Myocardial Contrast Two-Dimensional Echocardiography: A Complement to Coronary Angiography*

SAMUEL MEERBAUM, PHD, FACC†

Los Angeles, California

Rapid development of a new methodology is not altogether unusual in the current environment of diagnostic and interventional cardiology. Remarkable benefits might be projected, but scientists and clinicians alike must first develop an adequate understanding of the method's advantages and limitations. Myocardial contrast two-dimensional echocardiography represents a promising new diagnostic technique that has undergone extensive experimental validations as well as recent clinical trials. The preceding article in this issue of the Journal by Keller et al. (1) deals with an interesting application of contrast echocardiography and joins the growing literature in this field.

Progress in contrast echocardiography. After early exploration (2,3), the Journal of the American College of Cardiology published in 1984 a seminar (4) featuring articles on echo contrast agents, assessment of ischemic risk zones and study of regional myocardial blood flow and function, by myocardial contrast echocardiography. Despite encouraging progress, the need was recognized to develop contrast agents as quantitative microcirculatory tracers, standardize intracoronary or alternate injections and enhance the echo image quality that underlies valid tissue contrast analysis. Significant recent developments include sonicated or other agents containing extremely small microbubbles (3 to 5 μm) to be uniformly distributed and delivered in optimal concentrations (5,6). Computer-aided methods now permit dynamic study of myocardial contrast appearance-disappearance, yielding several potential indexes of perfusion (7). In recognition of current limitations, efforts are under way to develop dedicated ultrasound instrumentation (8). Contrast echocardiography is particularly well suited for detection and delineation of severely underperfused myocardium, for example, after coronary occlusion (9). In the catheterization laboratory, when contrast echocardiography (with 2 ml intracoronary sonicated Renografin-76) was performed on patients with normal coronary arteries, anatomically corresponding myocardial regions were satisfactorily delineated (10). This technique defines underperfused myocardium, distal to an angiographically demonstrated severe coronary artery lesion and indicates a return of regional perfusion after successful vessel dilation by angioplasty (11). Clinical contrast echocardiographic quantitation of myocardial blood flow remains to be demonstrated, but this ultimate goal seemed attainable in experiments with the use of new echo contrast agents and dynamic analysis (12).

Is myocardial contrast echocardiography really necessary? The question might be asked whether this method provides significantly more information than that obtained through fully noninvasive two-dimensional echocardiographic measurements of regional wall motion. The answer is that, although severe underperfusion is generally associated with severe dysfunction, there are exceptions and dissociation (for example, in early reperfusion). The extent and configuration of underperfused myocardium may not be adequately defined by the area of dysfunction. With regard to the site and severity of vessel stenosis, myocardial blood flow clearly depends on the input from the epicardial coronary arteries, but other factors (for example, cardiac contraction) also have a major effect. The primary physiologic determinants of myocardial survival, that is, the level and distribution of tissue blood flow, may not be fully described by the severity of the coronary lesions. Therefore, myocardial perfusion measurements should supplement evaluation of coronary arteries and assessment of regional contractile function. In comparison with other promising techniques, contrast echocardiography combines real time tomographic imaging with good resolution, significant economy, flexibility of application and minimal toxicity.

Myocardial contrast echocardiographic characterization of coronary stenoses. Feinstein et al. (13) used intracoronary sonicated Renografin-76 without complications in 50 patients in the absence of or with significant coronary lesions. Case descriptions indicated that perfusion deficiencies may be evident in some patients even in the presence of normal coronary arteries. After arteriography, Griffin et al. (14) studied regional myocardial echo intensities in 28 patients with normal or diseased coronary arteries. Intracoronary hand-agitated Renografin-76 injection allowed safe and reproducible study of perfusion zones, but myocardial enhancement was too heterogeneous to permit quantitative evaluation of moderate coronary stenoses. Ten Cate et al. (15) applied videodensitometric contrast echocardiographic...
analysis of myocardial regions visualized in apical four chamber views of the left ventricle. Using intracoronary sonicated iopamidol in 12 patients with a wide range of single vessel stenosis, these investigators found a significant correlation between area under the echocardiographic intensity-time curve and percent coronary artery stenosis.

**Evaluation of functional significance of coronary lesions.**

Because myocardial blood flow may not become impaired until a coronary artery is severely constricted, study of the functional significance of moderate coronary lesions is best accomplished by measuring the coronary reserve or potentiation of regional myocardial perfusion in the presence of pharmacologically induced hyperemia, for example, by intracoronary papaverine. Cheirif et al. (16) studied 40 patients, of whom 27 had various coronary lesions and 13 had normal coronary arteries. Contrast echocardiography was performed before and 10 to 15 s after administration of 8 to 10 mg intracoronary papaverine. Peak regional myocardial echo intensities increased significantly after papaverine in the normal coronary subset, but remained unchanged in patients with angiographically demonstrated lesions.

Two advantages of the smaller (nine patients) study by Keller et al. (1) in this issue of the Journal are that it was limited to patients with single vessel stenosis and it compared in each patient the normal coronary subset, but remained unchanged in patients with angiographically demonstrated lesions.

References


