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Echocardiographic Evaluation of Patients with Congestive Heart Failure

Mohsin Alam, MD

Echocardiography is a useful noninvasive test for evaluating patients with suspected heart failure and enlarged cardiac silhouette. This test can obtain the dimensions and wall thickness of all four cardiac chambers and can evaluate left ventricular function. The test results are reproducible, and in many instances the etiology of heart failure can be determined. (Henry Ford Hosp Med J 1986;34:163-7)

Echocardiography is a valuable noninvasive test for evaluating patients with suspected heart failure (1-3). This test not only determines left ventricular size and function but also can shed light on the etiology of heart failure. Furthermore, the test usually makes it possible to differentiate between patients with heart failure and those who have an enlarged cardiac silhouette for other reasons, such as pericardial effusion. The following three variables obtained from M-mode and two-dimensional studies are useful in analyzing cardiac structure and function in patients with heart failure:

1. Cardiac dimensions: Enlargement of any cardiac chamber during systole or diastole can be diagnosed and quantitated.
2. Ventricular wall thickness: Systolic and diastolic thickness of ventricles can be measured, and the presence or absence of ventricular hypertrophy can be determined.
3. Left ventricle function: Wall motion, fractional shortening, and ejection fraction of the left ventricle can be obtained from echocardiographic studies. The presence of hypokinesis, akiness, or dyskinesis of left ventricular segments can be determined from various two-dimensional views.

Echocardiographic Features

Normal
The patient without heart disease has normal cardiac dimensions and left ventricular wall motion. This is demonstrated in Figs 1 and 2.

Congestive or dilated cardiomyopathy
Patients with congestive cardiomyopathy have a dilated left ventricle during diastole (> 56 mm) (Figs 3 and 4). Left ventricular wall motion is reduced in a generalized manner, and the diastolic wall thickness is within the normal range (7 to 11 mm). Left atrium, right atrium, and right ventricular chambers may also be enlarged depending on the severity of the myocardial disease and the duration of heart failure.

Coronary artery disease
Echocardiography performed on patients with coronary artery disease reveals features similar to those seen with congestive cardiomyopathy except that wall motion abnormalities are usually segmental (2). Left ventricular dyskinesis and thrombi may also be observed in patients following myocardial infarction (Fig 5).

Hypertensive heart disease
Patients with this disease have features of left ventricular pressure overload with increased (> 12 mm) diastolic thickness of the septum and posterior wall and poor ventricular function (Fig 6). With increasing heart failure the left ventricle may dilate and thus have features similar to those of congestive cardiomyopathy.

Valvular heart disease
Aortic stenosis—Patients with severe aortic stenosis who experience heart failure usually have hypertrophied left ventricles with reduced excursions similar to those of hypertensive heart disease. The presence of a thickened calcified aortic valve with reduced opening verifies the diagnosis.

Chronic aortic insufficiency—Patients who have heart failure due to aortic insufficiency exhibit features of left ventricular dilatation and poor wall motion similar to those patients with congestive cardiomyopathy. Diastolic fluttering of the mitral valve, aortic valve abnormalities including a bicuspid aortic valve and aortic valve thickening or redundancy, or aortic root abnormalities (aortic dissection or aortic root dilatation) are helpful diagnostic features.
Fig 1—M-mode echocardiogram of a normal patient. The right and left ventricular chambers and wall thickness are normal with good left ventricle function. PW = posterior left ventricular wall, LVC = left ventricle chamber, RV = right ventricle, and S = interventricular septum.

Fig 2—Two-dimensional parasternal long axis view of a normal patient during systole and diastole. The magnitude of change in left ventricular diameter (white arrow) from diastole to systole indicates normal wall motion. A = aorta, LA = left atrium, LV = left ventricle, RV = right ventricle, S = interventricular septum, and PW = posterior left ventricular wall.
Fig 3—M-mode echocardiogram of a patient with congestive cardiomyopathy. Note that left ventricular chamber is dilated with poor septal as well as posterior wall motion. A tiny amount of pericardial effusion is also present. The extent of left ventricular enlargement and dysfunction can be appreciated when compared with normal ventricle (Fig 1). RV = right ventricle, S = interventricular septum, LVC = left ventricle chamber, PW = posterior left ventricular wall, and PE = pericardial effusion.

Fig 4—Two-dimensional parasternal long axis view during diastole and systole of a patient with dilated or congestive cardiomyopathy. Note increased left ventricle diameter (white arrow) during diastole with generalized poor wall motion. RV = right ventricle, S = interventricular septum, A = aorta, LVC = left ventricle chamber, LA = left atrium, PW = posterior left ventricular wall, and MV = mitral valve.
Chronic mitral insufficiency—Heart failure resulting from mitral insufficiency features a dilated, poorly contracting left ventricle and dilated left atrium. Mitral valve abnormalities such as thickening or prolapse may be present. If insufficiency is secondary to a dilated, poorly contracting left ventricle, the valve appearance may be normal.

Mitral stenosis—Heart failure resulting from predominant mitral stenosis usually spares the left ventricle. The left ventricular chamber dimensions and wall motion are usually normal. The left atrial chamber is usually dilated with frequent dilatation of the right ventricle and right atrium, and features of pulmonary hypertension are present. A thickened calcified mitral valve with stenotic features verifies the diagnosis.

Restrictive or infiltrative cardiomyopathy
The patient with restrictive cardiomyopathy has hypertrophied right and left ventricles, usually with enlarged left and right atria. In amyloid heart disease, a glistening appearance of the myocardium with concomitant pericardial effusion may occur (4). The echocardiographic features of this entity are discussed elsewhere in this Journal (5).

Hypertrophic cardiomyopathy
In patients with hypertrophic cardiomyopathy the left ventricular septum is asymmetically hypertrophied compared to the left ventricular posterior wall (6). The presence of systolic anterior motion of the mitral valve differentiates the obstructive from the nonobstructive type of hypertrophic cardiomyopathy. When heart failure ensues, wall motion of the left ventricle may or may not be reduced.

Congenital heart disease
Patients with various congenital heart lesions have cardiac chamber dilatation, hypertrophy, or dysfunction depending on the type of congenital heart defect. The defect can usually be identified by echocardiography.

The following case reports demonstrate the value of echocardiography in patients with congestive heart failure.

Case Reports

Case 1
A 60-year-old woman with a history of chronic congestive heart failure was referred to Henry Ford Hospital because of increasing shortness of breath, swelling of ankles, and a 40 lb weight gain. She was previously diagnosed as having congestive cardiomyopathy. She had no history of chest pain and had been a diabetic for ten years.

Physical examination revealed a heart rate of 110 beats/min irregularly irregular and a blood pressure of 110/80 mm Hg. The patient was in respiratory distress. There was marked jugular venous distention to the angle of jaw with prominent V waves. Cardiac auscultation revealed a diminished first heart sound and increased pulmonic component of the second heart sound. A grade III/VI holosystolic murmur was heard at the lower left sternal border. No diastolic murmurs were heard. There was 4+ pitting edema and massive ascites.

Echocardiogram revealed findings of severe calcific mitral stenosis. There was also evidence of pulmonary hypertension; marked tricuspid insufficiency; and dilated right ventricle, right atrium, and left atrium. The left ventricular dimensions were within normal limits with good wall motion. Cardiac catheterization confirmed a heavily calcified stenotic mitral valve (valve area 0.9 cm²) with severe pulmonary hypertension and tricuspid insufficiency. The left ventricle wall motion and coronary arteries were normal.

This patient was previously diagnosed as having idiopathic congestive cardiomyopathy and indeed had silent mitral stenosis. Echocardiogram made the correct diagnosis and prompted referral to cardiac surgeons for mitral valve replacement and tricuspid valve ring annuloplasty.

Case 2
A 38-year-old woman had a history of myocardial infarction in 1983 and 1984. She underwent coronary artery bypass graft surgery for angina pectoris. Three months later she presented with increasing shortness of breath, jugular venous distention, S3 gallop, and bilateral rales over the base of the lungs. She was treated for congestive heart failure.

![Fig 5—Two-dimensional apical four-chamber view of Case 2 with apical myocardial infarction and heart failure. In the middle panel the outline of endocardial surface of left ventricle is traced during systole and diastole. Note that there is dyskinetic motion of the apex with left ventricular thrombus (T). RV = right ventricle, S = interventricular septum, LV = left ventricle, RA = right atrium, and LA = left atrium.]
Echocardiography revealed dyskinetic left ventricular apex and a large apical left ventricular thrombus. She was initially treated with intravenous heparin and then with coumadin therapy.

Echocardiography in this patient confirmed the clinical finding of left ventricle dysfunction due to coronary artery disease and also demonstrated a large ventricular thrombus which was not suspected clinically.

Discussion
Ultrasound of the heart is a valuable noninvasive tool in evaluating patients with enlarged hearts and suspected heart failure. In many instances the etiology of heart failure and the severity of left ventricular dysfunction can be determined. Because of its narrow beam properties, M-mode echocardiography has limitations in determining left ventricular function. Furthermore, the left ventricular apex is not imaged with this technique. Two-dimensional echocardiography can accurately evaluate ventricular segments because of its greater spatial orientation and multiple views (7). However, a sound, technical study is essential for this analysis. Cardiac ultrasound is safe, painless, and portable and can be performed in critically ill or pregnant patients. This test should be performed in every patient with idiopathic congestive heart failure. In this way surgically correctable lesions responsible for heart failure are not missed. Patients with heart failure and systemic emboli also should have this test. It can be repeated to follow the effect of medical and/or surgical treatment on left ventricular performance. The test is relatively expensive and should not replace clinical evaluation for the routine follow-up of patients with heart failure.

References

Fig 6—M-mode echocardiogram of a patient with hypertensive heart disease. Note that left ventricular septum (S) and posterior wall (PW) thickness (white arrows) are increased (> 12 mm) with poor wall motion during systole. RV = right ventricle, LVC = left ventricle chamber, and MV = mitral valve.