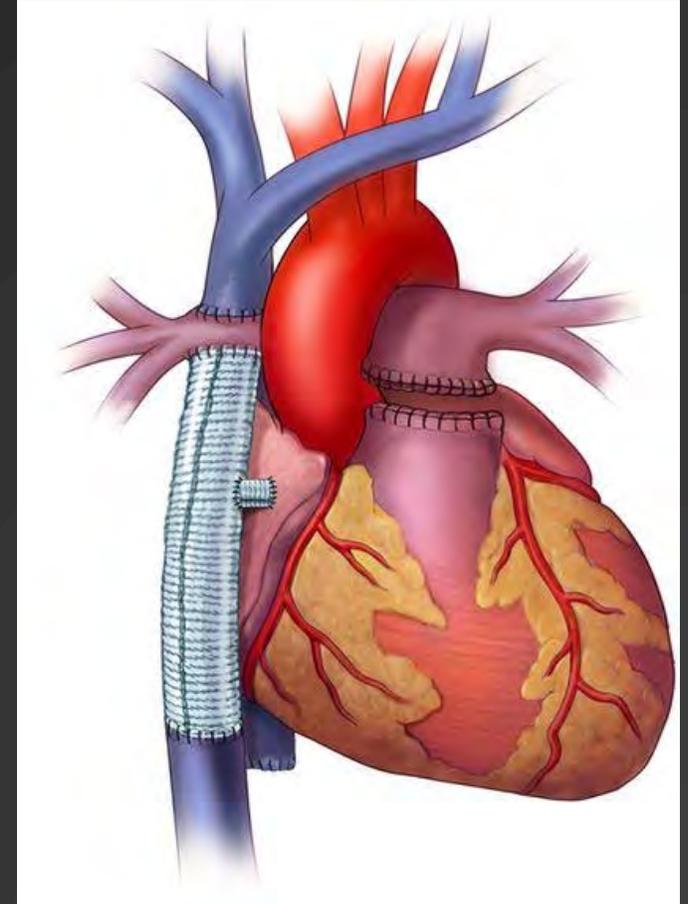
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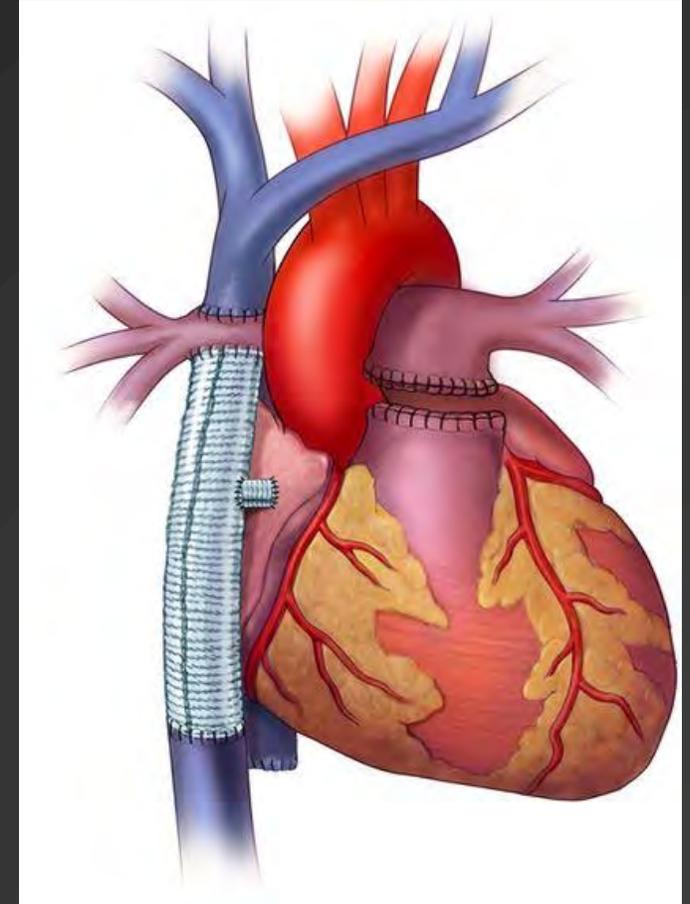
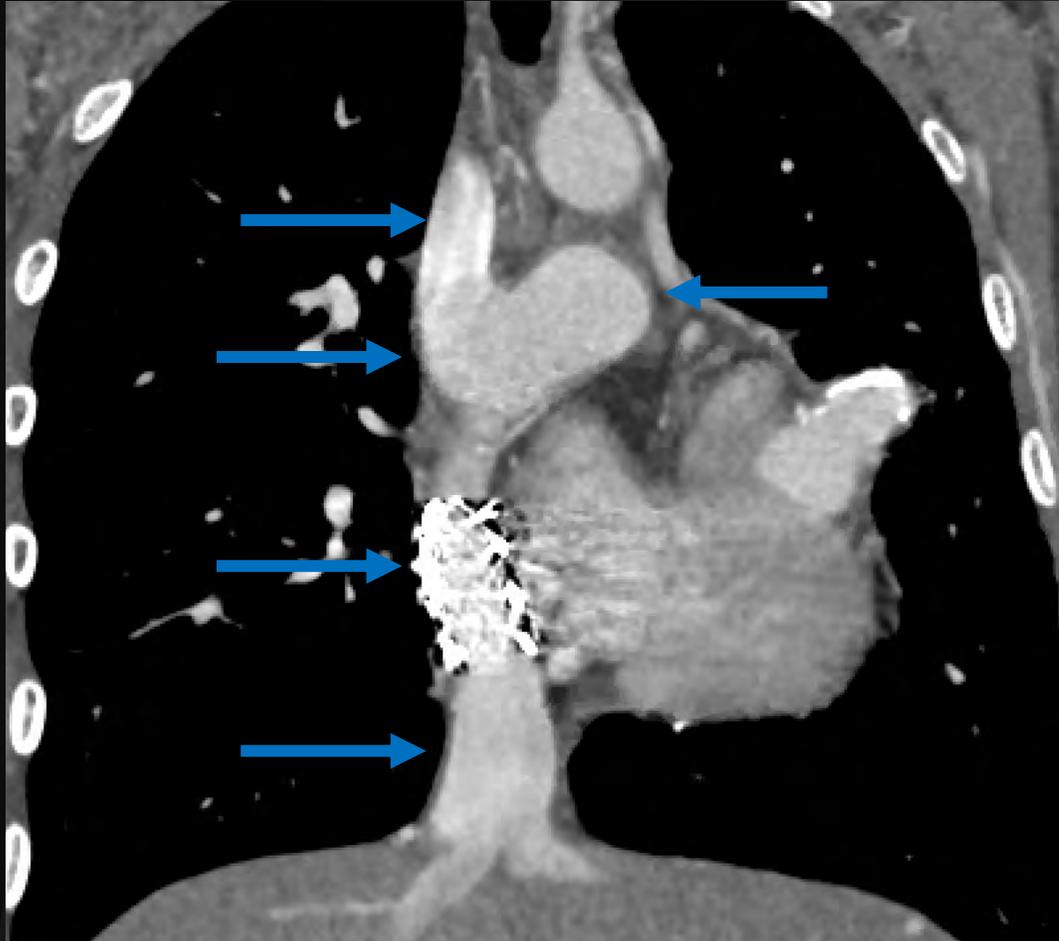
# Montages chirurgicaux



# Montages chirurgicaux



# Montages chirurgicaux



Conclusion

- Scanner cardiaque, angioscanner, coroscanner
  - Accessible (en théorie...)
  - Performant pour l'analyse morphologique
  - Pré-requis:
    - Enfant calme (+/- sédaté)
    - Perfusion de bon calibre
    - Apnée si possible
    - Temps d'analyse
  - Collaboration radiologue / pédiatre-cardiologue