MEETING HIGHLIGHTS

Meeting Highlights of the 17th Annual Scientific Sessions of the American Society of Echocardiography
Baltimore, Maryland, June 3–7, 2006

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The 17th Annual Scientific Sessions of the American Society of Echocardiography (ASE), Baltimore, Maryland, June 3–7, 2006, focused on the comprehensive evaluation of the cardiovascular patient and were the forum for presentation of the latest advances in ultrasound techniques that are essential to patient diagnosis and management. This highly successful 5-day conference, which attracted more than 3,000 attendees and a record number of faculty from all over the world, was chaired by Dr. William A. Zoghbi. Among the highlights of the conference was the Edler Lecture, named for the father of echocardiography, given by ASE president Dr. Bijoy Khandheria and entitled “Back to the Future.” The lecture showcased the evolution of ultrasound techniques over the years and glimpsed into its future. Another highlight was Dr. Jonathan Lindner’s presentation of the Harvey Feigenbaum Lecture, “Thinking Big, Looking Small: Diagnostic Opportunities by Echo Imaging of the Molecular Basis of Disease,” which recognized young faculty with significant contributions to the field of echocardiography.

YOUNG INVESTIGATOR AWARD COMPETITION

The Young Investigator Competition features meritorious research from young investigators at the annual scientific sessions. Among the 4 finalists who competed, Dr. Josef Korinek from the Mayo Clinic was the winner for his work on segmental strain during acute myocardial ischemia (1). His group demonstrated that quantitative strain with echocardiography closely reflects changes in high-energy phosphate metabolism seen during acute myocardial ischemia. Myocardial biopsies were obtained from control and ischemic regions for measuring the ratio of adenosine tri- to diphosphate (ATP/ADP ratio). A mathematical model based on dyskinesis strain, post-segmental strain was validated and prospectively shown to accurately predict the ATP/ADP ratio. This study provided, for the first time, a mathematical method for noninvasive estimation of energy reserves of acutely ischemic myocardium, which may be useful for optimizing therapeutic interventions during acute coronary syndromes. Two of the other finalists demonstrated the utility of tissue Doppler in evaluating cardiac disease states. Dr. Kalpana Prakasa (2) showed that tissue Doppler and strain was superior to conventional echocardiography in diagnosing arrhythmogenic right ventricular dysplasia. Dr. Sanjiv Shah (3) used tissue Doppler as well as mitral inflow parameters to evaluate the physiology of the third heart sound in diastolic dysfunction. The most important determinants of S3 were found to be an increased deceleration rate of early mitral inflow, elevated filling pressures, and abnormal ventricular relaxation measured by tissue Doppler. Dr. Nozomi Watanabe (4), using novel software to analyze 3-dimensional (3D) volumetric images, demonstrated that dynamic changes of papillary muscle position occur during the treatment of heart failure. These changes resulted in reduction of tenting of the mitral valve which was associated with the observed improvement in functional mitral regurgitation after therapy.

ECHOCARDIOGRAPHY IN EVALUATION OF SYSTOLIC AND DIASTOLIC FUNCTION

Myocardial mechanics and systolic function. Echocardiographic advances in tissue Doppler and speckle tracking technology have recently allowed the imaging and measurement of circumferential, radial, and torsional myocardial mechanics. Speckle tracking algorithms have provided a method to study myocardial mechanics comprehensively in health and disease. At the scientific sessions, Goto et al. (5) showed that left ventricular (LV) untwisting velocity is decreased in patients with LV hypertrophy secondary to systemic hypertension. The untwist velocity was even lower in patients with hypertrophic cardiomyopathy. Mizuguchi et al. (6) expanded the potential application of myocardial mechanics to evaluate ventricular-arterial coupling by investigating the relationship between early diastolic radial strain...
and vascular stiffness in the carotid arteries. Vascular stiffness parameters showed dependency on early diastolic strain rate and was independent of age and all other spectral Doppler indexes of diastolic function. Other investigators presented data which showed that 2-dimensional strain analysis of the myocardium was an excellent tool to detect regional myocardial ischemia, transmural extent of necrosis, and extent of myocardial scar (7–9). Another exciting application of myocardial mechanics was demonstrated by Uranishi et al. (10). Persistent abnormal post-systolic strain was seen after brief ischemia although peak systolic strain had returned to normal, suggesting that post-systolic strain may be an avenue for ischemic memory imaging by echocardiography (10). The same group also demonstrated that imaging of cardiac perfusion and mechanics was possible with speckle tracking methods and was superior to the tissue Doppler approach (11,12).

**Doppler indexes and role of B-type natriuretic peptide in heart failure.** Echocardiography has an established role in the diagnosis, classification and prognosis of heart failure. On the other hand, B-type natriuretic peptide (BNP) has had an increasing role in the diagnosis and prognosis of heart failure. Symposia and original research at the meeting emphasized that Doppler indexes of diastolic function are more sensitive to changes in filling pressure compared with BNP, the latter relating more to overall cardiac function, structure, and filling pressures among other factors. Dall’Bianco et al. (13) examined BNP levels and indexes of LV filling pressures by Doppler echocardiography in patients with first-time pulmonary edema. The BNP levels were lower in patients with preserved systolic function compared with those with depressed function. However, filling pressure estimates by mitral-to-tissue Doppler velocity ratio (E/E’)) was comparably elevated. The authors concluded that a lower BNP level in heart failure with preserved systolic function is not necessarily indicative of lower filling pressures. Burjonroppa et al. (14) extended this observation to patients with elevated BNP of >1,000 pg/ml. There was no correlation of the elevated BNP levels with any of the Doppler parameters of filling pressure, left atrial or LV size, or ejection fraction (EF). Furthermore, BNP was markedly elevated in a subgroup of patients with sepsis, with normal EF, and without evidence of volume overload, emphasizing the need to combine imaging data with BNP in management of patients with comorbidities where BNP elevation may be nonspecific.

**Left atrial size and outcomes.** Left atrial (LA) size has been shown recently to be a sensitive indicator of diastolic dysfunction. Work by Penafiel et al. (15) and Ristow et al. (16) corroborated these observations and demonstrated the power of LA size in predicting exercise capacity and cardiovascular outcome. The incremental value of LA anteroposterior dimension to that of the presence of coronary artery disease by electron beam computerized tomography was examined by Osranek et al. (17) in 1,004 patients. On multivariable Cox regression analysis, LA dimension, coronary calcification, and age were the only significant predictors of death. This study shows the important prognostic power of simple echocardiographic measurements in relatively low-risk populations and raises the question of whether measurement of LA volumes may result in even superior prediction models of cardiovascular outcome.

**Restrictive cardiomyopathy and constrictive pericarditis.** Imaging of myocardial function by tissue Doppler can provide new insights into cardiac function in patients with constrictive pericarditis. In one study, systolic and diastolic function of the interventricular septum were noted by strain Doppler echocardiography to be normal in patients with constriction but abnormally reduced in those with cardiac amyloidosis (18). In addition, some patients with constriction were noted to have abnormal septal motion after early diastole, which was not present in patients with cardiac amyloidosis. The clinical application of these new observations awaits their comparison with established and time-honored criteria for the diagnosis of constrictive pericarditis but may be useful in equivocal cases where there is minimal respiratory variation in mitral inflow and annular velocity is at low normal values. Finally, in an initial report in patients with systemic amyloidosis, BNP was increased in 24% of 73 patients with LV wall thickness ≤12 mm (19). Although this may suggest early cardiac involvement, follow up of these patients is essential to determine whether BNP, and potentially tissue Doppler imaging, will have a role in predicting preclinical disease in this population.

**Cardiac resynchronization therapy.** Evaluation of regional function with tissue Doppler or speckle tracking is currently an integral part of the assessment of cardiac dyssynchrony. Original research presented at the meeting provided additional refinement of this role. The importance of radial assessment of dyssynchrony compared with the conventional longitudinal evaluation was highlighted by a few investigations. Suffoletto et al. (20) showed that improvement in radial synchrony after cardiac resynchronization therapy (CRT) by speckle tracking was associated with longitudinal synchrony and with greater improvement in stroke volume than when radial synchrony was not optimized. The work by Seo et al. (21) demonstrated that assessment of radial dynamics is superior to longitudinal dyssynchrony in predicting the hemodynamic outcome after
CRT. The greatest increase in cardiac output and \( \frac{dP}{dt} \) was seen in those with the most marked radial dyssynchrony. Patients with segmental paradoxical regional expansion, assessed by strain imaging had a greater acute response to CRT as measured by changes in EF and decrease in LV end-systolic volume compared with those without paradoxical expansion (22). These data add to the growing body of echocardiographic parameters which continue to refine and improve outcomes in CRT. Cannesson et al. (23) presented data which advance the case that LVEF—a criterion for selecting patients for CRT—can be measured reproducibly by a unique automated system based on artificial intelligence. The method is able to recognize endocardial borders and calculate LV biplane volumes and EF with no user interaction. It improved reproducibility of readers, particularly novice readers (23).

A clinically useful byproduct of 3D echocardiography and its quantification of regional LV wall motion is the ability to measure the temporal aspects of regional endocardial systolic contraction. This methodology has been used in CRT despite its relatively low temporal resolution. The standard deviation of the regional ejection times (interval between the R wave and the peak systolic endocardial motion) has been used as an index of myocardial synchrony. This approach was used by Saloux et al. (24) to identify patients with LV mechanical dyssynchrony. An acceptable correlation was reported by the authors comparing traditional strain rate indexes of LV dyssynchrony with that of real-time 3D. Maddukuri et al. (25) described the acute and long-term effect of CRT on LA volumes in patients with advanced heart failure. The LA volumes were measured by 3D at baseline and 48 h and 2 months after CRT. This study demonstrated that in patients with advanced heart failure, CRT results in an acute and persistent reduction in LA volumes.

The presence and clinical impact of systolic dyssynchrony in patients with systolic heart failure is now well established. However, there is little information on the presence of dyssynchrony in other patient groups. In one study using tissue Doppler imaging, patients with aortic regurgitation and diastolic dysfunction (both groups with normal EF) had a high prevalence of dyssynchrony which was similar to that of patients with LV systolic dysfunction and depressed EF (26). Similarly, using tissue Doppler imaging and echocardiographic phase imaging, dyssynchrony was observed in patients with type II diabetes mellitus and normal EF (27). The impact of mechanical dyssynchrony on cardiac function and clinical events has yet to be determined in these groups. However, pending functional correlates, these observations suggest similar pathophysiology roles of mechanical dyssynchrony in patients with and without depressed EF.

**STRESS AND CONTRAST ECHOCARDIOGRAPHY**

**Stress echocardiography.** As stress echocardiography continues to mature, the prognostic value of this diagnostic tool becomes more evident. This year’s scientific sessions expanded our ability to use the strength of a positive or negative stress echocardiogram in high-risk populations, such as patients with diabetes or with chronic kidney disease. Weiniger-Mik et al. (28) from Poland studied over 200 diabetics with pharmacologic stress echocardiograms and followed them for over 4 years. Diabetes and positive stress echocardiogram were independent predictors of cardiac events (relative risk [RR] 2.7 for diabetes, \( p = 0.04; \) RR 3.8 for stress echocardiography, \( p = 0.005 \)). Tita et al. (29) from Henry Ford Hospital in Detroit demonstrated the utility of stress echocardiography in patients with chronic renal disease. In a study of over 500 patients evaluated for renal transplantation and followed for almost 3 years, a negative stress echo was extremely good in predicting event-free survival, with a 95% specificity and a 96% negative predictive value.

**Contrast echocardiography.** The importance of contrast during stress echocardiography in enhancing endocardial visualization is well recognized. Moir et al. (30) from the Mayo Clinic documented its use and importance in a retrospective review of over 21,000 patients. In this large cohort, contrast was used in 21% (\( n = 4,645 \)) of patients who had suboptimal image quality without contrast. Of the 1,460 patients referred for angiography, there was no difference in parameters of test accuracy between the contrast and noncontrast groups, further demonstrating that contrast can salvage a suboptimal echocardiogram during a stress test. Although contrast has an established role in contemporary rest and stress echocardiography to enhance endocardial border detection, it also has emerging roles in myocardial perfusion, targeted imaging, and targeted therapy. Nanotechnology has advanced the characteristics of novel microbubbles to allow imaging of specific biologic activities. An example of this work is from Cho et al. (31) at the University of Virginia, who demonstrated molecular imaging of vascular inflammation by using polymeric sialyl Lewis\(^X\) (PSLe\(^X\)), a ligand for microbubble targeting. In a murine model, they showed that PSLe\(^X\)-targeted microbubbles attached specifically and effectively to small vessels in inflamed hind limb of the mouse and that these targeted microbubbles were successfully imaged with echocardiography. Work by Marsh et al. (32) at Washington University in St. Louis, Missouri, had previously demonstrated fibrin targeting of perfluorocarbon nanoparticles to thrombi in vitro and in vivo, with attendant enhancement of acoustic reflectivity from the thrombus surface. In the study presented at the scientific sessions, the utility of the nanoparticles was extended by incorporation of a traditional plasminogen-activating enzyme (streptokinase). These fibrin-targeted nanoparticles specifically enhanced reflectivity of clot surfaces in vitro while at the same time delivering clot-dissolving drugs that resulted in nearly complete clot digestion. This demonstrates the potential utility of such agents for image-based monitoring of thrombolytic enzyme activity.
VALVULAR HEART DISEASE

Valvular heart disease was addressed in several sessions at the meeting. For valvular regurgitation, faculty emphasized the integrative approach of 2D and color Doppler recently highlighted in the guidelines for evaluation of valvular regurgitation from the ASE and endorsed by the American College of Cardiology and the American Heart Association (33). The potential role of real-time 3D echocardiography (RT3DE) with color Doppler in the evaluation of valvular regurgitation was featured at the meeting. An important study by Little et al. (34) from the Methodist DeBakey Heart Center described the use of RT3DE for direct measurement of the vena contracta of mitral regurgitation (MR). The authors used a creative in vitro model to generate a variety of regurgitant jets and effective regurgitant orifice areas. The use of RT3DE could directly and accurately measure the vena contracta area. This measurement can be used as an estimate of effective regurgitant orifice area. Other investigations demonstrated that dynamic changes of the mitral valve apparatus can be tracked and evaluated in health and disease with RT3DE. Veronesi et al. (35), using novel software, were able to track the changes of the mitral valve annulus and annular descent throughout the cardiac cycle. In addition, this software was able to define the position of the papillary muscle in 3D space. Watanabe et al. (4) demonstrated that dynamic changes in the position of the papillary muscles occur during the treatment of heart failure and account for the improvement in functional MR.

Clinical trials of new percutaneous therapies for valvular heart disease have been underway and will require serial quantitation of valvular regurgitation. The E-Valve percutaneous mitral valve repair system (E-Valve, Inc., Menlo Park, California) uses a clip to diminish MR and create a functional double orifice of the valve. The results of 1-year follow-up of the EVEREST I (Endovascular Valve Edge-to-Edge Repair Study) were presented (36). Patients with moderate-severe MR were serially evaluated with regurgitant volumes, regurgitant fraction, pulmonary vein flow, and color flow mapping at baseline and 6 and 12 months after the procedure. The repair was successfully performed, reducing regurgitation in both degenerative and functional MR, with a low incidence of complications. Serial evaluation demonstrated that the reduction in MR observed immediately after the procedure can be maintained for at least 1 year.

Techniques to reduce functional MR without atriotomy at cardiac surgery were also investigated using echo Doppler guidance (37). The technique tested attaches a pad on the anterior and posterior side of the LV with a band through the center of the LV. The concept is to tighten the band, thereby reducing the annular diameter of the mitral valve and therefore the degree of MR. Soni et al. (37) in New Delhi used epicardial echocardiography to position the posterior pad and transesophageal echocardiography to optimize the amount of tension needed. Precise posterior pad placement was the main factor in reducing MR and led to repositioning of the posterior pad 2 to 3 times on average. The MR was reduced by at least 1° in all patients studied. These investigations emphasize the important role of Doppler echocardiography in guiding interventional therapy for MR.

VASCULAR DISEASE

With the increased importance of vascular disease and the focus on prevention, the 2006 Scientific Sessions initiated a didactic track for vascular disease and featured original research contributions in the field. In addition to the utility of ultrasound in identifying carotid and other vascular disease, the impact of contrast ultrasound in peripheral vascular disease was highlighted. Investigators explored its potential to further define vascular borders, to detect abnormalities of the vasculature, vasa vasorum, and filling defects. Contrast enhances suboptimal images of vascular structures, including the aortic arch and carotid and cerebral arteries. Contrast was used with transcranial color Doppler, a routine reliable method to assess basal cerebral vessels and the functional significance of internal carotid stenoses. Investigators demonstrated a marked improvement in vessel detection with color Doppler and enhancement of Doppler measurements after use of contrast with Definity (Bristol-Myers Squibb Medical Imaging, North Billerica, Massachusetts) in patients undergoing evaluation for cerebrovascular events (38).

Other investigators studied in vitro aortic wall specimens from patients with Marfan syndrome and control individuals using ultrasound backscatter analysis to determine the feasibility of this technique to ascertain abnormal aortic wall characteristics that correlate to histologic changes (39). Several studies integrated information from 2D imaging/Doppler and hemodynamic analysis to study the feasibility of obtaining characteristics of structure and function as well as cardiac-vascular coupling in normal and vascular disease states (40, 41).

PEDIATRIC CARDIOVASCULAR DISEASE AND ADULT CONGENITAL HEART DISEASE

Congenital cardiovascular malformations. Echocardiography is well suited for the prenatal diagnosis of congenital cardiovascular abnormalities. A commercially available 40-MHz ultrasound biomicroscopy system was used to evaluate 73 mouse embryos exposed to retinoic acid (42). Araujo et al. (42) demonstrated that ventricular septal defects and conotruncal abnormalities were evaluated with very good sensitivity and specificity, but the atrioventricular canal region was not well visualized. With a standard 3-vessel (and trachea) view during fetal echocardiography, Patel et al. (43) diagnosed 37 aortic arch anomalies in 2,398 fetuses. Five fetuses had an associated chromosomal anomaly (2 with 22q11 microdeletion). This rigorous form of screening allowed for more appropriate prenatal counseling and improved perinatal management.
Right ventricular function. A study of postoperative tetralogy of Fallot patients showed changes in right ventricular systolic and diastolic function parameters measured by tissue Doppler imaging (44). Jone Liao et al. (44) found that tricuspid annular velocities, but not mitral or septal annular velocities, correlated with troponin levels at 0, 24, and 48 h after repair. Further evaluation of these newer methods of right ventricular function assessment is needed to determine their role in clinical care.

“Advanced” myocardial function assessment. The addition of more advanced techniques, such as tissue Doppler and 2D strain and strain rate analyses, has the potential to significantly improve our understanding of myocardial function in the developing heart and in congenital heart disease. The utility of speckle tracking techniques in evaluating myocardial function of fetuses was demonstrated in 2 studies. Younaszai et al. (45) used strain and strain analysis to characterize normal myocardial function in second- and third-trimester fetuses, and Lorch et al. (46) were able to detect differences in fetuses of diabetic mothers with septal hypertrophy compared with control subjects.

In pediatric heart transplant patients, left ventricular strain and strain rates were found to be markers for acute rejection (47). These parameters appeared to remain mildly abnormal following resolution of acute rejection determined by biopsy. In an elegant study of 19 children with hypertrophic cardiomyopathy, Ganame et al. (48) demonstrated that a reduction in strain and strain rate was associated with increased wall thickness and reduced exercise capacity. They also showed that post-systolic shortening was higher in the segments with greatest hypertrophy. The ability to quantify changes in regional myocardial function provides a valuable tool for the monitoring of this disease process.

CONCLUSIONS

Significant advances in imaging technology have occurred recently and were featured at the ASE Annual Scientific Sessions. This comprehensive conference showcased how cardiovascular ultrasound methods are integrated in the overall care of patients and are used to detect early disease, determine response to therapy, and guide clinical decision making. Next year’s ASE Scientific Sessions’ Chair, Dr. Roberto Lang, and current ASE President, Dr. Michael Picard, are organizing an exciting program for June 16–20, 2007, in Seattle, Washington. We hope to see you there!

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