Introduction

Constrictive pericarditis (CP) is an inflammatory process of the pericardium, leading to a thickened, scarred, and often calcified pericardium that limits diastolic ventricular filling. The diagnosis of CP can be challenging because of its protean presentations and the difficulty of distinguishing it from other disease entities with similar symptoms and hemodynamics. In this review, we will focus on morphologic and hemodynamic assessment by echocardiography for the diagnosis of CP.

Two-dimensional and Doppler echocardiographic findings

Most patients with CP show characteristic 2-dimensional echocardiographic abnormalities. These include abnormal ventricular septal motion with prominent respiratory septal “bounce”, calcified or thickened pericardium, or dilated inferior vena cava. These abnormal 2-dimensional echocardiographic findings are the most important clue for the diagnosis of CP and the observation of these findings should raise the diagnostic possibility of CP. Further demonstration of characteristic Doppler findings such as respiratory variation in mitral inflow velocity will support the diagnosis of CP. Hatle et al.1) described the unique feature of respiratory variation in mitral inflow (Fig. 1) and hepatic vein velocities (Fig. 2) in patients with CP, and this substantially improved the accuracy for the diagnosis of CP. However, a subset of patients with CP does not demonstrate such respiratory variation in Doppler velocities,2)3) and mitral inflow velocities may be indistinguishable from those of other causes of heart failure. Therefore, a lack of these typical respiratory flow velocity changes should not exclude the diagnosis. There are 2 possible explanations for the absence of typical respiratory changes in Doppler velocities in patients with CP.4) First, some patients may have a combination of restrictive cardiomyopathy (RCM) and CP. Because the ventricular filling is limited by a noncompliant restrictive myocardium as well as a constrictive pericardium, full respiratory variation in ventricular filling may not occur. Second, the normal inspiratory intrathoracic pressure decline may not produce significant variation in mitral inflow velocities if the left atrial pressure is markedly increased and results in earlier mitral valve opening at a steeper portion of the left ventricular pressure curve. In this situation, repeat Doppler examination after an attempt...
to reduce preload has been shown to unmask the typical respiratory variation of mitral inflow. Recently, tissue Doppler echocardiography (TDE) has been used as a method to evaluate the diastolic function by measuring early diastolic mitral annular velocity (E’). The E’ profile during diastole reflects shortening and lengthening of the myocardial fibers along a longitudinal plane, and it can be used to quantify longitudinal mitral annular motion. It has been shown that E’ (measured by TDE) is reduced in patients with restricted mitral inflow without sufficient respiratory variation. The recording of E’ by TDE should be an essential part of echocardiographic Doppler evaluation of all patients with heart failure, especially when CP is suspected.

Although E’ by TDE is very helpful diagnostic indicator for CP, it also has some caveats. Since previous investigations did not study patients with combined CP and RCM (constrictive pericarditis with coexisting myocardial abnormality), it is not clear whether E’ would still be as diagnostic as in isolated CP. A cut off E’ value of 8 cm/s has been shown to be a good discriminator between CP and RCM. However, in a subset patient with CP who had coexisting myocardial abnormalities, E’ might not be high. In addition, despite excellent specificity of E’ of 8 cm/s for differentiating CP from RCM, its sensitivity was relatively low, especially in patients with CP who had underlying myocardial abnormality. Therefore, additional parameters will be helpful for further accurate diagnosis. In contrast to CP, LV longitudinal systolic function is abnormal in patients with RCM. Garcia and colleagues demonstrated that the onset of E’ occurred 7.5 ± 3.5 ms after peak mitral inflow.
velocity in patients with RCM, compared to 22 ± 19 ms earlier in controls.9) Subsequently, T(E') has been shown to correlate with index of LV relaxation.10 It has also been shown that with the worsening of heart failure by rapid pacing, E' not only progressively decreased but also delayed in onset.12) This finding suggests that when relaxation is abnormal, not only the magnitude of E' is reduced but its onset is also delayed in reference to the onset of mitral valve opening or mitral inflow. A recent study has shown that S' and T(E') have incremental value for differentiation between CP and RCM; S' was significantly higher and T(E') was shorter in patients with CP compared with RCM. Although diagnostic accuracies of S' and T(E') were lower than that of E', when combining E', S' and T(E'), sensitivity and diagnostic accuracy for differentiating CP from RCM could be improved.12) With this robust discriminatory power, we propose a diagnostic algorithm for discrimination of CP form RCM (Fig. 4). If the mitral inflow is pseudonormal or restrictive (high E, low A, short deceleration time) in patients with suspected CP or RCM, the next step should include assessment of septal mitral annular velocity by TDE. If E' is normal or accentuated (≥8 cm/s), a diagnosis of CP is favored. If E' is low (<6 cm/s), RCM or heart failure from myocardial disease should be considered. In patients with “gray zone E' (6-8 cm/s)”, additional measurements of T(E') and S' would be helpful for further accurate diagnosis. In addition, the presence of additional two-dimensional and Doppler echocardiographic features of CP can further confirm the diagnosis.

**CONCLUSION**

Since echocardiography is capable of assessing cardiovascular structure, function, and hemodynamics noninvasively, it is well suited for the evaluation of patients with suspected constrictive pericarditis. Abnormal 2-dimensional echocardiographic findings such as abnormal ventricular septal motion with prominent respiratory septal “bounce”, calcified or thickened pericardium, or dilated inferior vena cava are easily recognized by transthoracic echocardiography. Hemodynamic assessment by Doppler echocardiography provides the unique feature of respiratory variation in mitral inflow and hepatic vein velocities in patients with CP, and this substantially improved the accuracy for the diagnosis of CP. Recent developments in echo-Doppler techniques made non-invasive diagnosis of CP more accurate. Especially, the recording of E' by TDE should be an essential part of echocardiographic Doppler evaluation of all patients with heart failure, especially when CP is suspected.

**References**

8. Sohn DW, Chai IH, Lee DJ, Kim HC, Kim HS, Oh BH, Lee MM, Park YB, Choi YS, Seo JD, Lee YW. Assessment of mitral annulus velocity by Doppler tissue imaging in the evaluation of left ventricular diastolic function. J Am Coll Cardiol 1997;30:474-80.