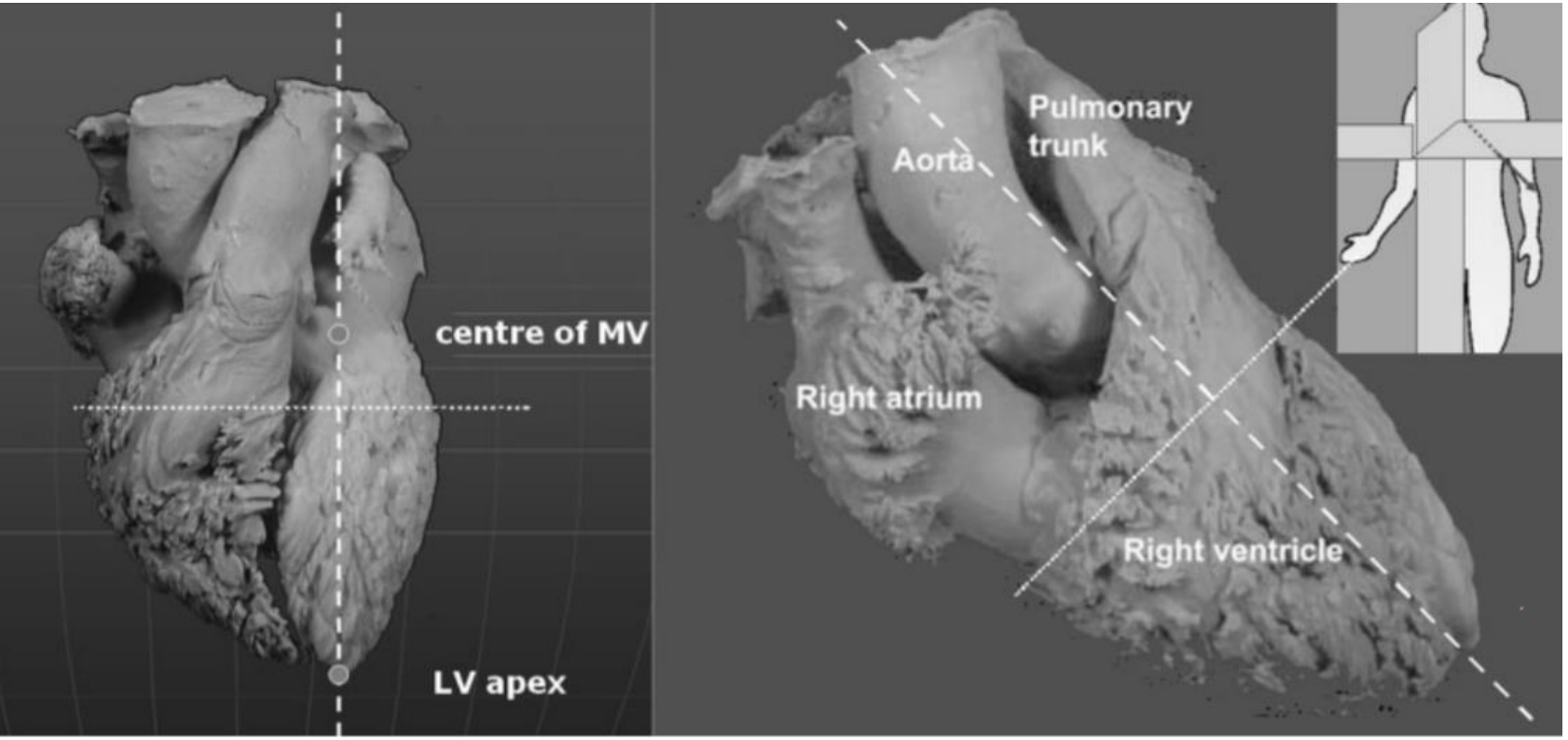
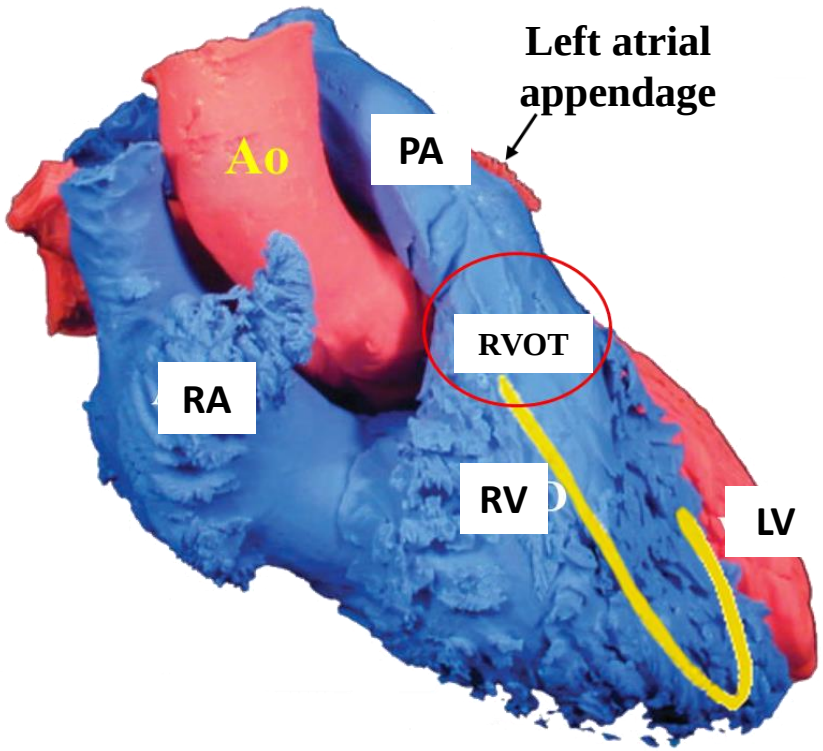
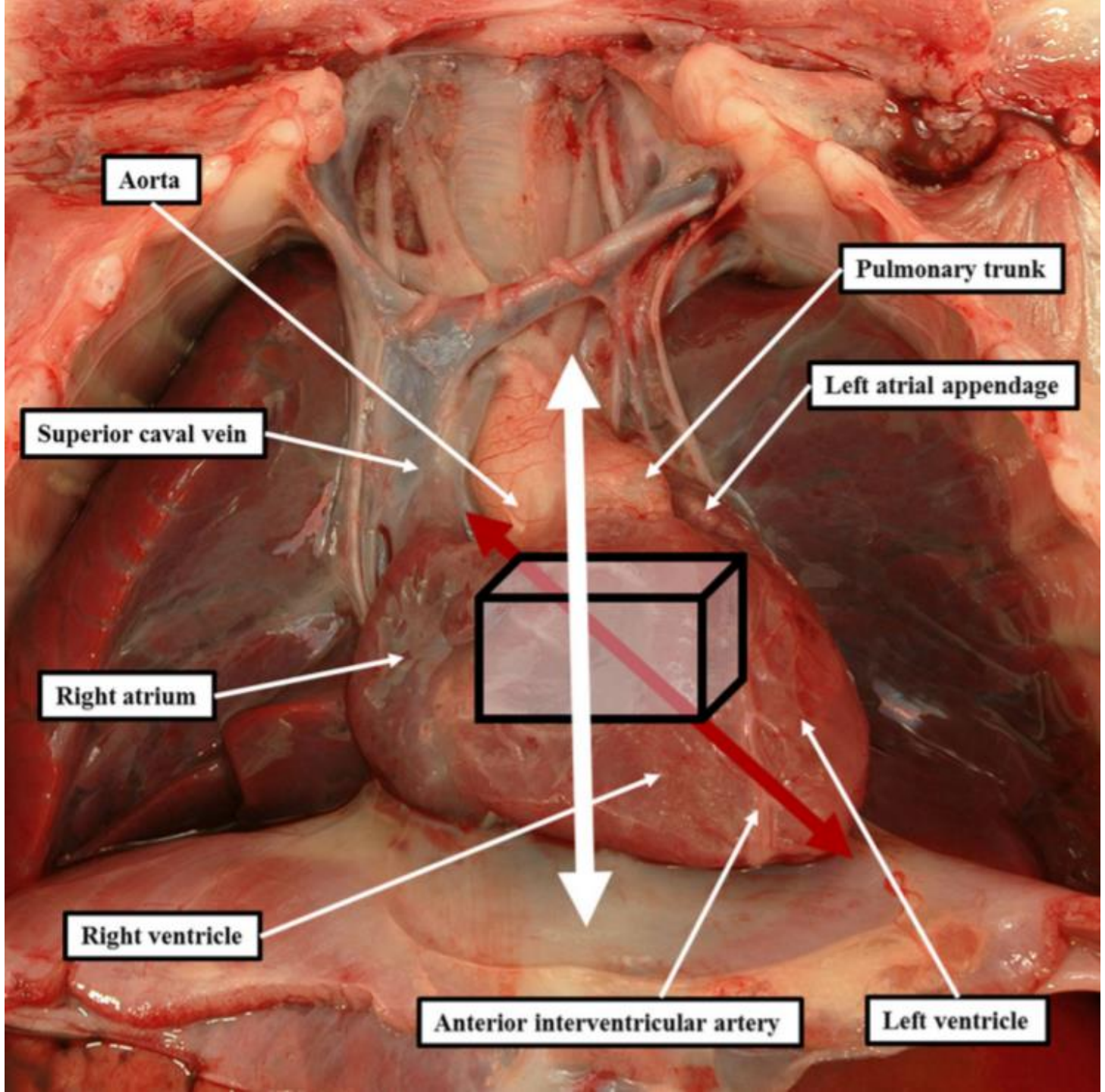
American Heart Association Writing Group on Myocardial Segmentation and Registration for Cardiac Imaging. Standardized myocardial segmentation and nomenclature for tomographic imaging of the heart. A statement for healthcare professionals from the Cardiac Imaging Committee of the Council on Clinical Cardiology of the American Heart Association. Additionally, this nomenclature should also be used for electrocardiogram.

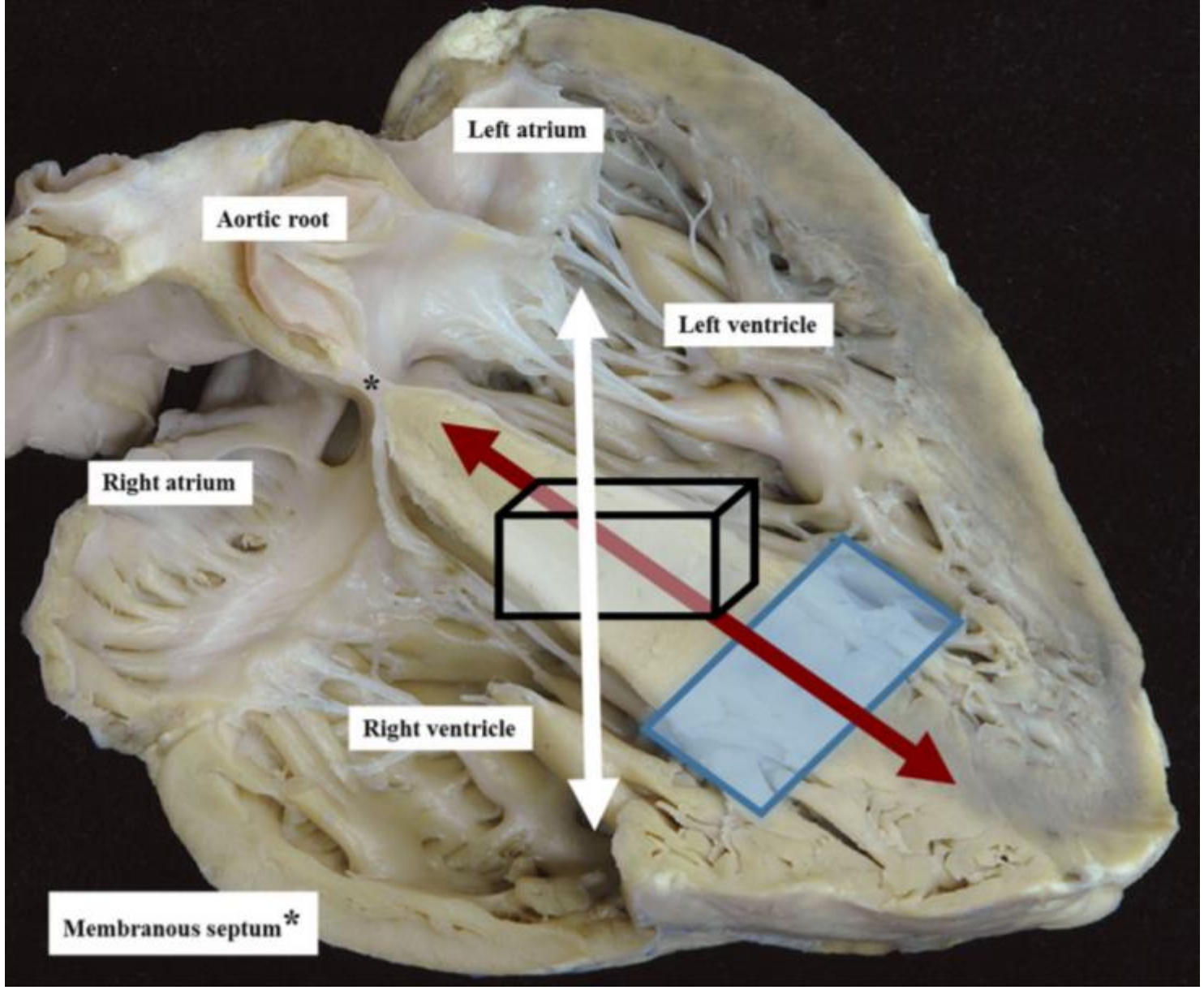


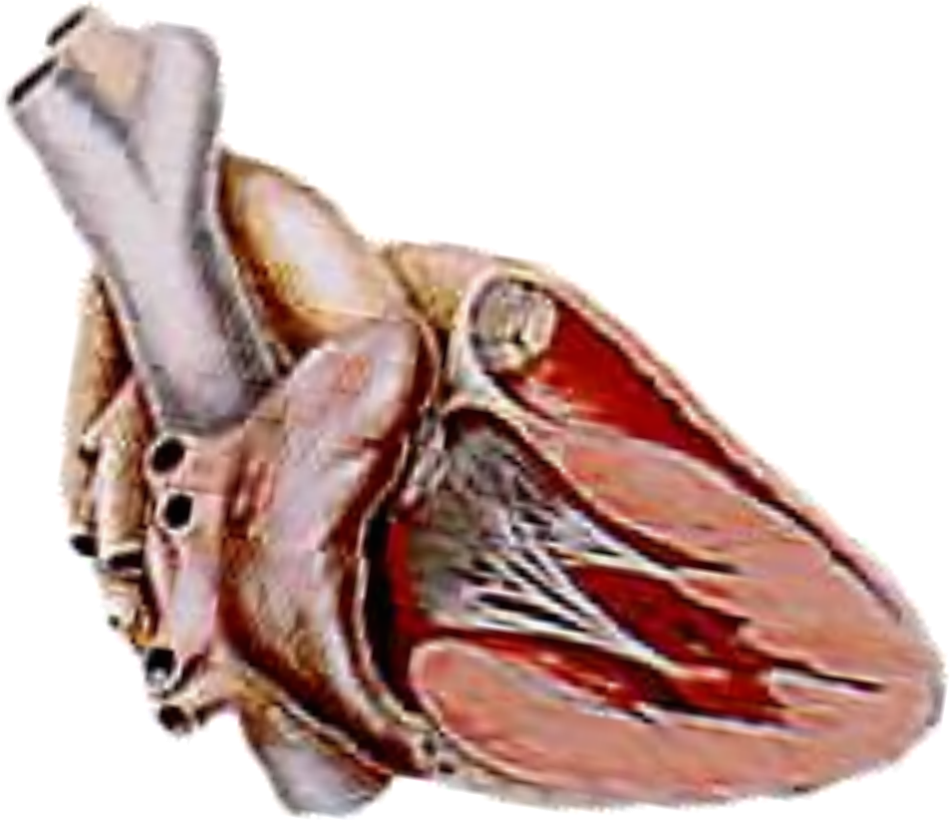


The left panel shows the heart in its ‘‘Valentine’’ position, with the long axis of the left ventricle and its defining points (dashed line) and a short axis (dotted line). In the right panel, we have positioned the heart in attitudinally appropriate fashion, showing the angulation of the ventricular axes relative to the axes of the body.

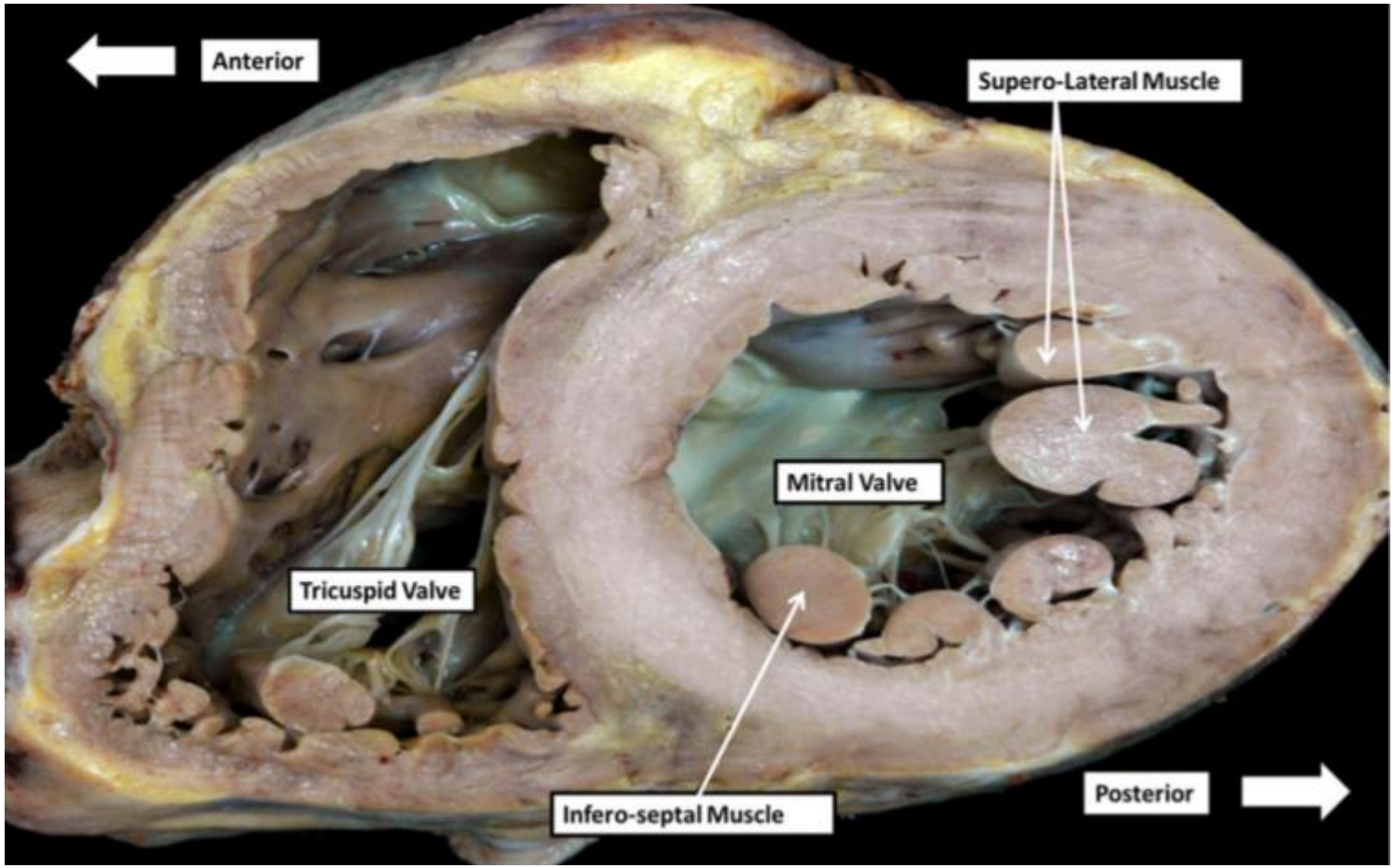


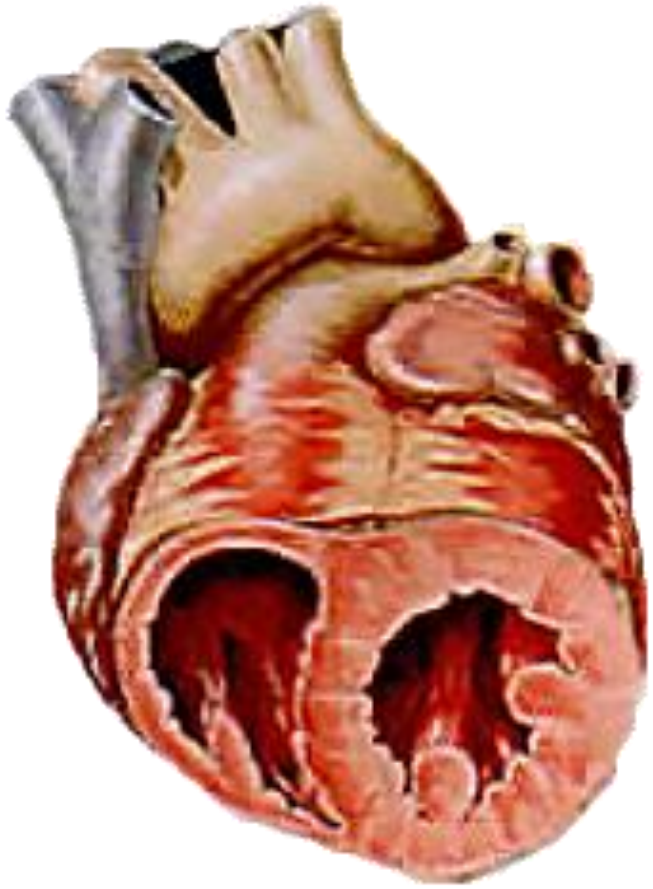
The image shows the location of the heart as it normally lies within the thorax, with the key features labeled as seen from the front, in the setting of the "Anatomical Position." Note the marked skew between the long axis of the heart (double headed red arrow) and the long axis of the body (double white headed arrow). [Color figure can be viewed at wileyonlinelibrary.com] de Almeida et al 2919.



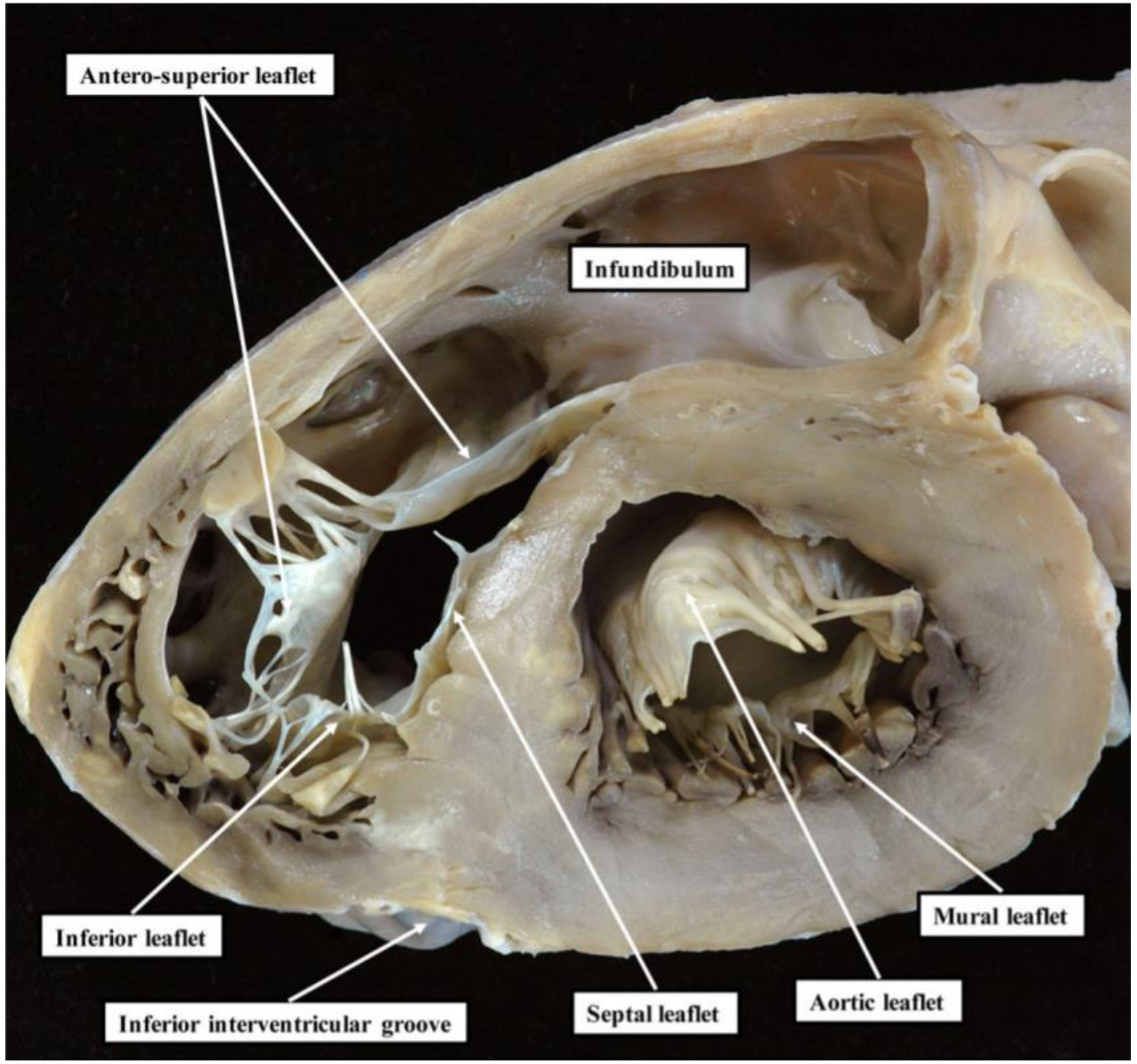


The image shows a “four chamber” cut taken through the heart as it would lie in its appropriate position within the thorax (see Fig. 1). Although the right ventricle is the anterior of the two ventricles, its inlet component is to the right of the left ventricle. [Color figure can be viewed at wileyonlinelibrary.com] de Almeida et al 2019



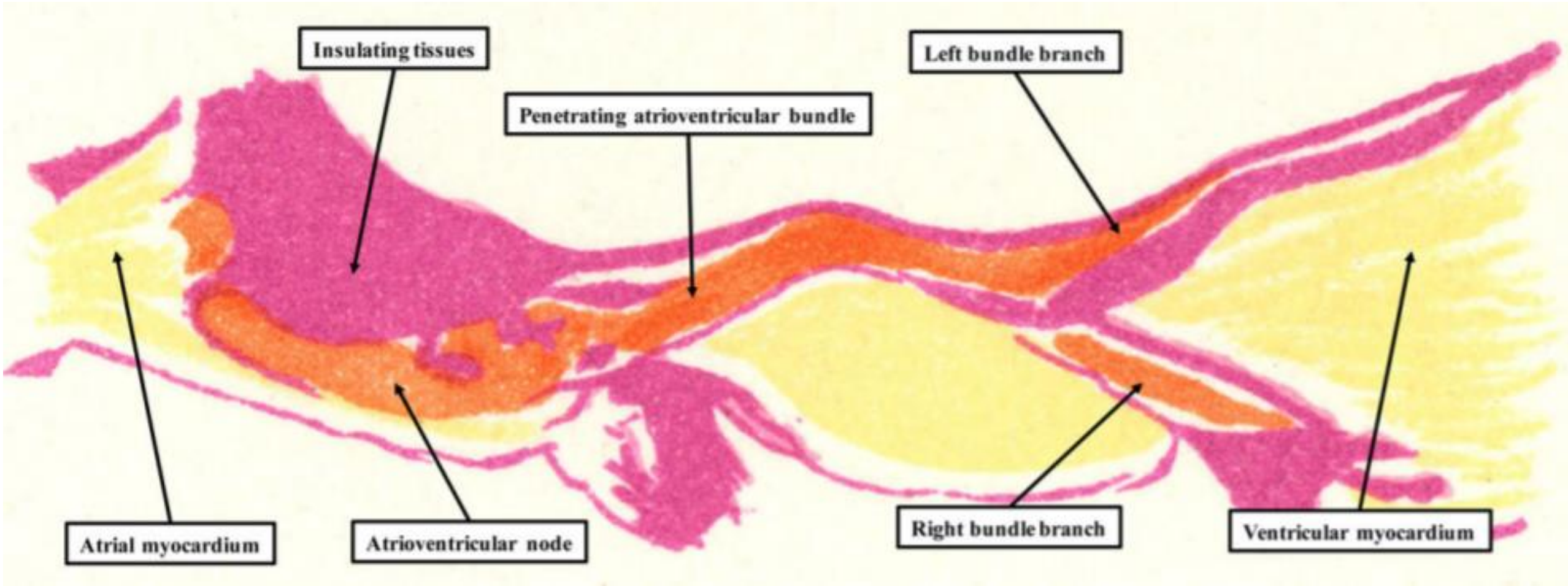


The images show a short axis cut across the ventricular cone orientated to replicate the left anterior oblique view obtained by clinicians using angiography. The sternal surface of the ventricular cone is anterior, while the wall seen to the right hand of the observer is posteriorly located. The papillary muscles of the mitral valve are located infero-septally and supero-laterally, and not “postero-medially” and “antero-laterally” as they are currently described in all anatomic textbooks bar one. [Color figure can be viewed at wileyonlinelibrary.com] de Almeida et al 2019



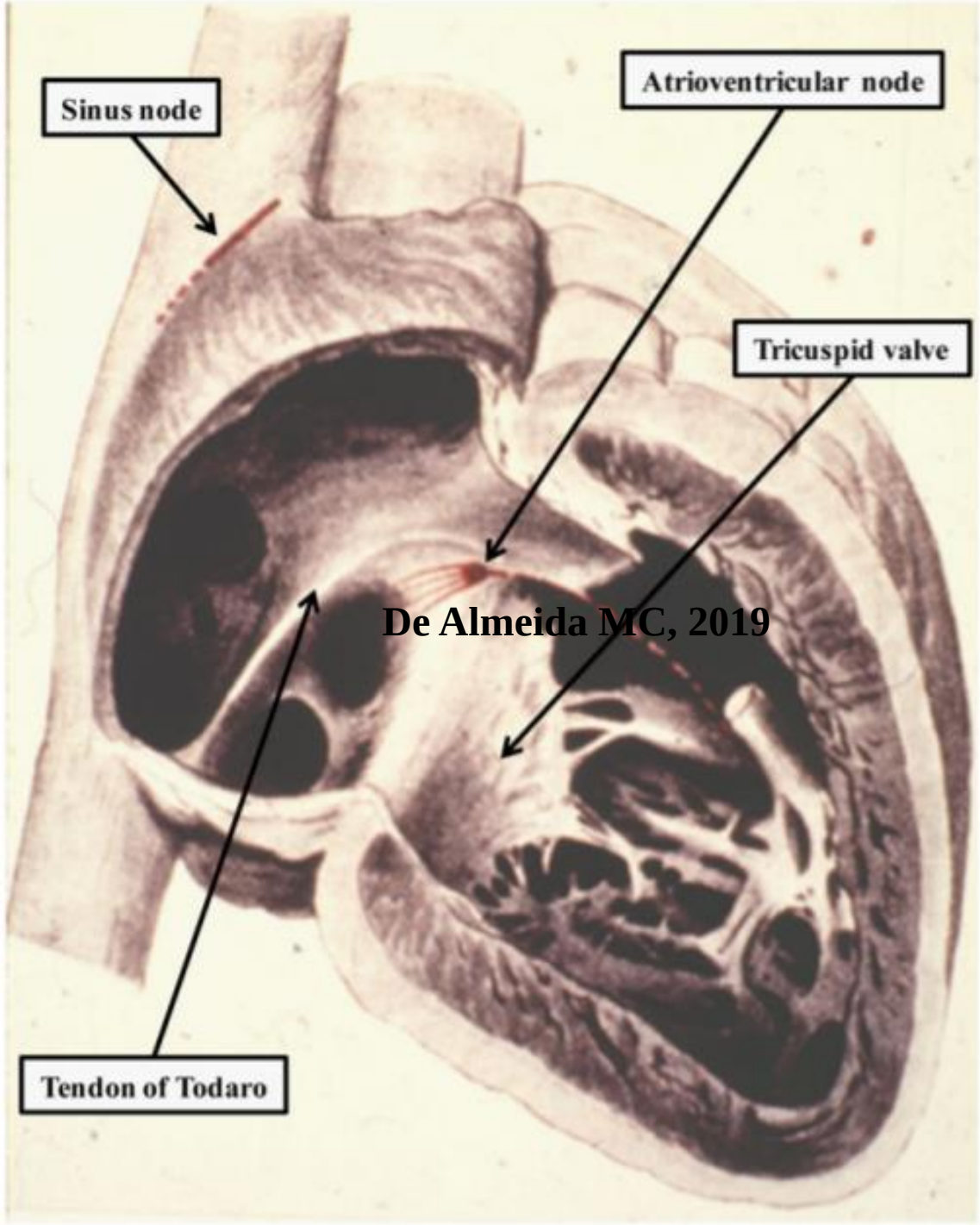
De Almeida MC, 2019

The image shows another short axis cut of the ventricular cone orientated so as to replicate the left anterior oblique angiographic projection. As can be seen, the leaflet of the tricuspid valve guarding the diaphragmatic surface is located inferiorly, and not “posteriorly” as described in all current anatomic textbooks bar one. Note also the location of the inferior atrioventricular groove. The artery found within this groove is similarly inferior, rather than “posterior.”



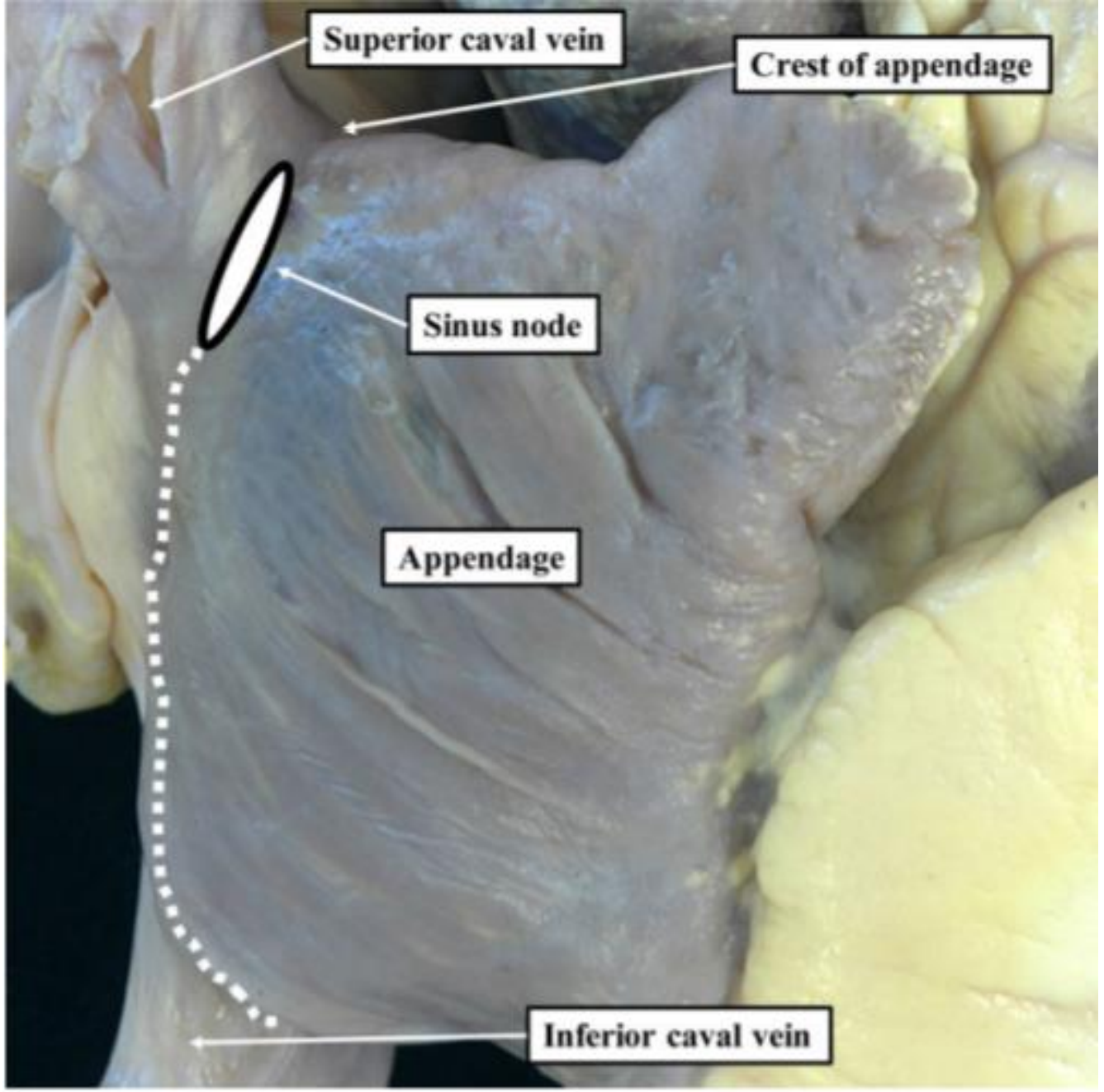
De Almeida MC, 2019

The drawing from the original monograph of Tawara (1906) has been scanned and reorientated as close as possible in attitudinally appropriate fashion. It shows the accuracy with which Tawara identified the atrioventricular conduction axis, which is shown in orange, with purple showing the insulating components of the atrioventricular junctions. [Color figure can be viewed at wileyonlinelibrary.com]



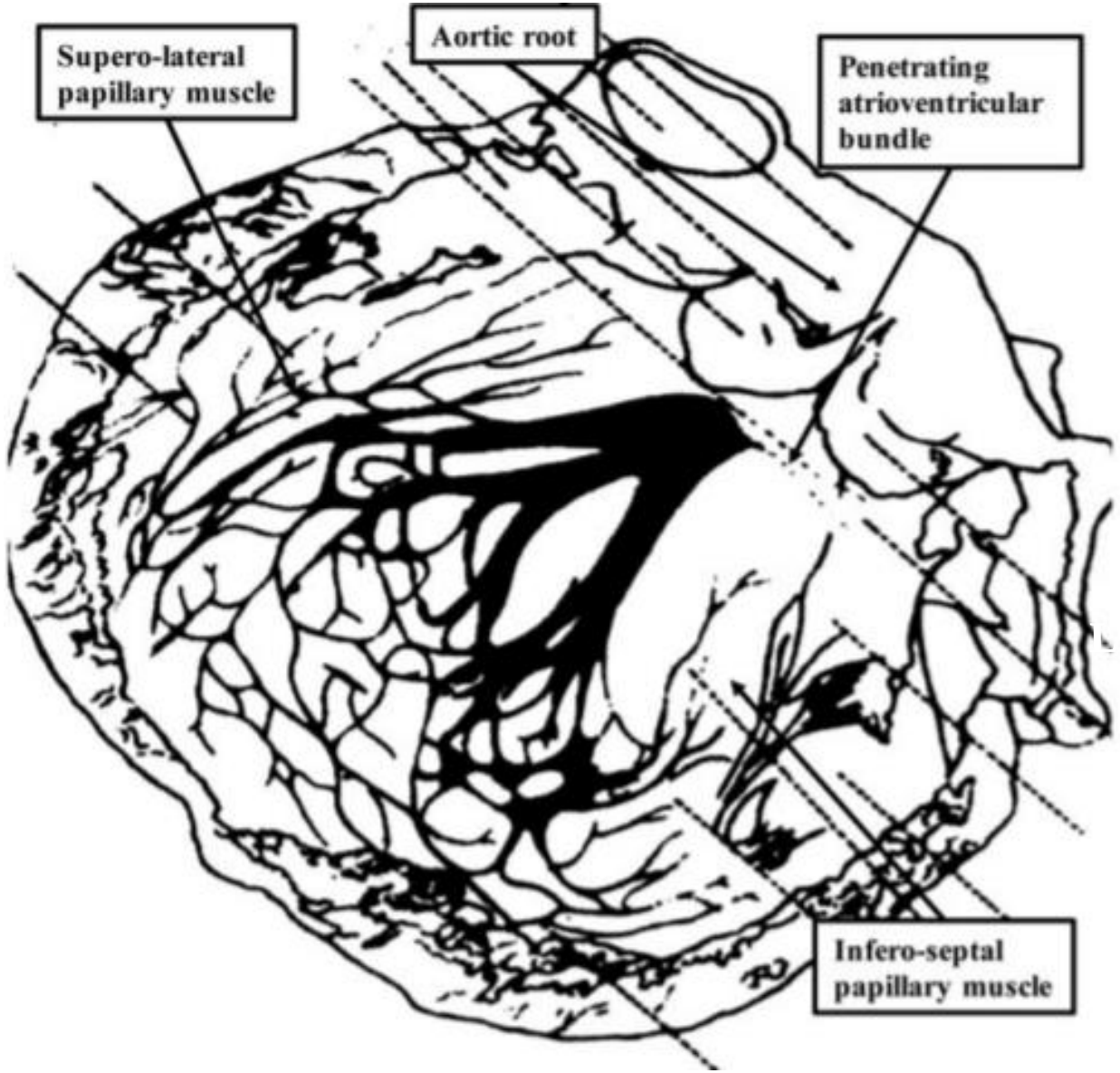
The drawing made by Koch in 1907 to show the location of the sinus and atrioventricular nodes is drawn in attitudinally appropriate fashion. It also shows the location of the triangle that now bears his name. [Color figure can be viewed at wileyonlinelibrary.com

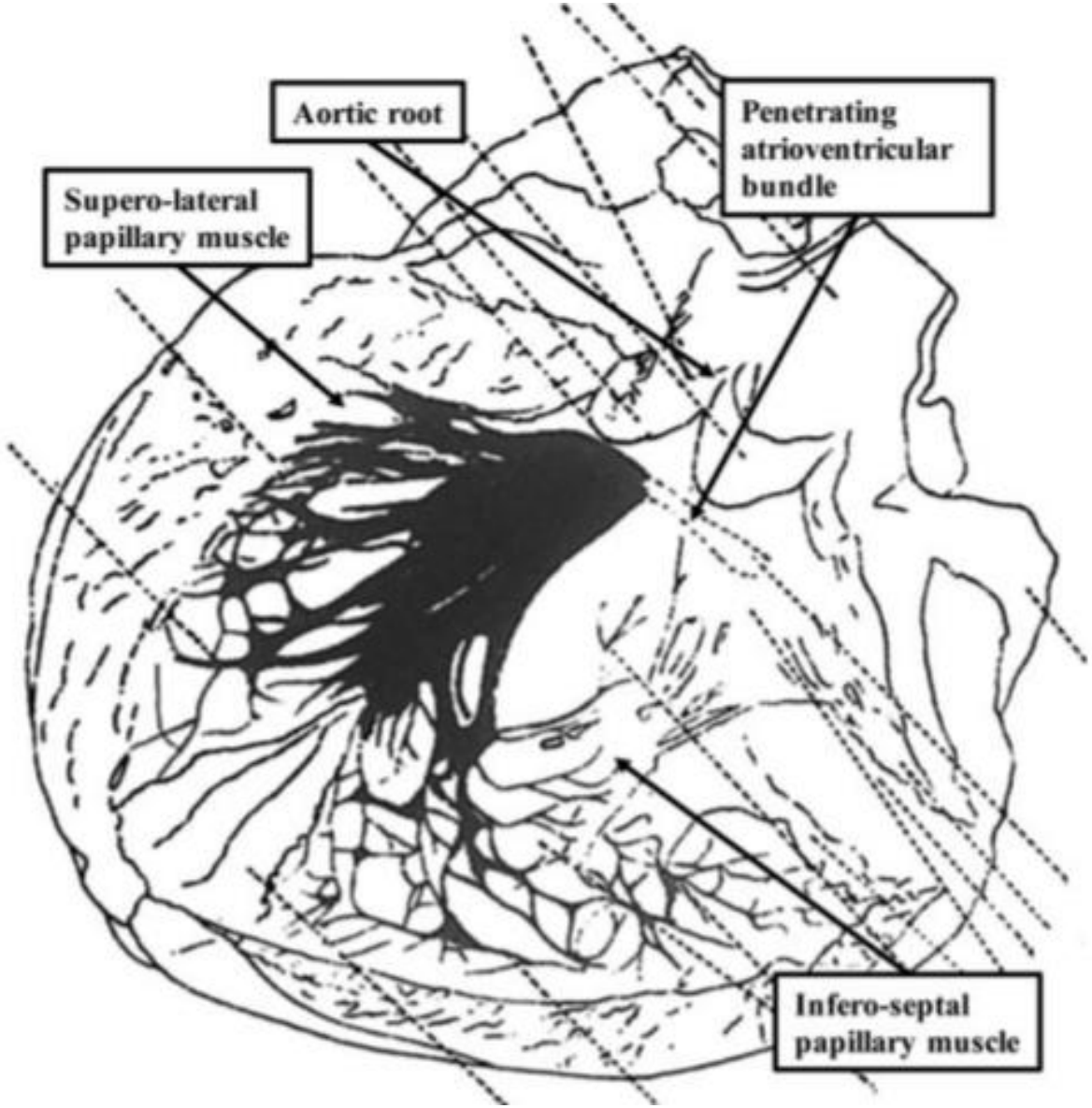
De Almeida MC, 2019



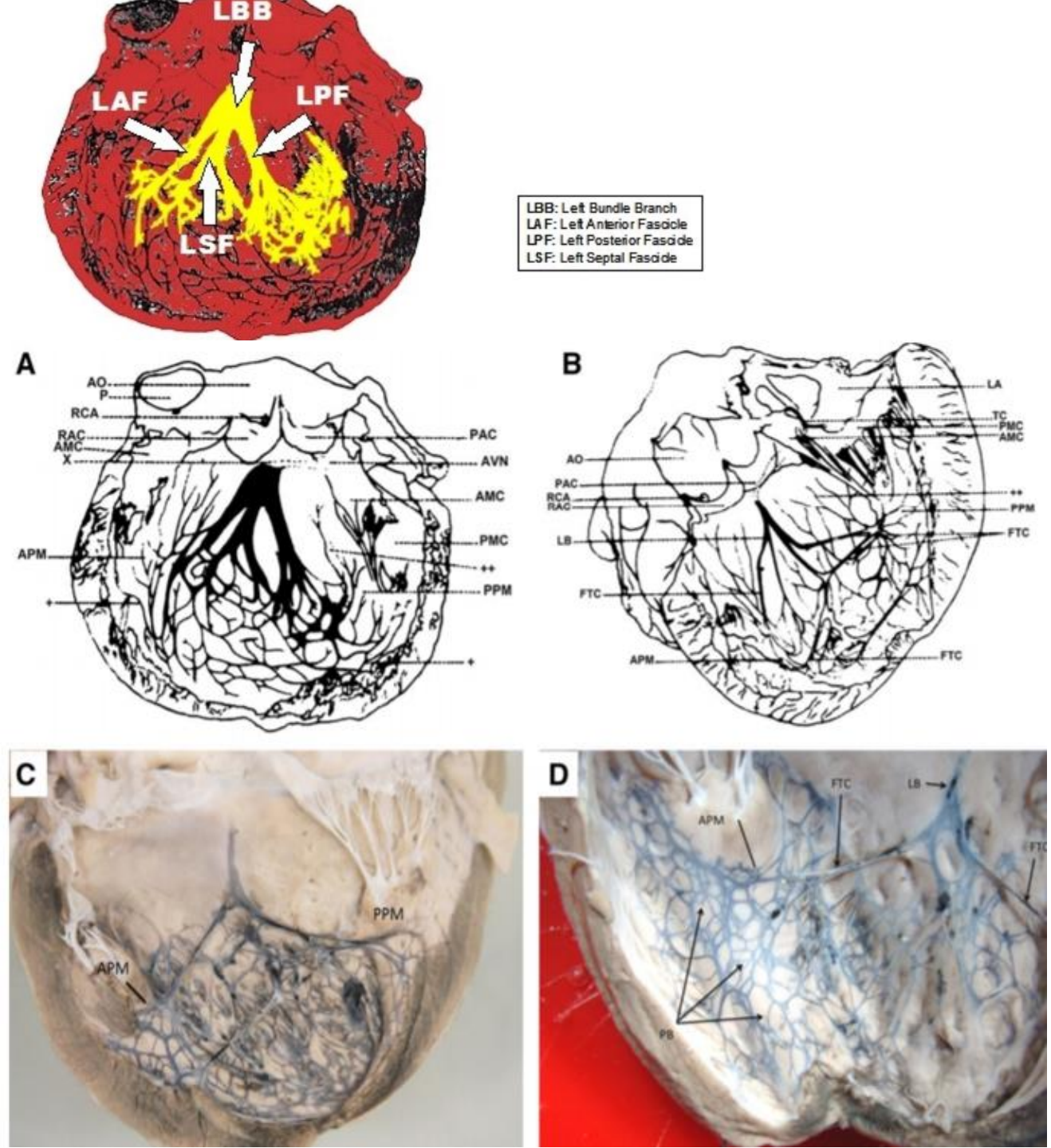
De Almeida MC, 2019

The image shows the parietal surface of the right atrium photographed in attitudinally appropriate fashion. The white area within the black outline shows the usual location of the sinus node. [Color figure can be viewed at wileyonlinelibrary.com]

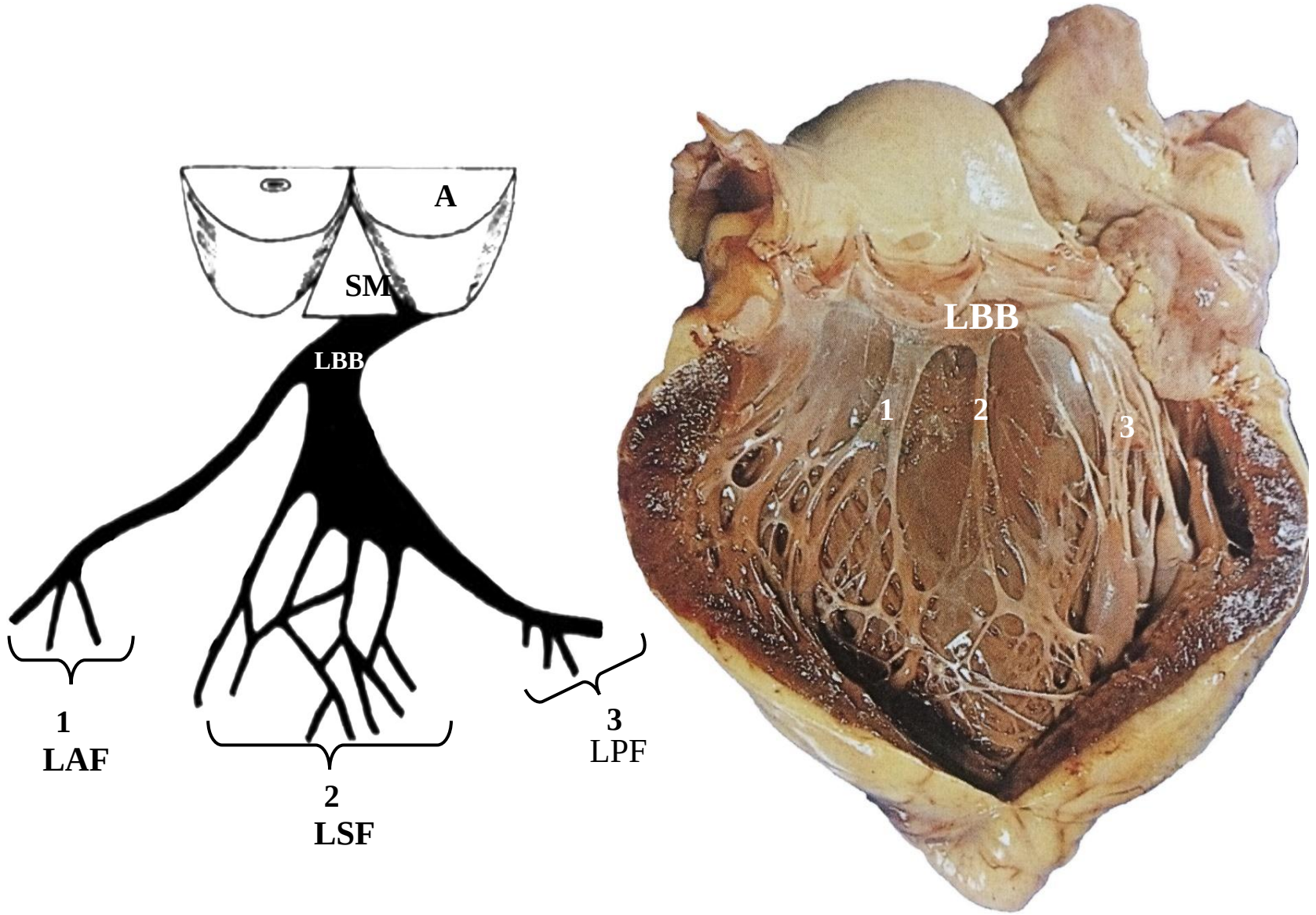




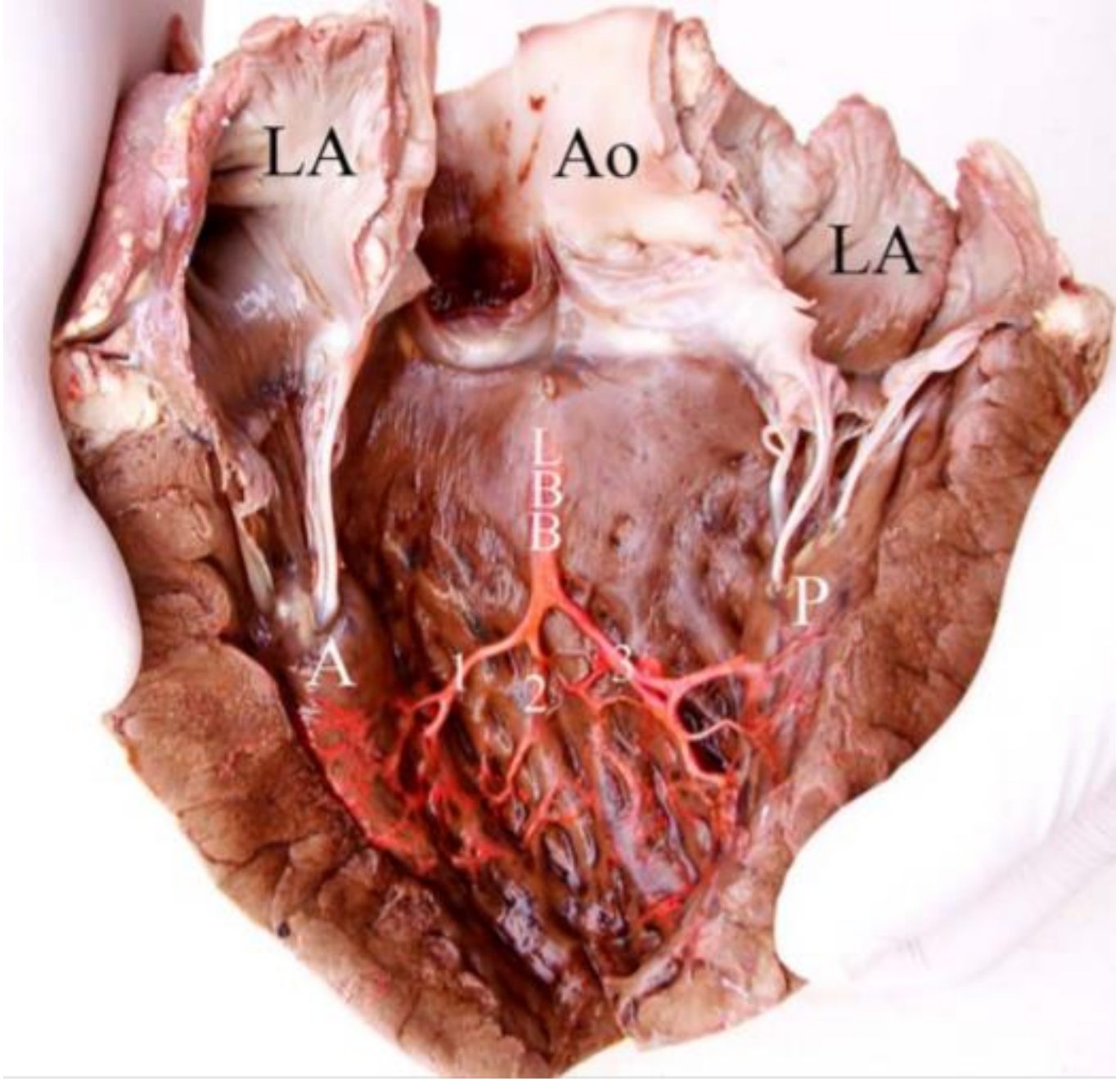
The drawings are taken from the original monograph of Tawara (1906). They show the variation in the manner of branching of the left bundle branch in two human hearts. De Almeida MC, 2019



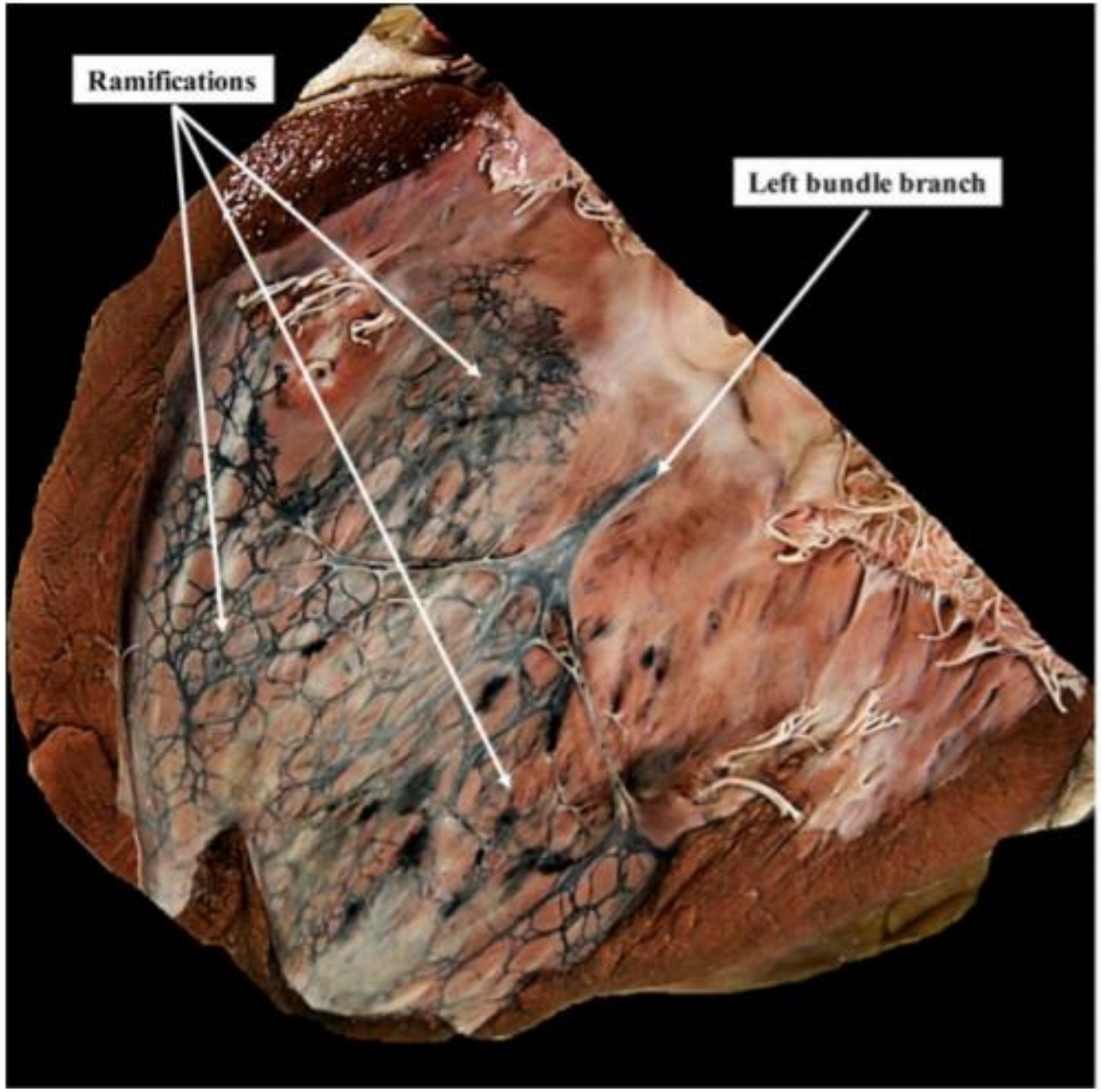
1 a Tawara's representation of the opened human heart showing the left bundle branch with its characteristic three main divisions and associated Purkinje network (Tawara 1906). AO Aorta, P pulmonary artery, RCA right coronary artery, RAC right coronary cusp of the aortic valve, PAC posterior cusp of the aortic valve, APM anterior papillary muscle, PPM posterior papillary muscle, AMC anterior cusp of the mitral valve, PMC posterior cusp of the mitral valve, AVN atrioventricular node, X bifurcation site of the His bundle into the left and right bundle branches, single cross ramifications of the Purkinje network, double crosses a 2-cm-long false Chordae tendineae carrying Purkinje fibers from the tip of the posterior papillary muscle to the upper posterior portion of the ventricular septum. b Tawara's representation of the bovine heart showing the left bundle branch and its main divisions with the associated Purkinje network (Tawara 1906). Abbreviations as in a, TC chordae tendineae for the mitral valve, LA left atrium, LB left bundle branch of the connecting system, FTC false Chordae tendineae leading divisions of the left bundle branch to the anterior and posterior papillary muscles, double crosses terminal ramification of the Purkinje going backwards toward the base of the left ventricle. c Photograph of the left bundle branch and its main divisions with associated Purkinje network in an ovine heart injected with India ink. APM Anterior papillary muscle, PPM posterior papillary muscle. d Photograph of the left bundle branch and its main divisions with associated Purkinje network in an India ink injected bovine heart. APM Anterior papillary muscle, FTC false Chordae tendineae, LB left bundle, PB perforating rami, PPM posterior papillary muscle. The network pattern is particularly evident on the APM. Bars c 1 cm, d 2 cm

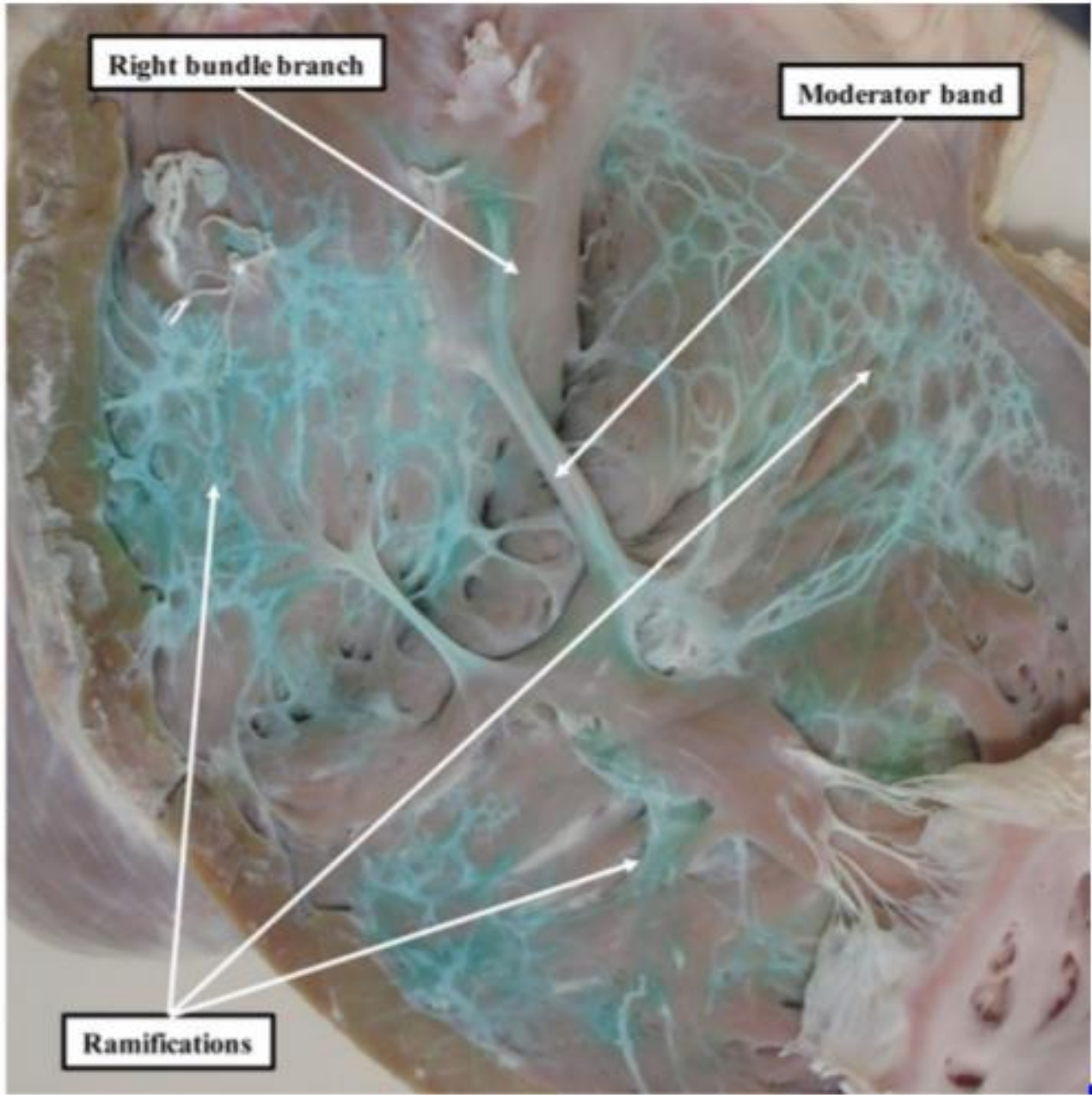


LBB: Left Bundle Branco.; LAF: Left Anterior Fascicle.; LSF: Left Septal Fascicle.; LPF: Left Posterior Fascicle



Bos mutus left ventricle injected ABS solutions, showing the left bundle branch (LBB) gave off three branches (slight corrosion). 1, anterior branch; 2, middle branch; 3, posterior branch; A, anterior papillary muscle; P, posterior papillary muscle; LA, left atrium; Ao, aorta

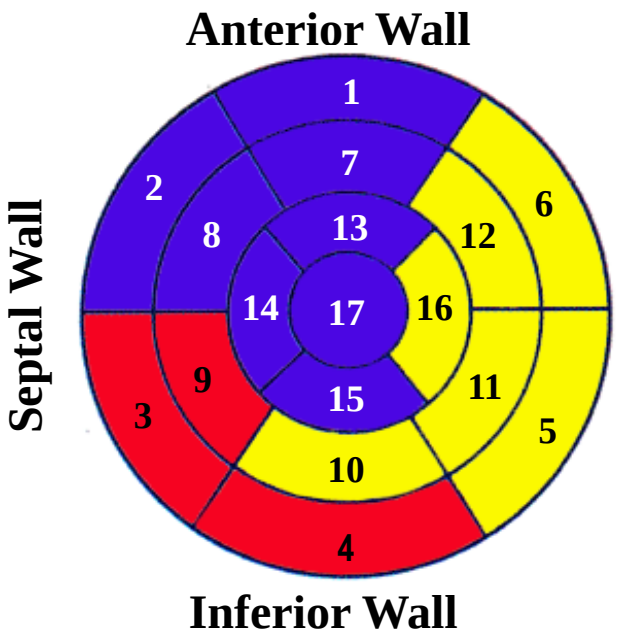


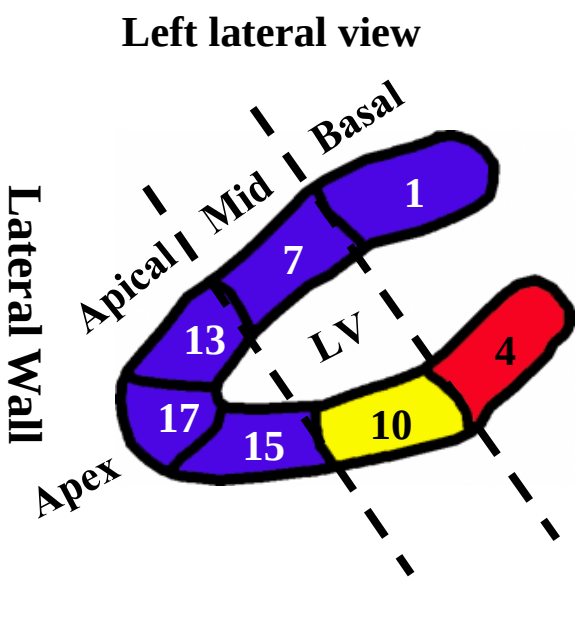


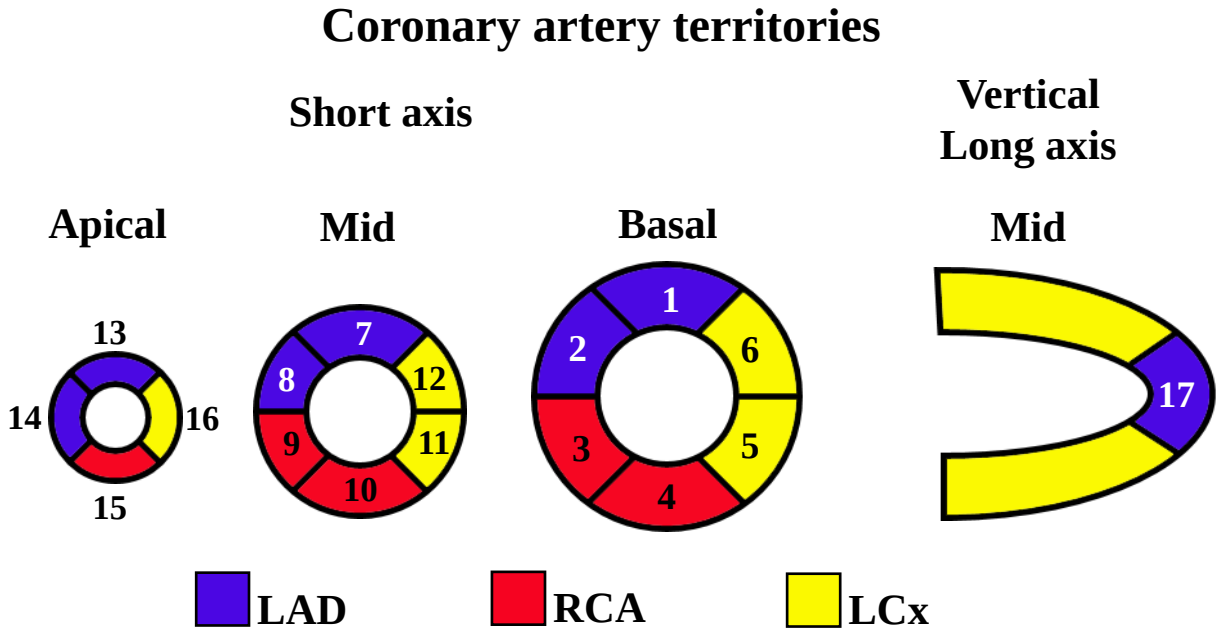
The images show the ramifications of the bundle branches in the left (left hand panel) and right (right hand panel) ventricles of the bovine heart subsequent to injection of colored inks into the sheaths insulating the specialized cardiomyocytes.

Ventricular segmentation heart walls with Contrast-Enhanced Cardiovascular Magnetic Resonance (CE-CMR)

Polar map short axis in "bull's-eye"



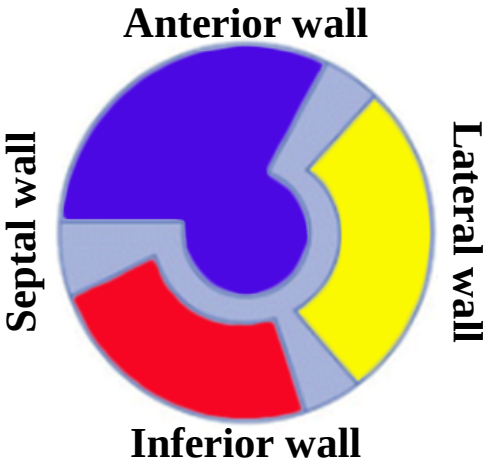




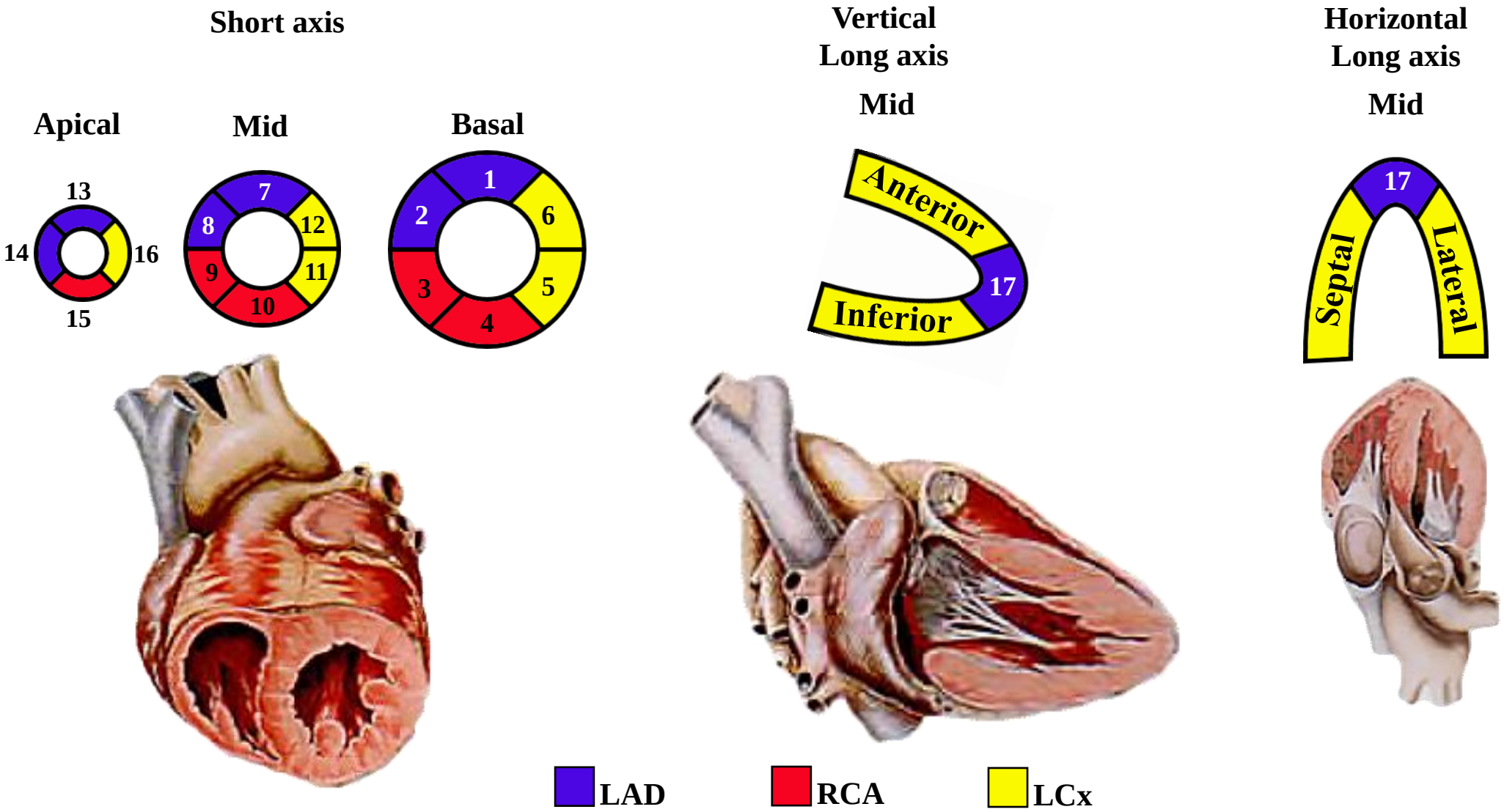
17 myocardial segments and the recommended nomenclature for tomographic imaging of the heart. Data from the individual short-axis tomograms can be combined to create a polar map plot, representing a 2D compilation of all the 3D short-axis perfusion data. Standard nomenclature for the 17 segments is outlined.

1. Basal anterior
2. Basal anteroseptal
3. Basal inferoseptal
4. Basal inferior
5. Basal inforolateral
6. Basal anterolateral
7. Mid anterior
8. Mid anteroseptal
9. Mid inferoseptal
10. Mid inferior
11. Mid inferolateral
12. Mid anterolateral
13. Apical anterior
14. Apical septal
15. Apical inferior
16. Apical lateral
17. Apex

The 17 myocardial segments to the territories of the LAD, RCA, and LCx. The 2D compilation of perfusion data can then easily be assigned to specific vascular territories.

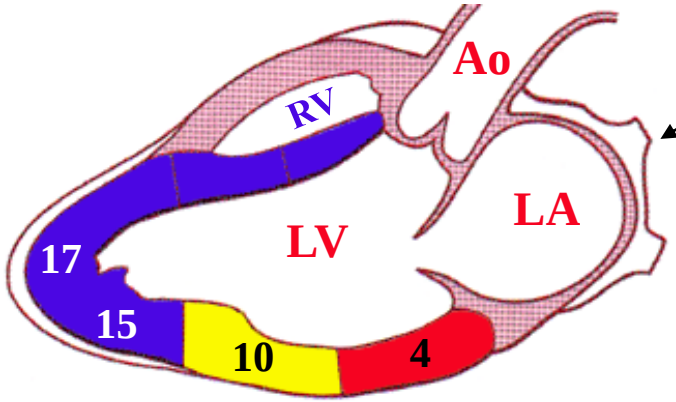


Coronary artery territories

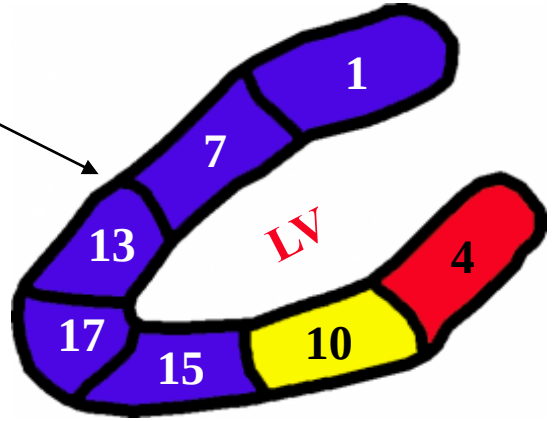


Cerqueira MD, Weissman NJ, Dilsizian V, Jacobs AK, Kaul S, Laskey WK, Pennell DJ, Rumberger JA, Ryan T, Verani MS; American Heart Association Writing Group on Myocardial Segmentation and Registration for Cardiac Imaging. Standardized myocardial segmentation and nomenclature for tomographic imaging of the heart. A statement for healthcare professionals from the Cardiac Imaging Committee of the Council on Clinical Cardiology of the American Heart Association. Circulation. 2002 Jan 29;105(4):539-42.

Left Ventricle myocardial segmentation, standard standard 17-segment model, and vascular territories

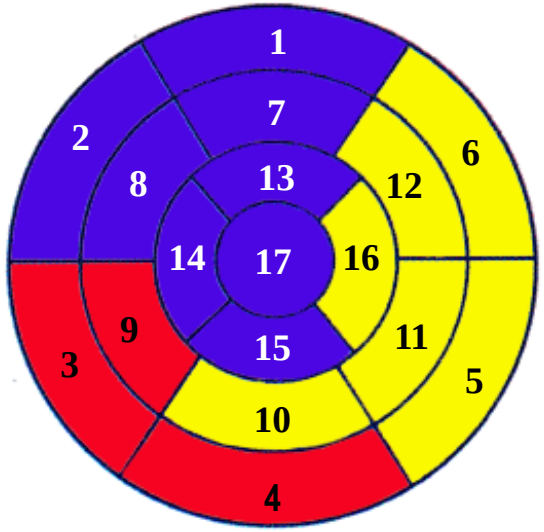


Longitudinal paraesternal



Bulls eye (apical short axis)

Anterior Wall

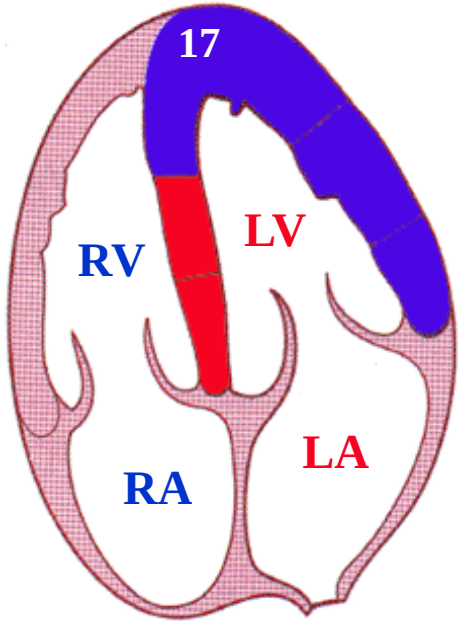


Septal Wall

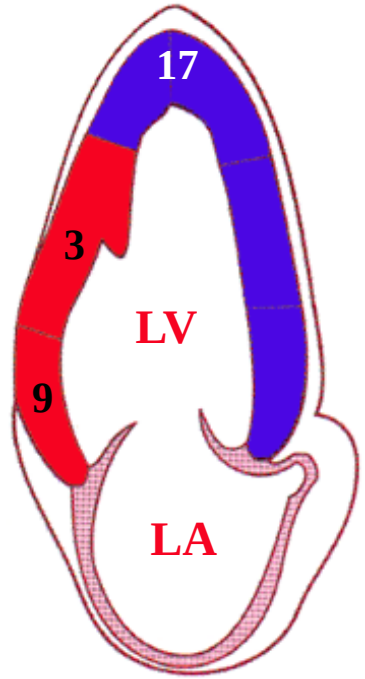
Lateral Wall

Inferior Wall

Apical four chambers



Apical two chambers

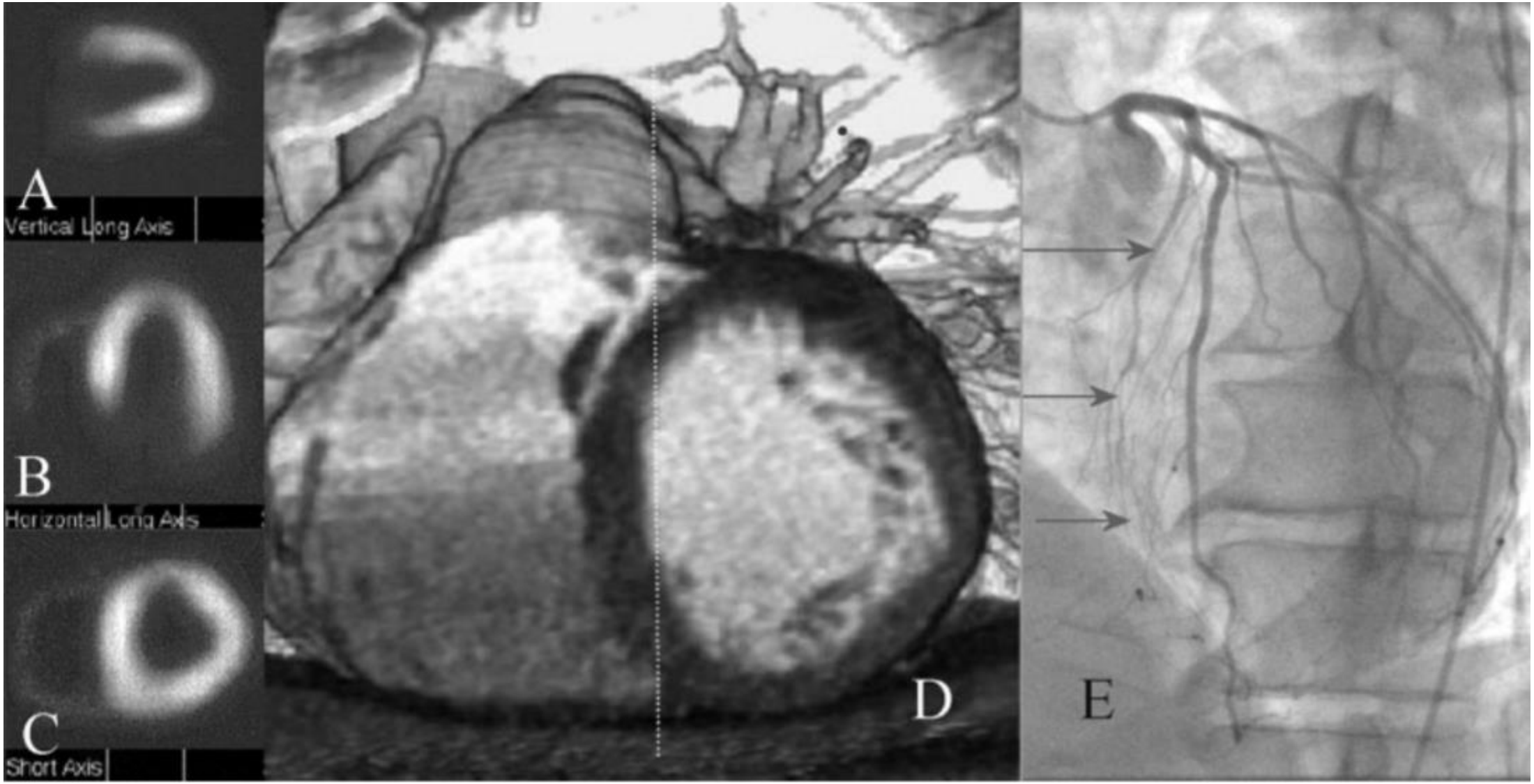


Left Anterior Descending (LAD)

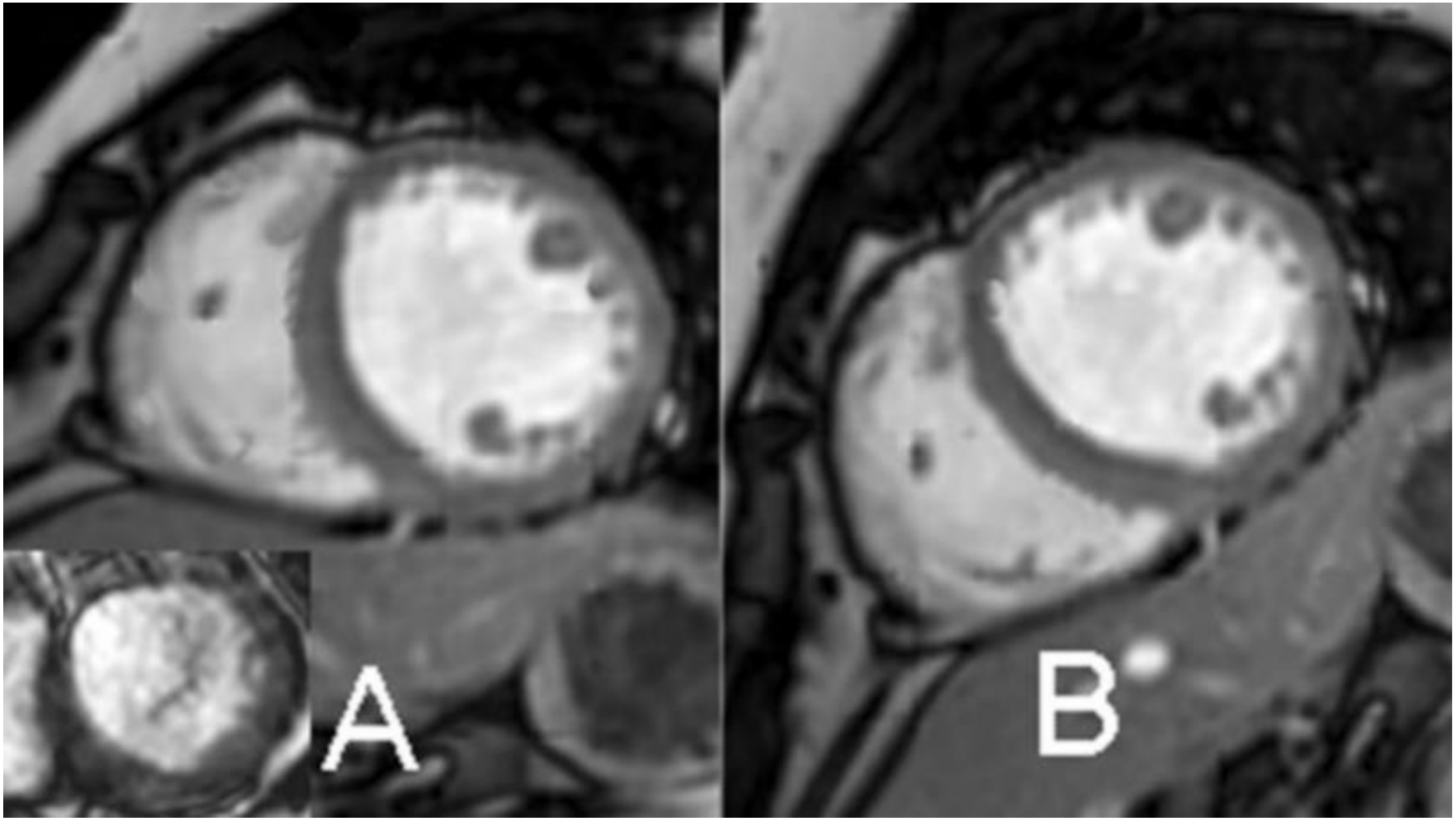
Left Circunflex (LCx)

Posterior Descending (RCA or LCx)

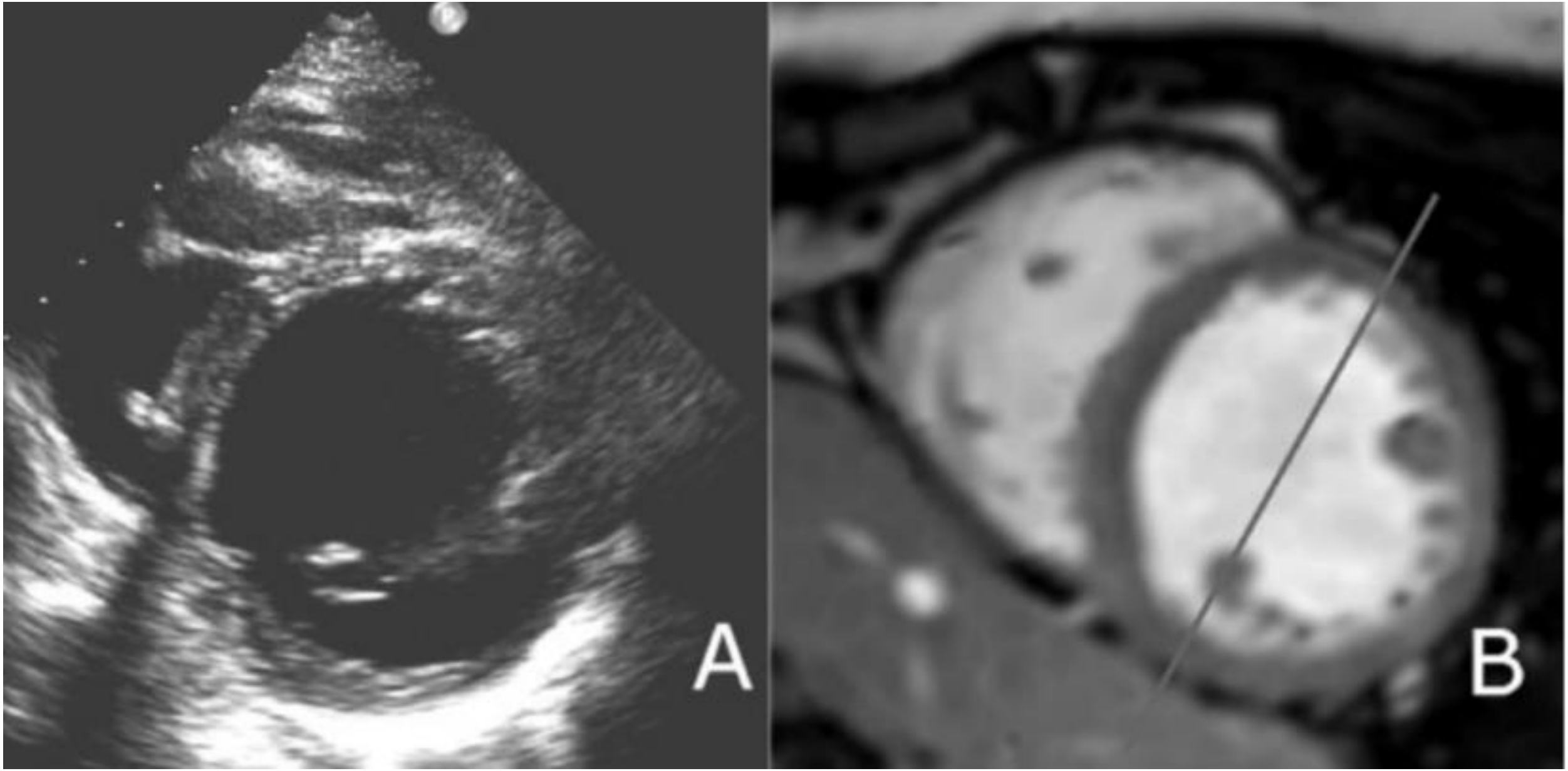
The apex is analyzed separately, usually from a vertical long-axis slice.



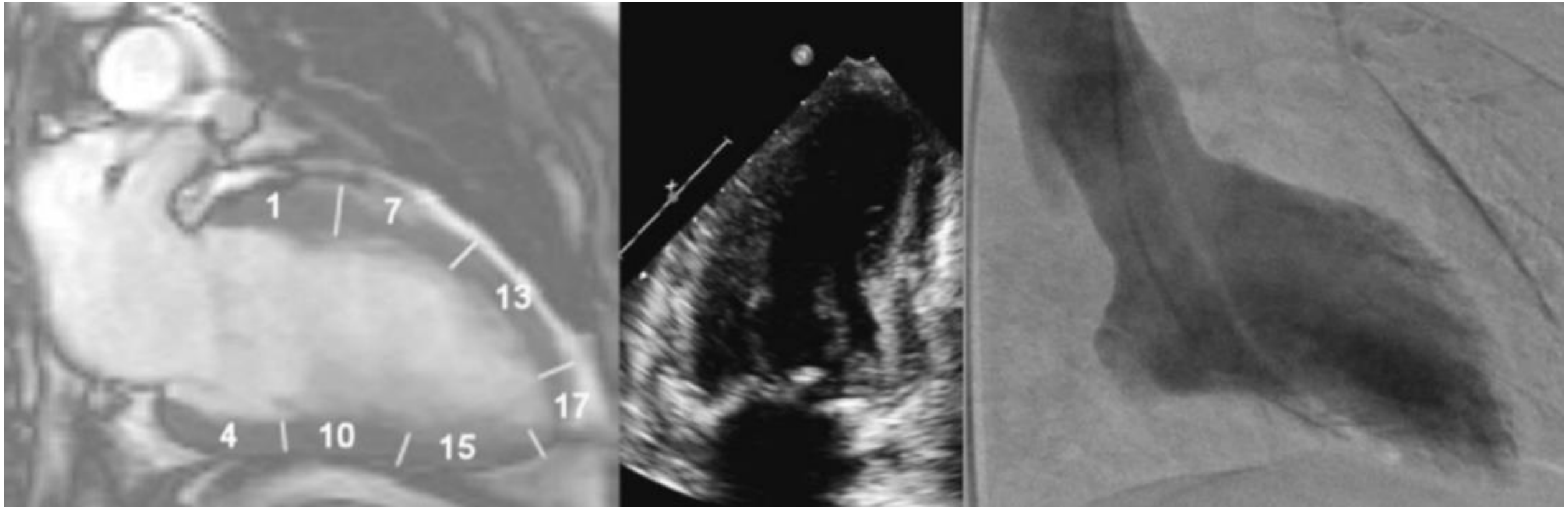
These clinical images show the orientation of the septum. In the vertical long axis (A), horizontal long axis (B), and short axis (C) views as obtained with nuclear imaging, and in the short axis computerized tomographic scan (D), the septum is vertically oriented (dotted line). The left anterior oblique selective coronary angiogram is shown in Panel E, with the septal vessels arrowed, confirming that the septum is parallel to the spine.



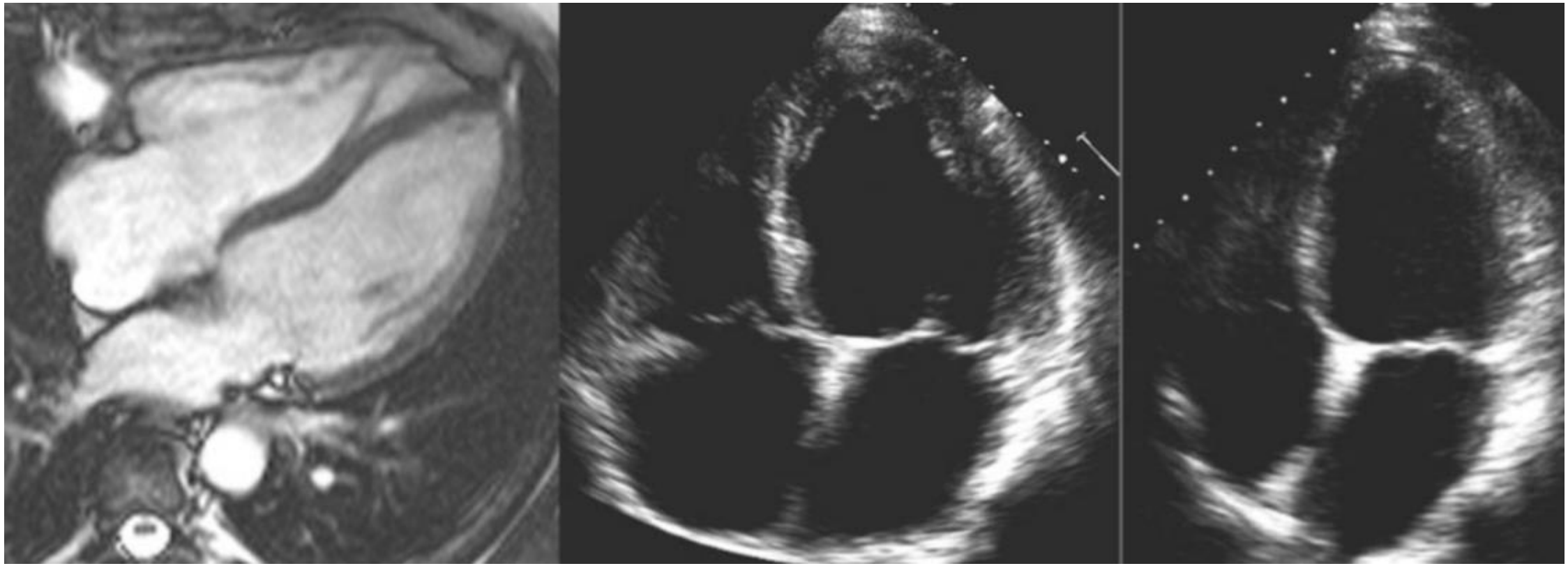
In (A) we show a magnetic resonance short axis in correct orientation. The inset shows the zone of apposition between the leaflets of the mitral valve in their closed position. In Panel B, the same image is rotated.



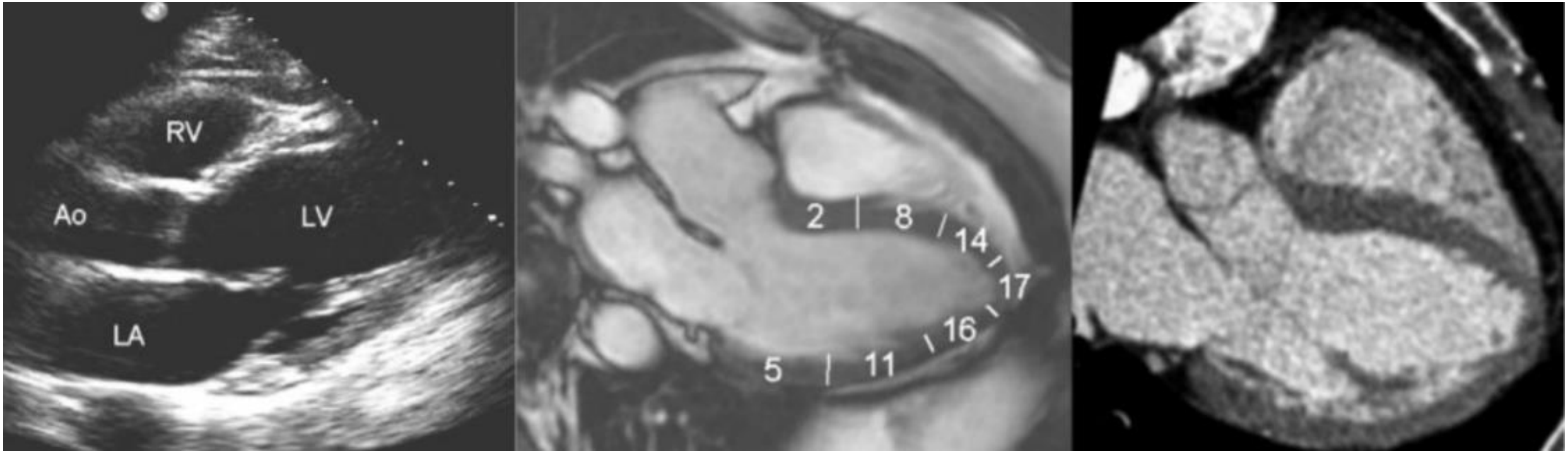
An echocardiographic short axis view (A) is in its usual display position, and (B) is a magnetic resonance image seen in short axis and rotated to the same orientation. The grey line is the plane of the vertical long axis.



The left panel shows the vertical long axis image, with its segmental pattern, as obtained using magnetic resonance imaging. The middle panel shows the apical two chamber echocardiographic view, while the right panel shows a left ventricular angiogram in right anterior oblique projection.



These panels show to the left, the transvalvar four chamber view as obtained using magnetic resonance imaging, in the middle the echocardiographic transvalvar four chamber view, and to the right, the echocardiographic segmental four chamber view. The echocardiographic views are shown in conventional fashion, with the apex of the sector to the top. As can be seen, it would be better to rotate these images through 908 in clockwise fashion so as to produce better correlation with the magnetic resonance image.



These images show, to the left, the echocardiographic parasternal long axis view, in the middle the view of the left ventricular outflow tract obtained using magnetic resonance imaging, with superimposition of the segmental pattern, and to the right the comparable view of the outflow tract obtained with computerized tomography.

1. Bayés de Luna A, Wagner G, Birnbaum Y, Nikus K, Fiol M, Gorgels A, et al. A new terminology for left ventricular walls and location of myocardial infarcts that present Q wave based on the standard of cardiac magnetic resonance imaging: A statement for healthcare professionals from a committee appointed by the International Soci. Circulation. 2006;114(16):1755–60.
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3. Bayes de Luna A, Wagner G, Birnbaum Y, Nikus K, Fiol M, Gorgels A, et al. A new terminology for left ventricular walls and location of myocardial infarcts that present Q wave based on the standard of cardiac magnetic resonance imaging: a statement for healthcare professionals from a committee appointed by the International Soc. Circulation. United States; 2006 Oct;114(16):1755–60.
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7. Goldwasser D, Senthilkumar A, Bayés de Luna A, Elosua R, Carreras F, Pons-Llado G, Kim RJ. Lateral MI Explains the Presence of Prominent R Wave (R ≥ S) in V1. Ann Noninvasive Electrocardiol. 2015 Nov;20(6):570-7. doi: 10.1111/anec.12260.
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9. D Duan et al. J Morphol 278 (7), 975-986. Jul 2017.Morphological Study of the Atrioventricular Conduction System and Purkinje Fibers in Yak J Morphol 278 (7), 975-986. Jul 2017