The 2003 Annual Scientific Sessions of the American Society of Echocardiography (ASE) survived a last-minute change in venue from Toronto to Las Vegas, attracting more than 2,400 registrants to a multidimensional program. This paper outlines the structure of the meeting and highlights presentations related to clinical and research applications of echocardiography. It is worth noting that the ASE provides disease-based as well as technique-based education, a concept that is reflected in both the subject matter presented and the faculty of the Annual Scientific Sessions.

The membership of the ASE is diverse and includes physicians (cardiologists, radiologists, anesthesiologists, and fellows) as well as sonographers, nurses, and department managers. To meet the continuing educational needs of members, the ASE 2003 included the following tracks: Disease of the Day (coronary artery disease, valve disease, and heart failure on successive days); Meet the Experts/How to; Cutting-Edge Technology; Cases; Core Curriculum (ultrasound basics); Sonography; Intraoperative Echocardiography and Pediatric Echocardiography. Special sessions included technique-based symposia and co-sponsored sessions with the Society for Vascular Ultrasound, European Society of Cardiology, Intersocietal Commission for the Accreditation of Echocardiography Laboratories, and the ASE Women's Health Advisory Group. A session was also offered in Spanish. Special lectures included: the Edler Lecture, “Good Morning ASE,” given by President Pam Douglas; the Feigenbaum Lecture, “Should We Examine the Heart or the Myocardium: Recent Advances in Tissue Characterization,” by Dr. Thomas Marwick; and “Back to the Future,” a review of the evolution of echocardiography, by Dr. Jamil Tajik. Informal, small-group, how-to sessions and two popular “games” offered a change in tempo from structured didactic sessions.

“Echo Jeopardy,” the creation of John Gorcsan III, featured echocardiography luminaries who competed using the game-show format. A local society challenge had a “stump the other team” approach. The President’s Reception this year featured a celebration of the 50th anniversary of echocardiography.

Major topics for the didactic and abstract sessions included abnormalities of ventricular function, valve disease with a focus on the intraoperative setting, contrast echocardiography, new technology, and pediatric echocardiography.

VENTRICULAR FUNCTION

The ASE 2003 showcased new methods for assessing ventricular systolic and diastolic function, many of which hold the promise of noninvasive indexes that are load- and translation-independent. These included methods based on Doppler tissue imaging (strain and strain rate), threedimensional (real-time and reconstructive) techniques, and tissue tracking. These modalities enhance the quantitation and reproducibility of cardiac ultrasound, and application of these and other techniques for assessing patients who are candidates for biventricular pacing and mechanical assist to the failing ventricle shows enormous promise. These quantitative techniques and ultrasound contrast methods are increasingly being applied to increase the accuracy of state-of-the-art stress echocardiography. In addition, the invited speakers, Drs. Gary Heller, Warren Manning, and Joao Lima, compared these techniques with the latest advances in complementary nuclear and magnetic resonance technologies.

The Feigenbaum Lectureship is awarded annually to an outstanding young investigator. This year’s recipient, Thomas Marwick, who has previously made major contributions to the field of stress echocardiography, focused on advances in tissue Doppler, strain rate, and strain imaging. Tissue Doppler recordings represent the velocity of movement of the myocardium itself during contraction and filling. Dr. Marwick discussed the superiority of these techniques over conventional gray-scale imaging to demon-
strate early myocardial functional abnormalities in patients with subtle forms of dysfunction, in particular, diabetic cardiomyopathy. Strain and strain rate calculations are derived from the transmyocardial velocity gradients delineated by tissue Doppler, are independent of overall cardiac motion and tethering, and appear to provide the earliest and most sensitive measures to detect impaired myocardial performance.

Michael Firstenberg, MD, was featured as one of the Young Investigator Award finalists. The work done by him and his colleagues demonstrated a relationship between ventricular contractility and early diastolic intraventricular pressure gradients derived from color M-mode recordings, which may serve as a link between systolic contractility and early diastolic function (1).

The disease-based discussions incorporated a multimodality discussion of dilated and hypertrophic cardiomyopathy, hypertensive heart disease, heart failure with normal systolic function, and more unusual myopathies with distinct echocardiographic features. Douglas Wigle, MD, an expert in hypertrophic myopathy, presented historic and recent data on this disease and emphasized the major role that echocardiography plays in the clinical care of affected patients.

The topics of heart failure and ventricular function were featured as one of the “Disease of the Day” topics. Dr. Steven Lester reviewed the assessment of systolic function using conventional two-dimensional and newer Doppler tissue-based approaches. Dr. Allan Klein reviewed the state-of-the-art assessment of left ventricular (LV) diastolic function by combining Doppler measures of mitral and pulmonary venous flow, mitral annular velocities assessed by Doppler tissue imaging, and color Doppler M-mode-derived mitral inflow propagation. He pointed out that a constellation of findings may be recognized by echocardiography in the presence of diastolic dysfunction, which represents positive evidence of its existence, pathophysiologic type, and severity. Dr. Mario Garcia reviewed the important role of echocardiography in surgical therapy for the failing heart, including the Dor procedure for ventricular volume reduction in patients with apical aneurysms, and various cardiac containment devices that are evolving to attenuate the deleterious process of ventricular remodeling.

An important recent therapeutic advance for heart failure associated with left bundle branch block is biventricular pacing, also known as cardiac resynchronization therapy. In their lectures, Drs. Picard, Thomas, Gorcsan, and Nihoyannopoulos reviewed recent advances in echocardiographic Doppler techniques to quantify mechanical dyssynchrony in these patients. Such measurements are critical to select patients who will benefit from resynchronization therapy. Dr. Sogaard and his co-workers presented a new technique known as tissue synchronization imaging. This is a modification of the tissue Doppler method in which the myocardium is color coded for measurements of time-to-peak velocity, thus providing a quantitative means of assessing LV synchrony. It superimposes temporal information on regional cardiac anatomy.

Recent research in ventricular function was highlighted in the presentation of Young Investigator Award finalist, Dr. Troughton, who reported echocardiographic determinants of brain natriuretic peptide levels in symptomatic systolic heart failure (2). Kanzaki et al. (3) demonstrated consistent and significant early reductions in mitral regurgitation occurring with biventricular pacing, using the volumetric Doppler method. Pislaru et al. (4) reported on the use of cardiac elastography to detect differences in myocardial compliance of stunned and infarcted reperfused myocardium. Gao et al. (5) presented work on assessing ventricular function with tissue Doppler acceleration, the first derivative of velocity. In addition, Reynolds et al. (6) provided new insights into the causes of paradoxical septal motion in a large series of patients undergoing cardiac surgery. This is only a small sample of the many evolving roles of echocardiography for the assessment of cardiac function that were presented at these scientific sessions.

VALVULAR FUNCTION

A team approach. Management of valvular heart disease requires a clear understanding of disease etiology, quantitation of its severity, and determination of the optimal timing and choice of surgical intervention. Improvements in the anatomic and functional assessment of valve disease by echocardiography and innovations in surgical techniques have led to earlier surgical intervention and better long-term patient outcomes. The intraoperative session track highlighted the important collaborative relationship that has developed between cardiac surgeons, cardiologists, and anesthesiologists performing perioperative echocardiography. Cardiac surgeons have increasingly recognized the importance of echocardiography for clinical decision-making and patient follow-up. Echocardiographers have learned how to provide key information to the surgeon and to understand how surgical decisions are made. The faculty included three highly regarded cardiac surgeons: Drs. Larry Cohn, Tirone David, and John Elefteriades. Sessions were disease-based and focused on clinical decision-making and outcomes.

Aortic valve disease. In patients with valvular heart disease, echocardiography is essential for determining disease etiology and severity. In patients with aortic valve disease, the most common causes of disease are degeneration, a bicuspid aortic valve, endocarditis, and functional regurgitation secondary to aortic root disease. Aortic valve repair is possible in only a small percentage of patients, primarily those with non-stenosed bicuspid aortic valves or cusp prolapse. When valve replacement is required, controversy still exists surrounding the best valve choice. Newer tissue prostheses appear to have better longevity. The decision about which valve to implant is made based on patient age, need for anticoagulation or re-operation, and patient lifestyle choices. The Ross procedure is an effective long-term
solution for younger patients requiring aortic valve replacement but requires careful avoidance of geometric mismatch for optimal results. The majority of patients undergoing this procedure have bicuspid aortic valves. This condition is associated with annulo-aortic ectasia and aortic root dilation, which are the leading causes of late autograft failure. The Ross Registry indicates that surgeons highly experienced in performing this procedure can achieve excellent results; however, the results are not uniformly successful. Echocardiographic studies are essential for follow-up. At the Toronto General Hospital, survival is 98% at seven years, with 86% freedom from 3+ or 4+ aortic regurgitation and 95% freedom from re-operation on the pulmonary autograft.

Aortic aneurysm. Dr. Elefteriades presented data from Yale detailing the natural history of thoracic aortic aneurysms and an algorithm for making a decision about the timing of aortic root replacement surgery. A prospectively accumulated database of over 1,600 patients with thoracic aneurysms and dissection has been accumulated. Thoracic aortic aneurysms grow at an annual rate of 0.1 cm/year, although there is individual variability. When an ascending thoracic aneurysm reaches 6 cm, adverse annual event rates reach 3.6% for rupture, 3.7% for dissection, and 10.8% for death. Surgical mortality for thoracic aneurysms was only 2.5%, confirming that surgery can be undertaken at a relatively low risk. Risk benefit analysis strongly supports elective ascending aortic root replacement when the ascending aorta reaches 5.5 cm and 5.0 cm if the patient has Marfan syndrome. Intraoperative echocardiography is essential in these patients and can predict the need for supracoronary versus infracoronary root replacement. Aortic valve sparing surgery (David operation) with re-implantation of the valve in a Dacron graft is frequently possible in patients with aortic root aneurysms. This operation is associated with good results at 10-year follow-up with 75% freedom from moderate or worse aortic regurgitation.

Mitral valve repair. Mitral valve repair for degenerative disease is being increasingly performed and has been shown to decrease late mortality and morbidity. In three Mayo clinic studies, symptomatic patients with flail leaflets offered early mitral repair were shown to have better late outcomes than patients treated medically. Dr. David presented a study of 488 consecutive patients undergoing mitral valve repair for floppy valves, 199 of whom were asymptomatic or minimally symptomatic. Asymptomatic patients were younger and had better ventricular function, a lower incidence of coronary disease, and higher rates of atrial fibrillation than symptomatic patients. Survival at 15 years for asymptomatic patients was 76%, which was identical to a general Canadian population matched for age and gender. Freedom from re-operation at 15 years was 91%, demonstrating the long-term effectiveness of mitral valve repair when performed by an expert surgeon. This lends further weight to the performance of early mitral valve repair for severe mitral regurgitation, as long as there is a high likelihood that repair rather than valve replacement is possible.

The ability to repair more floppy valves has been made possible by important surgical advances, including the use of artificial chordae, annular reconstruction, and minimally invasive thoracotomy. Surgical repair is rendered increasingly more difficult in the setting of involvement of the anterior leaflet, severe myxomatous degeneration, and annular abnormalities such as dysjunction or severe calcification. Transesophageal echocardiographic (TEE) studies can accurately quantitate the degree of leaflet and annular disease. Data from Dr. Omran, comparing intraoperative TEE and surgical pathology, show an excellent correlation with the central portions of both leaflets most commonly involved (P2, A2), followed by medial segments (P3, A3) and infrequently lateral segments (P1, A1). This information predicts the extent of surgery required and, therefore, the likelihood of repair, which will vary with the surgeon’s capabilities. As demonstrated by Dr. Savage from the Cleveland Clinic, intraoperative TEE studies are essential in all patients undergoing mitral repair to recognize complications such as dynamic outflow obstruction, inadequate repair, inadvertent coronary ligation, and mitral inflow obstruction.

Ischemic mitral regurgitation is more difficult to repair due to multiple potential abnormalities involving the mitral annulus, papillary muscles, chordae, and distorted LV geometry. The use of mitral annular rings alone does not deal with abnormalities of abnormal LV geometry and often may not adequately improve regurgitation. Innovations in three-dimensional echocardiography show great promise in better understanding the mechanism of regurgitation and the importance of leaflet tethering. Experimental surgical approaches proposed by Dr. Robert Levine include the use of an external inflatable patch device in animal models to improve geometric distortion of the LV and the cutting of leaflet-tethering commissural chordae. Dr. David has used the latter technique in a small number of patients with good early results.

Hypertrophic cardiomyopathy. Myectomy in patients with hypertrophic obstructive cardiomyopathy refractory to medical therapy can be performed with low mortality and morbidity, with excellent long-term results. Echocardiography can provide essential information on the length and extent of myectomy required so that septal muscle is removed about 1 cm below the level of leaflet septal contact. Associated mitral regurgitation is usually greatly improved or abolished, unless independent factors are present. About 25% of patients require additional surgery to relieve obstruction at other levels, to bypass or unroof coronary arteries, or for valve repair or replacement. Intraoperative complications, such as incomplete relief of obstruction or creation of a ventricular septal defect, can be detected and corrected during a second pump run.

Videoscopic and small-incision surgery have been used with great success in noncardiac operations. As shown by
Dr. Cohn, minimally invasive cardiac surgery is increasingly being performed with an operative mortality similar to open-sternotomy cases. Benefits include a shorter length of hospital stay, decreased need for blood transfusion, less atrial fibrillation, faster patient rehabilitation, and lower hospital cost. Transesophageal echocardiography is often essential to monitor operation quality and air removal.

**Intraoperative echocardiography.** A session entitled “Patient Outcomes and Intraoperative Echocardiography: What Do We Know?,” presented by a group of cardiac anesthesiologists, included presentations and discussion by Drs. Mathew, Swaminathan, Sherman, and Vezina. The session emphasized the important areas in which intraoperative TEE has helped guide intraoperative decision-making in patients with valvular and coronary disease. Controlled outcomes studies are needed to prove the benefit and delineate the role of intraoperative TEE, especially as its use becomes more routine. Perioperative neurologic dysfunction remains an important complication in patients with atherosclerotic heart disease. Epi-aortic echocardiographic studies can identify patients at high risk of embolic complications. Dr. Kathryn Glas presented a study indicating that this risk can be reduced by the use of alternate cannulation sites and off-pump techniques with a “no-touch” approach to the atherosclerotic aorta.

In the past decade, major advances have been made in the management of valvular heart disease. Echocardiography has played an important role initially in the determination of disease etiology and severity. More recently, intraoperative echocardiographic studies have become the standard of care, especially in patients undergoing valve repair or innovative surgery. Studies are becoming a routine adjunct to the surgical procedure, with greater reliance on performance of perioperative echocardiography by cardiac anesthesiologists. The ongoing collaboration of surgeons and echocardiographers, along with improvements in technology and surgical innovation, should lead to even better patient outcomes in the future.

**CONTRAST ECHOCARDIOGRAPHY**

Contrast echocardiography remains an active and growing field of interest in echocardiography. Despite the fact that there is no contrast agent that has been approved for myocardial contrast echocardiography (MCE) (or perfusion imaging), expertise in this modality is progressively increasing. In some laboratories, methods of MCE for assessing perfusion at rest and with exercise have moved into the clinical mainstream. Successful performance of contrast echocardiography requires knowledge regarding the handling and administration of the agents and optimal instrument settings, and discussions were devoted to the “how to” of implementation and the complementary roles played by physicians, sonographers, and nurses. Abstract presentations built on previous validation of MCE, using nuclear, magnetic resonance, and angiographic gold standards to explore the use of contrast echocardiographic-determined perfusion to define prognosis in patients with coronary artery disease. Insights into coronary physiology in health and disease provided by contrast echocardiography, as well as the impact of ultrasound on microbubbles, were also reviewed.

**MCE for coronary pathophysiology.** The value of MCE for assessing microvascular function and perfusion patterns was shown in several studies. One study showed the differences in perfusion patterns obtained during distal embolization of various size microbubbles. Another showed how direct intracoronary administration of dobutamine and adenosine caused similar increases in myocardial blood flow velocity in normal myocardium and decreases in myocardial blood volume in the presence of coronary stenosis. Thus, the direct coronary effects of adenosine and dobutamine differ from their intravenous effects. Also examined was the effect of the K+ channel opener, nicorandil, in a model of coronary occlusion. This agent increased blood flow in the risk area, despite causing hypotension at large doses. Another study showed that brain natriuretic peptide limits infarct size in a model of coronary occlusion, whereas another showed that patients with amyloidosis have impaired function of coronary arterioles, despite having normal epicardial coronary arteries. A separate study confirmed that the cyclic changes in backscatter seen on MCE are due to changes in myocardial arteriolar blood volume, corroborating previous observations.

**MCE in acute coronary syndromes.** One study showed that MCE had incremental value over other parameters measured in these patients, whereas another involving >800 patients showed that the timing of MCE after the onset of chest pain (up to 12 h) did not affect the ability of MCE to prognosticate events up to 14 days later. A study of 82 consecutive patients with acute anterior wall infarction showed that in those with dyssynergy, the perfusion score index on MCE predicted LV function on follow-up and was a better marker for this purpose than other routinely derived clinical markers, thus confirming previous observations. Dr. Janardhanian, a finalist for the Young Investigator Award competition, confirmed the ability of MCE to quantify the transmural extent of necrosis in patients with acute myocardial infarction (7). Although this has been previously shown in animal studies, the new finding here was the excellent correlation of MCE with magnetic resonance imaging (MRI), a newer method of assessing perfusion.

**Low-energy, real-time MCE.** Although real-time, low mechanical index imaging is popular because of the ease of microbubble agent administration and the ability to simultaneously see wall motion, the limitations of this approach are becoming apparent. One presentation that generated considerable interest examined the effect of ultrasound on microbubble destruction during low-power, real-time imaging. It was shown that if the number of pulses required to destroy bubbles to derive replenishment curves was ≥6, there was an artificial reduction in the measured micro-
bubble velocity. Furthermore, even very low mechanical indexes resulted in a gradual destruction of microbubbles during their microvascular transit and a progressive increase in the measured microbubble velocity. The type of multi-pulse technique and the polarity of pulses used during low-power imaging also influenced the rate of microbubble destruction. Because of the low dynamic range compared with ultraharmonic B-mode imaging, these methods were also reported to underestimate the extent of myocardial viability in patients with poor LV function.

**MCE for coronary flow reserve.** The MCE measurements of flow reserve were reported in several different patient populations (e.g., hypertension, diabetes, and myocardial infarction) by different investigators. Because capillaries are the bottleneck for hyperemic flow after the exogenous administration of vasodilators, measuring microbubble velocity in tissue rather than coronary flow velocity in larger vessels makes more sense. Drinking of black and green tea was shown to improve flow reserve. Flow reserve was shown to be maximized in patients with diabetes whose blood sugar was well controlled. The mechanism behind the improvement in flow reserve by euglycemia in diabetics and by drinking green and black tea in normal subjects was not explored.

New insights into coronary physiology and pathophysiology with MCE dominated the lecture and state-of-the-art presentations. Use of echocardiography in assessing flow-function relationships can be a very powerful tool in patients with coronary artery disease. In this regard, the importance of quantification of both flow (with MCE) and function (particularly with contrast-enhanced LV opacification) was stressed in order to be able to separate ischemia, infarction, stunning, and hibernation. Several abstracts also dealt with this issue. Newer imaging methods, such as 1.5 harmonic imaging, with and without real-time digital subtraction, received a lot of attention. The MCE image quality with these new methods is excellent and, similar to ultraharmonic imaging, they have great promise for assessing myocardial perfusion with intermittent high mechanical index imaging.

**Automation of MCE.** The need for automation for quantification, display, and interpretation of MCE images was also stressed by several computer-savvy investigators. In particular, different algorithms for image alignment and segmentation were presented. Also discussed were the merits and limitations of parametric imaging. It is becoming increasingly clear that quantitative tools will make the routine acceptance of MCE more feasible.

**Targeted diagnostics and therapy.** Interest in targeted microbubble techniques for imaging and therapeutic applications remains high. Techniques for gene and drug delivery, imaging angiogenesis and inflammation, as well as contrast-enhanced thrombolysis, were reviewed. This year’s Young Investigator Award went to Dr. Bekeredjian, who reported gene delivery to tissue via ultrasound-induced microbubble destruction (8).

**MCE for cardiac masses.** An interesting and relatively new indication for MCE described at the meeting was the discrimination of intracardiac masses based on quantitative MCE. Compared with myocardium, tumors showed higher blood velocity and volume, which also separated them from intracardiac thrombi. Several different types of cardiac tumors were discussed. Another interesting new application was the use of contrast media for the diagnosis of acute aortic dissection. In patients with obstructive hypertrophic cardiomyopathy, MCE has been increasingly used to guide ethanol ablation. Although the numbers were small, a study reported that the size of the risk area on MCE predicts post-procedural complications in this setting.

Overall, the echocardiographic community is becoming more familiar with contrast echocardiography, particularly MCE and its potential for assessing the microvasculature. The variety of topics addressed indicates that there is both intellectual and pragmatic interest in this modality. It is likely that the field will grow even more rapidly when an agent has been approved for myocardial perfusion and when a reimbursement schedule is put in place. The adoption of this technique for assessing resting and stress myocardial perfusion will have obvious implications in the care of patients with coronary artery disease.

**NEW TECHNOLOGY**

In addition to technical advances in the assessment of ventricular function and contrast perfusion noted earlier, the ASE 2003 highlighted the emerging roles and clinical applications of intracardiac, real-time and reconstructive three-dimensional, and hand-carried ultrasound. Current intracardiac ultrasound catheters—steerable devices with imaging and Doppler capability—are gaining widespread use in guiding catheter-based interventions, including arrhythmia ablation, valvuloplasty, and device closure. Real-time, three-dimensional techniques with new color flow mapping capability are particularly useful in displaying valvular and ventricular anatomy and physiology. Hand-carried devices with varying capabilities are being used as an adjunct to physical examination in a variety of settings, including the emergency room, intensive care unit, and medical student teaching.

**PEDIATRIC ECHOCARDIOGRAPHY**

The Council on Pediatric Echocardiography honored David J. Sahn, MD, with its Founders Award for his remarkable contributions to the field of congenital cardiac imaging. Dr. Sahn has been at the forefront of cardiac ultrasound throughout its evolution, making key contributions for over 25 years.

The Pediatric Track of the Scientific Sessions highlighted recent innovations in pediatric cardiac imaging. Dr. Pedro del Nido from the Children’s Hospital in Boston discussed his collaborative work with Dr. Gerald Marx on real-time, three-dimensional echocardiographic guidance of robotic catheter insertion.
surgery for intracardiac repair of congenital cardiac anomalies. Although current techniques of thoracoscopic surgery on extracardiac structures are based on optical imaging (video-assisted), a different imaging strategy is required for intracardiac surgery on the beating heart (off cardiopulmonary bypass). Dr. del Nido discussed his team’s work on refining image-rendering algorithms and instrumentation to achieve three-dimensional ultrasound images that appear similar to those obtained using an endoscope. Their efforts are currently directed at developing image-processing techniques to enhance the ultrasound images, modifying surgical instruments that are more clearly visualized by three-dimensional echocardiography, and refining techniques to perform surgical manipulations under ultrasound guidance. The investigators found, for example, that coating the robot’s arms with a thin layer of rubber significantly reduced specular reflection from the instrument, resulting in decreased image artifacts and enhanced depiction of the robot’s arms. In addition to real-time, three-dimensional echocardiography, Dr. del Nido’s group is also exploring the use of electromagnetic instrument tracking, in collaboration with Dr. John Triedman from the Children’s Hospital in Boston, as well as with investigators from Boston University (image processing), Harvard University (bioengineering), and industry.

**High-intensity focused ultrasound (HIFU).** Dr. Achi Ludomirsky from the University of Michigan reviewed the potential applications of HIFU in patients with congenital heart disease (CHD). In contrast to the nonharmed high-frequency, low-amplitude ultrasound energy used in medical imaging, HIFU results in both thermal and mechanical effects that cause tissue damage. It has been used to break down blood clots and kidney and gallbladder stones, ablate tumors, and cause lipolysis. Dr. Ludomirsky’s team has been investigating the use of HIFU to create targeted lesions in cardiac tissue. Using ultrasound imaging guidance, the HIFU system generates a burst of energy at a specific amplitude, frequency, and duration, resulting in tissue damage at a specific depth and tissue volume. Their in vitro experiments have shown that precise defects could be created in the atrial septum, ventricular septum, pulmonary valve, pericardium, and other samples of cardiac tissue. In the future, Dr. Ludomirsky aims to further refine the instrumentation and technique of HIFU, raising the possibility of clinical applications such as performing atrial septectomy or opening a stenotic valve noninvasively.

Dr. Azaria Rein from the Hadassa University in Jerusalem presented new techniques for post-processing, display, and analysis of tissue Doppler imaging (TDI). Dr. Rein’s group measured LV and right ventricular myocardial velocities and strain rate in 98 healthy fetuses whose gestational age ranged from 16 to 40 weeks. The group from Jerusalem found that while myocardial velocities exhibited a close positive linear association with gestational age, there was no significant correlation between strain rate and gestational age, indicating that the strain rate is independent of maturational changes in cardiac function. Dr. Rein also presented a new technique for computerized automatic tracking of ventricular myocardium. His group’s work appears promising for the assessment of regional myocardial function and arrhythmias, both prenatally and postnatally.

**Echocardiographically guided catheter procedures.** Another area that generated intense interest was echocardiographically guided transcatheter intervention in the fetus. Dr. Wayne Tworetzky from the Children’s Hospital in Boston reviewed his center’s experience with 20 fetal cardiac interventions, including 13 balloon aortic valvuloplasties for critical aortic stenosis, 5 atrial septostomies for an intact or restrictive atrial septum, and 2 balloon pulmonary valvoplasties for pulmonary atresia with an intact ventricular septum. Procedures were performed after institutional review board approval and informed consent, with maternal general anesthesia, uterine relaxation, and fetal anesthesia. Initial procedures were performed with the needle advanced through the maternal abdomen and uterine wall and then through the fetal chest wall and cardiac chambers. Later in the experience of Dr. Tworetzky and his colleagues, several procedures incorporated a laparotomy and uterine exposure to facilitate optimal fetal positioning and better orientation of the needle relative to the target cardiac structure. The investigators achieved technical success in 13 of 20 aortic valve dilations, 5 of 5 atrial septostomies, and 0 of 2 pulmonary atresia cases.

**Echocardiography as an investigational tool.** Dr. Steven Colan from the Children’s Hospital in Boston and Dr. Colin Phoon from the New York University highlighted the use of echocardiography as a research tool in clinical trials and laboratory animals. Dr. Colan discussed challenges faced by investigators who design and implement multicenter clinical trials in which outcome variables are measured by echocardiography. Dr. Phoon presented his work on assessment of cardiovascular physiology in mice embryos. Using Doppler techniques, Dr. Phoon and his group noninvasively measured blood flow as early as the straight heart tube stage. This remarkable technologic achievement opens the door for further research on the interactions between genetics, cardiac morphogenesis, and embryonic cardiovascular physiology.

**MRI.** Dr. Andrew Powell from the Children’s Hospital in Boston and Dr. Mark Fogel from the Children’s Hospital in Philadelphia discussed the increasing role of MRI as a complementary modality to echocardiography in the noninvasive evaluation of CHD. Dr. Powell presented data on the use of velocity-encoded cine MRI to quantify the shunt ratio in patients with an atrial septal defect. Compared with catheterization-based oximetry, the mean difference (bias) between the two techniques was 2.3%, with upper and lower limits of agreement of 0.54 and −0.42, respectively. Dr. Powell also discussed the use of MRI to evaluate myocardial perfusion and viability in patients with CHD. In his
presentation, Dr. Fogel concentrated on the complementary role of MRI in the evaluation of right ventricular function and emphasized its strengths compared with two-dimensional echocardiography, including its independence of acoustic windows and geometric assumptions.

Considerable interest focused on the use of TDI for evaluation of ventricular function (9–12). Pauliks et al. (11) found that isovolumic acceleration is more reflective of myocardial contractility than are the more traditional TDI indexes of peak systolic (S-wave) myocardial velocity. Taken together with other abstracts and recent publications on TDI in patients with CHD, the emerging impression suggests that this technique can detect global and regional ventricular dysfunction. However, further research is required to determine its sensitivity, specificity, reproducibility, and prognostic value in the pediatric age group. Hejmadi et al. (13) presented the use of three-dimensional echocardiography to measure LV and right ventricular mass in 30 fetuses ranging in gestational age from 12 to 31 weeks. Right and left ventricular mass correlated with each other and with gestational age. In another abstract presentation on fetal echocardiography, Spurney et al. (14) presented a study on the assessment of fetal mouse cardiovascular function. The primary goal of their study was to establish a Web-based data base of normal values and digital images. Using a 15-MHz linear phased-array transducer, they longitudinally studied over 1,000 C57BL/6J mouse fetuses from 12.5 to 18.5 days after conception. Their database includes fetal crown to rump length, heart rate, shortening fraction, myocardial performance index, and Doppler indexes of inflow and outflow velocities. The research community that studies genetically modified mice models of cardiovascular anomalies can use this Web-based normative database.

**ASE 2004**

Next year’s meeting will be held in San Diego, California, on June 27 to 30. In addition to the program elements outlined thus far, ASE 2004 will feature a “Meeting Within a Meeting,” a multidisciplinary approach to patients with atrial fibrillation.

**REFERENCES**