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Case Report

A classic diagnosis with a new 'spin'

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SUMMARY

We describe a case of pericardial constriction following viral pericarditis and illustrate the use of cardiac magnetic resonance imaging in the diagnostic process. The advantages of cardiac magnetic resonance in the investigation of pericardial disease are briefly explained.

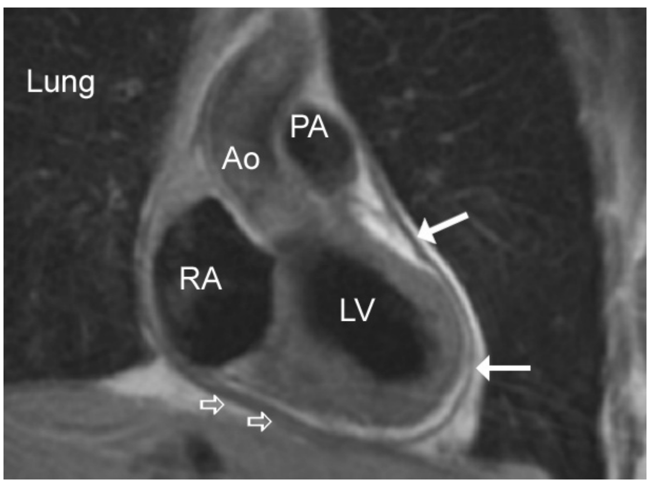

Fig 1. Coronal MRI through the left ventricular outflow tract showing normal (solid arrows) and thickened pericardium (open arrow), visible as the black layer in between bright layers of pericardial and epicardial fat.

AO=Aorta; LV=Left ventricle; PA=Pulmonary Artery; RA=Right Atrium

INTRODUCTION

Constrictive pericarditis and restrictive cardiomyopathy are characterized by similar clinical features, and similar findings at echocardiography and cardiac catheterisation. It is important to discriminate between these two entities as the former can be cured by the procedure of pericardiectomy, whereas those patients with restrictive cardiomyopathy do not benefit from surgery. The emerging technique of cardiac magnetic resonance imaging (CMR), which compensates for cardiac motion by gating the acquisition to the cardiac cycle, may prove particularly useful in differentiating these conditions.

CASE REPORT

A 45-year-old female presented to her general practitioner (GP) with a two month history of increasing dyspnoea. The GP noted bilateral pleural effusions and referred the patient to respiratory outpatients. Five months previously the patient had been admitted with chest pain. Troponin levels were normal, and she had been discharged with the diagnosis of atypical chest pain.

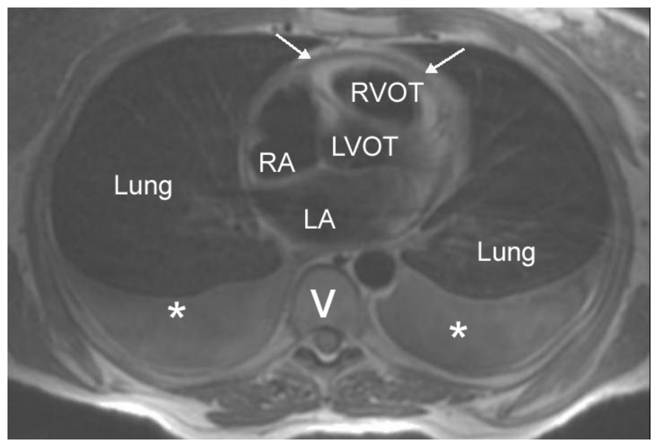

Fig 2. Axial MRI at the level of the right ventricular outflow tract demonstrating large bilateral pleural effusions (*) and thickened pericardium (arrows).

LA=Left Atrium; LVOT=Left ventricular outflow tract; RA=Right Atrium; RVOT=Right ventricular outflow tract; V=Vertebral Body;

After review at outpatients a CT chest was performed that showed no abnormality other than the effusions. Investigations for underlying infective, autoimmune or neoplastic causes were negative. Pleural aspiration indicated that the fluid was a transudate, and when the effusions recurred, the patient was referred to cardiology for further investigation.

At cardiology outpatients, physical examination revealed an elevated jugular venous pressure, mild peripheral oedema and a left sided pleural effusion. Pulsus paradoxus, an exaggeration of the normal decrease in systolic blood pressure during inspiration, was not present. However Kussmaul's sign[1,2],

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an increase in jugular venous pressure during inspiration (it should normally fall with negative intrathoracic pressure) was demonstrated. The electrocardiogram showed sinus rhythm with small QRS complexes, and constrictive pericarditis was suspected clinically. An echocardiogram revealed normal left and right ventricular sizes, with normal ventricular systolic function and no significant valvular abnormality.

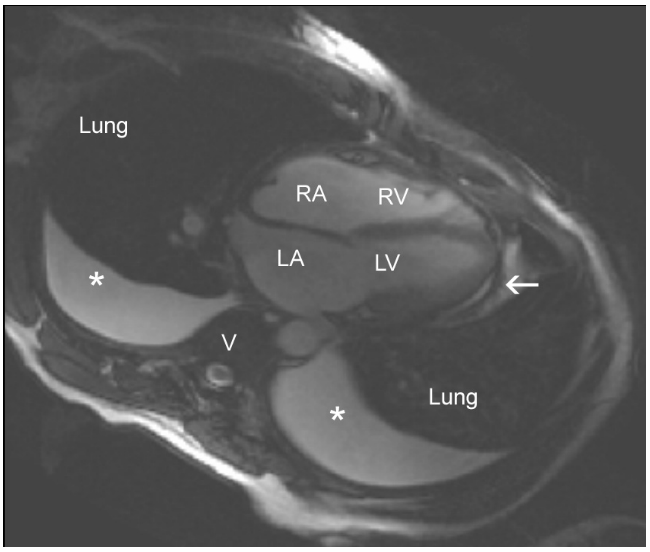

Fig 3. The four chamber view of the heart below is a still frame taken from cine sequence. The moving images show abnormal septal motion ('septal bounce') which is more commonly demonstrated by echo in patients with pericardial constriction. In addition there are bilateral pleural effusions and evidence of pericardial thickening (arrow).

*LA= Left Atrium; LV= Left Ventricle; RA=Right Atrium; RV= Right Ventricle; V=Vertebral Body; *=Pleural Effusion*

A cardiac MRI scan (CMR) was performed using a 1.5 Tesla Signa scanner (General Electric Medical Systems, Amersham, UK) and images are shown in Figures 1-3. The thickened pericardial layer is demonstrated as a black line between the brighter fat layers[3]. Note that the width of the pericardium is variable, being thicker in some parts than others. Additional MRI sequences produced moving cine images, which showed abnormal septal motion, with the characteristic 'septal bounce', resulting from inter-dependence of ventricular pressures.

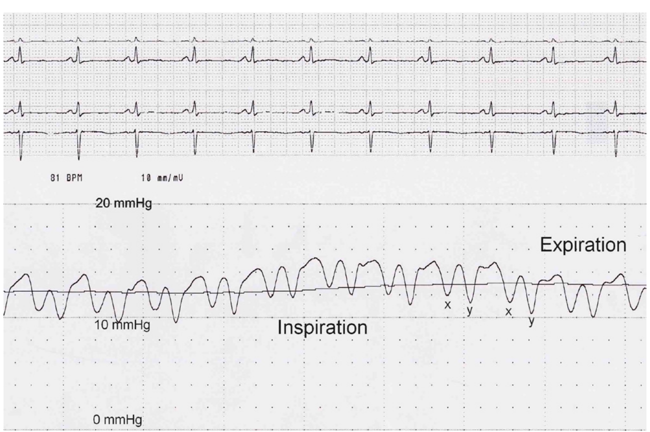

Fig 4. Right atrial pressure tracing. Right atrial pressure is elevated (mean 12 mmHg) and a prominent y descent is visible. The mean right atrial pressure rises with inspiration, the physiological basis for Kussmaul's sign.

The patient was taken to the catheter laboratory for further investigation. Coronary angiography demonstrated normal coronary arteries. Pressure wave tracings from cardiac catheterisation are shown in Figures 4 and 5. Right atrial pressure is elevated, and then rises further with inspiration (fig.4). The 'y' descent is steep and prominent, consistent with early rapid filling of the right ventricle. Figure 5 shows simultaneous pressure tracings from the left and right ventricles with classic diastolic 'dip and plateau' configuration (the square root sign). This results from rapid early diastolic filling of the ventricles (dip), which is then halted by pericardial restraint (plateau). This tracing also demonstrates equalisation of right and left ventricular pressures during diastole. The patient was referred to the cardiac surgeons and both constriction and a thickened pericardium were confirmed at the time of pericardiectomy. The patient remains well following her definitive cardiac surgical procedure.

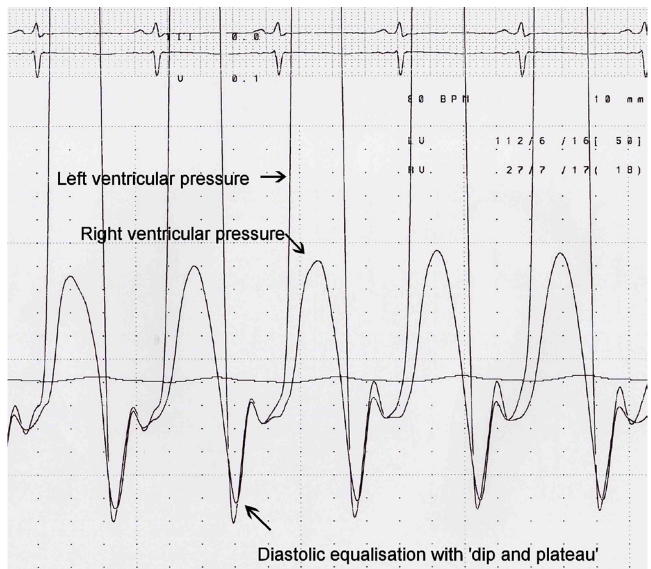

Fig 5. Simultaneous left and right ventricular pressure recordings. The classical diastolic equalisation with the dip and plateau pattern (square root sign) is seen in both pressures tracings.

DISCUSSION

Trans-thoracic echocardiography (TTE) is usually the initial investigation when pericardial disease is suspected. It is widely available, portable, and provides both functional and anatomical information. However, pericardial tissue has a low signal to noise ratio with ultrasound and cannot be easily identified by TTE. Additionally, the small field of view during both transthoracic and transoesophageal echocardiography means that some sections of the pericardium may not be visualised, and the full extent of the pericardium cannot be seen in any one imaging plane. Therefore the echocardiographic diagnosis of pericardial disease is usually made from functional assessment by Doppler criteria, and many of these features overlap with those of restrictive cardiomyopathy.

In recent years cardiac MRI has become a routine imaging

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procedure to demonstrate anatomy, function, and even myocardial perfusion and coronary arteries. Applying standard MRI protocols to the heart would result in uninterpretable images due to motion artefacts from cardiac contraction. The development of cardiac gating, which permits the acquired MRI data to be synchronized with the electrical activity of the heart, allows cardiac motion to be effectively 'frozen' and high quality images to be obtained. Although pacemakers, claustrophobia, and intracerebral aneurysm clips remain contraindications to MRI, coronary artery stents and many prosthetic heart valves can be imaged safely.

A variety of MRI sequences may be applied to cardiac imaging. The scanner may be used to produce still, anatomic, images, in which the apparent intensity of tissues may be manipulated by the type of sequence used so that, for example, signal from fat can be suppressed. This is useful in the diagnosis of arrhythmogenic right ventricular dysplasia, where fatty tissue infiltrates the myocardium, and in the diagnosis of cardiac tumours such as lipomas. In fact the principle of different tissues exhibiting particular intensities with certain types of pulse sequences can used to non-invasively characterise cardiac tissue as viable or irreversibly scarred after myocardial infarction. In addition, MRI can produce moving, 'cine', images allowing assessment of wall motion (analogous to B-mode echocardiography) and allow quantification of flowing blood (analogous to Doppler echocardiography).

MRI provides excellent delineation of the pericardium without the use of contrast media or ionising radiation. Unlike echocardiography, the large field of view has the potential to demonstrate associated abnormalities in the chest or mediastinum such as lymphadenopathy or local invasion, although the absence of such pathology by MRI is not definitive.

The pericardium is relatively easy to distinguish. It has a fibrous nature and low water content, which causes it to appear as a band of low signal intensity between the relatively bright, high signal, epi- and pericardial fat layers. Normal pericardial thickness on these images is less than 2mm.

A pericardial thickness of greater than 4mm indicates abnormal thickening, and if accompanied by signs or symptoms of heart failure, is strongly suggestive of constriction. CMR is very useful in differentiating constrictive pericarditis from restrictive cardiomyopathy in symptomatic patients, a distinction which is often difficult to obtain by other methods. The reported sensitivity, specificity, and accuracy for the diagnosis of constrictive pericarditis by CMR is 88%, 100%, and 93% respectively[4].

Pericardial thickening alone is not diagnostic of constriction, and other signs such as dilated inferior vena cava, or dilated atria, should be sought. Cine CMR imaging provides functional data such as the abnormal motion of the interventricular septum, and phase contrast CMR can, like Doppler TTE, demonstrate the abnormal ventricular filling patterns. While TTE will remain the primary cardiac imaging modality in the immediate future, CMR provides a powerful tool in cases of diagnostic uncertainty, and can provide a comprehensive non-invasive evaluation of pericardial disease.

The authors have no conflict of interest.

REFERENCES

1. Kussmaul A, Stern Mt. Pericarditis and the paradox pulse. *Berl Klin Wochenschr* 1873:38.
2. Bilchick KC, Wise RA. Paradoxical physical findings described by Kussmaul: pulsus paradoxus and Kussmaulls sign. *Lancet* 2002;**359(9321):**1940-2.
3. Smith WH, Beacock DJ, Goddard AJ, Bloomer TN, Ridgway JP, Sivananthan UM. Magnetic resonance evaluation of the pericardium. *Br J Radiol* 2001;**74(880):**384-92.
4. Masui T, Finck S, Higgins CB. Constrictive pericarditis and restrictive cardiomyopathy - evaluation with MR imaging. *Radiology* 1992;**182(2):**369-73.
5. Wang ZJ, Reddy GP, Gotway MB, Yeh BM, Hetts SW, Higgins CB. CT and MR imaging of pericardial disease. *Radiographics* 2003;**23 Spec No:**S167-S180.

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