

Pericardium MDCT anatomy - "Around the heart"

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Learning objectives

To know the normal anatomy of the pericardium, with special focus on their sinuses and recesses.

To describe the imaging characteristics of multidetector computed tomography (MDCT) of the normal pericardium.

To review some imaging features of the normal pericardium that can simulate pathological conditions of the mediastinum, and how to distinguish them on MDCT imaging.

Background

The cardiac and pericardial structures are usually readily demonstrated with CT, even if chest CT is performed for evaluation of noncardiac structures.

Development of faster scanning techniques, cardiac gating, and advanced post processing software has improved the visualization of more anatomic details of the heart and pericardium. As MDCT resolution has improved, the pericardial recesses can be identified as defined anatomical structures in a larger amount of scans.

Knowing and understanding the anatomy and normal variations of the pericardium is essential to distinguish normal from pathological findings. All radiologists who perform chest imaging need to be familiar with the appearances of both the normal pericardium and common pathologies. Thin-section computed tomography (CT) or image reformatting in nonaxial planes has shown to be very helpful in some cases.

The pericardium encloses the heart and the great vessels origin, and consists of two layers (visceral and parietal).

The fibrous parietal layer has attachments to the diaphragm, sternum, and costal cartilage. The serous visceral layer is a thin mesothelial layer adjacent to the heart's surface. Between these two layers, there is a virtual cavity - the pericardial cavity, which normally contains a small amount of clear fluid (15-50ml), which forms a protective layer around the heart, acting as a barrier against local inflammation and limiting its movement within the mediastinum. The serous fluid is distributed mostly over the atrioventricular and interventricular grooves and is often seen, particularly within the pericardial recesses.

The reflection lines of the serous pericardium between the great vessels at the base of the heart are arranged around two complex connected tubes: the transverse and oblique sinuses, and include other several smaller recesses (Fig. 1 on page 4). These are not separated compartments but extensions of the pericardial cavity.

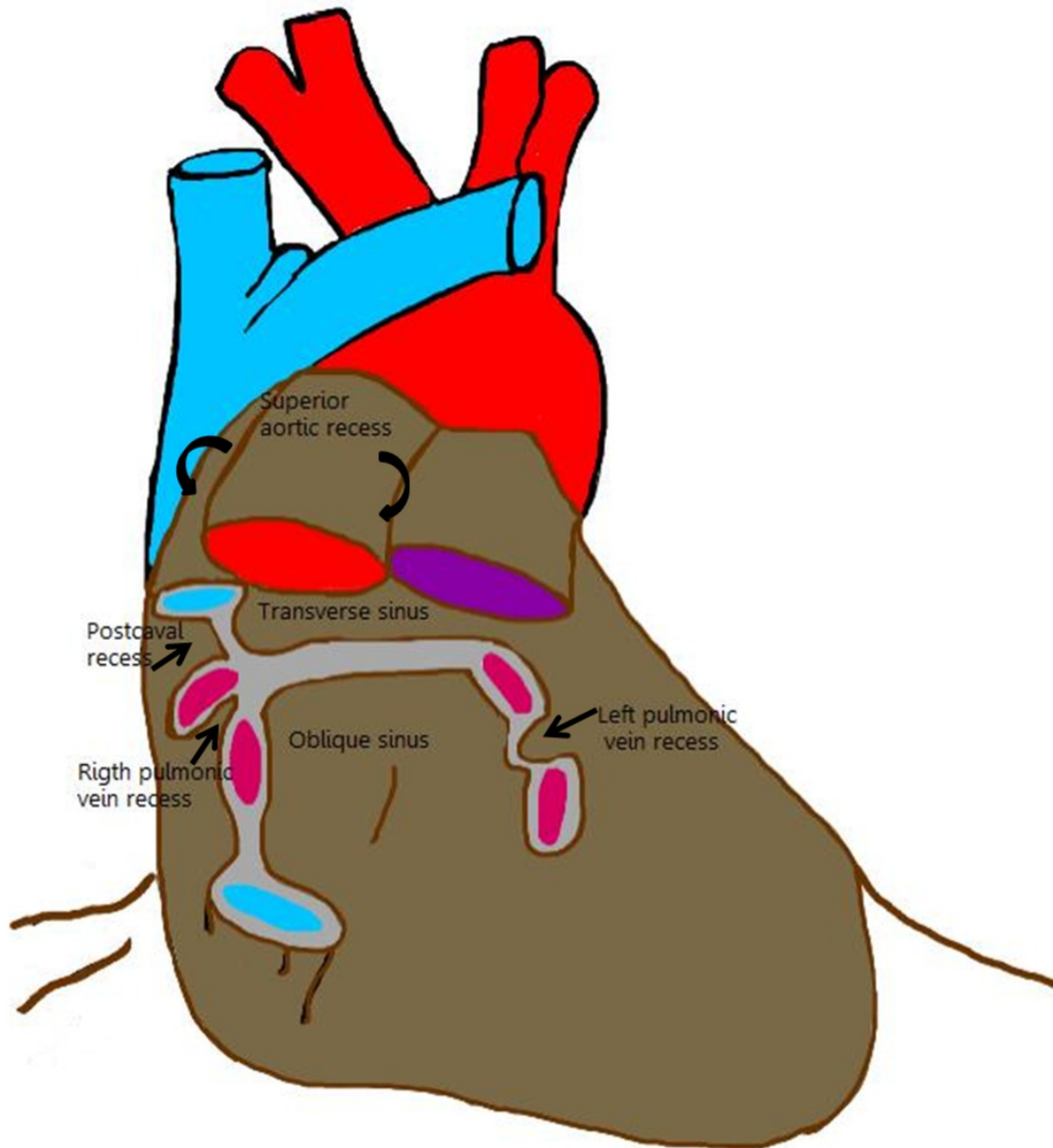


Fig. 1: Schematic draw showing the normal pericardial anatomy.

References: Radiologia, Hospital Geral, Centro Hospitalar e Universitário de Coimbra - Coimbra/PT

These sinuses have a reserve function and may strategically accumulate fluid in the presence of increased fluid content, thus creating pocketlike structures (the so-called pericardial reserve volume).

Images for this section:

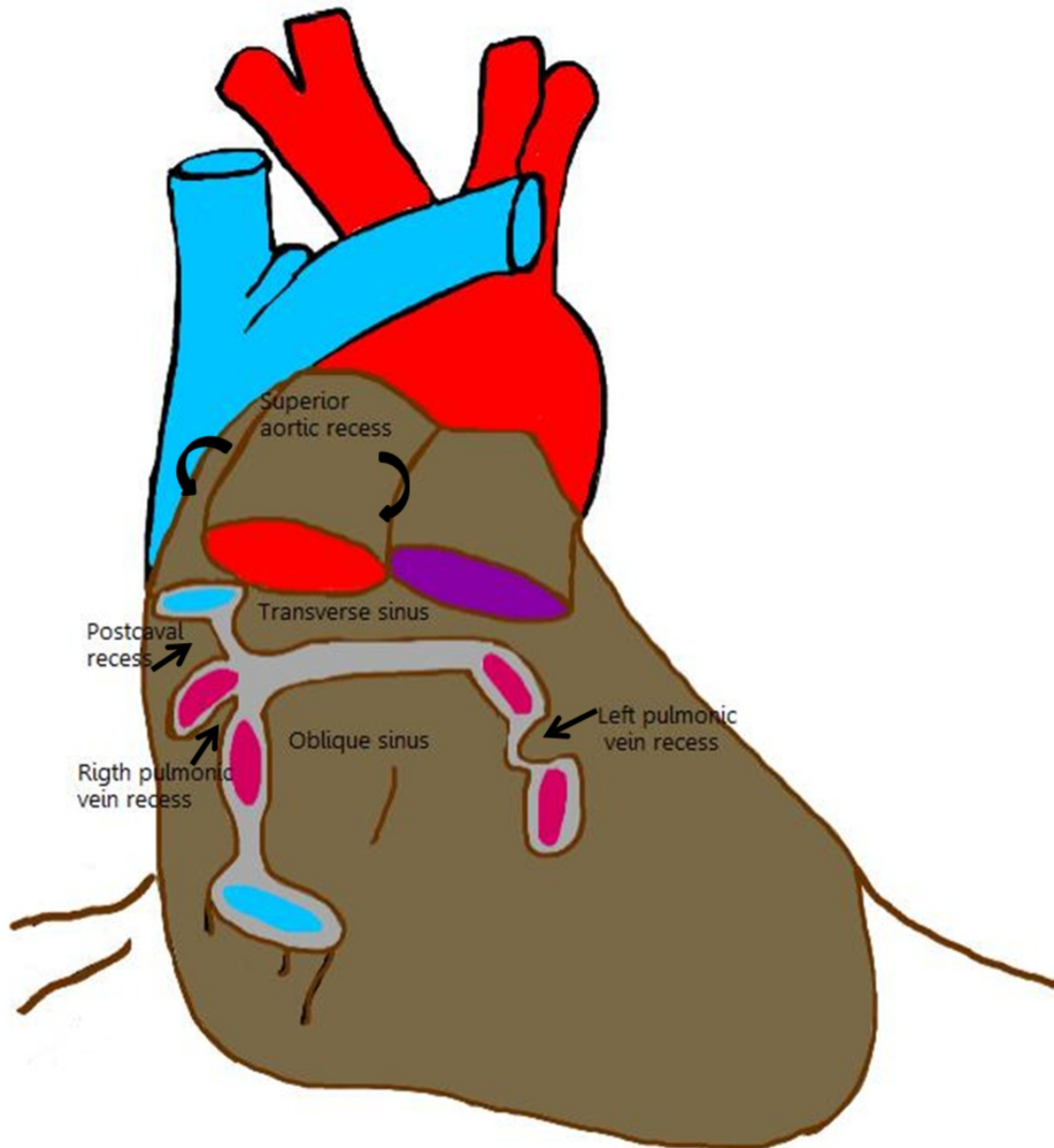


Fig. 1: Schematic draw showing the normal pericardial anatomy.

Findings and procedure details

The normal pericardium is seen as a very thin linear density surrounding the heart, typically, the pericardium is best visualized along the right ventricle, and often not visualized over the left ventricle because of a sparseness of epicardial fat and the vicinity of pulmonary parenchyma (Fig. 2 on page 18).

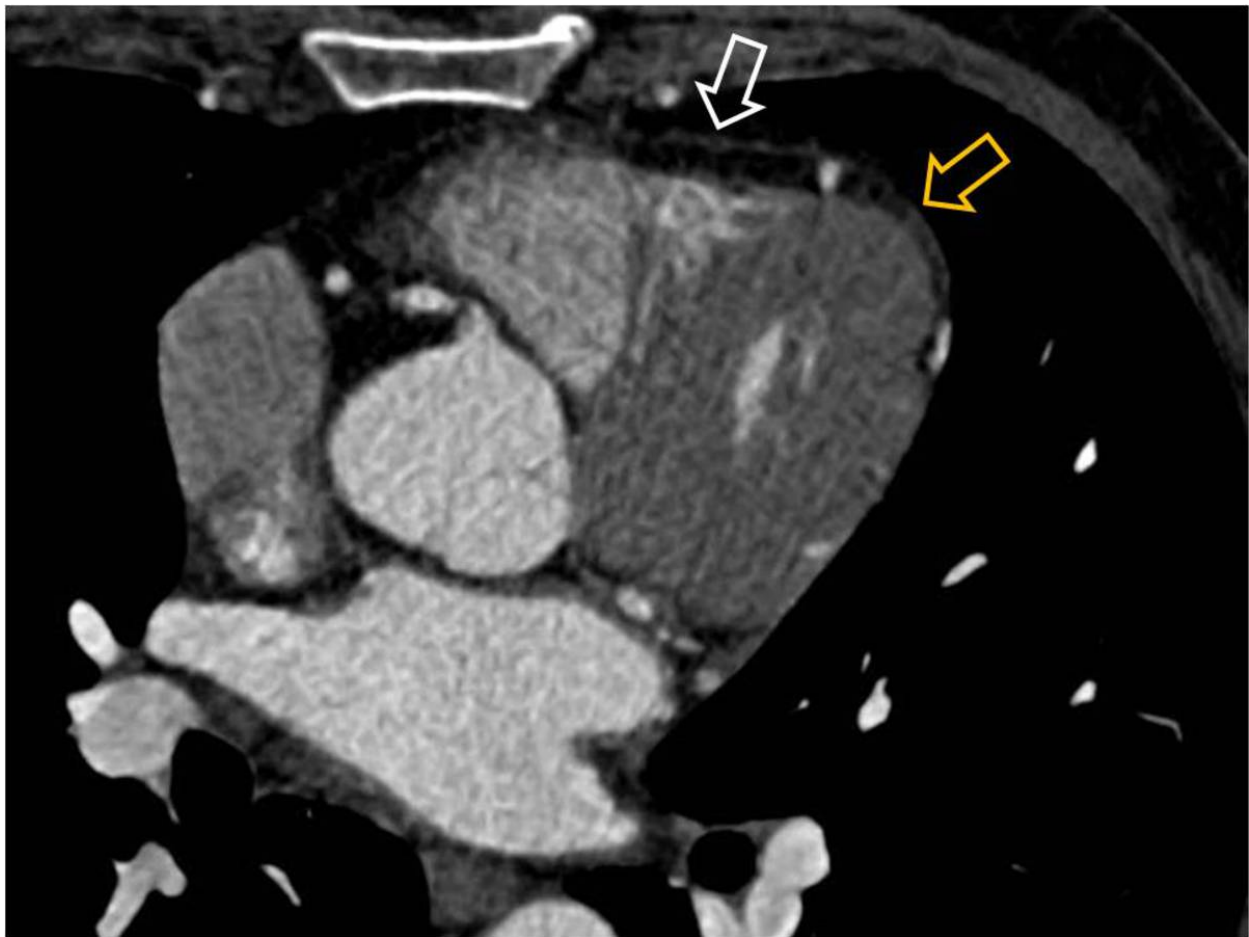


Fig. 2: Axial CT image showing the normal appearance of the pericardium and how it is best visualized along the RV (white arrow), and often not visualized over the left ventricle (orange arrow) because of a sparseness of epicardial fat and the vicinity of pulmonary parenchyma.

References: Radiologia, Hospital Geral, Centro Hospitalar e Universitário de Coimbra - Coimbra/PT

Normal pericardial thickness ranges from 0.7 to 2.0 mm on CT images. These values slightly overestimate those obtained in anatomic cadaveric studies (0.4-1.0mm) .

Differences can be explained by the intrinsically limited spatial and temporal resolutions of CT, which do not allow one to fully discriminate between pericardial layers and fluid component. It can be difficult to differentiate fluid from thickened pericardium in MDCT imaging and MR imaging is usually superior.

Discrimination of the pericardium from the myocardium requires the presence of epicardial fat or pericardial fluid. The higher-attenuation is distinguished in relation to the low-attenuation mediastinal fat anteriorly and epicardial fat posteriorly. Epicardial fat normally increases with age, and is common to find excessive fat accumulation in older, obese, diabetic, or patients with steroid excess.

The outer layer, the fibrous pericardium, is attached internally to the epicardium and extends cranially above level of the aortic root. Moreover, this layer is continuous with the deep cervical fascia and is attached to the sternum and the diaphragm by loose ligaments that impede cardiac displacement in the mediastinum.

Pericardial sinuses and recesses can be identified as areas of water attenuation around the great mediastinal vessels. Most recesses are linear when not filled with fluid and bandshaped as the fluid content increases. However, they may also present as crescent, triangle, spindle, ovoid, hemisphere, or irregular shapes.

Pericardial recesses are commonly described as lymph nodes, but they can also simulate other conditions, including aortic pathology. To distinguish pericardial sinuses and recesses some basic criteria may be useful:

- Sharply outlined structures with uniform water-equivalent attenuation without walls or rims in the expected anatomic location of the pericardial sinuses and recesses ([Fig. 3](#) on page 18).

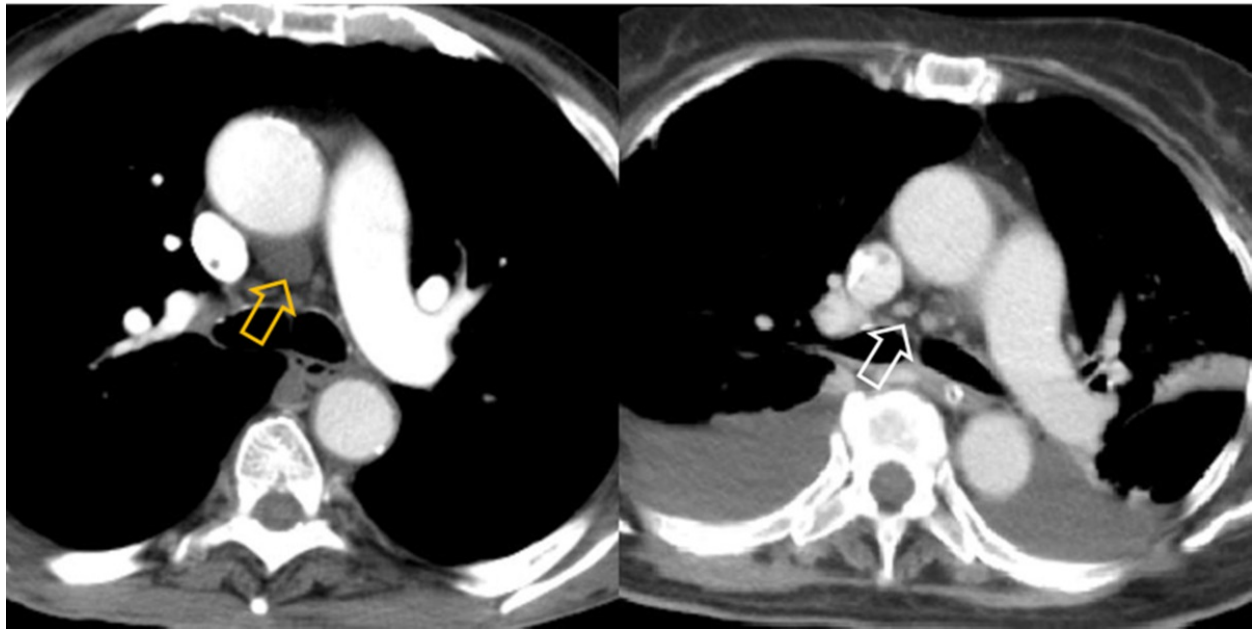


Fig. 3: Axial CT images showing the characteristic pericardial recesses: sharply outlined structures with uniform water-equivalent attenuation without walls or rims in the expected anatomic location (orange arrow) and enlarged lymph nodes with a more round shape with peripheral enhancement (white arrow).

References: Radiologia, Hospital Geral, Centro Hospitalar e Universitário de Coimbra - Coimbra/PT

They can be better identified and understood by subdividing them according to the part of the pericardial cavity from which they arise. The three main sites of origin are the transverse sinus, the oblique sinus and the pericardial cavity proper.

The recesses that are in direct continuation with the pericardial cavity are the right and left pulmonic vein and the retrocaval (or postcaval) recess. The superior and inferior aortic recesses and the right and left pulmonary artery recesses are related to the transverse sinus and the posterior pericardial recess, is a part of the oblique sinus ([Table 1](#) on page 19).

Related sinus/space	Recesses
Pericardial cavity proper	Right and left pulmonic vein recesses Postcaval recess
Transverse pericardial sinus	Superior aortic recess Right and left pulmonary artery recesses Inferior aortic recess
Oblique pericardial sinus	Posterior pericardial recess

Table 1: Division of the pericardial recesses according to the part of the pericardial cavity from which they arise.

References: Radiologia, Hospital Geral, Centro Hospitalar e Universitário de Coimbra - Coimbra/PT

In the following section each recess and possible pitfalls will be described in more detail

Pericardial cavity proper

Right and left pulmonic vein recesses

They are located between the superior and inferior pulmonary veins on both sides, where the pericardium is attached to the venous *adventitia*, projecting superiorly and medially, indenting the side walls of the oblique sinus ([Fig. 1](#) on page 19). They are usually small, with a diameter up to 1cm. At CT, the left pulmonic vein recess is identified more frequently than the right pulmonic vein recess, however, the latter is usually deeper than the former. As the pulmonary veins penetrate the fibrous pericardium to enter the left atrium, a serosal sleeve of pericardium invests the veins. At the level of the inferior pulmonary vein, pericardial fluid in the sleeve can be misinterpreted as adenopathy. Fluid in the sleeve can be seen anterior and posterior to the vein, whereas adenopathy typically occurs on one side of the vein and narrows the vein ([Fig. 4](#) on page 20).



Fig. 4: Axial CT image showing the pulmonic vein recesses. The left (orange arrow) is identified more frequently than the right pulmonic vein recess (white arrow), however, the latter is usually deeper than the former.

References: Radiologia, Hospital Geral, Centro Hospitalar e Universitário de Coimbra - Coimbra/PT

Postcaval recess

The postcaval recess is a diverticulum of the pericardial cavity proper, extends behind and along the right lateral aspect of the superior vena cava. It is bounded by the right pulmonary artery and the right superior pulmonary vein ([Fig. 5](#) on page 21).

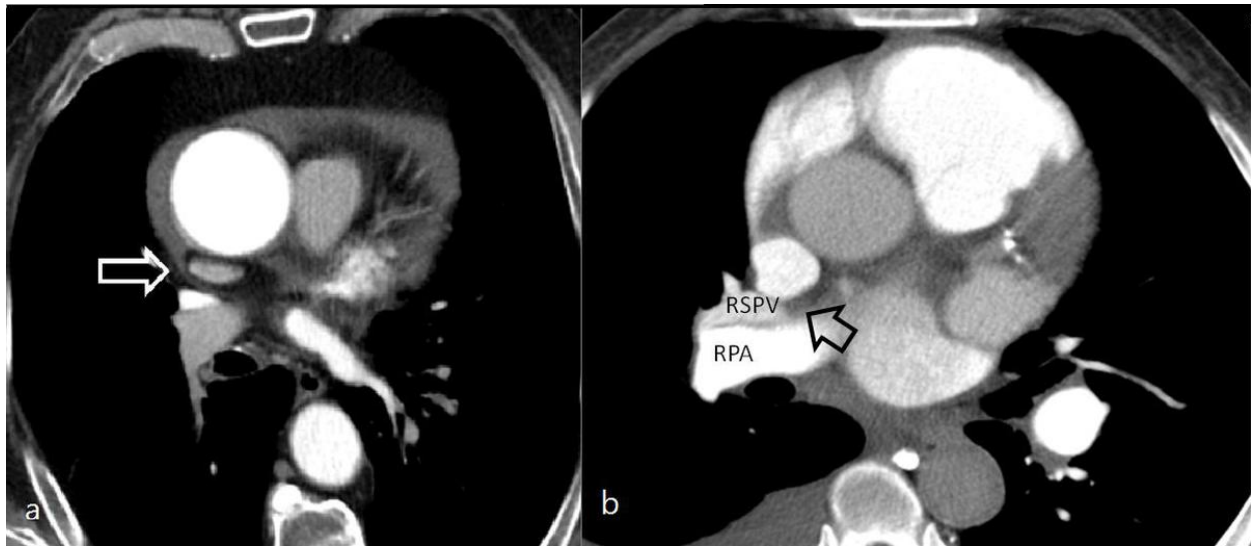


Fig. 5: Axial CT images showing the postcaval recess, a diverticulum of the pericardial cavity proper (white arrow in a))that extends behind and along the right lateral aspect of the superior vena cava. b) The postcaval recess is bounded by the right pulmonary artery (RPA) and the right superior pulmonary vein (RSPV)(black arrow).

References: Radiologia, Hospital Geral, Centro Hospitalar e Universitário de Coimbra - Coimbra/PT

Transverse pericardial sinus

This space is located posterior and inferior to the ascending aorta and pulmonary trunk and above to the left atrium. It connects with the pericardial cavity between the ascending aorta e superior vena cava, but this connection is not always clearly seen. It has a linear-shaped virtual cavity that should not be misinterpreted, when filled with fluid, as a focal aortic dissection or as an enlarged mediastinal lymph node on CT images (Fig. 6 on page 22).



Fig. 6: Axial CT imaging showing the transverse pericardial sinus, located posterior and inferior to the ascending aorta and pulmonary trunk and above to the left atrium.

References: Radiologia, Hospital Geral, Centro Hospitalar e Universitário de Coimbra - Coimbra/PT

Several minor recesses take origin from this space:

- Superior aortic recess:

The superior aortic recess is a superior extension of the transverse sinus that extends anterior to the ascending aorta. It attaches directly to the aorta so that intervening fat is not identified. This lack of a fat plane also helps distinguish fluid in the pericardial recess from precarinal lymph nodes. This recess may simulate aortic dissection or thrombus on non enhanced CT ().

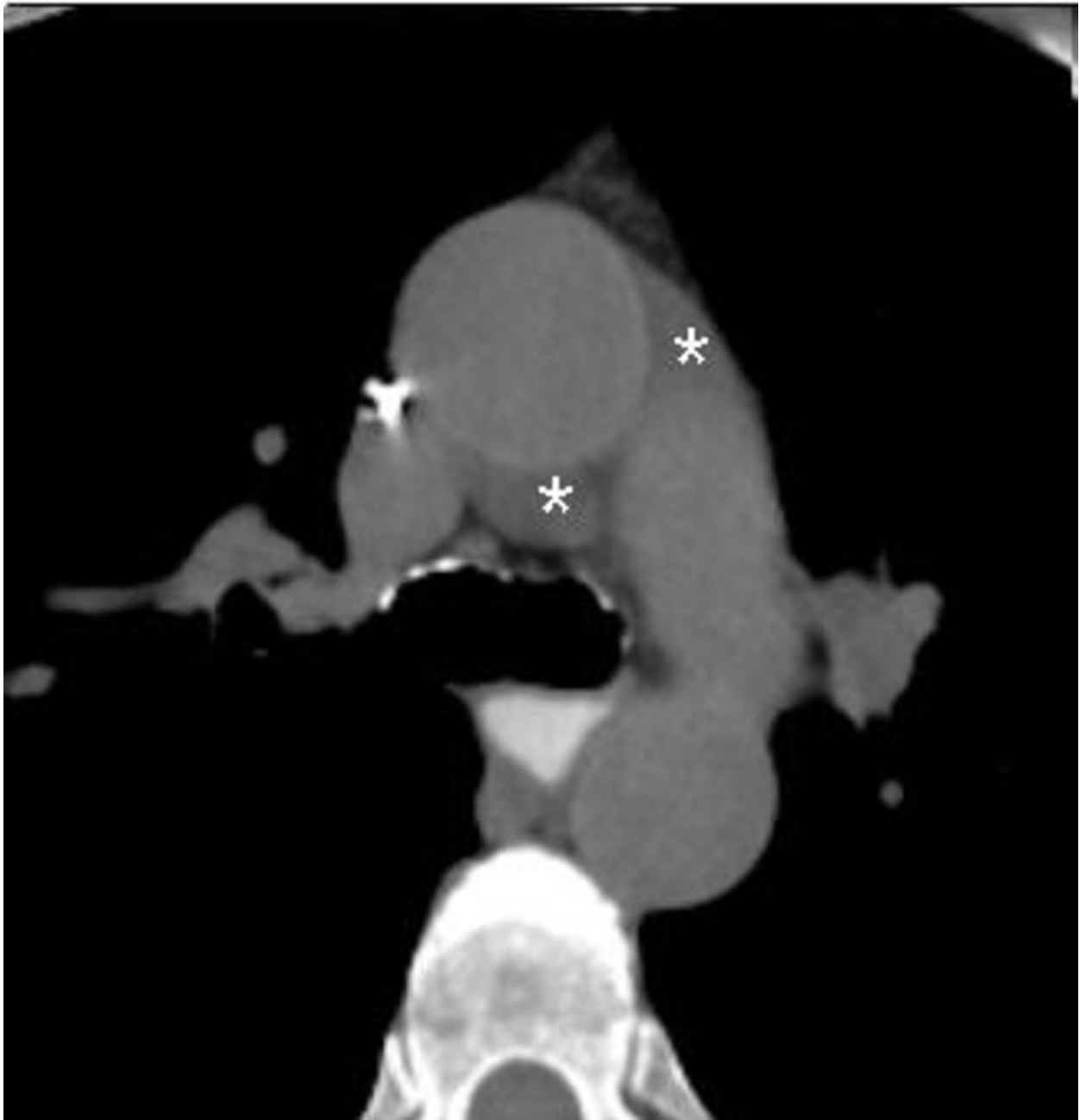


Fig. 7: Axial non enhanced CT image showing the superior aortic recess extending adjacent to the ascending aorta (asterisc). It attaches directly to the aorta so that intervening fat is not identified, which may simulate an aortic dissection or thrombus.

References: Radiologia, Hospital Geral, Centro Hospitalar e Universitário de Coimbra - Coimbra/PT

Some authors divided the superior aortic recess in anterior, posterior and right lateral portions ([Fig. 8](#) on page 23).

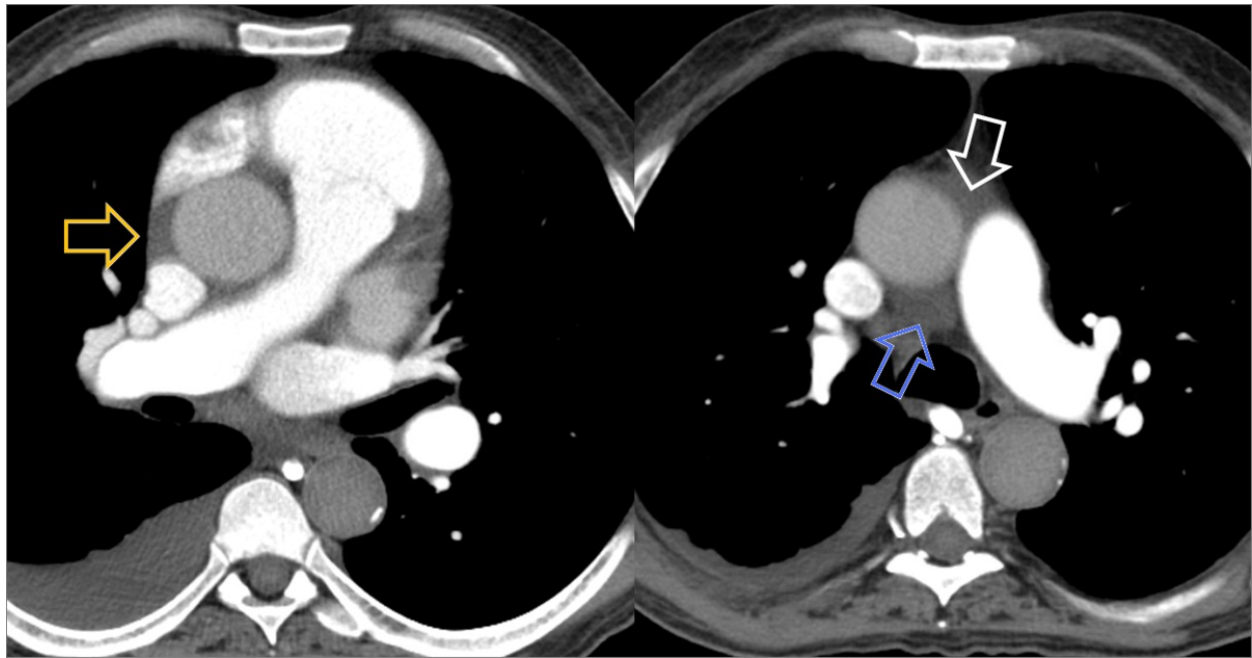


Fig. 8: Axial CT image showing the superior aortic recess and its anterior (white arrow), posterior (blue arrow) and right lateral (orange arrow) portions.

References: Radiologia, Hospital Geral, Centro Hospitalar e Universitário de Coimbra - Coimbra/PT

The **anterior** extension of the superior aortic recess is seen between the ascending aorta and pulmonary trunk, taking a characteristic triangular shape with a characteristic cleft as it indents between the great vessels. Differentiation of this recess from adenopathy is facilitated by the typical location and appearance. Fluid in this pericardial space has a well-circumscribed contour with a beaklike extension as it drapes in front of the aorta and pulmonary artery. Although visual analysis can often differentiate pericardial fluid from adenopathy, measurement of attenuation values can be useful. Fluid in the anterior portion of the superior aortic recess has also been described as mimicking the appearance of aortic dissection.

The **lateral** portion similarly insinuates itself between the ascending aorta and the SVC.

The **posterior** portion lies posterior to the ascending aorta, where it is sometimes referred to as the superior pericardial recess or superior sinus. On CT images manifests as a well-defined characteristic crescentic fluid collection adjacent to the posterior wall of the ascending aorta usually at the level of the left pulmonary artery. Cephalad extension of this recess can take a variety of shapes including triangular, crescent-shaped or oval and can be seen to extend up into the right paratracheal region where it can be mistaken for adenopathy or brochogenic cyst. Use of thin sections and two-dimensional reformatted images can help demonstrate the connection of the recess to the pericardium ([Fig. 9](#) on page 24). Other distinguishing features of the posterior portion of the superior aortic recess are its location directly posterior to the ascending aorta, its crescent shape,

the fluid attenuation. These features help distinguish fluid in the pericardial recess from precarinal lymph nodes, which tend to be round or oval and of soft-tissue attenuation.



Fig. 9: Sagittal CT reformatation demonstrating the connection of the anterior and posterior portions of the superior aortic recess to the pericardium.

References: Radiologia, Hospital Geral, Centro Hospitalar e Universitário de Coimbra - Coimbra/PT

Right and left pulmonary artery recesses

They form the lateral extent of the transverse sinus and are located below the right and left pulmonary arteries, respectively (Fig. 10 on page 25).

The right pulmonary recess is inferior to the proximal right pulmonary artery. This recess is bounded by the reflection of serous pericardium extending from the right pulmonary artery to the superior vena cava.

The left pulmonary recess is bounded superiorly by the left pulmonary artery, inferiorly by the left superior pulmonary vein and medially by the ligament of Marshall, a vestigial fold of the remnant left superior vena cava. Fluid collections within the pulmonic recesses can mimic the appearance of lymphadenopathy.



Fig. 10: Axial CT images showing the left pulmonary recess bounded superiorly by the left pulmonary artery, inferiorly by the left superior pulmonary vein and medially by the ligament of Marshall, a vestigial fold of the remnant left superior vena cava (black arrow) and the right pulmonary recess located inferior to the proximal right pulmonary artery. This recess is bounded by the reflection of serous pericardium extending from the right pulmonary artery to the superior vena cava.

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- Inferior aortic recess:

The inferior aortic recess is a crescentic diverticulum between the right lateral aspect of the ascending aorta and the right atrium. It is a caudal extension from the transverse sinus lying between the ascending aorta and the superior vena cava or the right atrium and

extends down to the level of the aortic valve ([Fig. 11](#) on page 27). It can be sometimes mistaken for an aortic dissection or lymphadenopathy.

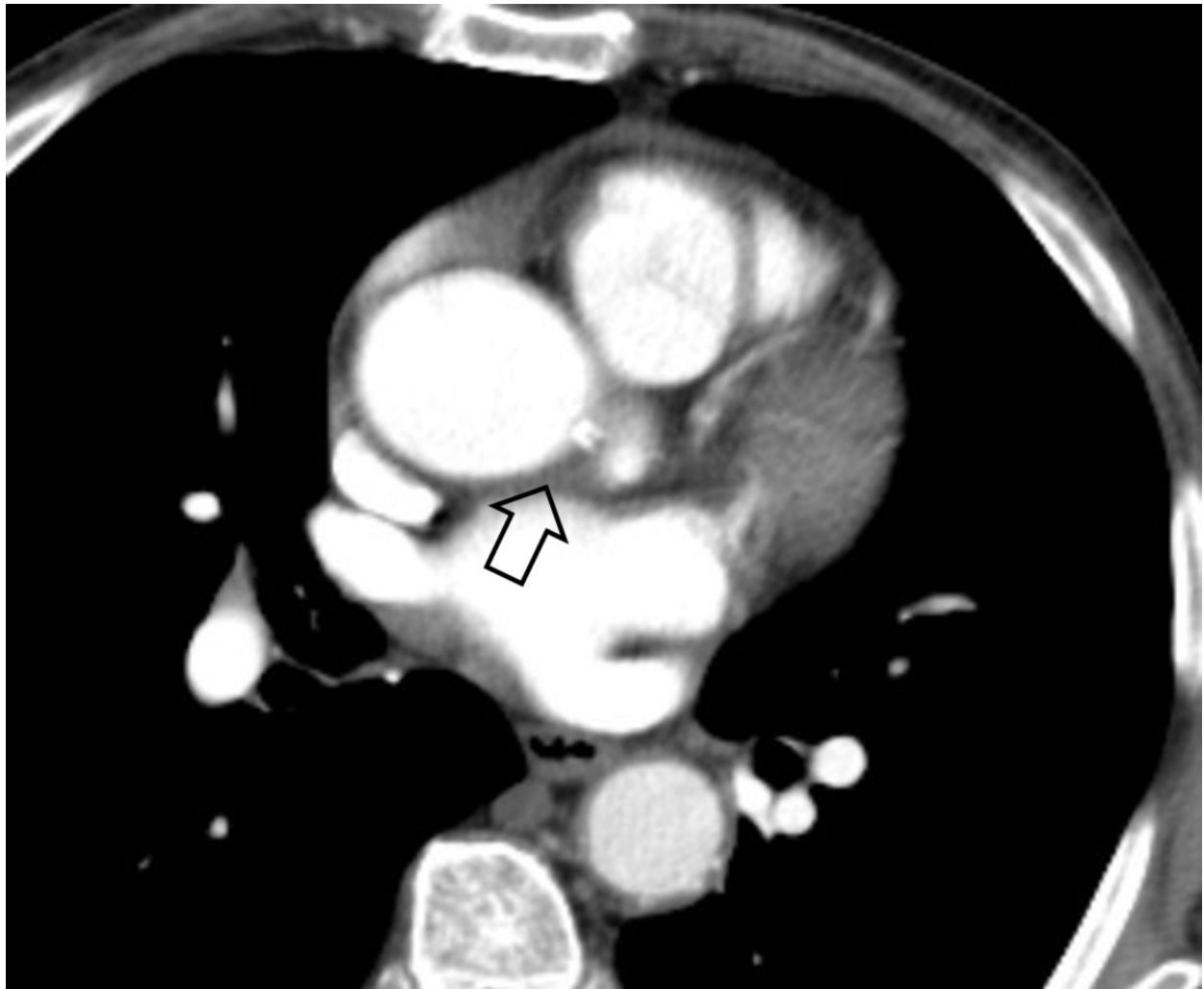


Fig. 11: Axial CT image showing the location of the inferior aortic recess (white arrow).

References: Radiologia, Hospital Geral, Centro Hospitalar e Universitário de Coimbra - Coimbra/PT

Oblique pericardial sinus

The oblique pericardial sinus is the most posterior pericardial space ([Fig. 1](#) on page 19). It has an inverted U-shaped pericardial reflection located behind the left atrium and is inferior to the transverse sinus, from which it is separated by a double reflection of serous pericardium. In Ct images the oblique sinus is usually clearly separated from the transverse sinus by a fat plan ([Fig. 12](#) on page 26).

Fluid in the oblique sinus can simulate abnormalities in the esophagus, descending thoracic aorta, and subcarinal and bronchopulmonary lymph nodes.

- Posterior pericardial recess

The oblique sinus extends superiorly behind the right pulmonary artery and medial to the bronchus intermedius, where it is called the posterior pericardial recess. Fluid in the posterior pericardial recess may be mistaken for peribronchial or subcarinal lymph nodes.



Fig. 12: Axial CT image showing the oblique pericardial sinus (white open arrow) and the fat plan between it and the transverse pericardial sinus (white closed arrow).

References: Radiologia, Hospital Geral, Centro Hospitalar e Universitário de Coimbra - Coimbra/PT

Images for this section:

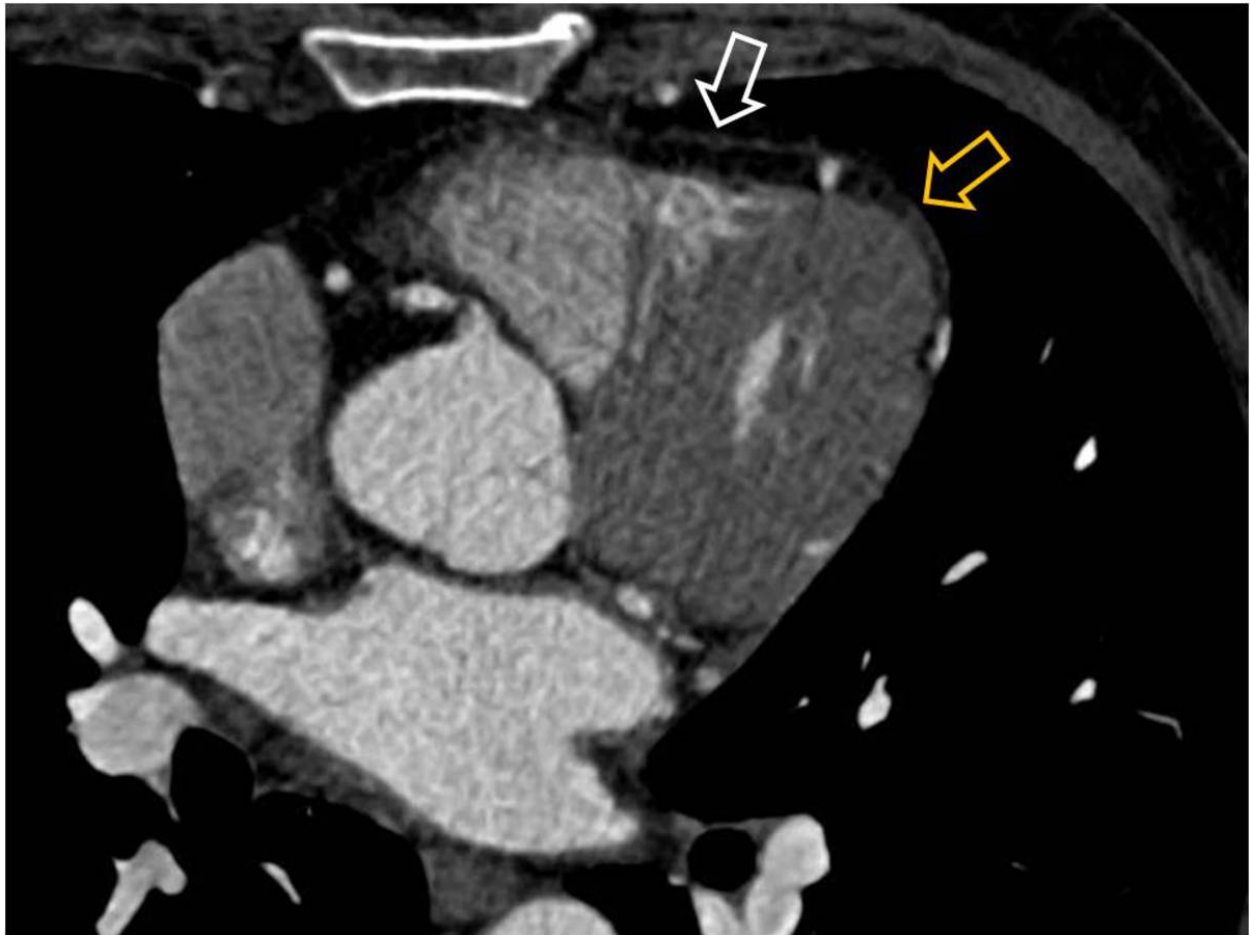


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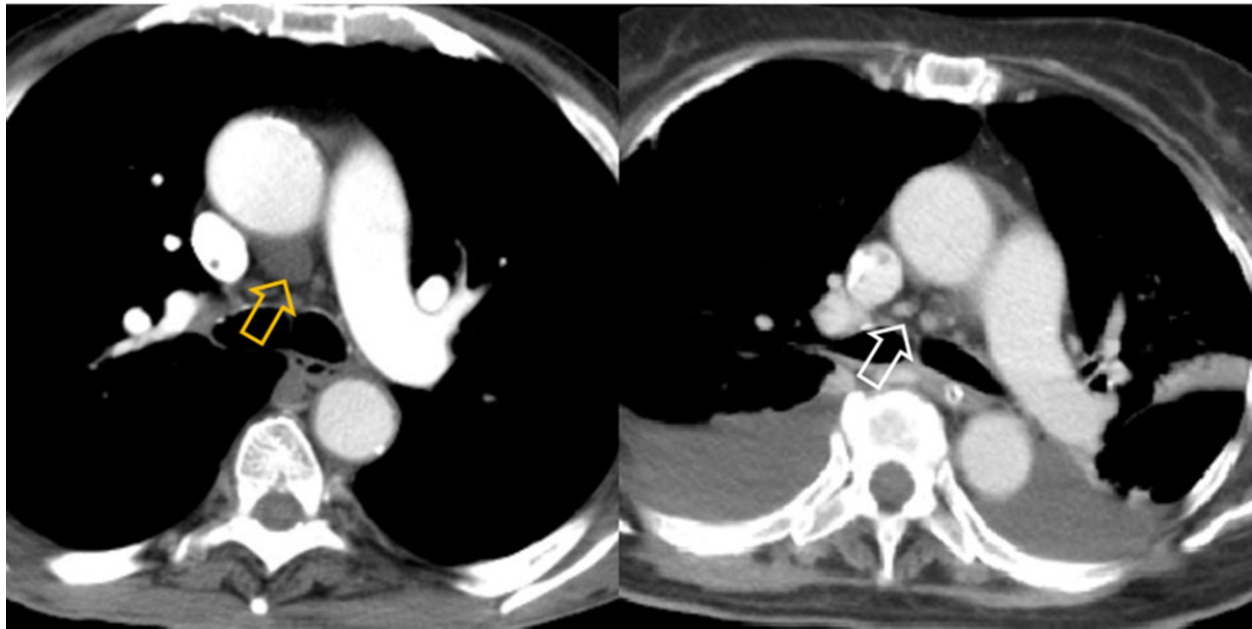


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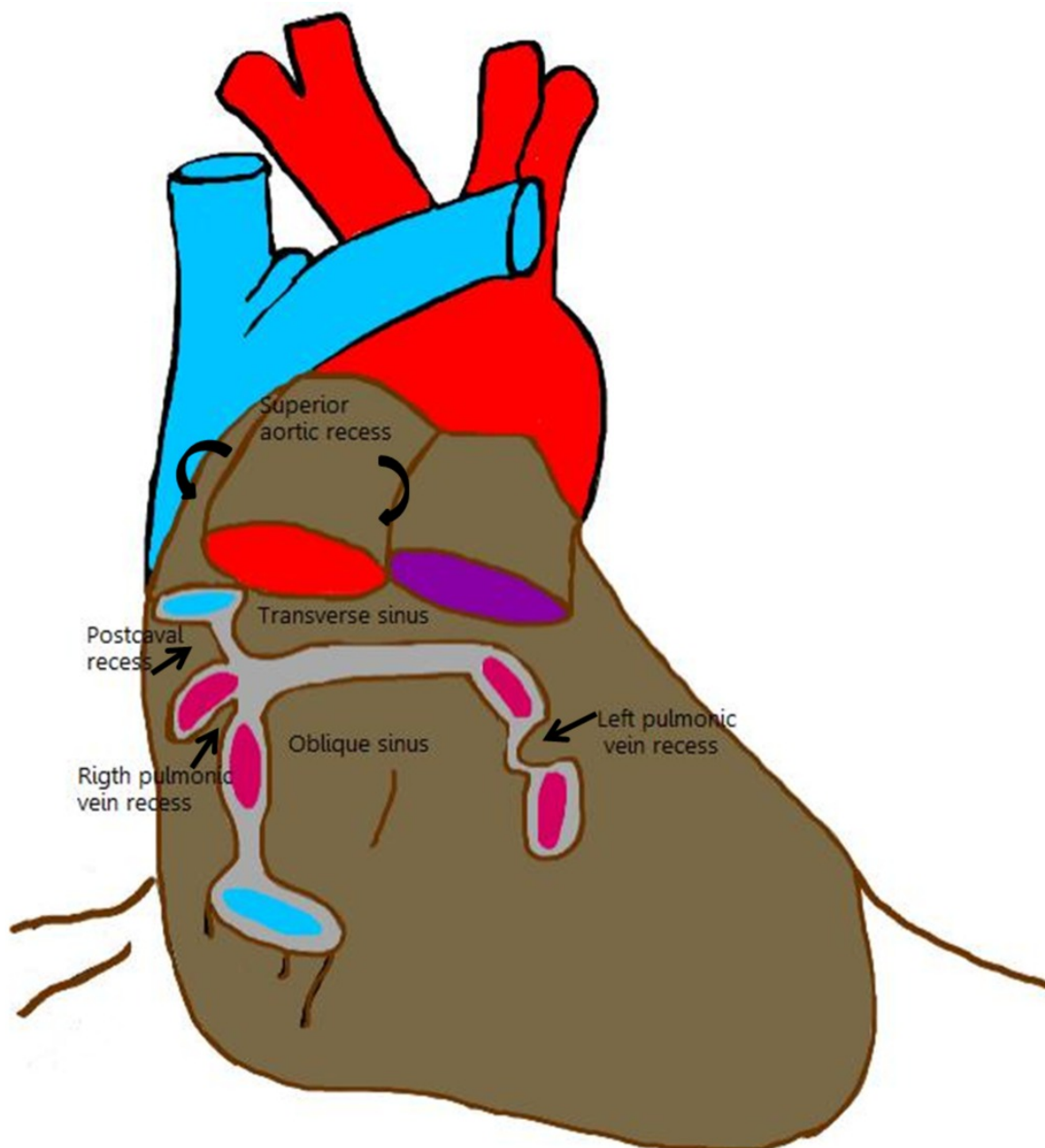


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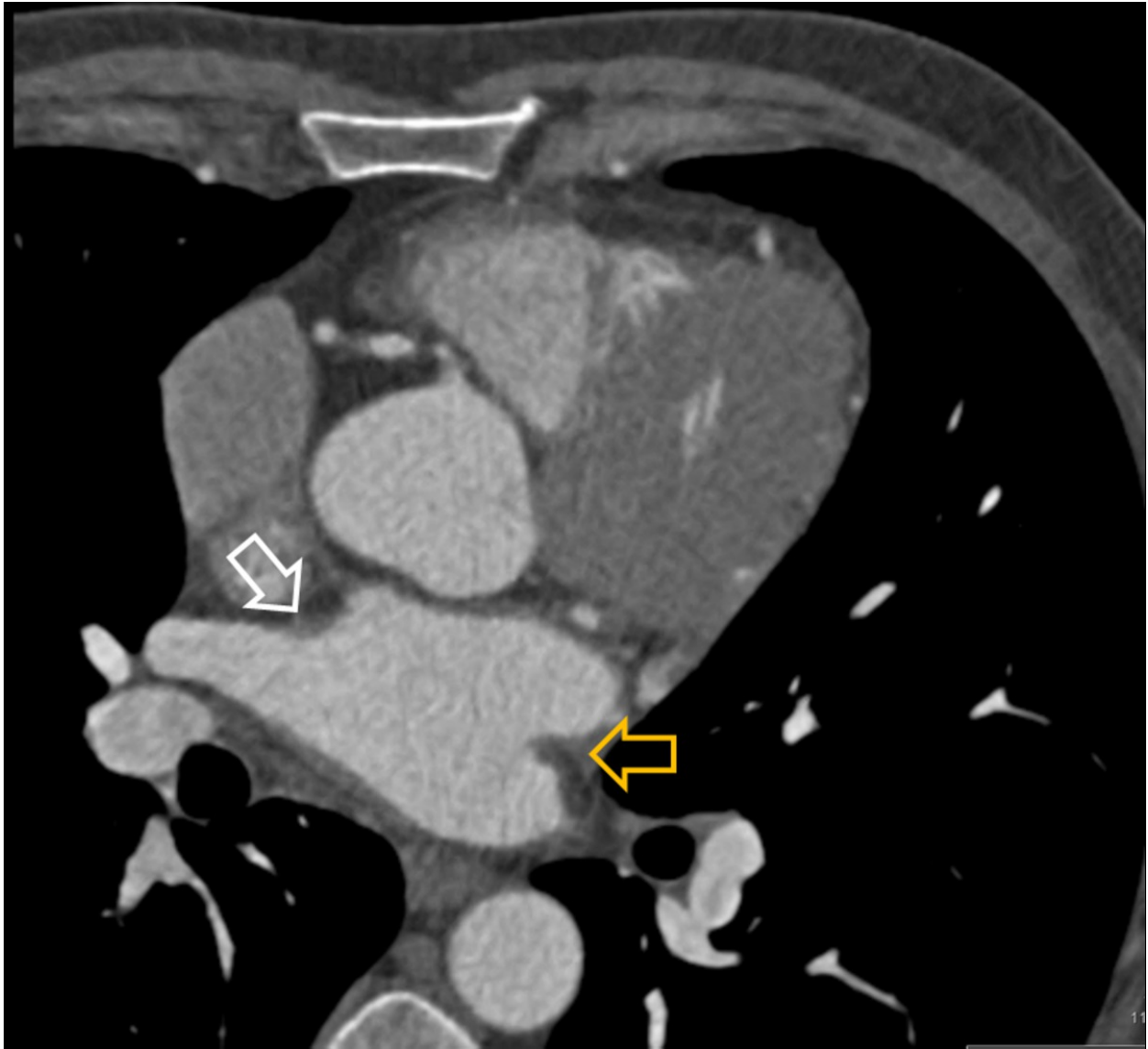


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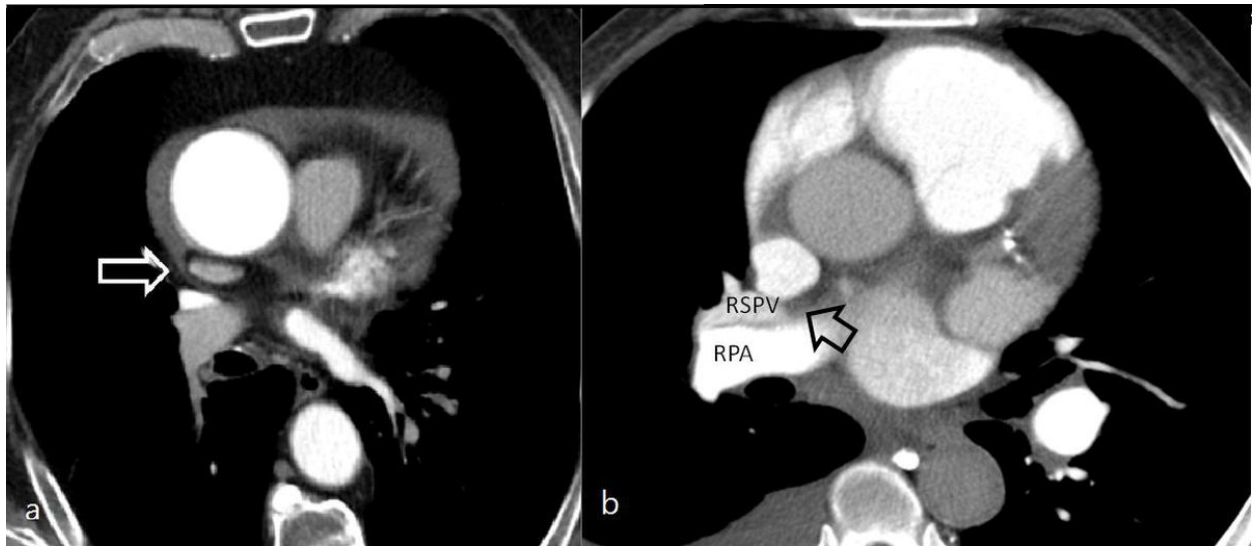


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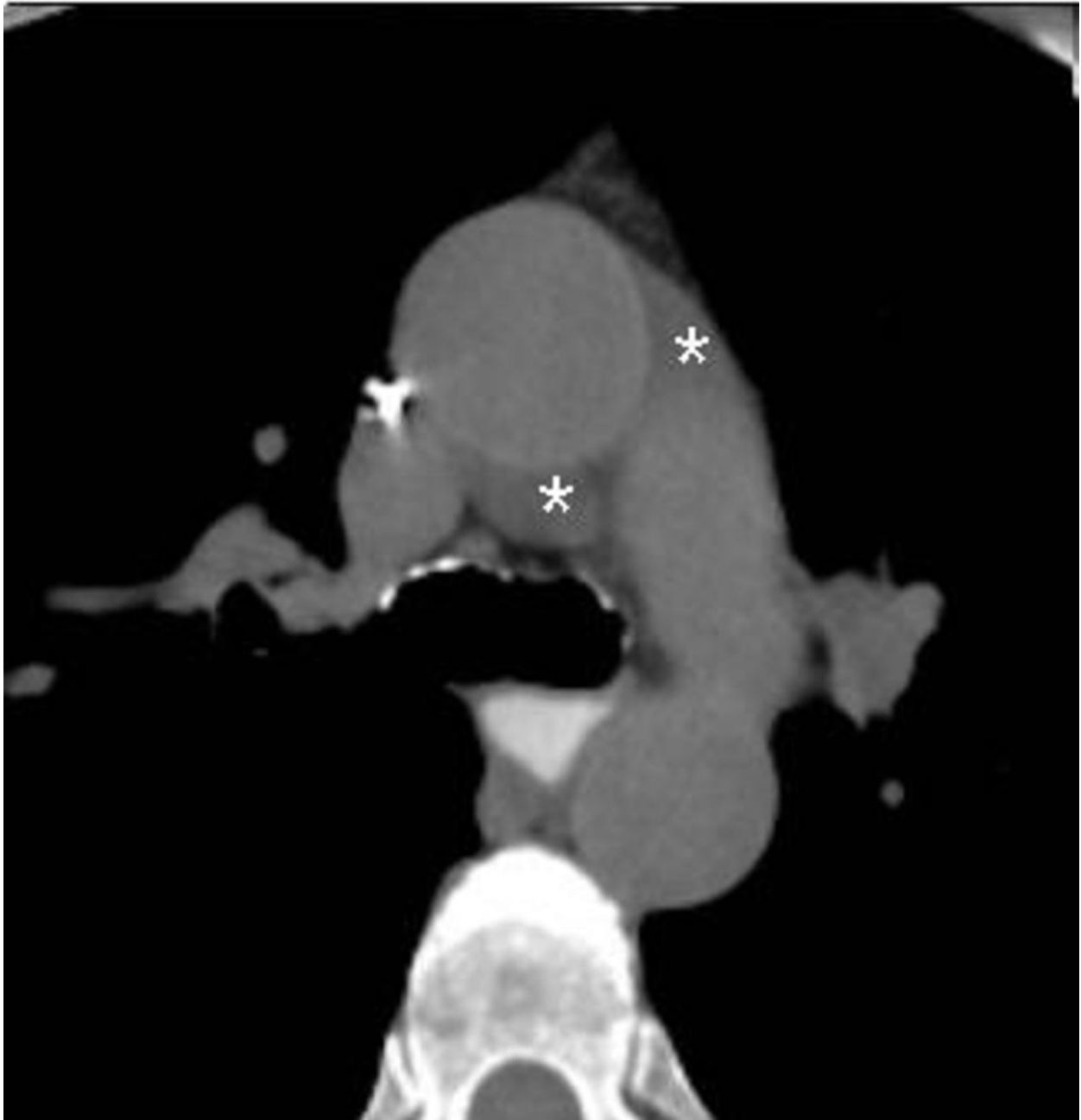


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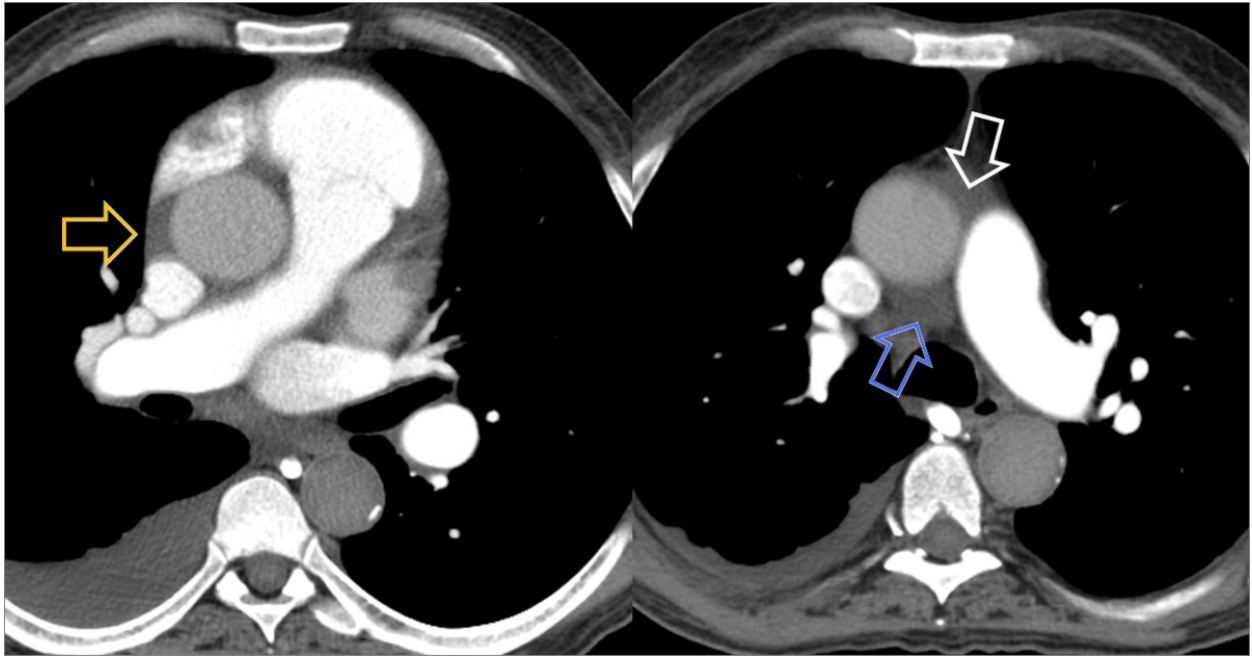


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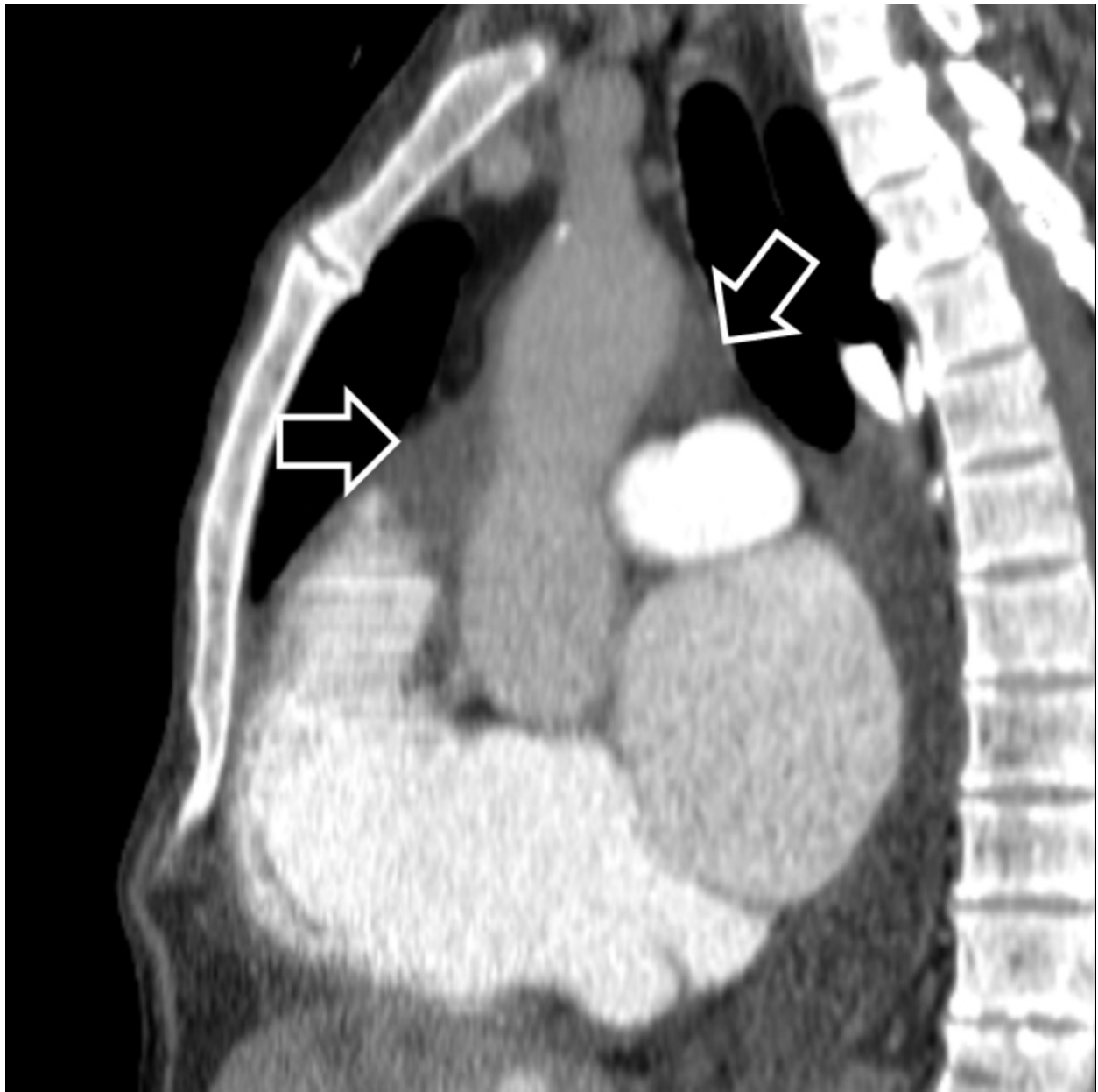


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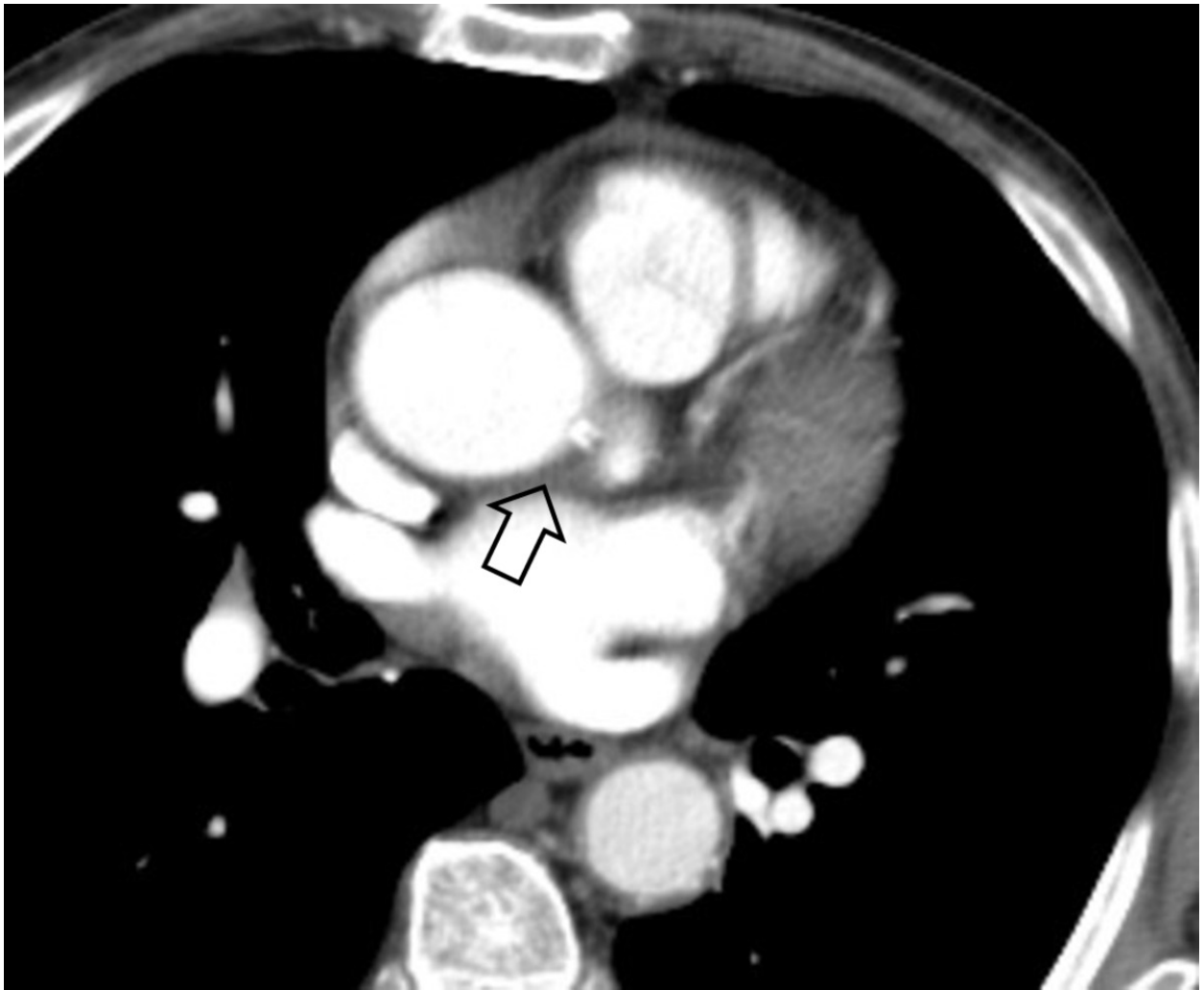


Fig. 11: Axial CT image showing the location of the inferior aortic recess (white arrow).

Conclusion

Faster scanning techniques and cardiac gating allow improved visualization of finer anatomic details of the heart and pericardium compared with older scanning techniques. This has augmented our ability to identify and characterise the pericardium, allowing us to differentiate between the normal anatomy and pathology with a precise relationship to other anatomical structures.

Because misinterpretation of the pericardial recesses as a mediastinal abnormality can have important clinical ramifications, a comprehensive understanding of pericardial anatomy is essential because the basic criteria to distinguish them is based in a sharply outlined structure, with uniform water-equivalent attenuation, without walls or rims in the expected anatomic location of the pericardial sinuses and recesses.

Personal information

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References

Bogaert J, Francone M, *Pericardial Disease: Value of CT and MR Imaging*, Radiology: Volume 267: Number 2-May 2013

Broderick LS, Brooks GN, Kuhlman JE. *Anatomic Pitfalls of the Heart and Pericardium*. RadioGraphics 2005; 25:441-453

O'leary SM, Williams PL, Williams M P, Edwards AJ, Roobottom CA, Morganhughes G J And Manghat N E. *Imaging the pericardium: appearances on ECG-gated 64-detector row cardiac computed tomography*. The British Journal of Radiology, 83 (2010), 194-205

Olson MC, Posniak HV, McDonald V, Wisniewski R, Moncada BR, *Computed tomography and magnetic resonance imaging of the pericardium*. Volume 9, Number 4, 149, July, 1989 RadioGraphics

Oyama N, Oyama N, Komuro K, Nambu T, Manning WJ, Miyasaka K. *Computed tomography and magnetic resonance imaging of the pericardium: anatomy and pathology*. Magn Reson Med Sci 2004 Dec 15;3(3):145-52

Peebles CR, Shambrook JS, Harden S. *Pericardial disease-anatomy and function*. The British Journal of Radiology, 84 (2011), S324-S337

Truong MT, Erasmus JJ, Gladish GW, Sabloff BS, Marom EM, Madewell JE, Chasen MW, Munden RF. *Anatomy of Pericardial Recesses on Multidetector CT: Implications for Oncologic Imaging* AJR 2003;181:1109-1113