409 Young Investigators Awards Competition – Clinical Investigations

Monday, March 25, 1996, 4:00 p.m.–5:30 p.m.
Orange County Convention Center, Room 231

4:00

409-1 Clinical Application of Three-Dimensional Echocardiographic Laser Stereolithography: Effect of Leaflet Funnel Geometry on the Coefficient of Orifice Contraction, Pressure Loss and the Gorlin Formula in Aortic Stenosis

Dan Gilon, Edward G. Cape, Mark D. Handschumacher, Charles Sears, Joan Solheim, Michael VanAuker, Mary Etta E. King, Arthur E. Weyman, Robert A. Levine. *Mass. General Hospital, Boston, MA; Childrens Hospital, Pittsburgh, PA, Santin Engineering, Peabody, MA*

Three-dimensional (3D) echo reconstruction can allow us to address uniquely 3D scientific questions: for example, the effect of 3D leaflet geometry *proximal* to the limiting orifice of a stenotic valve on the coefficient of orifice contraction (Cc = effective/anatomic orifice area). For a given flow rate and anatomic area, *a lower Cc gives a higher maximal velocity, pressure gradient, and possible pressure head loss*; and Cc, assumed constant in the Gorlin equation, may vary with valve shape. To date, it has not been possible to study this with *actual 3D valve shapes in patients.* 3D echo was used to reconstruct the geometries typically seen in patients with aortic stenosis (AS): a mobile, doming, vertical bicuspid valve, an intermediate horizontal valve, and a flatter immobile tricuspid valve. 2 models of each geometry were then constructed by *stereolithography* (computerized laser polymerization), with orifice areas of 0.5 and 1 cm^2. Effective area and Cc were determined for flow rates producing physiologic velocities of 1-3 m/s. *Results:* Cc varied prominently with shape (averages over flow rates follow):

Coefficient of contraction

Anat. orifice area	Dome	Intermediate	Flat
1.0 (cm^2)	0.90	0.85	0.76
0.5 (cm^2)	0.85	0.81	0.70

These differences, relating to shape (near 0.6 for flat plates, 1.0 for tubes), translated into differences up to 40% in the pressure drop for the same anatomic area and flow rate. Gorlin area (fundamentally derived from *effective*) also varied relative to anatomic. *Conclusions:* Cc and the related net pressure loss are importantly affected by the variations in leaflet geometry seen in patients with AS. Echocardiography stereolithography can allow us to address such unique 3D questions.

4:15

409-2 Assessment of Absolute Coronary Artery Flow and Flow Reserve in Humans With Magnetic Resonance Imaging

W. Gregory Hundley, Richard A. Lange, Geoffrey D. Clarke, Benjamin Meshack, Jerri Payne, Charles Landau, Dany Sayad, DuWayne Willett, John E. Willard, L. David Hillis, Ronald M. Peshock. *University of Texas Southwestern Medical Center, Dallas, Texas*

Absolute coronary arterial flow and flow reserve measurements are useful for determining the functional importance of an epicardial stenosis and assessing disease processes which affect the coronary microcirculation; however until recently, these measurements have required an invasive technique performed during catheterization or open heart surgery. Velocity-encoded, phase-difference magnetic resonance imaging (MRI) is a noninvasive technique that can visualize coronary arteries and measure coronary arterial flow in animals, but its accuracy in humans is unknown. Accordingly, 12 subjects (7 men, 5 women, aged 44 to 67 years) underwent MRI followed immediately by intracoronary Doppler wire measurements of flow in the left anterior descending artery or one of its diagonal branches at rest and after intravenous adenosine (140 μg/kg/min). For the 12 patients, the correlation between MRI and invasive measurements of (a) coronary arterial flow {Coronary $flow_{MRI}$ (ml/min) = 0.85 × Coronary $flow_{Catheterization}$ (ml/min) + 17 (ml/min), $r = 0.89$} and (b) flow reserve {Coronary flow $reserve_{MRI}$ = 0.79 × Coronary velocity $reserve_{Catheterization}$ + 0.34, $r = 0.89$} was excellent. For the range of flow reserves (0.7 to 3.7) measured by MRI, the agreement between the 2 techniques was 0.1 ± 0.4 (5 ± 14%). In conclusion, velocity-encoded, phase-difference MRI provides accurate measurements of epicardial coronary arterial flow and flow reserve in humans, thereby providing a noninvasive method for directly visualizing coronary arteries and assessing the physiologic response of the coronary circulation to pharmacologic stimuli.

4:30

409-3 Single Site Radiofrequency Catheter Ablation of Atrial Fibrillation

Koichiro Kumagai, Kikuya Uno, Celeen Khrestian, Albert L. Waldo. *University Hospitals of Cleveland, Cleveland, OH*

Preliminary mapping studies of induced atrial fibrillation (AF) in the canine sterile pericarditis model show that multiple unstable reentrant circuits which primarily involve the septum and atrial epicardium and include Bachmann's bundle (BB) are responsible for generating and maintaining AF. These reentrant circuits cyclically disappear and reform from wave fronts coming from the septum, primarily via BB. To test the hypotheses that BB is a critical region for sustaining AF and that catheter ablation of BB both terminates AF and prevents its sustained reinitiation, simultaneous multisite mapping studies during AF and after ablation of BB were performed by recording (392–406 electrodes) from both atria and the atrial septum during 8 induced AF episodes in 8 dogs with sterile pericarditis. Activation maps of sustained AF (mean duration 36 ± 22 min) during 12 consecutive 100 ms windows were analyzed. Unstable reentrant circuits (mean number 1.3 ± 0.2/window, range 1–4) were observed during AF. 61% of the reentrant circuits involved BB. When the reentrant circuits disappeared, RA free wall was reactivated by wave fronts coming from the atrial septum and/or the LA primarily via BB (53%) and sites of breakthrough from the septum most often involved BB (61%). Radiofrequency catheter ablation of the mid portion of BB in 3 dogs terminated AF and sustained AF no longer could be induced. Mapping studies of non-sustained AF induced after ablation showed that no reentrant circuit involved BB, and no wave fronts entered RA via BB. In this model of AF, 1) BB is critical for the maintenance of AF, 2) catheter ablation of BB terminates sustained AF and prevents its maintenance even if AF is initiated by rapid atrial pacing.

4:45

409-4 Quantification of LV Endocardial Motion Using Segmental Analysis of Color Kinesis Images

Victor Mor-Avi, Philippe Vignon, Rick Koch, David Prater, Roberto Lang. *University of Chicago, Chicago IL*

Color Kinesis (CK) is a new echocardiographic technique based on tissue characterization, which provides color-encoded images reflecting LV endocardial motion throughout systole and diastole on a frame-by-frame basis. To allow objective assessment of the magnitude and temporal patterns of endocardial motion, we developed a quantitative segmental analysis of these images. CK end-systolic and end-diastolic images acquired in 20 normal subjects were analyzed to obtain normal patterns of LV contraction and relaxation. The systolic normal patterns provided the basis for automated diagnosis of regional systolic LV wall motion abnormalities in 40 patients (figure, normal pattern shown as a dashed band on the background). This automated analysis was found to be as accurate as visual interpretation of 2D echocardiograms but with the advantage of being quantitative. The diastolic normal patterns were used to identify abnormal LV filling in 12 patients with LV hypertrophy. Additionally, we studied the ability of quantitative segmental analysis of CK images to reflect drug-induced variations in the temporal characteristics of endocardial motion during LV contraction and relaxation (N = 8, Dobutamine and Esmolol). To separate the inotropic effects of Dobutamine from those secondary to elevated heart rate, data acquired with Atropine were also analyzed (N = 7). These studies demonstrated the ability of CK to provide a basis for sensitive, non-invasive, quantitative evaluation of the magnitude and temporal patterns of LV contraction and relaxation on a regional basis, both in disease states and during pharmacological interventions.