Coronary Arteries Normal and Otherwise

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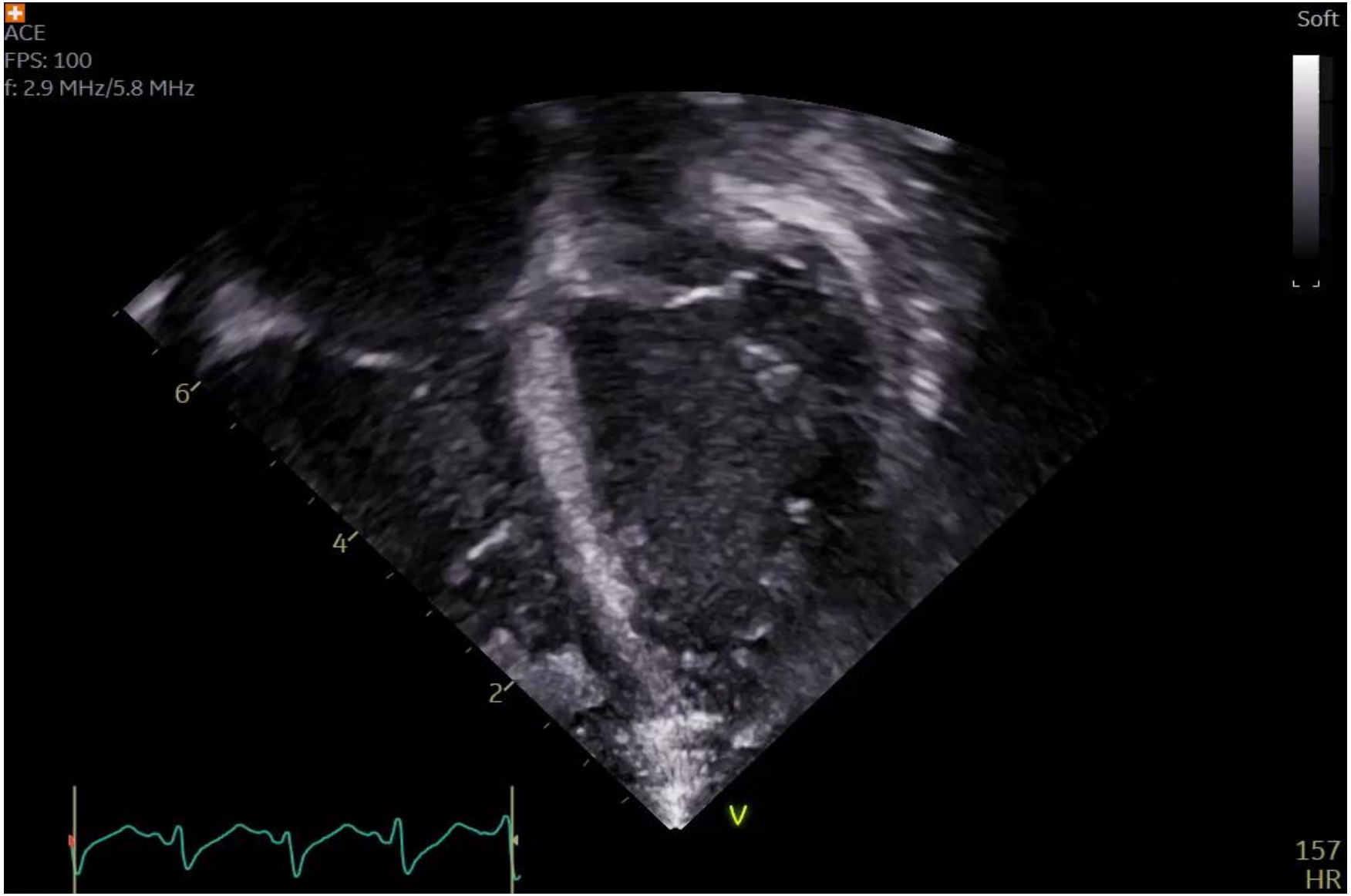
Professor Pediatric Cardiology

September 7, 2024

https://www.openculture.com/2020/09/leonardo-da-vincis-elegant-studies-of-the-human-heart.html

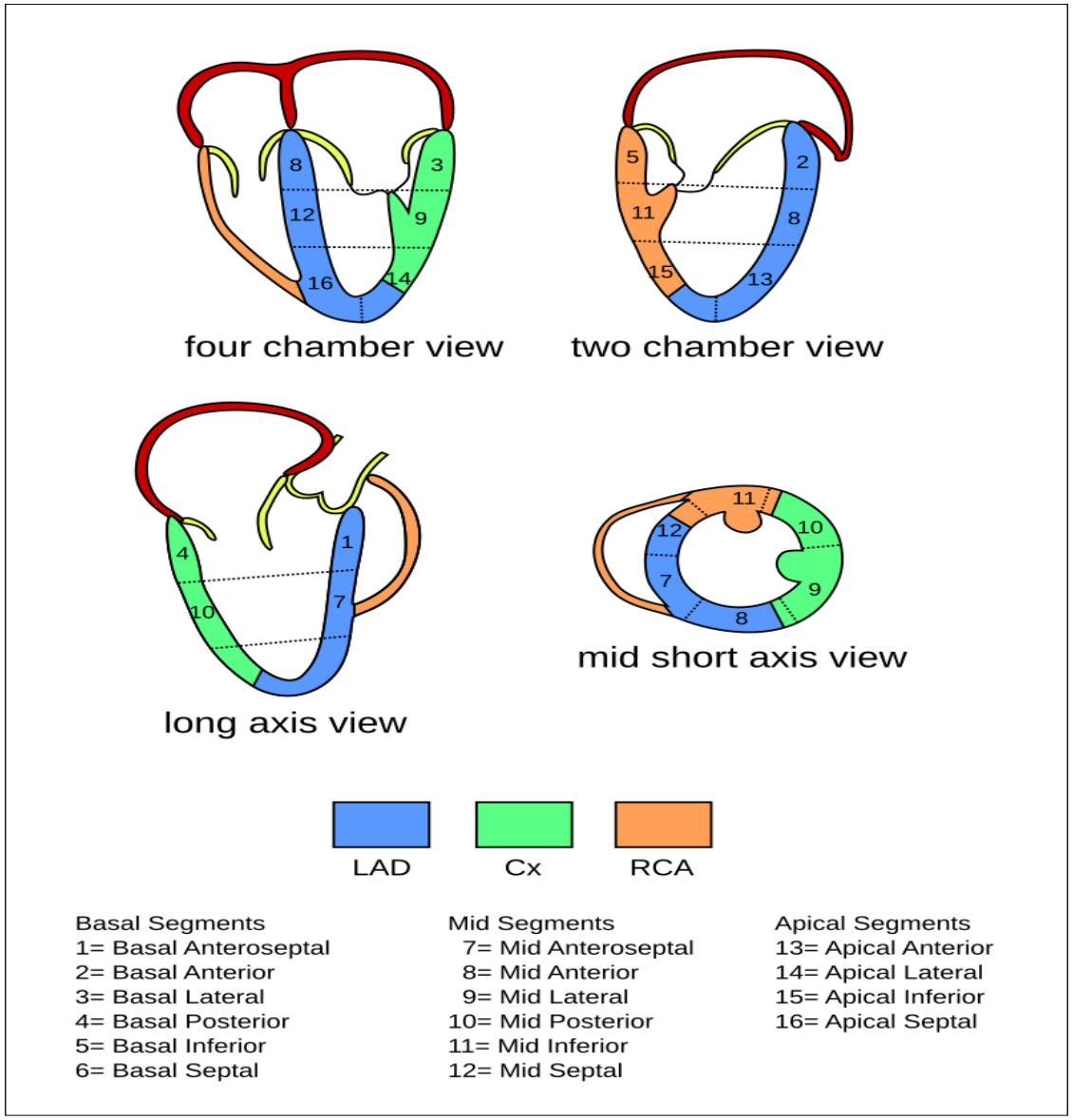
On Call Saturday Morning…



FIRST EDITION
FIRST AID TRAINING

What is the Differential Diagnosis?

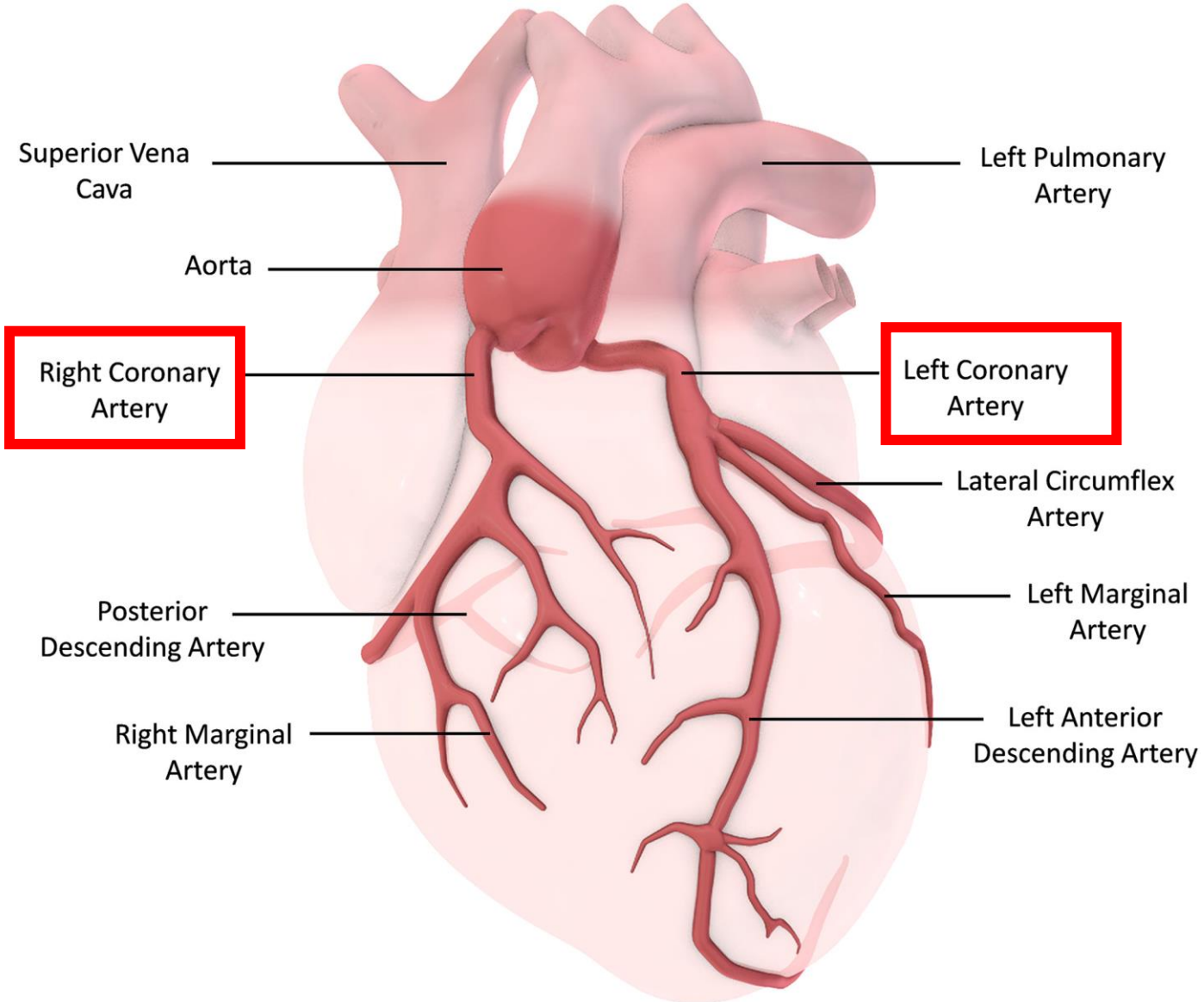
A **primary heart muscle** problem	• Cardiomyopathy
A **temporary heart muscle** problem	• Myocarditis (infection of heart muscle) • Toxin (chemotherapy, metabolic disease, poison) • Inflammatory Process (sepsis, Kawasaki Disease/MIS-C)
A **vicarious heart muscle** problem	• Structural Defect (valvar stenosis) • Coronary Issues



By CardioNetworks: Drj - CardioNetworks: TEE_coronary_region.svg, CC BY-SA 3.0, https://commons.wikimedia.org/w/index.php?curid=24733769

Qualitative regional functional assessment → **Identify abnormally contracting myocardial segment** → **Distribution of the coronary artery of interest**

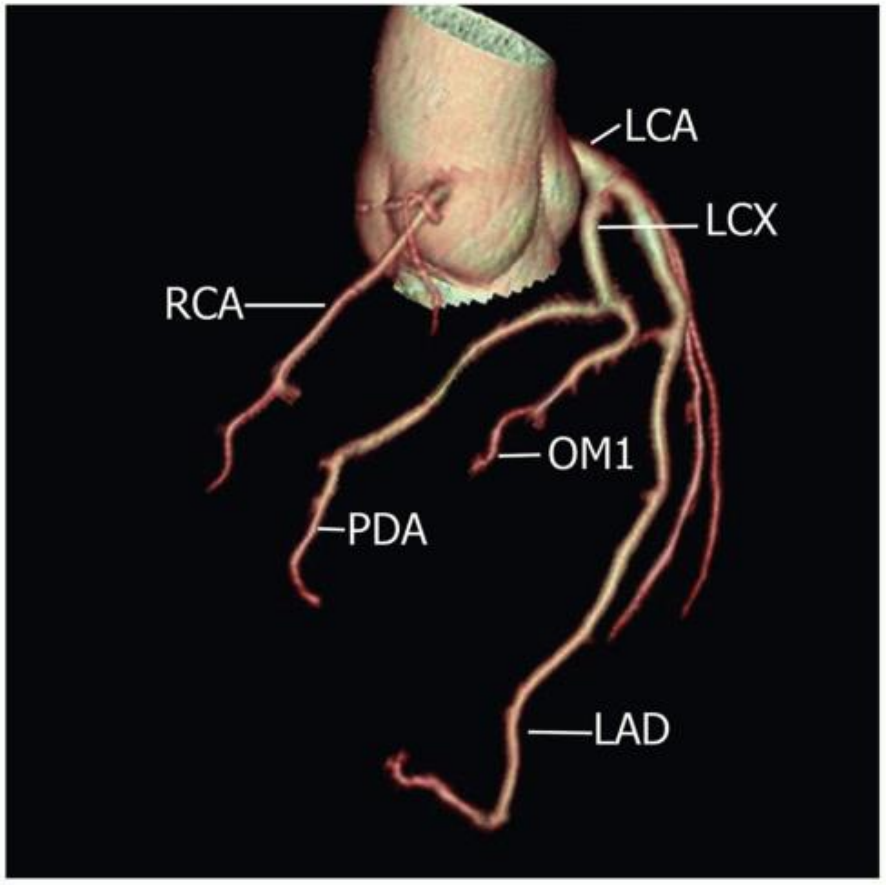
Systole → LV walls move inwards and thicken

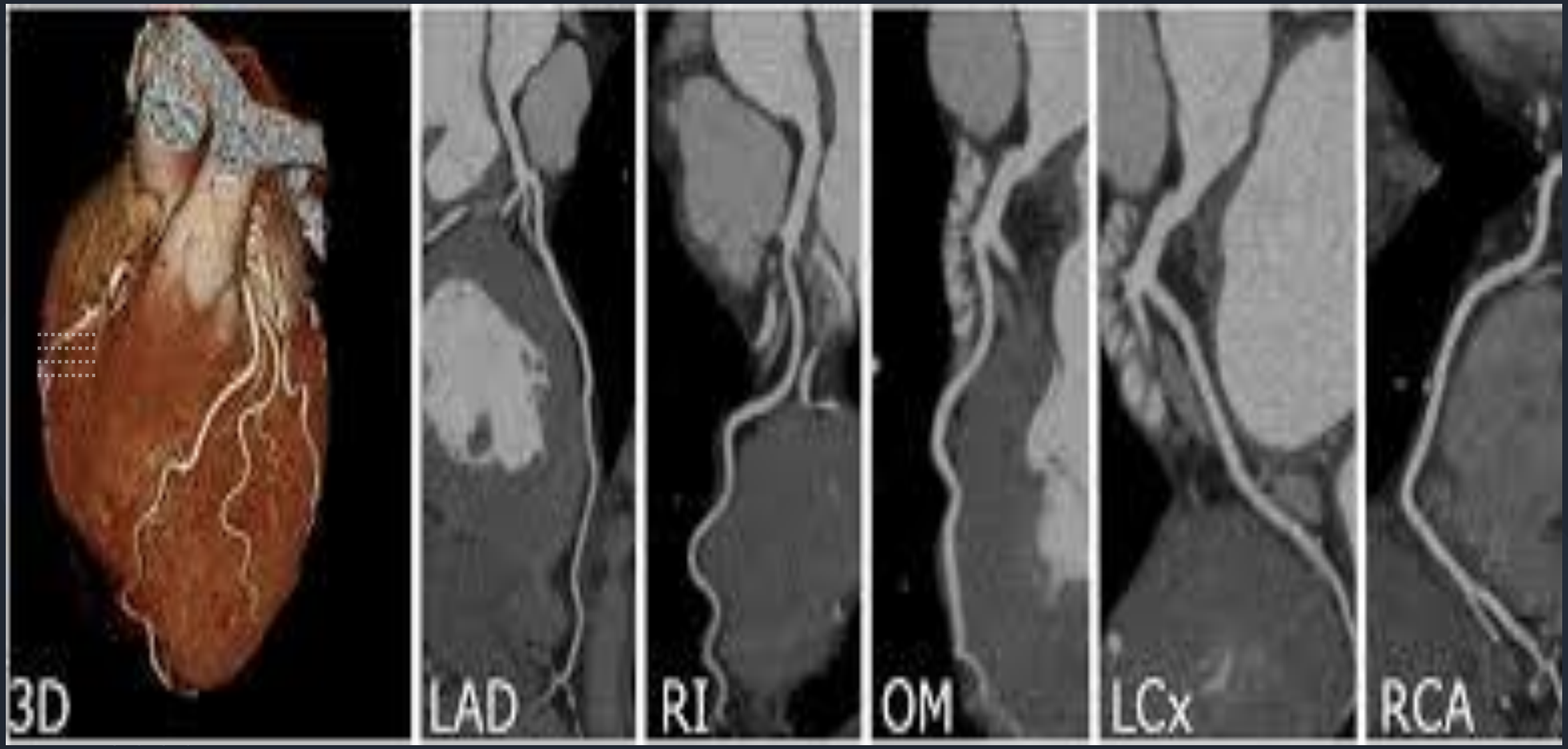


Ramai D, Lai J, Monzidelis C, Reddy S. Coronary Artery Development: Origin, Malformations, and Translational Vascular Reparative Therapy. Journal of Cardiovascular Pharmacology and Therapeutics. 2018;23(4):292-300. doi:10.1177/1074248418769633

Root Systems

Shutterstock





JSCI

Heavy Lifting

Appropriate Augmentation of Cardiac Output is Crucial

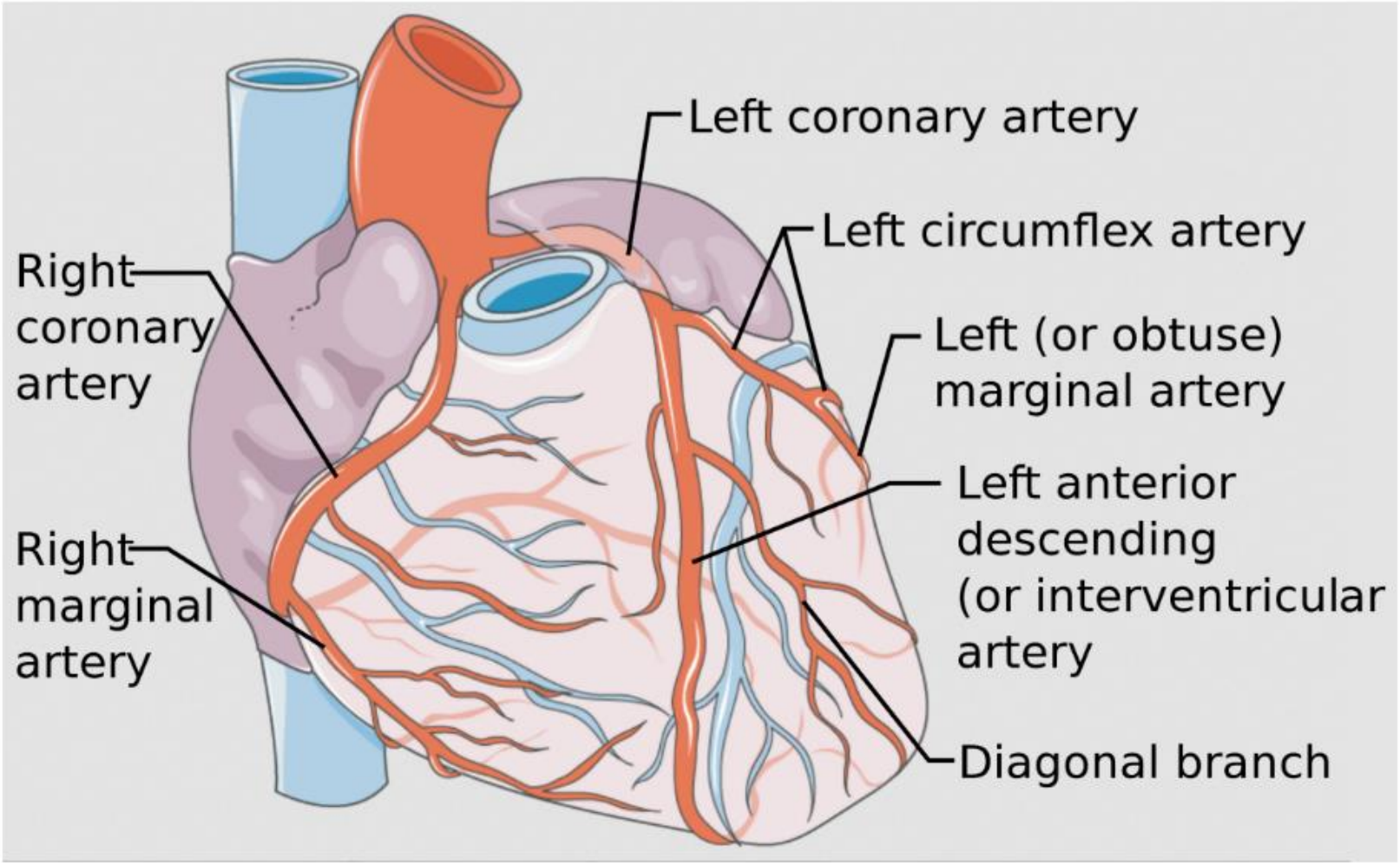
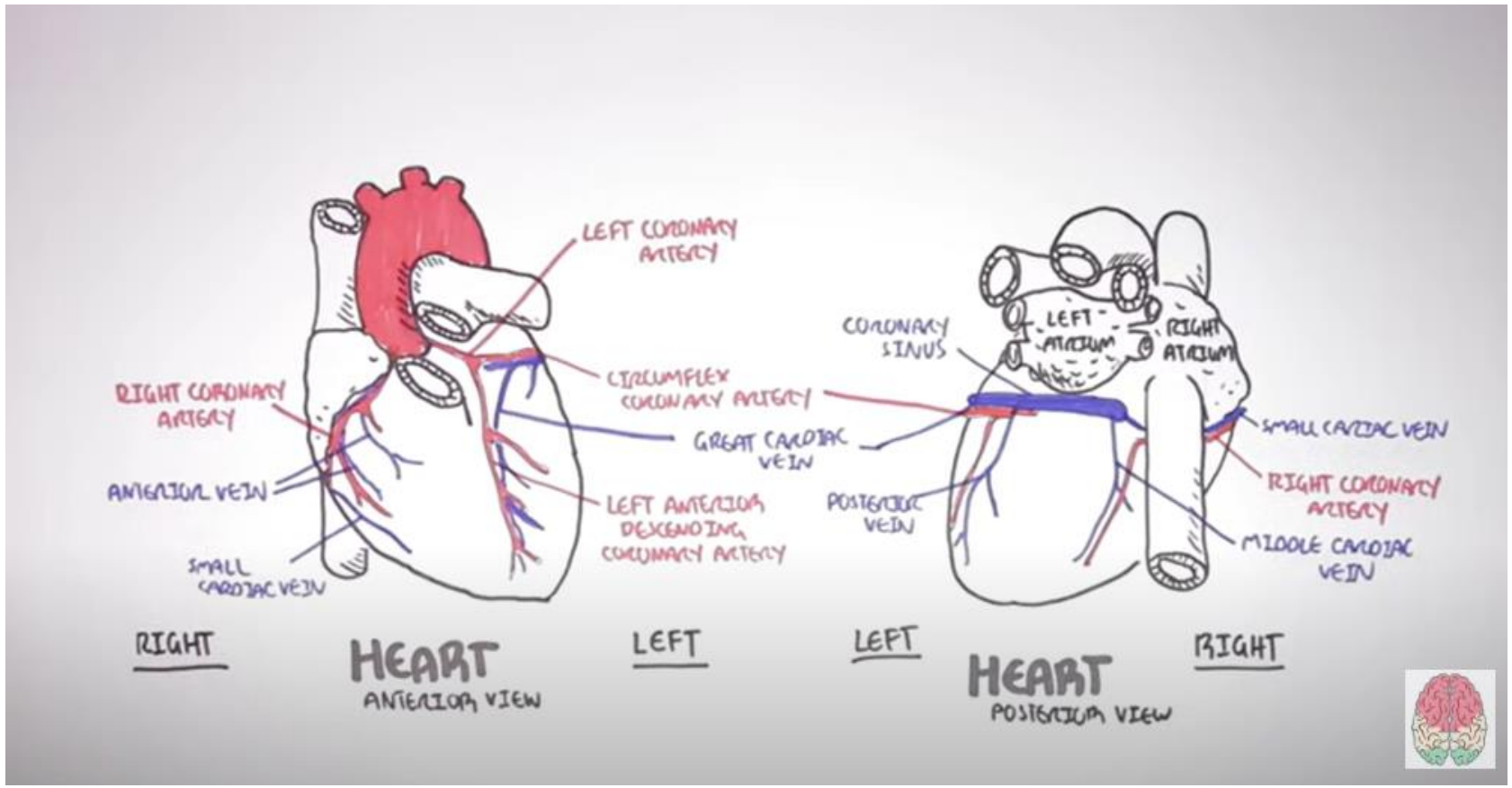
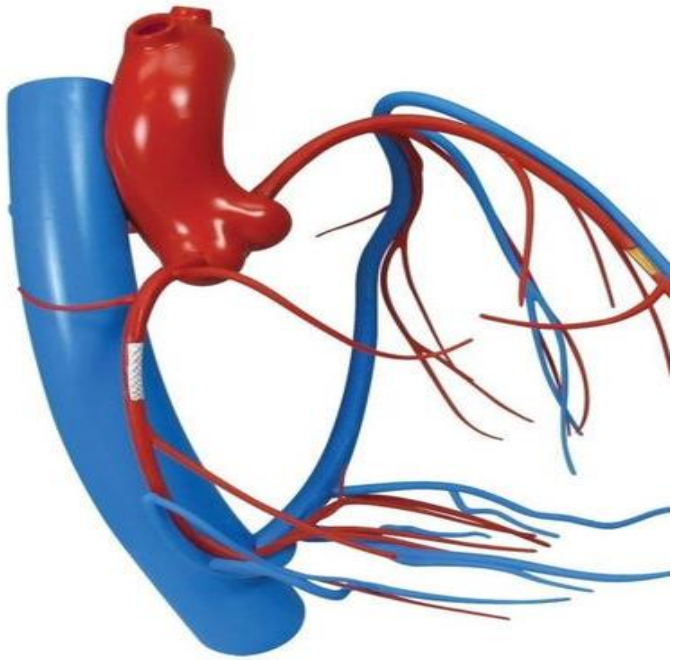


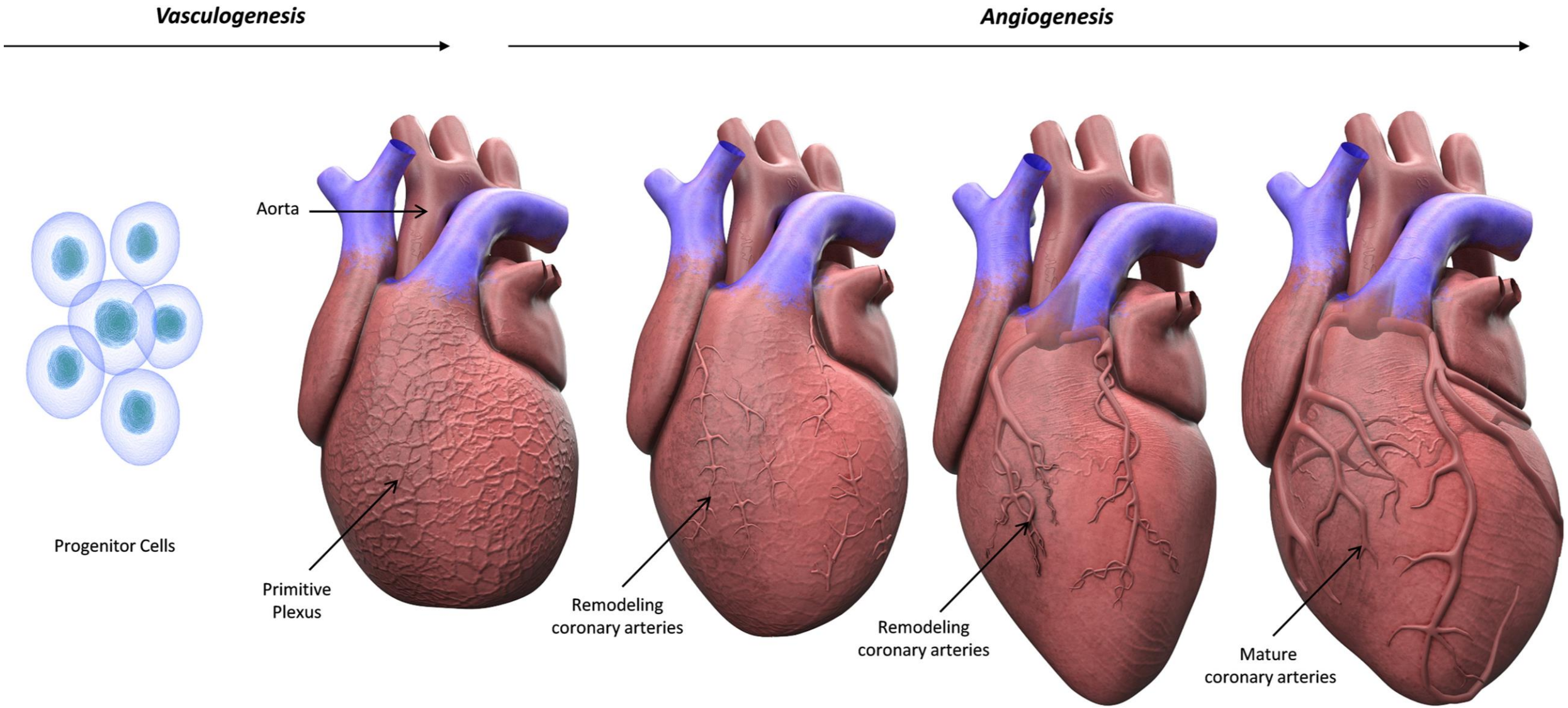
Figure 1 ***Coronary Artery Anatomy***

The distribution of the coronary arteries and pattern of blood supply to the myocardium is shown. Source: Coronary vessels, with annotated arteries by Mikael Häggström, used under Creative Common License CC BY 3.0. No changes have been made to this image.

But how does blood get from the heart, to the heart and back to the heart?







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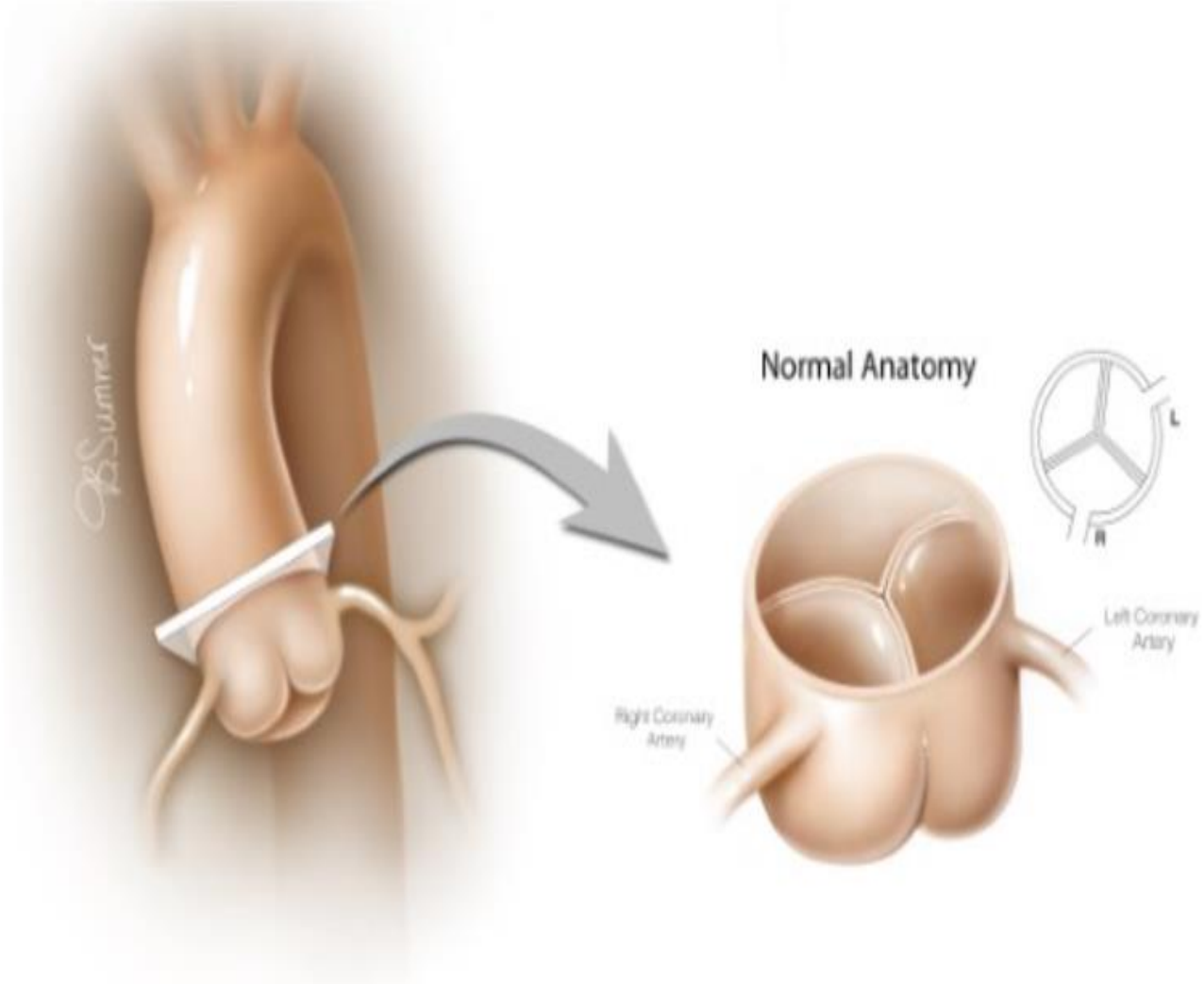
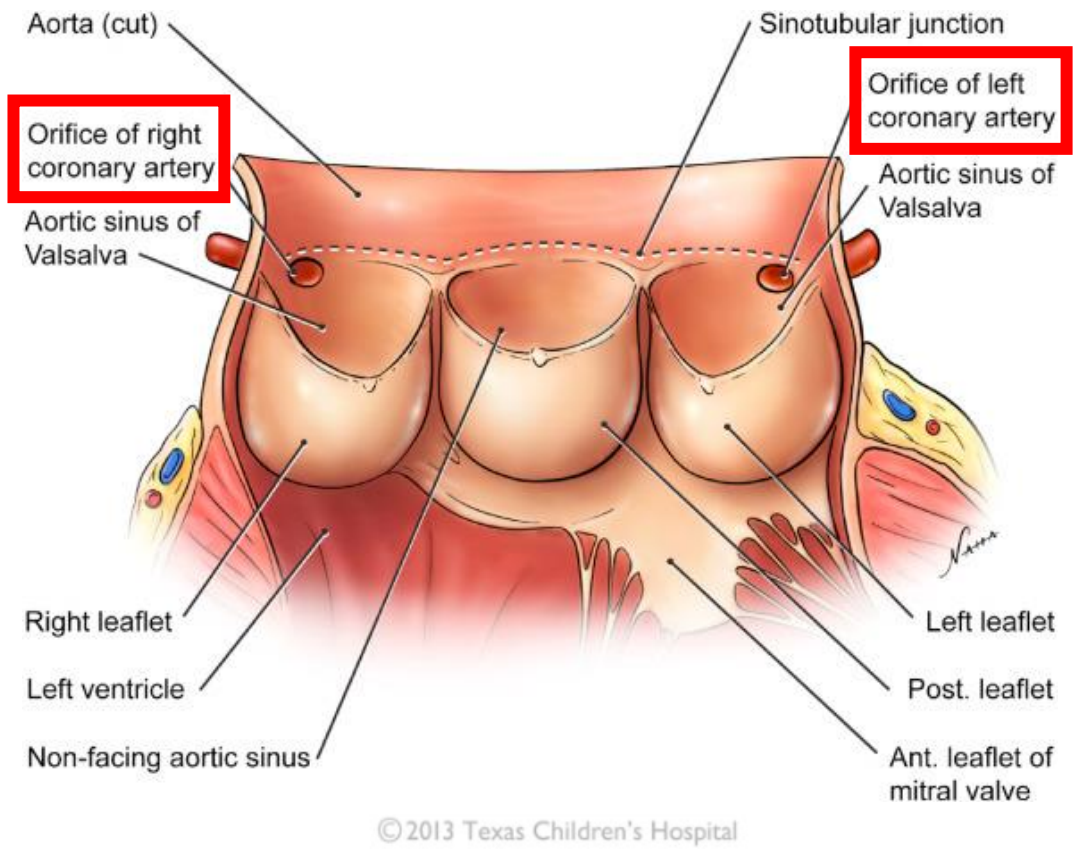
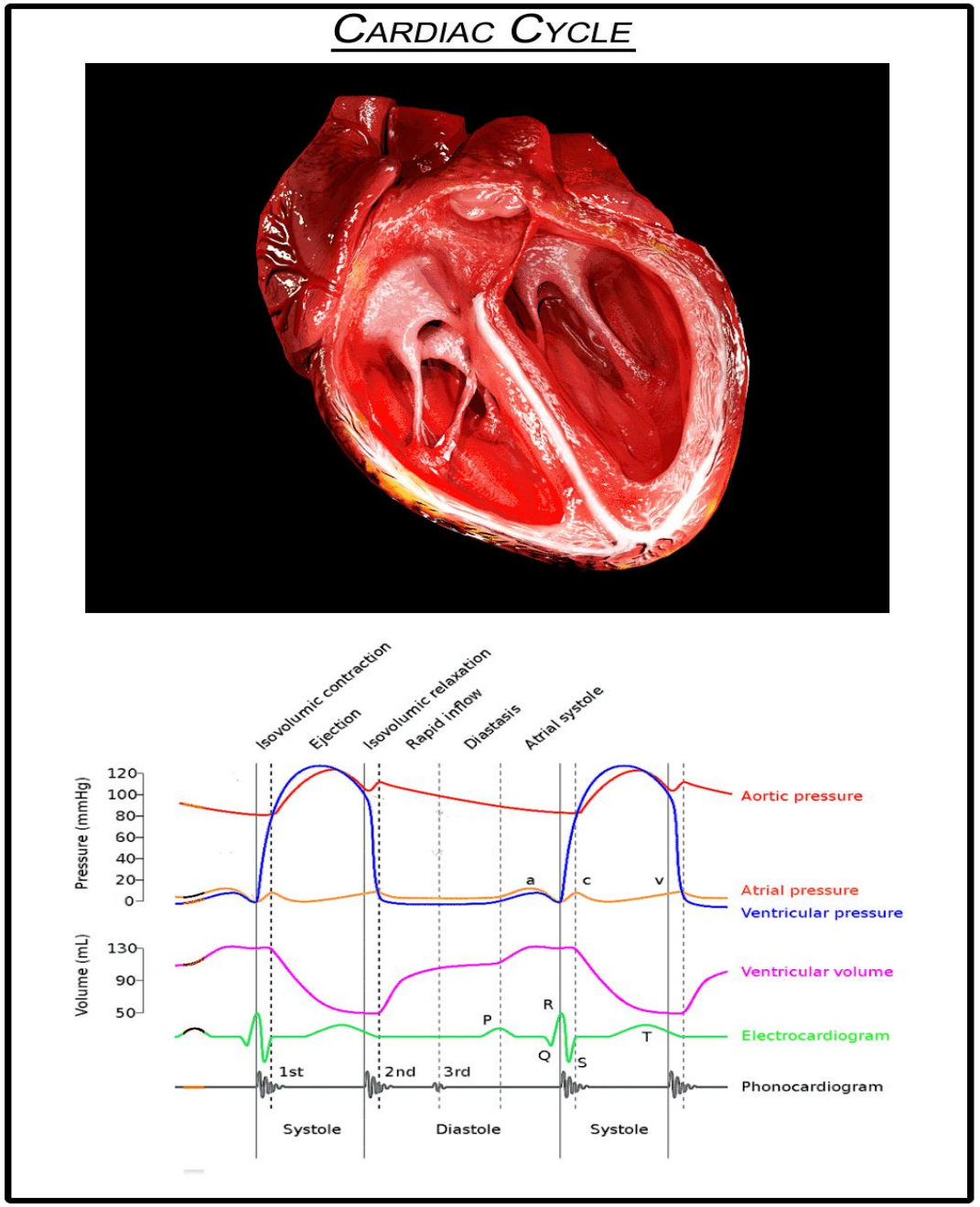


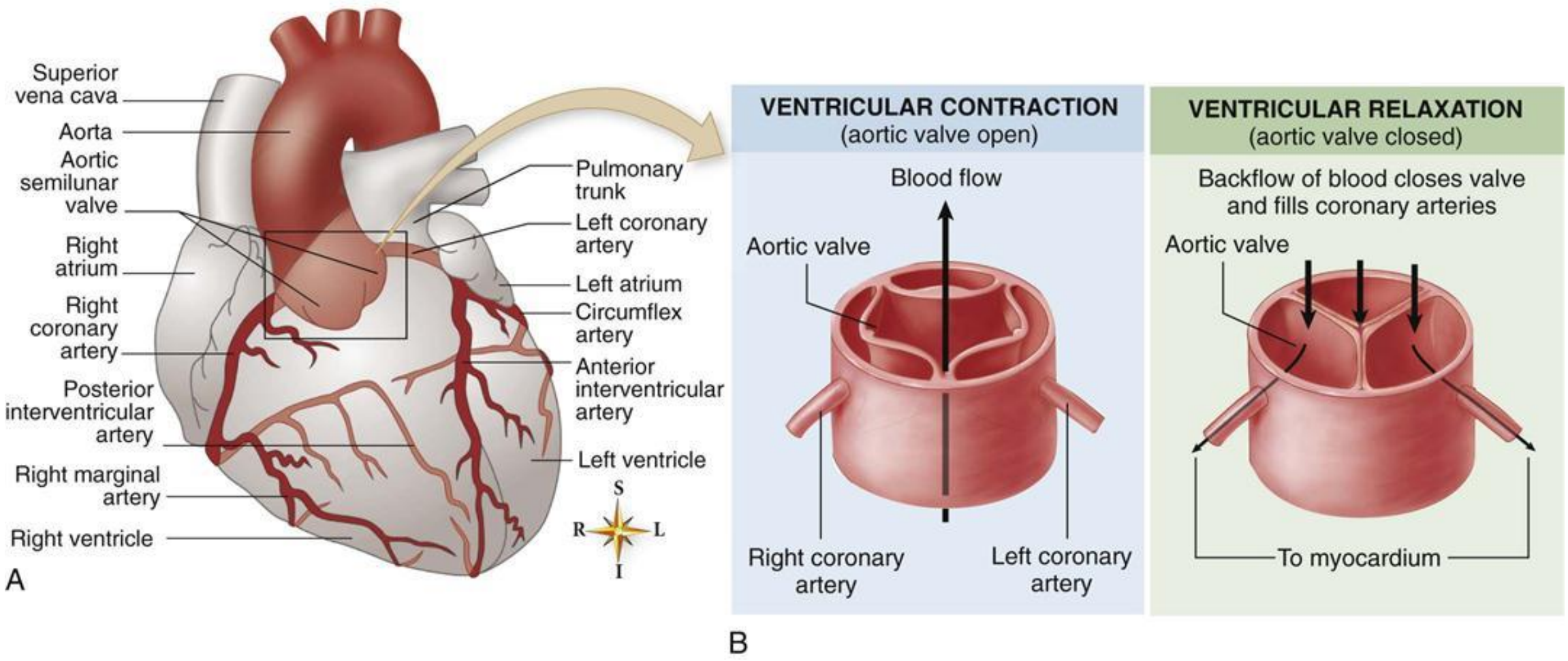


Science Direct

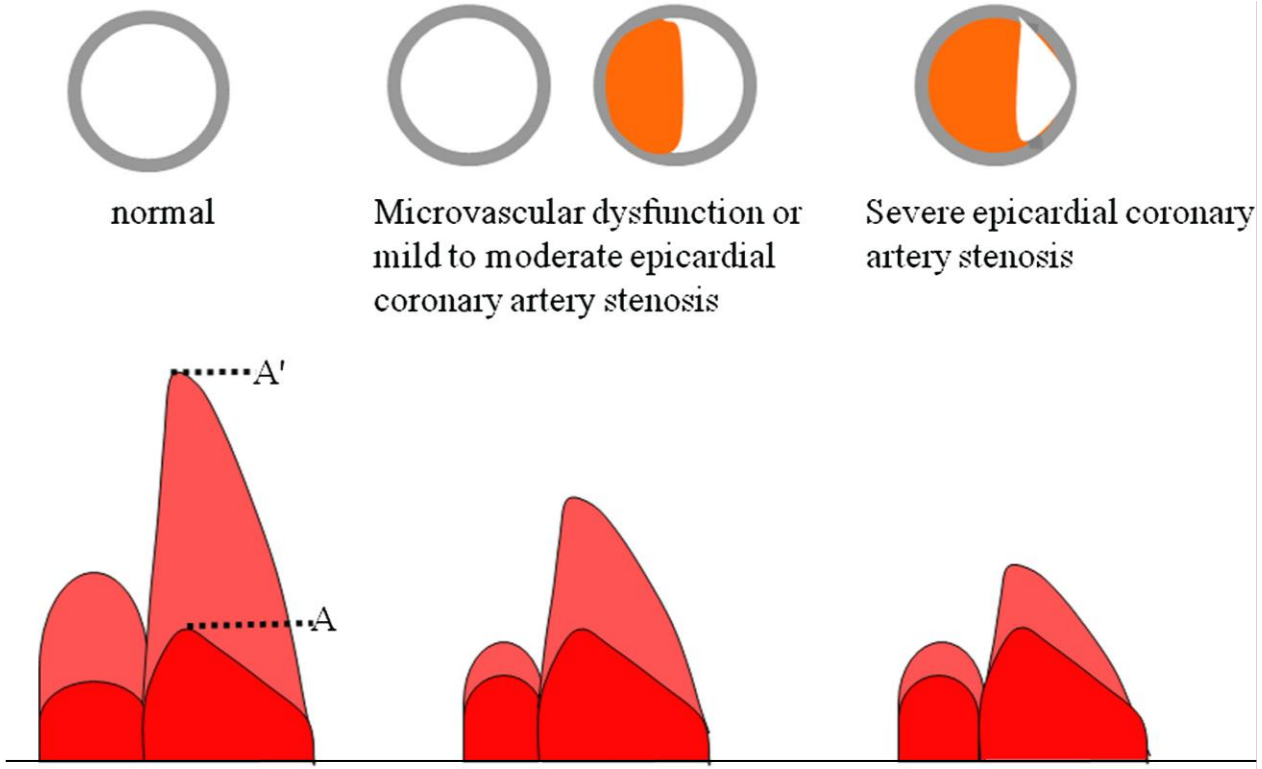


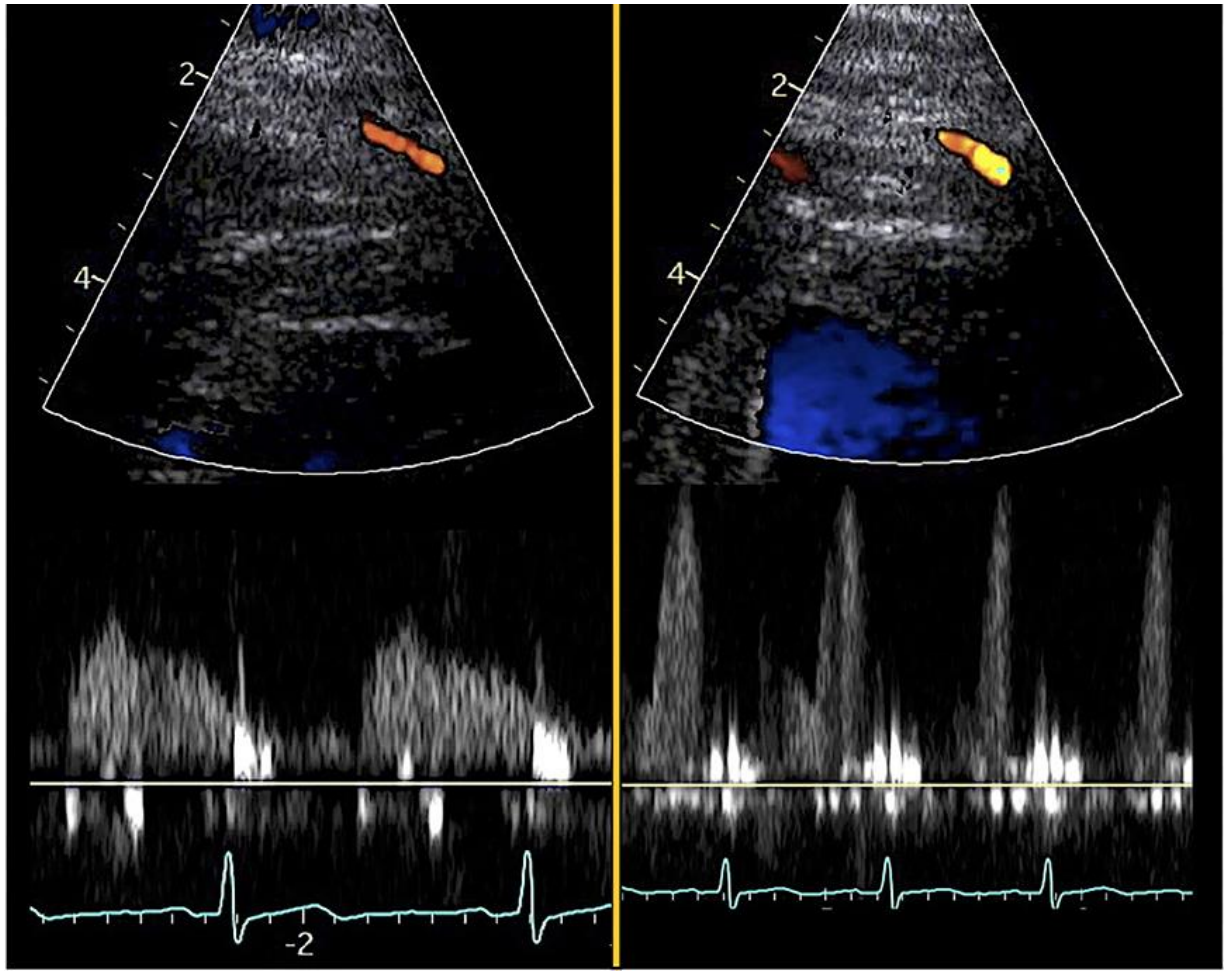
Unimpeded (Laminar) Flow

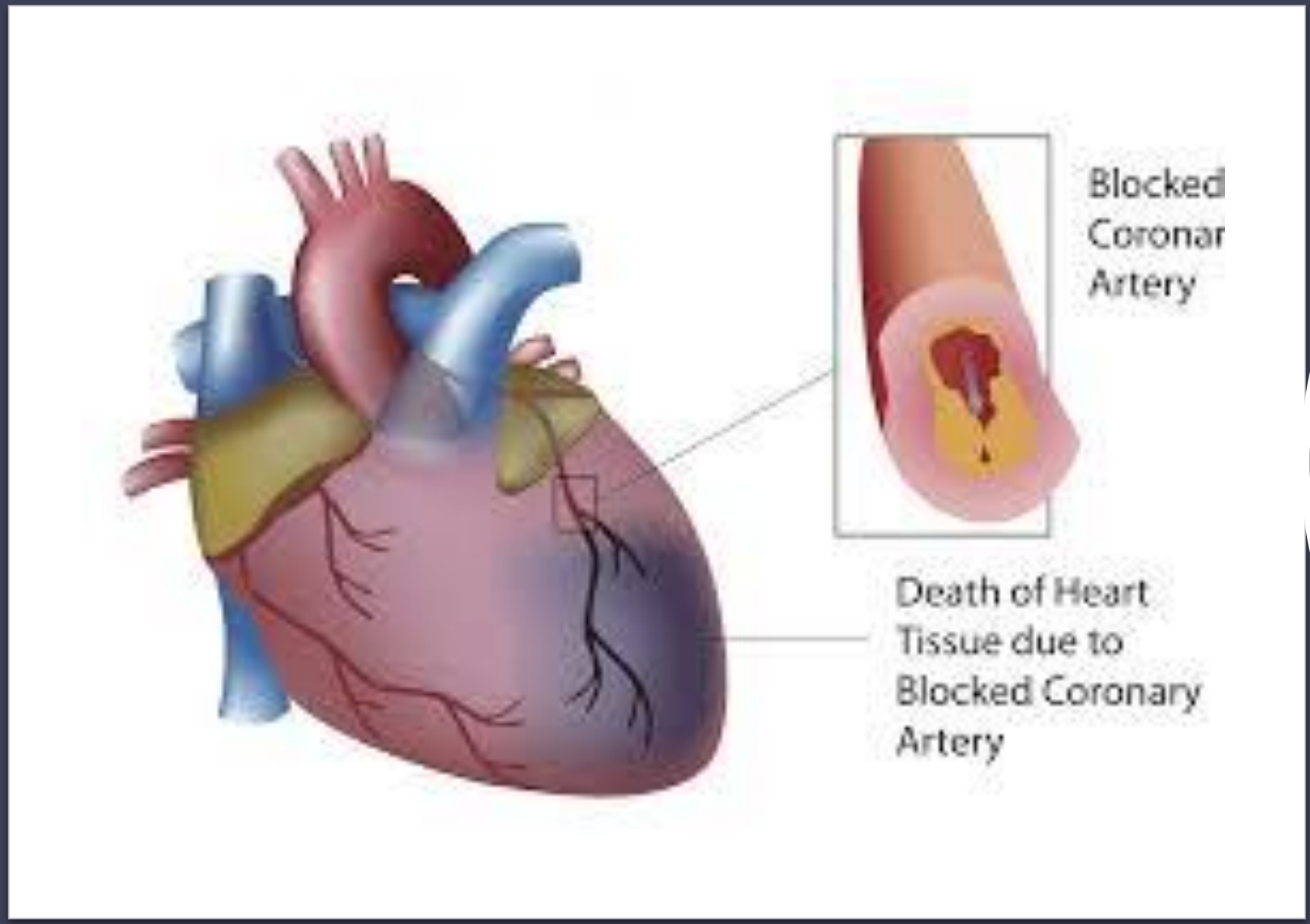
EPA


Superior vena cava
Aorta
Aortic semilunar valve
Right atrium
Right coronary artery
Posterior interventricular artery
Right marginal artery
Right ventricle
Pulmonary trunk
Left coronary artery
Left atrium
Circumflex artery
Anterior interventricular artery
Left ventricle
S
R
L
I
A
VENTRICULAR CONTRACTION
(aortic valve open)
Blood flow
Aortic valve
Right coronary artery
Left coronary artery
VENTRICULAR RELAXATION
(aortic valve closed)
Backflow of blood closes valve and fills coronary arteries
Aortic valve
To myocardium
B

Coronary Pulsed Wave Doppler at Rest and with Exercise







Anything that impairs flow causes damage to the muscle

What Can Go Wrong

Congenital

Complex Congenital Heart Defects

- D-TGA
- Tetralogy of Fallot
- Truncus

Isolated Coronary Artery Anomalies

Acquired

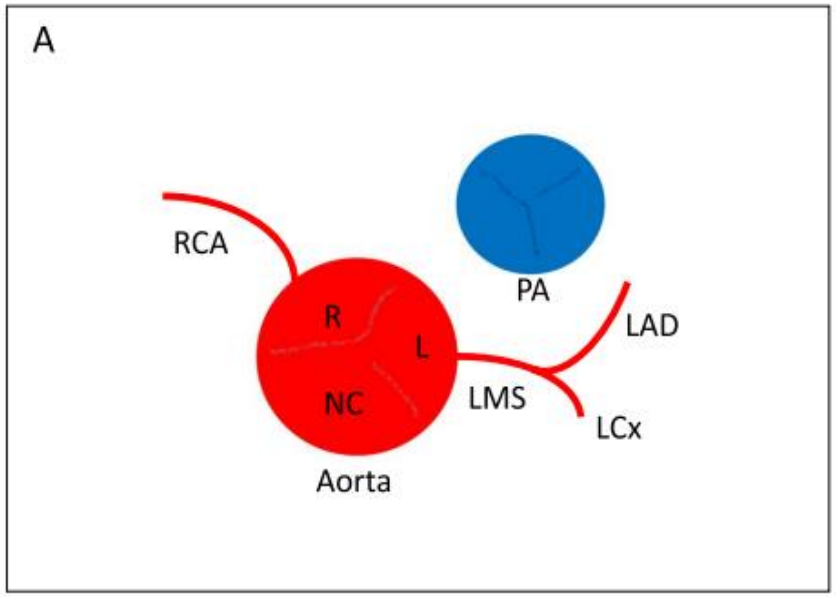
Kawasaki

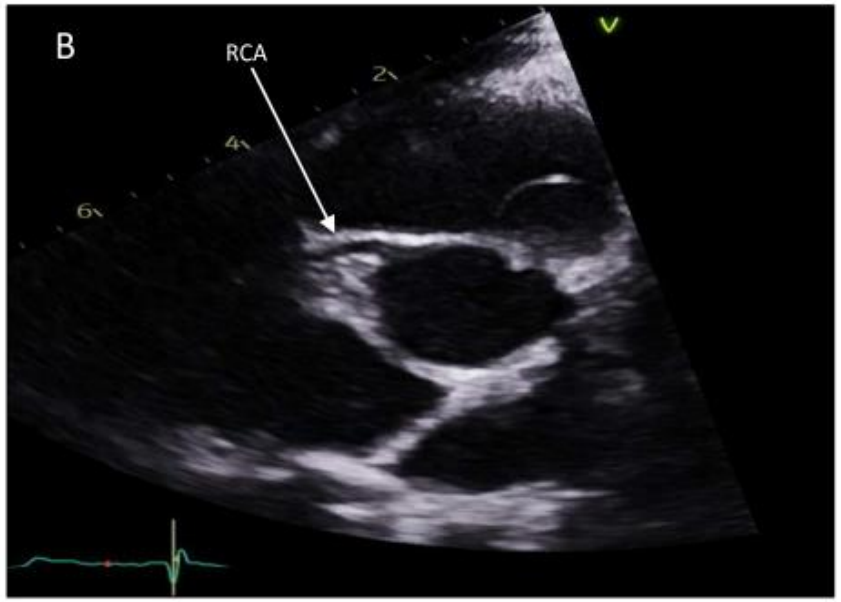
Williams Syndrome

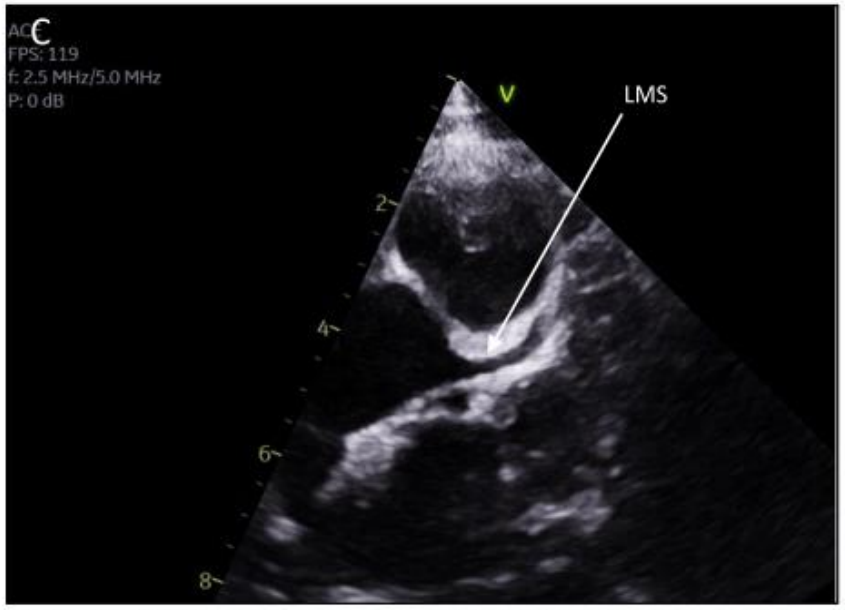
Post-surgical

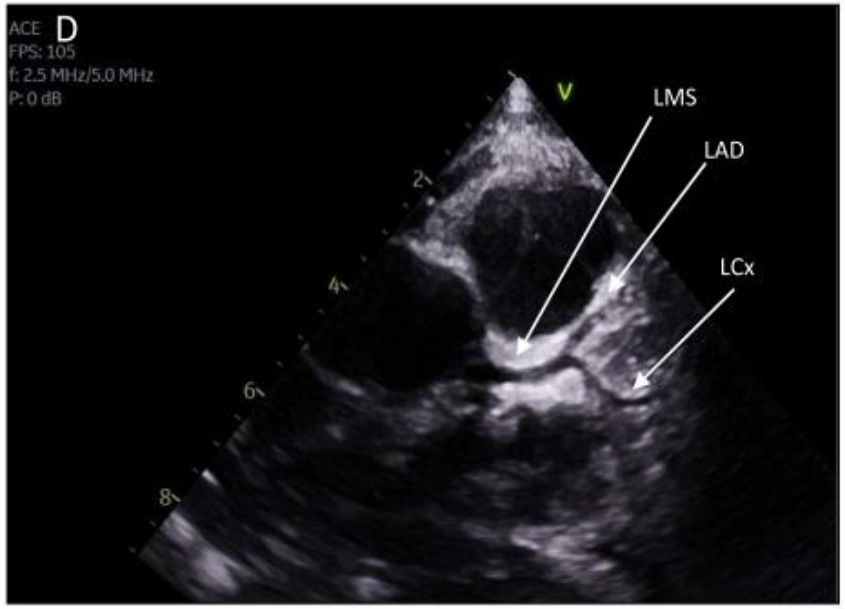
Ectasia (Dilation)

Normal









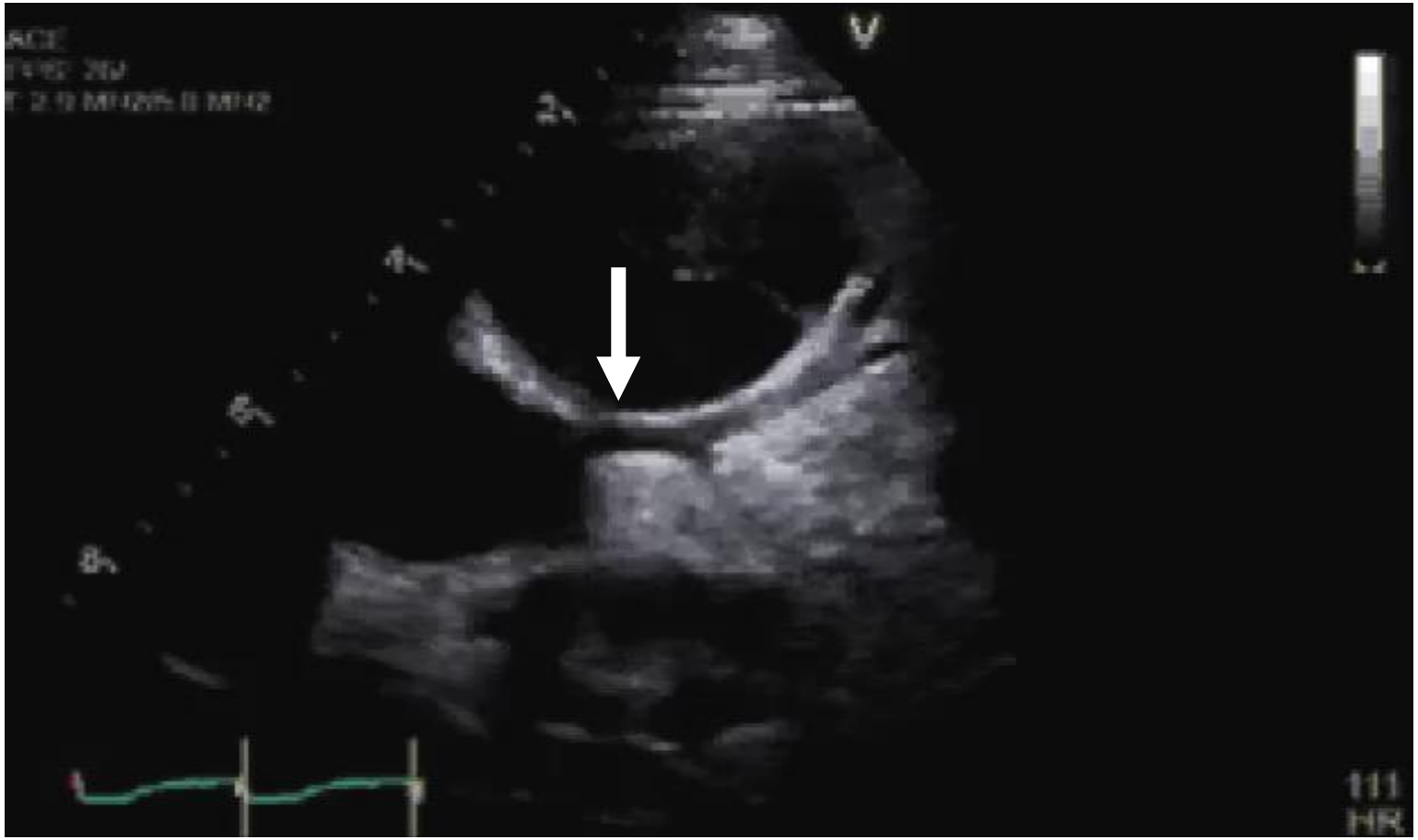
*Bhatia, R.T., Forster, J., Ackrill, M. et al. Coronary artery anomalies and the role of echocardiography in pre-participation screening of athletes: a practical guide. Echo Res Pract **11**, 5 (2024). https://doi.org/10.1186/s44156-024-00041-4*

Left Main Coronary Artery (LMCA or LCA)

Course: between the RVOT (anteriorly) and the LA (posteriorly).

Branches: left anterior descending (LAD) and left circumflex (LCx) coronary arteries.

- A 3rd artery may be present - ramus intermedius (variable branching).

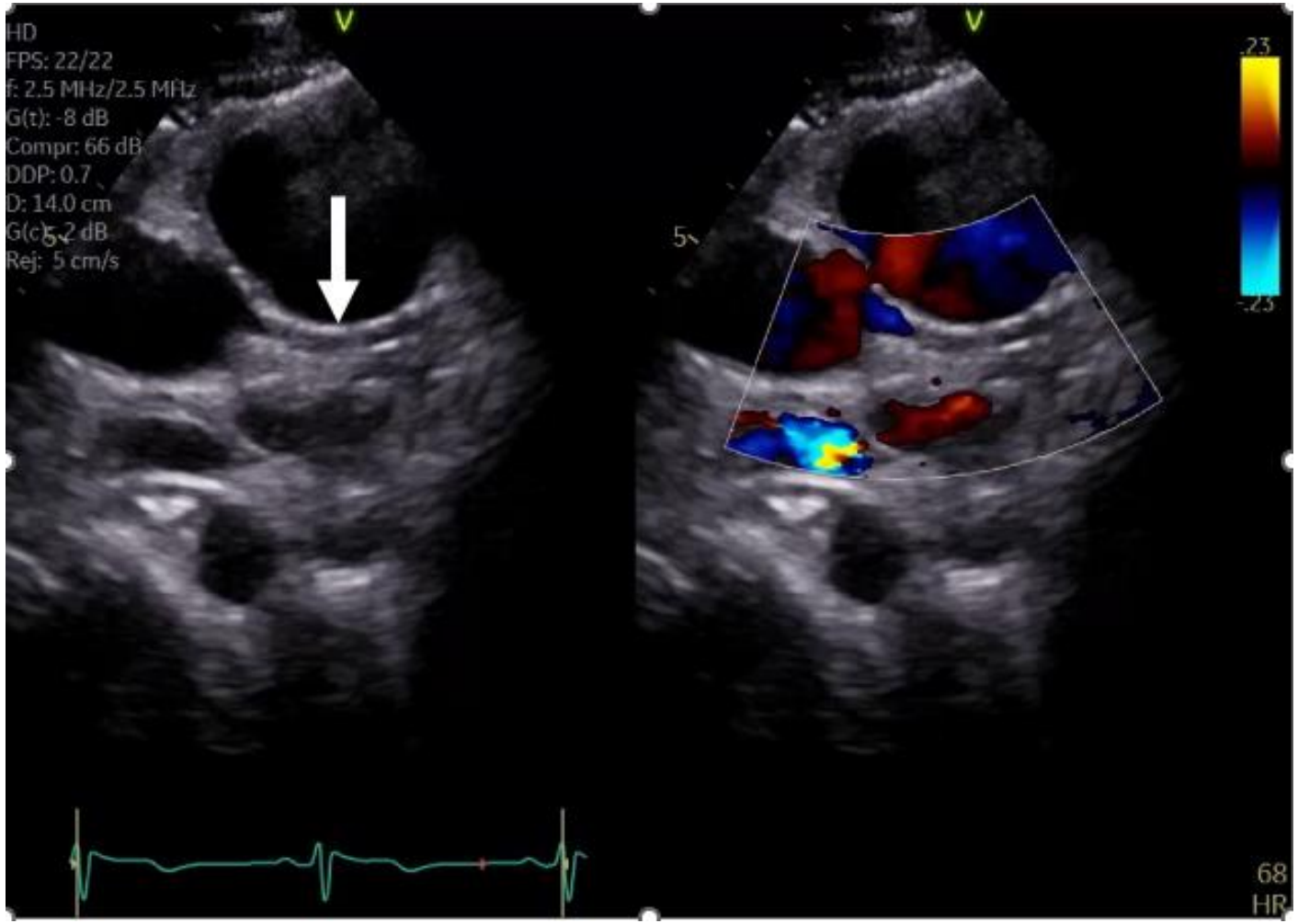


Left anterior descending artery (LAD)

Course: along the anterior interventricular groove continuing to the cardiac apex

Supplies: anterior, anterolateral, and anteroseptal walls of LV

Branches: septal perforators, diagonal arteries

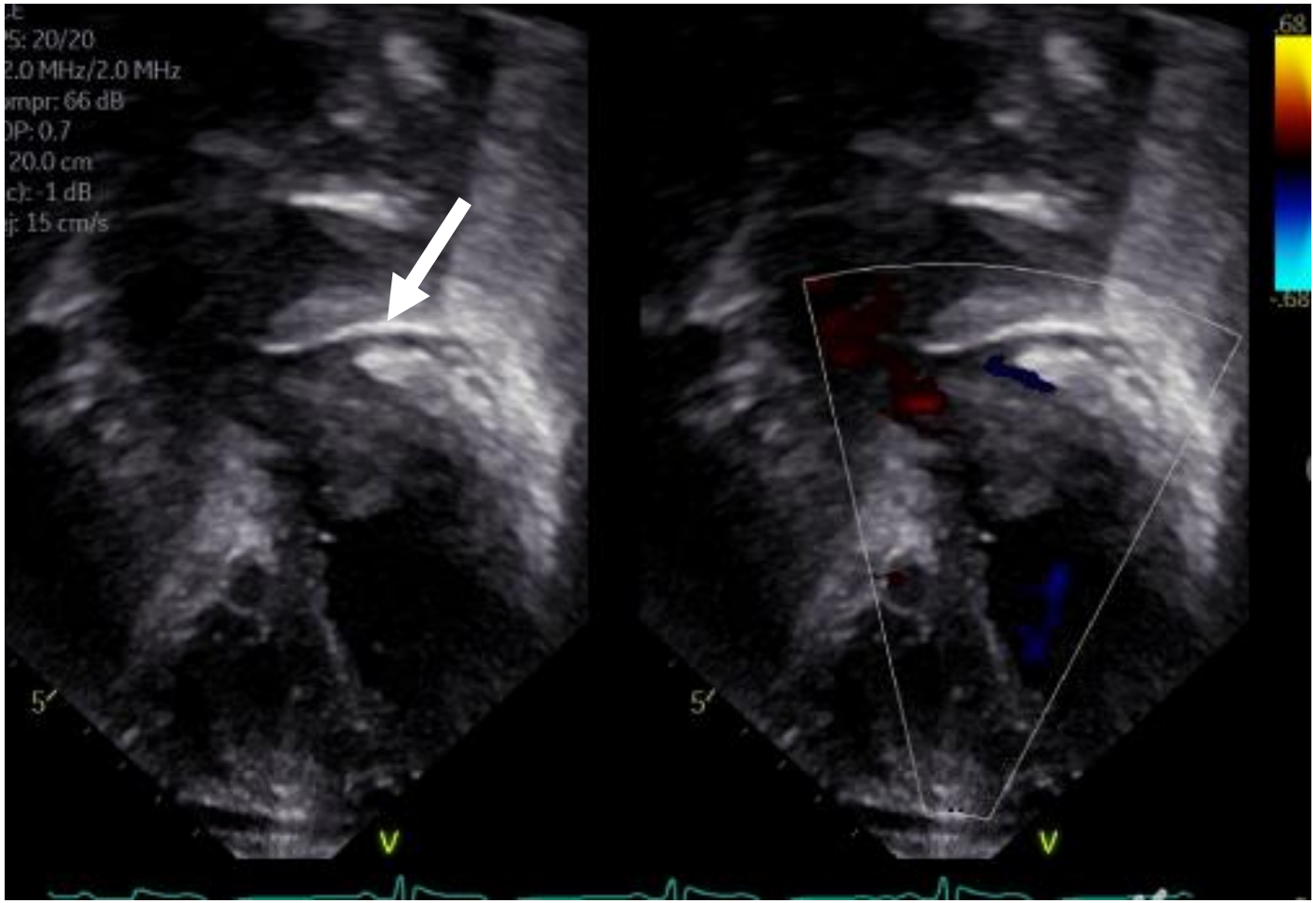


Circumflex coronary artery

Course: travels along the left AV groove between the LA and LV towards the crux (where the AV groove intersects with IVS

Supplies: lateral LV wall

Branches: obtuse marginal arteries, posterior descending artery (if left dominant coronary system*)



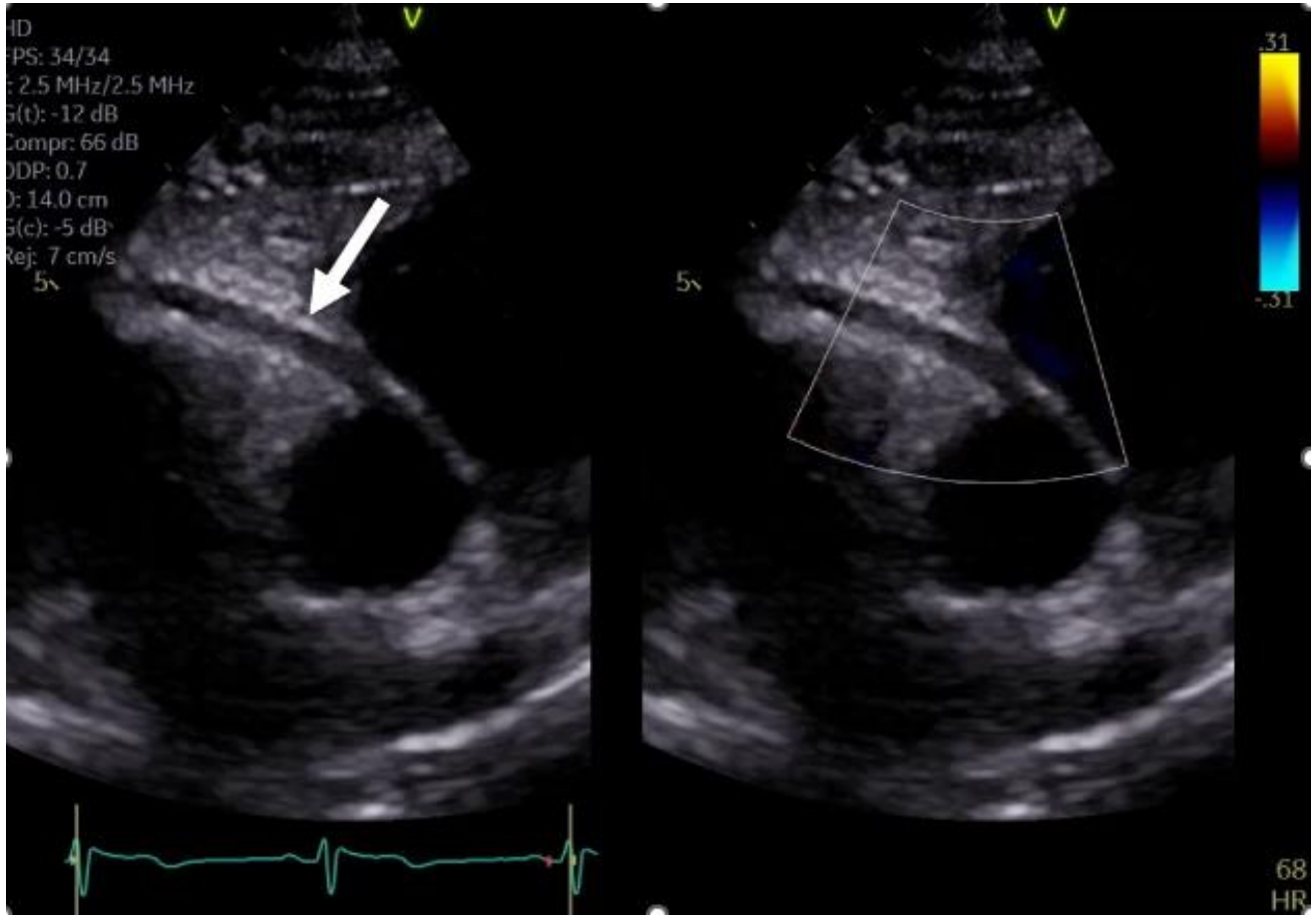
Right main coronary artery (RCA)

Course: along the right AV groove between the RA and RV

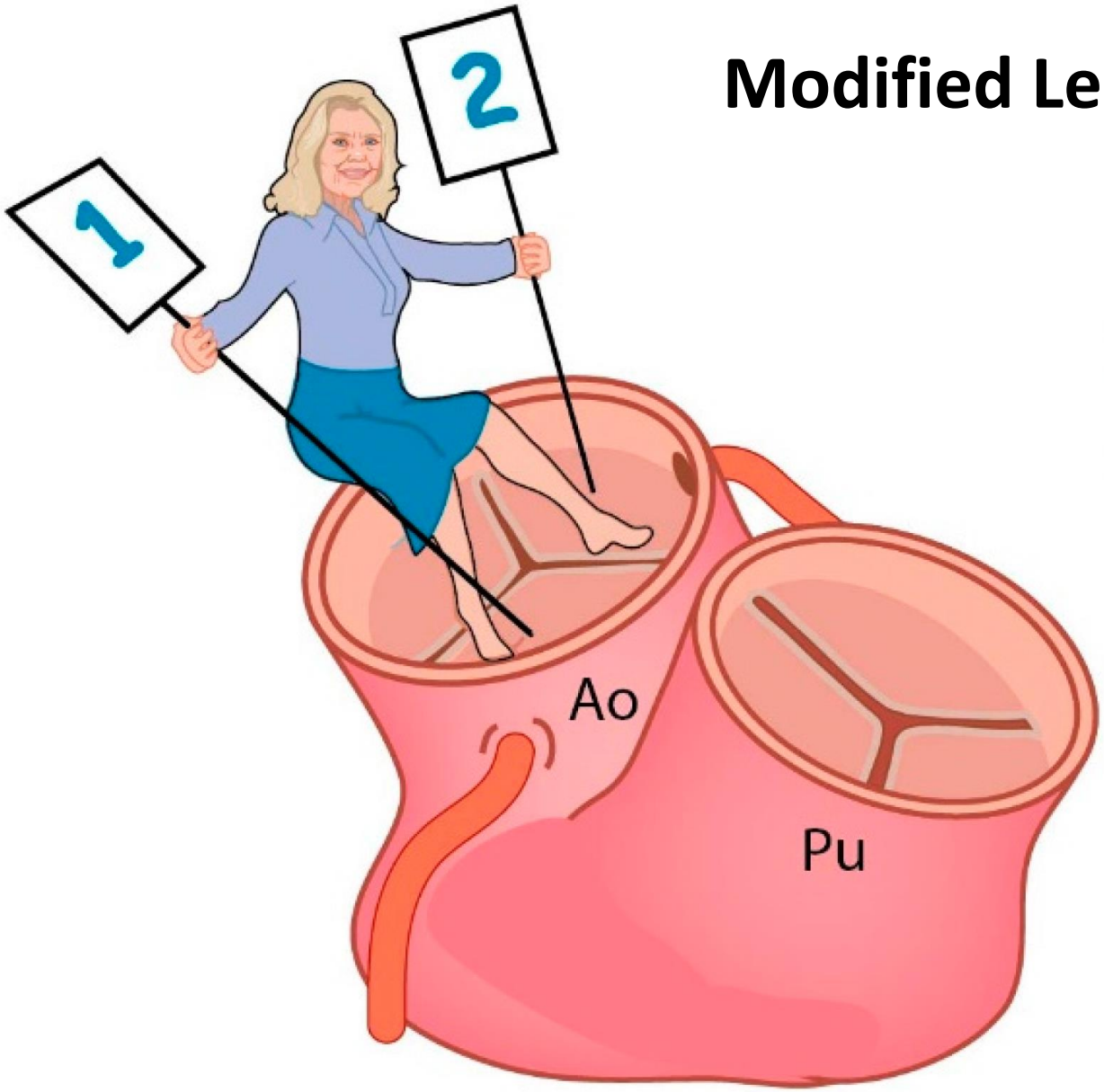
Supplies: RA, SA node, AV node, RV, inferior LV wall, inferior ventricular septum

Branches:

- Conal branch
- SA node artery
- Acute marginal arteries
- Posterior descending artery and posterior LV branch *(if right dominant coronary system*)*



Modified Leiden (Surgeon's view)



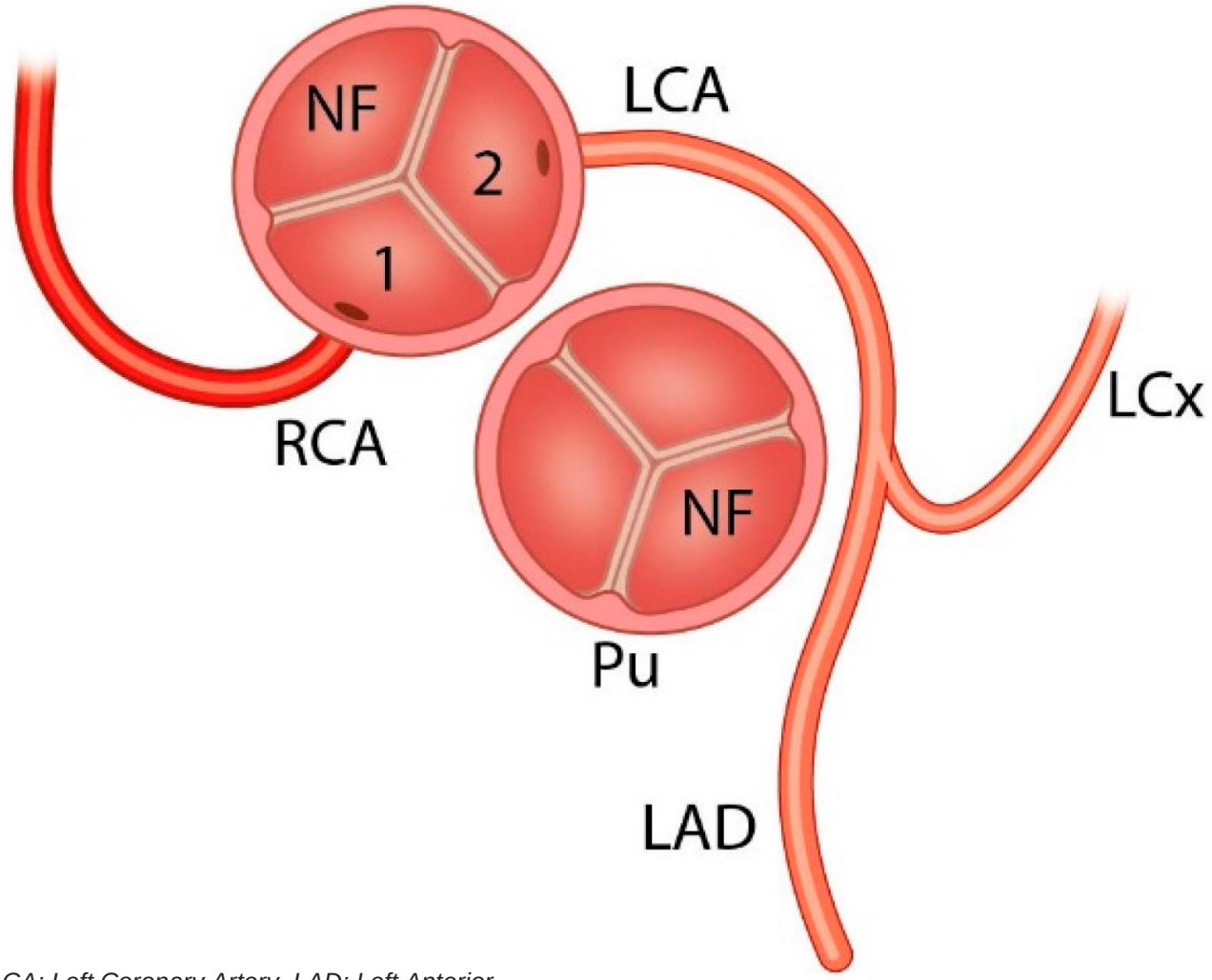
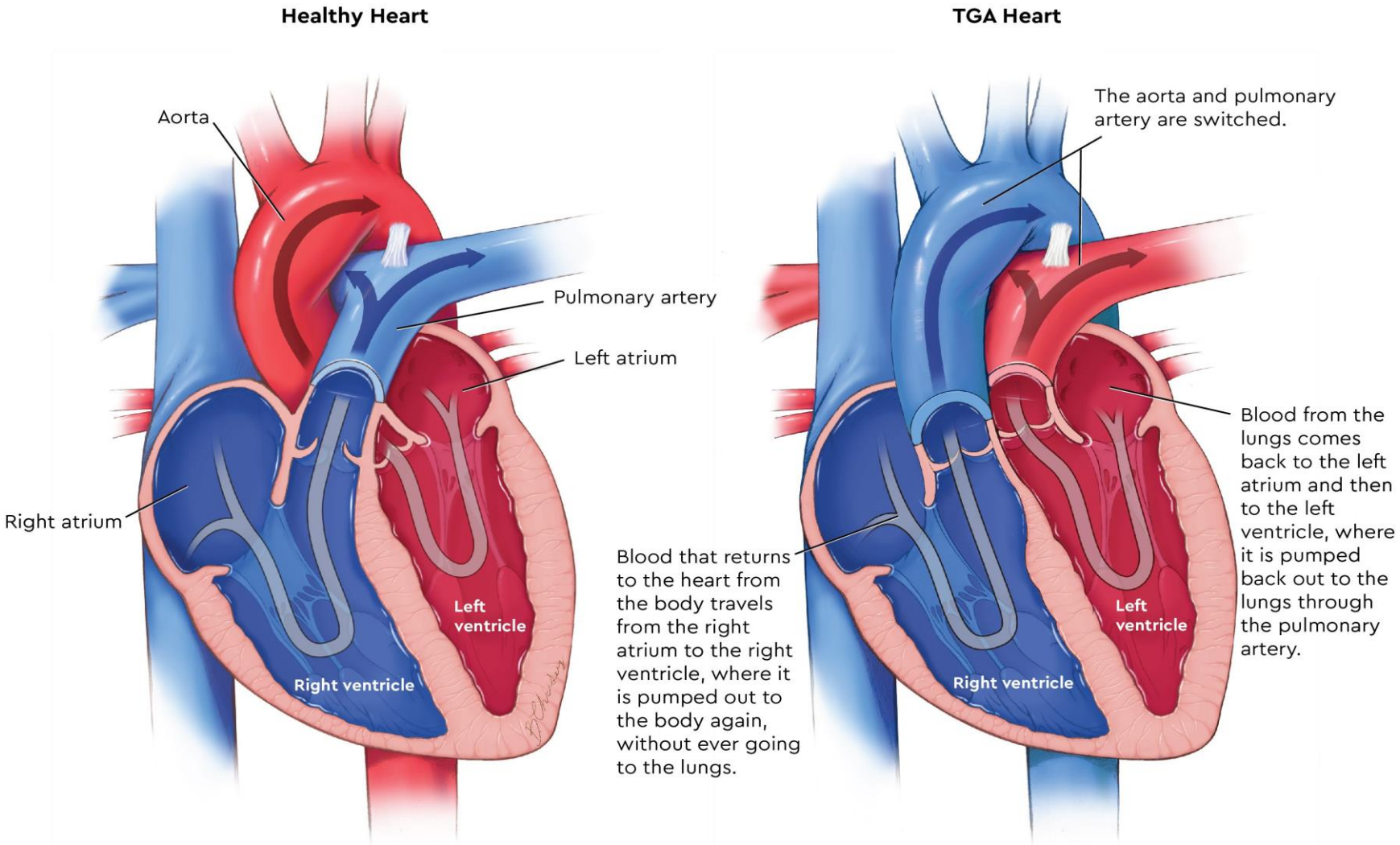
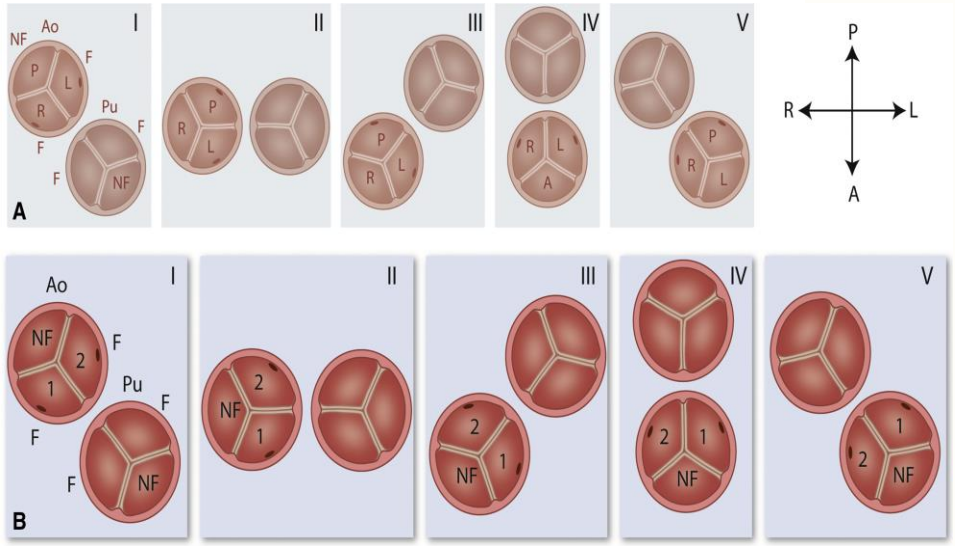


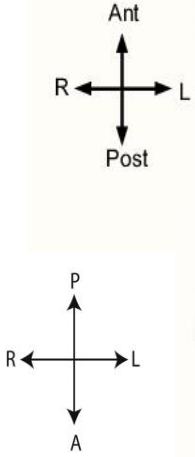
Figure 1. *Ao: aorta, Pu: Pulmonary artery, NF: Non Facing sinus, RCA: Right Coronary Artery, LCA: Left Coronary Artery, LAD: Left Anterior Descending artery, LCx: Left Circumflex artery. The observer sits in the non-facing sinus of the aorta and looks towards the facing sinuses. Sinus 1 is on her right-hand side, while sinus 2 is on her left-hand side. The coronary arteries are described in a counterclockwise fashion: 1RCA-2LAD LCx. (Adapted with permission from: Gittenberger de Groot et al. J Thorac Cardiovasc Surg. 2018 Dec;156(6):2260–2269).*

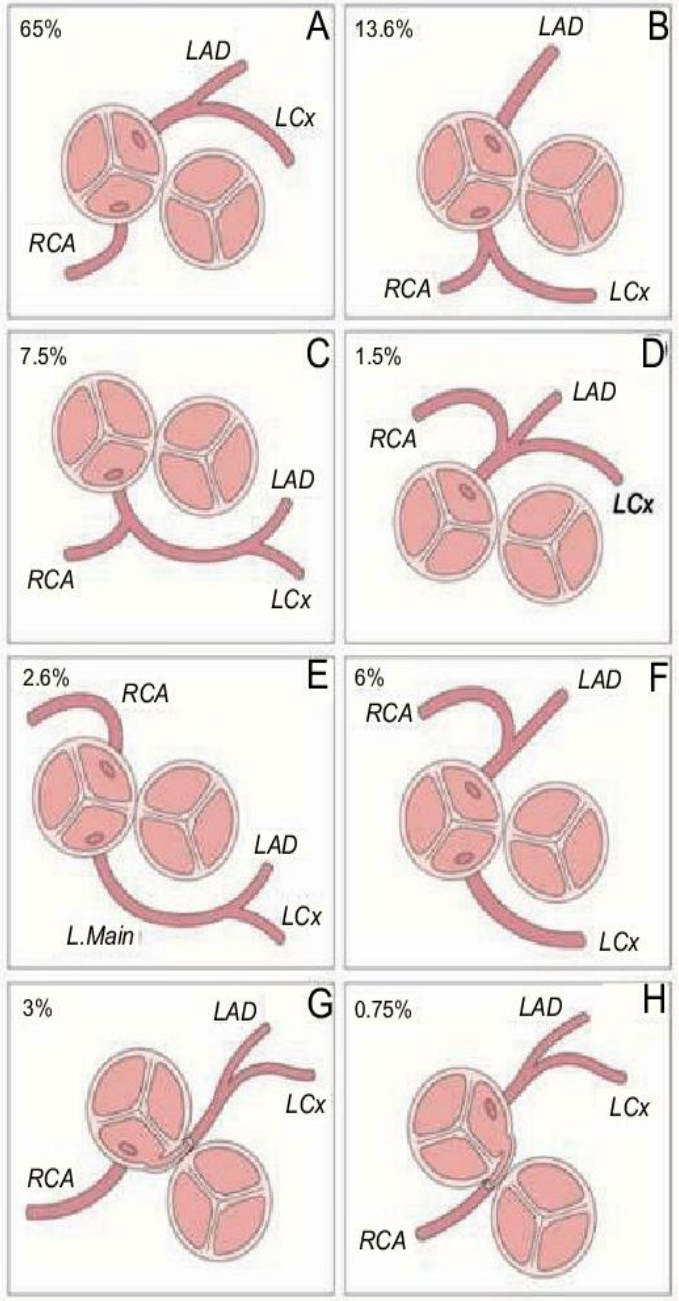
D-Transposition of the Great Arteries

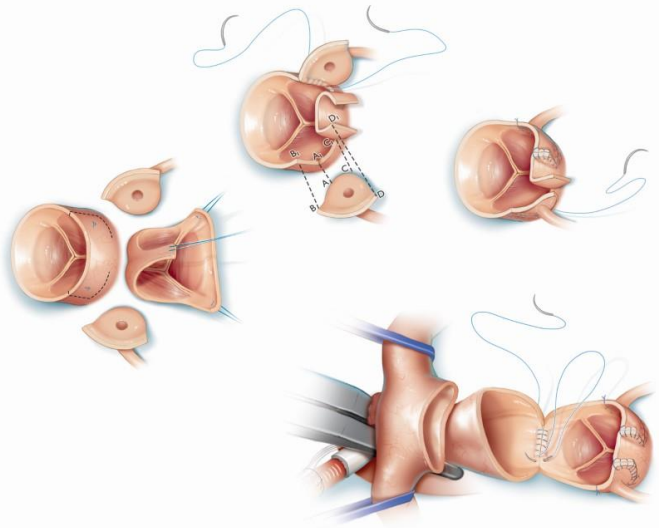


d-TGA

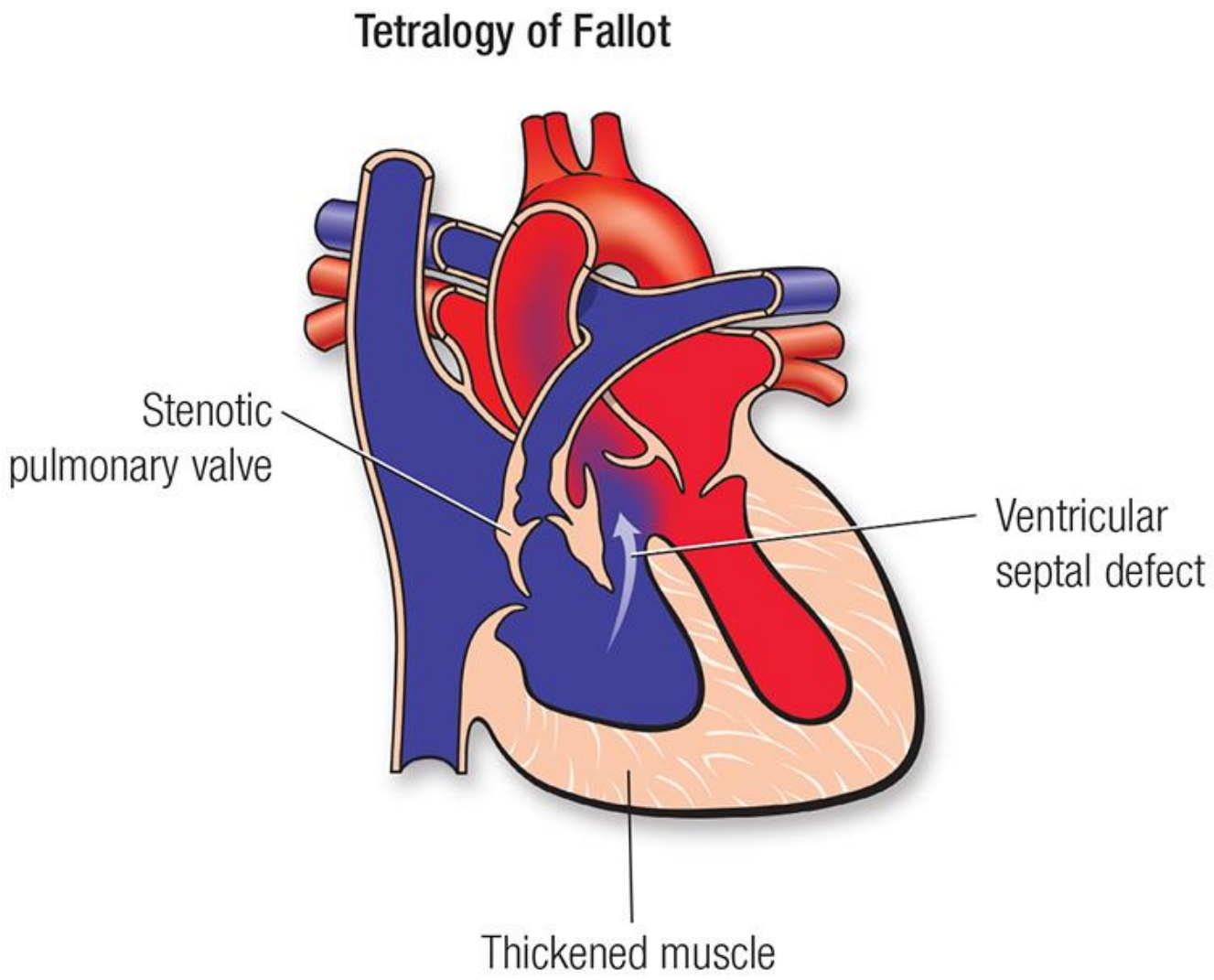




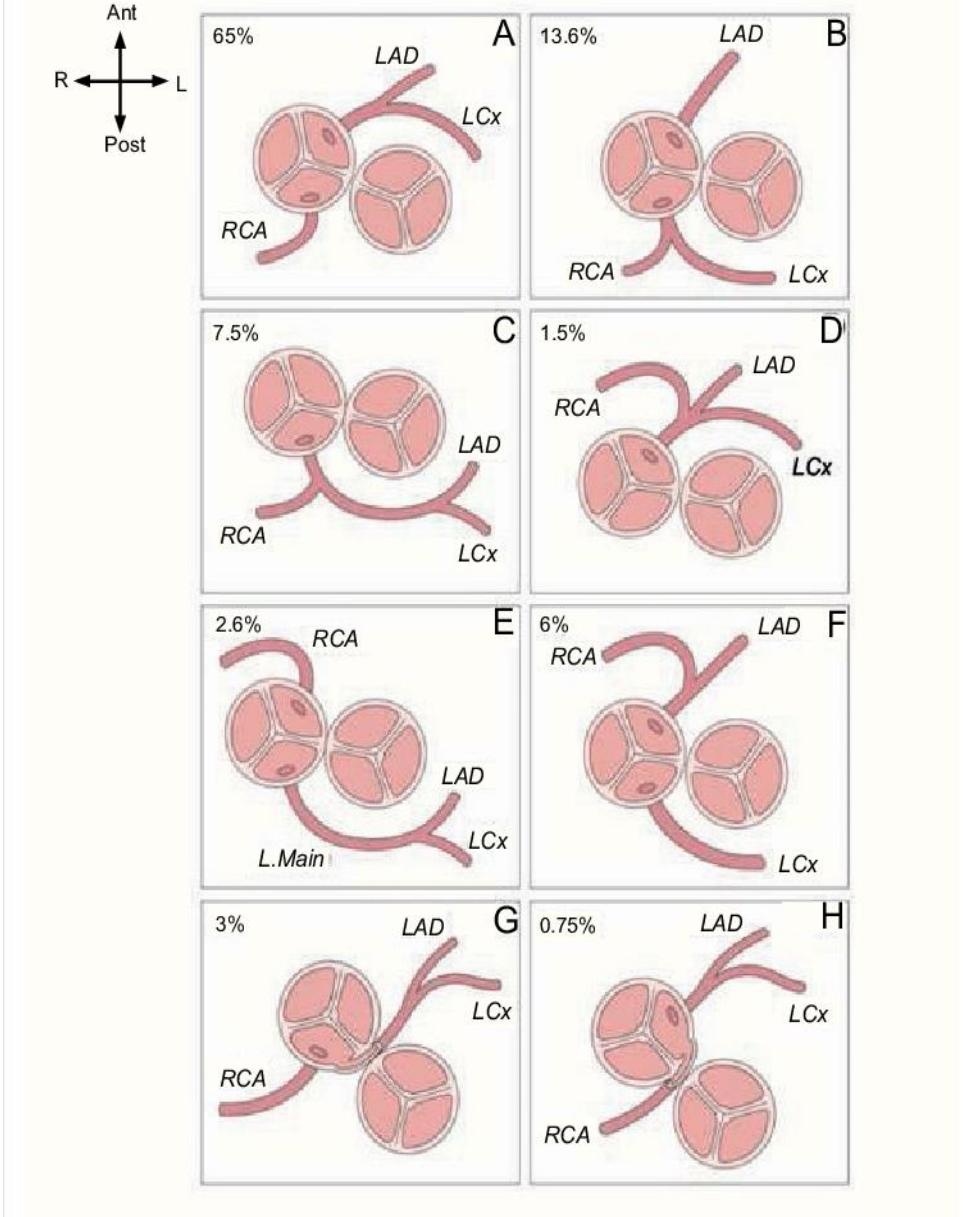




Upload from Anne Marie Valente, MD



AHA



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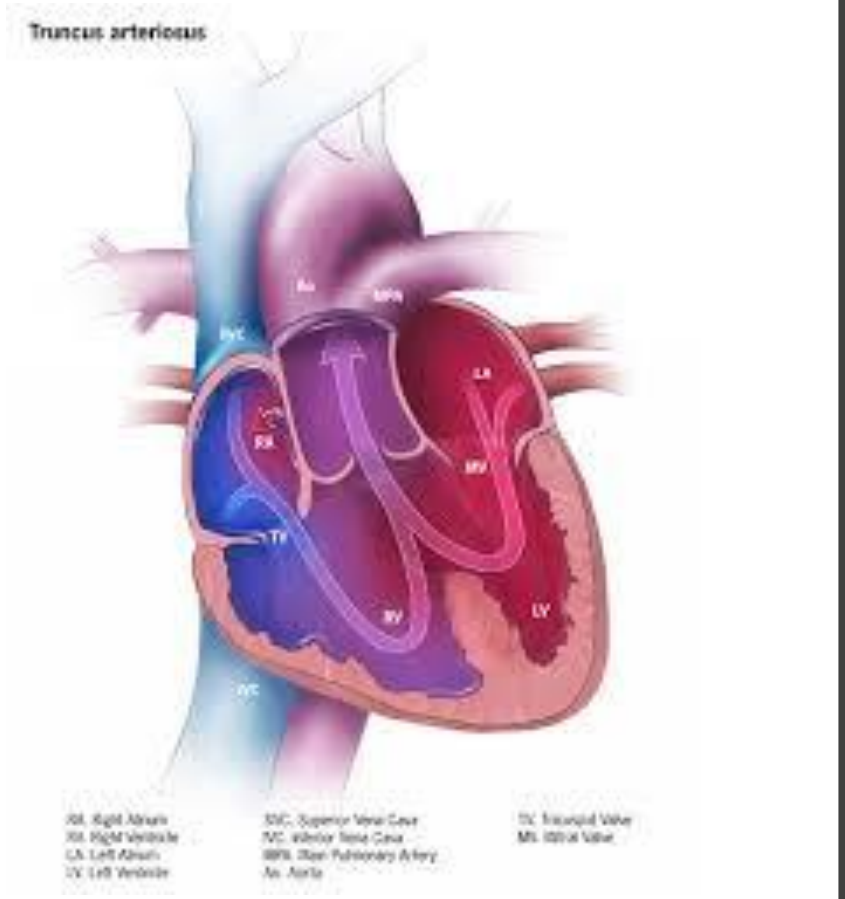


Corpus ID: 16383380

CLINICOPATHOLOGIC CORRELATIONS Coronary Arterial Origin in Persistent Truncus Arteriosus

S. Shrivastava, J. Edwards • Published 2005 • Medicine

Specimens of heart from 30 subjects with persistent truncus arteriosus were studied for the nature and sites of coronary arterial origin. These factors were related to the sinuses of the truncus...
Expand

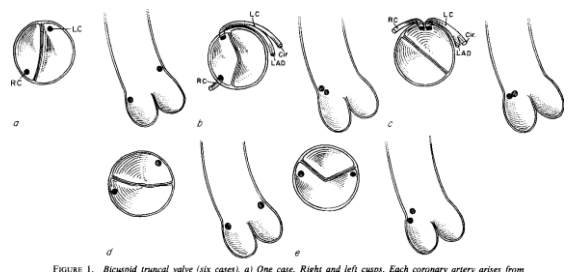
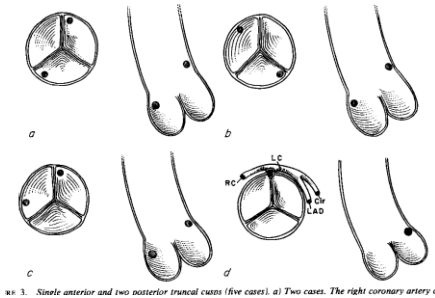
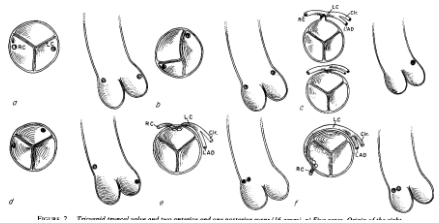


FIGURE 1. *Bicuspid truncal valve (six cases). a) One case. Right and left cusps. Each coronary artery arises from*



Single anterior and two posterior truncal cusps (five cases). a) Two cases. The right coronary artery a



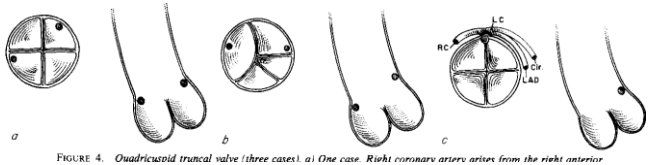


FIGURE 4. *Quadricuspid truncal valve (three cases). a) One case. Right coronary artery arises from the right anterior*

Truncus Arteriosus

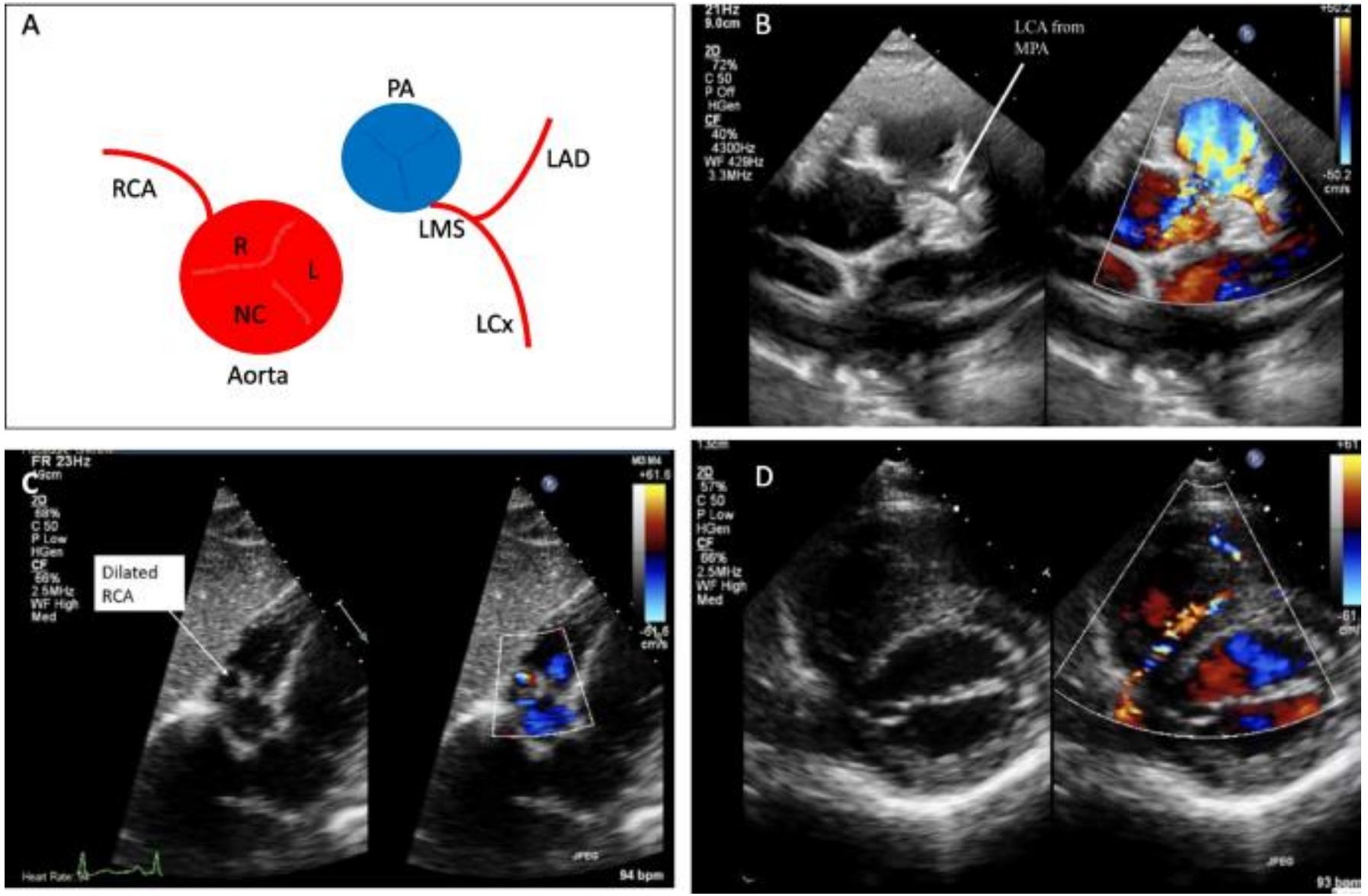
- Truncal valves can be bicommissural, tricomissural Quadricommissural…
- Coronary arteries can arise anywhere in the aortic root

Anomalous Origins: ALCAPA vs. AORCA

The Independent

Sentient Media

ALCAPA



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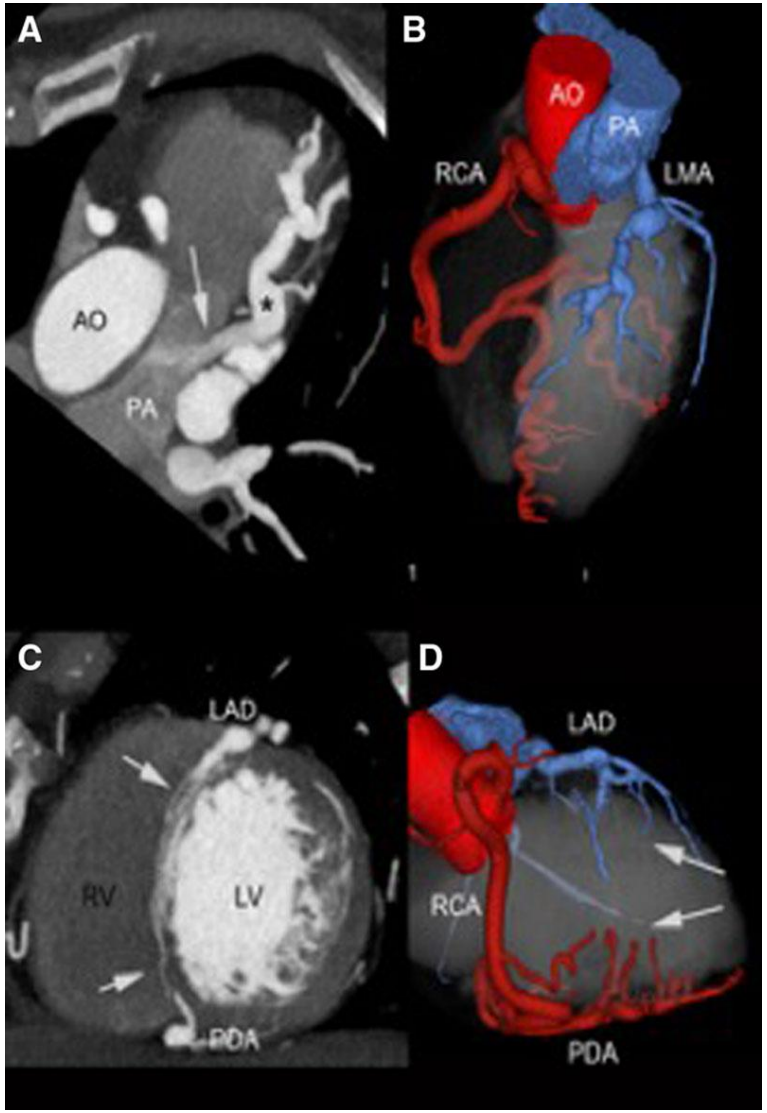
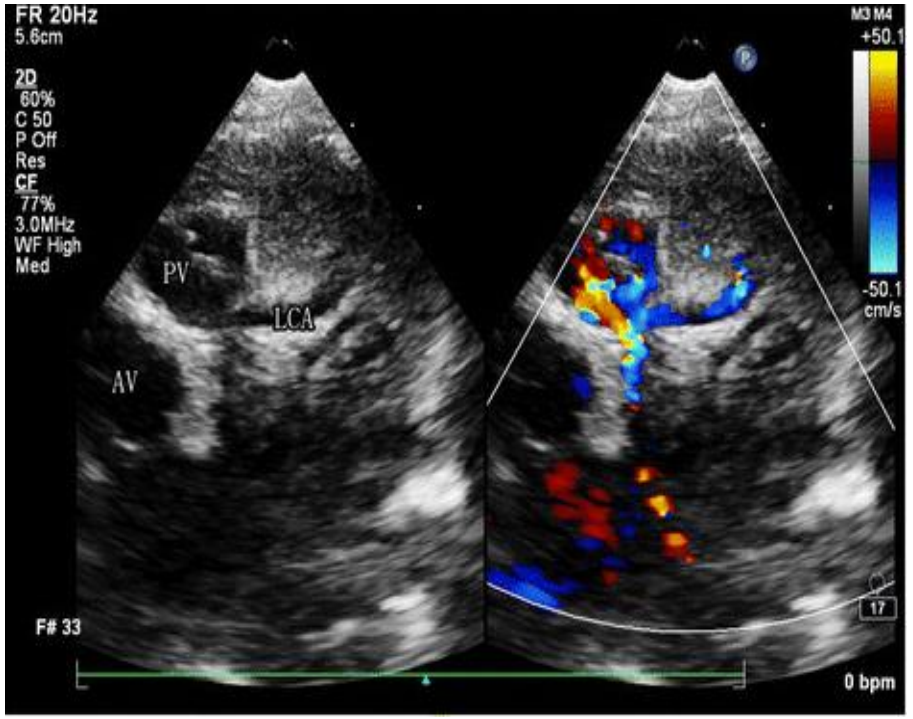
Anomalous **L**eft **C**oronary **A**rtery from **P**ulmonary **A**rtery (ALCAPA)

Hints things are anomalous:

1. Myocardial dysfunction
2. Color flow – Direction
3. RCA enlargement
4. Collaterals

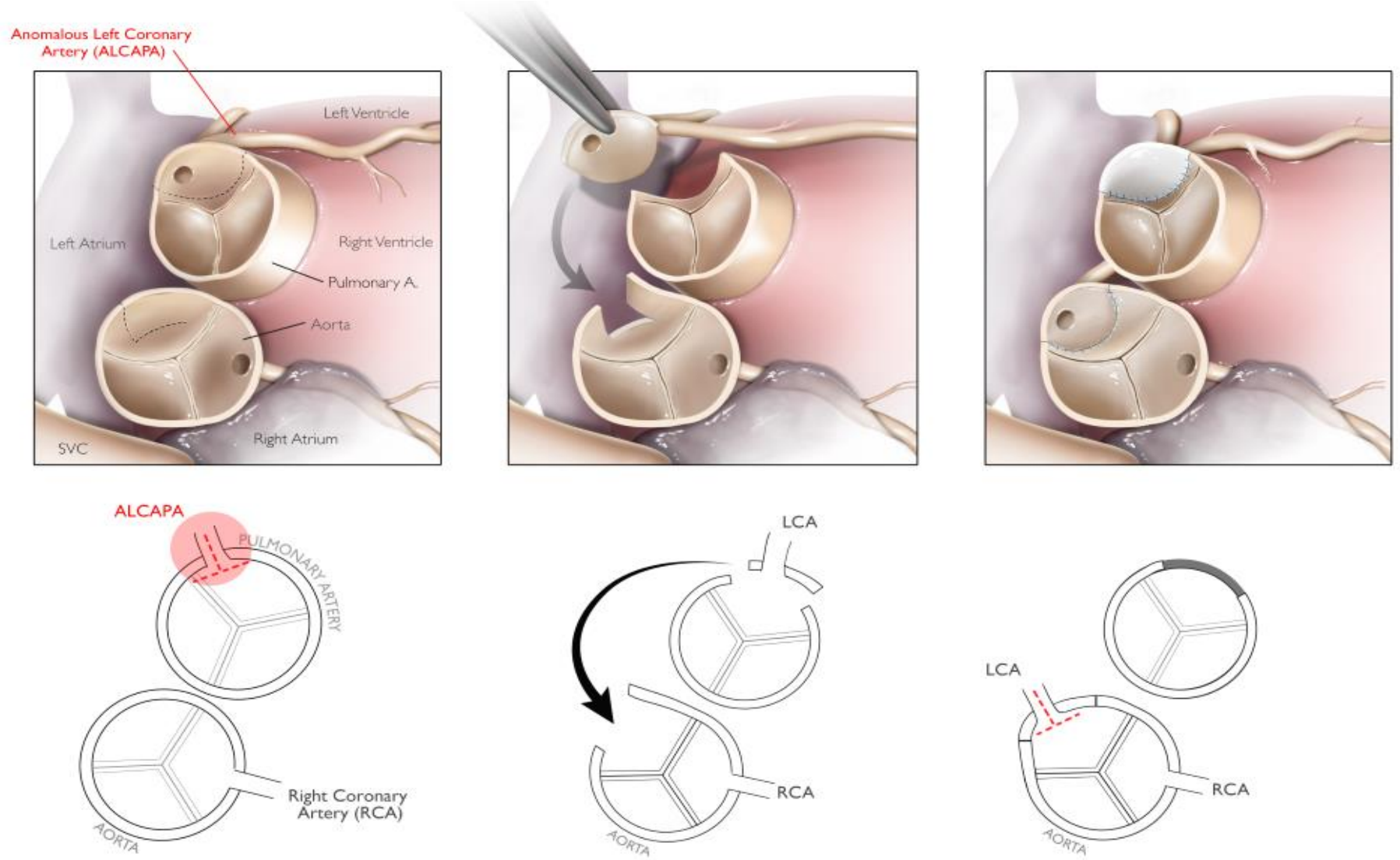
CT Angiography





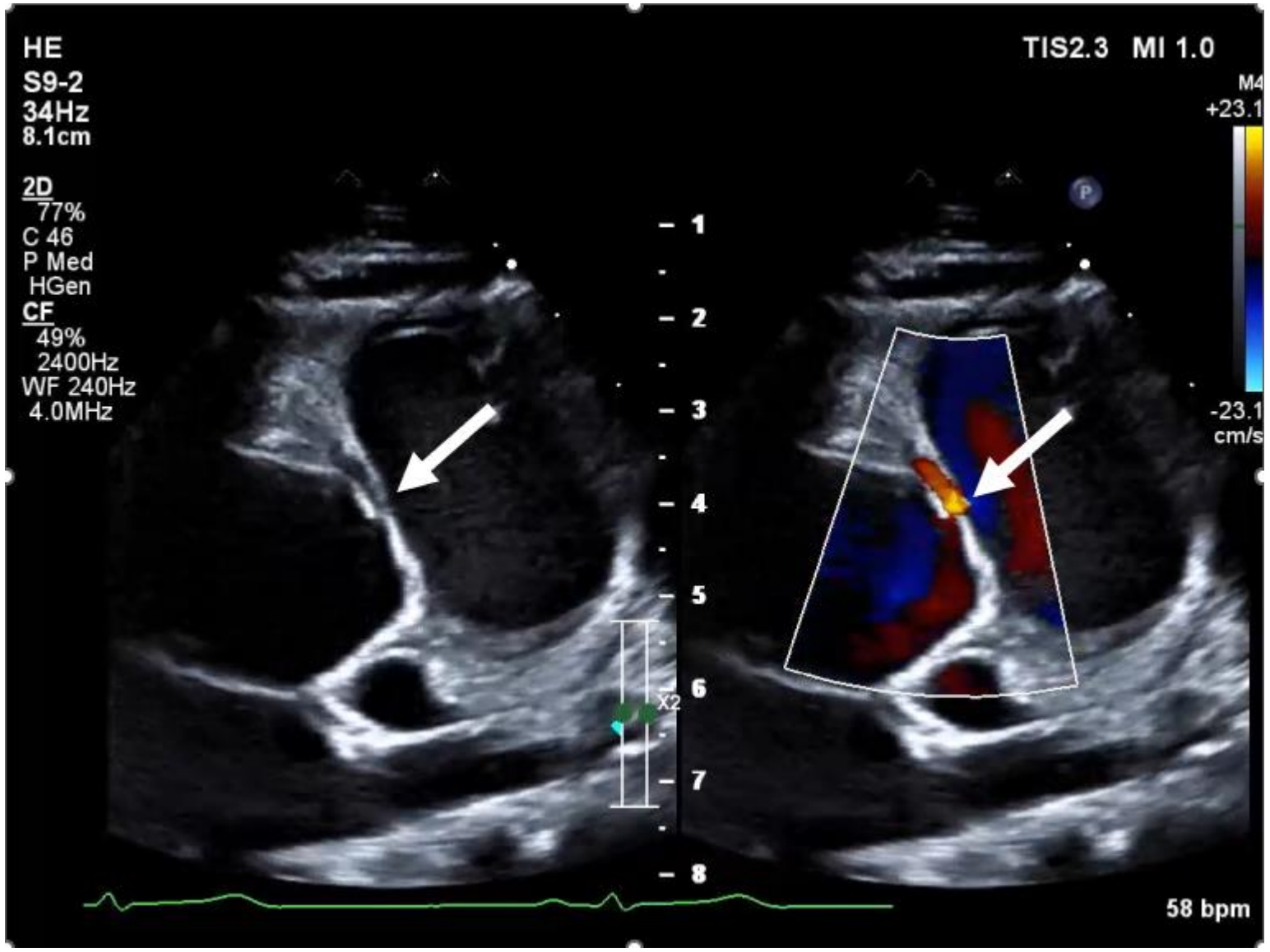
Trevizan LLB, Nussbacher A, da Silva MCB, Ishikawa WY, de Oliveira SA, Sitta MDC, Szarf G. Anomalous Origin of the Left Coronary Artery From the Pulmonary Artery As a Rare Cause of Left Ventricular Dysfunction. Circ Cardiovasc Imaging. 2019 Dec;12(12):e009724. doi: 10.1161/CIRCIMAGING.119.009724. Epub 2019 Nov 26. PMID: 31766859.

Dehaki MG, Al-Dairy A, Rezaei Y, Ghavidel AA, Omrani G, Givtaj N, Afjehi RS, Tatari H, Jalali AH, Mahdavi M. Mid-term outcomes of surgical repair for anomalous origin of the left coronary artery from the pulmonary artery: In infants, children and adults. Ann Pediatr Cardiol. 2017 May-Aug;10(2):137-143. doi: 10.4103/0974-2069.205140. PMID: 28566821; PMCID: PMC5431025.



Coronary Reimplantation

AORCA


HE
S9-2
34Hz
8.1cm
2D
77%
C 46
P Med
HGen
CF
49%
2400Hz
WF 240Hz
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+23.1
-23.1
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7
8
X2
58 bpm

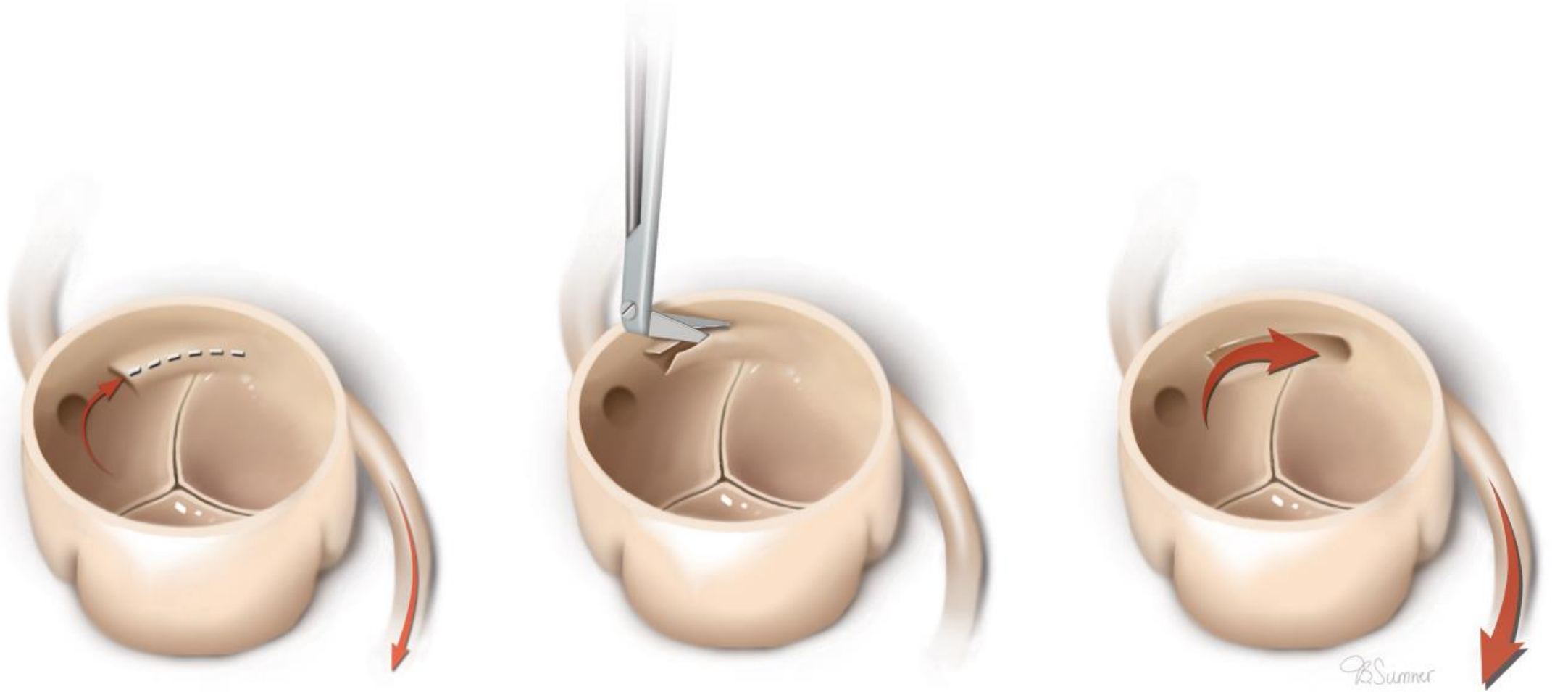
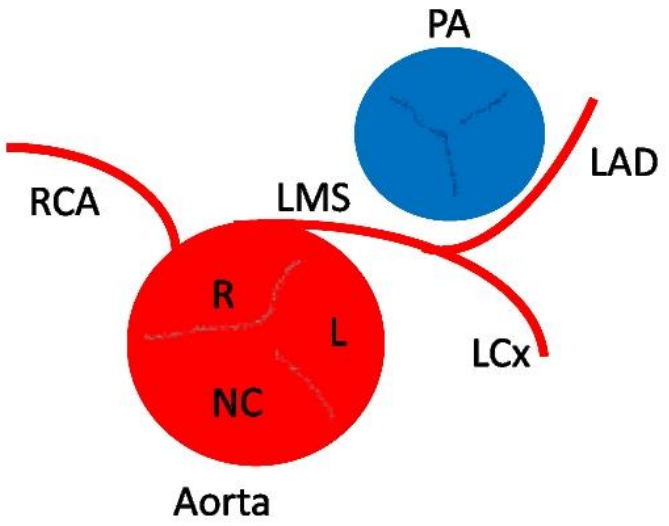


Figure 10. ***Unroofing Procedure of Intramural Segment in Anomalous Coronary Artery***

AOLCA



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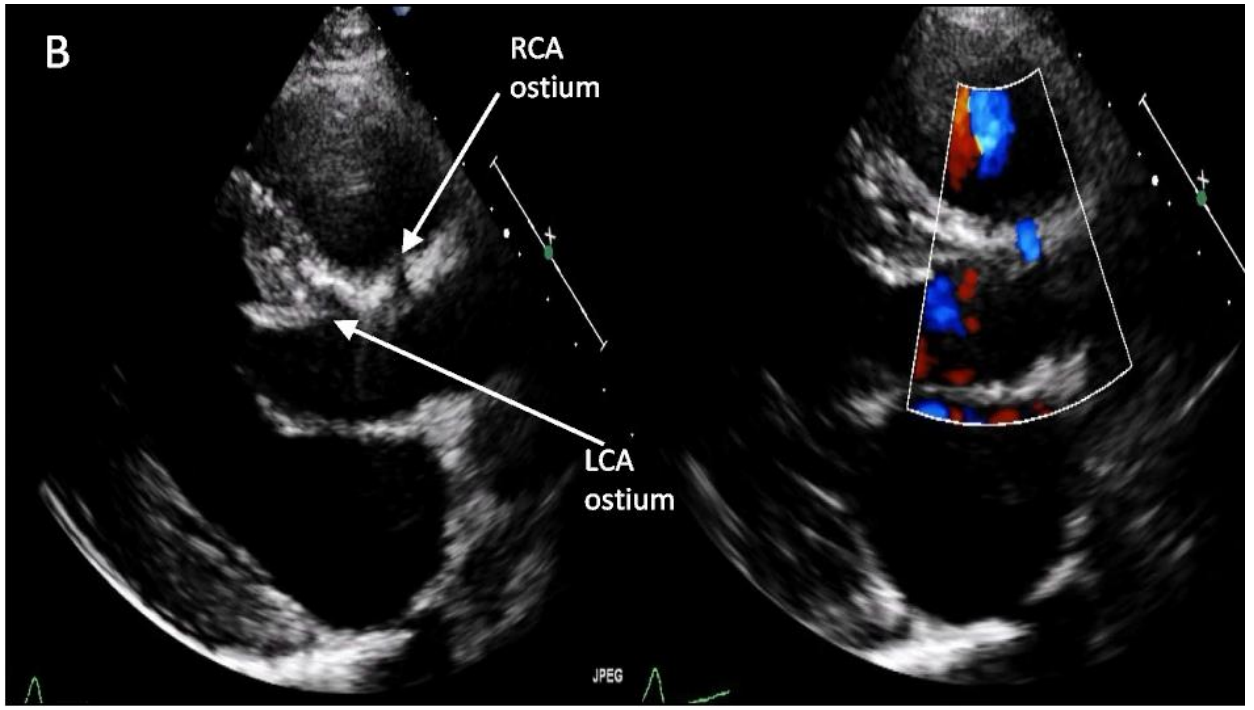
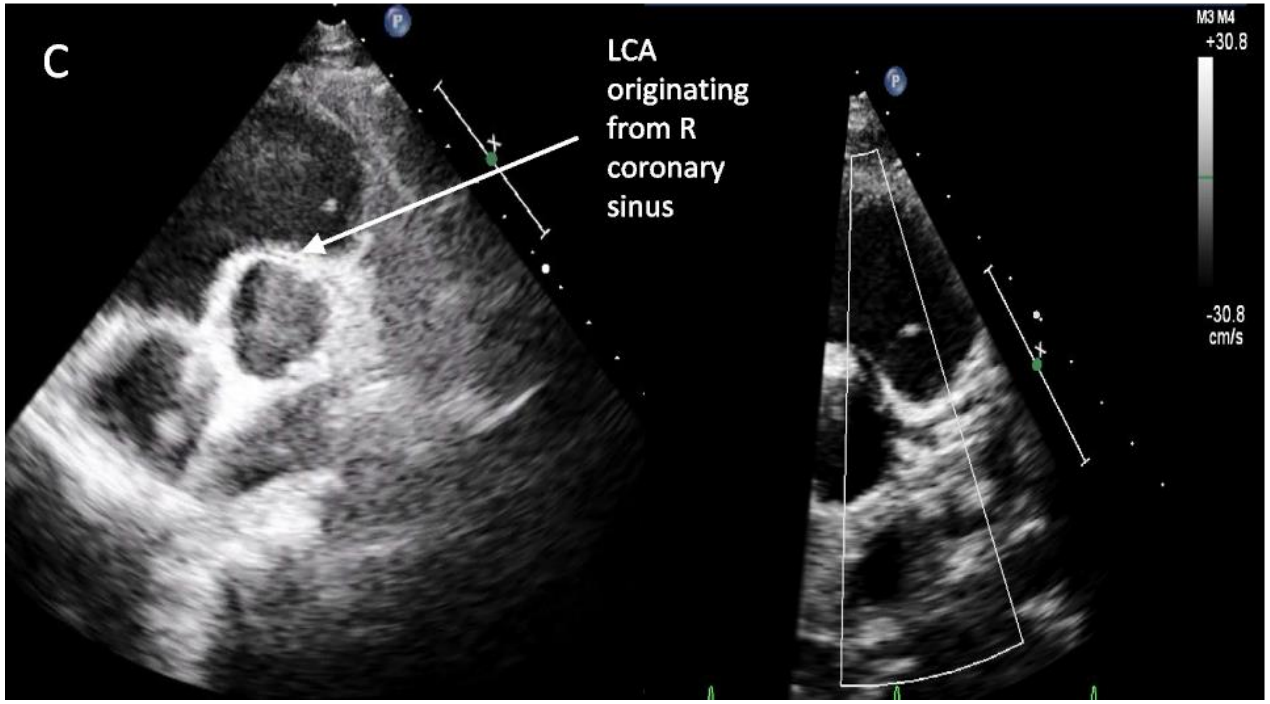
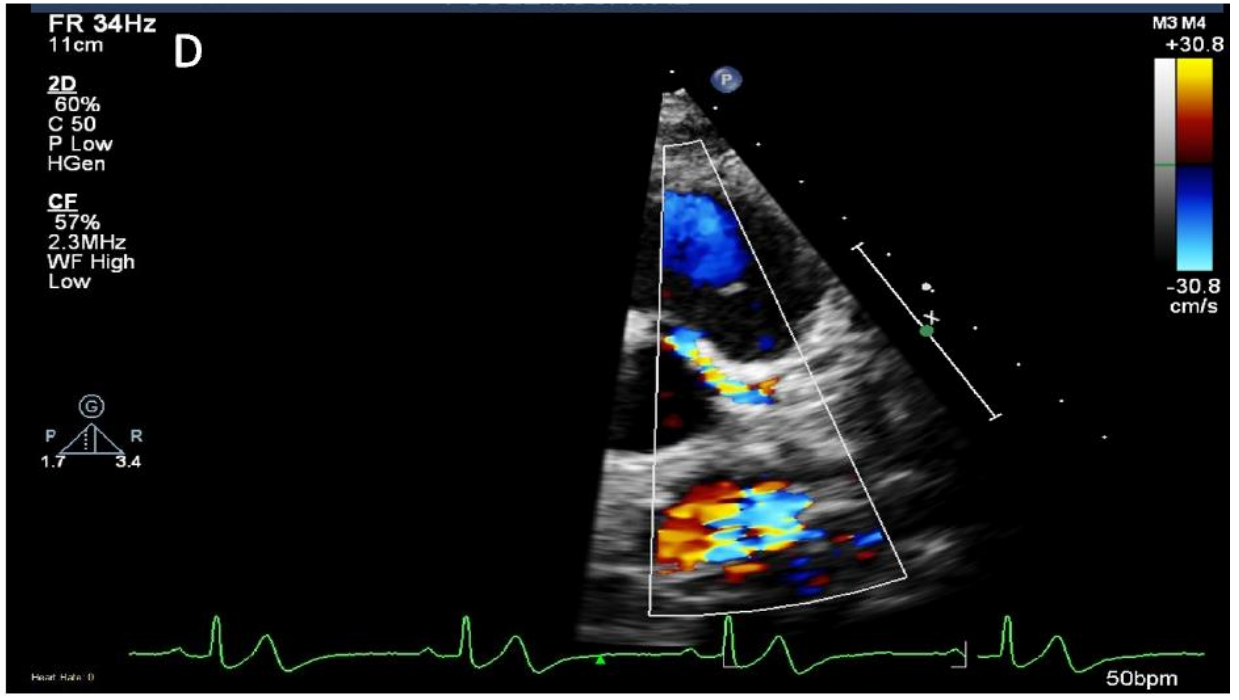
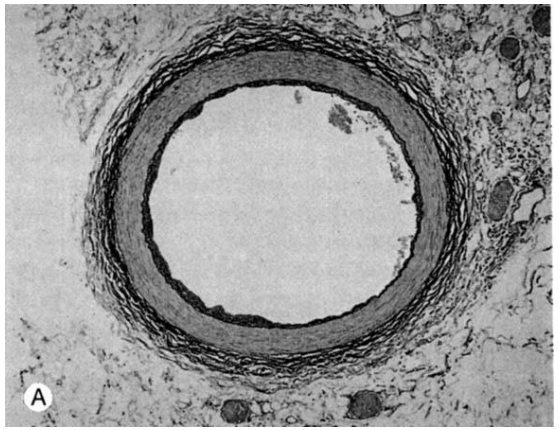
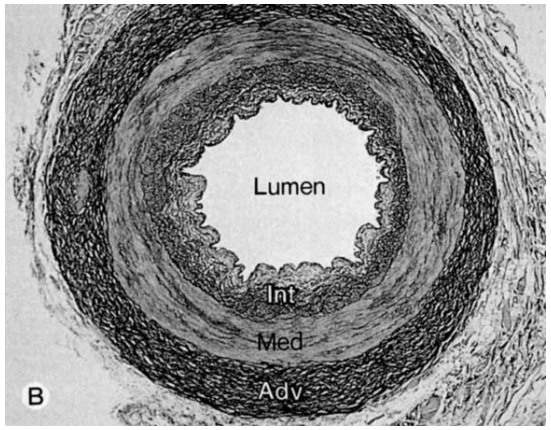
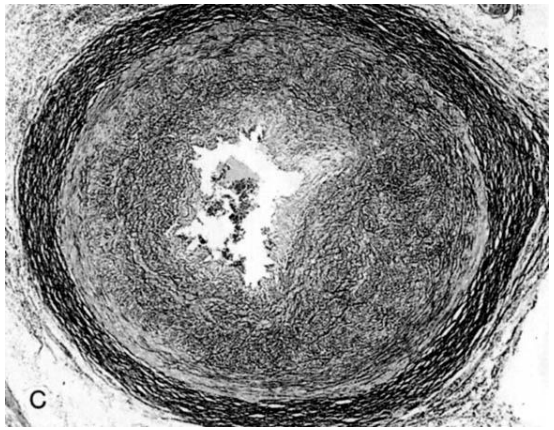


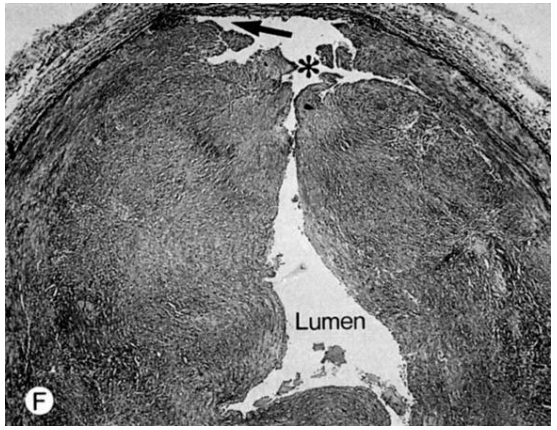


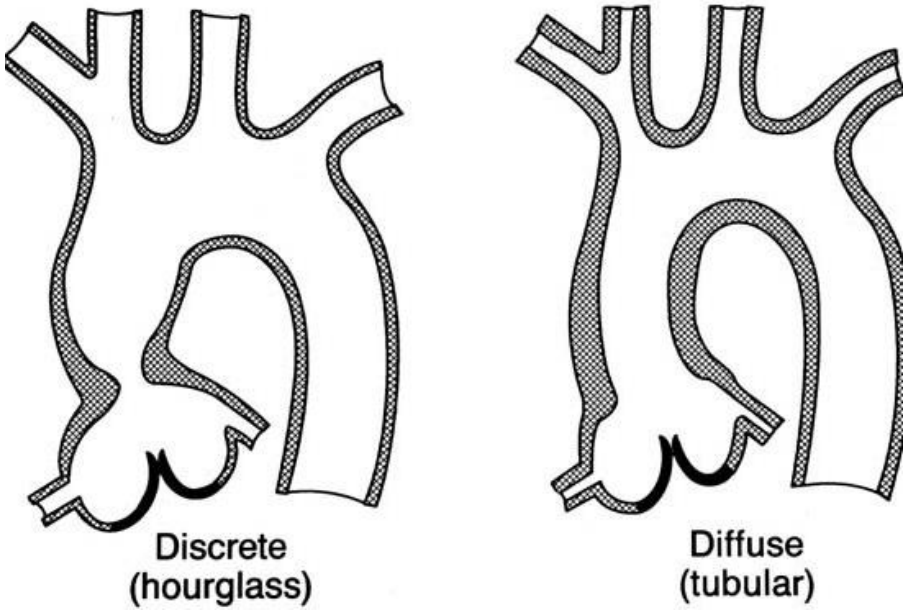








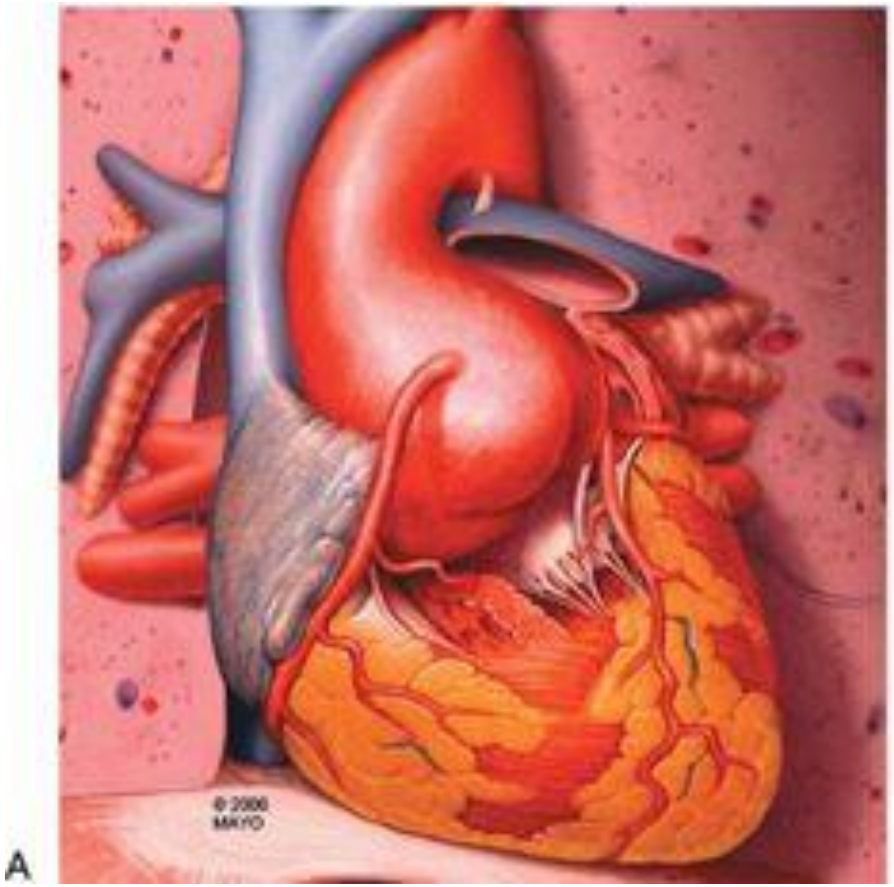


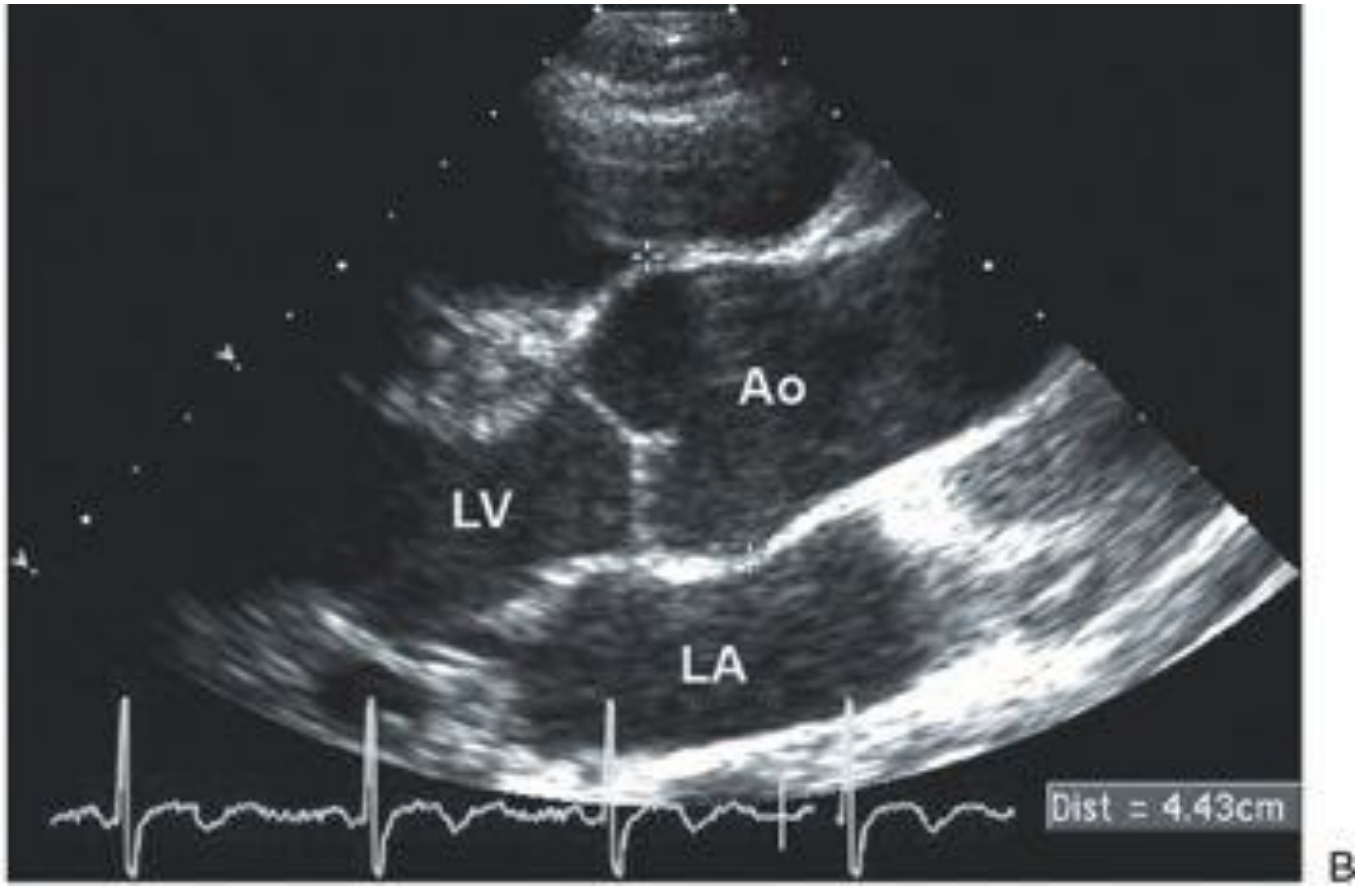


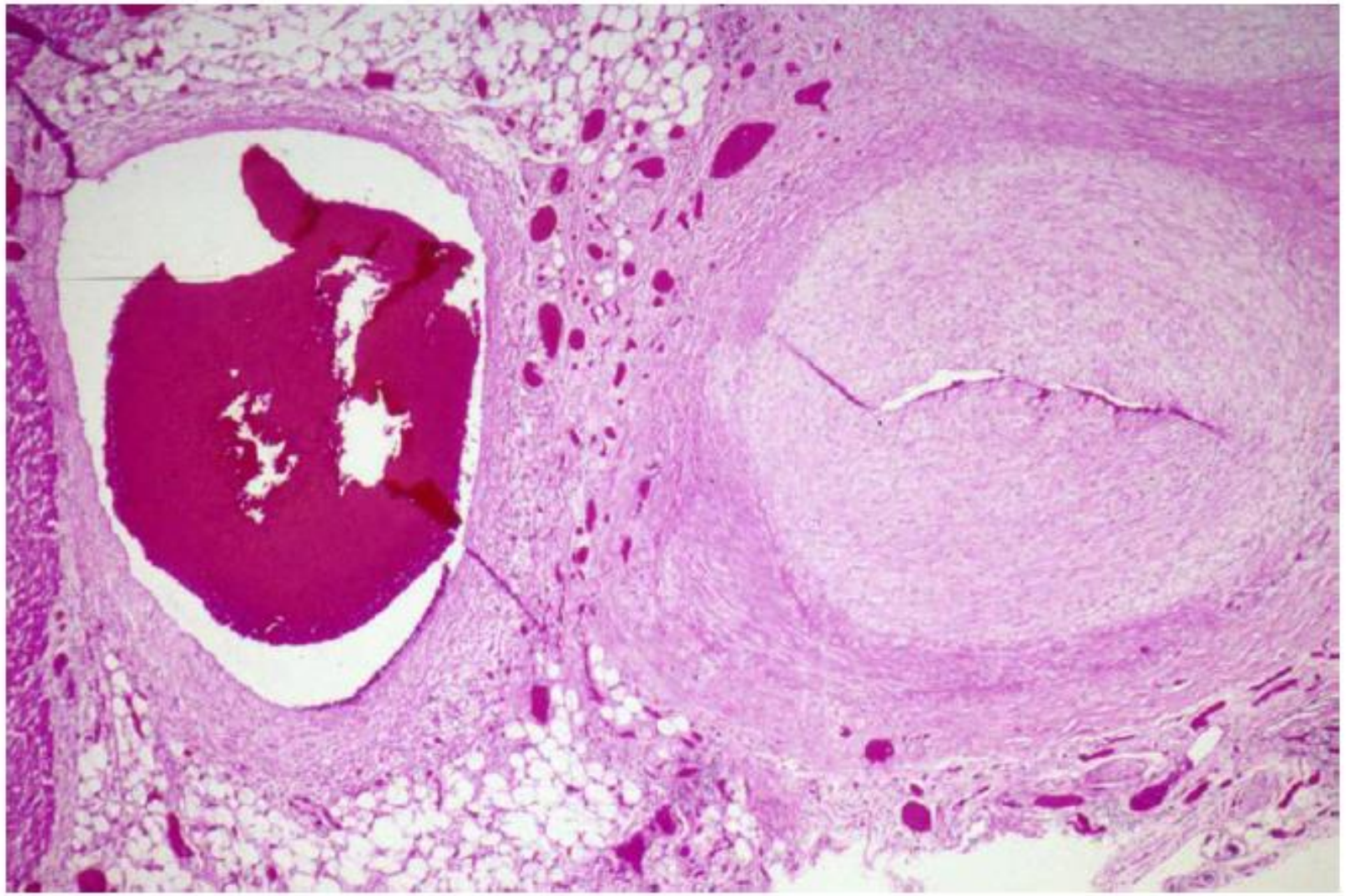
Williams Syndrome

Coronary artery involvement is seen in up to 45% of patients with supravalvar aortic stenosis.

Marfan or Loeys-Dietz







Kawasaki Disease - 3 Stages of Coronary Pathology

1. Necrotizing Arteritis → arterial wall into adventitia

   2 weeks

2. Subacute Vasculitis → asynchronous infiltration lymph, plasma

   2 weeks → chronic

3. Luminal Myofibroblastic Proliferation (LMP) → active lymphoproliferative process


AHA SCIENTIFIC STATEMENT

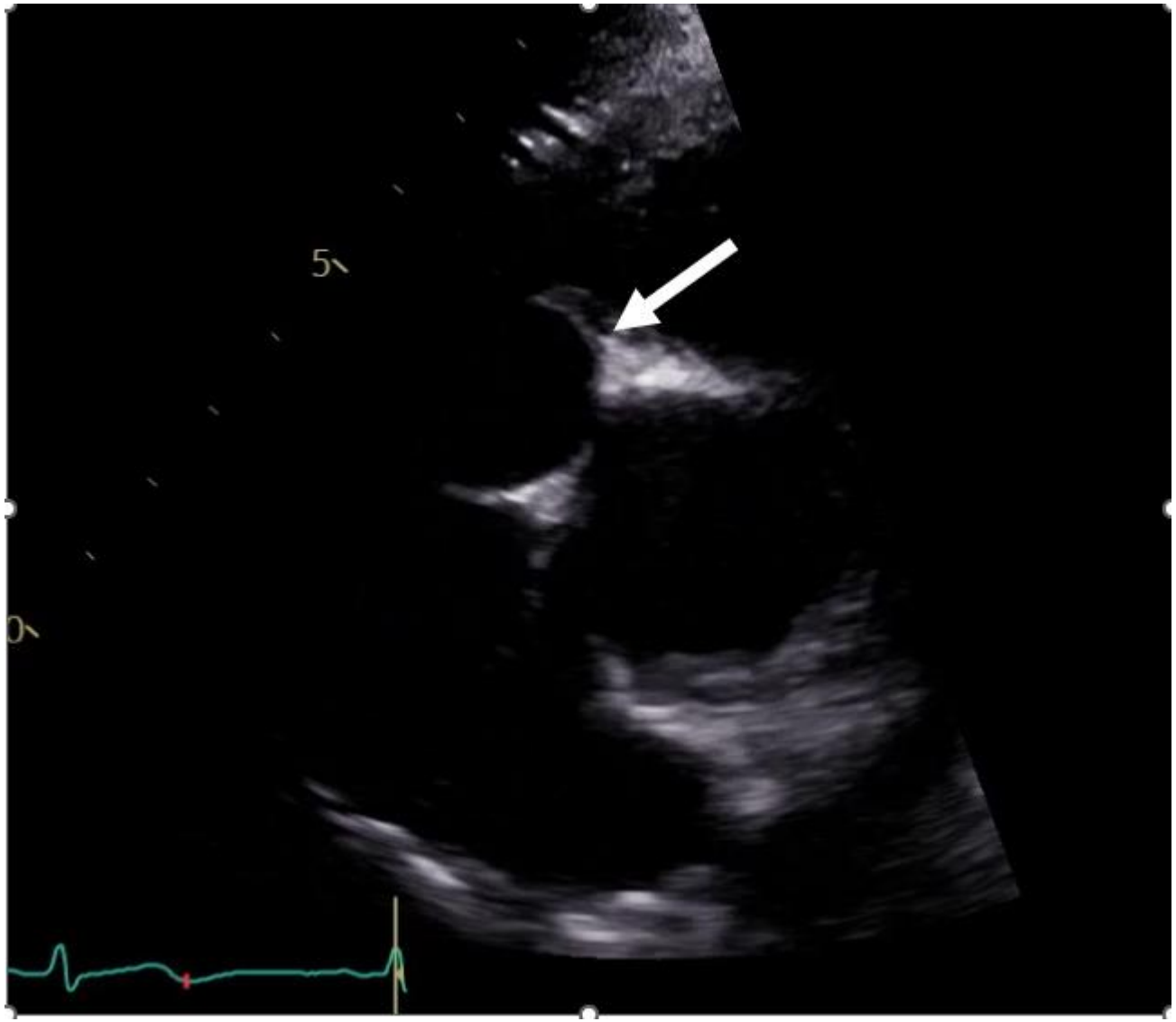
Diagnosis, Treatment, and Long-Term Management of Kawasaki Disease

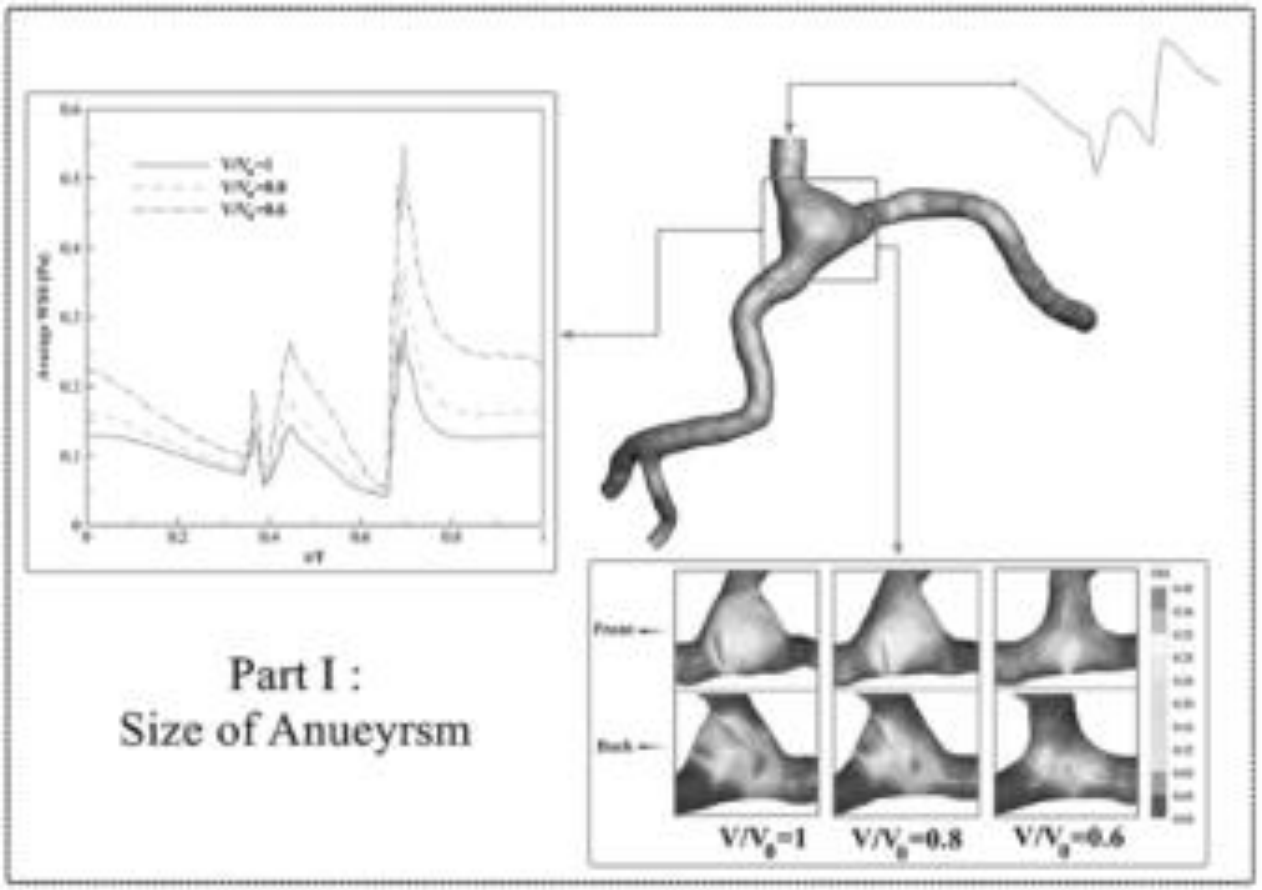
A Scientific Statement for Health Professionals From the American Heart Association

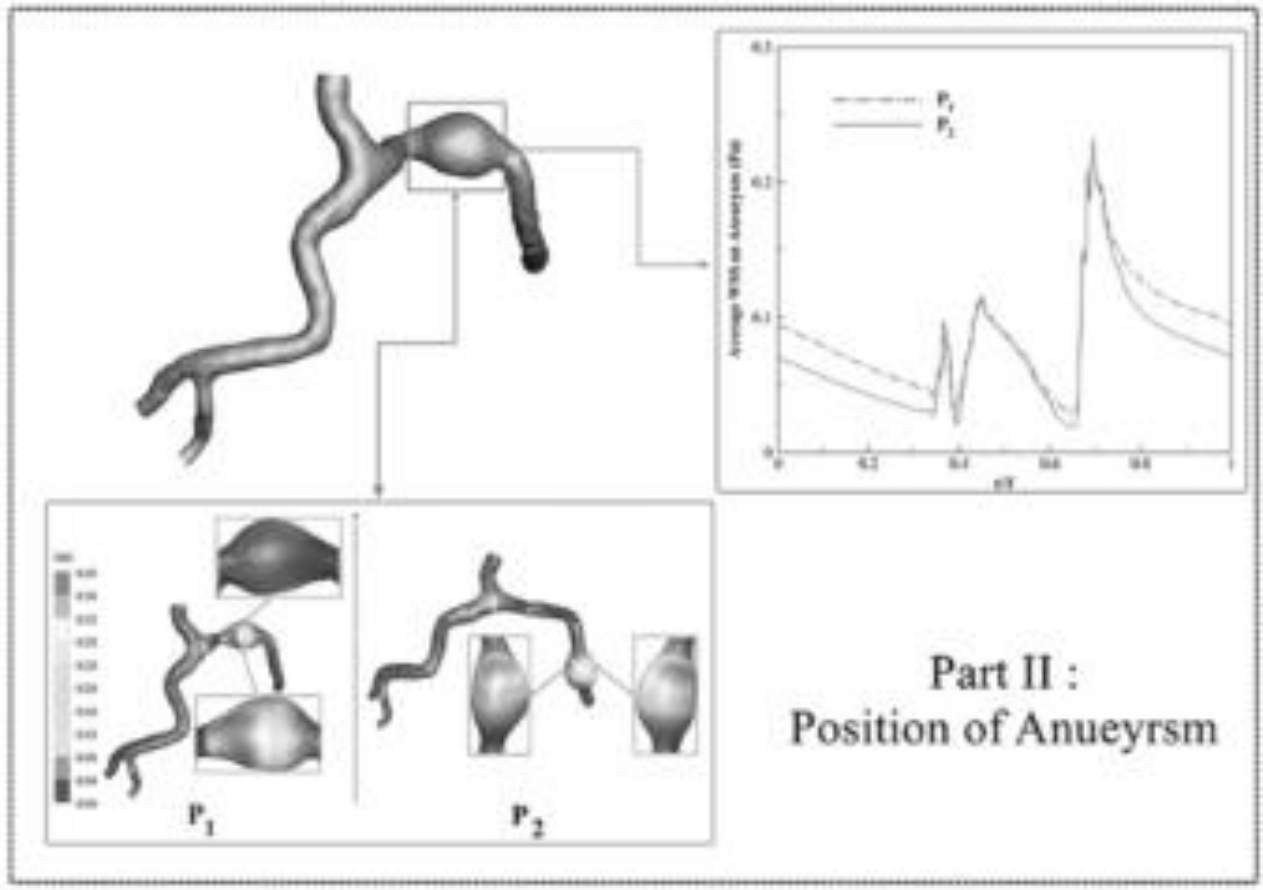
The goals of long-term management are to prevent thrombosis and myocardial ischemia…

Kawasaki Disease

Aneurysms completely change flow dynamics within the vessel







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Effect of Aneurysm Geometric Features


CARDIAC
CARDIAC

The Coronary Arteries are a Source of Life

Original artwork by Maudsch

- Where they originate and travel determines the distribution of blood in the myocardium
- The health of the vasculature determines flow dynamics
- The health of the myocardium depends on the unimpaired flow of the coronaries