Pericardial disease: MDCT an MR findings.

Poster No.: C-2220
Congress: ECR 2015
Type: Educational Exhibit
Authors: F. J. BORJA CONSIGLIERE, C. Biurrun Mancisidor, G. Vega-Hazas Porrúa, J. Vega Eraso, A. Borja Consigliere, I. Echegoyen Juaristi; San Sebastián/ES
Keywords: Congenital, Acute, Diagnostic procedure, MR, CT, Cardiac
DOI: 10.1594/ecr2015/C-2220

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 is 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 slideshows and any other multimedia files are not available in the pdf version of presentations.

www.myESR.org
Learning objectives

To show pathologic conditions of the pericardium and describe MDCT and MR findings.

Background

The diagnosis of pericardial disease keeps being challenging, even with modern cardiac imaging modalities. It requires integration of medical history, physical examination, laboratory tests and in some occasions invasive procedures such as fine needle aspiration or biopsy.

Transthoracic US is the first line imaging technique used in patients suspected of pericardial disease. However, cardiac CT and cardiac MR are very good alternatives due to their excellent delineation of pericardial anatomy and better tissue characterization.

Heart beat synchoronized multidetector CT scan can reduce artifacts related to cardiac movement and therefore image misinterpretation or non diagnostic scans. A better visualization of pericardium, pericardial sinus and recesses, and remainder of the heart can be achieved.

A functional cardiac analysis can be included.

Also, it is the gold standard to visualize calcified pericardium.

MR merges morphologic with functional imaging. A combined MR approach including cine imaging, T1 and T2 weighted imaging and contrast enhanced imaging allows better tissue characterization of the pericardial abnormalities and assessment of the remainder of the heart, while phase-contrast MR and real time cine imaging can be used to assess the functional impact on cardiac filling.

Findings and procedure details

Normal Pericardium
The pericardium is a thin, avascular and relatively inelastic fibroserous sac which covers the heart and the root of great vessels. It is surrounded by a variable quantity of epicardial fat (Fig. 1 on page 8).

Pericardium is best seen next to the right ventricle and worst seen next to the free wall of the left ventricle.

Its thickness varies from 1.2-1.7 mm in MR and 0.7 to 2 mm in CT.

Pericardial sinus and recesses can be seen as lines when they are empty or stripes when the quantity of fluid increases. They can adopt different morphologies such as triangular, ovoid and irregular.

**CONGENITAL PERICARDIAL ANOMALIES**

**Pericardial Cyst**

They are encapsulated cysts implanted on the pericardium which are not connected with the pericardial cavity.

On CT and MR they appear as a encapsulated, well-defined and fluid filled structure implanted on the pericardium (Fig. 2 on page 9). Typically located at the the cardiophrenic sulcus, most often on the right side (70%). Pericardial cysts are usually asymptomatic and do not contain septa nor nodularities.

Pericardial cysts should be differentiated from encapsulated pericardial effusions and other cystic structures such as bronchogenic cysts and thymic cysts.

**Pericardial Diverticulum**

Rare condition that can be congenital or acquired. It is a focal herniation through a defect in the parietal pericardium. It can be differentiated from a pericardial cyst by identifying a direct communication with the pericardial cavity. A pericardial diverticulum should be suspected when a complete wall cannot be identified in all parts of the lesion. They typically occur in the cardiophrenic angles and have the tendency to change in size over time and with postural change.

**Pericardial Defect**
Uncommon entity with a spectrum of anatomical defects ranging from a small defect to total absence of the pericardium. Partial defects are far more common than total defects, and large partial defects are more common than small partial defects. It may be associated with other malformations (heart/vascular malformations, bronchogenic cyst or hiatus hernia).

Patients are often asymptomatic but cardiac and lung structures can herniate through the defect with variable symptoms.

Diagnose may be suspected on routine chest radiographs showing an abnormal left cardiac contour with excessive levorotation ad aortic-cardiac indentation (Fig. 3 on page 9 A).

On CT and MR the diagnosis may be challenging since usually the defect is located at the lateral side of the left ventricle, which is also the worst depicted area of the pericardium in normal condition (Fig. 3 on page 9 B). Therefore, the diagnosis of the defect usually relies on other signs, such as excessive levorotation, cardiac indentation at the location of the defect and lung interposition between aorta and main pulmonary artery (Fig. 3 on page 9 C and D).

Functional MR and CT may be helpful by showing excessive mobility of the cardiac apex during the cardiac cycle.

ACQUIRED PERICARDIAL DISEASES

Effuse Pericardial Disease

Abnormal fluid accumulation may be seen in heart failure, renal insufficiency, infection, neoplasm, trauma and myocardial infarction.

CT and MR can visualize the complete pericardial sac, with better depiction of distribution and amount of fluid accumulation compared to echocardiography. Focal fluid accumulation can be also identified with better precision.

In general, a pericardial width greater than 4 mm should be regarded as abnormal.

Pericardial effusion characterization can be made with CT and MR. On CT, effusion with high attenuation values (higher than water) is more likely to be due to hemopericardium (Fig. 4 on page 10), malignancy, purulent exudate, or hypothyroid-related effusion. Low attenuation pericardial effusions have been reported in cases of chylopericardium (Fig. 5 on page 11). On MR, transudates typically have low signal intensity on T1-weighted images and high signal intensity on T2-weighted images. Exudates, having high protein and cell content, increase T1 relaxation and shorten T2 relaxation. The
signal intensity of an hemorrhagic pericardial effusion is dependent on the duration of the disease. With balanced SSFP-gradient-echo techniques, presence of fibrinous strands and coagulated blood can be seen within the pericardial fluid.

**Cardiac Tamponade**

Stretching capacity of the pericardial layers is limited, acute accumulation of pericardial contents can lead to cardiac chamber compression with decreased cardiac filling and subsequently impaired stroke volume. CT and MR has a limited role in the diagnosis of acute cardiac tamponade, these patients usually are in a critical situation, the diagnose is clinical and confirmed by echocardiography. It requires urgent therapeutic measures.

In some cases chronic, less severe forms can be identified by CT and MR (Fig. 6 on page 12).

**Inflammatory Pericarditis**

Usually echocardiography is the first modality to assess the pericardial inflammation. In some cases can be necessary to perform a CT or MR to obtain a diagnose.

The acute presentation is an important differential in the assessment of acute chest pain, but pericarditis can also present in sub-acute or chronic forms.

CT can show thickening of the pericardial layers with contrast enhancement. In chronic forms, pericardial layers are thickened and effusions can loculate as a consequence of adhesion.

On MR, thickening of the pericardial layers, as well as associated pericardial effusion can be well depicted on T1-weighted imaging or cine imaging, while T2-weighted imaging allows visualization of edema of the inflamed pericardial layers (Fig. 7 on page 13). Pericardial enhancement on contrast-enhanced MRI studies is an appropriate way to detect pericardial inflammation. In chronic pericarditis the pericardium might become more irregular and streaky enhancement of the surrounding fat and enhancement of adjacent myocardial tissue, indicating associated epicarditis or myocarditis.

**Constrictive Pericarditis**

Chronic fibrosing pericarditis is characterized by a thickened, fibrotic and/or calcified pericardium.

MR is a very accurate method for diagnosis, except in detection of pericardial calcification. CT has an excellent visualization of pericardial calcification (Fig. 8 on page 14),
even for very small quantities and can also detect intramiocardial extension of the fibrocalcifying process. Both techniques show a diffuse thickening of the pericardium, with or without calcification. Now days calcified pericardium is less frequently seen because there has been a reduction in the incidence of tuberculosis, while iatrogenic causes have become more important.

It is fundamental to make the differential with restrictive cardiomyopathy which has a different treatment. The treatment for constrictive pericarditis is to perform an early pericardiectomy.

PERICARDIAL MASSES AND PSEUDOMASSES

Different entities can cause masses or pseudomasses of the pericardium, such as neoplasm, pericardial fibrosis after radiotherapy, pericardial hematoma or infection after surgery and pericarditis.

Imaging is fundamental for diagnose.

CT and MR show the mass location and its relation to contiguous anatomical structures.

They contribute to differentiate the mass by its content or tissue characterization and enhancement pattern. MR has a better tissue characterization than CT.

PET-CT can contribute by assessing the functional pattern of neoplasms and demonstrating local and distant dissemination.

Pericardial Hematoma

CT and MR image findings will depend on the age of the collection.

Usually pericardial hematomas appear after cardiac surgery.

MR is very useful in the diagnosis of pericardial hematoma. Acute hematomas demonstrate homogeneous high signal intensity, whereas sub-acute hematomas (1-4 weeks) typically show heterogeneous signal intensity, with areas of high signal intensity on both T1-weighted and T2-weighted images. On T1-weighted and gradient-echo images, chronic organized hematomas may show a dark peripheral rim and low signal intensity internal foci that may represent calcification, fibrosis, or hemosiderin deposition (Fig. 9 on page 15). High signal intensity areas on T1-weighted or T2-weighted images often correspond to hemorrhagic fluid. Differential diagnosis should be done with coronary or ventricular pseudoaneurysms, or neoplasms that may resemble hematomas. Administration of gadolinium contrast allows the differentiation of these entities, because
hematomas do not enhance. Also cine MR imaging may be used to detect internal flow in pseudoaneurysms. See also (Fig. 10 on page 16).

**Pericardial Gossypiboma**

Pericardial gossypiboma or foreign body granuloma should be considered in patients with previous cardiac surgery. In the pericardium, it includes surgical sponges in the pericardial space overlooked after pericardiectomy.

**Pericardial Fat Necrosis**

It is a benign entity of unknown cause. It typically manifests with sudden onset of chest pain, mimicking other diseases such as myocardial infarction and pulmonary embolism. Chest pain resolves within 3-7 days. Usually affects moderate obese patients.

Chest radiography may show a high density, well defined paracardiac mass.

CT and MR imaging show an epicardial fatty encapsulated mass, located anterior, with inflammatory changes or necrosis (Fig. 11 on page 17, Fig. 12 on page 18).

**PERICARDIAL NEOPLASMS**

**Pericardial Metastasis**

Pericardial metastasis are far more common than primary neoplasms. They can reach the pericardium through the lymphatics, blood supply or invade it directly from the lungs or mediastinum.

Frequently the source of metastasis are breast cancer, lung cancer, lymphoma and melanoma (Fig. 13 on page 19).

Pericardial affection by metastasis should be suspected on CT and MR when there is effusion, an irregularly thickened pericardium or a pericardial mass. Hemorrhagic effusion secondary to metastasis often have high signal intensity on T1-weighted or T2-weighted imaging. Most neoplasms have low signal intensity on T1-weighted imaging and high signal intensity on T2-weighted imaging. One exception is melanoma which has high signal in T1-weighted imaging due to the high concentration of melanin.

Metastatic nodules and masses usually enhance after iv contrast administration.
Primary Neoplasms

Among benign tumors we can find lipoma, lipoblastoma, teratoma, fibroma, hemangioma, paraganglioma which in some cases can be locally invasive or have metastasis, and inflammatory pseudotumor.

Among malignant tumors we can find mesothelioma, primary sarcomas (angiosarcoma, synovial sarcoma, fibrosarcoma, liposarcoma, rabdomiosarcoma and undifferentiated sarcoma) and lymphoma (Fig. 14 on page 20).

CT and MR imaging are often helpful in the diagnostic workup, because they provide an accurate description of the pericardial abnormalities and the relationship to the surrounding structures and facilitate understanding of the underlying cause. However, generally a biopsy is required in order to obtain the final diagnosis.

Images for this section:

Fig. 1: Normal pericardium: Thin soft tissue dense layer surrounding the heart and the root of great vessels. A variable quantity of epicardic fat is also seen.
Fig. 2: Pericardial cyst: Encapsuled, well-defined and fluid filled structure implanted on the right side of pericardium. The cyst has a low signal on T1-weighted imaging (asterisk in left image) and a very high signal on T2 SPIR imaging (asterisk in right image).
Fig. 3: Pericardial defect: A) Chest radiograph showing an abnormal left cardiac contour with excessive levorotation and aortic-cardiac indentation, no tracheal displacement. B) Left partial pericardial defect. This CT image is not able to determine the pericardial defect, since left precardium is also the worst depicted area of the pericardium in normal condition. C and D) In many cases the diagnosis usually relies on other findings, such as lung interposition between aorta and main pulmonary artery, MR image in C and CT image D.
**Fig. 4:** Hemopericardium: Left: Coronal non enhanced CT reconstruction. High attenuation pericardial effusion due to hemopericardium (arrow). High attenuation values in ascending aortic wall due to extensive intramural hematoma (arrowheads). Right: Coronal non enhanced CT reconstruction. High attenuation values and moderate quantity of pericardial effusion (arrows) and more severe pleural effusion (empty arrowheads) due to RV myocardial and pericardial perforation by a pacemaker wire.
Fig. 5: Chylopericardium: Asymptomatic young woman in whom a routine chest radiography showed enlargement of the cardio-pericardial silhouette. CT image shows a large quantity of low attenuation fluid. Diagnosis was chylopericardium due to agenesis of the thoracic duct.
Fig. 6: Cardiac Tamponade: 72 year old man with midthoracic pain and cardiogenic syncope. Axial enhanced CT shows a large pericardial effusion flattening the anterior cardiac contour (arrow in A). Dilatation of the IVC with a diameter greater than the adjacent abdominal aorta (asterisk in B). There is also reflux of contrast material within the suprahepatic veins (thin arrows in C). Left pleural effusion is also seen in A.
Fig. 7: Inflammatory pericarditis after catheter ablation for atrial fibrillation: Late gadolinium enhanced T1 viability sequence long-axis (A). SSFP short axis (B). THRIVE sequence coronal oblique reconstruction (C). Horizontal long-axis STIR image (D). Enhancement of the entire pericardium after contrast administration (A and C). Thickening of pericardial layers (B). Diffuse hyperintense signal of the pericardium in STIR imaging.
Fig. 8: Constrictive Pericarditis: CT non enhanced imaging, axial (left) and coronal reconstruction (right). Diffusely thickened pericardium and calcified pericardium (arrows). Bilateral pleural effusion.
Fig. 9: Pericardial Hematoma: 80 years old man with prior aortic valve substitution (3 months earlier), the patient presents to the ER with acute chest pain and fever. Heterogeneous signal intensity, with areas of intermediate signal intensity on T1-weighted (asterisk in A) and high signal intensity on T2-weighted (asterisk in D) images. On SSFP gradient-echo image a dark peripheral and basal low signal foci is observed, which represent hemosiderin deposition (arrows in C). Administration of gadolinium contrast shows no internal enhancement (B) which suggests pericardial hematoma.
Fig. 10: Pericardial Hematoma: 67 years old woman who had prior mitral valve substitution two years earlier. In an echocardiographic control a 5 cm extrinsic mass is seen. Axial contrast enhanced CT confirms the presence of an hypodense mass with pericardial dependance which causes mass effect over the left ventricle. No enhancement within the mass is observed. The findings are compatible with pericardial hematoma.
**Fig. 11:** Pericardial Fat Necrosis: 54 years old man with acute onset of chest pain. (A) Normal chest radiography taken a few weeks earlier. (B) Same patient, the chest radiography shows a basal mass-shaped opacity in the left hemithorax at the time of the onset of chest pain. (C) Oblique coronal enhanced CT reconstruction and (D) axial enhanced CT image show an anterior mass located in the pericardial fat. The mass has fatty attenuation values surrounded by a thin hyperdense rim, compatible with inflammatory changes or necrosis.
Fig. 12: Pericardial Fat Necrosis: (A) non enhanced T1-weighted axial image, (B) non enhanced T1 fatsat axial image, (C) enhanced T1-weighted axial image and (D) enhanced T1 fatsat axial image. Anterior mass located in the pericardial fat. The mass looses signal in fat suppressed sequences depicting its fatty nature, hypointense rim in T1 and hyperintense rim in T1 fatsat denote inflammatory changes or necrosis.
Fig. 13: Pericardial Metastasis: Left: 64 years old man with metastatic melanoma in central nervous system, lungs and bones. Enhanced CT axial image, a nodule was found in the subepicardial fat, compatible with metastasis. Right: Enhanced CT axial image shows a lung metastasis of larynx carcinoma with pericardial infiltration by contiguity. Also necrotic adenopathies in mediastinum and right hilium.
**Fig. 14:** Cardiac-Pericardiac Lymphoma: Enhanced CT coronal reconstruction image (left), T1-weighted axial image (top-right) and SSFP axial image (bottom-right). Subepicardial mass with extension to the right ventricle and atrium. The mass envelops the right coronary artery.
Conclusion

Although the echocardiography is still the first test used to assess pericardial disease, currently CT and MR offer multiple advantages and provide additional information especially in loculated pericardial effusions, hemorrhagic effusions, constrictive pericarditis and in the evaluation and characterization of pericardial masses.

Personal information

References


