08:30 - 10:30 S3 - New Echocardiography Technologies in Practice Hall D

Chairs: **Y. Agmon**
Z. Vered

08:30 **3-Layers Myocardial Strain in Normal Subjects and in Patients with Wall Motion Abnormalities. A Novel Speckle Tracking Software**

M. Leitman [1] *, M. Lysiansky* [2] *, P. Lysyansky* [3] *, Z. Friedman* [3] *, V. Tyomkin* [1] *, D. Adam* [2] *, Z. Vered* [1]
[1] *Zerifin,* [2] *Haifa*

08:45 **Diastolic Myocardial Mechanics Correlate with Hemodynamics in Obstructive Hypertrophic Cardiomyopathy**

S. Carasso [1,2] *, P. Garceau* [1] *, A. Woo* [1] *, L. Schwartz* [1] *, H. Rakowski* [1]
[1] *Toronto, ON,* [2] *Haifa*

09:00 **Day-to-day Variation of Left Ventricular Segmental Longitudinal Strain in Patients with Ischemic Heart Disease**

D. Blondheim [1] *, Y. Tsadok* [2] *, A. Asif* [1] *, S. Meisel* [1] *, M. Shochat* [1] *, A. Frimerman* [1] *, M. Kazatsker* [1] *, A. Shotan* [1]
[1] *Hadera,* [2] *Haifa*

09:15 **2D Strain Speckle Tracking Analysis in Acute Peri-myocarditis**

M. Leitman, G. Moravski, Z. Vered
Zerifin

09:30 **Changes in Left and Right Ventricular Structure and Function of Donor Hearts During the First Year After Heart Transplantation Using Tissue Doppler Imaging, Myocardial Performance Index and Myocyte Size Assessment**

S. Goland [1] *, L.S.C. Czer* [2] *, R.J. Siegel* [2] *, K. Burton* [2] *, K. Zivari* [2] *, A. Rafique* [2] *, M.A. De Robertis* [2] *, D. Luthringer* [2] *, E. Schwarz* [2] *, A. Trento* [2]
[1] *Rehovot,* [2] *Los Angeles, CA*

09:45 **Assessment of Left Ventricular Segmental Function Using 9-Slice Short Axis Imaging Derived From 3-Dimensional Echocardiography**

Y. Agmon, D. Mutlak, S. Reisner
Haifa

10:00 **Three-Dimensional Mitral Annular Tracking Demonstrates Important Structural and Functional Annular Differences depending on the Etiology of Mitral Regurgitation**

S.H. Little, S. Ben Zekry, W.A. Zoghbi
Houston, TX

10:15 **Real-time 3D Transesophageal Echocardiography is Superior to 2D Transesophageal Echocardiography in Localizing Mitral Valve Pathology: Comparison with Surgical Findings**

S. Ben zekry, S.H. Little, S.F. Nague, E.L. Herrera, K. Singh, W.A. Zoghbi
Houston, TX

3-Layers Myocardial Strain in Normal Subjects and in Patients with Wall Motion Abnormalities. A Novel Speckle Tracking Software

Marina Leitman [1], Michael Lysiansky [2], Peter Lysyansky [3], Zvi Friedman [3], Vladimir Tyomkin [1], Dan Adam [2], Zvi Vered [1]

[1] *Department of Cardiology, Assaf Harofeh Medical Center, The Sackler School of Medicine, Tel Aviv University, Zerifin, Israel,* [2] *The Technion Institute of Science, Haifa, Israel,* [3] *General Electric Healthcare, Israel*

Purpose: The left ventricle is composed of 3 layers of fibers that provide LV contraction. Different techniques have allowed measurement of transmural myocardial strain. Circumferential movement of the endocardial and epicardial layers permits measurement of strain in myocardial layers: endocardium, midlayer and epicardium.
We measured circumferential and longitudinal strain in 3 myocardial layers with modified 2D strain speckle technique.
Methods: 20 subjects with normal LV function and 11 patients with wall motion abnormalities underwent echocardiographic examination. Short axis and apical views were analysed with a novel modified 2D strain speckle technique that is capable of measurement of longitudinal and circumferential strain in 3 myocaridal layers.
Results. In normals longitudinal and circumferential strain was highest in endocardium, and lowest in epicardium in all levels. Longitudinal endocardial and midlayer's strain was highest in the apex and lowest in the base. Epicardial longitudinal strain was homogenous over the LV. Circumferential strain was highest in the apex and lowest in the base in all 3 layers. Longitudinal and circumferential strain in abnormal segments was of lower amplitude, with late diastolic peak, and double peak. Tethered segments had significantly lower strain than corresponding segments of normals.
Conclusion: LV longitudinal and circumferential strain are highest in the endocardium and lowest in the epicardium. Circumferential strain is highest in the apex and lowest in the base.
Longitudinal endocardial and midlayer strain are highest in the apex and lowest in the base, longitudinal epicardial strain is uniform over the LV.

Diastolic Myocardial Mechanics Correlate with Hemodynamics in Obstructive Hypertrophic Cardiomyopathy

Shemy Carasso [1,2], Patrick Garceau [1], Anna Woo [1], Leonard Schwartz [1], Harry Rakowski [1]

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Background Hypertrophic cardiomyopathy (HCM) is characterized by myocardial hypertrophy, fiber disarray and fibrosis interfering with myocardial force generation and relaxation. Since conventional echo-Doppler methods inadequately assess diastolic function in obstructive HCM, we sought to determine LV diastolic mechanics in these patients, and correlate these to invasive hemodynamic diastolic parameters.

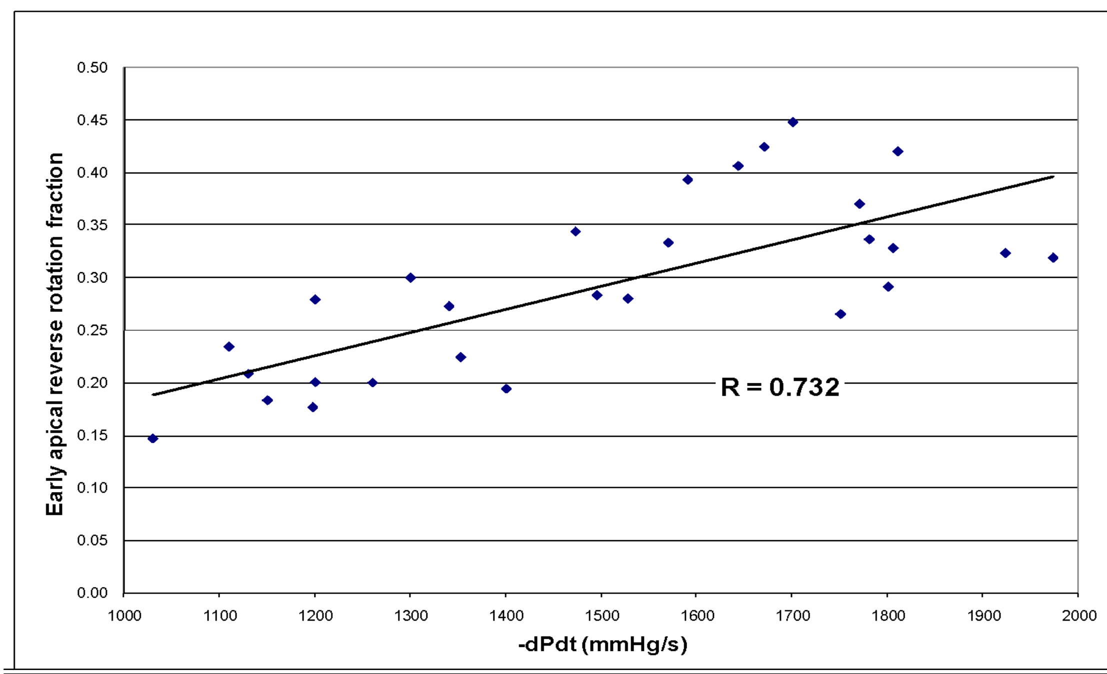
Methods We studied 30 patients with obstructive HCM undergoing septal ethanol ablation (SEA). We measured longitudinal and circumferential strain, strain rate (SR), and rotation. To assess early relaxation, early apical reverse rotation fraction (EARRF), related to apical suction, was measured using:

$$EARRF = \frac{\theta_{peak} - \theta_{t(peak)+10\%CL}}{\theta_{peak}}$$; CL denotes cycle length.

To isolate systolic-independent diastolic dysfunction we calculated an early diastolic to systolic strain-rate ratio (SR E/S ratio). Diastolic echo parameters and mechanics were correlated with LV end diastolic pressure (LVEDP) and negative dP/dt measured at the cath-lab prior to SEA.

Results Conventional echo parameters of diastolic dysfunction did not correlate with either LVEDP or –dP/dt. EARRF (figure) correlated with –dP/dt (R=0.73), and SR E/S ratio correlated with LVEDP (R=0.49).

Conclusions In obstructive HCM, biplane mechanics offer an improved estimate of diastolic function. EARFF probably relates to relaxation while SR E/S ratio to filling pressures and myocardial stiffness.



Day-to-day Variation of Left Ventricular Segmental Longitudinal Strain in Patients with Ischemic Heart Disease

David Blondheim [1], Yossi Tsadok [2], Aya Asif [1], Simcha Meisel [1], Michael Shochat [1], Aaron Frimerman [1], Mark Kazatsker [1], Avi Shotan [1]

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Background: Little is known about the magnitude of spontaneous changes in segmental LV function for lack of sensitive tools to determine small variations. Automatic analysis of longitudinal strain (LS) has a small variability and a greater sensitivity to wall motion abnormalities than highly experienced readers.

Methods: Five IHD patients had a total of 18 repeated echo studies performed at a fixed hour in the morning, before any medication was ingested. Segmental LS based on speckle tracking was measured by Vivid 7 software. Segments with high quality recordings obtained from the 3 standard apical views were analyzed. Mitral medial- and lateral-annular and LV apical points were manually located. Endocardial tracking, LV division into 6 segments per-view and collection of data on peak-LS, peak-systolic-LS and time-to-peaks (TTP) was performed automatically. The analysis was performed by a layman, blindedly.

Results: Repeated studies of 375 segments were available for analysis. Mean standard deviation (SD) and coefficient of variation (COV=SD/mean) of the parameters studied are presented in table. For comparison: intra-observer variation of the method for LS is 1.4±0.2.

	Peak LS	Peak Syst. LS	TTP LS	TTP Syst. LS
Mean SD	2.5±0.8	2.4±0.7	24.8±22.0	1.7±0.9
COV	0.32	0.29	0.89	0.53

No significant differences in daily variations between basal, mid and apical segments or between normal, hypokinetic and akinetic segments were found.

Conclusions: Ranges for day-to-day variation in LS measurements were determined. Spontaneous changes in LS are measurable and must be taken into account when evaluating changes in segmental strain in a given patient.

2D Strain Speckle Tracking Analysis in Acute Peri-myocarditis

Marina Leitman, Gil Moravski, Zvi Vered
Cardiology Department, Assaf Harofeh Medical Center, Zerifin, Israel

Background. Echocardiographic changes in acute peri-myocarditis vary from obvious regional LV dysfunction to apparently normal heart. Modfied 2D strain speckle tracking method permits measurement of strain in 3 myocardial layers. We measured strain in 3 myocardial layers pre-strech, postsystolic index and torsion in the patients with acute peri-myocarditis.
Methods. 4 patients with acute peri-myocarditis and 8 normal subjects underwent echocardiographic examination. Short axis and apical views were stored and analysed with Modified 2D strain speckle tracking method capable of measurement of strain in 3 myocardial layers.
Results. Longitudinal strain in the patients with peri-myocarditis in each myocardial level was significantly lower than in control subjects. Postsystolic index in patients with peri-myocarditis was higher than in normals (Table 1). Circumferential strain (Table 2) in the patients with peri-myocarditis was also lower than in controls. Pre-strech index in the patients with peri-myocarditis was higher than in normals. Torsion in the patients with peri-myocarditis was lower than in control.
Conclusion. Longitudinal and circumferential strain in patients with peri-myocarditis is lower than in normal subjects. Torsion in peri-myocarditis is lower than in controls. Pre-strech index and postsystoloc longitudinal index are higher peri-myocarditis than in normals. Further studies with larger groups of patients with and without wall motion abnormalities a required.

Table-1					
LONG	B A S A L				
	Endo	Mid	Epi	PSI L	prestrech
Abn	-17.9	-16.8	-16	11.8	2.33
N	-20.3	-19.6	-18.9	2	3
p	**0.03**	**0.01**	**0.008**	**0.06**	0.58
LONG	M I D V E N T R I C L E				
	Endo	Mid	Epi	PSI L	prestrech
Abn	-19.6	-17.8	-16.4	3.3	1.2
N	-23	-20.6	-18.7	0.59	0.76
p	**0.005**	**0.007**	**0.02**	**0.017**	0.69
LONG	A P E X				
	Endo	Mid	Epi	PSI L	prestrech
Abn	-24	-16.9	-12.4	13.1	2
N	-31.3	-22.6	-16.7	2.5	1.8
p	**0.005**	**0.007**	**0.01**	**0.037**	0.89

Table -2

SHORT	B A S A L						
	Endo	Mid	Epi	PSI R	PSI C	PRE	
Abn	-24.9	-17.1	-11.6	10.2	5.2	5.2	
N	-30.5	-21.4	-15.3	9.9	5	4.8	
p	**0.006**	**0.02**	**0.02**	0.7	0.85	**0.02**	
SHORT	M I D V E N T R I C L e						
	Endo	Mid	Epi	PSI R	PSI C	PRE	
Abn	-28.1	-20	-13.9	6	5.8	5.9	
N	-36.2	-26.2	-18.9	6	0.04	1.23	
p	**7.3X10(-5)**	**0.003**	**0.006**	**0.006**	0.06	**0.05**	
SHORT	A P E X						
	Endo	Mid	Epi	PSI R	PSI C	PRE	Torsion
Abn	-28.5	-22	-17.4	22.9	2.4	3.6	4.4
N	-48.1	-36.4	-28.3	34.1	0.4	0.3	16.3
p	**0.6x10(-12)**	**2.5x10(-15)**	**5.6x10(-6)**	0.21	0.11	**0.06**	**0.03**

Changes in Left and Right Ventricular Structure and Function of Donor Hearts During the First Year After Heart Transplantation Using Tissue Doppler Imaging, Myocardial Performance Index and Myocyte Size Assessment

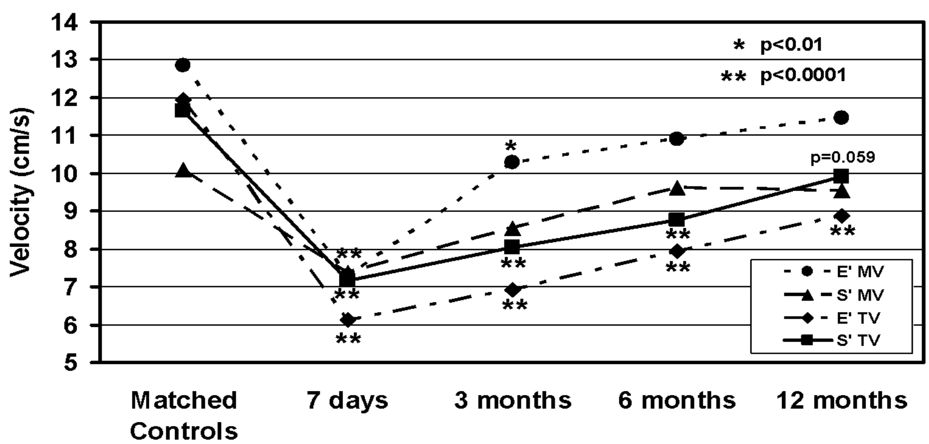
Sorel Goland[1], Lawrence S.C Czer[2], Robert J Siegel[2], Kevin Burton[2], Kaveh Zivari[2], Asim Rafique[2], Michele A De Robertis[2], Daniel Luthringer[2], Ernst Schwarz[2], Alfredo Trento[2]

[1] *Cardiology Department, Kaplan Medical Center, Rehovot, Israel,* [2] *Cardiology and Cardiothoracic surgery, Cedars-Sinai Medical Center, Los Angeles, CA, USA*

Objectives: Normal changes in Tissue Doppler imaging (TDI) velocities and myocardial performance index (MPI) after heart transplantation (HTx) have not been evaluated. Aim: To assess left and right ventricular (LV and RV) structure and function during the 1st year after HTx using TDI and MPI. Methods.20 donors (mean age 35±13, 20 M) had baseline echocardiogram (echo) and 20 recipients (mean age 59±9, 14 M) underwent serial echo including MPI and TDI systolic (S'), early (E') and late (A') diastolic velocities of RV and LV during 1st year post HTx. TDI of RV and LV was not available in all donors and was taken from matched controls.

Results: 96 studies (20 donors/controls and 76 recipients) were analyzed. Increase in LV mass occurred at 7 days, most likely due to post-op tissue edema or ischemic changes with normalization at 3 months. An increase in MPI and a decrease in E', S' velocities on TDI occurred at week 1 with gradual improvement within the 1st year (Fig). Normalization of LV and RV MPI occurred at 6 months and LV TDI velocities at 1 year. TDI velocities of RV at 1 year remained lower than in controls. No patient had >grade IA rejection at follow-up. Myocyte size was measured in H&E-stained on biopsies at 7 days and 1 year after HTx. Although changes in myocyte size varied in individual patients, on average no significant change was found (-3%±6%).

Conclusions: Impairment of bi-ventricular systolic and diastolic function by TDI and MPI occurs early after HTx with gradual improvement during the 1st year. This study provides for the first time the expected values of TDI velocities and MPI of both LV and RV for HTx recipients without significant rejection during the 1st year after HTx.



p-values for the comparison between velocities of the matched controls to the recipient velocities at each time interval following Heart Transplantation.

Assessment of Left Ventricular Segmental Function Using 9-Slice Short Axis Imaging Derived From 3-Dimensional Echocardiography

Yoram Agmon, Diab Mutlak, Shimon Reisner
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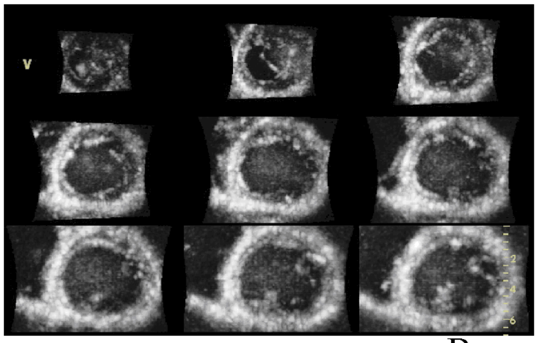
Background: The left ventricle (LV) can be displayed in multiple simultaneous short axis cine-loops using 3-dimensional echocardiography (3DE). We examined whether it is feasible to assess LV segmental function using this application of 3DE.
Methods: Fifty arbitrarily selected patients (age 57±15 yrs, 60% men) were examined by both 2-dimensional echocardiography (2DE) and 3DE using a Vivid 7 ultrasound machine equipped with a 3DE transthoracic matrix probe (GE Healthcare, Wauwatosa, WI). LV segmental wall motion was determined by standard 2DE imaging from parasternal and apical windows. Using a 16-segment model, each segment was coded as normal, hypokinetic, or akinetic (the latter category included dyskinetic and aneurysmal segments). Subsequently, 3DE was performed and full volume 3DE datasets were acquired from the cardiac apex during breath-holding (ECG-gated sum of volumetric data from 4 consecutive cardiac cycles). The heart was displayed in a 9-slice short axis cine-loop format from apex to base, with 3 slices at each LV level (apex, mid, and base; *Figure*). Segmental function was determined by the average function of the 3 slices within each segment. 3DE segmental analysis was blindly assessed without knowledge of the of the 2DE interpretation.
Results: By 2DE (the "gold standard" for segmental analysis) – segmental LV dysfunction was evident in 22 patients (44%): 619 segments were normal (77.4% of 800 segments) and 181 were abnormal (22.6%; 99 hypokinetic [12.4%] and 82 akinetic segments [10.2%]). When segments were analyzed as normal, hypokinetic, or akinetic – the 2 techniques agreed in 87% of segments and when segments were dichotomized to normal or abnormal segments (the latter combining hypokinetic and akinetic segments) the 2 techniques agreed in 90% of segments. The sensitivity, sensitivity, positive, and negative predictive values of 3DE to detect an abnormal segment by 2DE were 95%, 74%, 82%, and 93%, respectively. The most common discrepancy between the 2 techniques was in the interpretation of basal inferior wall segmental function (disagreement in 9 patients [18%]). Six of 7 patients with segmental wall motion abnormalities in multi-vessel distribution were correctly identified by 3DE.
Conclusions: Segmental LV wall motion analysis is feasible via 3DE with a 9-slice short axis display. This technique may supplement and assist the standard assessment of LV segmental function via 2DE.

End-diastole

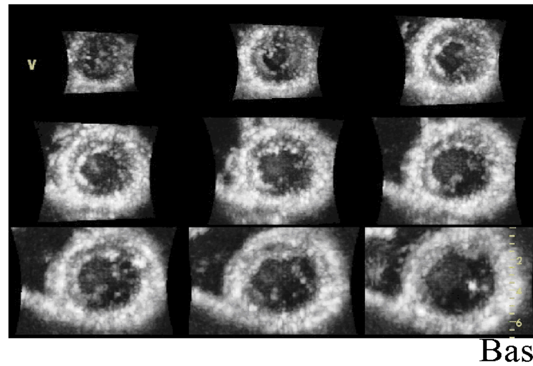
Apex



Base

End-systole

Apex



Base

Three-Dimensional Mitral Annular Tracking Demonstrates Important Structural and Functional Annular Differences depending on the Etiology of Mitral Regurgitation

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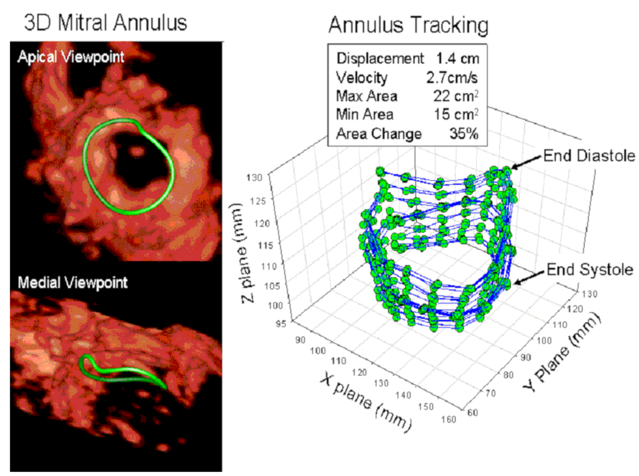
Cardiovascular Imaging Institute, The Methodist DeBakey Heart & Vascular Center, Houston, TX, USA

Background: Real-time 3D echocardiography and unique software permit mitral annulus (MA) tracking throughout systole to assess MA remodeling and function. Whether mitral annulus structure and function are altered differently, depending on the etiology of mitral regurgitation (MR), is currently not well known.

Methods: We evaluated dynamic MA characteristics in patients with significant MR secondary to mitral valve prolapse (MVP-MR) and functional MR (F-MR) and compared them to normal controls. Novel 3D tracking software (based on 3D optical flow combined with block matching) was used to identify 16 circumferential equidistant MA points and to track changes in MA area and apical descent from end-diastole to end-systole (see figure-patient example). Patients with at least moderate MR underwent a complete transthoracic 2D and quantitative Doppler study with 3D full volume MA imaging from the apical 4 chamber view.

	Normal (N=15)	Prolapse MR (N=15)	Functional MR (N=13)
End-Diastolic Volume (ml)	133 ± 21	148 ± 62	229 ± 68*§
LV Ejection Fraction (%)	61 ± 5	63 ± 19 §	31 ± 9*§
Maximum MA Descent (mm)	11 ± 2	9 ± 3 * §	6 ± 2*§
Largest MA Area (cm^2)	13 ± 3	23 ± 5 *§	16 ± 4*§
MA Area Change (%)	26 ± 8	22 ± 5 §	15 ± 5 *§



*** p<0.05 vs control; § p<0.5 vs PMR or FMR**

Results: For each group studied, LV size, function and dynamic MA characteristics are shown in the table. Compared to normals, the F-MR patients demonstrated end-diastolic MA area enlargement with reduced systolic area change and reduced apical decent. In comparison, MVP-MR patients demonstrated the largest end-diastolic MA area with preserved annular area change and only mild reduction of apical decent. This finding suggests that MVP-MR may involve significant MA remodeling without deterioration of MA systolic function.

Conclusion: Patients with MR have significant mitral annular enlargement, irrespective of MR etiology. However, in contrast to functional MR, patients with MR secondary to MVP have the largest annular remodeling—almost twice normal—and yet have preserved annular function and dynamicity.

Real-time 3D Transesophageal Echocardiography is Superior to 2D Transesophageal Echocardiography in Localizing Mitral Valve Pathology: Comparison with Surgical Findings

Sagit Ben zekry [1], Stephen H Little [1], Sherif F Nague [1], Elizabeth L Herrera [2], Karanbir Singh [2], William A Zoghbi [1]

[1] Cardiology Department, [2] Anastesiology Department, Cardiovascular Imaging Institute, The Methodist Hospital Debakey Heart and Vascular Center, Houston, TX, USA

Background: The incremental value of transesophageal (TEE) real time 3-Dimensional (3D) echocardiography over 2D TEE in diagnosing mitral valve pathology is unknown. The aim of the study was therefore to assess the comparative accuracy of 3D TEE and 2D TEE in identifying the mechanism of mitral regurgitation (MR) and mitral valve pathology.

Methods: Patients with significant MR referred for mitral valve repair were consecutively enrolled. In the operating room, a standard 2D TEE of the mitral valve was performed. A 3D TEE was also obtained with a zoomed (live image) view of the mitral valve and a full volume acquisition. 2D and 3D images were stored separately and reviewed by 2 independent observers, blinded to the surgical findings and all other data. The valve was assessed for the MR mechanism: functional or organic. In patients with organic MR, the presence and location of leaflet prolapse and/or flail were noted. The surgical findings served as the gold standard.

Results: Nineteen patients (60.4±9.1 years, 6 females) were studied. Fourteen patients with organic MR were correctly diagnosed by 2D and 3D TEE (100% accuracy and agreement). Twelve patients had prolapse, and there was a good agreement between 2D and 3DE in identifying the prolapsed valve (accuracy: 89.5% for 2D and 84.2% for 3D, $k=0.87$, $p<0.001$). There were 11 patients with flail leaflets; all flail segments were located in the posterior leaflet (all in P2). A good agreement between 2D TEE and 3D TEE was seen in diagnosing flail leaflets (accuracy: 84.2% for 2D, 89.4% for 3D, $k=0.784$, $p=0.001$). However, 3D TEE was more accurate in identifying the flail posterior leaflet scallop (accuracy: 97.4% for 3D and 85.9% for 2D, $p=0.004$).

Conclusions: Both 2D and 3D TEE reliably identify the mechanism of MR. However, 3D TEE has the incremental value of more accurately identifying the leaflet scallop with the flail segment, most likely because 3D TEE allows a full geometric view of the valve. These results have potential significant implications in guiding surgical repair.