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Role of CT and MRI in Diagnosis of Pericardial Diseases

Ahmed Abd Al-Fattah Aborashed, Mohamed Ismail Ahmed, Abdullah Mohamed Wali Ali*
Department of Radio-diagnosis, Faculty of Medicine – Al-Azhar University
***Correspondence author:** Abdullah Mohamed Wali Ali, **Mobile:** (+20) 01062122664,
E-mail: abdullahwali033@gmail.com

ABSTRACT

Background: Pericardial disease is an important cause of morbidity and mortality in patients with cardiovascular disease. Although the pericardium is usually sufficiently thick to be identified on CCT and CMR, visualization at the most common site of pericardial defects, the lateral, posterior, and inferior left ventricular wall, can be poor because of a paucity of fat.

Objective: The aim of this study was to evaluate the role of CT & MRI in the diagnosis of pericardial diseases.

Patients and Methods: 30 patients with cardiac abnormalities were included. All patients' data of preoperative were reported. Range of age was 15-59 years. 20 patients were male and 10 patients were female.

Results: In our study MR imaging showed accuracy of 93% for differentiation between constrictive pericarditis and restrictive cardiomyopathy on the basis of depiction of thickened pericardium. In our study on MR images, an intact pericardial line may be observed if an adjacent tumor extends to the pericardium but not through it. Tumors that have invaded the pericardium may be recognized by focal obliteration of the pericardial line and the presence of pericardial effusion. Hemorrhagic pericardial effusions secondary to metastases usually have high signal intensity on SE images.

Conclusion: CT and MR imaging should be used when findings at echocardiography are difficult to interpret or conflict with clinical findings.

Keywords: CT, MRI, Pericardial diseases.

INTRODUCTION

The pericardium represents a simple, two-layered, fibroelastic sac that surrounds the heart and provides lubrication and protection. Normally, it is a thin-walled structure (< 3 mm) with minimal pericardial fluid (< 50 ml). The normal pericardium is fairly distensible, precluding excessive constraint of the ventricles [1]. The pericardium has been described as an intracardiac pressure modulator, limiting acute distention of any cardiac chamber [2].

Pericardial diseases are important causes of morbidity and mortality in patients with cardiovascular disease. Inflammatory diseases of the pericardium constitute a spectrum ranging from acute pericarditis to chronic constrictive pericarditis. Other important entities that involve the pericardium include benign and malignant pericardial masses, pericardial cysts, diverticula, as well as congenital absence of the pericardium [3].

The pericardium may be secondarily involved by a large group of systemic diseases, such as infective, autoimmune, and neoplastic processes. Moreover, iatrogenic causes – for example, after cardiac surgery or radiation therapy-represent an important cause of pericardial related morbidity and mortality [4].

Clinical diagnosis with a detailed examination is often complemented by ECG, chest x-ray (CXR) and echocardiography, as well as potentially hemodynamic catheterization depending on the nature and severity of the symptoms. While these tools have a broad and well-established role in the diagnosis of pericardial disease, newer modalities, such as cardiac computed tomography (CCT) and cardiovascular magnetic resonance imaging (CMR) are important methods for aiding in diagnostic evaluation [3, 5].

Echocardiography is the method of choice for evaluating most pericardial diseases. When competently performed in patients with good acoustic windows, echocardiography accurately detects all pericardial effusions and provides clinically relevant information about their size and hemodynamic importance. The technique is less reliable than MRI and CT in detecting pericardial thickening/constriction and calcification as well as small loculated effusions, but is still extremely useful in these conditions [6].

In the evaluation of pericardial disease, CT and MRI traditionally have been used as adjuncts to echocardiography. However, CT and MRI are particularly useful as sensitive and noninvasive methods for evaluating loculated or hemorrhagic pericardial effusion, constrictive pericarditis and pericardial masses. Both CT and MRI provide excellent delineation of the pericardial anatomy and can aid in the precise localization and characterization of various pericardial lesions, including effusion, constrictive pericarditis, pericardial thickening, pericardial masses and congenital anomalies. Both modalities provide a larger field of view than doe's echocardiography, allowing the examination of the entire chest and detection of associated abnormalities in the mediastinum and lungs. Soft tissue contrast on CT scans and MR images also is superior to that on echocardiograms. Given the many potential applications of these modalities in the evaluation of pericardial diseases, familiarity with the CT and MR imaging features of these diseases is important for optimal management of the patient [3, 7].

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Aim of the work

The aim of this study was to evaluate the role of CT and MRI in the diagnosis of pericardial diseases.

PATIENTS AND METHODS

In this study work, 30 patients with cardiac abnormalities were included. All patients' data of preoperative were reported. Range of age was 15-59 years. 20 patients were male and 10 patients were female.

The study was conducted in Faculty of Medicine, Alhussein Hospital, Al-Azhar Univeristy between June 2018 and June 2019.

The patients were referred to Radiology Department from the Outpatient, Inpatient and Emergency Units of the Orthopedics Department.

Inclusion criteria:

- All patients either male or female who are presented by suspected pericardial diseases.

Exclusion criteria:

- Patients who are candidates for cardiac catheterization and stent.
- Patients who are known to be ischemic heart disease

All the patients will be submitted to the following:

- Demographic and clinical data collection Including patient's name, age, gender, cardiac history, ECG, cardiac echocardiography, phone number and past history of related significance. and
- Informed consent including procedure prescription and benefits was obtained from each patient.

Ethical approval and written informed consent:

- **An approval of the study was obtained from Al-Azhar University academic and ethical committee.** Every patient signed an informed written consent for acceptance of the operation.

Imaging procedure:

- For pericardial imaging by means of CT equipped with multidetector technology, use of a high-resolution volumetric acquisition with a section thickness of greater than 3 mm generally yields an excellent anatomic depiction of the pericardium. Image artifacts related to cardiac motion can be minimized by using ECG-synchronized acquisitions, which improve visualization of the pericardial sinuses and recesses and thus reduce the risk of misinterpreting these pericardial structures as enlarged lymph nodes or focal aortic disease.
- Comprehensive MR imaging of the pericardium includes morphologic assessment of the heart, pericardium and surrounding mediastinum, assessment of global and regional LV and RV function, assessment of ventricular coupling by using real-time imaging during free breathing, assessment of ventricular filling during breath holding or free breathing by using real-time imaging, tissue characterization and evaluation of pericardial mobility and fusion of pericardial layers
- Black-blood T1-weighted spin-echo MR imaging performed with a fast segmented sequence is the best approach for morphologic study of the heart, pericardium, and mediastinum.
- The use of a small field of view and a saturation pulse positioned on the frontal chest wall may improve pericardial visualization.
- To guarantee complete depiction of the heart, it is advisable to image the heart and pericardium in two perpendicular planes.
- T2-weighted spin-echo imaging, preferably performed by using a short-tau inversion-recovery sequence (also called triple-inversion spin echo), enables depiction of pericardial fluid and/or edema of the pericardial layers in patients with inflammatory pericarditis.

Statistical analysis

Recorded data were analyzed using the statistical package for social sciences, version 20.0 (SPSS Inc., Chicago, Illinois, USA). Quantitative data were expressed as mean ± standard deviation (SD). Qualitative data were expressed as frequency and percentage.

The following tests were done:

- Independent-samples t-test of significance was used when comparing between two means.
- Chi-square (x^2) test of significance was used in order to compare proportions between two qualitative parameters.
- The confidence interval was set to 95% and the margin of error accepted was set to 5%. The p-value was considered significant as the following:
- Probability (P-value)
  - P-value < 0.05 was considered significant.
  - P-value < 0.001 was considered as highly significant.
  - P-value > 0.05 was considered insignificant.

RESULTS

MRI scan had superiority over CT regarding congenital absence of pericardium, pericardial fibroma and primary pericardial mesothelioma, sarcoma /angiosarcoma and lymphoma. Furthermore, CT scan was superior over MRI regarding constrictive pericarditis, calcification, pericardial teratoma and pneumopericardium. Moreover, there was no significant difference between both imaging technique considering pericardial effusion, acute pericarditis, and pleuro-pericadium cyst.

Socio Demographic Data

Table (1) showed the age of all included patients with range of 15-59 years.

Additionally, the gender distribution between all included patients is 20 males and 10 females.

Table 1: The age and sex of the patients

	Number of patients	Range of age

Case	30	15-59 years
	No	(%)
Case: Male	20	66.6%
Female	10	33.3%

Pericardial effusion

There were 10 cases of pericardial effusion in which CT scan could detect. Subsequently, MRI detected the same 10 cases. Therefore, there was no superiority between both imaging regarding pericardial effusion (table 2).

Table (2): Cases of pericardial effusion

Imaging	Number	%
CT	10	100
MRI	10	100

Acute pericarditis

There was 1 cases of acute pericarditis in which CT scan could detect. Subsequently, MRI detected the same case. Therefore, there was no superiority between both imaging regarding acute pericarditis (table 3).

Table (3): Cases of acute pericarditis

Imaging	Number	%
CT	1	100
MRI	1	100

Constrictive pericarditis

There were 4 cases of constrictive pericarditis in which CT scan could detect. On the other hand, MRI detected only 2 cases. Therefore, there was significant superiority for CT over MRI regarding constrictive pericarditis (table 4).

Table (4): Cases of constrictive pericarditis

Imaging	Number	%
CT	4	100
MRI	2	50

Pericardial calcification

There were 3 cases of pericardial calcification in which CT scan could detect. On the other hand, MRI detected only 1 case. Therefore, there was significant superiority for CT over MRI regarding pericardial calcification (table 5).

Table (5): Cases of pericardial calcification

Imaging	Number	%
CT	3	100
MRI	1	34

Pericardial teratoma

There were 2 case of pericardial teratoma in which CT scan could detect. On the other hand, MRI detected 1 case. Therefore, there was significant superiority for CT over MRI regarding pericardial teratoma (table 6).

Table (6): Cases of pericardial teratoma

Imaging	Number	%
CT	2	100
MRI	1	50

Pericardial lipoma

There were 2 case of pericardial lipoma in which CT scan could detect. Subsequently, MRI detected the same 2 cases. Therefore, there was no superiority between both imaging regarding pericardial lipoma (table 7).

Table (7): Cases of pericardial lipoma

Imaging	Number	%
CT	2	100
MRI	2	100

Pneumopericardium

There were 4 case of pneumopericardium in which CT scan could detect. On the other hand, MRI could detect 2 cases. Therefore, there was significant superiority for MRI over CT regarding pneumopericardium (table 8).

Table (8): Cases of pneumopericardium

Imaging	Number	%
CT	4	50
MRI	2	100

Pleuro-pericadium cyst

There were 2 case of pleuro-pericadium cyst in which CT scan could detect. Subsequently, MRI detected the same 2 cases. Therefore, there was no superiority between both imaging regarding pleuro-pericadium cyst (table 9).

Table (9): Cases of Pleuro-pericardium cyst

Imaging	Number	%
CT	2	100
MRI	2	100

Pericardial mesothelioma

There were 1 cases of pericardial mesothelioma in which CT scan could detect 1 case. Also, MRI could detect the same case. Therefore, there was significant superiority for MRI over CT regarding pericardial mesothelioma (table 10).

Table (10): Cases of pericardial mesothelioma

Imaging	Number	%
CT	1	100
MRI	1	100

ILLUSTRATIVE CASES

Case 1

A 22-years-old Caucasian man with no complaints or co-morbid conditions presented to our hospital after an abnormal medical check-up before being hired for a job. The young man was healthy and had good functional capacity. He denied fever, weight loss, previous disease, or any neoplasm history in his family. His physical examination revealed that he was apyrexial, normotensive, and eupneic. His thyroid, lymph node, chest and abdominal examinations were normal.

Gross examination showed a rounded tumor measuring 8.0 cm × 8.0cm × 4.0cm and weighing 66g. The tumor was predominantly cystic, with a thin, sharply delineated wall filled with sebaceous material and hair.

Diagnosis: Picture suggestive of mature cystic teratoma.

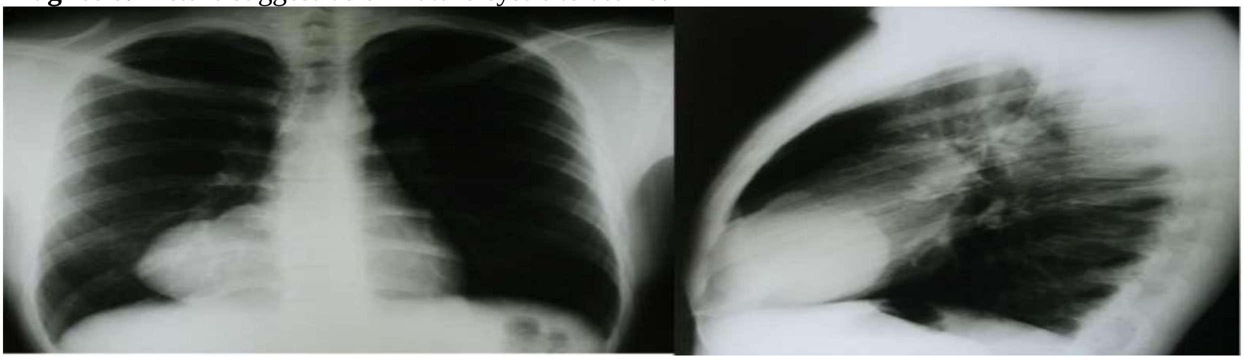

Figure (1): Chest X-ray (PA & lat views) showed a mass in the right cardiophrenic sinus with homogeneous, hazy density and a partially well- delineated margin continuous to cardiac shadow.

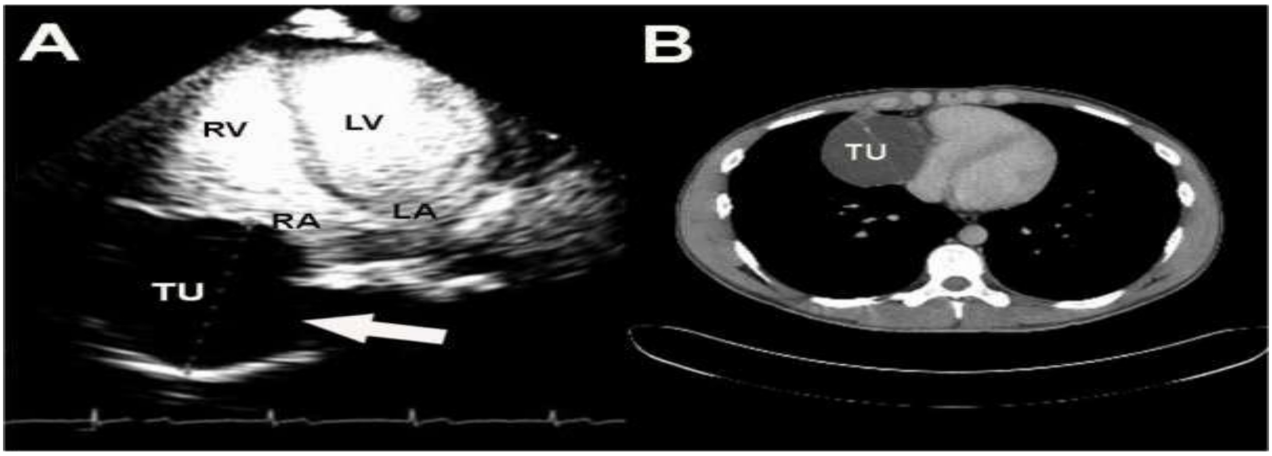

Figure (2): (A) Contrast-enhanced echocardiographic image obtained after intravenous injection of lipid-encapsulated micro bubbles. The apical four-chamber view demonstrated normal left ventricular opacification and low opacification of the tumoral mass. (B) CT image demonstrating a septate cystic mass containing septal calcification, which was continuous to the pericardium and caused extrinsic compression of the right atrium.

Case 2

A 15-years-old, asymptomatic sports boy underwent routine ECG exam by a sport medicine physician, in which several extra-systoles were detected and no significant findings were seen at echocardiography. Therefore, he was referred for cardiac magnetic resonance.

Axial images revealed normal rotation of the heart and the pericardial coat extending over the inferior and anterior walls of the left ventricle in sagittal images. It was observed that the medium-apical portion of the posterior-lateral wall of the left ventricle was not covered by pericardium and was in direct contact with pulmonary parenchyma. Both ventricles were normal for morphology and function particularly the left ventricular wall did not show any alteration suspicious for herniation of cardiac structures through the defect.

Diagnosis: MRI showed partial absence of the pericardium sac on the left side.

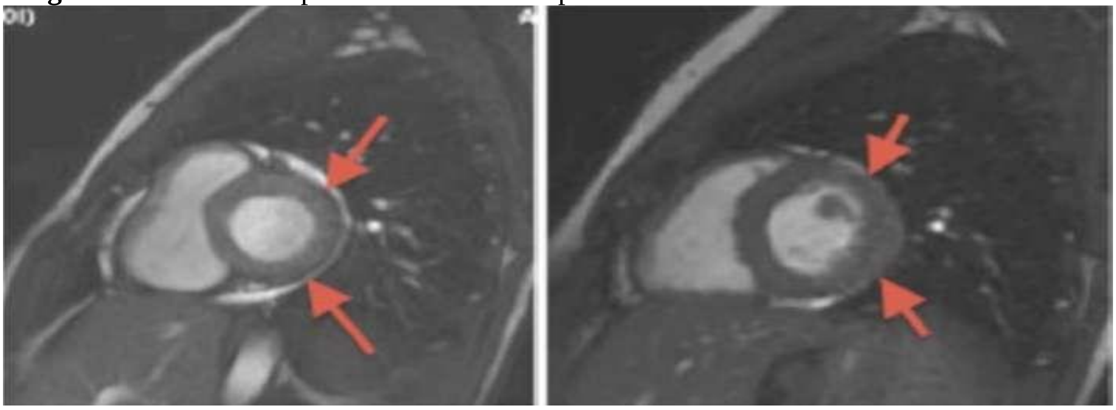

Figure (3): MRI, sagittal scans: partial agenesis of the left pericardium. (a) The basal portion of the posterior-lateral wall of the left ventricle is covered by pericardium (arrows), which appears as a hypointense line between the myocardium (of medium intensity) and the adipose pericardial tissue (hyperintense). (b) The pericardial coating disappears in the medium-apical portion (arrows). No signs of herniation or ischemia are detected.

Case 3

A 55-years-old woman presented to the emergency department with complaints of breathing difficulty that had persisted for 2 days. The patient is a home maker with no history of exposure to asbestos. On examination, the patient was in sinus rhythm with a blood pressure of 110/80 mmHg. Ultrasound identified bilateral mild to moderate pleural effusion. The patient was then shifted to the ICU because of severe breathing difficulty. Echocardiogram showed mild pericardial effusion. The patient was evaluated with CT.

Diagnosis: Picture suggestive of primary malignant pericardial mesothelioma**.**

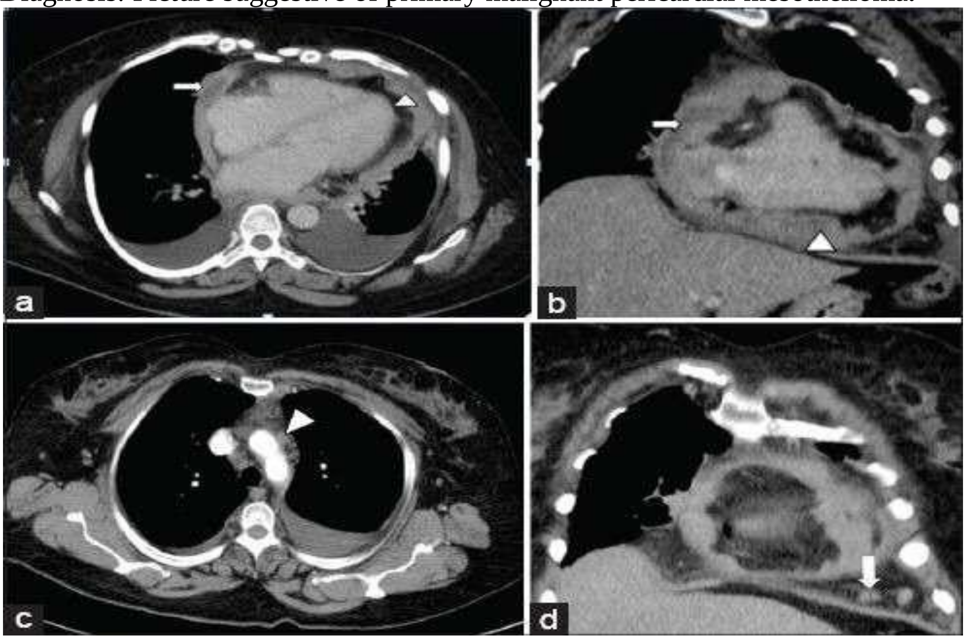

Figure (4): 55 years old woman with breathing difficulty. (a and b) Contrast-enhanced axial and reformatted coronal CT images of the thorax showed lobulated thickening of the pericardium (arrow head) and fluid collections within the pericardial sleeves (arrow). (c and d) Contrast- enhanced axial and coronal reformatted CT images of the thorax showed enlarged prevascular (arrow head) and pericardial lymph nodes (arrow).

DISCUSSION

In the evaluation of pericardial disease, computed tomography (CT) and magnetic resonance (MR) imaging traditionally have been used as adjuncts to echocardiography [8].

However, CT and MR imaging are particularly useful as sensitive and noninvasive methods for evaluating loculated or hemorrhagic pericardial effusion, constrictive pericarditis, and pericardial masses. Both CT and MR imaging provide excellent delineation of the pericardial anatomy and can aid in the precise localization and characterization of various pericardial lesions, including effusion, constrictive pericarditis, pericardial thickening, pericardial masses, and congenital anomalies such as partial or complete absence of the pericardium [9]. Both modalities provide a larger field of view than doe's echocardiography, allowing the examination of the entire chest and detection of associated abnormalities in the mediastinum and lungs. Soft-tissue contrast on CT scans and MR images also is superior to that on echocardiograms. Given the many potential applications of these modalities in the evaluation of pericardial diseases, familiarity with the CT and MR imaging features of these diseases is important [10].

CT or MR imaging should be used when findings at echo are nondiagnostic or difficult to interpret or when loculated or hemorrhagic pericardial effusion and pericardial thickening are suspected. CT and MR imaging also are useful for further characterization of pericardial masses detected at echocardiography. CT and MR imaging provide excellent visualization of the pericardium in most patients [11].

The thickness of the normal pericardium, measured on CT scans and on MR images, is less than 2 mm. Discrimination of the pericardium from the myocardium on radiologic images requires the presence of epicardial fat or pericardial fluid. The diagnosis of constrictive pericarditis is greatly aided by the excellent depiction of the pericardium at CT and MR imaging [12].

Pericardial thickness of 4 mm or more indicates abnormal thickening and when it is accompanied by clinical findings of heart failure, becomes highly suggestive of constrictive pericarditis. Pericardial thickening may be limited to the right side of the heart or to an even smaller area, such as the right atrioventricular groove. An additional advantage of CT is its high sensitivity in depicting pericardial calcification, which is also associated with constrictive pericarditis [13].

It is important to remember, however, that neither pericardial thickening nor calcification is diagnostic of constrictive pericarditis unless the patient also has symptoms of physiologic constriction or restriction. At both CT and MR imaging, the central cardiovascular structures may show a characteristic morphology in constrictive pericarditis [14].

Most benign neoplasms are curable with surgery and therefore radiologic detection and characterization is critical. The early diagnosis of malignant neoplasms plays a role in palliation. In cases of lymphoma, chemotherapy may result in remission of disease. Chest radiographs are frequently abnormal, reflecting the location and extent of tumor and prompting further investigation. CT & CMR are generally necessary to accurately delineate the tumor implantation and to better evaluate the extent of tumor spread. Disruption of the pericardial lining, presence of an associated hemorrhagic effusion, and invasion of the tumor into the epicardial fat tissue, myocardium or into a cardiac chamber (rather than causing displacement of these structures) are characteristics of a lesion with an aggressive nature. Associated lymphadenopathy is another important finding suggesting malignancy. Tissue characterization with CMR is superior to cardiac CT and echocardiography. CMR can differentiate tumor from thrombus and is often helpful to assess the perfusion of a pericardial mass with the use of gadolinium contrast. The final diagnosis depends on typical pathologic features [11].

In our study MR imaging showed accuracy of 93% for differentiation between constrictive pericarditis and restrictive cardiomyopathy on the basis of depiction of thickened pericardium.

In our study on MR images, an intact pericardial line may be observed if an adjacent tumor extends to the pericardium but not through it. Tumors that have invaded the pericardium may be recognized by focal obliteration of the pericardial line and the presence of pericardial effusion. Hemorrhagic pericardial effusions secondary to metastases usually have high signal intensity on SE images. Most neoplasms have low signal intensity on T1-weighted images and high signal intensity on T2-weighted images. Metastatic melanoma is an exception; it may have high signal intensity on T1-weighted images because of the paramagnetic metals bound by melanin.

CONCLUSION

Sites of malignant disease usually enhance significantly after the administration of contrast material. Infection, neoplasm, injury and congenital disease all may affect the pericardium.

CT and MR imaging should be used when findings at echocardiography are difficult to interpret or conflict with clinical findings.

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