younger age group (32-40 years), whereas pHPN (after age 40) and coronary artery disease (after age 50) tended to occur in higher frequency later in life. All patients were treated with continuous positive airway pressure, weight reduction, angiotensin blocking agents, aspirin, statins and coronary interventions when indicated. 252 (95%) demonstrated improvement in quality of life measurement. **Conclusion**: OSA causes profound adverse effects on cardiac functions that lead to a host of echocardiographic abnormalities. We recommend that Recho be performed in all patients with OSA, and Decho be part of the workup of OSA patients after age 55 to guide effective medical management of these debilitating illnesses.

1112-148 Two-Dimensional Point-to-Point Measurements and Best Slice Algorithm Improve Accuracy of Echocardiographic Left Ventricular Mass Determination: A Magnetic Resonance Imaging Correlation in Humans

David S. Owens, Christopher K. Dyke, Andrew E. Arai, Jonathan F. Plehn, National Institutes of Health, National Heart Lung and Blood Institute, Bethesda, MD

Background: Left ventricular mass (LVM) is a powerful predictor of cardiovascular outcome and serves as a focal point in epidemiologic and therapeutic studies. Conventional M-mode and 2-d echocardiographic LVM determinations suffer from acquisition angulation error and throughput limitations, respectively. We, therefore, developed a cylindrical hemiellipsoid "best slice" model (BSM) which tailors point to point (PTP) measurements to an algorithm minimizing long axis oblique angulation and maximizing short axis and apex-base length. Methods: We compared diastolic and systolic echocardiographic and cardiac MRI LVM determinations in 48 patients (30 men, 18 women, mean age = 46) undergoing both studies within a two week period. Models tested included: 1) standard ASE M-mode (ASE), 2) angle-independent PTP modification of ASE (ASE-PTP) and 3) 2D echo planimetric mass by bullet formula (PLAN). Conclusions: 1) In all models tested, end-systolic calculations correlated better than those at end-diastole; 2) BSM had higher correlation and less error than other PTP methods, and was comparable to planimetry in both accuracy and error; 3) Traditional ASE M-mode was inferior to 2-d PTP and planimetric models. Therefore, end-systolic BSM calculations, with higher correlations than ASE and the potential for increased throughput over planimetry, should be considered in epidemiologic and therapeutic investigations targeting LVM.

LV Mass Correlations: Echocardiography v. MRI

Model	Cardiac Timing	Pearson Correlation	95% CI	SEE
ASE	End-diastole	0.71*	0.53-0.83	55g
ASE-PTP	End-diastole	0.74*	0.63-0.87	39g
ASE-PTP	End-systole	0.78*	0.65-0.88	38g
PLAN	End-diastole	0.82*	0.68-0.90	32g
PLAN	End-systole	0.87*	0.76-0.93	25g
BSM	End-diastole	0.79*	0.65-0.88	30g
BSM	End-systole	0.85*	0.74-0.91	25g
		*p < 0.0001		

1112-149 Does Use of Harmonic Imaging Increase the Yield of Echocardiographic Left Ventricular Mass Measurements on a Population Basis? The Strong Heart Study

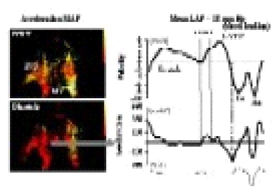
Richard B. Devereux, Marcello Chinali, Jennifer E. Liu, Mary J. Roman, Lyle G. Best, James Galloway, Elisa T. Lee, Barbara V. Howard, Weill Cornell Medical College, New York, NY

Background: introduction of harmonic imaging has been accepted as improving the quality of clinical echocardiograms but no data exist on a population basis concerning its ability to reduce the frequent problem of inability to obtain left ventricular (LV) measurements by echocardiography in overweight or elderly adults.
Methods: we compared the yield of linear measurements needed to measure LV mass and fractional shortening between the second exam of the population-based Strong Heart Study (SHS-2) in 1993-1995 with fundamental imaging and Strong Heart Family Study (SHFS) in 2001-2003 with harmonic imaging. Echocardiograms were read by identical procedures with verification by highly-experienced echocardiographers.
Results: SHS-2 and SHFS participants 50-79 years of age (n=3,185 and 716, respectively) were similar in age (both 61±7 years), gender (63 vs 65% women) and diabetes prevalence (49 and 48%) but the SHFS participants studied by harmonic imaging were heavier (body mass index 32.7±8.9 vs. 31.1±6.3 kg/m^2, p<0.001) and had higher prevalence of hypertension (61 vs 49%, p<0.001). The yield of needed LV measurements increased from 2,901/3,185 (91%) to 680/716 (95%, p<0.001) in the entire population and rose similarly in the age ranges 50-59 (93% to 97%), 60-69 (90% to 94%) and 70-79 (88 to 92%)(all p<0.01). LV measurement yield was also higher with harmonic imaging in obese participants (BMI>30 kg/m^2, 93% vs 90%) and in normal to overweight participants (98% vs 93%)(both p<0.05).
Conclusion: introduction of harmonic imaging has increased the yield of LV measurements needed to quantitate LV geometry and function on a population basis, including elderly and obese adults, which have posed a particular challenge to echocardiography.

1112-150 Regional Spectrum of Tissue Doppler-Derived Myocardial Acceleration During Isovolumic Relaxation and Its Relationship to Peak Filling

Ikuo Hashimoto, Brent J. Barber, Michael Jones, Xiaokui Li, David J. Sahn, Oregon Health & Science University, Portland, OR, National Heart, Lung & Blood Institute, Bethesda, MD

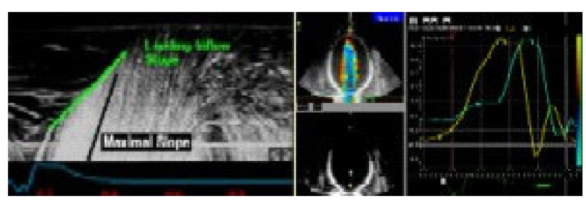
Background: This study evaluated the regional distribution of peak diastolic myocardial acceleration (pACC) and its relationship to left ventricular (LV) pressure and peak negative dP/dt (-dP/dt$_{max}$) as indices of diastolic function.
Methods: We examined 8 sheep by using 2D high frame rate digital tissue Doppler imaging (GE/VingMed Vivid FiVe) in apical 4-chamber cineloops to evaluate mitral valve annular velocity at septum and LV lateral wall. pACC derived from tissue Doppler echocardiography was analyzed during isovolumic relaxation (IVRT) and LV filling period (LVFP) from both sides of mitral valve annulus. After scanning in a baseline condition, we changed hemodynamic status by blood administration, dobutamine and metoprolol infusion. We compared the difference of pACC during IVRT and LVFP over these different conditions with -dP/dt$_{max}$ measured with a high frequency manometer tipped catheter.
Results: pACC of septal mitral valve annulus during IVRT showed a good correlation with -dP/dt$_{max}$ (r = 0.80, p < 0.0001) and varied little on blood loading. Mean LAP correlated well with pACC of septal mitral valve at annulus during LVFP (r = 0.80, p < 0.0001), but less with lateral wall.
Conclusions: Septal annulus pACC during IVRT appears to be a sensitive, preload independent marker for evaluation of LV diastolic function, and pACC during LVFP correlated well with mean LAP; combining the parameters should be especially useful.



1112-151 Digital Velocity Propagation Time Compared to Color M-Mode to Assess Flow Propagation Across the Left Ventricular Inflow: An In Vitro Study

Mark Trinh, Donald R. Stevens, Laura M. Nugent, Xiaokui Li, Aarti Hejmadi Bhat, David J. Sahn, Oregon Health & Science University, Portland, OR

Background: The purpose of this study was to determine the accuracy of color M-Mode (CMM) in measuring the actual wavefront of flow propagation velocity (WFFPV) of mitral valve inflow and test the relationship with rate of inflow in a balloon model.
Methods: Variably compliant latex balloons were used to model the left ventricle and were connected via a wide inlet to a pump, which generated pulsatile flow. This balloon was then submerged in a water bath and a transesophageal probe was positioned near the apex. CMM images were obtained under 2D color flow guidance at 10 different stroke volumes (SV, 20 ml to 40 ml) and heart rates (HR, 40 bpm to 70 bpm) to assess WFFPV. Microbubbles were used as a contrast agent to visualize particle tracks at the wavefront of the inflow so as to directly compute reference WFFPV. Classically defined M-mode rates as well as derived velocity time upstroke propagation time were compared.
Results: Filling flow rate (SV x HR) correlated well with the WFFPV as estimated by the bubble technique (r=0.94); correlation with balloon stroke volume was poor for color (r=0.62), but much better for direct velocity upstroke propagation (r=0.86).
Conclusions: CMM can be used to assess the WFFPV, but, in this in-vitro model, it appeared to underestimate the actual WFFPV.



1112-152 Strain Rate Imaging for Identifying Tissue Torsion in Myocardial Segments: An In Vitro Model Study

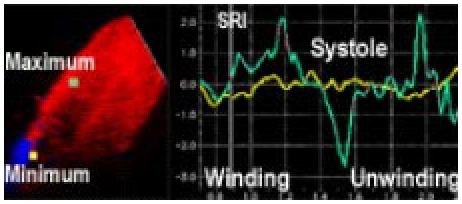
J. Salvador de la Cruz, Amariek J. Jensen, Sarah L. Nelson, Nick W. Liu, Xiaokui Li, Aarti Hejmadi Bhat, Muhammad Ashraf, David J. Sahn, Oregon Health & Science University, Portland, OR

Background: The Torrent-Guasp theory hypothesizes that left ventricle is formed from a myocardial band twisted into a descending inner band and an ascending outer band that run orthogonal to each other and overlap in the septum. We attempted to identify the difference between the twisted and nontwisted segments of myocardium in a dynamic model.
Methods: We used a strip of fresh lean beef (2.5 x 2.5 x 12.5 cm) attached to a Travenol cardiac rotational pump and pulley in a water bath. The sample was twisted on one end at different cycle rates (12, 26, 40 rpm) and different degrees of rotation (45°, 90°). Tissue Doppler imaging was performed with a GE/VingMed Vivid 5 with a 2.5 MHz trans-

ducer. Frame rates were 96-133.7 fps. Images were taken at a 90° (tangential) and 10-35° (longitudinal) angle in relation to the torsion axis of the meat. Strain rate obtained by EchoPac® software was compared between the area of maximum and minimum rotation on the strip of meat.

Results: A significant difference was observed in strain rate between the maximum and minimum twist region for both tangential ($p = 0.017$) and longitudinal ($p = 0.026$) imaging. Strain rate between the tangential and longitudinal orientation imaging in the maximum and minimum twist region had no statistical significance ($p = 0.93$, $p = 0.67$).

Conclusions: High frame rate strain rate analysis is sensitive to myocardial twist with relatively little angle sensitivity and has the potential to accurately identify torsion in different myocardial layers.



POSTER SESSION

1113 Better Measures of Cardiac Anatomy and Function: What Does Real-Time Three-Dimensional Echocardiography Offer?

Monday, March 08, 2004, 3:00 p.m.-5:00 p.m.
Morial Convention Center, Hall G
Presentation Hour: 4:00 p.m.-5:00 p.m.

1113-153 Relative Importance of Errors in 2-D Echocardiographic Calculation of Left Ventricular Volumes: Insights From Live 3-D Echocardiography and Cardiac Magnetic Resonance Imaging

Rupa R. Krishnaswamy, Aasha S. Gopal, Rena S. Toole, Florentina Petillo, William Schapiro, Nathaniel Reichek, St. Francis Hospital, Roslyn, NY, Stony Brook University, SUNY, Stony Brook, NY

Background: Important sources of error that limit accuracy of LV volumes by 2D echo include assumptions about geometry and image plane orientation, but the relative contribution of each has not been determined. We used 3D echo and cardiac magnetic resonance imaging (CMR) to define and quantify these sources of error.

Methods: LV volumes were calculated in 31 normal subjects using: a) 2D echo summation of disks (ellipsoid shape assumption) method from two apical views (orthogonal assumption). b) Biplane images selected from 3D echo (Philips 7500) (ellipsoid shape assumption) in which the two apical views are known to be orthogonal to each other. c) Image selection from 3D echo using 8 equally spaced long axis rotational apical slices, an approximating surface model and manual boundary tracing (Tomtec). d) CMR (1.5T Siemens) using contiguous, short axis, TrueFISP cine images. Methods c and d are free of assumptions of image position or LV geometry. Results were compared to CMR using Pearson's correlation, linear regression, Bland-Altman analyses and ratios of differences in RMS % error. **Results:**

	2D EDV	Bi-Plane 3D EDV	3D EDV	2D ESV	Bi-Plane 3D ESV	3D ESV	2D EF	Bi-Plane 3D EF	3D EF
r	0.50	0.96	0.98	0.41	0.82	0.90	0.22	0.45	0.69
SEE (ml)	19.6	6.7	4.4	9.3	6.6	5.6	6.8	5.4	3.9
p	0.02	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	0.2	0.01	<0.0001
RMS % Error	34.1%	15.4%	7.0%	54.9%	31.6%	12.7%	73.5 %	16.5%	9.4%
Bias (ml)	-30.6	-14.0	0.8	-23.7	-13.5	-1.2	9.7	6.7	0.8
Width of Limits of Agreement	88.6	27.9	17.9	56.6	35.0	28.2	34.5	27.1	21.1

Conclusions: RMS % error values from 2D echo and biplane 3D echo indicate that approximately 55% of total error is attributable to non-orthogonal image plane positioning, 25% to geometric assumptions in the ellipsoid model and 20% to residual boundary tracing error in 8-plane 3D echo versus CMR. Geometric assumptions may contribute more error in misshapen LVs, while tracing error magnitude may depend on image quality.

1113-154 Optimal Echocardiographic Method for Determination of Right Ventricular Volumes and Systolic Function

Satheesh Joseph, Aasha S. Gopal, Rupa R. Krishnaswamy, Rena S. Toole, Florentina Petillo, William Schapiro, Nathaniel Reichek, St. Francis Hospital, Roslyn, NY, Stony Brook University, SUNY, Stony Brook, NY

Background: Several 2-dimensional echocardiographic approaches have been developed to obtain right ventricular (RV) end-diastolic (EDV) and end-systolic (ESV) volumes. However, the complex shape of the RV presents challenges for accurate volume determination. 3-dimensional methods such as live 3D echo are now widely available and may be more accurate. The objective of this study was to characterize the optimal echocardiographic method for calculating RV size and function as compared to volumetric cardiac magnetic resonance imaging (CMR). **Methods:** RV volumes were obtained for 31 normal subjects (21 men, ages 21-76 yrs, mean 56.7 yrs) using 1) a 2D echo area-length method, recommended by the American Society of Echocardiography 2) 3D echo (Philips 7500)using an approximating surface model (TomTec) and 8 rotationally equidistant , electronically generated apical slices, and 3) CMR (1.5 T Siemens Sonata) using contiguous, short axis, ECG gated, breath-hold, TrueFISP cine images (146 x 256 matrix, 8 mm slice thickness, 31 x 38 cm FOV). Echocardiographic results were compared to CMR using Pearson's correlation, linear regression, and Bland-Altman analysis. **Results:**

	r	SEE (ml)	Regression Equation	p	Bias (ml)	Lower Limits (ml)	Upper Limits (ml)
2D RV EDV	0.51	29.0	y = 0.5 x + 52	0.004	-14	-78	49
3D RV EDV	0.84	16.2	y = 0.7 x + 8.5	<0.0001	-27	-62	8
2D RV ESV	0.44	12.1	y = 0.2 x + 32	0.045	-24	-67	18
3D RV ESV	0.83	11.0	y = 0.7 x + 7.2	<0.0001	-14.7	-39.6	10.2

Conclusions: 1) Live 3D echo is markedly superior to conventional 2D algorithms for estimation of RV volumes. 2) 3D echo underestimation of absolute RV volume can be regression-corrected, since variability is limited. 3) 3D echo validation in abnormal right ventricles over a wide range of RV EF and shape is needed to assure clinical utility.

1113-155 Direct Quantification of Left Ventricular Volume by Real-Time Three-Dimensional Echocardiography: Validation by Cardiac Magnetic Resonance Imaging

Enrico G. Caiani, Lissa Sugeng, Cristiana Corsi, Peter MacEneaney, Lynn Weinert, Rick Koch, Roberto Battani, Keith A. Collins, Victor Mor-Avi, Roberto M. Lang, University of Chicago, Chicago, IL, Politecnico di Milano, Milan, Italy

The evaluation of LV volume from 2D images is limited because it is based on extrapolation of manually or semi-automatically traced endocardial borders using geometric modeling. This methodology is time-consuming, subjective and relatively inaccurate. We developed a technique for detection of LV cavity from real-time volumetric (RT 3D) data and direct quantification of LV volume without geometric modeling and validated it against cardiac MRI. **Methods.** 25 unselected patients underwent 2D and RT 3D echocardiography (Philips SONOS 7500, X4 probe) and cardiac MRI (GE, 1.5T FIESTA, short axis views). Endocardial border was manually traced from the 2D images to obtain end-systolic (ES) and end-diastolic (ED) volume from apical 2- and 4-chamber views using the method of discs. Custom software was used to automatically detect the LV cavity from the RT 3D data, following manual endocardial initialization in 4 apical cross-sections and adjustments in the short axis view. ES and ED volumes were computed directly from voxel counts. All measurements were performed by 3 independent observers. Linear regression and Bland Altman analysis were used to compare echo data with MRI (GE, MASS software). **Results.** Generating one LV volume from RT 3D required <3 min including the initialization. RT 3D volumes correlated better with MRI than the 2D volumes with less bias and inter-observer variability (table). **Conclusions.** Semi-automated detection of the LV cavity from RT 3D data allows accurate, direct measurement of LV volumes.

		Regression	r	Bias (ml)	95% confidence interval (ml)	Inter-observer variability (%)
EDV	**3D**	**y=0.99x-1.4**	**0.96**	**-4.0**	**40.1**	**9**
	2D (A4C)	y=1.05x-13.4	0.90	-5.3	66.3	24
	2D (A2C)	y=0.85x+12.0	0.83	-13.6	80.3	29
ESV	**3D**	**y=1.03x-0.5**	**0.97**	**-0.9**	**36.8**	**13**
	2D (A4C)	y=0.82x-42.1	0.94	-4.5	36.6	35
	2D (A2C)	y=0.90x-1.7	0.94	-10.9	42.9	42

1113-156 Assessment of Left Ventricular Volumes and Ejection Fraction by Live 3-D–Contrast Enhanced Echocardiography Comparison With Cine Magnetic Resonance Imaging

Agnes A. Pasquet, Bernhard Gerber, David Vancrayenest, Anne Marie D'Hondt, Jean-Louis Vanoverschelde, Cliniques Univeristaires Saint Luc, Brussels, Belgium

Background: Magnetic resonance imaging (MRI) is recognized as a reference technique to calculate left ventricular (LV) volumes and ejection fraction (EF). Recently introduced, live tridimensional echocardiography (3D) can be used with echo contrast agent to

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