Pericardial Recesses on Computed Tomography
Implications for the Pulmonologist

Hanna Dalla Pria Ferreira, MD[a], Lauren T. Erasmus, BS[b], Taylor A. Strange, MD[c], Jitesh Ahuja, MD[d], Rishi Agrawal, MD[d], Girish S. Shroff, MD[d], Smita Patel, MD[e], Mylene T. Truong, MD[d,*]

KEYWORDS

• Pericardium • Pericardial recess • Lymph node • Adenopathy • CT

KEY POINTS

- The pericardium encases the heart in a delicate fibrous-serosal sac. The reflections of the serosal layer form sinuses and recesses, which are located adjacent to the arteries and veins.
- Depending on the various locations and appearances of fluid-filled pericardial sinuses and recesses on computed tomography (CT), they can be misinterpreted as adenopathy/metastasis, a mediastinal cyst, or an aortic dissection.
- A comprehensive understanding of pericardial anatomy and variations is paramount for pulmonologists, to avoid unnecessary bronchoscopic biopsy of fluid-filled sinuses and recesses.

INTRODUCTION

The pericardium comprises a double-walled fibrous-serosal sac that encloses the heart. It consists of 2 parts: a fibrous outer part and a double-layered serous inner part. The parietal layer of the serous pericardium lines the inner surface of the fibrous pericardium. The visceral layer of the serous pericardium covers the heart and proximal great vessels. Around those vessels, the visceral layer produces reflections called sinuses and recesses.[1,2] Knowledge of these anatomic structures and their variants is crucial to avoid misinterpretation of fluid-filled pericardial sinuses and recesses as adenopathy, pericardial metastasis, or aortic dissection, which can impact patient management and treatment decisions.[3,4] With advances in multidetector computed tomography (MDCT) technology, pericardial recesses are frequently detected with thin-section computed tomography (CT), with a visualization rate of any pericardial recess of 85.2%.[2,4–6]

This review aims to offer a comprehensive understanding of pericardial anatomy and its variations observed on CT scans, potential pitfalls in image interpretation, and implications for the pulmonologist with respect to unnecessary diagnostic procedures or interventions.

ANATOMY OF THE PERICARDIAL RECESS

Definition and Location of the Pericardial Recess

The heart is enclosed by the pericardium, consisting of an outer fibrous layer (fibrous pericardium) and an inner double layer of serosa (serous pericardium). The fibrous pericardium is a sac of connective tissue that lays over the diaphragm and is

[a] Department of Radiology, Carver College of Medicine, University of Iowa Health Care, 51 Newton Road, 200 Medicine Administration Building, Iowa City, IA 52242, USA; [b] Department of Anatomy and Cell Biology, McGill University, 3640 University, Montreal, QC H3A 0C7, Canada; [c] Department of Pathology, University of Texas Medical Branch, 301 University Boulevard, Galveston, TX 77555, USA; [d] Department of Thoracic Imaging, University of Texas MD Anderson Cancer Center, 1515 Holcombe Boulevard, Unit 1478, Houston, TX 77030, USA; [e] Department of Radiology, University of Michigan at Ann Arbor, 1500 East Medical Center Drive, SPC 5868, Ann Arbor, MI 48109, USA
* Corresponding author.
E-mail address: mtruong@mdanderson.org

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attached to the central tendon of the diaphragm by the pericardiophrenic ligament. The apex of the fibrous pericardium is fused with the perivascular connective tissue at the root of the great vessels that leave the heart. Anteriorly, the fibrous pericardium is attached to the sternum by the sternopericardial ligaments. The serous pericardium comprises an outer parietal layer and an inner visceral layer. The visceral layer of the serous pericardium that covers the heart and not the great vessels is also known as the epicardium.[6–9] The potential space between the parietal and visceral layers of the serous pericardium is the pericardial cavity. Physiologically, this potential space can be filled with up to 50 mL of fluid secreted by mesothelial cells that facilitates the sliding of the layers of the serous sac against each other during the cardiac cycle.[1,2,6,10] The reflections of the serous pericardium form pericardial sinuses and recesses within the pericardial cavity.[1] The accumulation of pericardial fluid within the pericardial sinuses and recesses can be visualized on imaging by thin-section MDCT.[1,6,11] It is important to distinguish fluid-filled pericardial recesses from pathologic processes involving neighboring structures, such as the bronchi, esophagus, and lymph nodes.[1] The pericardial cavity contains not only the pericardial cavity proper but also 2 pericardial sinuses, namely, the transverse and oblique sinuses, which collectively have 8 recesses[2,6] (**Box 1**, **Fig. 1**).

Box 1
Pericardial sinuses and recesses

Pericardial sinuses and recesses

A. Transverse sinus
   a. Superior aortic recess
      i. Anterior portion of the superior aortic recess
      ii. Posterior portion of the superior aortic recess
         1. High-riding superior pericardial recess (variation)
      iii. Right lateral portion of the superior aortic recess
   b. Inferior aortic recess
   c. Right pulmonic recess
   d. Left pulmonic recess
B. Oblique sinus
   a. Posterior pericardial recess
C. Pericardial cavity proper
   a. Right pulmonary venous recess
   b. Left pulmonary venous recess
   c. Postcaval recess

Transverse sinus

The visceral layer of the serous pericardium form 2 pericardial tubular structures, one tube encompassing the aorta and pulmonary trunk and the second tube encasing the superior and inferior vena cava and the pulmonary veins. The transverse sinus is the space between these 2 pericardial tubes.[10,12] In one analysis conducted on 100 patients, the transverse sinus was observed in 95% of the cases on CT.[13] The transverse sinus is situated in a caudal and posterior position relative to the aorta and pulmonary trunk and in a cranial position relative to the left atrium. Within the transverse sinus, there are 4 recesses: the superior and inferior aortic recesses, as well as the left and right pulmonic recesses.[6]

Superior aortic recess The superior aortic recess is typically the most superior component of the transverse sinus and may be further divided into 3 distinct segments: the posterior, anterior, and right lateral portions.[2,10,14] The posterior portion of the superior aortic recess, also known as the superior pericardial recess, is typically observed on CT as a crescent-shaped fluid accumulation. It is situated behind the ascending aorta, frequently at the level of the left pulmonary artery and cranial to the right pulmonary artery[8,11,14] (**Fig. 2**). Using 4-, 16-, and 64-row MDCT evaluation, the visualization rate of the posterior aspect of the superior aortic recess was found to range between 70.2% and 84.4%.[4]

A frequently encountered variant of the posterior aspect of the superior aortic recess is the high-riding superior pericardial recess (HRSPR), which extends into the right paratracheal area.[8] This recess variant appears as a fluid-attenuation structure situated between the brachiocephalic vessels and the trachea. The HRSPR is contiguous with the posterior part of the superior aortic recess and lacks a well-defined wall.[15] When viewed on CT, the HRSPR generally presents as a triangular, round, spindle, semilunar, or oval shape[8,15] (**Fig. 3**). In 2000, a prospective analysis of 284 consecutive chest CT scans revealed a visualization rate of HRSPR in only 2% of the cases.[16] However, by 2006, a study involving 314 patients with the more technologically advanced 16-row MDCT reported a significantly higher detection rate at 6.6%.[15]

The anterior aspect of the superior aortic recess is positioned within the aortopulmonary window,

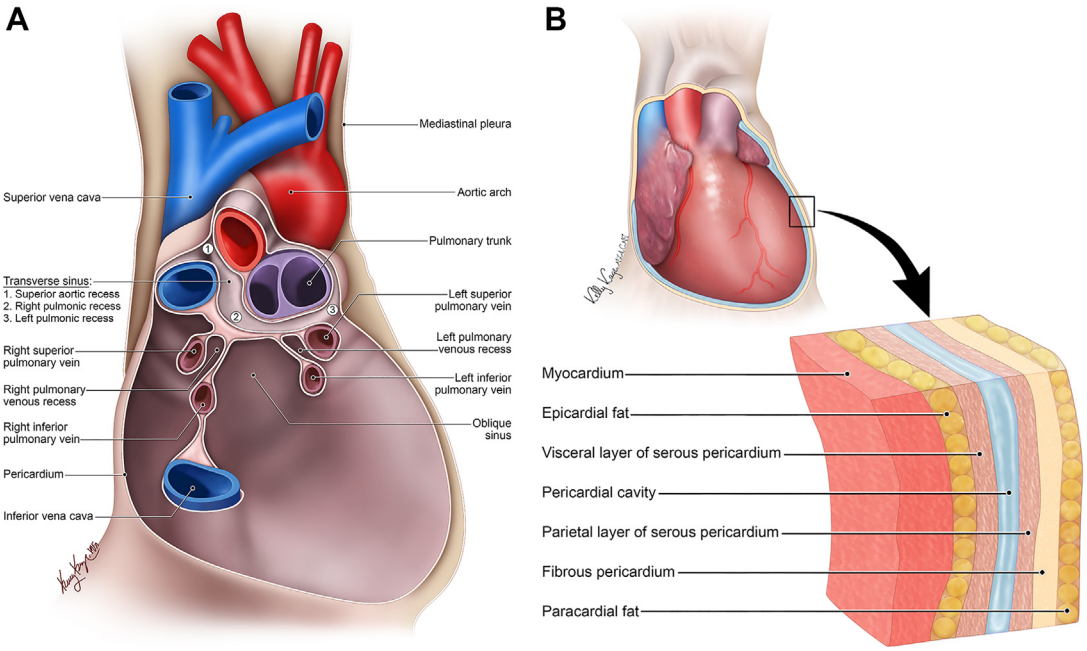

Fig. 1. Pericardial anatomy. (*A*) The interior of the serous pericardial sac seen from the front after removal of the heart and transection of the great vessels. One visceral layer of the serous pericardial tube encloses the aorta and pulmonary artery, and the second tube encloses the superior vena cava, inferior vena cava, and pulmonary veins. The transverse sinus is the space between the 2 tubes, comprising the superior aortic, inferior aortic (not shown), and right and left pulmonic recesses. The oblique sinus is the blind-ending pouch superior and posterior to the left atrium. The pulmonary venous recesses are located between the pericardial sleeves of the superior and inferior pulmonary veins. (*B*) The pericardial layers. Adjacent to the myocardium, the visceral layer of the serous pericardium where it covers the heart is also called the epicardium. The pericardial cavity is the potential space (*blue*) between the visceral and parietal layers of the serous pericardium. The fibrous pericardium is the outer layer of dense connective tissue. Note pericardial fat includes both epicardial fat and paracardial fat. (Image Courtesy of Kelly M. Kage, MFA, CMI. UT MD Anderson Cancer Center.)

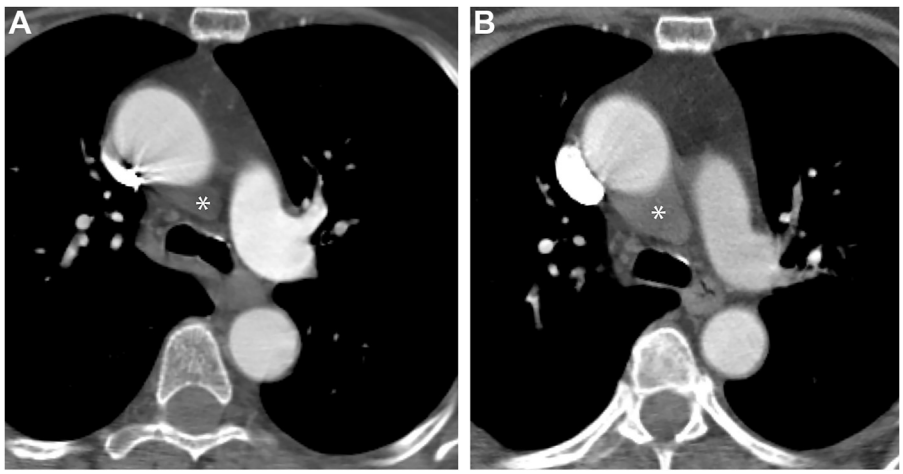

Fig. 2. Superior aortic recess. (*A*) Contrast-enhanced axial CT at a level just superior to the main pulmonary artery shows fluid in the superior aortic recess (*asterisk*) forming the typical crescent shape posterior to the ascending aorta. (*B*) Contrast-enhanced axial CT 1 year later shows increase in amount of pericardial fluid in the superior aortic recess (*asterisk*).

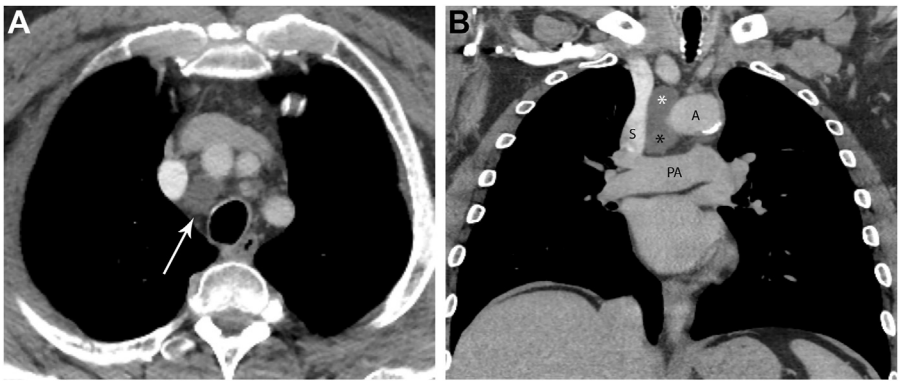

Fig. 3. High-riding variant of the superior aortic pericardial recess. (*A*) Contrast-enhanced axial CT at the level of the left brachiocephalic vein shows a cystic structure (*arrow*) at the right paratracheal region. (*B*) Coronal reformation demonstrates contiguity of the cystic structure (*white asterisk*) with the superior pericardial recess (*black asterisk*) of the transverse sinus. This "high-riding" variant can be misinterpreted as adenopathy when fluid attenuation and contiguity with the superior pericardial recess are not recognized. A, aorta; PA, pulmonary artery; S, superior vena cava.

which is situated between the ascending aorta and the pulmonary artery. Although it may be referred to as the aortopulmonary recess, this terminology is not universally recognized.[8,10,11,14] Commonly, this recess assumes a well-defined contour, frequently with a beak-like morphology, as it extends anterior to the aorta and pulmonary artery[11] (**Fig. 4**). The visualization rates of the anterior aspect of the superior aortic recess were found to vary depending on the imaging modality used. On 4-, 16-, and 64-row MDCT evaluation, the depiction rate ranged between 70.2% and 84.4%.[4]

The right lateral aspect of the superior aortic recess extends along the right side of the ascending aorta, usually at the sternal angle level, positioned anteriorly to and between the ascending aorta and the superior vena cava.[8,10] It typically assumes a triangular shape.[10] However, recent literature highlights the need for further investigation to ascertain whether the right lateral portion of the superior aortic recess is a normal anatomic variation or may be associated with a pericardial effusion, as has been identified on some studies.[4,10,14] Specifically, on a thin-section helical CT evaluation of 133 patients, the right lateral aspect of the superior aortic recess was observed in 2 individuals exhibiting moderate pericardial effusion. However, among the remaining 131 patients without pericardial effusion, no structures with similar near-water density were detected in this area.[14]

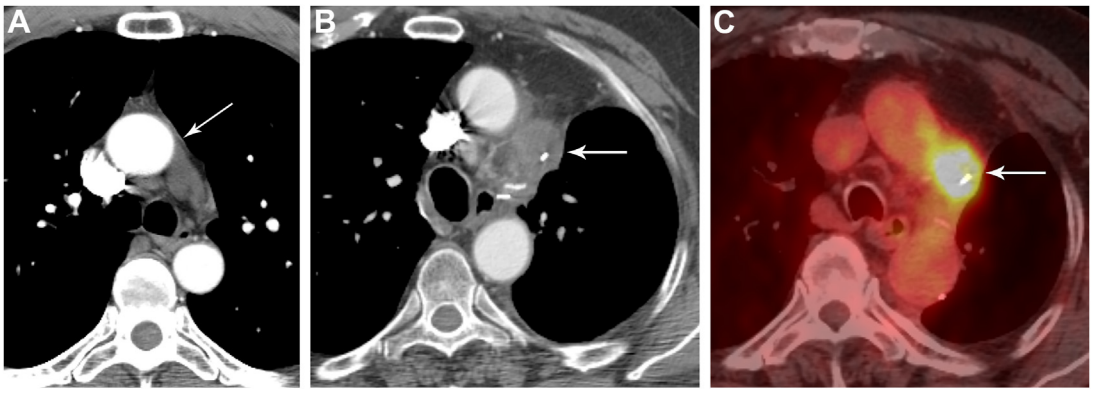

Fig. 4. Fluid in the aortopulmonary window (APW) recess versus nodal metastasis. (*A*) Contrast-enhanced axial CT shows pericardial fluid distending the APW recess. The fluid forms the typical beak-like appearance (*arrow*) as it drapes over the ascending aorta. (*B*) Contrast-enhanced axial CT shows adenopathy at the APW (*arrow*) in a patient with recurrent disease following left upper lobectomy for lung cancer. Soft tissue attenuation and lobular contour are features that differentiate adenopathy from a fluid-filled pericardial recess. (*C*) FDG-PET-CT shows FDG avidity of the APW adenopathy (*arrow*) and biopsy-confirmed nodal metastasis.

Inferior aortic recess The inferior aortic recess is the inferior extension of the transverse sinus located between the right atrium and the aortic root, at the level of the aortic valve and anterior to the left atrium.[11,14,17] Its appearance can vary depending on the lacuna formed by the surrounding structures.[5] The visualization rates of the inferior aspect of the superior aortic recess differed across various imaging techniques. Specifically, on 4-, 16-, and 64-row MDCT evaluation, the detection rate ranged from 10.8% to 43.4%.[4]

Right and left pulmonic recesses The lateral extent of the transverse sinus is referred to as the pulmonic recesses, situated on both the right and the left sides. The right pulmonic recess is positioned horizontally, inferior to the proximal portion of the right pulmonary artery and superior to the left atrium, with the aortic root serving as its posterior boundary.[4] The inferior tracheobronchial lymph nodes are adjacent to its posterior boundary.[2] The left pulmonic recess is bounded superiorly by the left pulmonary artery, inferiorly by the left superior pulmonary vein, and medially by the ligament of Marshall, which corresponds to the embryonic left superior vena cava.[10,11] On CT, fluid in the left pulmonic recess appears as a near-water-density structure between the left superior pulmonary vein and the left and right pulmonary artery.[10,14] The right and left pulmonic recesses communicate with the posterior superior aortic recess.[4] On 4-, 16-, and 64-row MDCT, the visualization rates of the right and left pulmonic recesses were similar, ranging from 37.4% to 48.4% and 42% to 48.4%, respectively.[4]

Oblique sinus

The oblique sinus is demarcated from the transverse sinus through a dual reflection of the serous pericardium, which forms the horizontal space between the left and right superior pulmonic veins.[14] The oblique sinus has a potential extension referred to as the posterior pericardial recess located in the subcarinal region.[5] The oblique sinus is a cul-de-sac structure or blind-ending pouch situated posterior to the left atrium and anterior to the esophagus[1,6] (**Fig. 5**). Typically, a fat plane is observed between the oblique sinus and the esophagus on CT, and the sinus may present as ellipsoid, circular, spindle-like, or triangular shaped.[1,6,14] Reports using 4-, 16-, and 64-row MDCT showed that the oblique sinus was visualized from 28.1% to 58.1%.[4]

The posterior pericardial recess, an upward right-sided extension of the oblique sinus, can be visualized on CT as a near-water structure extending posteriorly from the distal segment of the right pulmonary artery and medial to the intermediate bronchus.[14,18] The visualization of this recess varies from 6% to 67%.[13,14] It is worth noting that other studies using MDCT and thin-section CT did not specify rates for the posterior pericardial recess separately from the oblique sinus.[4,5]

Pericardial cavity proper

The pericardial cavity proper contains 3 distinct recesses, namely the postcaval (also known as retrocaval) recess, the right pulmonary venous recess, and the left pulmonary venous recess.[8]

Postcaval recess The postcaval recess is an outpouching of the pericardial cavity proper situated toward the posterior and right lateral aspect of the superior vena cava.[4,6] It is bounded superiorly by the right pulmonary artery and inferiorly by the right superior pulmonary vein.[8,11] On 4-, 16-, and 64-row MDCT, the depiction rate of the postcaval recess ranged from 5.4% to 7.8%.[4]

Right and left pulmonary venous recesses The right and left pulmonary venous recesses are in the region between the superior and inferior pulmonary veins, where the pericardium attaches to the venous adventitia. These recesses extend superiorly and medially, projecting posterior to the left atrium.[1,6] On imaging, fluid in the recess may be observed both anterior and posterior to the vein, whereas adenopathy typically presents on one side of the vein and causes narrowing of the vein[11] (**Fig. 6**). The depiction rates of the right and left pulmonary venous recesses yielded visualization rates ranging from 10.9% to 19.6% and 19.4% to 26.4%, on 4-, 16-, and 64-row MDCT, respectively.[4]

CLINICAL SIGNIFICANCE OF PERICARDIAL RECESS

Knowledge of the common presentations and anatomic variations of pericardial recesses on CT is essential for medical professionals. This understanding is critical for distinguishing fluid-filled pericardial recesses and sinuses from other entities in the differential diagnosis, including adenopathy, metastases, aortic dissection, and mediastinal cysts (**Table 1**). Accurately identifying the pericardial recesses can aid in diagnosis and avert unnecessary invasive procedures.[8,19,20] Awareness of the cross-sectional imaging anatomy and typical locations of pericardial recesses and the use of multiplanar reconstructions to demonstrate contiguity with other pericardial spaces are helpful.[2,19] Measuring Hounsfield units (HU) is useful to assess cystic structures in the mediastinum. In contrast to lymph nodes that typically exhibit measurements

Fig. 5. Oblique sinus fluid. Contrast-enhanced axial CT at the level of the main pulmonary artery shows fluid in the oblique sinus (*asterisk*) and lymph node (*arrow*) posterior to the oblique sinus. Note the difference in attenuation between fluid in the oblique sinus and adjacent enhancing lymph node.

ranging between 10 and 20 HU, sinuses and recesses frequently demonstrate values of 0.7 HU, as near-water density on CT imaging.[20] Fluid with proteinaceous material or hemorrhage can have higher attenuation values on CT and mimic solid lesions. Following the administration of contrast, pericardial recesses do not exhibit enhancement, whereas lymph nodes can show contrast enhancement[2,6] (**Fig. 7**).

A potential pitfall relates to the similar low attenuation of fluid-filled pericardial recesses and necrotic lymph nodes. However, the presence of a rim of soft tissue density or enhancement around a necrotic node may aid in the differentiation.[4–6,14] Typically, fluid-filled pericardial recesses do not exert mass effect on adjacent structures.[2] The presence of fluid in the pericardial space may result in a distinct, well-defined contour with a beak-like extension as it drapes over mediastinal structures, such as the aorta, heart, and pulmonary artery.[2,21]

Pericardial recesses can have varying shapes, including band, crescent, hemisphere, ovoid, round, triangle, and rhomboid.[14,17] As the volume of fluid increases, the shape often changes from those with corners and edges, such as band-like, triangular, and crescentic, to more rounded shapes, such as rhomboid, round, and ovoid.[4] In contrast, adenopathy usually exhibits a reniform shape with lobular margins and may exert mass effect on adjacent structures.[2,6]

Performing follow-up imaging evaluations for equivocal findings of pericardial recess fluid can be useful. On subsequent imaging, the amount of fluid in the recess may remain unaltered,[16,20] increase, decrease, or even completely disappear[3,22] (see **Fig. 2**). Using multiplanar reconstructions on imaging reassessment may prove advantageous in depicting the contiguity of fluid in various recesses with other pericardial spaces[23,24] (see **Fig. 3**). Despite anatomic structures that can impede the free flow of pericardial fluid,[25] positional changes during imaging acquisition may reveal gravity-dependent fluid shift within the pericardial recesses in some instances.[3] This phenomenon can be further evaluated using cardiac motion using techniques such as MRI cine sequences.[3] Varying the patient position for imaging acquisition can

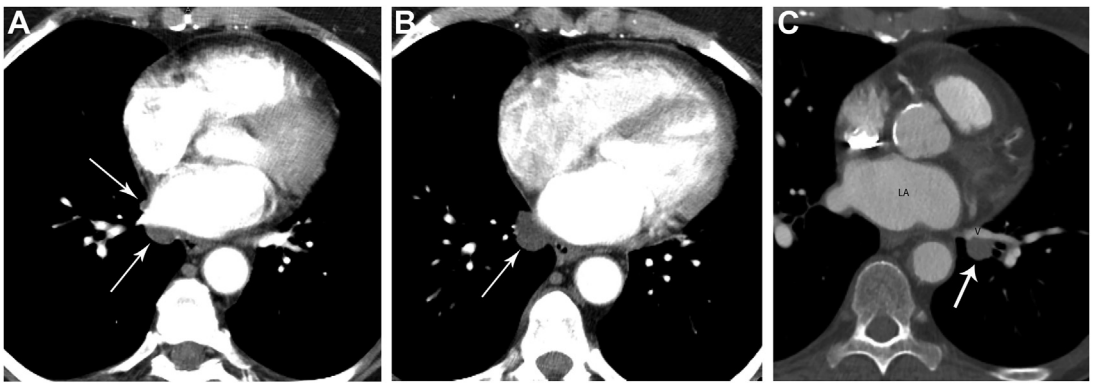

Fig. 6. Fluid in the pulmonary venous recess adjacent to the inferior pulmonary vein versus infrahilar nodal metastasis. (*A*, *B*) Contrast-enhanced axial CT shows fluid in the right pulmonary venous recess (*arrows*). Typical location, fluid attenuation, lack of mass effect, and lack of enhancement are features that help distinguish fluid from adenopathy or pericardial metastatic disease. (*C*) Contrast-enhanced axial CT shows soft tissue nodular opacity (*arrow*) posterior to the left inferior pulmonary vein and mass effect on the inferior wall of the vein (V) as it enters the left atrium (LA), consistent with nodal metastasis.

Table 1
Differential diagnosis of pericardial recesses

Sinuses and Recesses	Differential Diagnosis
Most locations	Adenopathy/ metastasis
Superior aortic recess	Aortic thrombus Aortic intramural hematoma Aortic dissection
Anterior portion of the superior aortic recess	Thymic tissue or neoplasm Mediastinal cysts Nerve sheath tumor Aortic aneurysm
Posterior portion of the superior aortic recess	Bronchogenic cyst
High-riding pericardial recess (variation)	Bronchogenic cyst Pericardial cyst Aortic dissection
Right lateral portion of the superior aortic recess	Thymic tissue or neoplasm Mediastinal cysts
Inferior aortic recess	Aortic dissection
Right pulmonic recess	Pulmonary embolism
Left pulmonic recess	Left atrial appendage thrombus
Oblique sinus	Bronchogenic cyst Esophageal lesions Cardiac lesions Descending thoracic aortic lesion
Posterior pericardial recess	Bronchogenic cyst Esophageal lesions Cardiac lesions

provide valuable information regarding the distribution of fluid within the recesses.[3]

Given the proximity of pericardial recesses to the trachea and carina, endobronchial ultrasound (EBUS) can be used to assess these pericardial recesses. Several image characteristics aid in distinguishing lymph nodes from pericardial recesses, with features such as Doppler signal, echogenicity, and anatomic cross-sectional correlation. In ultrasound evaluation, the posterior pericardial recess is situated more inferiorly relative to the subcarinal space compared with a lymph node, and it appears anechoic, 2 features that can aid in differentiation.[18,21] The superior aortic pericardial recess is depicted as a triangular area located in the lower paratracheal region, anechoic and Doppler-negative. Ultrasound evaluation can enhance the diagnostic process by identifying the fluid-attenuation feature specific to pericardial recesses, setting them apart from lymphadenopathy, and the absence of a Doppler signal aids in distinguishing a recess from vessels and the cardiac chambers.[21] In the context of ultrasound evaluation of a lesion that can be either a lymph node or a fluid-filled pericardial recess/sinus, transbronchial needle aspiration (TBNA) is feasible from an anatomic perspective. However, the need for needle aspiration has to be weighed with the risk of infection, notably mediastinitis and its grave clinical implications.[20,26]

The misinterpretation of typical pericardial recesses and sinuses as pathologic entities can have profound implications. In particular, it can lead to inaccurate staging, causing erroneous assessment of the severity or progression of a medical condition. Consequently, this can result in inappropriate treatment decisions, subjecting patients to unnecessary follow-up imaging or invasive procedures.

Differential Diagnosis of Pericardial Recesses and Sinuses

Adenopathy/pericardial metastasis

Mediastinal and hilar/infrahilar adenopathy and pericardial metastasis comprise important entities in the differential diagnosis of fluid-filled pericardial recesses. Lymph nodes and pericardial metastasis typically exhibit specific imaging characteristics on CT, including soft tissue attenuation (10–30 HU), lobular margins, and mass effect upon adjacent structures, and can show enhancement with administration of intravenous contrast (**Figs. 8–10**). In cases involving necrotic lymph nodes or metastases, the presence of a rim of soft tissue attenuation or enhancement can serve as a useful differentiating feature.[2,4–6,14] Fluid accumulation in various pericardial recesses, such as the anterior and right lateral parts of the superior aortic recess, pulmonic recesses, and pulmonary venous recesses, can lead to misinterpretation as adenopathy/metastasis.[2,6,11] The most common shape of fluid accumulation in the pericardial recesses mistaken for adenopathy/metastasis is ovoid or round.[2] In challenging cases, additional investigation or even biopsy may be considered because the misinterpretation of pericardial fluid as adenopathy/metastasis can have significant implications, including inaccurate clinical staging and inappropriate management and therapy decisions.[3,11]

Cystic lesions

Mediastinal cystic lesions are characterized by well-defined, round lesions containing fluid and lined with epithelium. They include congenital cysts (eg, bronchogenic, esophageal duplication,

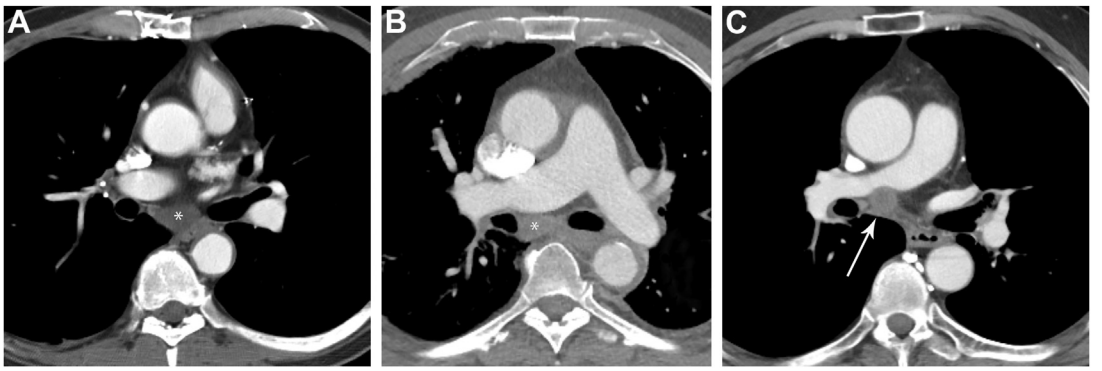

Fig. 7. Fluid in the oblique sinus versus subcarinal nodal metastasis versus pericardial metastasis. (*A*) Contrast-enhanced axial CT shows fluid in the oblique sinus (*asterisk*). (*B*) Contrast-enhanced axial CT shows soft tissue (*asterisk*) representing subcarinal nodal metastatic disease owing to pleural mesothelioma. (*C*) Contrast-enhanced axial CT shows enhancing nodular soft tissue (*arrow*) representing pericardial metastasis from lung cancer in the oblique sinus with mass effect on the posterior wall of the right pulmonary artery. Soft tissue attenuation, enhancement, and mass effect are imaging characteristics that can be seen in metastatic disease in pericardial recesses or adjacent mediastinal adenopathy.

neurenteric, pericardial, and thymic cysts), as well as meningocele, mature cystic teratoma, and lymphangioma. It is worth noting that certain tumors can undergo cystic degeneration, especially after radiation therapy or chemotherapy, resulting in a mixture of solid and cystic components on imaging.[27] Pericardial, bronchogenic, and mediastinal cysts can mimic pericardial recesses, primarily owing to their diverse shapes, in addition to their typical ovoid shape.[2,18,28]

Inaccurate diagnoses can occur when pericardial recesses and sinuses are mistaken for bronchogenic cysts, particularly in instances involving the HRSPR. This confusion arises because of the proximity of these pericardial structures to the trachea or main bronchi.[12,18,29]

Bronchogenic cysts are congenital anomalies that develop owing to abnormal ventral foregut budding between the 26th and 40th days of gestation. This aberrant bud subsequently matures into

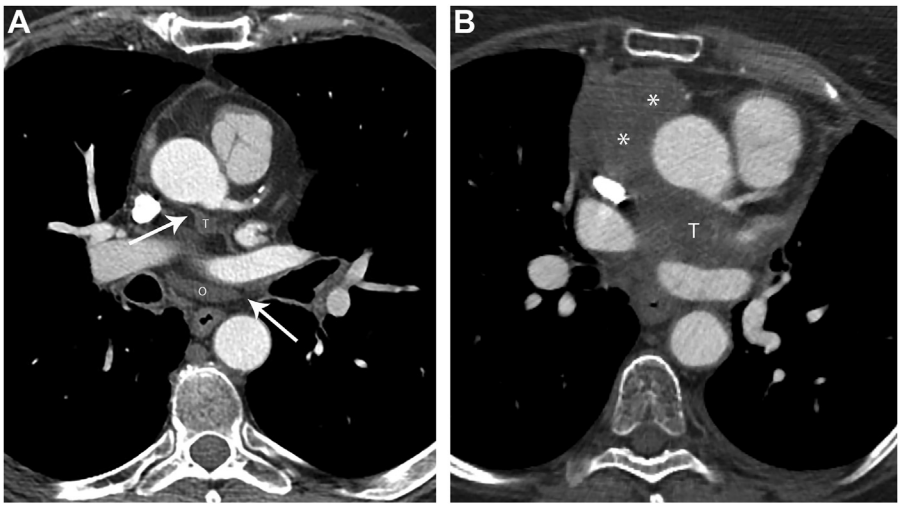

Fig. 8. Fluid versus pericardial metastasis in the inferior aortic recess of the transverse sinus. (*A*) Contrast-enhanced axial CT at the level of the ascending aorta shows fluid in the oblique sinus (O) and inferior aortic recess of the transverse sinus (T) posterior to the origin of the left anterior descending coronary artery. Note the fluid attenuation and typical beak-like appearance (*arrows*) of both pericardial fluid collections are useful to differentiate from adenopathy. (*B*) Contrast-enhanced axial CT in a patient with thymoma metastatic to the pericardium shows expansion of the transverse sinus (T) with soft tissue attenuation and pericardial tumor along the inferior aortic recess (*asterisks*) wrapping around the ascending aorta.

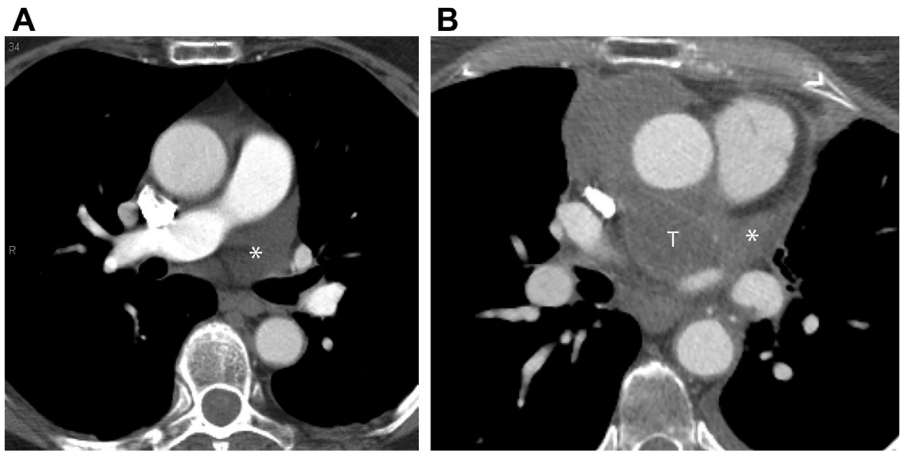

Fig. 9. Fluid versus pericardial metastatic disease in the left pulmonic recess of the transverse sinus. (*A*) Contrast-enhanced axial CT at a level just inferior to the right pulmonary artery shows fluid in the left pulmonic recess (*asterisk*) of the transverse sinus. (*B*) Contrast-enhanced axial CT shows heterogeneously enhancing soft tissue representing pericardial metastatic disease from thymoma in the left pulmonic recess (*asterisk*) of the transverse sinus (T). Soft tissue attenuation and enhancement help distinguish adenopathy or metastatic disease from recess fluid.

a fluid-filled pouch that lacks an outlet. These cysts are predominantly located in the mediastinum, typically near the tracheal carina.[30] Bronchogenic cysts are generally characterized by waterlike attenuation, although high-attenuation cysts have been documented.[30] These lesions are usually ovoid shaped with a well-defined, thin wall and may exert mass effect on adjacent structures.[2,10,18,30–32] With the administration of intravenous contrast material, enhancement of the cyst wall can aid in delineation. Although bronchogenic cysts can have attenuation values of fluid, some cysts have higher attenuation because of the presence of proteinaceous material or hemorrhage and can mimic solid lesions. These cysts can be attached to the mediastinum by a stalk or pedicle.[30] Bronchogenic cysts have been associated with a range of congenital abnormalities, such as cardiac shunts, mitral stenosis, diaphragmatic hernia, emphysema, and sequestration.[17,30]

Pericardial cysts are uncommon congenital anomalies and represent the most frequent benign pericardial masses. Although they can be found anywhere in the mediastinum, the most

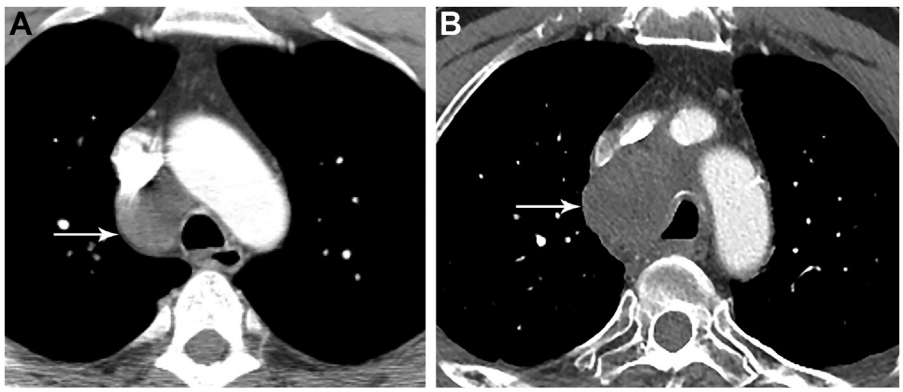

Fig. 10. High-riding variant of the superior aortic pericardial recess versus right paratracheal nodal metastasis. (*A*) Contrast-enhanced axial CT shows fluid distending the high-riding right paratracheal variant of the superior aortic pericardial recess (*arrow*). Assessment of the attenuation coefficient of this region was limited by the streak artifact from the intravenous contrast material in the superior vena cava. (*B*) Contrast-enhanced axial CT shows adenopathy in the right paratracheal region (*arrow*). Soft tissue attenuation, lobular contour, and mass effect on the right lateral wall of the trachea are features that differentiate adenopathy from a fluid-filled pericardial recess.

common location is at the right cardiophrenic angle. Pericardial cysts typically exhibit thin and smooth walls, lack internal septations, and are attached to the pericardium either directly or by a pedicle.[2,3,17] It can be challenging to differentiate pericardial diverticula, which share similar characteristics with cysts, from bronchogenic or thymic cysts in the appropriate locations. Pericardial cysts can arise in the area of pericardial recesses and sinuses.[33] The diagnosis of a pericardial cyst can be confirmed with CT, which provides a clear depiction of the cyst's location, size, and extent, as well as its fluid density. Pericardial cysts appear as well-defined ovoid lesions and do not exhibit enhancement with intravenous contrast administration. An important distinguishing feature of pericardial cysts is their ability to change in size and shape with variations in respiration or body position. In addition, they do not have connections to other pericardial recesses and sinuses.[17]

Thymic cysts are infrequent and account for approximately 1% of all mediastinal masses. They can manifest as either congenital or acquired conditions. Congenital thymic cysts are rare and originate from a patent thymopharyngeal duct. On the other hand, acquired thymic cysts may develop in individuals who have undergone therapy for mediastinal tumors or thoracotomy. These cysts can be unilocular or multilocular.[27] In the assessment of abnormalities near the anterior and right lateral portions of the superior aortic recess, it is crucial to consider cystic tumors in the anterior/prevascular mediastinum, including thymic cysts, cystic thymomas, and cystic teratomas, as potential differential diagnoses for pericardial recesses and sinuses, in addition to adenopathy.[2,5,8,23] Thymic cysts are typically well-defined, unilocular lesions with thin walls and fluid attenuation on CT. However, complications like hemorrhage or infection can lead to increased CT attenuation, resembling solid lesions. Curvilinear calcifications may be present in some cases. Thymic cysts can regress without intervention and may change in volume over time. Although wall enhancement is commonly seen on MRI, it is rarely visible on contrast-enhanced CT scans owing to CT's inferior soft tissue contrast resolution.[27,34]

Cardiovascular

The presence of fluid within the superior aortic recess, even within normal limits, can lead to misinterpretation as aortic thrombus, intramural hematoma, or dissection. In cases of aortic dissection, the superior extent of the superior aortic recess can be a source of ambiguity, particularly for type A dissections.[2] Likewise, the presence of fluid in the aortopulmonary window, inferior aortic recess, and oblique sinus can be mistaken for descending thoracic aortic dissection.[2,29]The presence of fluid in the superior pericardial recess can mimic imaging findings that resemble aortic lesions, particularly in cases of hemopericardium or thickened pericardium, where the recesses may show high attenuation.[35] The aortic root is particularly susceptible to artifacts that mimic type A aortic dissection on CT, as the curved shape of the superior pericardial recess can be mistaken for a circumferential dissection in axial images.[36] Nonelectrocardiography (ECG)-gated CT angiography carries a higher risk of false-positive diagnoses. Therefore, to evaluate equivocal findings on a nongated study, the use of ECG gating serves to minimize artifacts, optimize imaging quality, and reduce the potential for false-positive findings.[36]

Pericardial recesses and sinuses can often be misidentified as other vascular structures. For example, the left pulmonic recess can be misinterpreted as the left atrial appendage or thrombus. The right pulmonic recess can be mistaken for right pulmonary artery embolism.[29] Because of their proximity to the left atrium and pulmonary veins, the oblique sinus and posterior pericardial recess can be misinterpreted as intracardiac lesions, such as myxoma. Imaging characteristics of the oblique sinus and posterior pericardial recess that can aid in differentiation include fluid attenuation, a relatively lower position in the subcarinal space, and being surrounded by a fat tissue plane.[13,18,29] In order to distinguish pericardial recesses from cardiac conditions, cardiac CT plays a crucial role. It has high sensitivity in excluding thrombus in the left atrial appendage and offers valuable anatomic and functional information, serving as a complementary tool to echocardiography and MRI in ruling out cardiac masses.[37] Similarly, CT angiography with pulmonary embolism protocol is useful to identify pulmonary embolism.[38]

Miscellaneous

Other entities to consider in the differential diagnosis of pericardial recesses include esophageal and neurogenic lesions. In the subcarinal region, esophageal malignancy with low attenuation owing to necrosis can mimic pericardial fluid in the oblique sinus.[1,11,29] It is worth noting that the oblique sinus is usually separated from the esophagus by a visible fat plane on CT, aiding in the differentiation between these structures.[13] When examining the aortopulmonary window, it is important to consider the possibility of nerve sheath

tumors. This is especially relevant if there is clinical or imaging suspicion of recurrent laryngeal nerve injury, as it suggests the presence of a tumor rather than fluid in the pericardial recesses, specifically, the anterior portion of the superior aortic recess. Additional characteristics that suggest mass lesions instead of pericardial recesses include the presence of lobular margins and soft tissue attenuation.[2,13]

PERICARDIAL RECESS INTERVENTIONS

Diagnostic Interventions: Endobronchial Ultrasound and Transbronchial Needle Aspiration

During bronchoscopy with EBUS, it is possible to identify specific recesses as cystic and fluid-like structures located near the airway. On EBUS, a recess can be distinguished from a lymph node by its appearance as anechoic and the absence of a Doppler signal. It is crucial to stress that TBNA of fluid in pericardial recesses should be avoided whenever feasible. In one case report, TBNA of the oblique sinus recovered 2 mL of straw-colored fluid.[18,20,21] Reports have documented severe infections following TBNA of cystic structures during EBUS examinations. Furthermore, cases of bacterial infective pericarditis have been reported after TBNA of a subcarinal lymph node owing to the accidental puncture of the posterior pericardial recess.[18,20] Misinterpreting pericardial recesses as adenopathy can lead to inaccurate clinical staging in oncologic patients, which may result in diagnostic and therapeutic errors and unnecessary procedures. In patients with typical imaging characteristics, it may be appropriate to avoid invasive procedures.[18,20,21]

SUMMARY

Pericardial recesses are small reflections of the pericardium that can be detected on thin-section CT. Awareness of the anatomy and imaging characteristics of pericardial sinuses and recesses, as well as their variants is crucial to avoid misinterpretation as adenopathy, aortic dissection, or mediastinal masses. Useful imaging features to identify pericardial recesses include contiguity with other pericardial spaces or structures on multiplanar reconstructions and a beak-like shape as they drape over adjacent mediastinal structures. Conversely, adenopathy typically exhibits lobular margins, mass effect, and contrast enhancement. Accurate interpretation of pericardial recesses is important in avoiding unnecessary procedures as well as to aid in appropriate staging and patient management.

CLINICS CARE POINTS

- Thin section helical computed tomography (CT) detects small pericardial reflections.
- Pericardial reflections form recesses and sinuses that mimic adenopathy and aortic dissection on CT.
- Awareness of the imaging appearance of pericardial recesses is important to avoid unnecessary procedures or interventions.

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DISCLOSURE

The authors have nothing to disclose.

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