

# **Normalization of Mitral Annular Anatomy after Repair of Mitral Valve Prolapse: Geometric Quantification Using Intraoperative 3D TEE**

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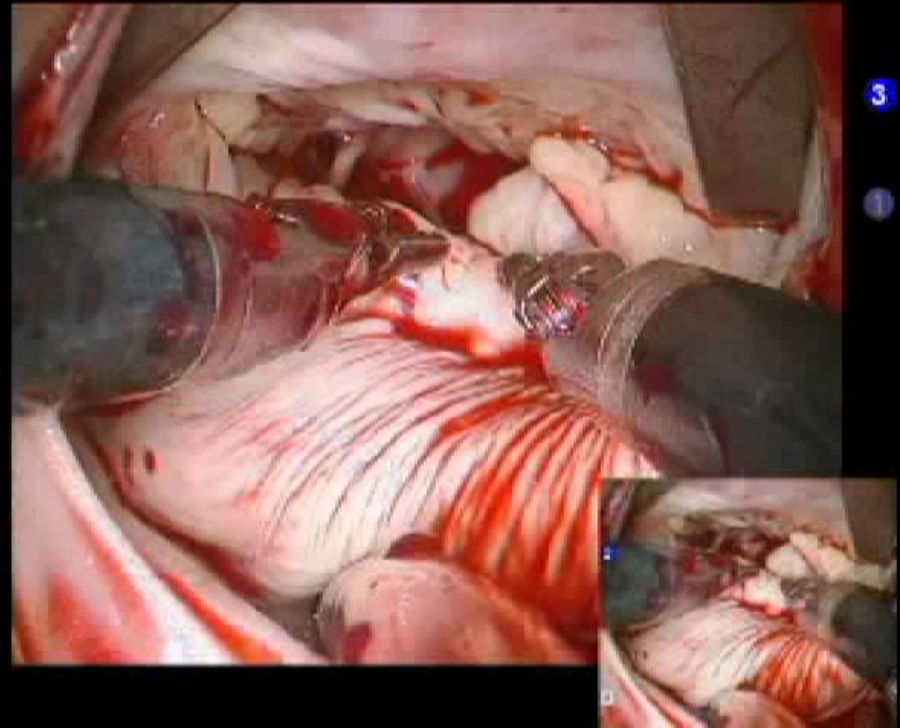
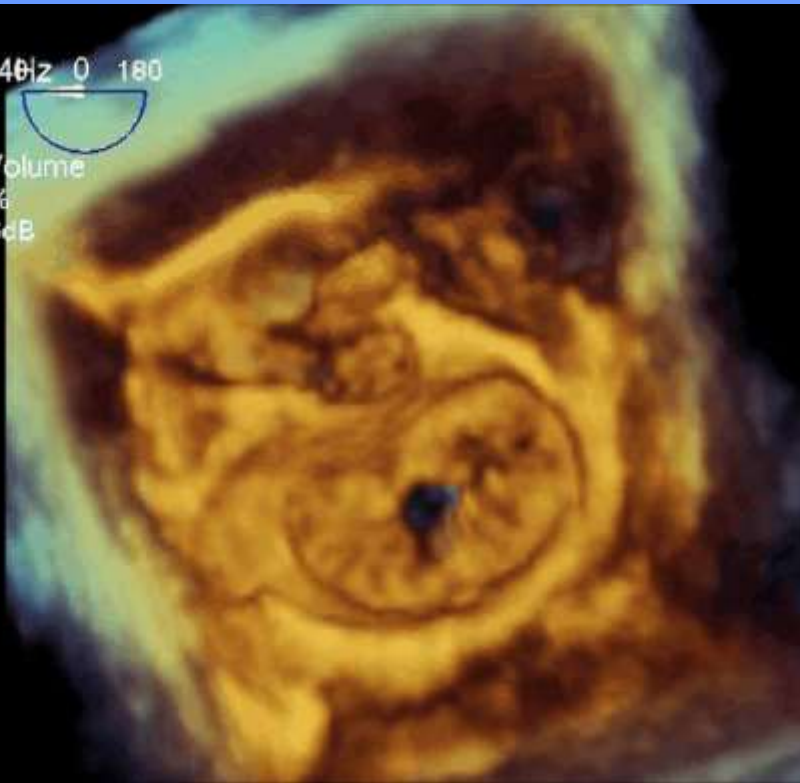
**Division of Cardiology, Department of Internal Medicine,**

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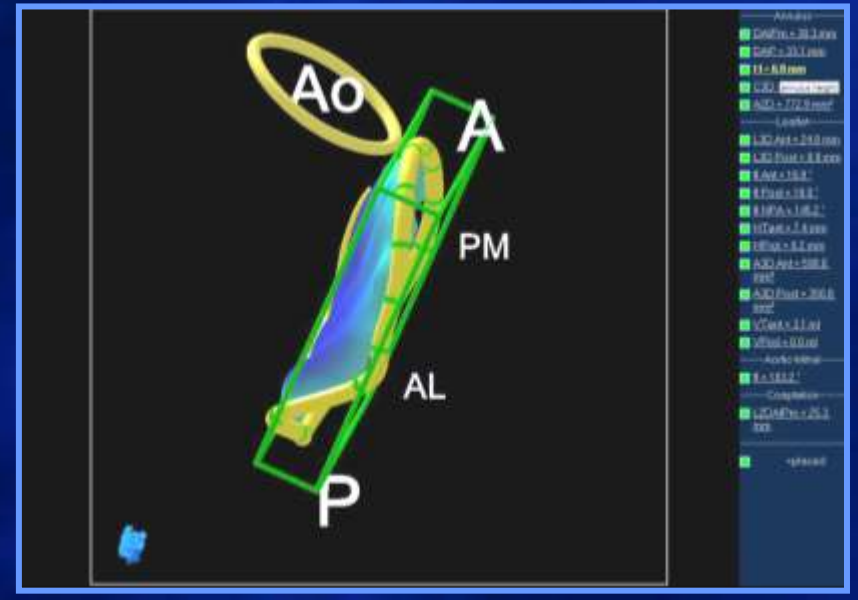
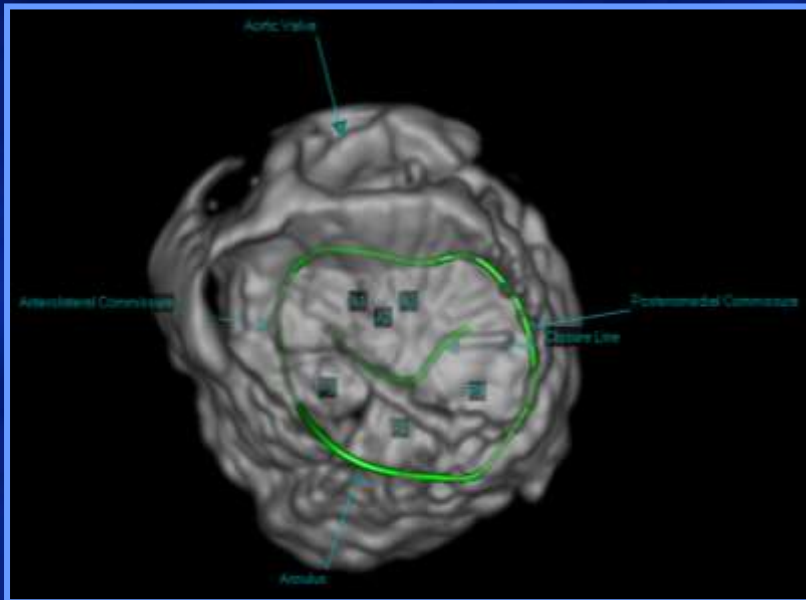
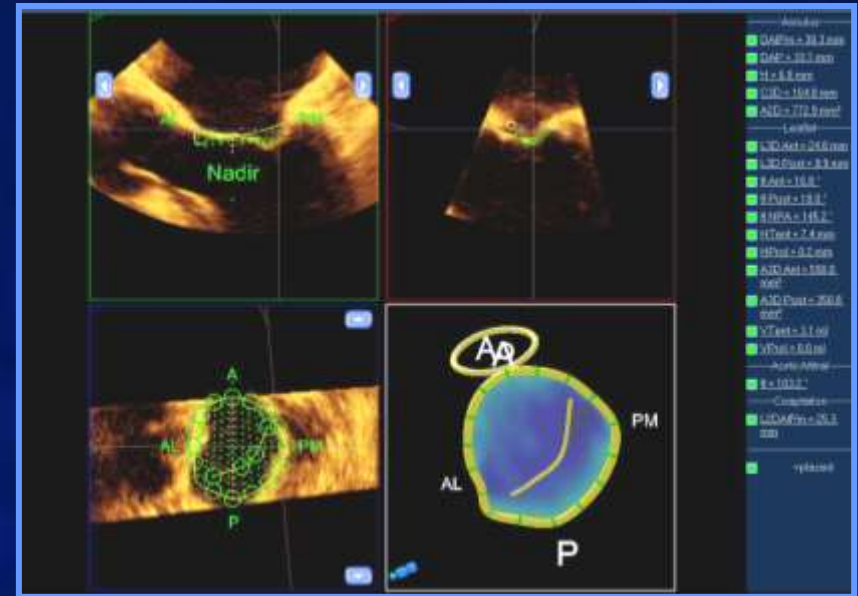
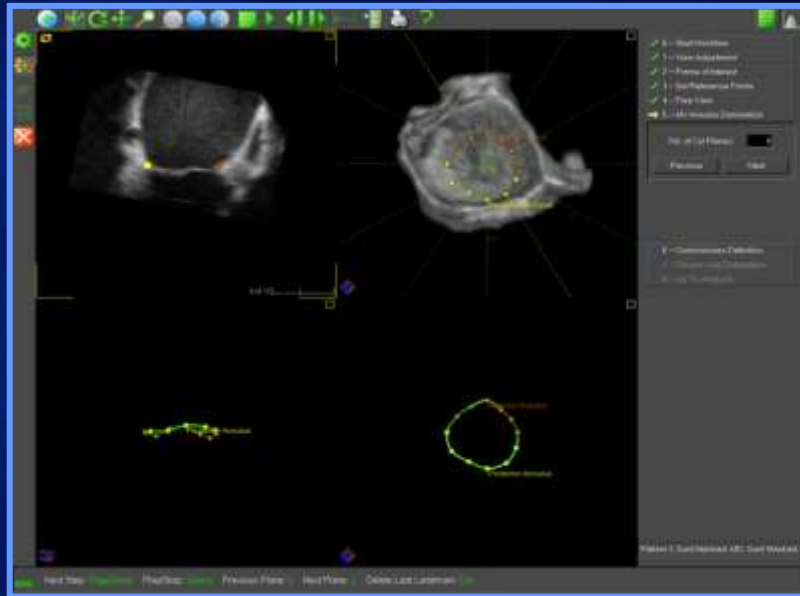
**Disclosures: None**

# Flail P2 with P3 Prolapse

VR 24Hz 0 180  
12cm  
Full Volume  
3D 1%  
3D 26dB



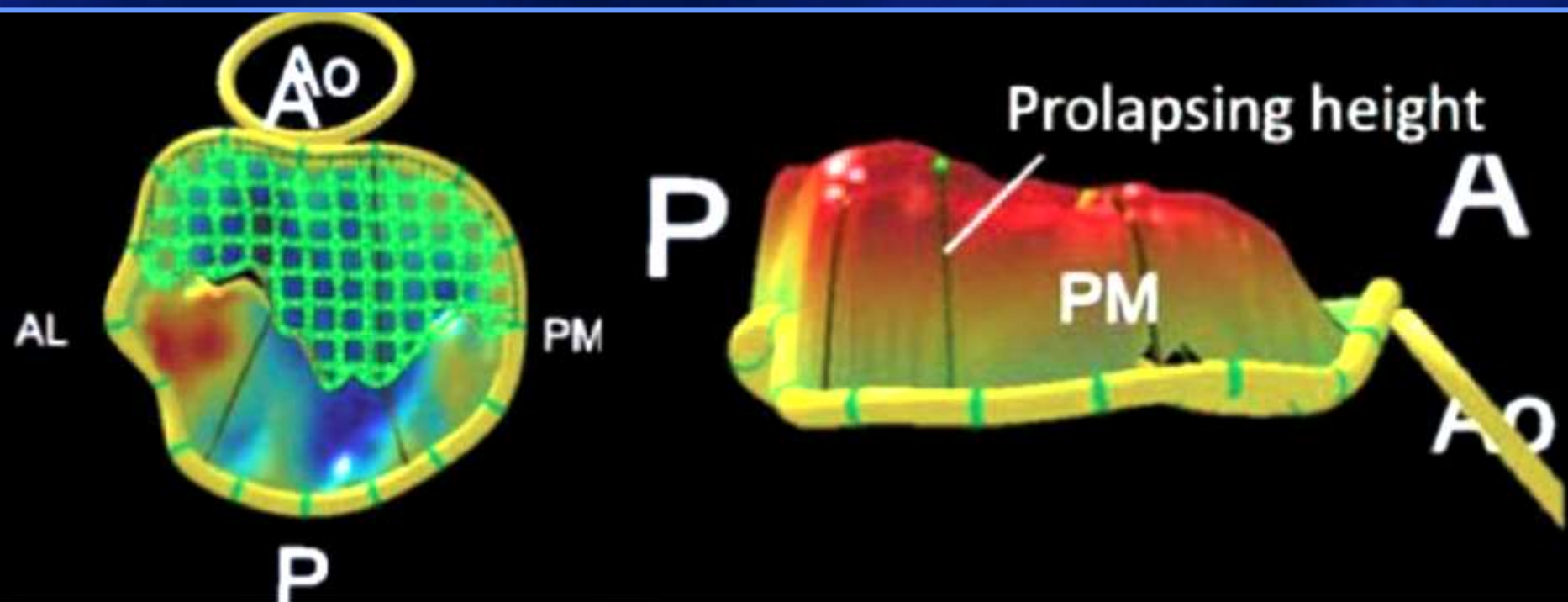
# Mitral Valve Assessment Software





## Can three-dimensional echocardiography accurately predict complexity of mitral valve repair?

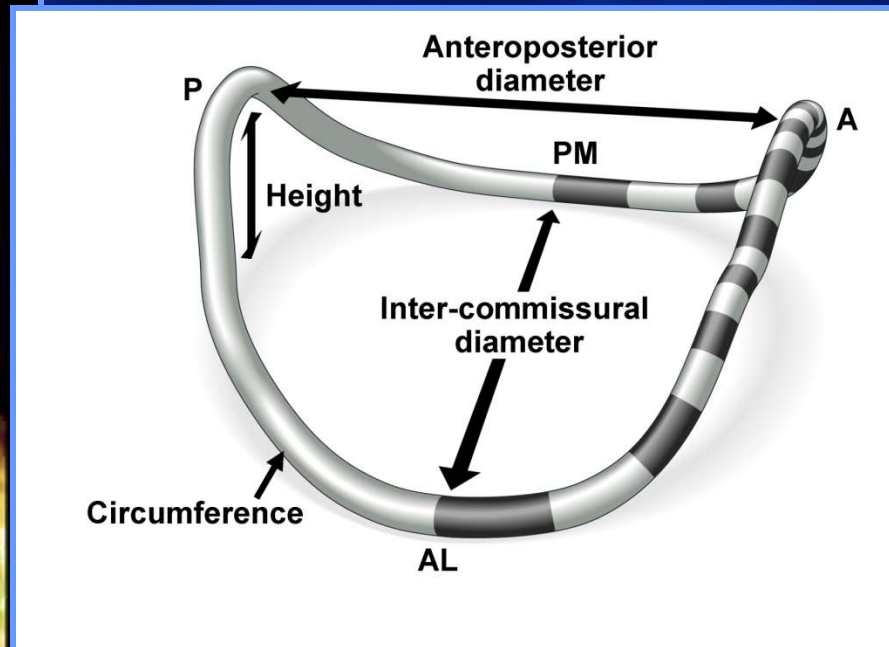
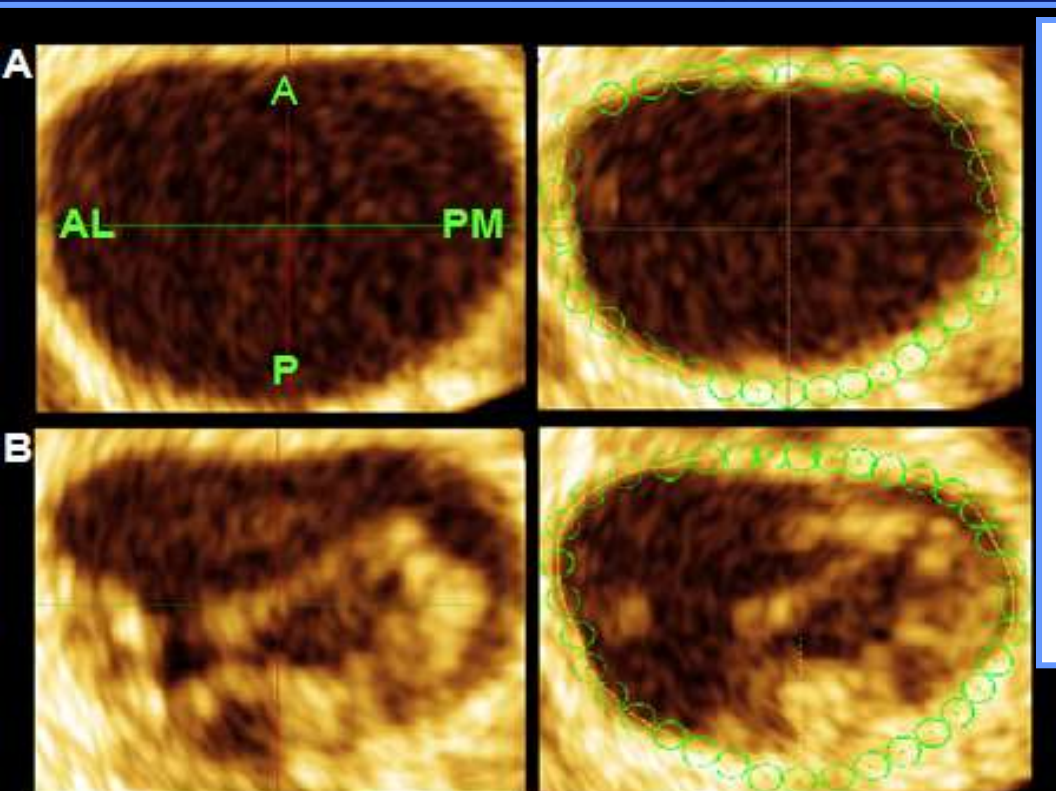
Joanna Chikwe<sup>a,\*</sup>, David H. Adams<sup>a</sup>, Kevin N. Su<sup>b</sup>, Anelechi C. Anyanwu<sup>a</sup>, Hung-Mo Lin<sup>c</sup>,  
Andrew B. Goldstone<sup>b</sup>, Roberto M. Lang<sup>d</sup> and Gregory W. Fischer<sup>b</sup>



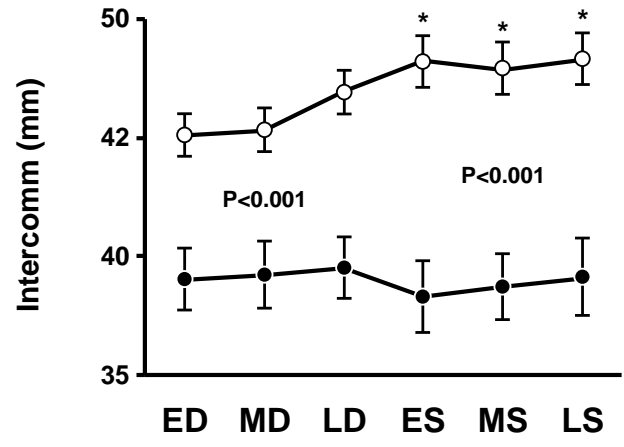
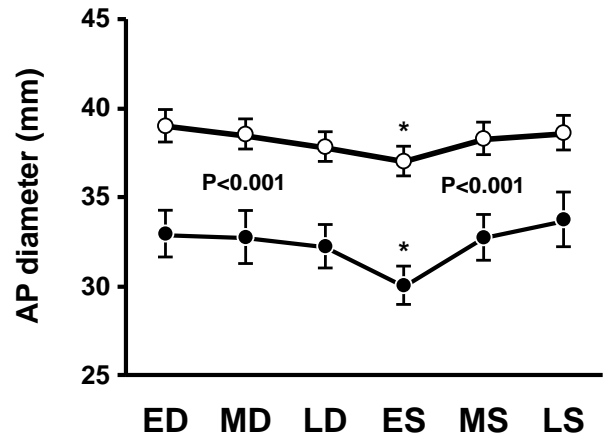
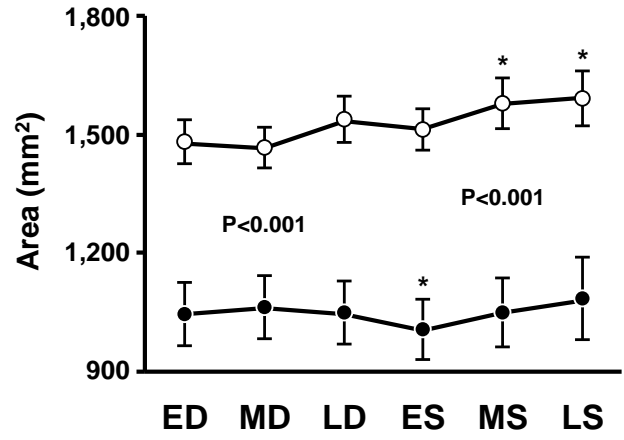
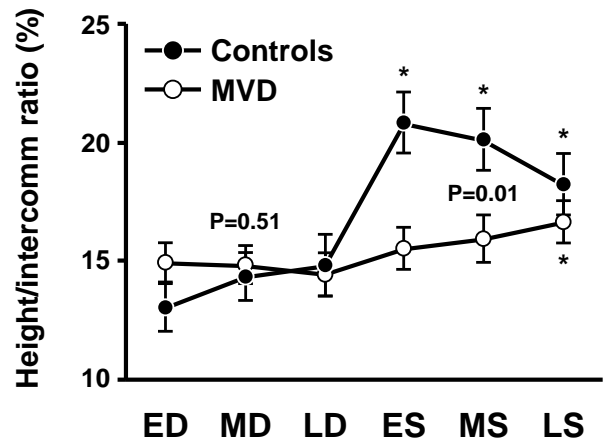
**CONCLUSIONS:** 3D transesophageal echocardiography provides an objective means of predicting mitral repair complexity in mitral regurgitation due to a range of etiology.

# Mitral Annular Dynamics in Myxomatous Valve Disease: New Insights Using Real-Time 3D Echocardiography

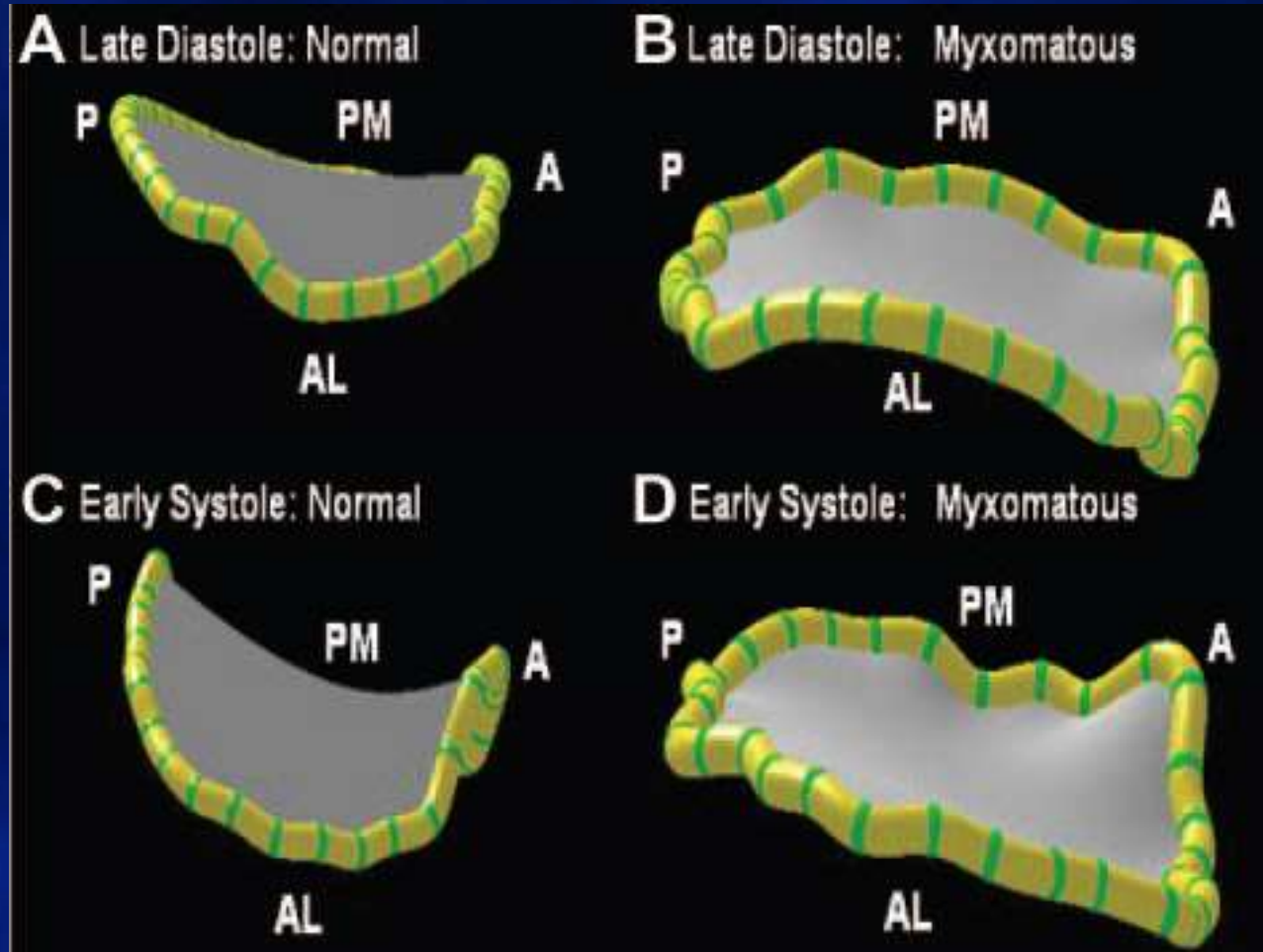
Grewal J et al. *Circulation* 2010



# Dynamic Motion of Mitral Annulus



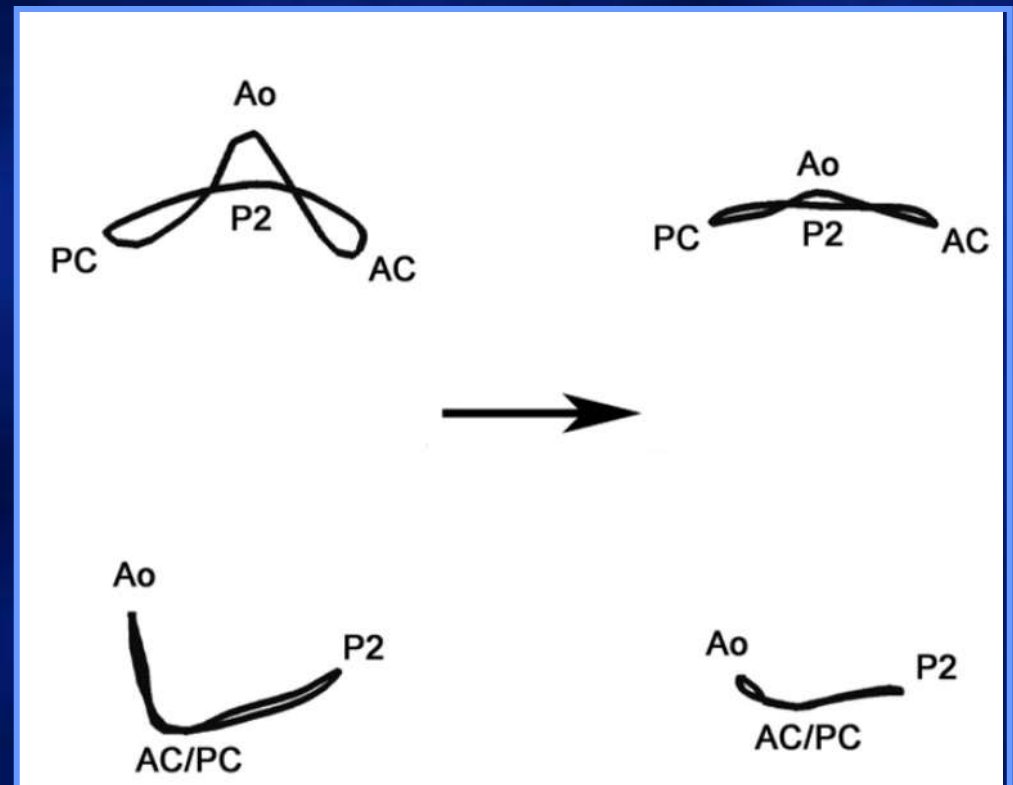
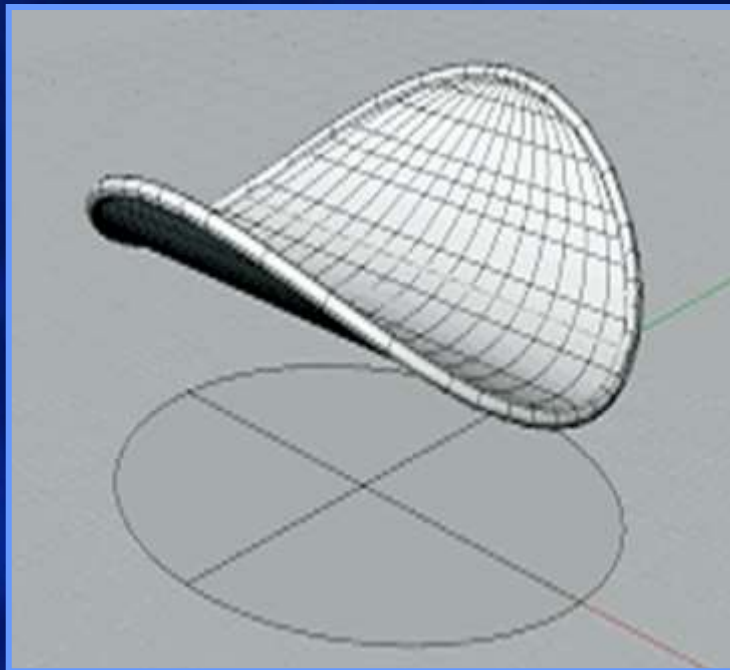
# Dynamic Motion of Mitral Annulus





# The Emerging Role of Three-Dimensional Echocardiography in Mitral Valve Repair

Liam P. Ryan, MD,\* Ivan S. Salgo, MD, MS,<sup>†</sup> Robert C. Gorman, MD,\*  
and Joseph H. Gorman, III, MD\*





# Background

- **The early systolic accentuation of mitral annulus, or saddle shape was believed to be lost in patient with severe MR caused by severe myxomatous change in previous “static analysis” 3D software.**

- **Whether the same pathophysiology of mitral annulus in severe myxomatous change be repeated in “dynamic analysis” 3D software.**
- **In addition, the post-operative mitral annular dynamics have not been fully delineated in myxomatous mitral valve disease.**

# Method: Patient Selection

## Inclusion:

- **Study group:** Patient undergoes valve repair plus annuloplasty for severe degenerative prolapse causing severe mitral regurgitation
  - **PRE:** 3-dimensional (3D) transesophageal echocardiography (TEE) evaluated pre-operatively (PRE)
  - **POST:** 3D TEE performed post-operatively
- **CONTROL:** non-mitral cardiac surgery with normal 2D TEE mitral valve anatomy

# Method: Patient Selection

## Excision:

- Barlow's disease (entirely myxomatous change of mitral valve)
- Left ventricular dysfunction (ejection fraction  $< 50\%$ )
- Atrial fibrillation
- Mitral stenosis or rheumatic heart disease



# Method: Measurement

- **Acquisition:**
- **Four beat breath-hold 3D full volume images were obtained using real time 3D TEE probe (X7-2t, iE 33, Philips Medical System, Bothell, Wa) and analyzed off-line utilizing novel 3D valve software (eSie Valve, pre-release version Siemens, Mountain View, CA) [Figure 1].**

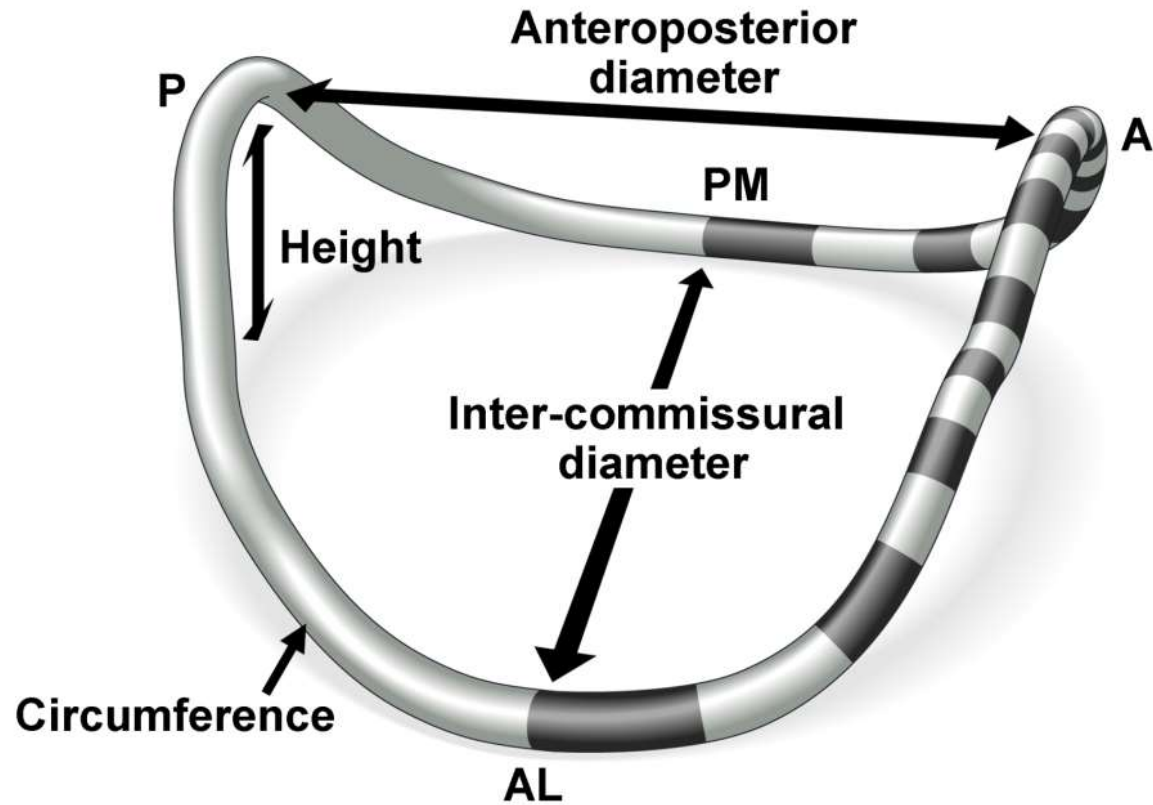
# Method: Measurement

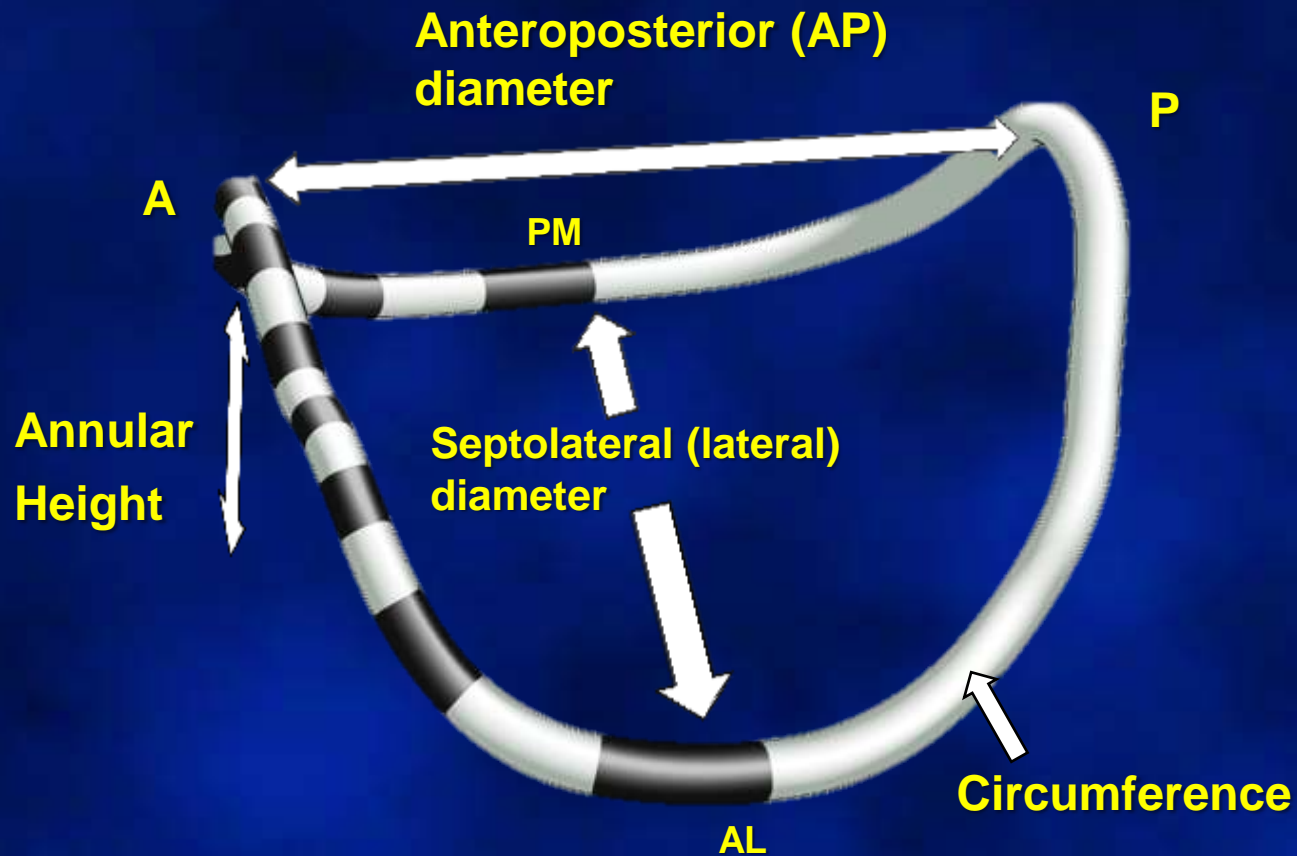
## 3D analysis:

- **Offline measurement**
- **Mitral annular and valvular geometric assessments were performed throughout the cardiac cycle including sequential quantification of annular height to analyze dynamic annular motion.**
- **Comparisons were made between PRE, POST, and Controls.**

# Grewal J et al. circulation 2010

## *Circulation* 2010

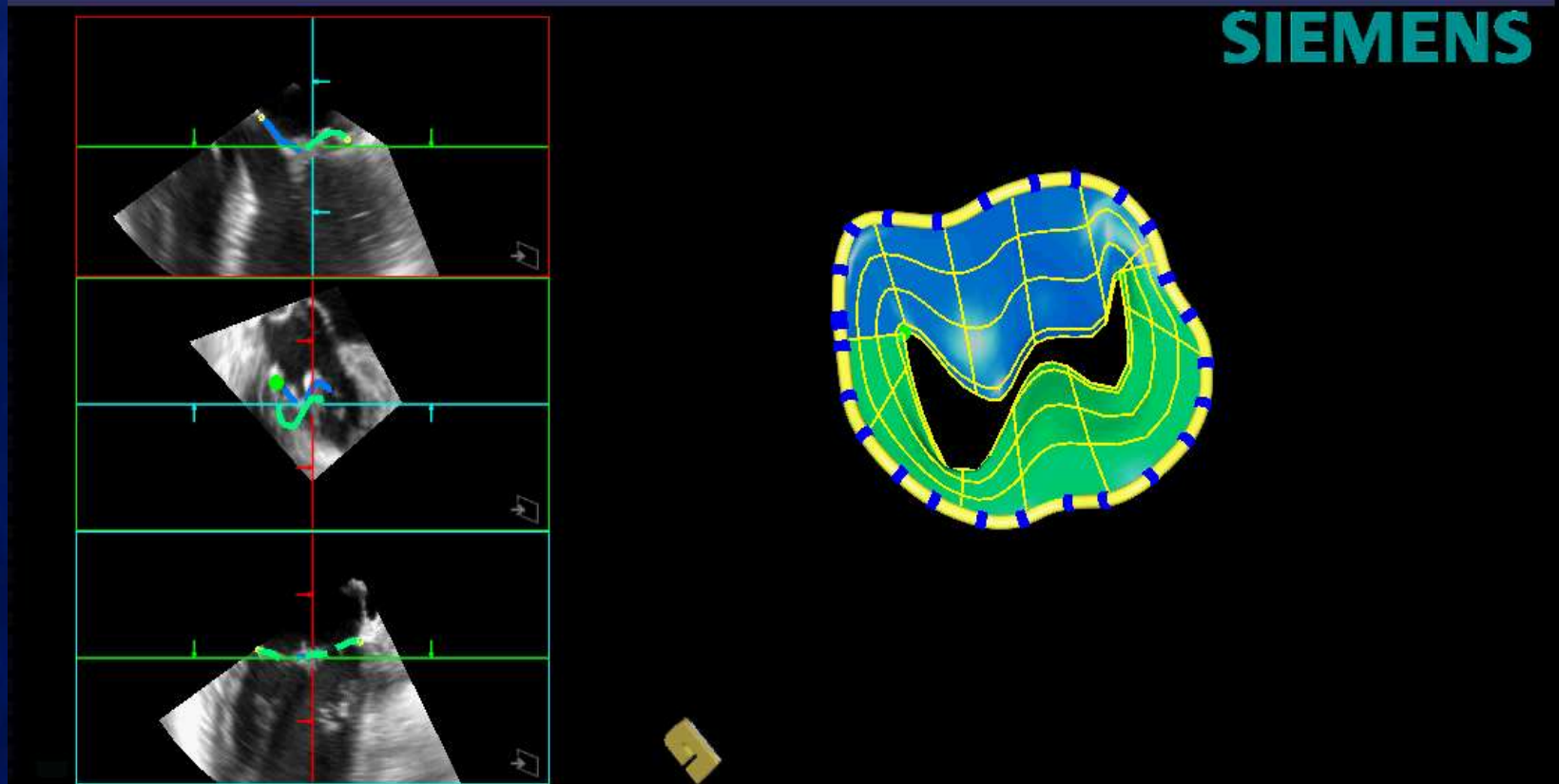




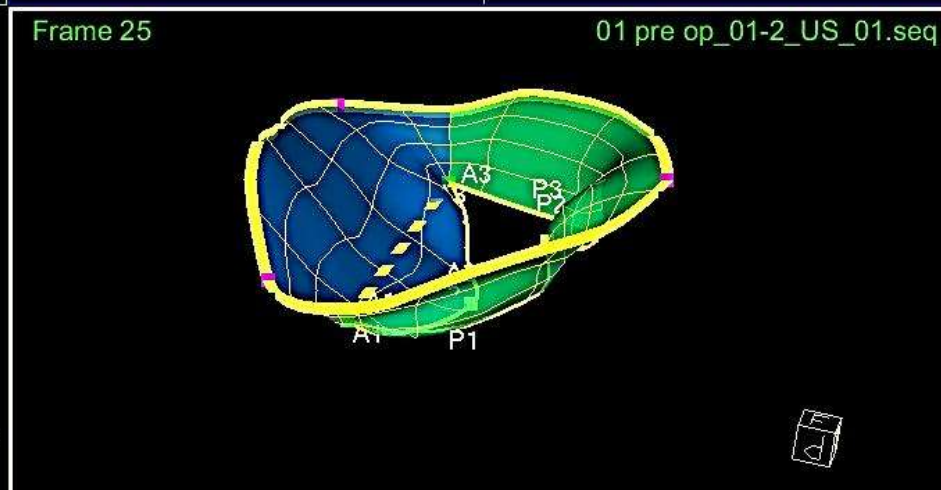
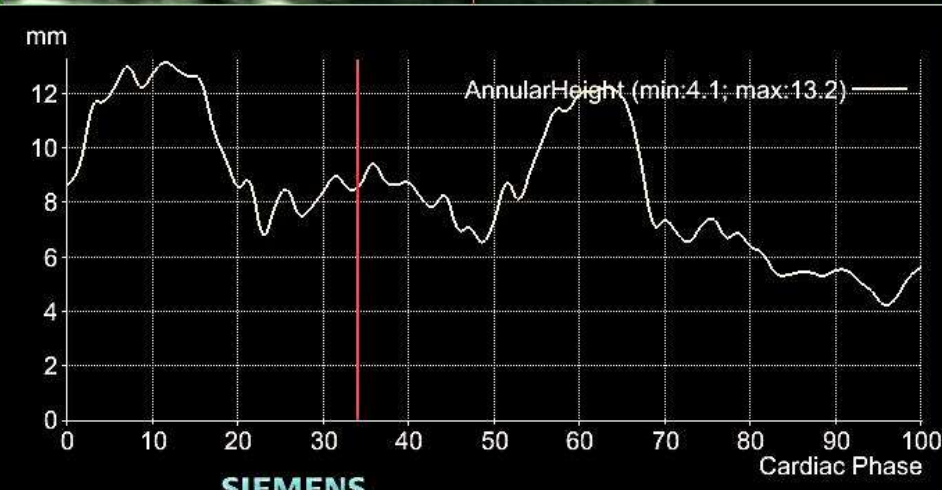
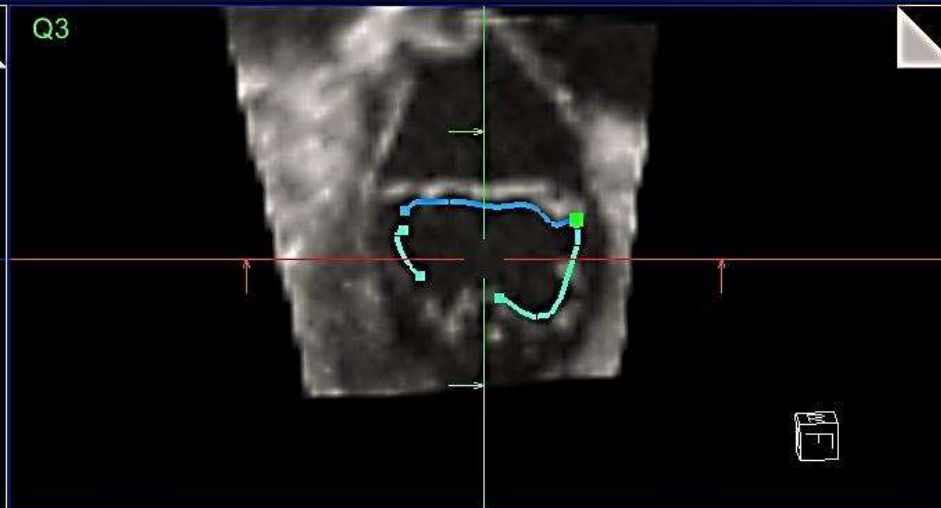
Modified from *Circulation* 2010;121:1423-1431



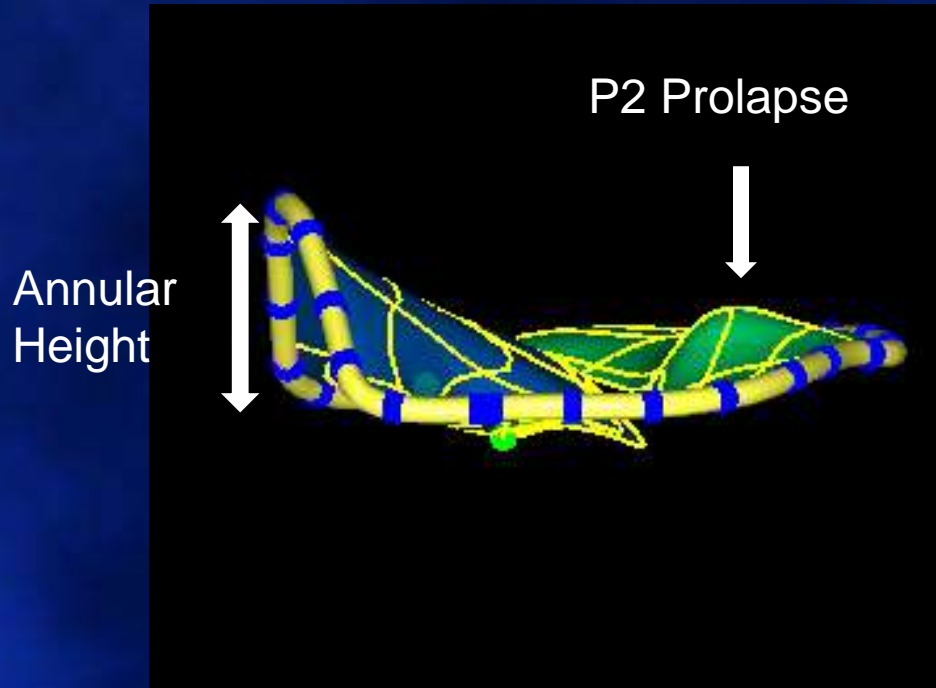
# Novel 3D software Dynamic assessment of mitral valve



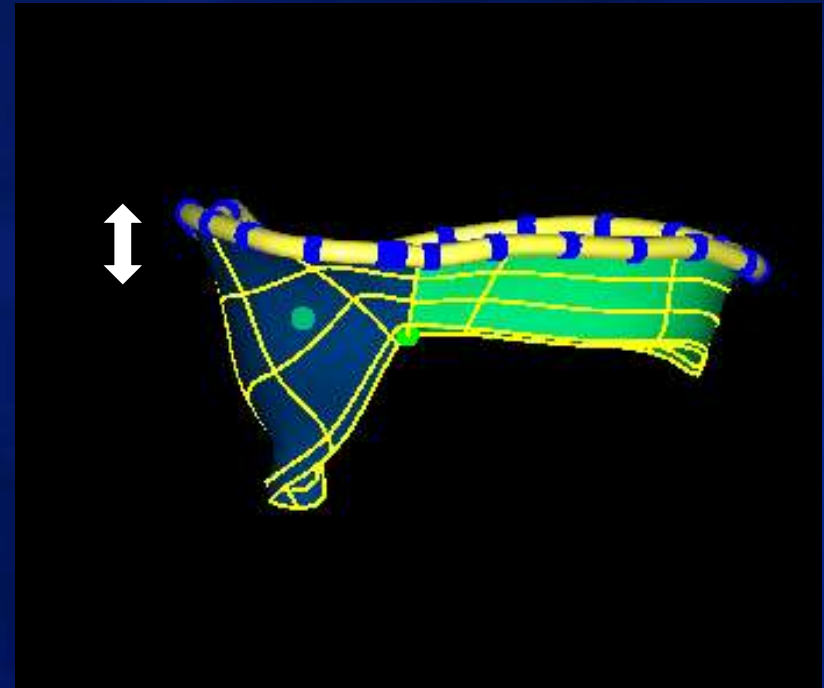
# Sequential MV assessment



# The change of annular height



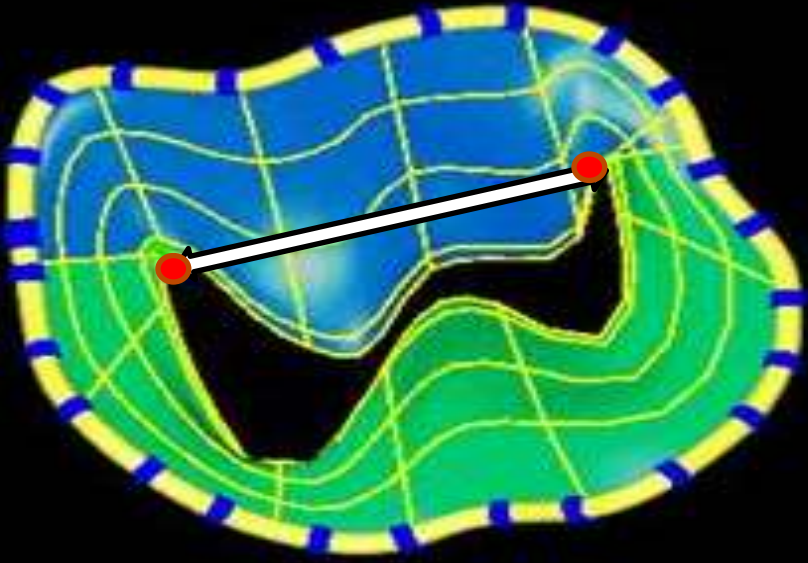
Mid- systolic phase



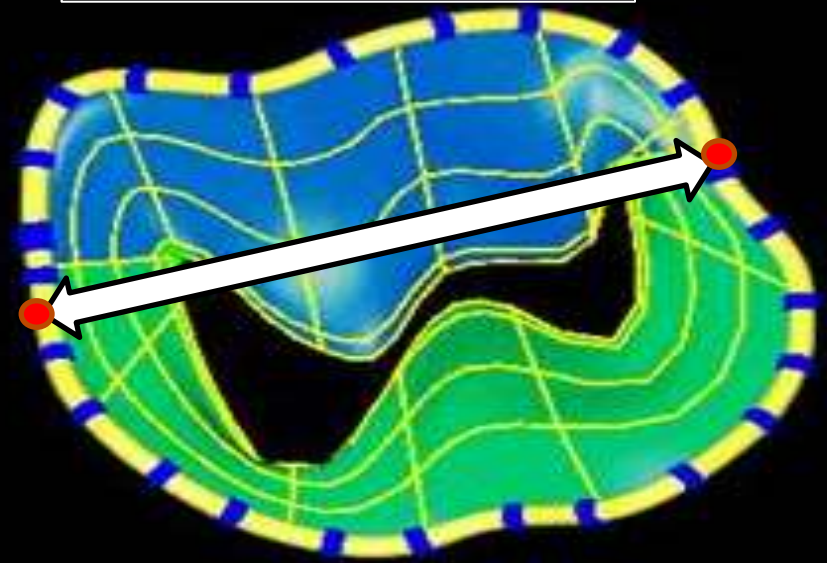
Mid diastolic phase

# Saddle shape= $AH/CW$ or $AH/LAT$ ?

Commissural Width



Septa-lateral (Lateral) Diameter





# Baseline Characteristics

	All patients (n=49)	MV Repair (n=25)	Control (n=24)	P value
<b>Age (year old)</b>	62.8 ± 13.0	61.5 ± 14.4	64.2 ± 14.4	0.467
<b>Male (%)</b>	32 (66.7)	17(68.0 )	15(65.2)	1.000
<b>Height (cm)</b>	171.7 ± 10.6	174.4 ± 11.1	168.8 ± 9.5	0.067
<b>Weight (kg)</b>	83.6 ± 15.9	79.5 ± 15.5	88.2±15.4	0.058
<b>BSA</b>	1.99 ± 0.2	1.96 ± 0.22	2.03 ± 0.3	0.265
<b>SBP (mmHg)</b>	124.9 ± 20.6	129.3 ± 14.9	130.3 ± 17.4	0.842
<b>DBP(mmHg)</b>	65.6 ± 12.3	72.0 ± 10.4	73.4 ± 13.0	0.070
<b>HR (bpm)</b>	65.7 ± 12.5	70.8 ± 17.3	64.3 ± 12.7	0.159

# Baseline Characteristics

	All patients (n=49)	MV Repair (n=25)	Control (n=24)	P value
<b>Cardiac Surgery</b>				
Robotic mitral repair		9		
Stenectomy mitral repair		16		
CABG			8	
AVR			9	
Myectomy			5	
Aneurysm repair			2	

# 2D TTE: PRE vs CONTROL

	Pre OP	Control	P value
LVEF (%)	64.9 ± 4.5	64.4±6.1	0.758
LVEDD (mm)	56.7±0.7	48.9±6.3	<0.0001
LVESD (mm)	34.8±2.5	30.2±5.9	0.0036
LV mass index	134.1±39.2	135.7±49.4	0.9027
LAVI	55.2±12.8	40.6±14.7	0.0006
Cardiac output index	2.88±0.5	3.41±0.91	0.0291
E/A	1.5±0.4	1.18±0.6	0.0598
E/E' (medial)	15.3±6.7	15.7±6.9	0.852
RVSP (mmhg)	32.7±14.4	34.1±7.7	0.7041
Regurgitation velocity(cm/sec)	5.5±0.6		
Reg TVI (cm)	166.7±31.4		
2D MR PISA radius (cm)	0.96±0.18		
Aliasing velocity (cm/s)	44.8±12.0		
Reg Flow	261.7±89.2		
2D EROA(cm <sup>2</sup> )	0.48±0.17		

# 2D TTE: PRE vs POST

	Pre OP	POST	P value
LVEF (%)	64.9 ± 4.5	57.9±5.8	0.0999
LVEDD (mm)	56.7±0.7	51.0±5.2	0.0834
LVESD (mm)	34.8±2.5	35.0±4.7	0.1076
LV mass index	134.1±39.2	107.5±31.1	0.2005
LAVI	55.2±12.8	48.5±23.0	0.2045
Cardiac output index	2.88±0.5	3.3±0.5	0.1475
E/A	1.5±0.4	1.4±0.6	0.2219
E/E' (medial)	15.3±6.7	22.6±7.1	0.4018
RVSP (mmhg)	32.7±14.4	31.1±4.7	0.6651
Post op max MVA	-	2.8±0.0.6	
Post OP mean MVPG	-	3.4±2.1	
Post OP HR	-	69.5±15.7	



# Intra op TEE and OP finding

	Pre OP
<b>Bileaflet prolapse</b>	7
<b>Prolapse at A1 (%)</b>	2(8)
<b>Prolapse at A2 (%)</b>	7(28)
<b>Prolapse at A3 (%)</b>	4(16)
<b>Prolapse at P1 (%)</b>	5(20)
<b>Prolapse at P2 (%)</b>	18(72)
<b>Prolapse at P3 (%)</b>	3(12)
<b>Chordae tendineae rupture</b>	18(72)
<b>Cleft noted by 2D TEE</b>	6(24)
<b>Cleft noted by op</b>	11(44)
<b>Pathology of resected mitral valve</b>	
<b>Myxomatous change</b>	23
<b>Fibrotic change</b>	2
<b>Robotic mitral repair</b>	9
<b>Stenectomy mitral repair</b>	16
<b>Neo-chordae repair</b>	6

# 3D measures (2)

	PRE (n=25)	CONT (n=24)	P value	POST (n=25)	CONT (n=24)	P value
Mean CW (mm) (systole)	25.3±5.0	19.9±3.1	<0.000 1	20.1±3.0	19.9±3.1	0.8201
Mean CW (mm) (diastole)	31.8±5.3	25.7±3.3	<0.000 1	22.9±3.6	25.7±3.3	0.0055
Mean IT (mm) (systole)	27.9±3.9	24.6±3.2	0.0021	21.2±2.3	24.6±3.2	<0.000 1
Mean IT (mm) (diastole)	28.4±4.2	25.5±2.7	0.0076	21.4±2.3	25.5±2.7	<0.000 1

CW: Commissural width  
IT: Inter-trigone

# 3D measures: Annular Height Distortion

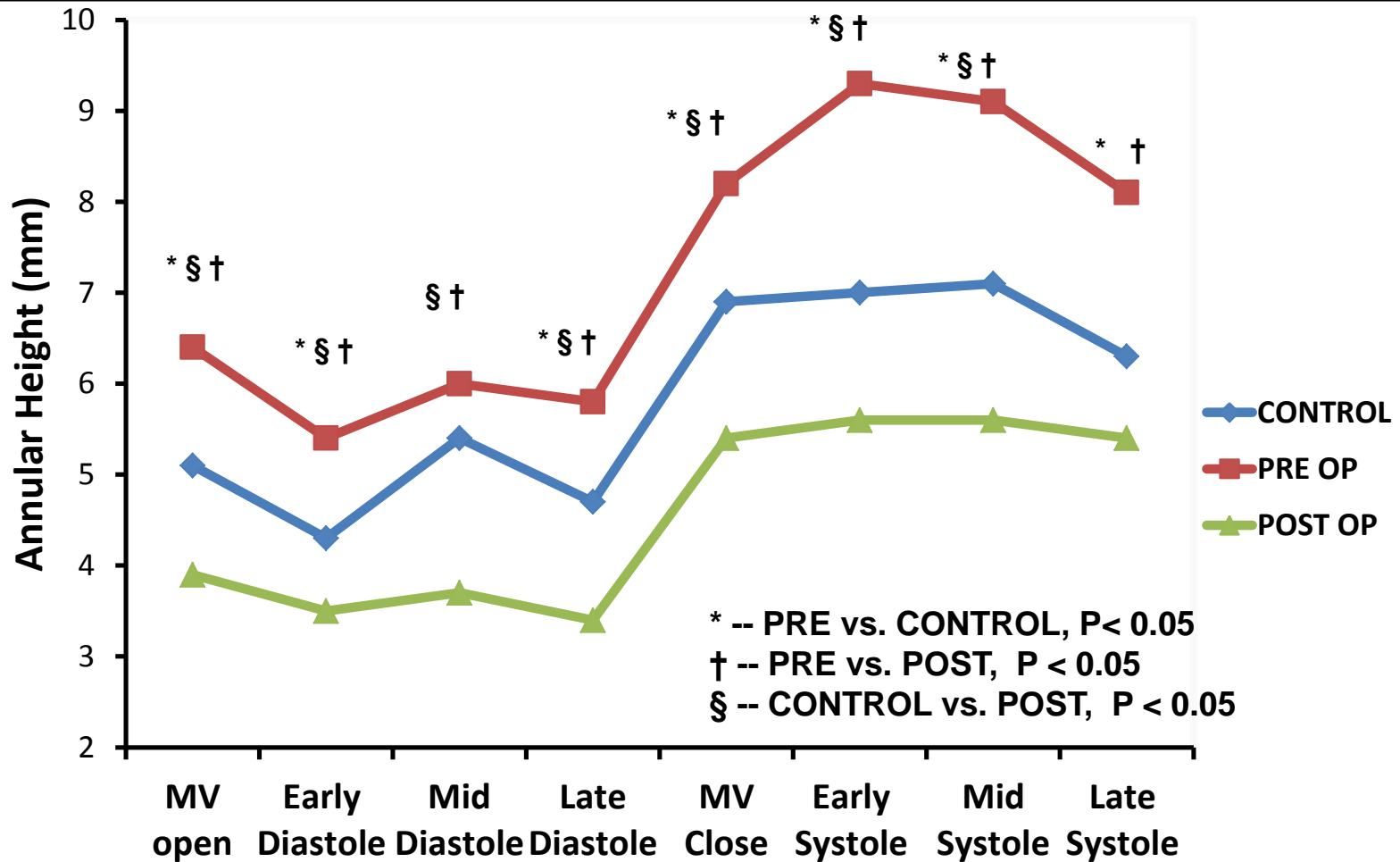
	<b>PRE (n=25)</b>	<b>CONT (n=24)</b>	<b>P value</b>	<b>POST (n=25)</b>	<b>CONT (n=24)</b>	<b>P value</b>
<b>Mean AH mm (systole)</b>	<b>8.7±2.4</b>	<b>6.8±1.6</b>	<b>0.002 2</b>	<b>5.6±1.1</b>	<b>6.8±1.6</b>	<b>0.0030</b>
<b>Mean AH Mm (diastole)</b>	<b>5.9±1.6</b>	<b>4.9±0.9</b>	<b>0.012 4</b>	<b>3.6±0.7</b>	<b>4.9±0.9</b>	<b>&lt;0.000 1</b>
<b>Max AH</b>	<b>9.9±2.5</b>	<b>7.5±1.8</b>	<b>0.000 3</b>	<b>6.2±1.2</b>	<b>7.5±1.8</b>	<b>0.0048</b>
<b>Min AH</b>	<b>4.8±1.5</b>	<b>4.1±0.9</b>	<b>0.048 2</b>	<b>3.0±0.7</b>	<b>4.1±0.9</b>	<b>&lt;0.0001</b>
<b>AH Distortion ( Max AH – min AH)</b>	<b>5.1±1.7</b>	<b>3.4±1.4</b>	<b>0.000 4</b>	<b>3.3±1.0</b>	<b>3.4±1.4</b>	<b>0.6653</b>

# 3D measures :

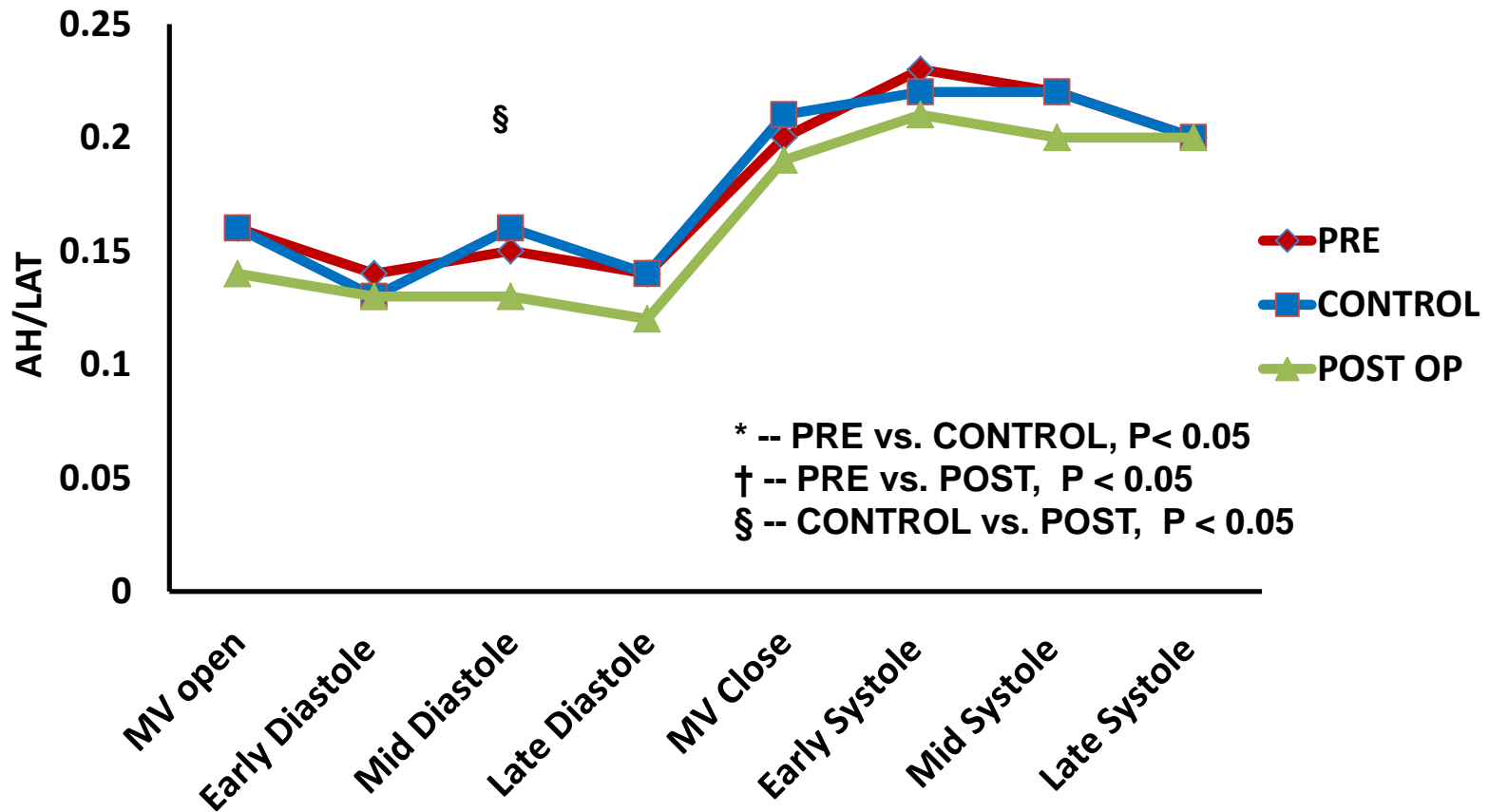
	PRE (n=25)	CONT (n=24)	P value	POST (n=25)	CONT (n=24)	P value
<b>AHCWR (systole)</b>	<b>0.35±0.07</b>	<b>0.35±0.09</b>	0.8266	<b>0.28±0.07</b>	<b>0.35±0.09</b>	0.0055
<b>AHCWR (diastole)</b>	<b>0.19±0.05</b>	<b>0.20±0.05</b>	0.6620	<b>0.17±0.05</b>	<b>0.20±0.05</b>	0.0335
<b>AH/Lat-D (systole)</b>	<b>0.21±0.04</b>	<b>0.21±0.05</b>	0.8578	<b>0.21±0.04</b>	<b>0.21±0.05</b>	0.5168
<b>AH/Lat-D (diastole)</b>	<b>0.15±0.03</b>	<b>0.15±0.03</b>	0.8814	<b>0.13±0.04</b>	<b>0.15±0.03</b>	0.0568



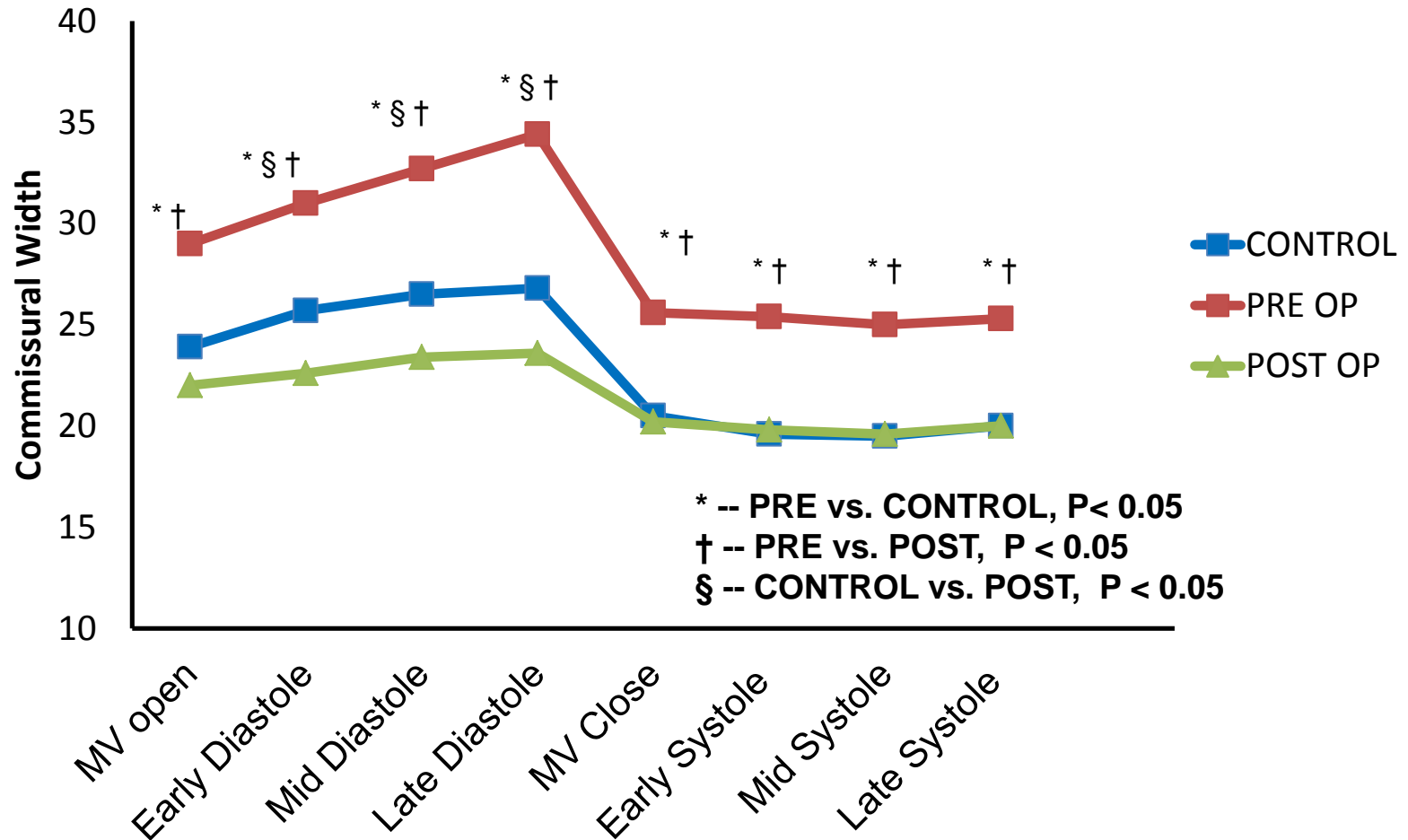
# Sequential Assessment of Annular Height



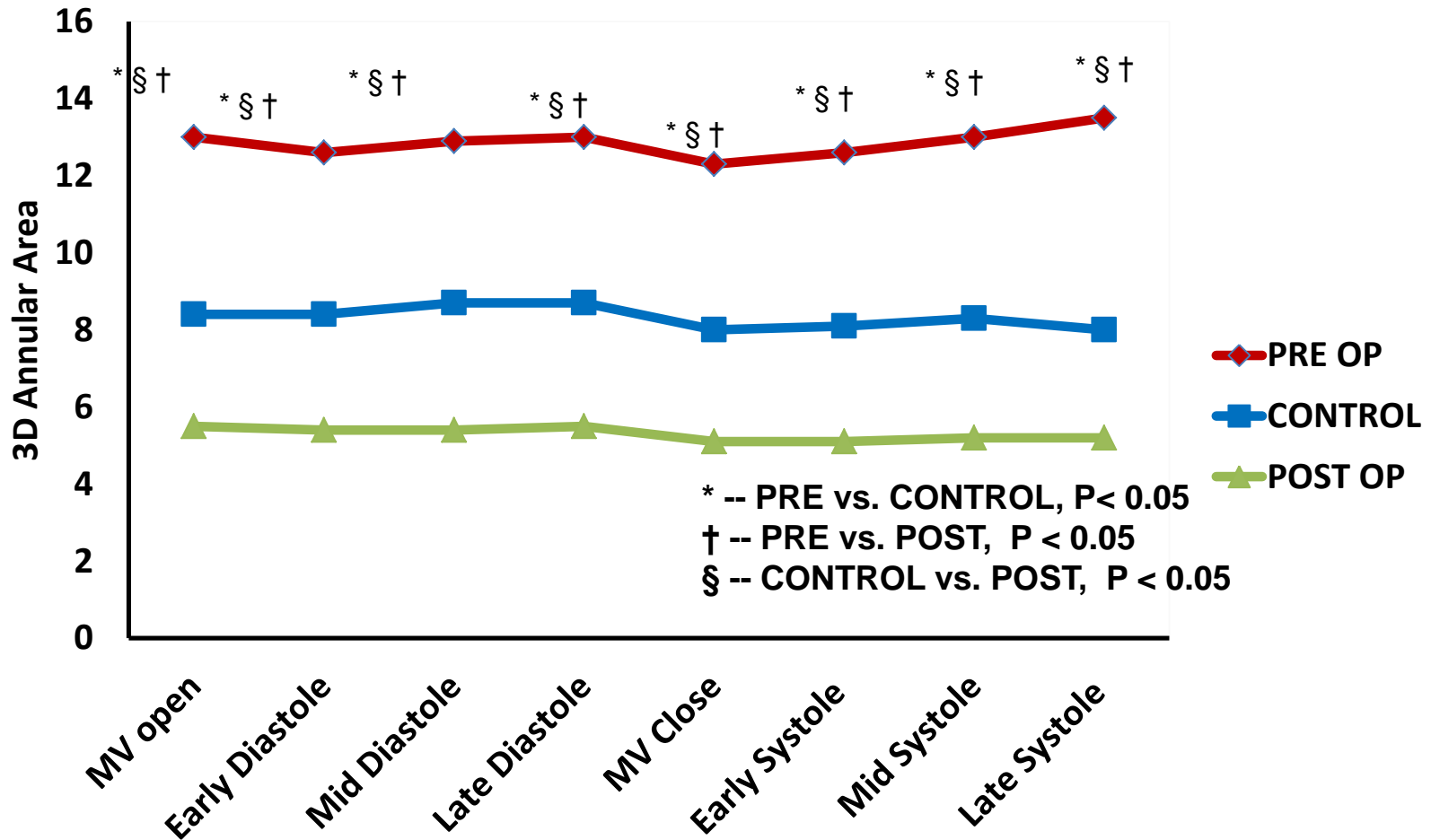
# Sequential Assessment of AH/LAT Diameter



# Sequential measure of Commissural Width

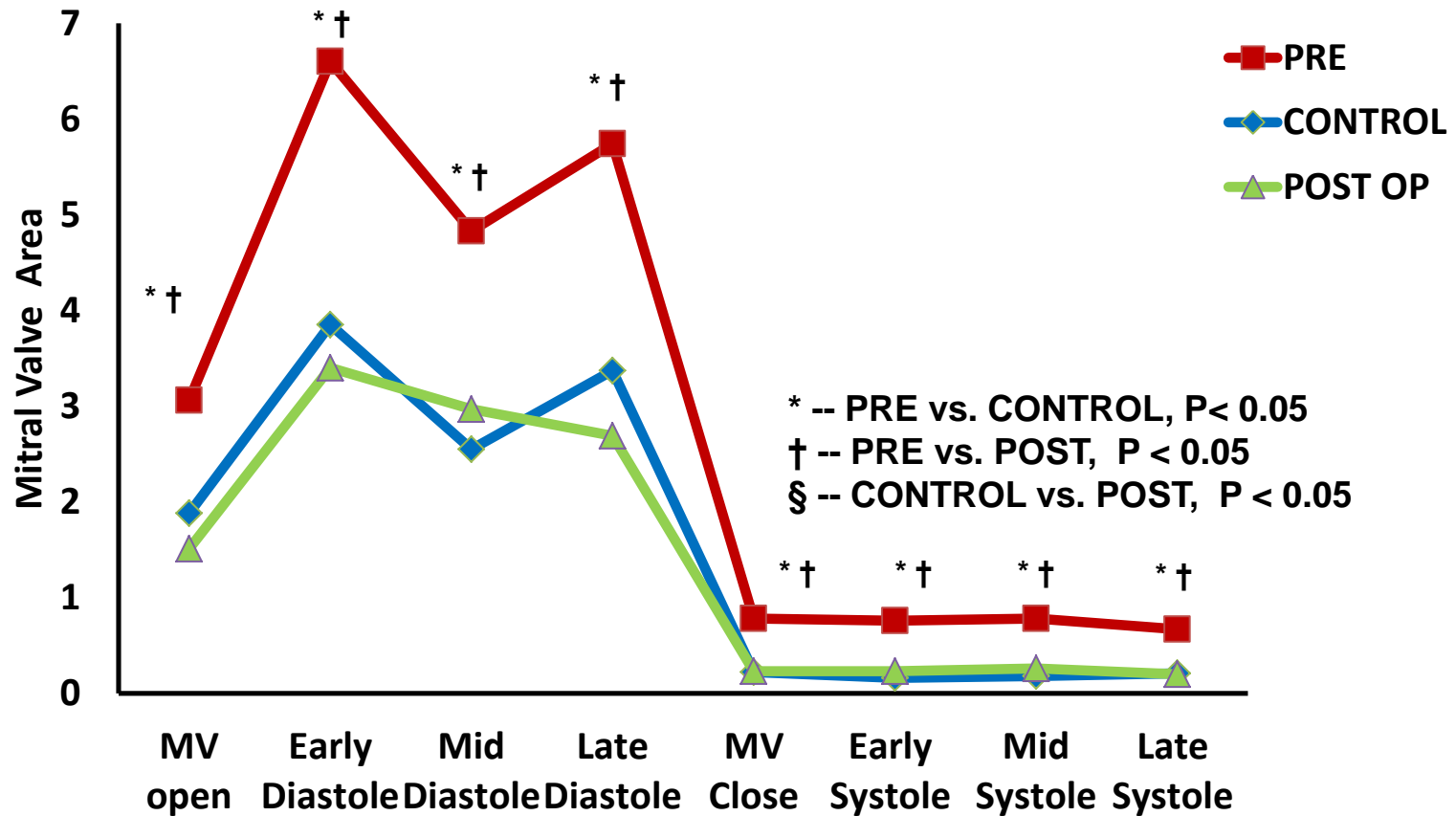


# Sequential measure of 3D annular area



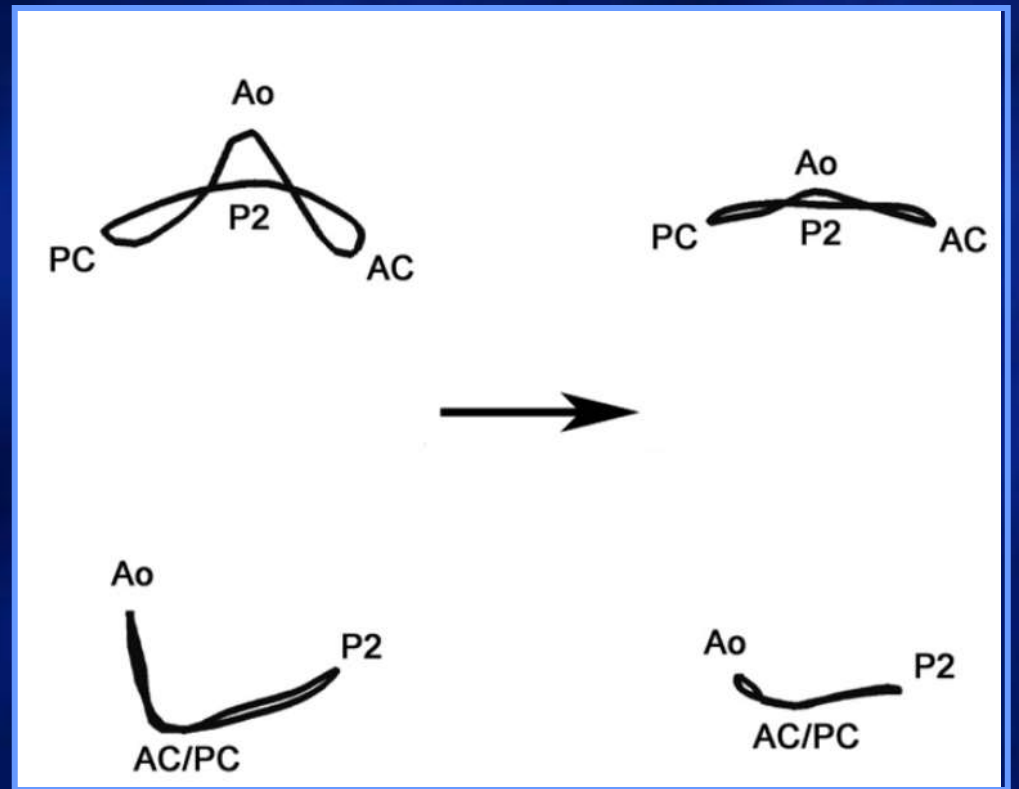
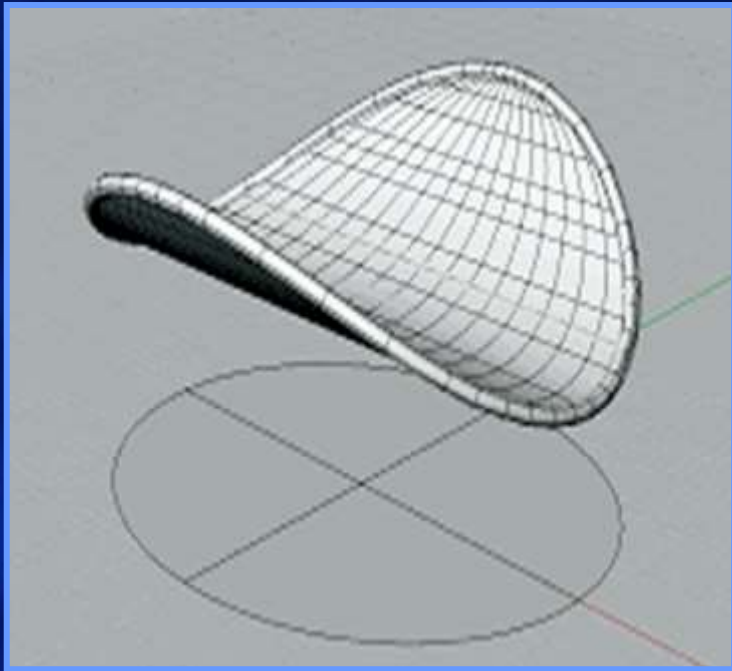


# Sequential measures of MVA



# Conclusion

- **The early accentuation of mitral annulus, or the saddle shape remains contact in patient with severe MR caused by myxomatous change with normal LVEF.**
- **Mitral valve repair and annuloplasty in those patient restore normal annulus dynamics, although the annular profile becomes smaller post-operatively.**



- **Sequential geometric assessment of valvular disease by Intra-op 3D TEE delineate mitral valve annular dynamics thus promises a complete and idea surgical design.**



# Thank You

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