The Role of Echocardiography in Acute Myocardial Infarction

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Our institutional experience with two-dimensional echocardiography and color flow Doppler tests, as well as a review of the literature, reveals that echocardiography is useful in diagnosing myocardial infarction. Furthermore, complications of myocardial infarction such as mitral regurgitation with or without papillary muscle rupture, acquired ventricular septal defect, true and false left ventricular aneurysms, left ventricular thrombi, right ventricular infarction, and pericardial effusion in the setting of acute infarction can be detected by cardiac ultrasound. Echocardiography is also useful in assessing prognosis of postinfarction patients based on degree of left ventricular dysfunction. This test, however, is not 100% sensitive and specific in diagnosing these entities and should be reviewed in context of a patient's history, physical findings, and other laboratory tests. (Henry Ford Hosp Med J 1991;39:165-9)

Two-dimensional (2-D) echocardiography with color Doppler is a useful noninvasive test in diagnosing and managing patients with acute myocardial infarction (MI) (1-3). Furthermore, cardiac ultrasound can detect complications which result postinfarction, such as mitral regurgitation with or without papillary muscle rupture (4), ventricular septal defect (5), true and false left ventricular (LV) aneurysms (6-8), LV thrombi (9-12), right ventricular infarction (13), and pericardial effusion (14). Echocardiography is also useful in assessing the prognosis of post-MI patients and identifying subsets of individuals at high risk for sudden cardiac death or pump failure (15). This report summarizes the Henry Ford Hospital experience in performing echocardiography in post-MI patients and reviews the literature on this subject.

Detecting and Quantitating Myocardial Injury Postinfarction

A 2-D echocardiogram will usually diagnose an infarcted left ventricle by virtue of systolic wall motion and thinning abnormalities of the involved segments (1-3). These patients usually have segmental asynergy, compared to global dysfunction in dilated cardiomyopathies. Patients with multiple MIs may, however, present with global LV dysfunction as well. In Fig 1, a 2-D echocardiogram of a patient with acute MI is depicted. Note akinesis and thrombus formation in the involved apical segment. The diastolic function of an infarcted left ventricle can be assessed from the pulsed Doppler velocity profile derived from the mitral inflow (16,17). Ischemic noncompliant left ventricle is characterized by a lower peak initial velocity (E) and an increased atrial filling velocity (A), with the E/A ratio < 1 (16).

Quantitation of Myocardial Injury

The LV asynergy after an acute MI is usually graded hypokinetic, akinetic, or dyskinetic, depending on the degree of systolic wall motion abnormalities. The American Society of Echocardiography (18) has recommended a 16-segment analysis of the heart (Fig 2). The views from which these segments are derived are obtained by placing the transducer at the point of maximal cardiac impulse (apical views) or the left parasternum (long and short axis views). A normal contracting LV segment is scored as 1, hypokinesis 2, akinesis 3, and dyskinesis 4. A LV score index is obtained by adding the score of all segments and then dividing it by the total number of segments evaluated. Thus, patients with high scores or a high score index have poor LV systolic function. Nishimura et al (15) have reported a LV score index of 2 or more within 12 hours of MI or admission as a poor prognostic sign for subsequent development of pump failure, malignant arrhythmia, or sudden death. The LV ejection fraction, which measures global systolic function, can be derived from end systolic and diastolic 2-D images and can identify high-risk individuals. The aortic flow velocity curve derived by pulsed Doppler echocardiography can also assess global LV systolic function, stroke volume, and cardiac output (19).

Complications of Myocardial Infarction

Mitral regurgitation

Mitral regurgitation usually results after acute MI due to papillary muscle dysfunction and fibrosis or rupture of one or more of its heads or protrusion of the mitral valve leaflets beyond mitral annulus simulating valve prolapse. Mitral valvular regurgitation can be semiquantitated by color flow Doppler by relating the area of the regurgitant mitral jet to the left atrial chamber (20). Echocardiographic features of papillary muscle rupture or
Fig 1—A 2-D echocardiogram of a patient with acute myocardial infarction is depicted in systole. Note the akinetic apex with a layered thrombus (arrow). LA = left atrium; LV = left ventricle; RA = right atrium; RV = right ventricle.

Partial rupture (4) include mobile mass of echoes attached to the normal chordae tendineae, absent tip of the papillary muscle, and mitral valve prolapse with mitral regurgitation (Fig 3). The presence of a normal mitral valve apparatus on 2-D echocardiography, however, does not rule out the diagnosis of papillary muscle rupture. Since medical therapy carries a high risk in these individuals and valve replacement surgery may be a reasonable alternative, it is therefore important to make a correct diagnosis as soon as possible. Mechanical factors such as papillary muscle rupture or ventricular septal rupture can also be suspected when a patient with severe pulmonary edema demonstrates dysfunction of only one or two ventricular segments (usually the inferior) with good overall LV systolic function and ejection fraction. Recently, transesophageal echocardiography with color flow Doppler has demonstrated a greater diagnostic potential of detecting mitral valvular abnormalities than the conventional transthoracic approach (21). We were able to demonstrate a ruptured papillary muscle (Fig 4) and mitral regurgitation (Fig 5) more clearly by this approach than by the transthoracic study in a postinfarction patient. Transesophageal imaging, however, is unpleasant, semi-invasive, and carries a small potential risk when compared with the transthoracic study.

Ventricular septal defect
The echocardiographic features of ruptured ventricular septum after an acute MI include a defect in the muscular septum in the area of poorly contracting muscle (5) and left to right shunt demonstrable by color flow Doppler (Fig 6). Since these patients have a poor prognosis with medical therapy and are potentially improved with surgery, it is important to make the diagnosis as soon as possible.

Fig 2—Sixteen left ventricular segments with their own coronary artery distribution are depicted. 2-C = apical two-chamber view; 4-C = apical four-chamber view; ANT = anterior; CX = left circumflex coronary artery; INF = inferior; LAD = left anterior descending coronary artery; LAT = lateral; LAX = parasternal long axis view; RCA = right coronary artery; SAX AP = short axis view at the level of the ventricular apex; SAX MV = parasternal short axis view at the level of mitral valve; SAX PM = parasternal short axis view at the level of papillary muscle; SEPT = septal.
Left ventricular thrombi

One of the most common complications detected by 2-D echocardiography after an acute MI is the development of a mural thrombus (9-12). The incidence of thrombi has been reported as high as 34% after anterior wall infarction and as low as 1.5% after an inferior wall infarction (10). Previous studies demonstrated that mobile and pedunculated thrombi (Fig 7) are more likely to embolize than a flat (Fig 1) or a laminated one (11). The risk of embolism is highest in the first four months of an acute MI. Recently, pulsed Doppler studies obtained from the mitral inflow, the septum, and the lateral wall of the left ventricle have demonstrated flow patterns which are predictors of future thrombus formation after an acute MI (22). A large, mobile, pedunculated ventricular thrombus in the presence of severe LV dysfunction and/or congestive heart failure are usual indications for long-term anticoagulant therapy with warfarin.

True left ventricular aneurysm

Following an acute MI, the involved segment may become transiently dyskinetic (6). With passage of time, the function of the infarcted segments and LV score index may improve, even at times to normal values. There are some subsets of patients in whom dyskinesis and systolic thinning of the involved segments become persistent, resulting in chronic aneurysm. These chronic LV aneurysms are detected by 2-D echocardiography by virtue of systolic bulging and thinning of the involved segments (Fig 7).

Left ventricular pseudoaneurysm

Pseudo, or false, aneurysms of the left ventricle after an acute MI are more rare than true aneurysms. Unlike true aneurysms, the pseudoaneurysms are bounded only by pericardium and are more apt to rupture (7,8). Early diagnosis and treatment is therefore imperative in these individuals since they are amenable to surgical aneurysmectomy. Two-dimensional echocardiographic characteristics of a pseudoaneurysm include an echo-free space (Fig 8) with a narrow neck (which distinguishes it from a true aneurysm). Color flow Doppler may confirm the diagnosis by demonstrating systolic communication (Fig 9) with the LV cavity (8). This feature also differentiates these patients from those with localized pericardial effusions or cysts.
Right ventricular infarction

Right ventricular infarction usually results after posteroinferior MI. The echocardiographic features of right ventricular infarction include hypokinesis or akinesis of the right ventricle with or without dilatation (13). Since the right ventricle is not well visualized from the parasternal views, subcostal or apical views may have to be employed to detect these abnormalities.

Pericardial effusion

Pericardial effusion may develop acutely in the MI patient as a result of pericardial irritation, anticoagulation, or thrombolytic therapy or may develop late as in Dressler’s syndrome. The pericardial effusion can be detected and semiquantitated by 2-D echocardiography. Hemodynamic compromise and cardiac tamponade may also be diagnosed by 2-D echocardiography (23) and cardiac Doppler (24).

Role of echocardiography in determining stunned myocardium

Recent studies in our institution indicate that a low-dose dobutamine infusion (5 to 10 μg/kg/min) can unmask viable but noncontractile myocardium (stunned) in patients with an acute MI (25). These patients had demonstrated a greater improvement in their segmental LV score index after revascularization procedures (bypass surgery or angioplasty) as compared to medical therapy. Thus, dobutamine echocardiography may be a good indicator of viable myocardium after an acute MI.

Conclusion

Two-dimensional echocardiography with color flow Doppler is a useful noninvasive test in detecting or confirming suspected complications of acute MI: tissue rupture, aneurysm or pseudoaneurysm, mural thrombus, and right ventricular infarction (26). The test is also useful in evaluating LV function in predicting a low-risk subgroup for ambulation and early discharge from the coronary care unit. As with any testing modality, echocardiography is not 100% sensitive or specific in detecting MI and its complications. Therefore, clinical evaluation, electrocardiogram, cardiac enzymes, isoenzymes, chest roentgenographic studies with or without radionuclide testing, right and left heart catheterization, and angiography may be needed to diagnose these patients.
Fig 9—Demonstrates color flow Doppler image of the patient with left ventricular pseudoaneurysm. Note the systolic color flow jet (arrow) directed from the left ventricle into the false aneurysm (arrow). LV = left ventricle; PAN = pseudoaneurysm; RV = right ventricle.

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References