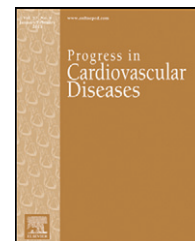


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Pericardial Masses, Cysts and Diverticula: A Comprehensive Review Using Multimodality Imaging

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ABSTRACT

Pericardial masses/tumors, cysts, and diverticula are quite rare. Presentation is variable and often patients may be asymptomatic with pericardial involvement initially only detected at time of autopsy. When patients do present with symptoms they are often non-specific and often mimic other conditions of the pericardium such as pericarditis, pericardial effusion, constriction or tamponade. Therefore, echocardiography and cross-sectional imaging are essential in identifying and characterizing pericardial disease. Imaging findings vary in specificity depending on the type of tumor. The purpose of this review is to describe the role of multi-modality imaging and characteristic findings in patients with pericardial masses/tumors, cysts, and diverticula.

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Abbreviations and Acronyms

cCT = Cardiac computed tomography

cMRI = Cardiac magnetic resonance imaging

The normal pericardium is comprised of an outer fibrous layer and an inner serous sac composed of mesothelial cells with visceral and parietal layers. The visceral layer is indistinguishable from the epicardium and lies atop of epicardial fat. There is additional pericardial fat which lies atop the fibrous layer. The average thickness of the pericardium is less than 2 mm, and it contains approximately 25–50 ml of transudative fluid.^{1,2} The pericardial sinuses are the reflection of the pericardial sac abutting the great vessels. The transverse sinus is located on the superior aspect of the heart, posterior to the ascending aorta and pulmonary artery, and anterior to the atria and superior vena cava. The oblique sinus is located inferiorly between the inferior vena cava and pulmonary veins.¹

On echocardiography the pericardium is often not directly viewed, but rather seen as a bright, hyperechoic line at the interface with lung tissue. Pericardial fluid is often only seen in systole as a thin, hypoechoic line around the myocardium and the pericardium is not directly visualized unless either the parietal or visceral pericardial layer is >5 mm thick.³ On cardiac computed tomography (cCT) the pericardium is visualized as a bright, linear structure around the heart in contrast to surrounding fat with an average thickness of 1.3–2.5 mm.^{3,4} By Cardiac Magnetic Resonance Imaging (cMRI) the average pericardial thickness is 1.2 mm in diastole and 1.7 mm in systole with variable visualization depending on the image plane.⁵ Pericardial fluid has low-signal intensity on T₁-weighted sequences; however, with fat suppression the background signal becomes suppressed and pericardial fluid develops a high signal intensity. Due to limits of spatial resolution pericardial fluid cannot be distinguished from the pericardial lining unless it is thickened.⁵ The difference between observed pericardial thickness and that measured by cMRI has been attributed to this difficulty in distinguishing pericardial fluid from the pericardial lining due to motion of the pericardial layers, limits of spatial resolution, and artifacts at the fat–fluid interface due to chemical shifts.^{5,6} The focus of this review will be on pericardial masses, cysts and diverticula, the use of multi-modality imaging in the identification of these lesions.

Pericardial tumors

Overall incidence of cardiac and pericardial tumors is low and has been shown to be 1–3 per 10,000 patients in autopsy series.^{7–9} Tumors in the pericardium can additionally be divided into primary or metastatic in origin. Metastatic tumors of the pericardium are more common than primary tumors, with estimated incidence from autopsy studies ranging widely from 20 to 1000 times more likely.^{8–11} Due to the rarity of these tumors, initial data were in the form of case reports and more recently as larger case series. Presentation is variable and often patients may

Pericardial disease comprises a diverse spectrum of disease processes, including pericarditis, effusions, tumors, and congenital abnormalities. The

be asymptomatic with pericardial involvement initially only detected at time of autopsy or on cross-sectional imaging in the current era.¹² When patients do present with symptoms they may be non-specific including chest pain, dyspnea, palpitations, syncope or systemic symptoms and often mimic other conditions of the pericardium such as pericarditis, pericardial effusion, constriction or tamponade.¹³ Physical examination findings may include a pericardial rub or knock, muffled heart sounds, elevated jugular venous distention, hepatomegaly, edema or pulsus paradoxus.¹⁴ Imaging findings vary in specificity depending on the type of tumor, but the most common findings are pericardial thickening or effusion.¹⁵ Specific findings on cross-sectional imaging suggestive of a malignant mass include local invasion, heterogeneous signal intensity, delayed enhancement and presence of a pericardial effusion.^{16–18}

Pericardiocentesis is recommended in cases of pericardial tamponade, recurrent or large pericardial effusion, or a pericardial effusion in the setting of known or suspected malignancy.¹⁹ Rapid reaccumulation of hemorrhagic pericardial fluid following pericardiocentesis is suggestive of malignancy.²⁰ Even in cases with imaging findings concerning for malignancy, biopsy is often required for diagnosis because imaging findings are often non-specific and pericardial fluid cytology may be negative.^{21–23} Caution is required in the interpretation of pericardial fluid analysis negative for malignancy regardless because in 25% of patients who have a pericardial biopsy with evidence of malignancy the initial fluid cytology was negative; however, up to two thirds of patients with known malignancy and a pericardial effusion do not have a neoplastic source of their effusion by biopsy.^{24–26} Treatment and prognosis of these tumors are beyond the scope of this review.

Primary tumors

Common primary neoplasms of the pericardium can be both benign and malignant. Benign primary neoplasms include lipoma, teratoma, fibroma and hemangioma and comprise approximately 80% of primary pericardial tumors.²⁷ Lipomas are slow-growing, typically asymptomatic, encapsulated collections of adipose cells which are thought to arise from the atrio-ventricular grooves.^{10,15} Teratomas are benign germ cell tumors found in infants and children with evidence of all three germ layers, calcifications and cystic components on pathology and imaging. They are often right-sided tumors which may cause compressive symptoms of adjacent structures including the right atrium, superior vena cava, pulmonary artery or aortic root.²⁸ Fibromas are solid masses most commonly found in children composed of fibroblasts which commonly have areas of calcification and rarely areas of necrosis or cystic change.^{10,28} Hemangiomas are vascular masses of either capillary, cavernous or arteriovenous etiology which may present in any age group, and when found in the pericardium are often of the cavernous type and arise from the visceral pericardium.^{28–30} Lymphangiomas may resemble cysts, however they usually have thicker walls, are multilocular and contain lymphocytes and blood vessels.³¹

Malignant primary neoplasms include mesothelioma, sarcoma (angiosarcoma, liposarcoma, undifferentiated) and lymphoma. Mesothelioma arises from the mesothelial cells of

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