Pericardial recesses and their mimics: what every radiologist needs to know to avoid misinterpretation

Poster No.: P-0073
Congress: ESTI 2014
Type: Educational Poster
Authors: C. Leal¹, H. M. R. Marques², R. Santos², J. P. A. Lopes², P. Ananias², N. Costa², M. Simões², A. Araújo², L. Figueiredo²; ¹Lavradio/PT, ²Lisbon/PT
Keywords: Education and training, Normal variants, Diagnostic procedure, CT, Mediastinum, Cardiac, Anatomy
DOI: 10.1594/esti2014/P-0073

Any information contained in this pdf file is automatically generated from digital material submitted to EPOS by third parties in the form of scientific presentations. References to any names, marks, products, or services of third parties or hypertext links to third-party sites or information are provided solely as a convenience to you and do not in any way constitute or imply ECR's endorsement, sponsorship or recommendation of the third party, information, product or service. ECR is not responsible for the content of these pages and does not make any representations regarding the content or accuracy of material in this file.

As per copyright regulations, any unauthorised use of the material or parts thereof as well as commercial reproduction or multiple distribution by any traditional or electronically based reproduction/publication method ist strictly prohibited.

You agree to defend, indemnify, and hold ECR harmless from and against any and all claims, damages, costs, and expenses, including attorneys' fees, arising from or related to your use of these pages.

Please note: Links to movies, ppt slide shows and any other multimedia files are not available in the pdf version of presentations.

www.myESR.org
Learning objectives

The purpose of our presentation is:

- To review the anatomy of pericardial recesses and their variants;

- To identify and illustrate the pericardial recesses on multidetector row computed tomography (MDCT);

- To realize how can pericardial recesses simulate disease and the consequent implications;

- To understand how to differentiate pericardial recesses from pathology.

Background

The **pericardium** is a fibroserous sac that surrounds the heart that consists of an outer **fibrous component** and an inner double-layered serous sac [1].

The **serous pericardium** is composed of an inner visceral layer or epicardium, which is adherent to the heart and great vessels (surrounding main pulmonary artery, ascending aorta and superior vena cava), and an outer parietal layer, which lines the fibrous pericardium [2].

The **pericardial cavity**, the space between the parietal and visceral layers of the serous pericardium, normally contains a small amount of fluid (15 to 50ml) that forms a protective layer around the heart, acting as a barrier against local inflammation and limiting its movement within the mediastinum [3].

The pericardium can be identified at **cross-sectional imaging** when it is outlined by mediastinal and subepicardial fat (the higher-attenuation pericardium is distinguished in relation to the low-attenuation mediastinal fat anteriorly and epicardial fat posteriorly) or when it is thickened or contains enough fluid, even in the absence of pericardial effusion [4, 3]. On **CT** this is seen as a thin line of fibrous tissue; the visceral pericardium cannot be visualized separately [3].
Multidetector technology, in allowing rapid acquisition of volumetric data with narrow collimation, with consequent high temporal and spatial resolution, has improved delineation of cardiovascular anatomy and routine visualization of the pericardial recesses even without pericardial effusion [1], that are identified in up to 44% of non-ECG-gated thin-section CT scans [3].

Pericardial sinuses and recesses can simulate mediastinal disease, such as adenopathy, pericardial tumors and cysts, bronchogenic cysts, pericardial cysts, thymic cysts, other mediastinal masses, the thymus, aortic dissection and esophageal diverticula or tumor [1, 4, 6].

Misreading of pericardial recesses as a mediastinal abnormality can have important clinical implications. In oncologic imaging, misinterpretation of pericardial fluid as adenopathy can lead to inaccurate clinical staging and inappropriate management and therapy [1].

So, a comprehensive understanding of the anatomy, appearance and typical locations of pericardial sinuses and recesses, together with better visualization with MDCT and the use of multiplanar reformation, are critical in avoiding misinterpretation and enabling improved diagnostic accuracy [1].

Imaging findings OR Procedure details

At the reflections of the serous pericardium between the great vessels at the base of the heart, two extensions of the pericardial cavity, known as the transverse sinus and the oblique sinus, are formed. As the pericardium extends onto the roots of the great vessels, the pericardial cavity proper and the sinuses form pericardial recesses [2].

The pericardial recesses can be categorized on the basis of whether they arise from the pericardial cavity proper, the transverse sinus or the oblique sinus [4].

The reflections of the serosal layers are arranged around two complex tubes. One tube encloses the aorta and pulmonary trunk. The second tube encloses the superior vena cava, the inferior vena cava and the four pulmonary veins. The transverse sinus is the passage between these two pericardial tubes and is divided into the superior and inferior aortic recesses and the right and left pulmonic recesses. The oblique sinus is the cul-de-sac located behind the left atrium [1].
Transverse Sinus

The transverse sinus is located posterior to the ascending aorta and main pulmonary artery and above the left atrium [2].

Fig. 1: Transverse sinus.

**References:** Serviço de Imagiology, Centro Hospitalar de Lisboa - Zona Central, Hospital de São José - Lavradio/PT

The recesses arising from the transverse sinus are four: the superior and inferior aortic recesses and the left and right pulmonic recesses [4].

- Superior Aortic Recess

The superior extent of the transverse sinus is the superior aortic recess. It attaches directly to the aorta so that intervening fat is not identified[4].
Fig. 2: Superior aortic recess.

References: Serviço de Imagiologia, Centro Hospitalar de Lisboa - Zona Central, Hospital de São José - Lavradio/PT

It is located anterior to the ascending aorta [4], between the aorta and the superior vena cava near the junction of the brachiocephalic veins [2], usually to the level of the sternal angle [5].

Fig. 3: Superior aortic recess - higher limits, at the level of the aortic arch.

References: Serviço de Imagiologia, Centro Hospitalar de Lisboa - Zona Central, Hospital de São José - Lavradio/PT
The superior aortic recess may be further subdivided into posterior, anterior and right lateral portions [5], as defined by Kubota et al [8].

The **posterior portion** of the superior aortic recess manifests on CT as a well-defined characteristically crescentic fluid collection directly adjacent to the posterior wall of the ascending aorta, usually at the level of the left pulmonary artery.

It can be referred to as the "superior pericardial recess" [3, 5].

**Fig. 4**: Posterior portion of the superior aortic recess (blue circle).
An important variant of the superior aortic recess, with origin at the posterior portion, is a cephalad extension, the **high-riding superior pericardial recess**, which may extend cephalad and rightward into the high right paratracheal region, between the brachiocephalic vessels and trachea and to the level of the transverse aortic arc [1, 5].

This can take a variety of shapes including triangular, crescent-shaped or oval and can be mistaken for adenopathy, a bronchogenic cyst or an unusually located pericardial cyst.

**Fig. 5**: High-riding superior pericardial recess (in continuity with the posterior portion of the superior pericardial recess).  
*References*: Serviço de Imagiologya, Centro Hospitalar de Lisboa - Zona Central, Hospital de São José - Lavradio/PT

Multiplanar reformation is important to show contiguity of the portion in the high right paratracheal region with the superior aortic recess [2, 3].
Fig. 6: Coronal reformatted images - High-riding superior pericardial recess (in continuity with the posterior portion of the superior pericardial recess).

References: Serviço de Imagiology, Centro Hospitalar de Lisboa - Zona Central, Hospital de São José - Lavradio/PT

The *anterior portion* of the superior aortic recess passes anterior to the ascending aorta and pulmonary artery, forming a triangular cleft, taking a characteristic shape as it insinuates itself between these great vessels [1, 2].
Fig. 7: Anterior portion of the superior aortic recess - characteristic triangular cleft. Blue circle - posterior portion of the superior aortic recess.

References: Serviço de Imagiologia, Centro Hospitalar de Lisboa - Zona Central, Hospital de São José - Lavradio/PT

Fluid within the anterior part of the superior aortic recess may also be seen adjacent to the aortic arch [2].

Crescentic fluid in the anterior portion of the superior and inferior aortic recesses has been described as mimicking the appearance of type A aortic dissection [4]. The characteristic shape and location of the recess may prevent an erroneous diagnosis.

The band- or irregular-shaped fluid in the anterior superior aortic recess sometimes could be confused with a mediastinal mass, pericardial cysts, thymic cysts or the thymus [6].
Fig. 8: Superior aortic recess - anterior portion (orange borders) in communication with the posterior portion (blue borders).

**References:** Serviço de Imagiologia, Centro Hospitalar de Lisboa - Zona Central, Hospital de São José - Lavradio/PT

The anterior portion of the superior aortic recess also includes the area known as the **aortopulmonary window recess**.

Fluid in this pericardial space has a well-circumscribed contour with a beak-like extension as it drapes in front of the aorta and pulmonary artery [1,2].

Fig. 9: Aortopulmonary window recess - an extension of the anterior portion of the superior aortic recess (blue ellipse).
The right lateral extension of the superior aortic recess is formed by the postcaval recess, a diverticulum of the pericardial cavity proper, usually small [3], which lies behind and along the right lateral aspect of the superior vena cava [3, 7] and insinuates itself between the ascending aorta and the SVC. Posteriorly, the postcaval recess becomes a small cleft bounded by the right pulmonary artery and the right superior pulmonary vein [2].

The right lateral portion of the superior aortic recess may be a more expansile space than the posterior and the anterior portions of the superior aortic recess, probably due to being largely surrounded by fatty tissue [7].

The postcaval recess appeared triangular when small in volume and became band-shaped when large in volume [6].
Fig. 11: Right lateral portion of the superior aortic recess.

References: Serviço de Imagiology, Centro Hospitalar de Lisboa - Zona Central, Hospital de São José - Lavradio/PT

The inferior portion of the superior aortic recess communicates with the transverse sinus[4].

A small effusion in the anterior and posterior superior aortic recesses was seen as triangular to crescentic and crescentic to hemispheric, respectively. As the volume of these recesses increased, their shapes became crescentic to band and ovoid, respectively [6].
- **Inferior Aortic Recess**

It is a crescentic diverticulum that extends inferiorly between the right lateral aspect of the ascending aorta and the right atrium, posterior to the aorta and anterior to the left atrium [4, 3]. The **caudal extent** of this recess is at the level of the aortic valve annulus [1].

The shape of the inferior aortic recess was observed as linear to band when small in volume and became a thick band as fluid increased [6].

![Fig. 12: Inferior aortic recess.](image)

**References:** Serviço de Imagiolegia, Centro Hospitalar de Lisboa - Zona Central, Hospital de São José - Lavernio/PT

- **Right and Left Pulmonic Recesses**

The right and left pulmonic recesses form the lateral extensions of the transverse sinus lying inferior to the right and left pulmonary arteries, respectively [1, 4].

The **right pulmonic recess** is horizontally situated [2] and lies inferior to the proximal portion of the 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 shape of the right pulmonic recess varied. It was generally observed as rhomboid to a more complex irregular configuration regardless of its volume and sometimes had a band shape [6].
**Fig. 13**: Right pulmonic recess.

*References*: Serviço de Imagiology, Centro Hospitalar de Lisboa - Zona Central, Hospital de São José - Lavradio/PT

The **left pulmonic recess** is located below the bifurcation of the pulmonary trunk, extends behind the left atrial appendage [2] and 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 [1].

The left pulmonic recess was linear to crescentic when small in volume and became a thick band to spindle shape as it increased [6].

Fluid collections within the pulmonic recesses can mimic the appearance of lymphadenopathy [4].
Fig. 14: Left pulmonic recess.
*References:* Serviço de Imagiology, Centro Hospitalar de Lisboa - Zona Central, Hospital de São José - Lavradio/PT

Fig. 15: Oblique sinus (blue borders) - Continuity with the left pulmonic recess.
*References:* Serviço de Imagiology, Centro Hospitalar de Lisboa - Zona Central, Hospital de São José - Lavradio/PT

Oblique Sinus
The oblique sinus is the most posterior extension of the pericardial space[3, 4] and lies superior and posterior to the left atrium, anterior to the esophagus [2, 4] and posteromedial to the left superior pulmonary vein and is inferior to the transverse sinus.

Fig. 16: Oblique sinus (blue borders); adjacent mediastinal lymph node (orange arrow, more dense.

References: Serviço de Imagiologia, Centro Hospitalar de Lisboa - Zona Central, Hospital de São José - Lavradio/PT

The transverse and oblique sinuses do not communicate [3, 4].

Superiorly, the oblique sinus is separated from the transverse sinus by a double reflection of serous pericardium that envelopes the left and right superior pulmonary veins [2].
The shape of the oblique sinus was observed as linear to band when small in volume and became a thick band as it increased [6].

Recesses Arising from the Oblique Sinus:

The upper right lateral extension of the oblique sinus lies behind the distal right pulmonary artery and medial to the bronchus intermedius [2, 3] and it is called posterior pericardial recess. Fluid in the posterior pericardial recess may be mistaken for peribronchial or subcarinal lymph nodes [4].

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

Recesses arising from the pericardial cavity proper
The three recesses of the pericardial cavity proper include the postcaval recess (that forms the right lateral extension of the superior aortic recess - see above) and the right and left pulmonary venous recesses [2, 4].

- **Right and Left Pulmonary Venous Recesses**

The right and left pulmonary venous recesses of the pericardial cavity proper, which are usually small, lie along the lateral borders of the heart between the superior and inferior pulmonary veins [3], projecting superiorly and medially posterior to the left atrium, indenting the side walls of the oblique sinus.

These recesses are located where the pericardium is attached to the venous adventitia [4]. As the pulmonary veins penetrate the fibrous pericardium to enter the left atrium, a serosal sleeve of pericardium invests the veins [1,2].

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, possibly because the left pulmonary veins often form a common trunk [4].

*Fig. 18*: Left Pulmonary Venous Recess.

**References**: Serviço de Imagiologia, Centro Hospitalar de Lisboa - Zona Central, Hospital de São José - Lavradio/PT

The left pulmonary venous recess was often recognized as linear to band-shaped when small in volume and became a thick band shape when large in volume [6].
The right pulmonary venous recess can extend caudally into the serosal sleeve of the inferior pulmonary vein. At the level of the right inferior pulmonary vein, pericardial fluid in this "sleeve" recess 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 [2].

![Image of right pulmonary venous recess](image)

**Fig. 19**: "Sleeve" recess of the right pulmonary venous recess, at the level of the right inferior pulmonary vein.

**References**: Serviço de Imagiologia, Centro Hospitalar de Lisboa - Zona Central, Hospital de São José - Lavradio/PT

The right pulmonary venous recess often appeared as a small hemisphere surrounding the pulmonary vein and became round to band-shaped when large in volume, projecting into the lung parenchyma [6].

The pulmonic vein recesses are in proximity to and can be mistaken for bronchopulmonary lymph nodes [4].

In a retrospective analysis of 588 multidetector CT examinations of the chest by Ozmen et al. [9] the most commonly visualized recess was the anterior superior aortic recess (70.6%), followed by the posterior superior aortic recess (56.8%), left pulmonic recess (42.0%), oblique sinus (41.2%), right pulmonic recess (37.4%), inferior aortic recess (26.5%), left pulmonary venous recess (22.1%), right pulmonary venous recess (15.1%) and postcaval recess.
(7.1%). At least one recess was visualized in 85.2% of examinations [9].

The small recesses such as the left and right pulmonary venous recesses, inferior aortic recess, and postcaval recess, which were hardly recognized using thick-section CT (2.5-4.7% prevalence), were depicted at 10.8-19.8% prevalence using thin-section CT (Kodama F et al.) [6].

Various **mediastinal and hilar lymph nodes** lie **adjacent** to every pericardial recess [6]:

- Paraaortic lymph nodes lie near the anterior superior aortic recess;
- Lower paratracheal lymph nodes, near the posterior superior aortic recess;
- Subaortic lymph nodes, near the left pulmonic recess;
- Hilar and inferior mediastinal lymph nodes, near the right pulmonic recess;
- Paraesophageal and inferior mediastinal lymph nodes, near the oblique sinus;
- Azygous and hilar lymph nodes, near the postcaval recess;
- Lower lobar lymph nodes and pulmonary ligament nodes, near bilateral pulmonary venous recesses.

**Imaging features** to identify fluid in the pericardial sinuses and recesses and **differentiate** them from adenopathy or other mediastinal pathology include:

- Typical location;
- Compatible morphology;
- Density (fluid attenuation);
- Absence of a definable wall, internal homogeneity and absence of enhancement after contrast administration [5];
- Lack of a fat plane between the recess and the near structures in the superior aortic recess [4];
- Lack of mass effect on adjacent structures;
- Contiguity with other pericardial spaces on multiplanar reformation.
The possible morphologies of the recesses include, as previously mentioned for each one, shapes such as point, line, band, crescent, spindle, hemisphere, ovoid, round, triangle, rhomboid or irregular [6]. Some recesses may become ovoid or round when collecting a moderate to large volume of fluid [6].

Although most lymph nodes appear denser than most fluid collections, it may still be difficult to distinguish lymph nodes from fluid collections in ovoid or round recesses and necrotic lymph nodes from recesses distended with fluid (they can appear to have near-water density centers; an enhanced rim is the clue to differentiation) [7].

**Fig. 20**: Orange arrow - posterior portion of the superior aortic recess (fluid attenuation, compatible morphology, absence of contrast enhancement, lack of a fat plane between the recess and the aorta). Blue arrow - aortopulmonary window adenopathy (contrast enhancement, globous ovoid morphology).

**References**: Serviço de Imagiologia, Centro Hospitalar de Lisboa - Zona Central, Hospital de São José - Lavradio/PT
When CT features are equivocal, magnetic resonance imaging (MRI) and positron-emission tomography (PET) combined with CT may be helpful to distinguish pericardial fluid from adenopathy or other entities.

Images for this section:

**Fig. 1:** Transverse sinus.

**Fig. 2:** Superior aortic recess.
**Fig. 7:** Anterior portion of the superior aortic recess - characteristic triangular cleft. Blue circle - posterior portion of the superior aortic recess.
**Fig. 8:** Superior aortic recess - anterior portion (orange borders) in communication with the posterior portion (blue borders).

**Fig. 3:** Superior aortic recess - higher limits, at the level of the aortic arch.
**Fig. 4:** Porterior portion of the superior aortic recess (blue circle).
**Fig. 9:** Aortopulmonary window recess - an extension of the anterior portion of the superior aortic recess (blue ellipse).

**Fig. 10:** Contrast enhanced CT - Pericardial recesses with fluid atenuation and no contrast enhancement. Coronal reformatted image revealing continuity between the fluid attenuation structures, confirming their origin. Orange arrow - posterior portion of the superior aortic recess; blue circle/ellipse - aortopulmonary window recess.
Fig. 11: Right lateral portion of the superior aortic recess.
**Fig. 12:** Inferior aortic recess.

**Fig. 5:** High-riding superior pericardial recess (in continuity with the posterior portion of the superior pericardial recess).
**Fig. 6:** Coronal reformatted images - High-riding superior pericardial recess (in continuity with the posterior portion of the superior pericardial recess).

**Fig. 16:** Oblique sinus (blue borders); adjacent mediastinal lymph node (orange arrow, more dense.)
Fig. 17: Transverse sinus (orange borders) and oblique sinus (blue borders) - do not communicate.

Fig. 15: Oblique sinus (blue borders) - Continuity with the left pulmonic recess.
Fig. 13: Right pulmonic recess.

Fig. 19: "Sleeve" recess of the right pulmonary venous recess, at the level of the right inferior pulmonary vein.
**Fig. 14:** Left pulmonic recess.

**Fig. 18:** Left Pulmonary Venous Recess.
**Fig. 20:** Orange arrow - posterior portion of the superior aortic recess (fluid attenuation, compatible morphology, absence of contrast enhancement, lack of a fat plane between the recess and the aorta). Blue arrow - aortopulmonary window adenopathy (contrast enhancement, globous ovoid morphology).
Conclusion

It is essential for every radiologist to have a comprehensive understanding of pericardial anatomy and to be familiarized with the appearances of pericardial recesses, so as to allow an accurate differentiation from other mediastinal structures or pathology.

References


**Personal Information**

C. Leal, H. Marques, R. Santos, N. Costa, M. Simões and A. Araújo are Consultant Radiologists and L. Figueiredo is a Senior Consultant of Radiology, Head of Department, at Hospital de Santa Marta - Centro Hospitalar de Lisboa Central (CHLC).

P. Ananias and J. P. A. Lopes are Radiology Residents at Hospital de Santa Marta - Centro Hospitalar de Lisboa Central (CHLC).