Review article

Echocardiography and coronary artery disease: Current and future applications

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Abstract

Echocardiographic techniques are becoming more widespread for evaluating patients with known or suspected coronary artery disease. Because it affords an excellent overall view of the heart, two-dimensional echocardiography, rather than M-mode echocardiography, is the imaging procedure of choice when dealing with coronary artery disease. This technique can be used to make the initial diagnosis of acute myocardial infarction, diagnose complications, and assess prognosis following myocardial infarction. Additionally by combining this test with stress testing, latent coronary artery disease can be detected. Recovery of wall motion can be assessed following interventions such as thrombolysis or balloon angioplasty. Investigational and future uses include tissue characterization, which may allow detection of ischemic but potentially viable myocardium, direct coronary visualization for detection of atherosclerotic involvement of the proximal coronary arteries and myocardial contrast echocardiography. The latter technique allows visualization of perfusion by way of injecting contrast material into the coronary circulation. This has been demonstrated to be an accurate means of determining myocardial infarction size in an animal model and is currently being used in a number of centers in patients at the time of cardiac catheterization. In summary two-dimensional echocardiography currently allows assessment of patients with myocardial infarction from the time of their presentation through their convalescent period with respect to diagnosis, prognosis and presence of complications. Exercise echocardiography can diagnose latent coronary artery disease. The newer investigational techniques show promise for furthering our ability to evaluate patients with coronary artery disease using echocardiography.

Introduction

The role of echocardiography in evaluating patients with pericardial, valvular and congenital heart disease is well established, however its utility in patients with coronary disease is not as firmly entrenched, and in many centers this technique is underutilized in patients with coronary disease.

The purpose of this paper will be to review the established uses of echocardiography in patients with coronary artery disease and a number of developments in this field which show promise for clinical applicability in the near future.
Echocardiographic methods

Of the three forms of cardiac ultrasound utilized clinically, two-dimensional scanning, M-mode echocardiography and Doppler techniques, two-dimensional echocardiography is the mainstay of imaging in patients with coronary disease. The premise underlying application of two-dimensional imaging in patients with coronary disease is that myocardial ischemia or infarction will produce wall motion abnormalities which are detectable with two-dimensional echocardiography. That these wall motion abnormalities occur instantly was demonstrated by Tennant and Wiggers in 1935 [1], and that they can be detected with two-dimensional echocardiography has been shown by numerous investigators [2-6]. While M-mode echocardiography can also detect wall motion abnormalities, the superior spatial orientation afforded by two-dimensional scanning make it superior to the older M-mode technique for evaluating ischemic wall motion abnormalities. The latter technique currently plays very little role in patients with coronary artery disease for defining wall motion abnormalities. M-mode echocardiography may be used in a “directed” manner from two-dimensional imaging to assay discrete areas of myocardium for tissue characterization or perhaps determination of myocardial perfusion as will be discussed subsequently. Doppler techniques may be used for assessment of diastolic properties of the heart and to follow systolic performance but do not play a role in the diagnosis of coronary disease. They may offer valuable information concerning specific complications of myocardial infarction such as mitral regurgitation and ventricular septal defect.

That abnormal wall motion can be detected by echocardiography has been demonstrated by numerous investigators [2-6]. This evidence was accumulated in the mid 1970’s in several laboratories and generally involved correlative studies between cardiac catheterization [2-4] or post-mortem examination [6] and echocardiography. Additionally correlative studies have been performed between radionuclide techniques and two-dimensional echocardiography [4-5]. All of these studies have shown excellent correspondence between the two-dimensional echocardiogram and other techniques with respect to the presence and location of abnormal wall motion. The presence of abnormal wall motion in patients with coronary artery disease is assumed to indicate active ischemia or myocardial infarction. When compared to the anatomic extent of myocardial infarction however echocardiography tends to overestimate the anatomic size of the infarct [6]. The extent of the wall motion abnormality can be quantified by several different methods, many of which are still under development. These range from the very simple visual assessment of wall motion as being normal, hypokinetic, akinetic, dyskinetic or aneurysmal to highly detailed schemes involving analysis of multiple systolic time points throughout the entire contraction sequence. It should be stressed that there are significant limitations to each of these techniques. One of the simpler semiquantitative schemes for analyzing wall motion is the generation of a wall motion score index [7]. This technique involves dividing the left ventricle into a predefined number of segments, each of which is then graded on a score generally ranging from one being normal up to four representing dyskinesis (Fig. 1). The total wall motion score or wall motion score index is then calculated, with higher numbers representing increasing degrees of left ventricular dysfunction. This relatively simple scoring scheme allows the interpreter to assign a number to the examination which is proportional to the severity of the left ventricular wall motion abnormality. A detailed discussion of the multiple schemes for analyzing wall motion is beyond the scope of this review article. For a detailed review of the various wall motion analysis schemes the reader is referred to the review article by Mann et al. [8].

Current utilization of echocardiography in coronary artery disease

Table 1 lists both the current and investigational uses of echocardiography in patients with known or suspected coronary artery disease. Those items listed as current uses are generally well within the range of any established echocardiography labora-