

Constrictive pericarditis: Morphological, functional and haemodynamic evaluation

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Learning objectives

To demonstrate the spectrum of appearances of constrictive pericarditis on MRI, plain films and CT.

To discuss the pathophysiology of the septal bounce, a common finding seen in constrictive pericarditis.

Background

Basics

- Inability of the ventricles to fill because of physical constraints imposed by a rigid, thickened, and sometimes calcified pericardium.

Causes

- Tuberculosis: in less developed countries
- Malignant disease (lung cancer, breast cancer, lymphoma)
- Mediastinal irradiation
- Histoplasmosis
- Purulent or recurrent viral pericarditis
- Rheumatoid arthritis
- Uremia
- Chest trauma or hemopericardium
- Cardiac surgery

Pathophysiology

- normal pericardium is 3 mm or less thick
- with chronic constriction, the pericardium may thicken to 6 mm or more
- with constriction, the impairment in ventricular filling is minimal in early diastole
- subsequently, diastolic pressure rises abruptly when cardiac volume reaches the anatomic limit set by the noncompliant pericardium
- stroke volume and cardiac output are reduced because of impaired filling, whereas intrinsic systolic function of the ventricles may be normal or only minimally impaired.

Clinical Manifestations

- dyspnea, weakness, anorexia, peripheral edema, hepatomegaly, splenomegaly, and ascites
- the pulse pressure is often narrowed
- pleural effusions are common
- the clinical picture may mimic hepatic cirrhosis, but with distended neck veins
- venous pressure often fails to fall with inspiration (Kussmaul's sign)
- heart sounds may be distant

Imaging findings OR Procedure details

Morphologic Abnormalities

Pericardial thickening and calcification

1. This thickening is usually most pronounced over the right heart side (right ventricle and anterior atrioventricular groove), and the pericardial delineation is often irregular
2. Greater than 4mm is suggestive; greater than 6mm: high specificity
3. though suggestive, the finding of pericardial calcification is not diagnostic of constriction
4. about 1 in 5 patients with CP have normal pericardium, and the isolated finding of thickened pericardium does not imply constrictive physiology

Chest x-ray

- may show pericardial calcification in tuberculous constriction

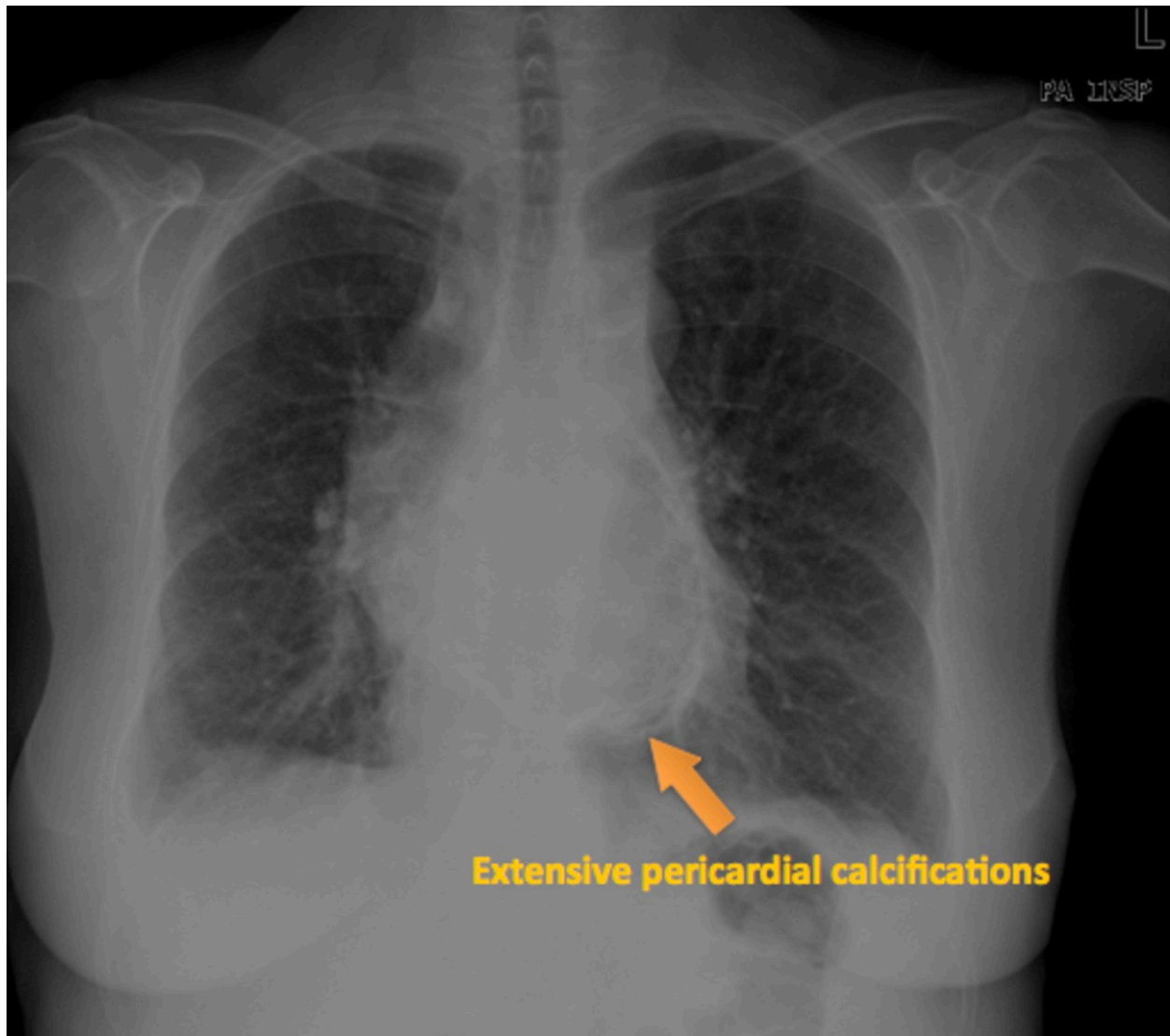


Fig.

References: F. Caseiro-Alves; Department of Radiology, Coimbra University Hospital, Coimbra, PORTUGAL

Echocardiography

- M-mode and 2-dimensional echocardiography show poor sensitivity to detect a pericardium more than 3 mm thick
- Transesophageal echocardiography, because of superior resolution, showed much better results

CT

- the most appropriate technique to depict pericardial calcification

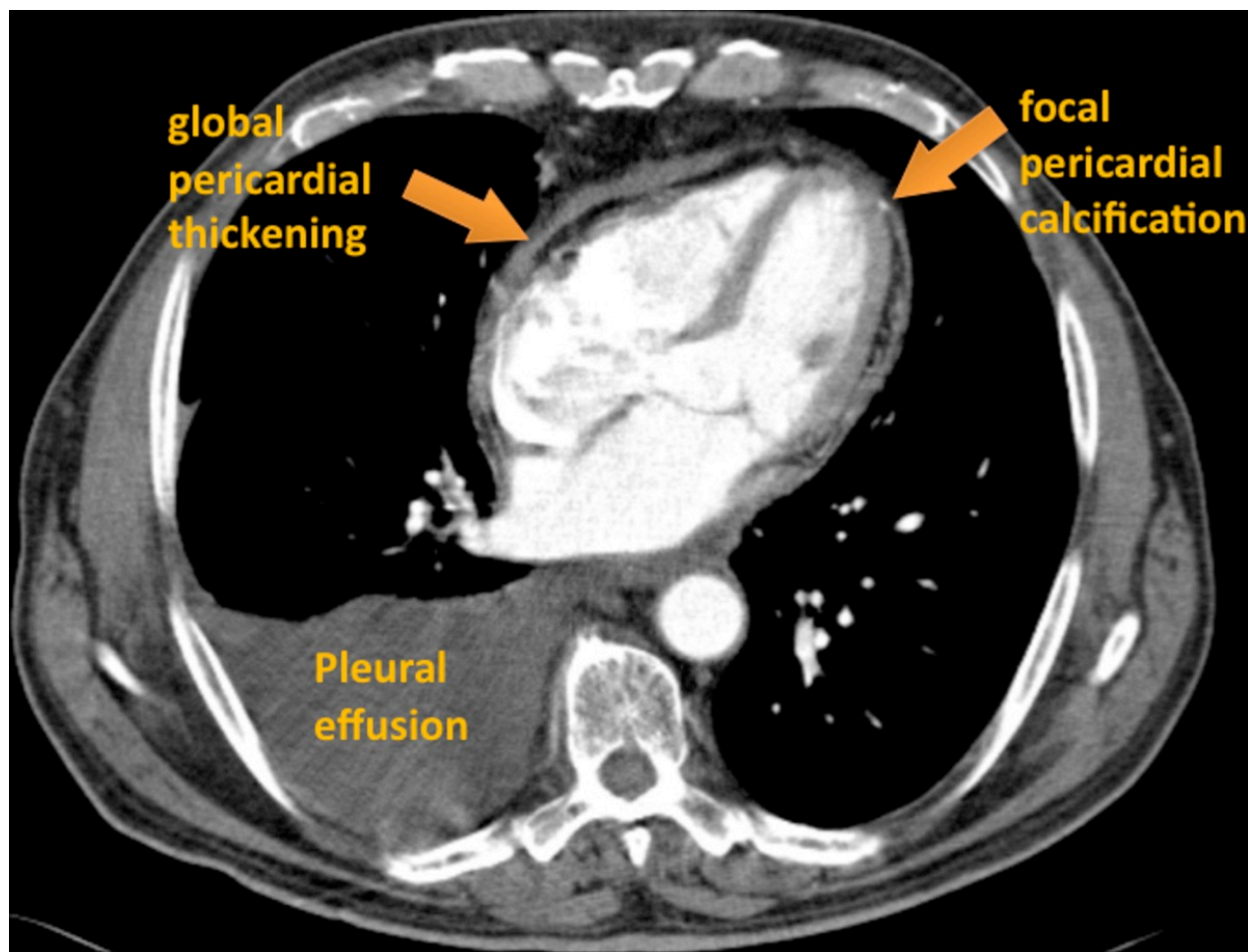


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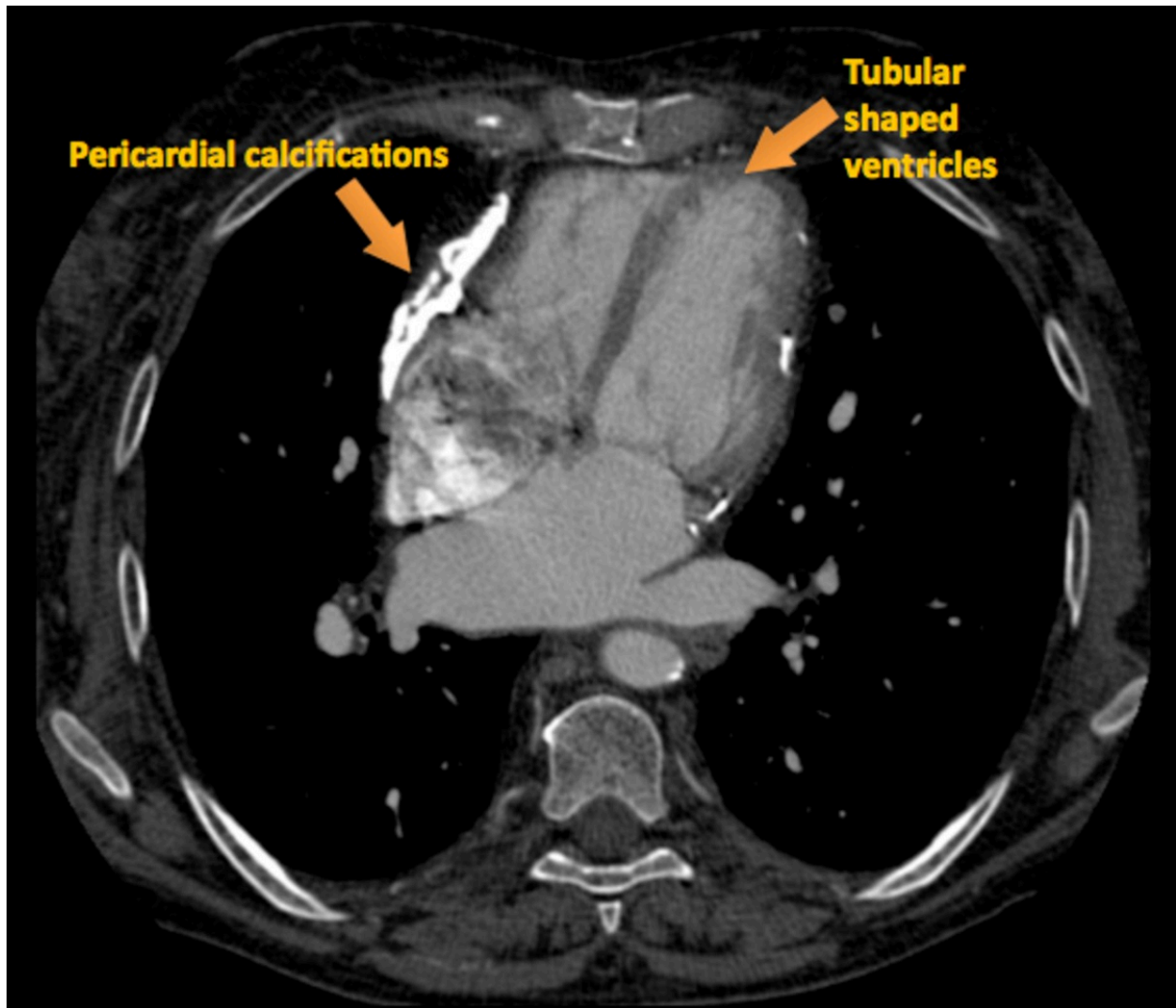


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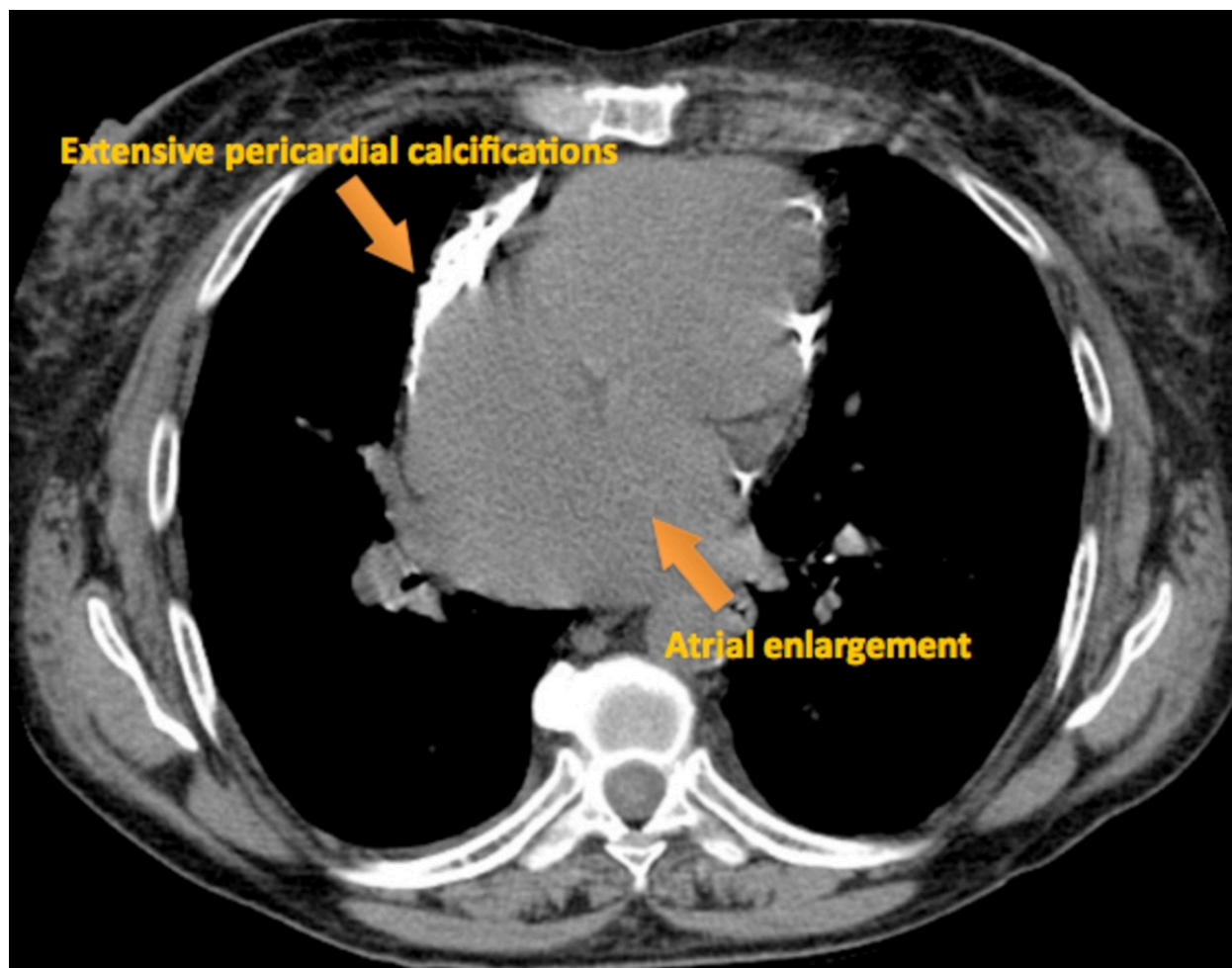


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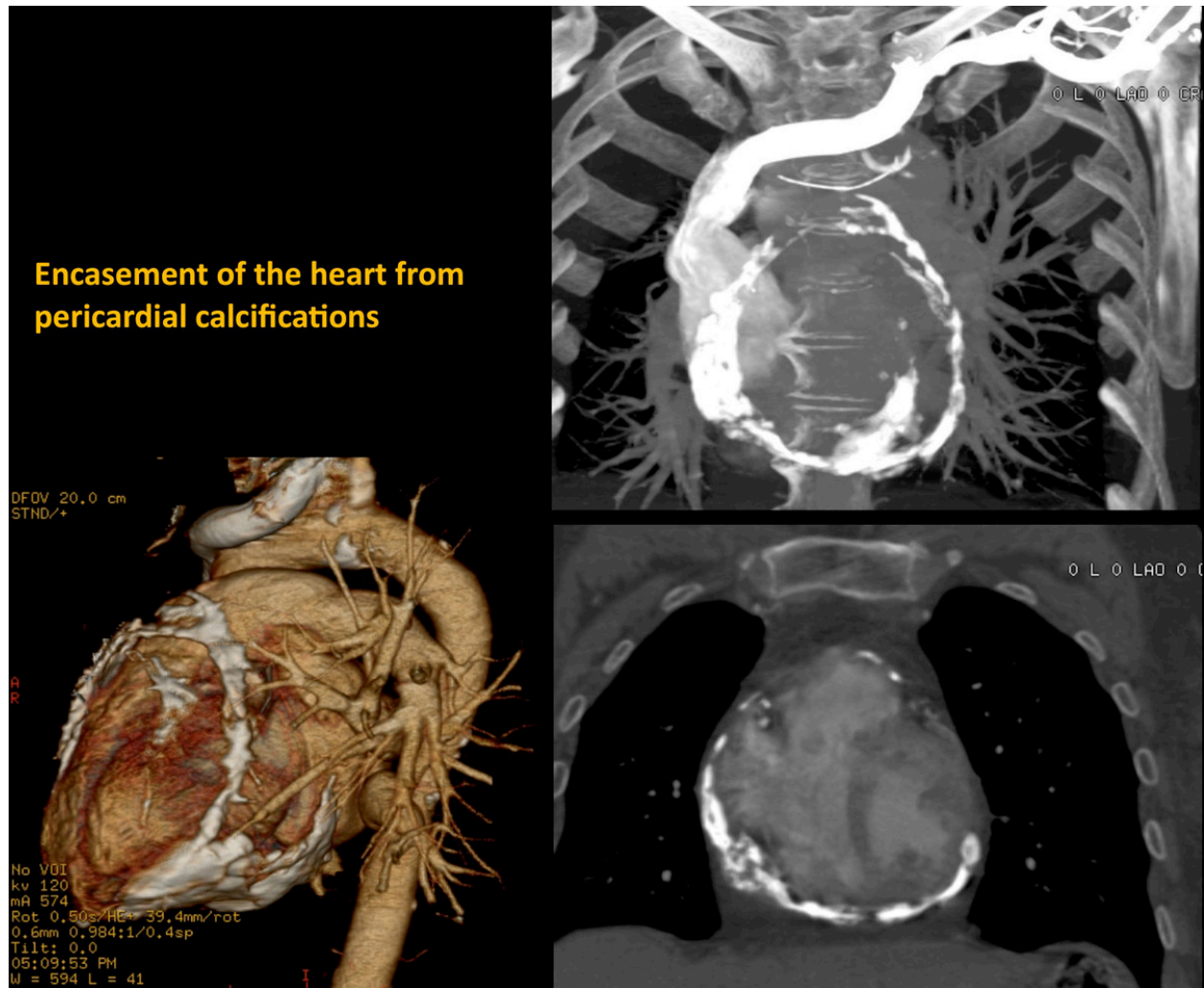


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MRI

- Abnormal pericardium with low signal on all sequence
- Occasionally in subacute forms, thickened pericardium may have moderate to high signal on T2wi
- and no enhancement after gadolinium
- delayed enhancement may be present, related to acute / subacute inflammation or fibrous thickening

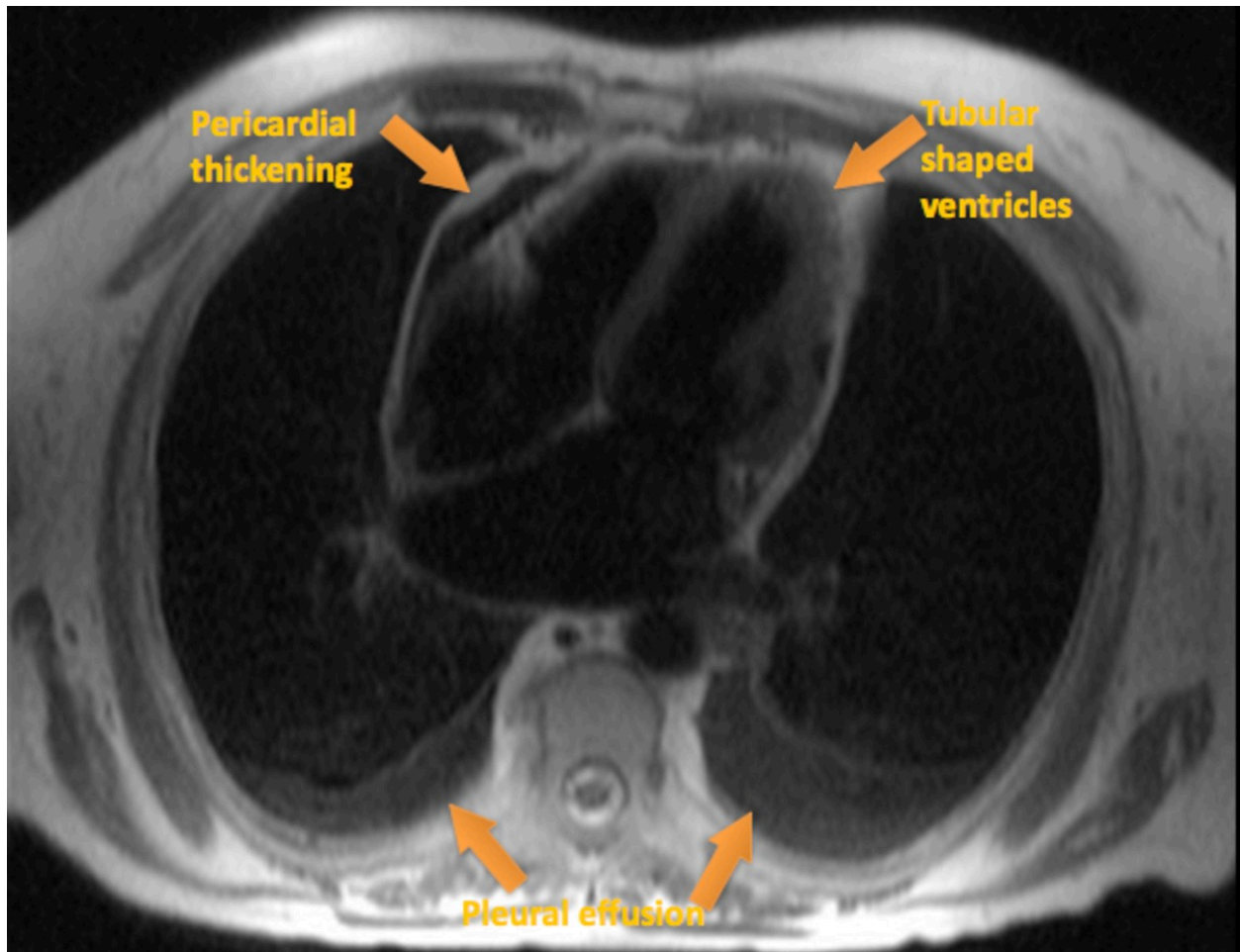


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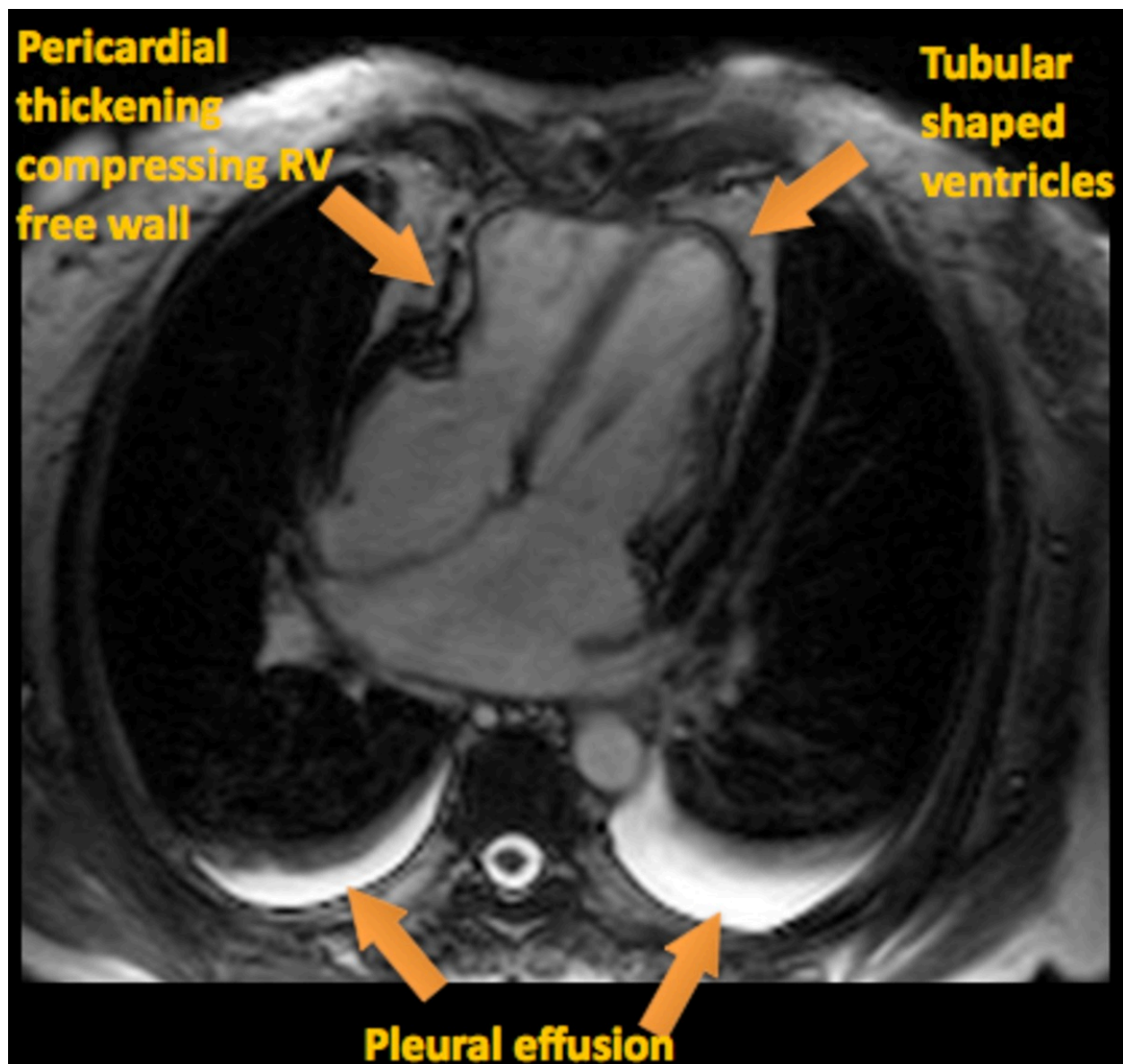


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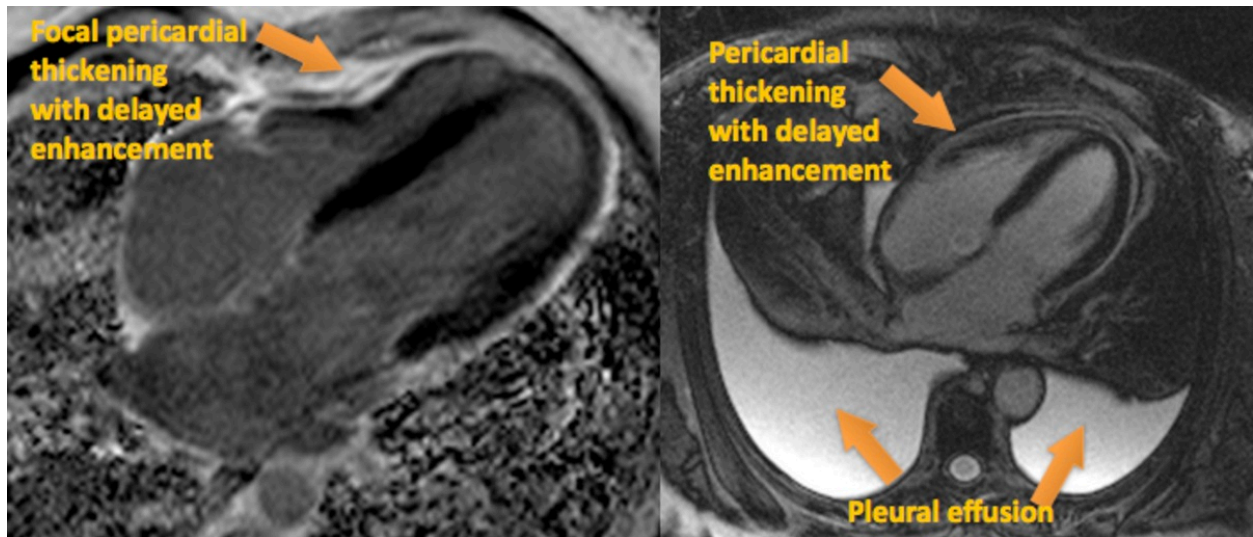


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Flattened or tubular-shaped appearance of the ventricles

- Ventricles constricted by the abnormal pericardium
- CT may show flattening of right ventricle in static image
- Cine MR more easily depicts small LV + tubular appearing RV

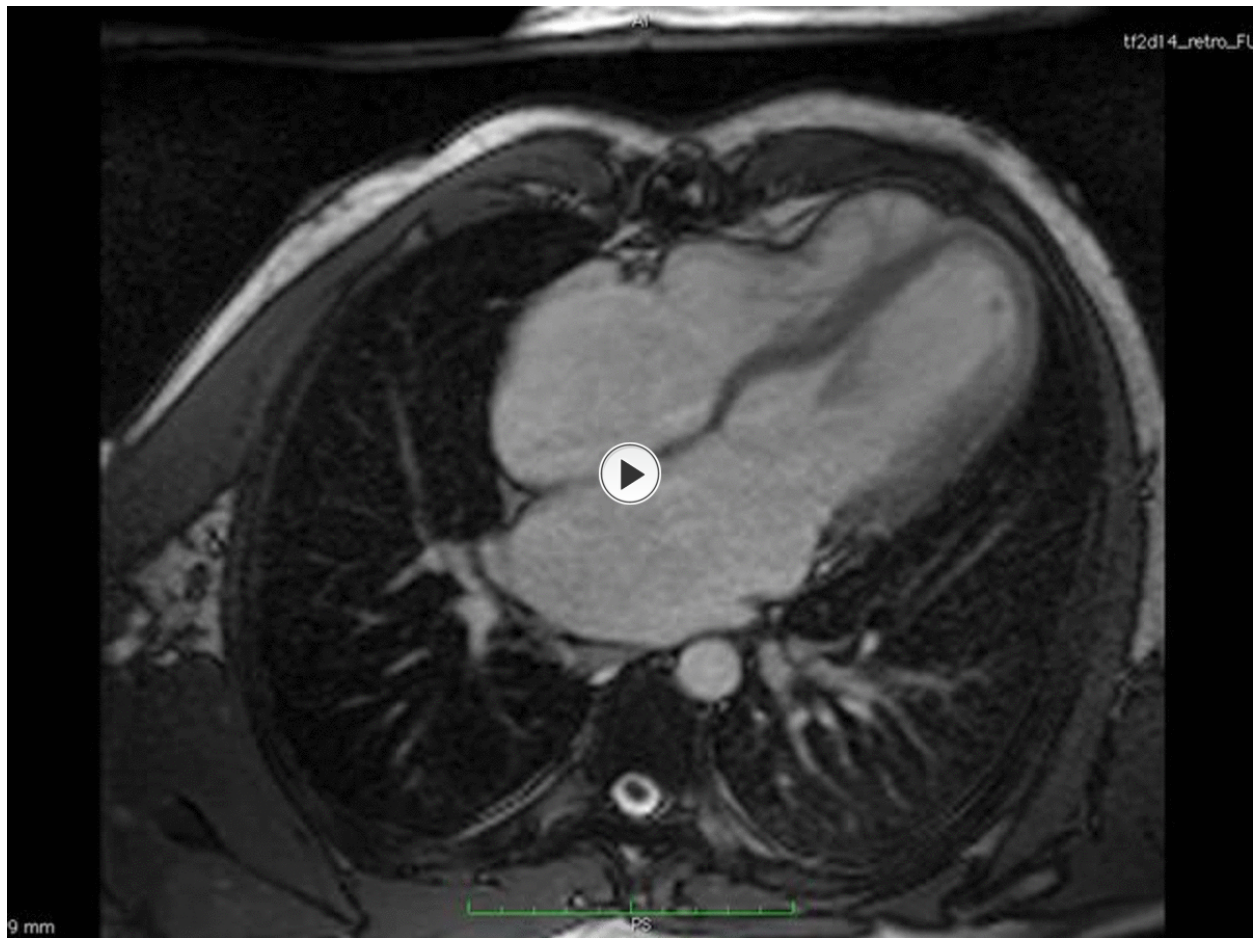


Fig.: Four-chamber cine MR images. Focal thickening of pericardium compressing RV free wall and causing impaired RV diastolic filling

References: F. Caseiro-Alves; Department of Radiology, Coimbra University Hospital, Coimbra, PORTUGAL

Atrial enlargement; enlargement of superior and inferior vena cavae

- as a result of the increased cardiac filling pressures
- Chest x-ray: Radiographic signs of atrial enlargement not sensitive or specific; Widened superior mediastinum (enlargement of SVC)
- US can show dilation of hepatic veins and distention of the coronary sinus and inferior vena cava
- CT and RM the best imaging modalities to detect these alterations

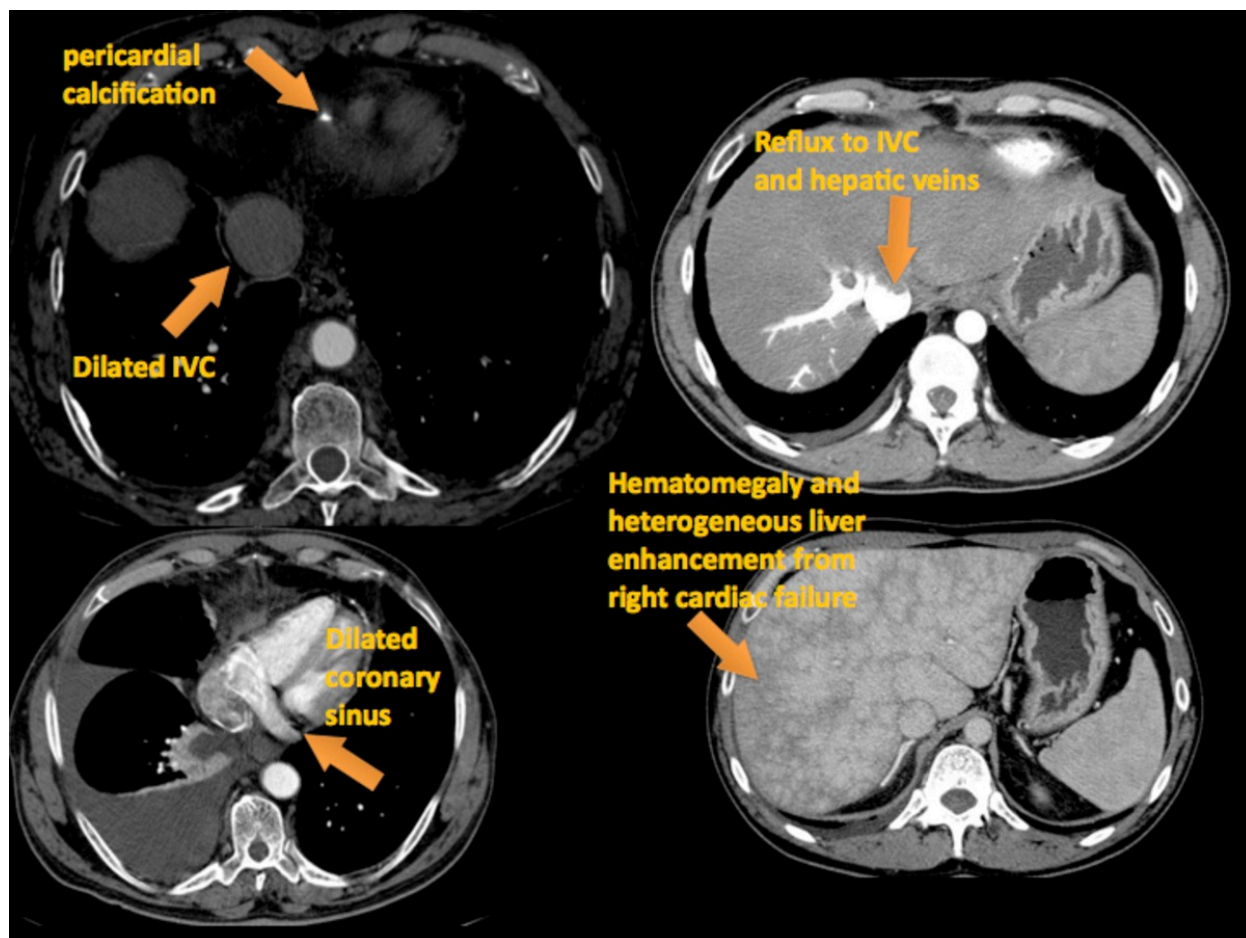


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Functional and Haemodynamic Abnormalities

The septal bounce

- The rate of falling is rapid in early diastole, and the rate of change in ventricular pressure at this time in the cycle is particularly rapid.
- Slight asymmetry of right and left ventricular falling rate can result in rapid changes in the pressure differential between the two sides of the ventricular septum.
- The septum may therefore shift in position very abruptly, responding to such rapid changes in pressure.
- Normally the septum is convex to the right
- The septal bounce reflects the limitation of RV filling secondary to the rigid pericardium, with resultant shift of the septum to the left during early diastole

- CMR with cine images can show early diastolic septal flattening or inversion in the majority of constrictive pericarditis patients

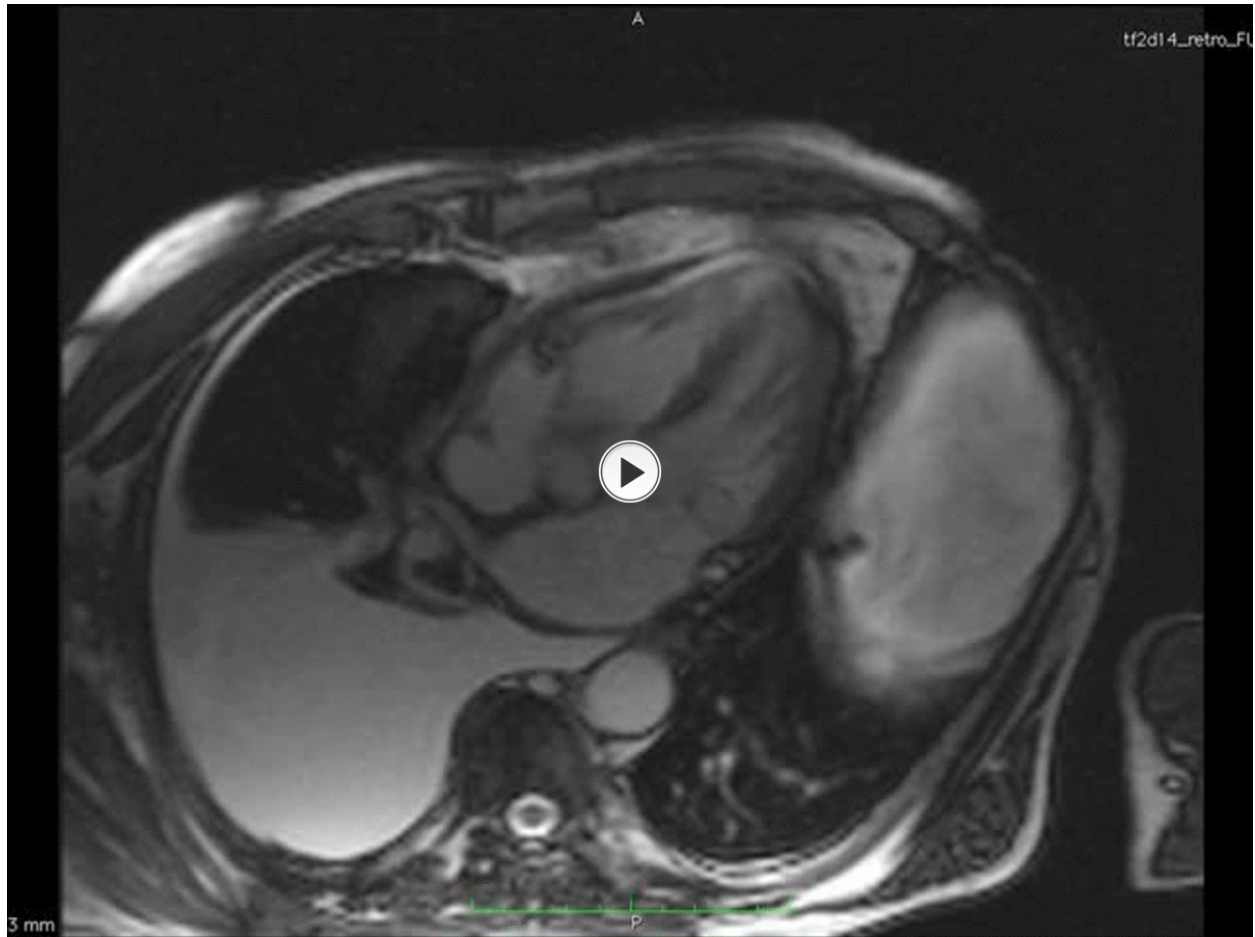


Fig.: Four-chamber cine MR movie. Abnormal septal curvature with early diastolic septal convexity towards the LV. Pericardial thickening and right pleural fluid.

References: F. Caseiro-Alves; Department of Radiology, Coimbra University Hospital, Coimbra, PORTUGAL

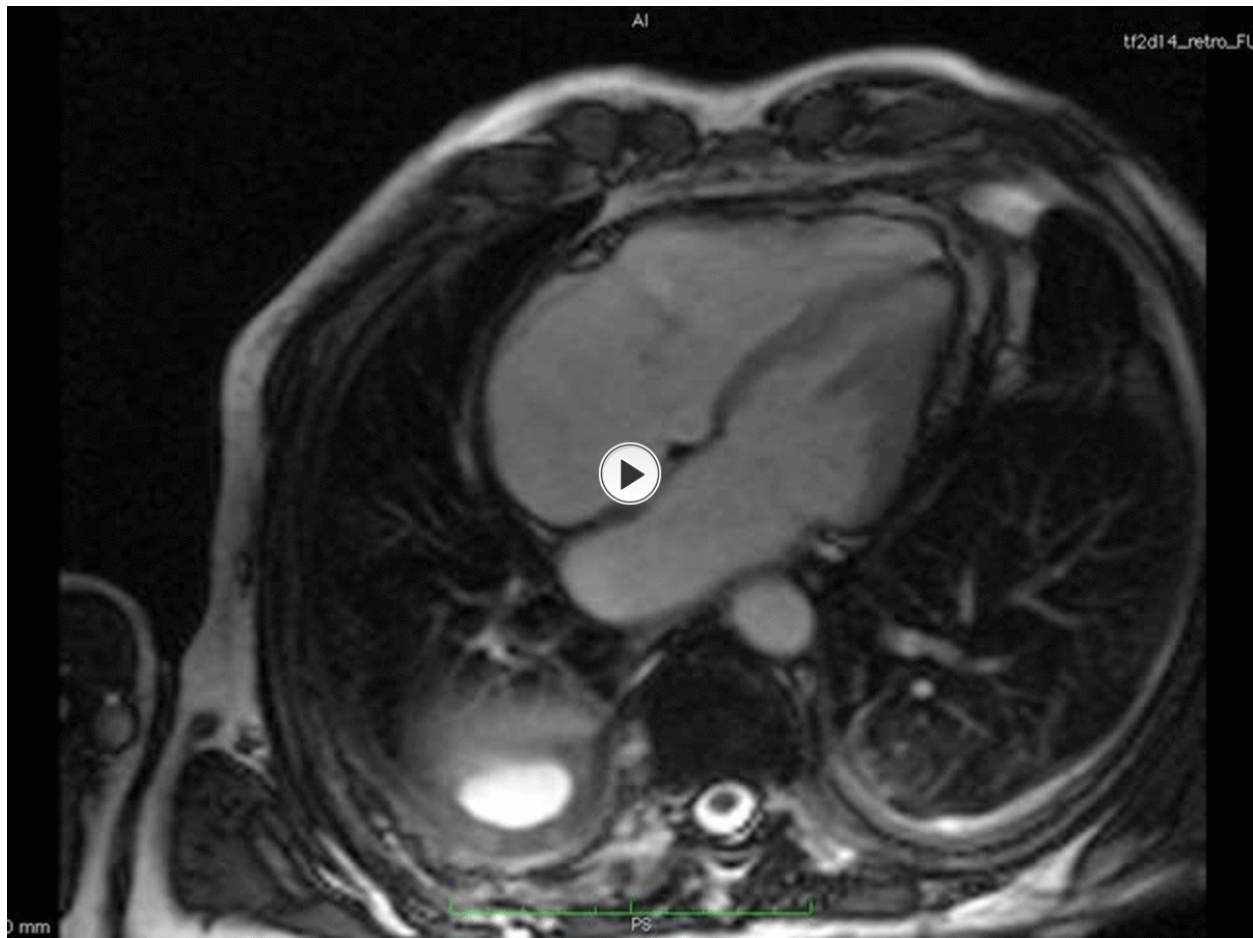
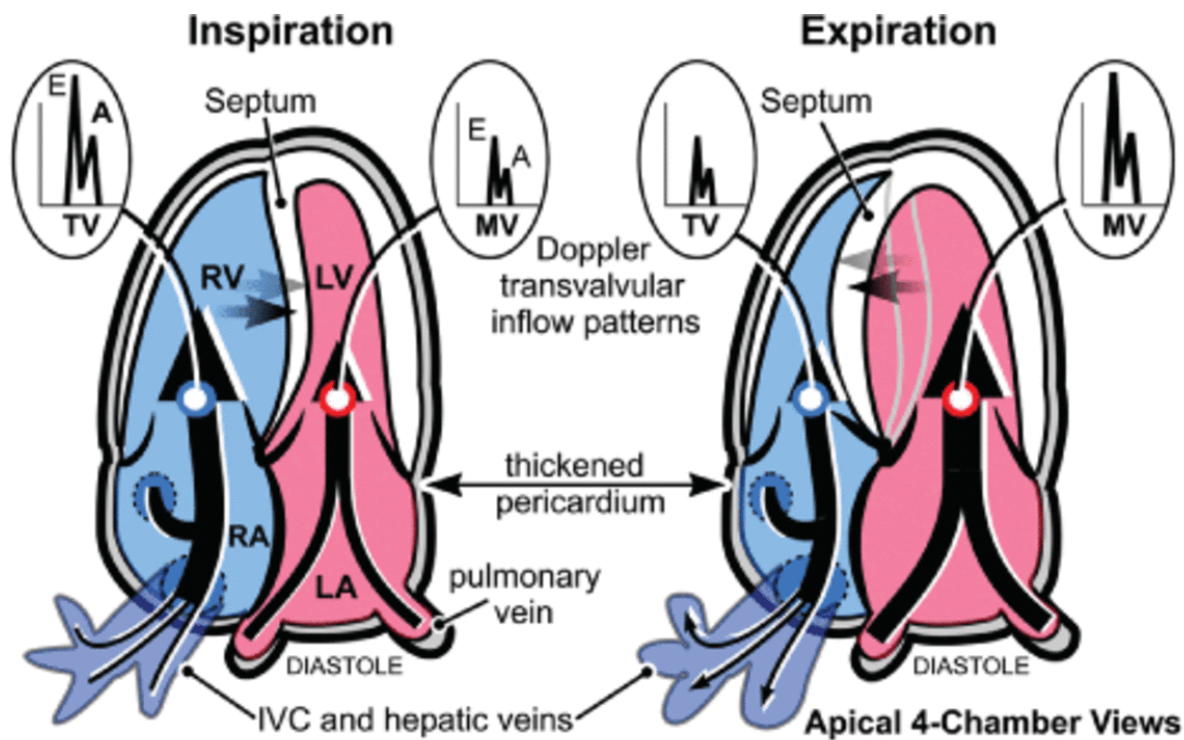


Fig.: Four-chamber cine MR movie. Septal bounce with early diastolic septal convexity towards the LV. Pericardial thickening.

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Ventricular septal shift with respiration

- Reciprocal changes in left and right ventricular volumes with respiration are one aspect of the increased degree of ventricular interdependence that is characteristic of constrictive pericarditis.
- Because the heart is enclosed within a relatively fixed volume, enlargement of one ventricle tends to be associated with a corresponding decrease in volume of the other ventricle.
- The septal inversion is indicative of the diminished compliance of the pericardium, such that any increase in RV filling (such as that caused by a deep inspiration) results in flattening or shift of the septum to the left



Source: Fauci AS, Kasper DL, Braunwald E, Hauser SL, Longo DL, Jameson JL, Loscalzo J: *Harrison's Principles of Internal Medicine*, 17th Edition: <http://www.accessmedicine.com>

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Fig.: Constrictive pericarditis. Doppler schema of respirophasic changes in mitral and tricuspid inflow. Reciprocal patterns of ventricular filling are assessed on pulsed Doppler examination of mitral (MV) and tricuspid (TV) inflow.

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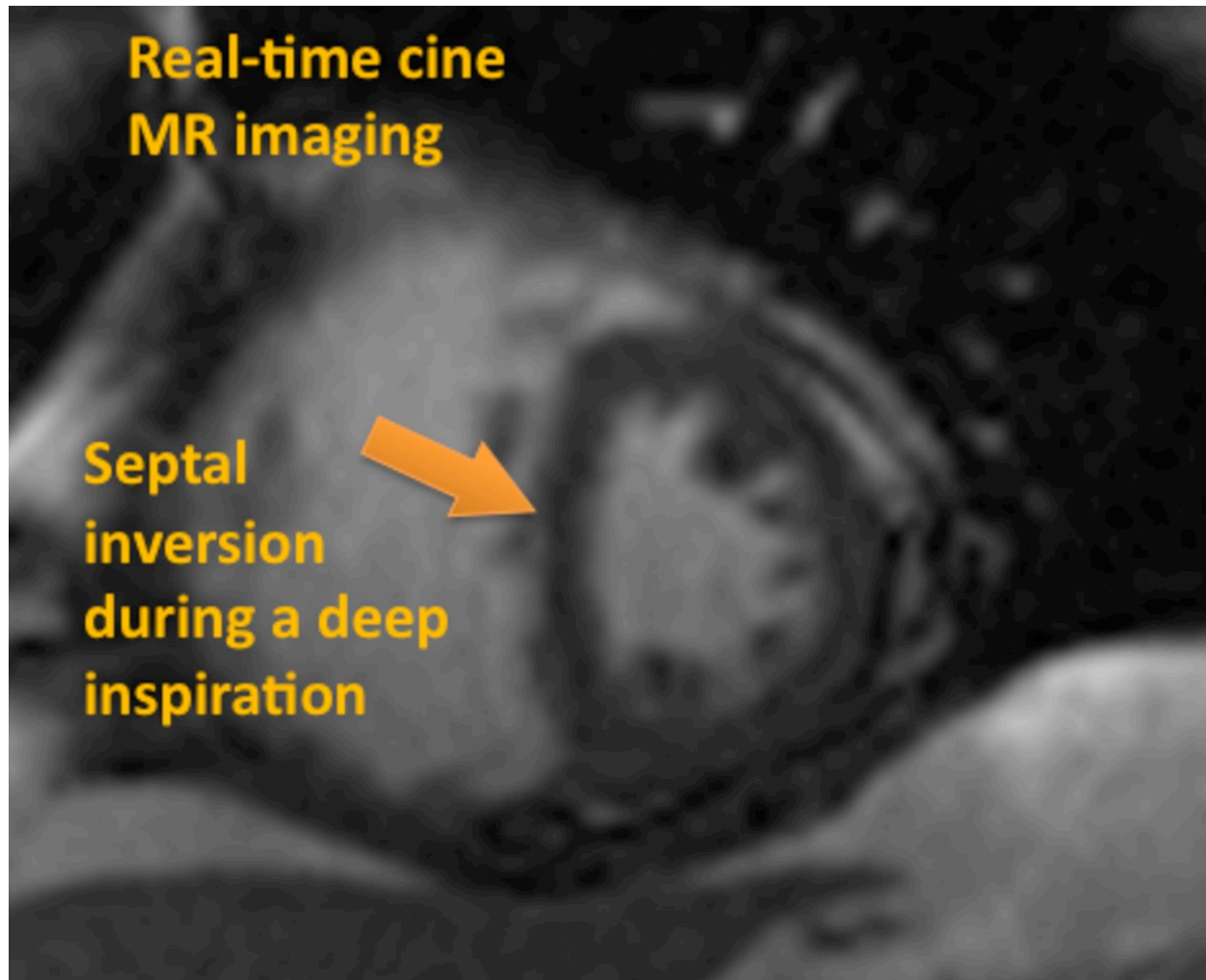


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Exaggerated variation in the velocity of early diastolic filling of the two ventricles with respiration

- The variation is reciprocal, the tricuspid velocity increasing in inspiration and the mitral velocity decreasing.
- The reciprocal ventricular variation reflects ventricular interdependence
- Velocity-encoded CMR typically shows a restrictive filling pattern with an enhanced early filling, and decreased or absent late filling
- Real-time velocity CMR is a potential alternative to echo-Doppler to assess the effects of respiration on cardiac filling, though ideally slice-tracking techniques are needed to compensate for through-plane motion

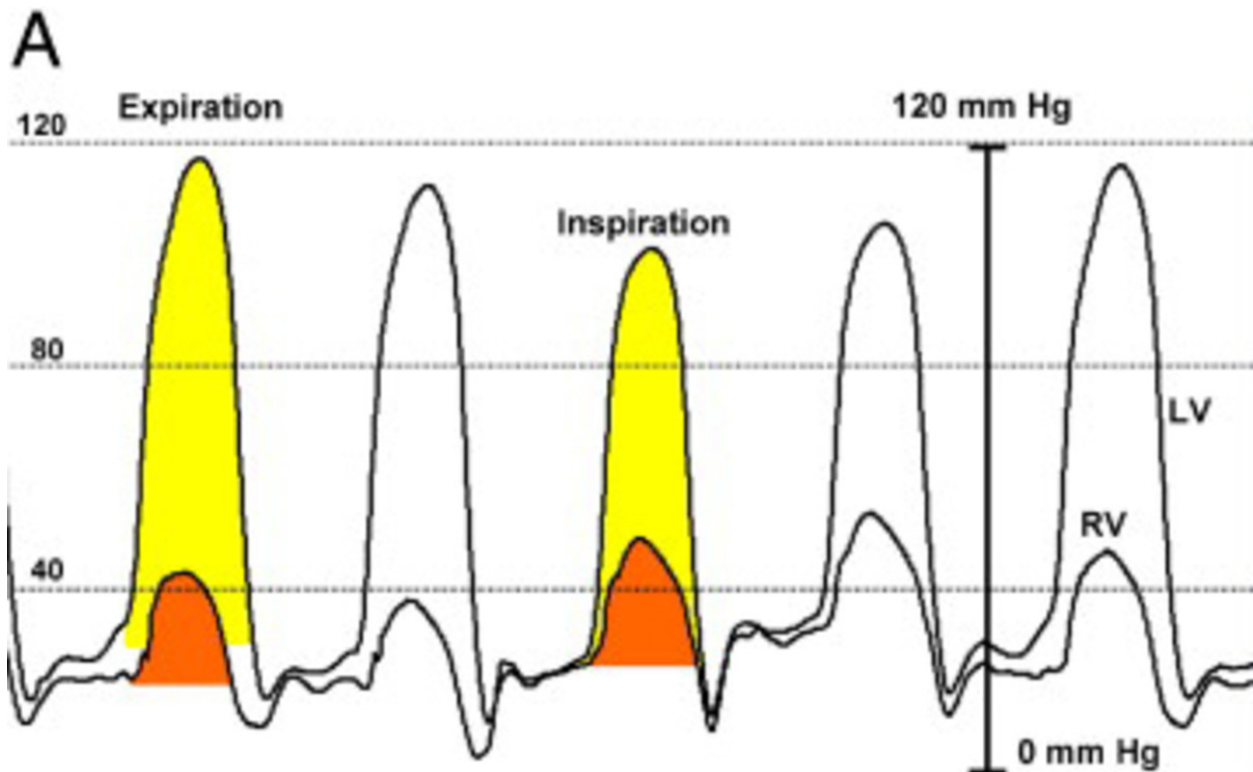


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Equilibration of diastolic pressures

- Nearly equal levels of diastolic pressure in all chambers of the heart are a hallmark of constrictive pericarditis
- This reflects the usually symmetrical pathological process around the entire heart

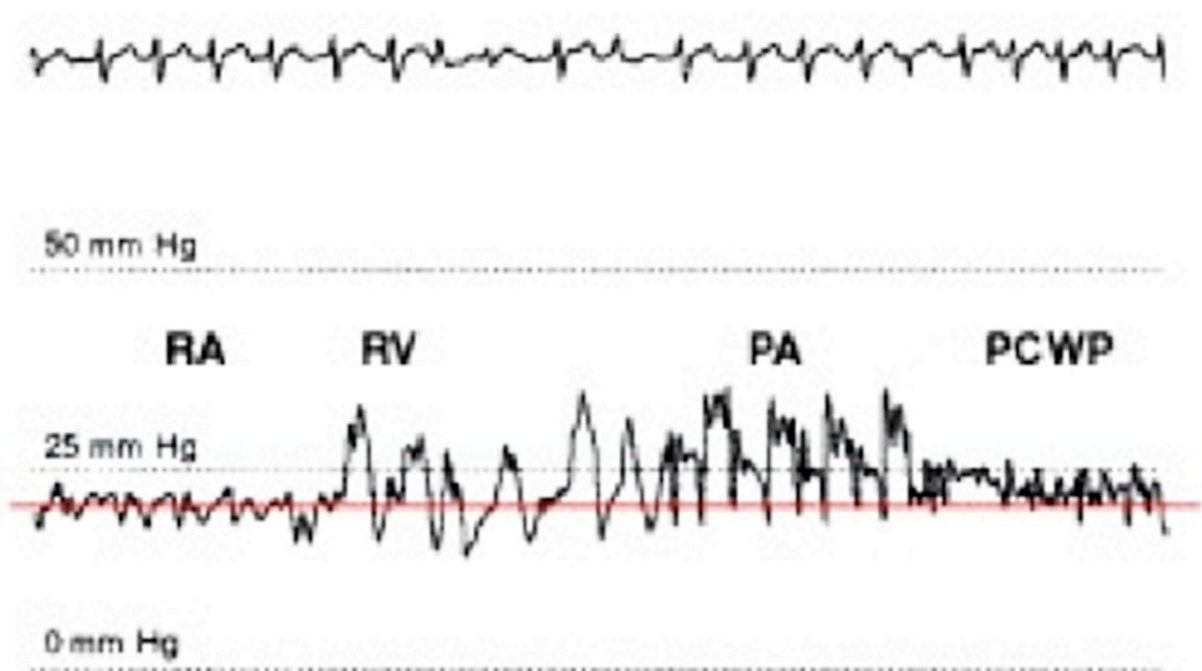


Fig.: RA - right atrium; RV - right ventricle; PA - pulmonary artery; PCWP - pulmonary capillary wedge pressure

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Diagnosis

- The first test should be plain posteroanterior (PA) and lateral chest radiography. If the results show characteristic pericardial calcification, the diagnosis of constrictive pericarditis is essentially established.
- If the plain radiographic findings are negative and clinical suspicion of constrictive pericarditis is present, echocardiography with an evaluation of Doppler inflow velocities of the mitral and tricuspid valves during inspiration and expiration should be performed. Ventricular interdependence is present in all patients with significant constrictive physiologies.
- Echocardiography is limited in its ability to detect pericardial thickening
- Both spin echo CMR and CT are superior to echocardiography in measuring pericardial thickness but CMR has the additional advantage of permitting assessment of haemodynamic impairment.
- CT is superior to MRI in detecting calcification
- But ultimately the diagnosis of constriction is one of altered physiology
- Therefore, cine images demonstrating altered hemodynamics are a more direct means of confirming the diagnosis
- MR imaging is the preferred technique for differentiation between constrictive pericarditis and restrictive cardiomyopathy

Differentiating Constrictive Pericarditis from Restrictive Cardiomyopathy

- Their clinical presentation and course overlap in many respects.
- Because treatment is radically different, distinguishing constrictive pericarditis from restrictive cardiomyopathy is extremely important.

Hemodynamic and Imaging Features of Constrictive Pericarditis Compared with Restrictive Cardiomyopathy

	Constriction	Restriction
Equal right-left side filling pressures	Present	Left at least 3-5 mm Hg > right
Respiratory variation in left-right pressures/flows	Exaggerated	Normal
Ventricular wall thickness	Normal	Usually increased
Atrial size	Possible LA enlargement	Biatrial enlargement
Septal "bounce"	Present	Absent
Pericardial thickness	Increased	Normal

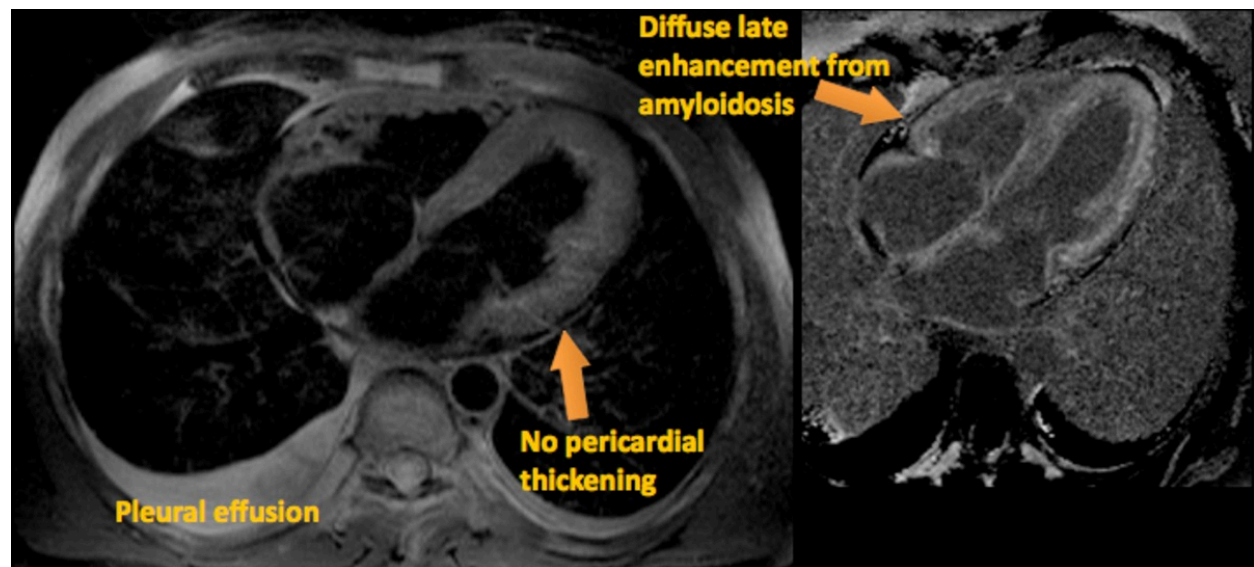


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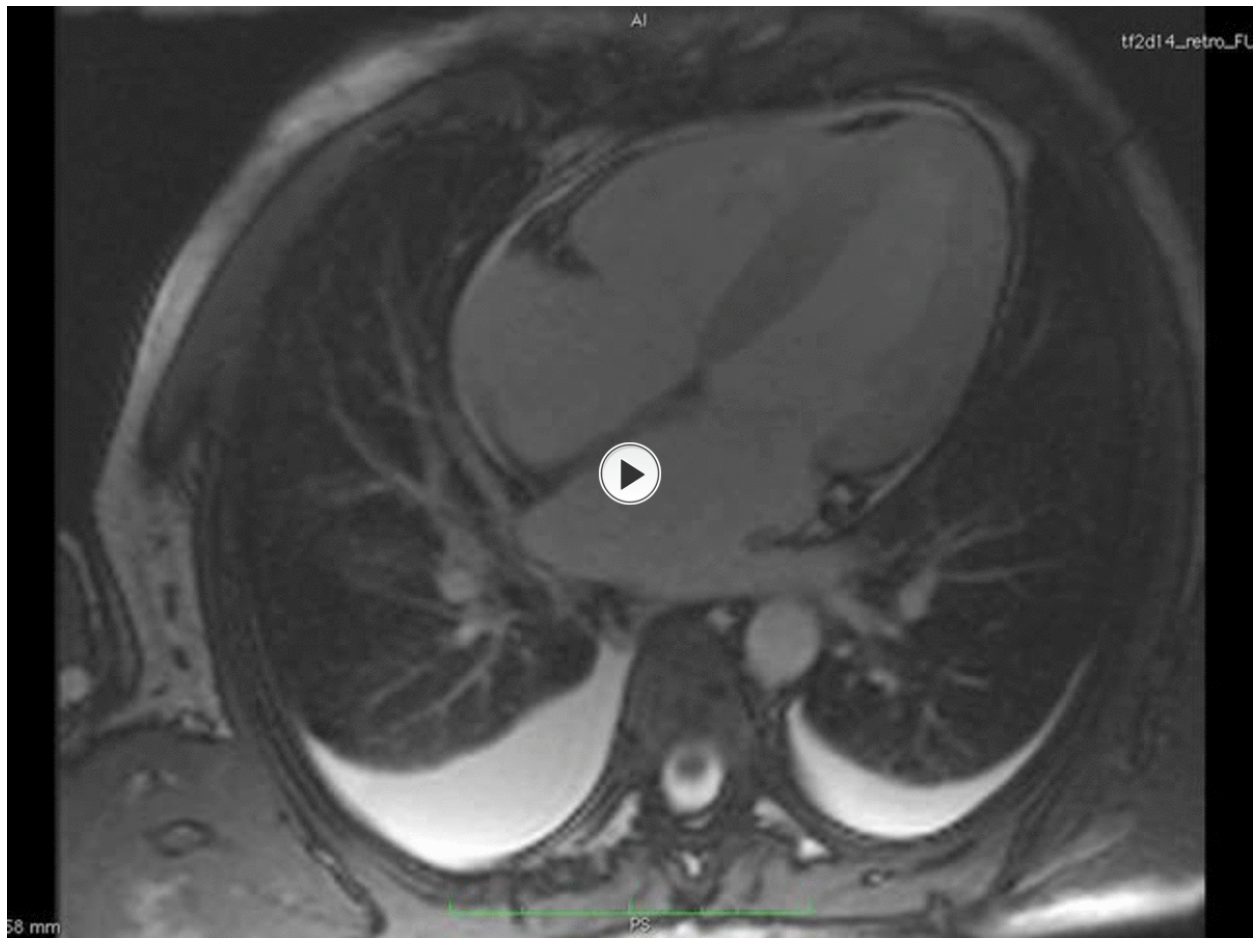


Fig.: Patient who has systemic amyloidosis and cardiac involvement. Cine imaging shows thickened LV walls with preserved systolic function. Bilateral pleural fluid.

References: F. Caseiro-Alves; Department of Radiology, Coimbra University Hospital, Coimbra, PORTUGAL

Management

- Constrictive pericarditis is a progressive disease.
- With the exception of patients with transient constrictive pericarditis, surgical pericardiectomy is the only definitive treatment. Transient constriction should be suspected in patients presenting relatively earlier after cardiac surgery or with relatively rapid development of symptoms. Such patients can be monitored for several months to look for spontaneous improvement. They may respond to a course of corticosteroids, and there is little to lose by managing them in this way.
- Pericardiectomy involves radical excision of as much of the parietal pericardium as possible.
- Hemodynamic and symptomatic improvement is achieved in some patients immediately after operation. In others symptomatic improvement may be delayed for weeks to months.

- From 70 to 80 percent of patients remain free from adverse cardiovascular outcomes at 5 years, and 40 to 50 percent at 10 years after pericardiectomy.

Conclusion

Despite a better understanding of the pathophysiologic basis of the imaging findings in constrictive pericarditis and the recent advent of MRI, which has dramatically improved the morphologic and dynamic evaluation of the pericardium, the diagnosis of constrictive pericarditis remains a challenge in many cases.

Personal Information

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