Evolving Advances in Echocardiography

Highlights from the 11th Annual Scientific Sessions of the American Society of Echocardiography
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This year's meeting of the American Society of Echocardiography, well attended by an international group of cardiologists and sonographers, encompassed all aspects of cardiovascular ultrasonographic imaging, including 3-dimensional echocardiography, contrast echocardiography, tissue Doppler imaging, and ultrasound stethoscopy. In addition to the 310 abstracts presented, a number of symposia and meet-the-experts sessions dealt with state-of-the-art knowledge in various facets of cardiovascular ultrasonographic imaging.

Main Points

- Prolonged myocardial hibernation induces progressive dilatation and dysfunction of the left ventricle without compensatory hypertrophy.
- Major cardiac pathology can be seen at the bedside using a handheld echocardiography system.
- Adenosine contrast echocardiography is effective in identifying viable myocardium.
- Use of tissue Doppler echocardiography may help avoid excessive biopsies in heart transplant patients.
- In patients with mitral valve prolapse, prognosis may be predictable using baseline echocardiographic characteristics.

Three-Dimensional Echocardiography

The accuracy of 3-dimensional echocardiography in the estimation of right ventricular (RV) and left ventricular (LV) volume, mass, shape, and function and of atrial volumes was demonstrated by a number of validation studies in patients as well as in animal models. Application of 3-dimensional echocardiography in pathophysiologic studies of ventricular remodeling and mitral apparatus geometry in ischemic syndromes was of special interest. Liu and associates,[1] in an experimental investigation of high-grade coronary stenosis, observed that prolonged myocardial hibernation induced progressive LV dilatation and dysfunction, with an insufficient compensatory LV hypertrophy similar to that observed in ischemic cardiomyopathy. They further noted that reperfusion only partially reversed the progressive remodeling process with a modest increase in LV ejection fraction. Corroboration of these observations in humans could emphasize the need for early recognition of hibernation and for appropriate intervention.

In another study of ischemic myocardium, Messas and colleagues[2] occluded the proximal circumflex coronary artery in 5 sheep (while maintaining the perfusion of papillary muscles) and employed 3-dimensional echocardiography to measure ischemic mitral regurgitation volume as well as the tethering distance between the ischemic papillary muscle tip and the anterior annulus. Without initial mitral regurgitation, inferior ischemia alone produced papillary muscle tip retraction, restricted leaflet closure, and mild to moderate mitral regurgitation. Adding papillary muscle ischemia consistently decreased mitral regurgitation and the tethering distance. This study raised the possibility that papillary muscle contractile dysfunction from inferobasal ischemia can, paradoxically, decrease mitral regurgitation by reducing leaflet tethering, thereby improving coaptation. This investigation emphasized the role of geometric fac-

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tors in the mechanism of mitral regurgitation and in planning potential therapy.

During the last few years, there has been increasing interest in translating 3-dimensional ultrasonographic data into physical models of the human heart. Previous approaches to physical modeling involved the use of laser stereolithography. Li and associates[3] presented a new approach: fabricating a physical replica of the human heart using ultraviolet light exposure to produce rapid prototyping. This and other modeling techniques could have important applications in preoperative planning for cardiac surgery.

Echocardiography Using Miniaturized, Handheld Ultrasonographic Units

This conference witnessed a new advance in ultrasonographic imaging. Groups from Tufts University[4] and the Mayo Clinic[5] presented their experiences with the use of a handheld, lightweight echocardiography system. This unit can be carried around the hospital during clinical rounds and, after physical examination of the patient at the bedside, a brief echocardiographic examination could be performed instantly. It was demonstrated that cardiac imaging studies of diagnostic quality could be obtained with such an instrument to assess LV and RV function; pericardial effusion; and any major morphologic, functional, and flow abnormalities. Comparison of bedside ultrasound stethoscopic information and subsequent comprehensive echocardiographic examination, performed in 30 patients by the Tufts group, indicated that there were no differences between conventional and bedside imaging in the recognition of major cardiac pathology. These instruments are of low cost and could revolutionize the approach to the clinical examination of a patient.

Contrast Echocardiography

During both the main meeting and a 1-day symposium on contrast echocardiography prior to the conference, a large number of presentations dealt with advances in contrast echocardiography, particularly on myocardial perfusion imaging. Many investigators presented their experience with real-time perfusion imaging using a variety of ultrasonographic contrast agents. Porter and colleagues[6] employed power-pulse inversion imaging using a very low mechanical index in 51 patients undergoing stress from either dobutamine or exercise. Correlation between angiographic location of more than 50% coronary stenosis and regional perfusion (assessed by myocardial contrast echocardiography) was excellent.

Dr Morcerf's team from Brazil[7] presented their extensive experience in adenosine myocardial contrast echocardiography in the evaluation of coronary artery disease (CAD). Following previous demonstrations that adenosine contrast echocardiography is a highly accurate technique, these researchers studied 117 patients with intermediate probability of CAD in whom both adenosine contrast echocardiography and nuclear single-photon emission CT imaging were performed. The assessment of perfusion by adenosine contrast echocardiography was feasible in 97% of the segments, and the overall concordance between the tests was 73%.

In another study, these investigators examined 19 consecutive patients undergoing percutaneous coronary interventions.[8] Both adenosine contrast echocardiography and dobutamine stress echocardiography were performed to assess how well adenosine contrast echocardiography can identify viable myocardium. This investigation showed that adenosine contrast echocardiography showed a greater than 90% concordance with dobutamine stress echocardiography in the recognition of viable myocardium in all coronary arterial territories.

These abstracts and other presentations during this meeting highlighted myocardial contrast echocardiography as a viable tool for perfusion imaging in patients with suspected and established CAD.

Tissue Doppler Echocardiography

Tissue Doppler imaging is a technique in which the velocity of motion of different regions of the myocardium can be quantified during both systole and diastole. Sun and colleagues[9] employed tissue Doppler echocardiography to examine whether this method can aid in the detection of cardiac transplant rejection. They evaluated 266 patients who underwent heart transplantation, measuring the mitral annular velocities and comparing them to biopsy data. The investigators observed that a cutoff velocity (measured at the inferior mitral annulus) of 9 cm or lower had a 64% sensitivity, a 56% specificity, and a 78% negative predictive value in recognizing rejection. It is conceivable that this technique could avoid excessive biopsies in transplant patients in whom Doppler echocardiography shows normal tissue.

This approach was also used in an investigation of patients in whom constrictive pericarditis or restrictive cardiomyopathy was suspected. Bashir and associates[10] studied 11 patients and obtained mitral annular velocities.

In this small study, a higher early diastolic annular velocity helped distinguish constrictive pericarditis from restrictive cardiomyopathy. Respiratory variation in annular velocities did not aid in the differentiation between constrictive pericarditis and restrictive cardiomyopathy.

Valvular Heart Disease

While mitral valve prolapse is a frequently noted condition, the long-term outcomes of patients in the general population who have this condition are not known. Avierinos and colleagues[11] followed 920 residents of Olmstead County, Minn, with mitral valve prolapse for a 5-year period. Of 920 patients, 15% died during the 5 years, and 4.7% required mitral valve surgery. Heart failure, atrial fibrillation, and ischemic stroke developed in 6.4%, 6.2%, and 4.7%, respectively. Besides a mortality rate higher than expected, univariate analysis showed a relatively high morbidity rate in subsets of patients with low ejection fraction, a large degree of mitral regurgitation, or enlarged left atrium. The investigators suggest that the outcome of mitral valve prolapse in the population is not uniformly benign and that prognosis can be predicted by baseline echocardiographic characteristics.

In another study, Girard and coworkers[12] examined the diagnostic approach to patients with mechanical aortic valve obstruction. The primary mechanisms of obstruction were pannus in growth in 26 patients, patient-prosthesis mismatches in 19 patients, and thrombosis in 6 patients. When they compared the diagnostic evaluation in the first half of the decade with that in the second half, there was stronger utilization of transesophageal echocardiography in the later years (93% vs 48%) and a trend toward decreased rates of cardiac catheterization (7% vs 30%). This study emphasized that the primary mode of evaluation of mechanical valve obstruction should be echocardiography and that hemodynamic catheterization is not routinely necessary.

Mohan and associates[13] examined the relation between mitral area in patients with mitral stenosis and the patients' ability to augment cardiac output during stress. Forty-nine patients with isolated mitral stenosis underwent dobutamine stress echocardiography. In 22 patients, the cardiac output rose to 50% or more, while in 27 patients, there was a smaller increase in the cardiac output. The change in mitral valve area with stress was minimal—only about 10% to 12%—with no difference between the groups. This study indicated that in patients with moderate and severe mitral stenosis, the mitral valve area does not increase significantly with higher flow volume and the increase in mitral valve area (mitral reserve) does not play a significant role in cardiac output response to hemodynamic stress.

Summary

The original abstracts and symposia at the 11th Annual Scientific Sessions of the American Society of Echocardiography continued to show the evolving advances in echocardiographic technology, the expanding clinical applications, and the important role of this discipline in patient care. In particular, the presentations and lectures emphasized that contrast echocardiography and 3-dimensional imaging are likely to play bigger roles in the future in the field of cardiovascular ultrasonographic imaging. ■

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