



3D TEE MV Acquisition, Manipulation and Quantitative Assessment

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Perioperative Interactive Education
<http://pie.med.utoronto.ca/TEE/>



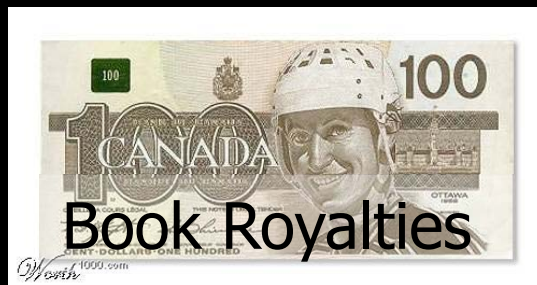
Outline



1. MV 3D Datasets
2. Acquisition
3. Optimization
4. Manipulation
5. Measurements

3D MV Analysis

- Angled views
- 3D live views
- Layout views
- Cropping
- MPR
- i-slice
- MV models



MV TEE 3D What Is It Good For



Anatomy + Function

- Mechanisms

Diagnose Pathology

- Prolapse, clefts
- Lesion location (MR)
- Lesion severity (MR)

Quantification

- Linear, MV area (MS)
- MR vena contracta area
- Models → #####

Procedural Guidance

Real-Time Three-Dimensional Transesophageal Echocardiography in the Intraoperative Assessment of Mitral Valve Disease

Grewal et al Journal of the American Society of Echocardiography Volume 22 Number 1 January 2009

Table 3 Detection of mitral valve pathology with 2D and live 3D transesophageal echocardiography compared with surgical findings

Characteristic	Sensitivity (%)		Specificity (%)		Accuracy (%)	
	2D	3D	2D	3D	2D	3D
P1	86	100	86	100	86	100*
P2	90	100	86	91	88	95
P3	63	100	82	94	79	93
A1	100	100	100	100	100	100
A2	78	100	88	100	84	100*
A3	0	100	92	97	86	98*
Bileaflet disease	77	100	89	100	86	100*
Chord rupture	95	95	91	91	93	95
Ischemic MR	60	80	100	100	95	98

* $P < .05$, 3D versus 2D transesophageal echocardiography.

MV 3D TEE How to Manipulate



No Special Software

- MV datasets/modes
- Display optimization
- En Face view
- Angled views
- Cropping

Specialized Software

- MPR
- i-slice
- MV models

A Framework for Systematic Characterization of the
Mitral Valve by Real-Time Three-Dimensional
Transesophageal Echocardiography

Ernesto E. Salcedo, MD, Robert A. Quaife, MD, Tamas Seres, MD, and John D. Carroll, MD, *Denver, Colorado*

J Am Soc Echocard 2009;22:1087-99.

MV TEE 3D Datasets Modes

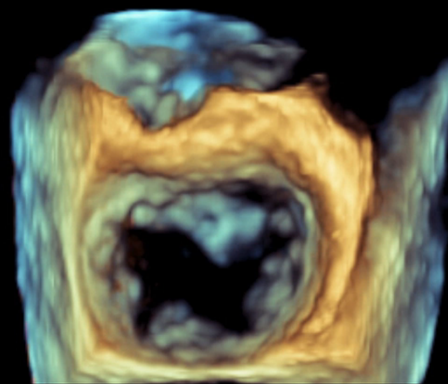


Spatial vs Temporal Resolution vs Size

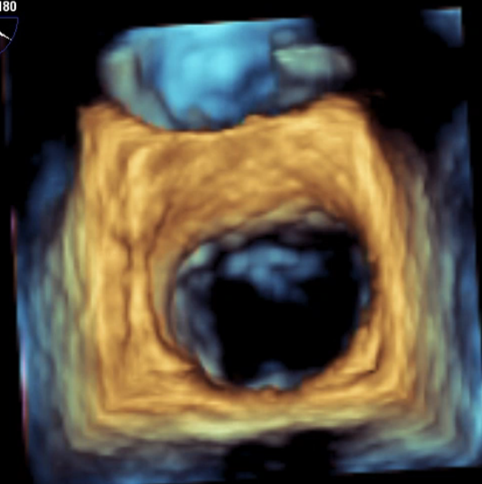
Live
10Hz



Zoom
13Hz



Full Volume
43Hz

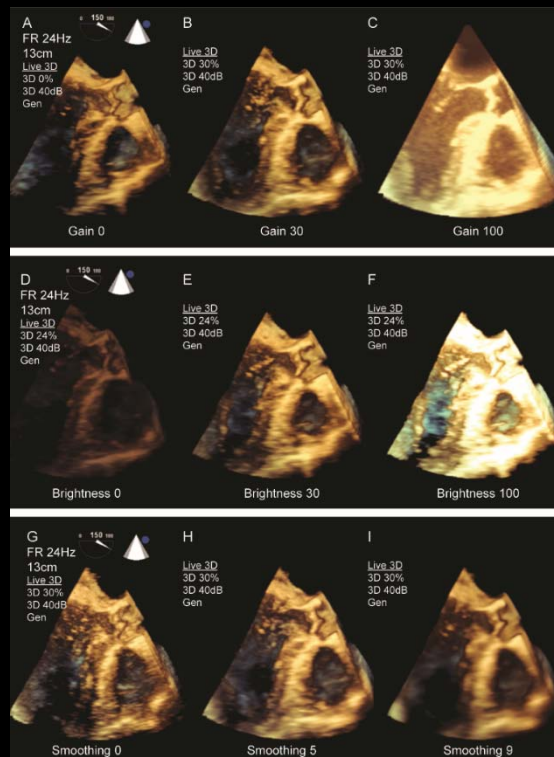


Lang RM, et al. JASE 2012;25:3-46.



MV TEE 3D Datasets Optimization

- Gain
- Brightness
- Smoothing
- Compression
- Vision
- Chroma

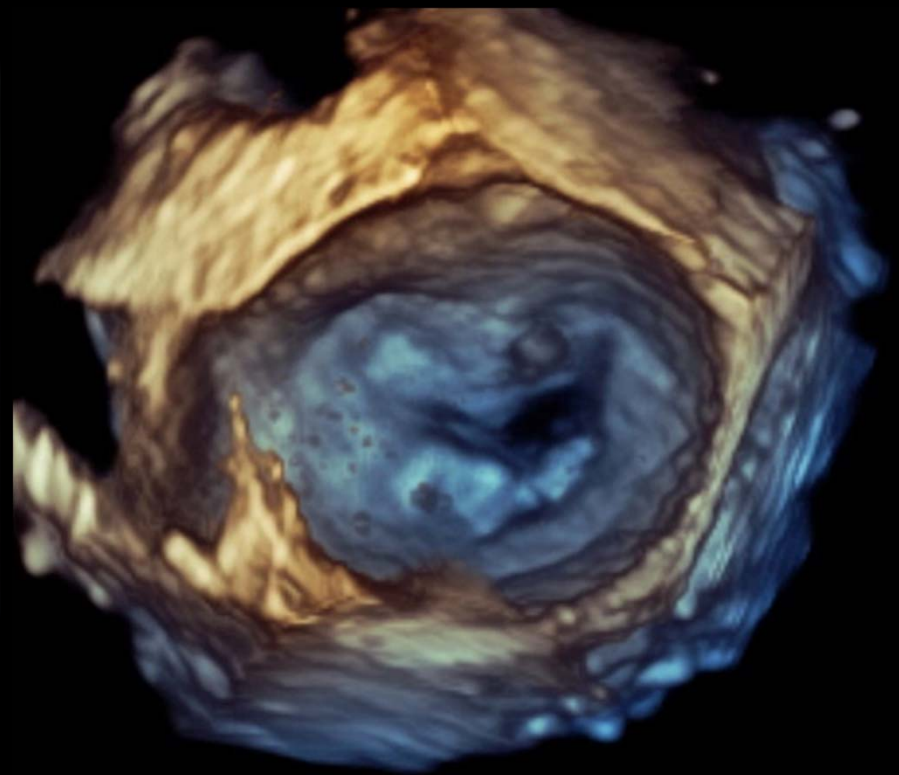
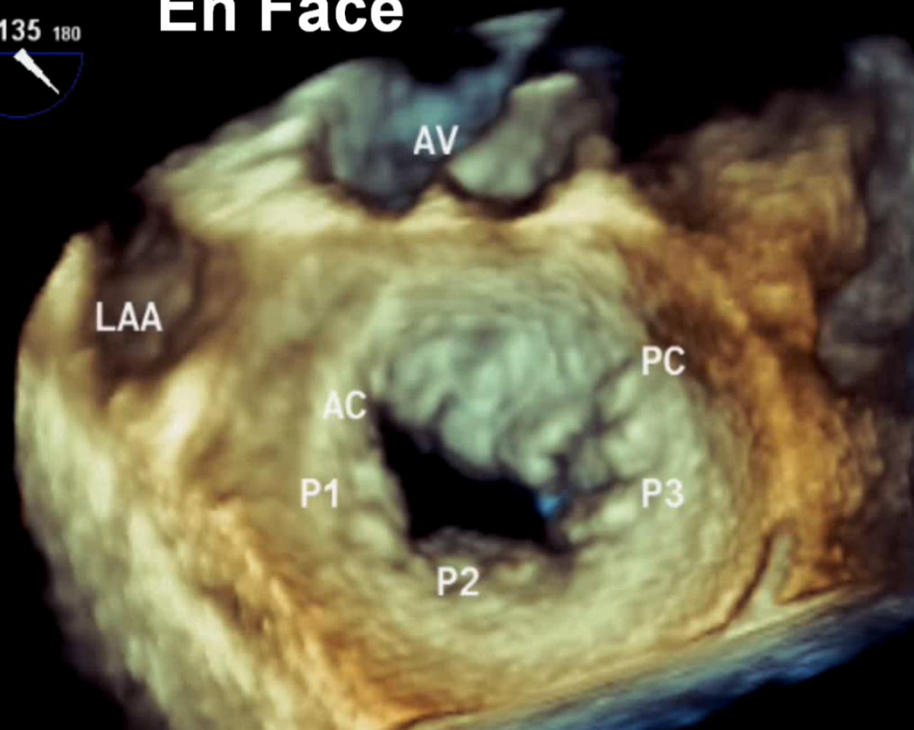


Vegas A, et al. Real-Time Three-Dimensional Transesophageal Echocardiography Springer, New York.

MV TEE 3D Imaging Display



En Face



Lang RM, et al. JASE 2012;25:3-46.

Mahmood F, et al. Anesth Analg 2012;115:779-84.

MV TEE 3D Imaging Dual Display



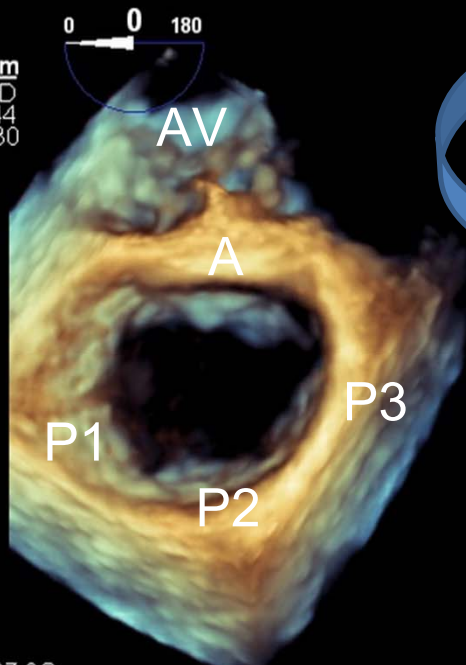
Adult Echo
X7-2t
12Hz
7.5cm

3D Zoom
2D / 3D
% 46 / 44
C 50 / 30
Gen

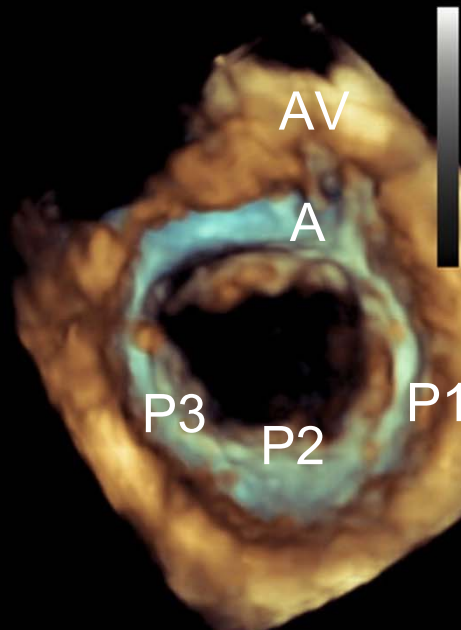
3D Beats 1

TIS 0.1 MI 0.3

M4



LA View



LV View

PAT T: 37.0C
TEE T: 39.1C

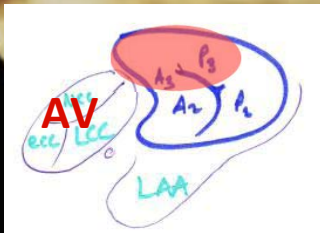
54 bpm

MV TEE 3D Angled Views

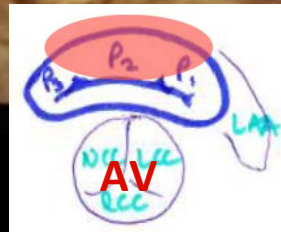


Counter-clockwise **Z rotation** of en-face view

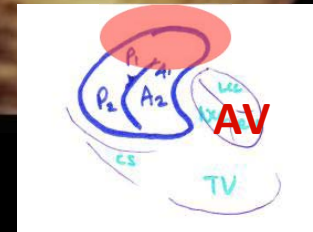
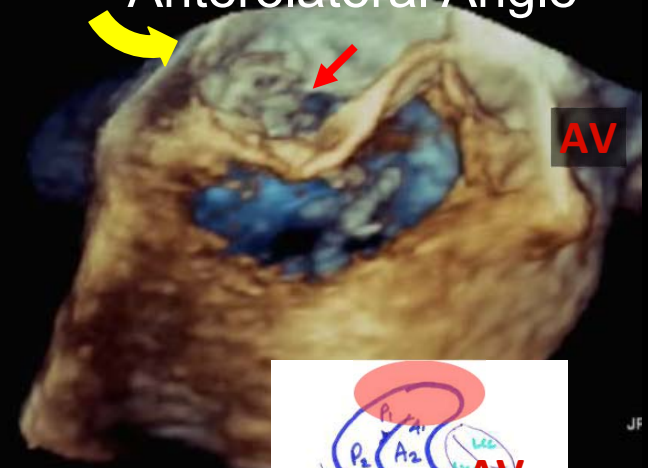
↶ Posteromedial Angle



↶ Scallop Angle

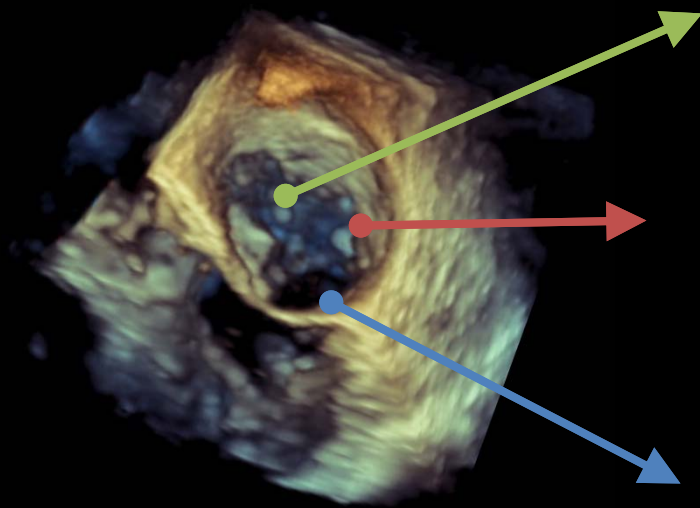


↶ Anterolateral Angle

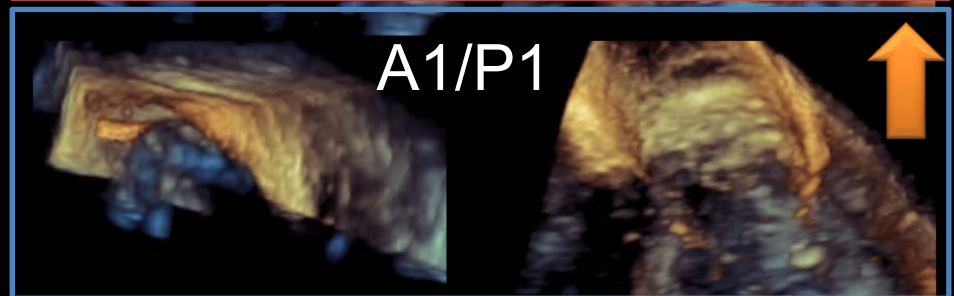
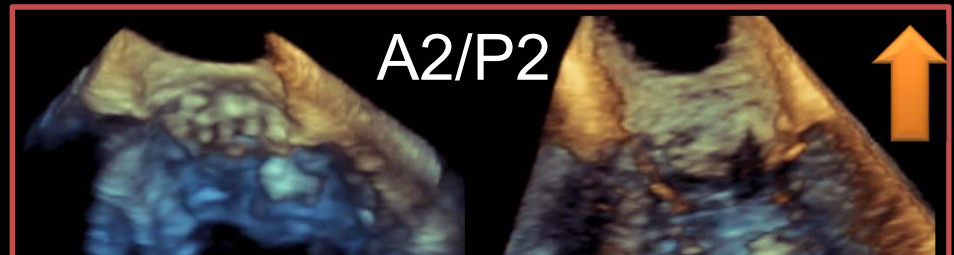
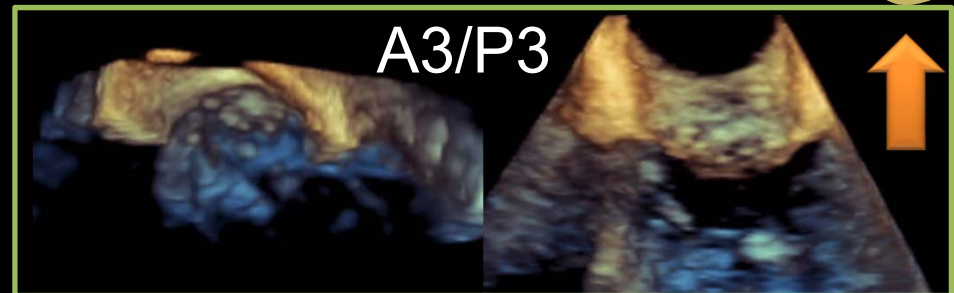


Biaggi P, et al. JACC Cardiovasc Imaging 2011;4:94-7.

MV 3D Live Views

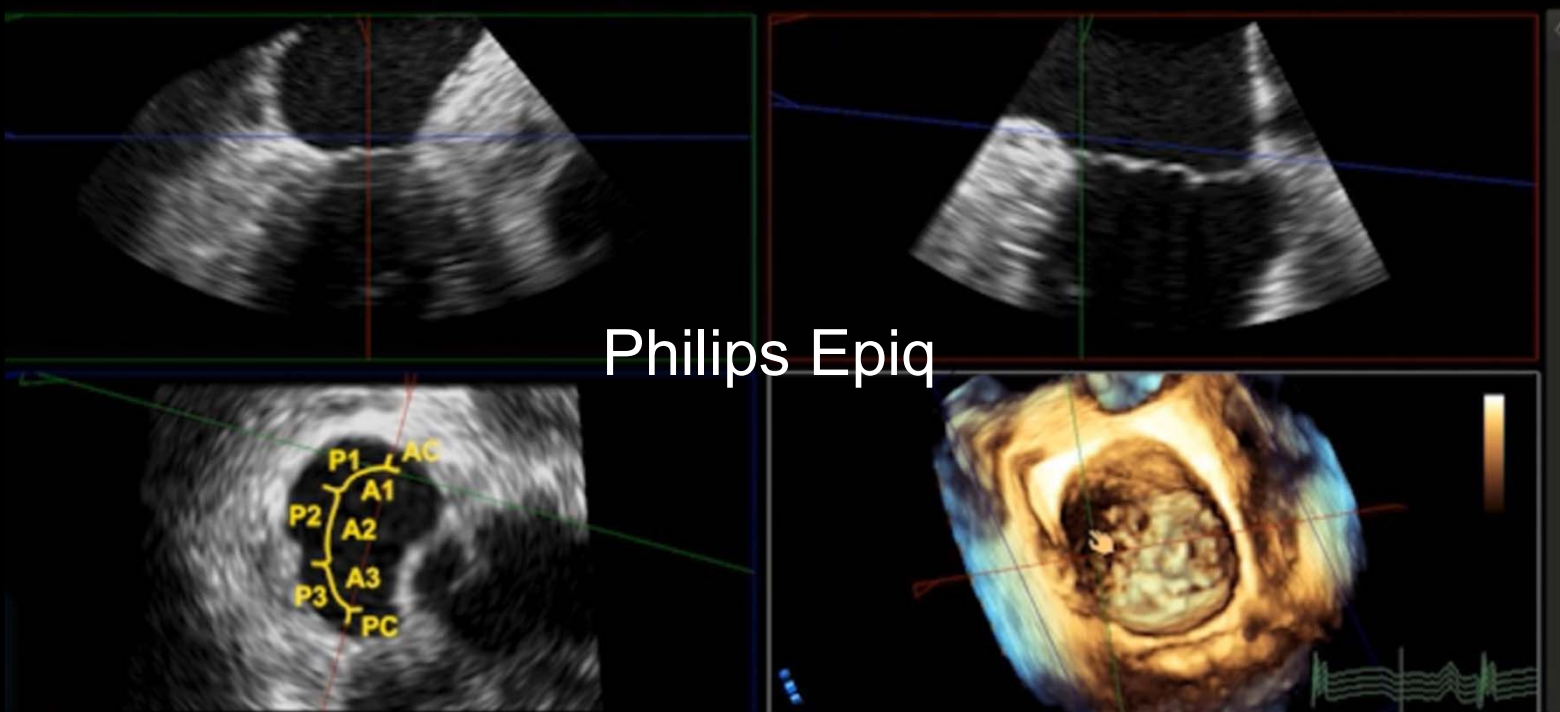


No Special Software
Elevational width



MV 3D Layout Views

No Special Software

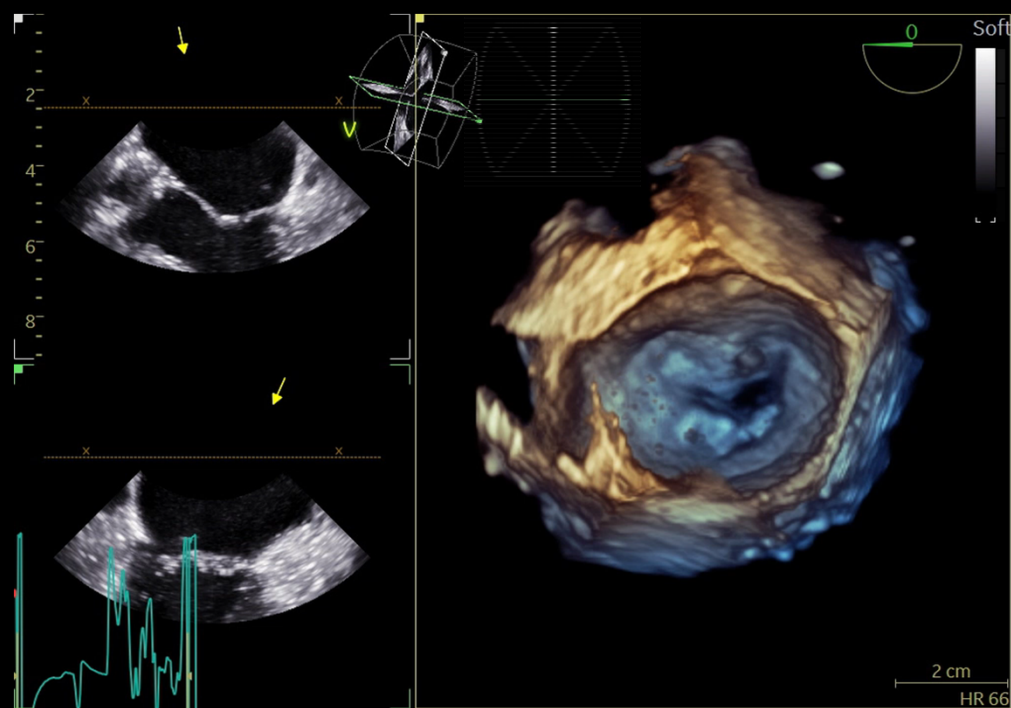


<https://pie.med.utoronto.ca>

MV 3D Flexislice (MPR)

No Special Software

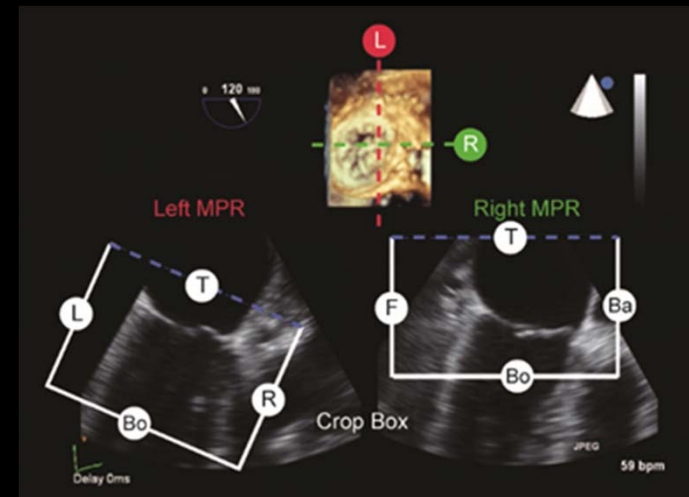
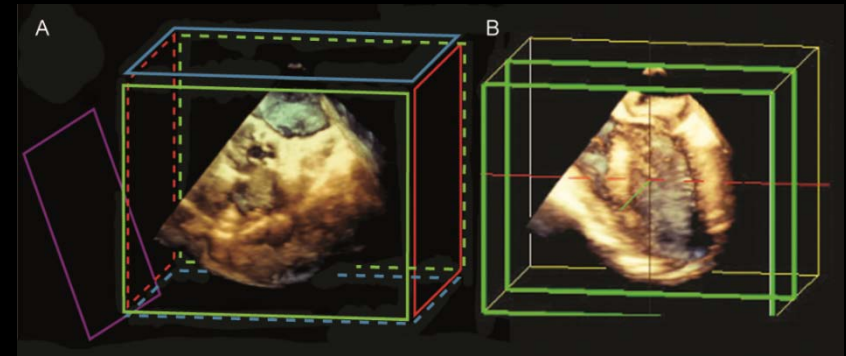
GE Vivid 9



MV TEE 3D Cropping Techniques



- Reset crop: Full dataset
- Auto crop: 50% removed
- Box crop: predefined planes
- Plane crop: movable plane
- i crop: adjustable box

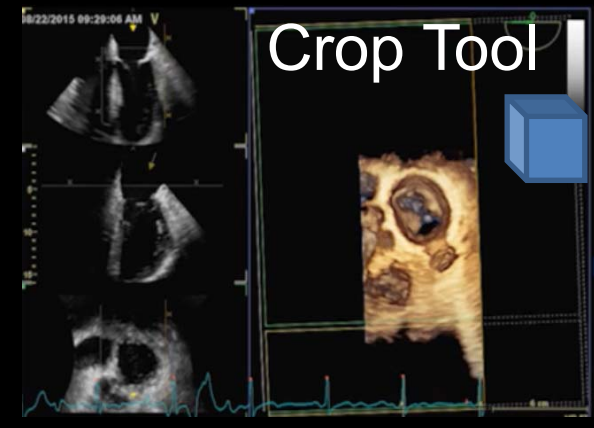
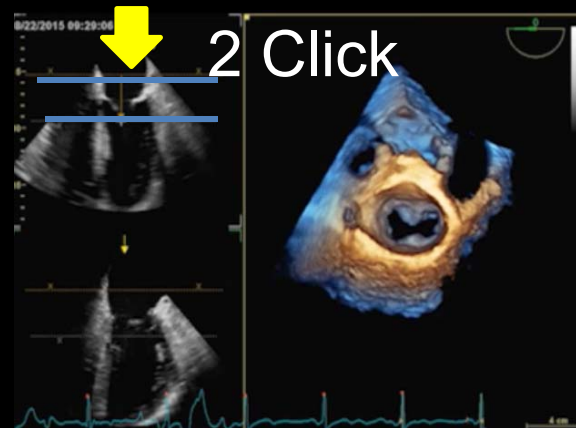
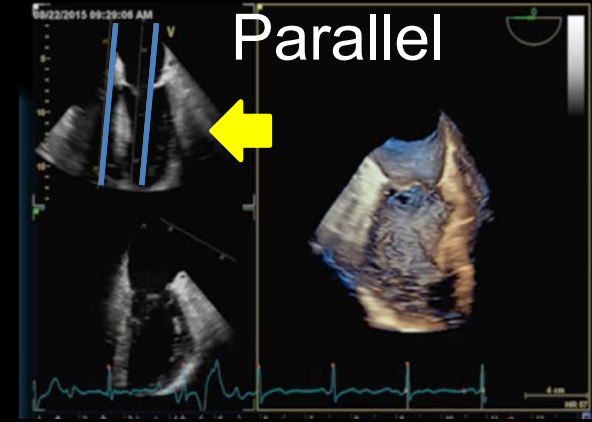
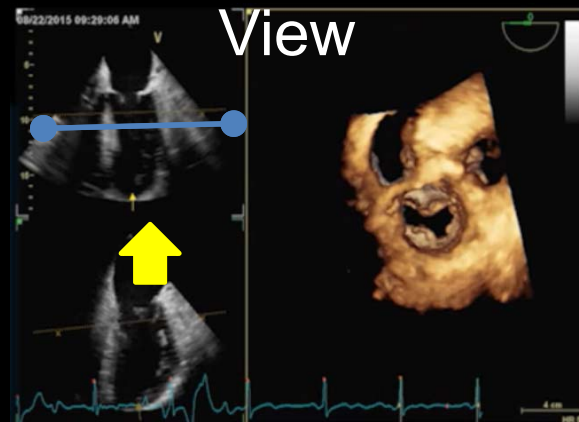


Vegas A, et al. Real-Time Three-Dimensional Transesophageal Echocardiography Springer, NY.

MV TEE 3D Cropping Techniques



- View crop
- Parallel crop
- 2 Click crop
- Crop Tool



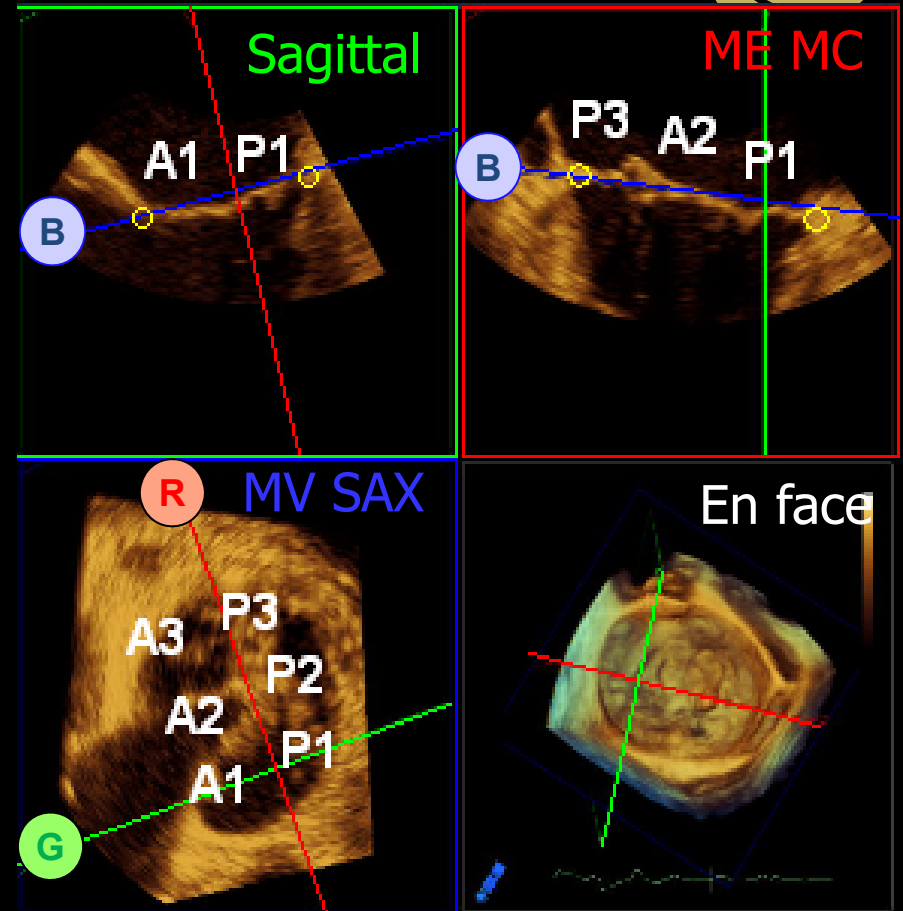
<https://pie.med.utoronto.ca>

MV TEE 3D MPR

Specialized Software (3DQ, MVN)

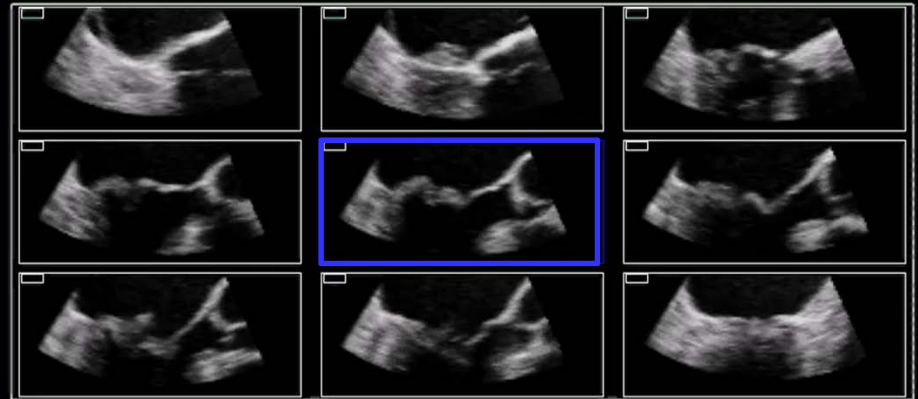
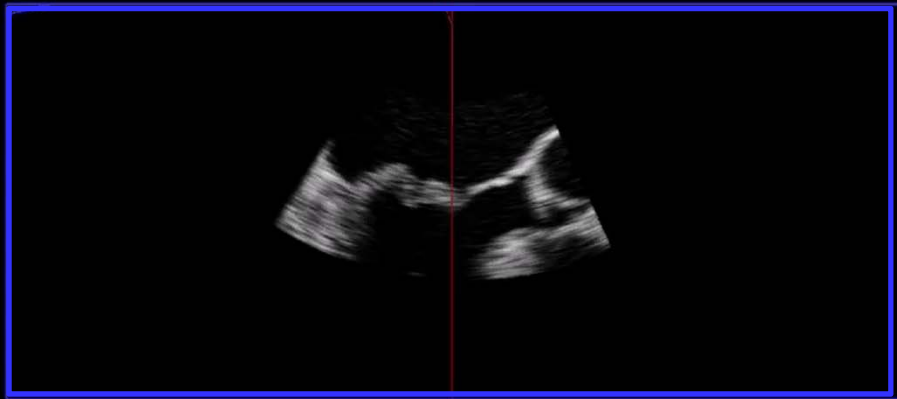
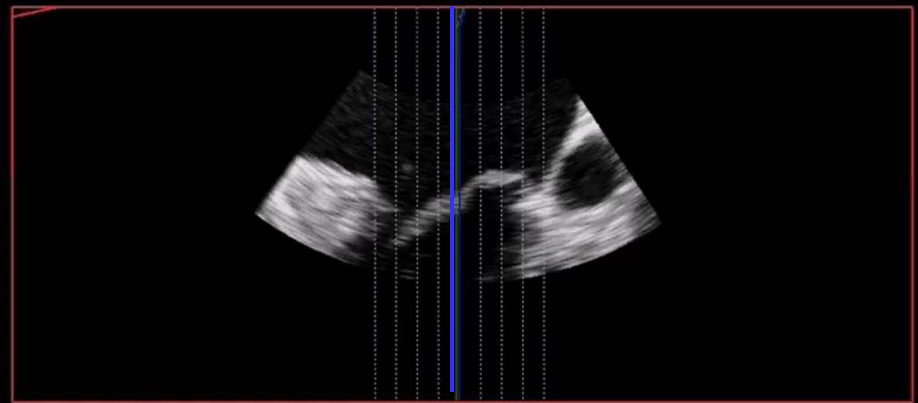
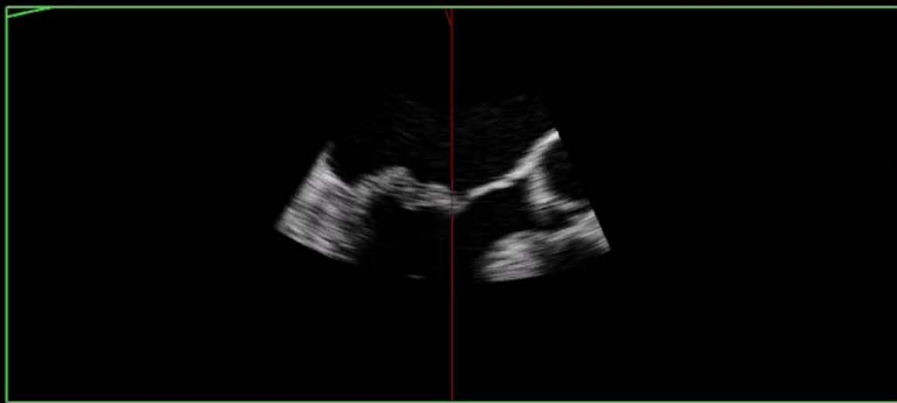
- Multiplanar reconstruction
- End-systole frame
- Leaflet motion to annulus related to SAX of MV

1. Blue pane MV SAX
2. Red pane MC view
3. Green pane sagittal cut thru MV



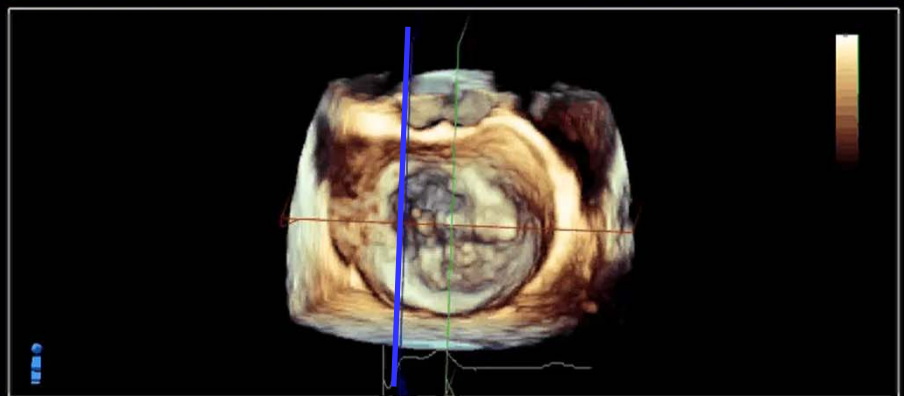
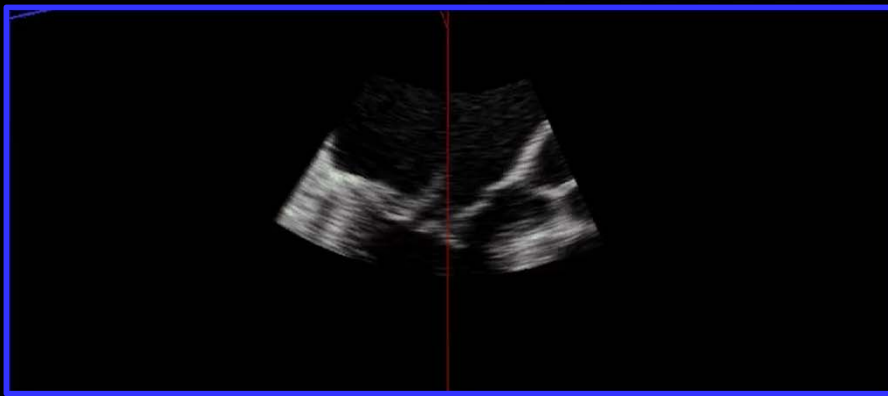
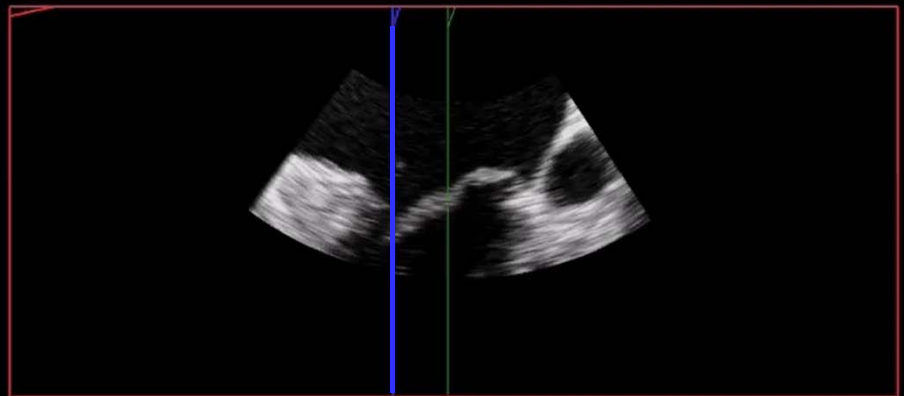
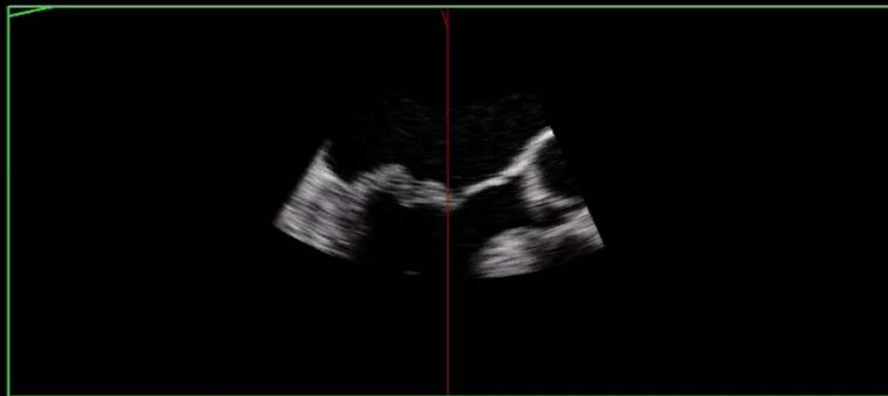
MV TEE 3D MPR i-Slice

Specialized Software 3DQ, MVN



MV TEE 3D MPR i-Slice

Specialized Software (3DQ, MVN)

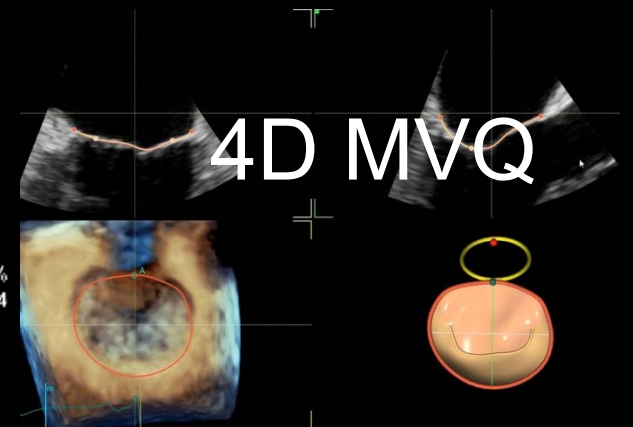
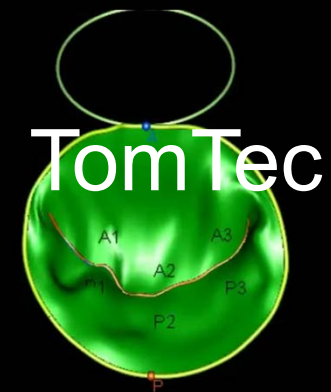
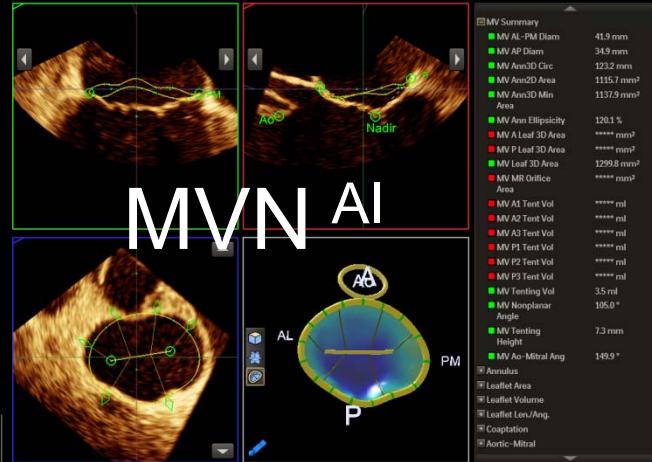


MV TEE 3D Models



Special Software

Dynamic
Static
Quantification

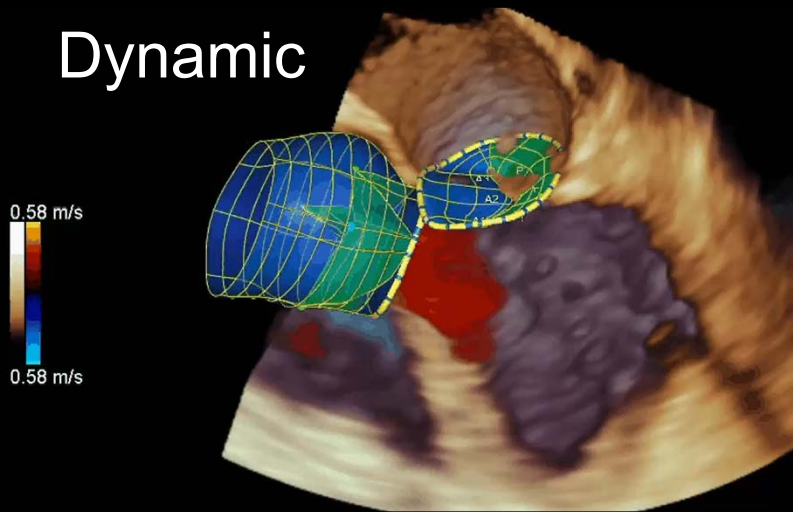


100%
1/14

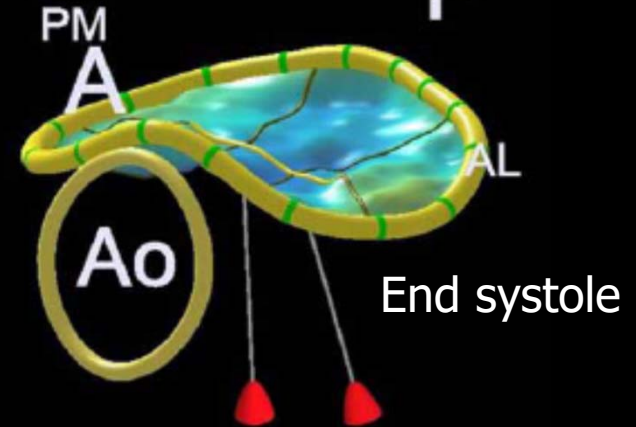
MV Annulus Anatomy 3D Models



Dynamic



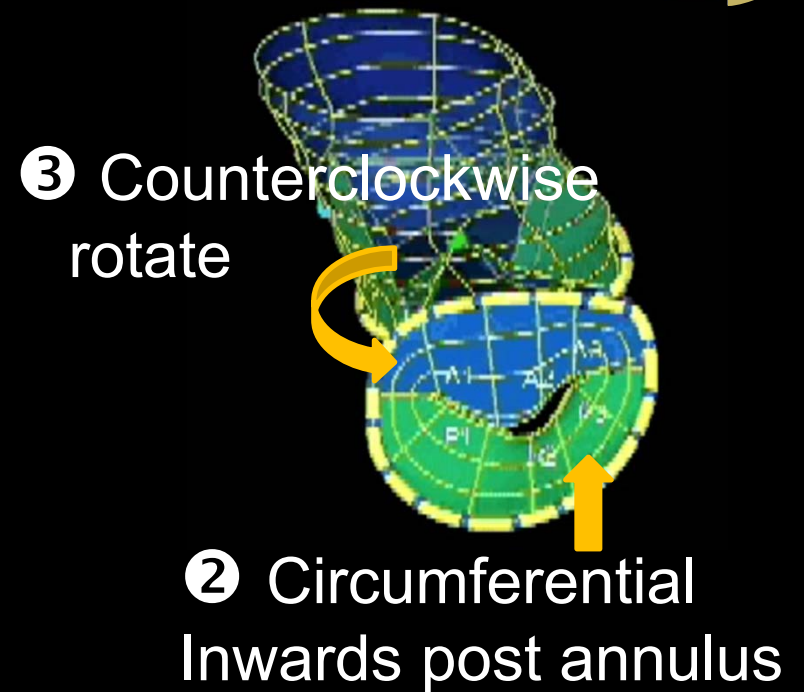
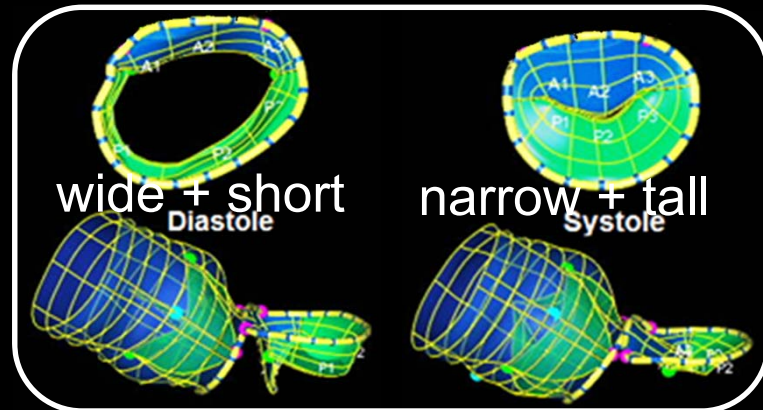
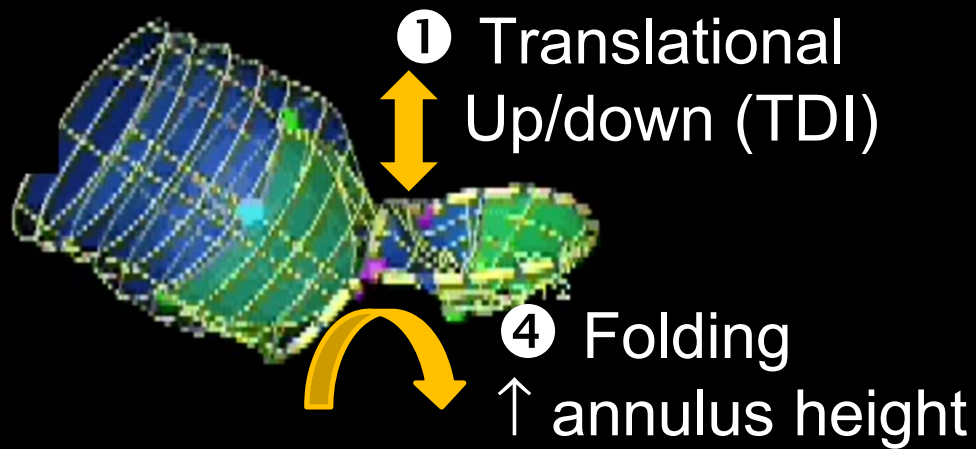
Static Parametric P



Saddle shape

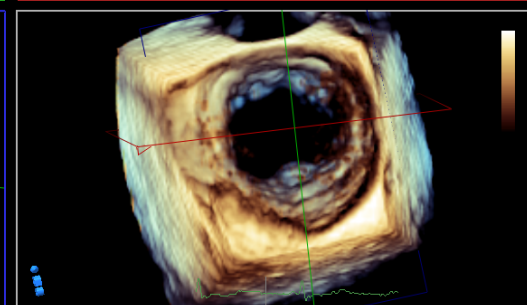
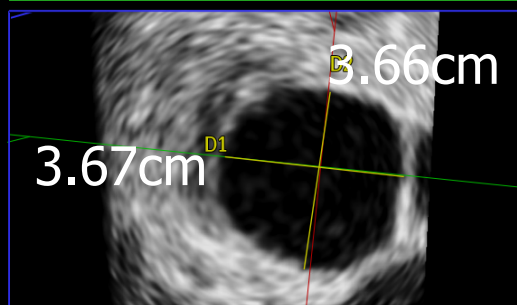
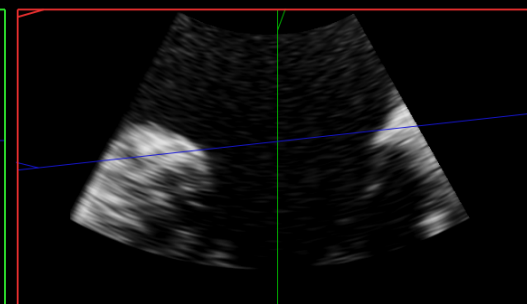
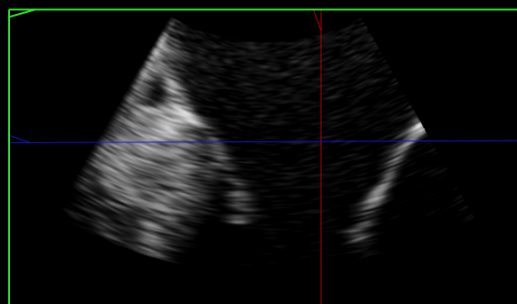
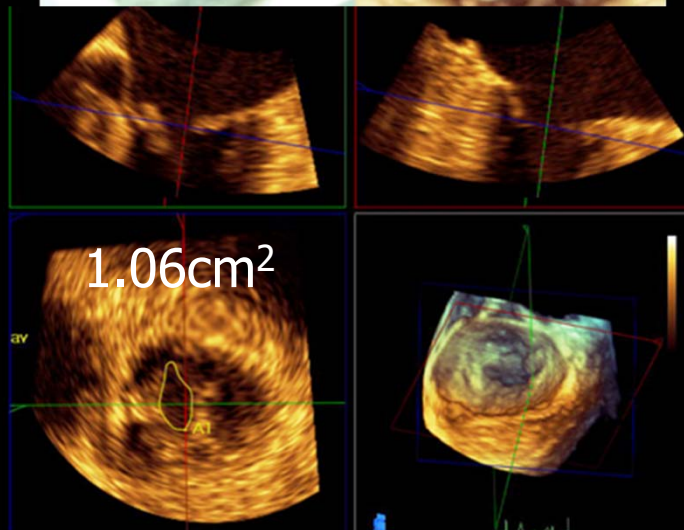
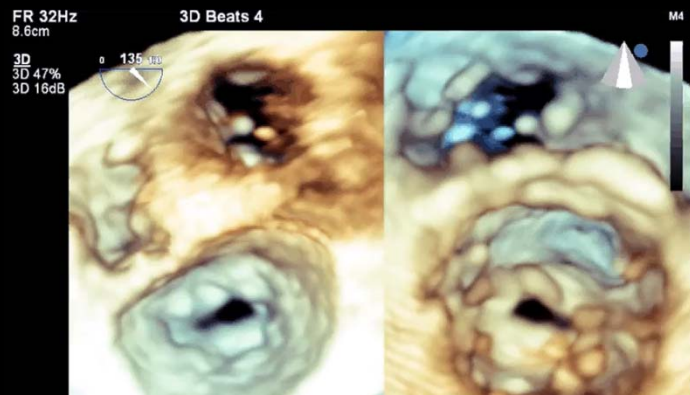
- High + low points
- Annulus height
- Reduce leaflet stress

MV Function Annulus Motion



Mahmood F, et al.
Anesth Analg 2015;121:34-58.

MV 3D TEE MPR Area/Annulus

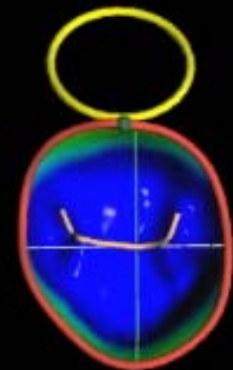
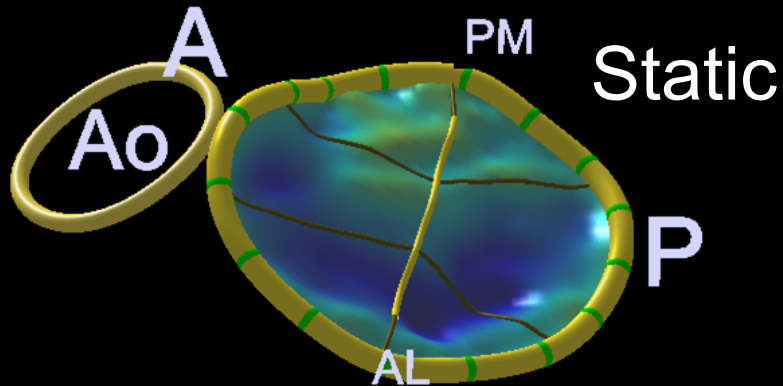
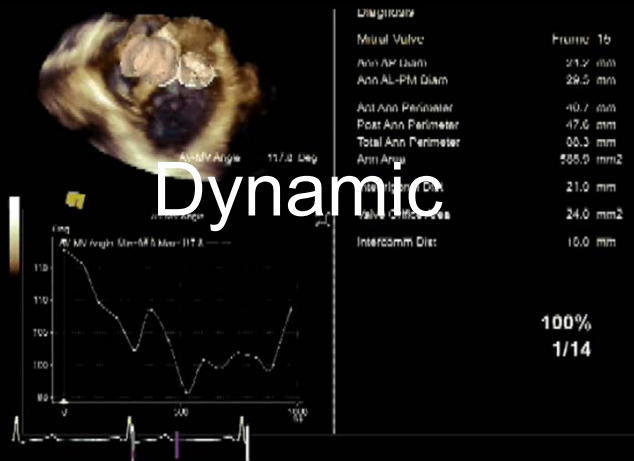


MV Annular Measurements

MV Measurements 3D Models



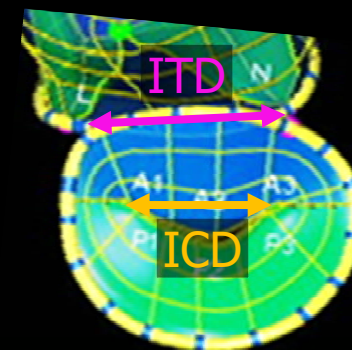
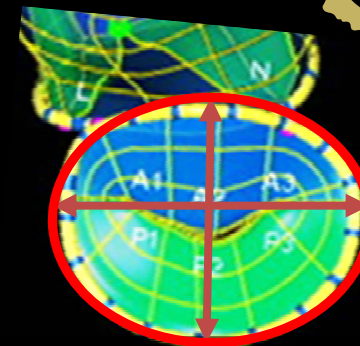
Linear	Volume/Area	Annulus
Diameter	Leaflet area	Annulus Height
Length	Tenting	AH/ICD
Circumference	Prolapse	Aorto-mitral angle
		Non-planarity angle



MV 3D Model Quantification

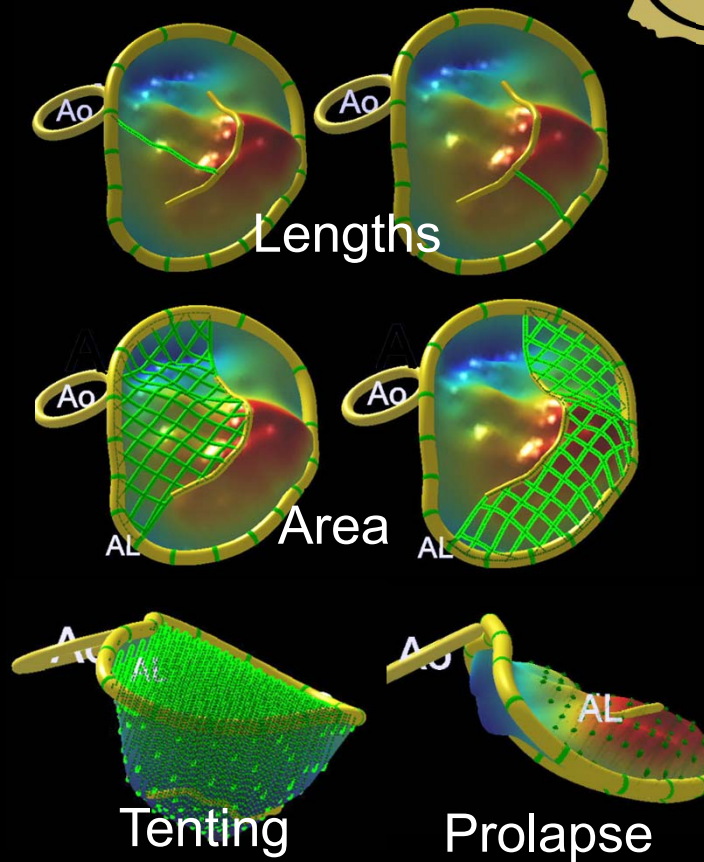
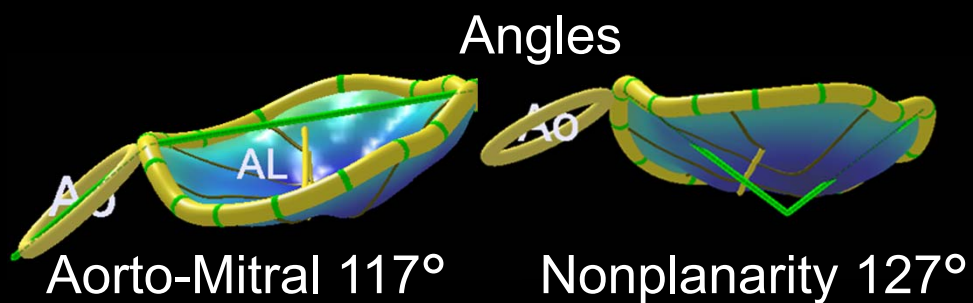
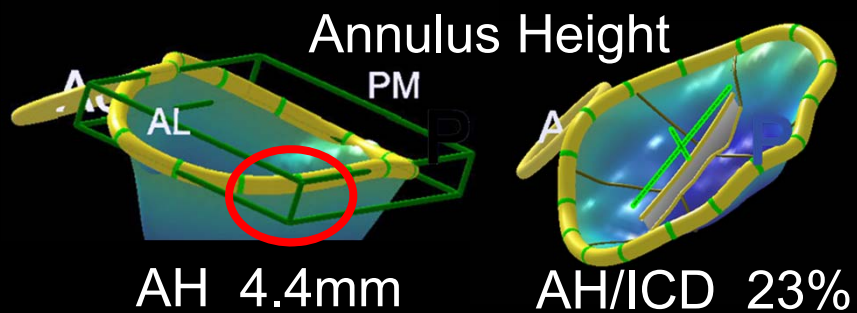


Normal Linear Measures at end systole	mm/m ² BSA
AP diameter	16.4 ± 1.3
ML diameter	
Anterior Leaflet Length	13.4 ± 1.0
Posterior Leaflet Length	7.8 ± 0.7
Circumference	57.8 ± 3.4
Inter-commissural distance (ICD)	18.7 ± 1.7
Intertrigonal distance (ITD)	



Munin MA, et al. Rev Argent Card 2014;82:279-284

MV 3D Model Quantification

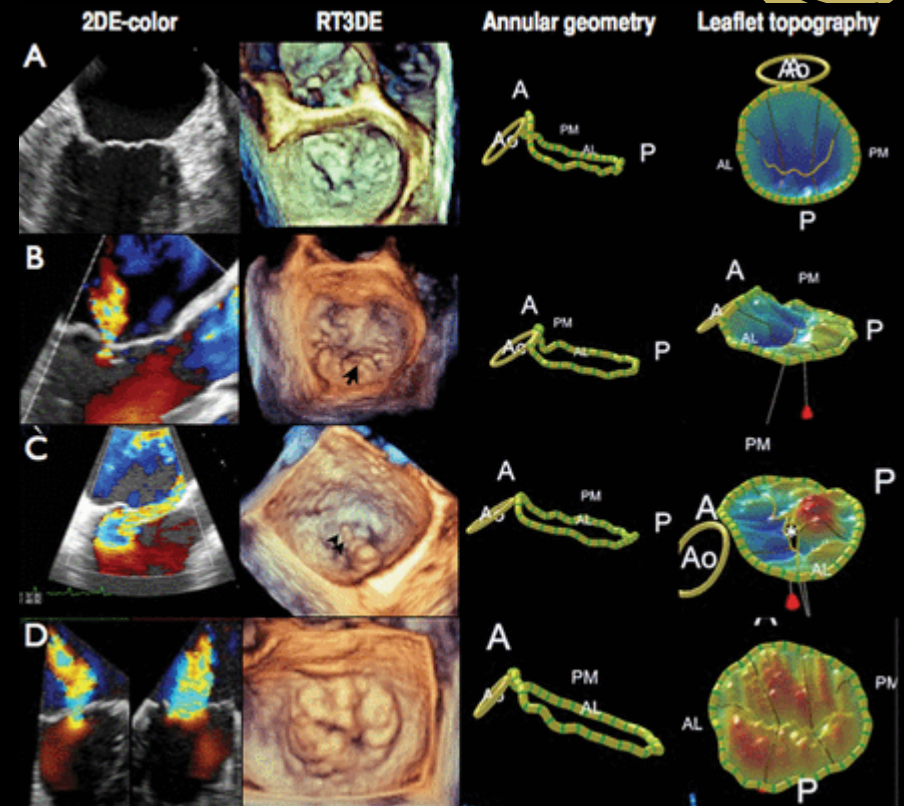


Clinical Applications Diagnosis



1°MV	AH/CW (%)	BV (cc)
Normal	23	----
Billowing	18	0.2
Flail	14	0.8
Barlow's	10	7.8

AH annular height
CW commissural width
BV billowing volume



Lee AP, et al. Circulation. 2013;127:832-84.

Applications MV Repair Success



Primary MR

- Leaflet Areas
 - Anterior, posterior
- Annular circumference
- Leaflet Angles
 - Anterior, posterior
- Heights/volumes
 - Prolapse
 - Tenting

Secondary MR

- Annulus diameter
- Leaflet angles
 - Posterior $> 45^\circ$
 - Anterior $> 25^\circ$
- Tenting
 - Height $> 1.0\text{cm}$
 - Volume
 - Area $> 2.5\text{cm}^2$
- Asymmetric tethering

Art to Science

MR Location + Quantification



Adult Echo
X8-2t
16Hz
8.3cm

3D Zoom
2D / 3D
% 65 / 45
C 49 / 30
HPen

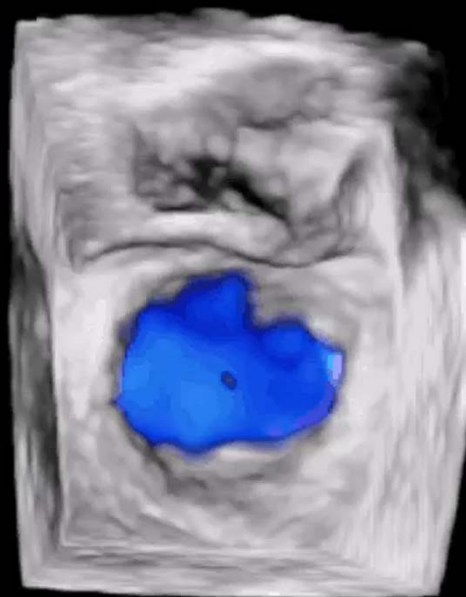
CE
% 48 / 50
6838Hz
WF 683Hz
4.4MHz



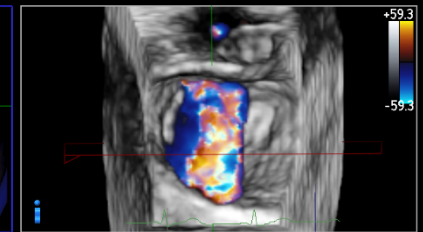
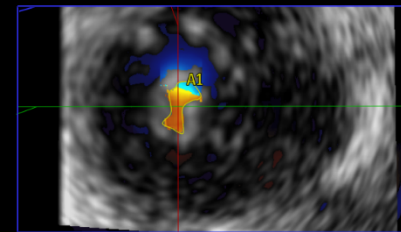
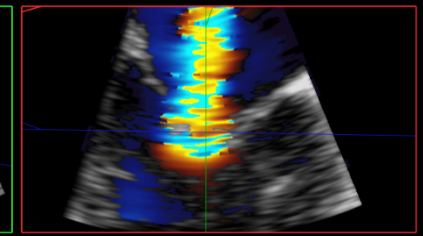
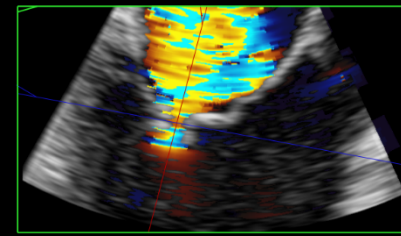
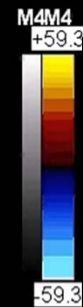
149/78

PAT T: 37.0C
TEE T: 39.6C

3D Beats 1



TIS0.5 MI 0.2



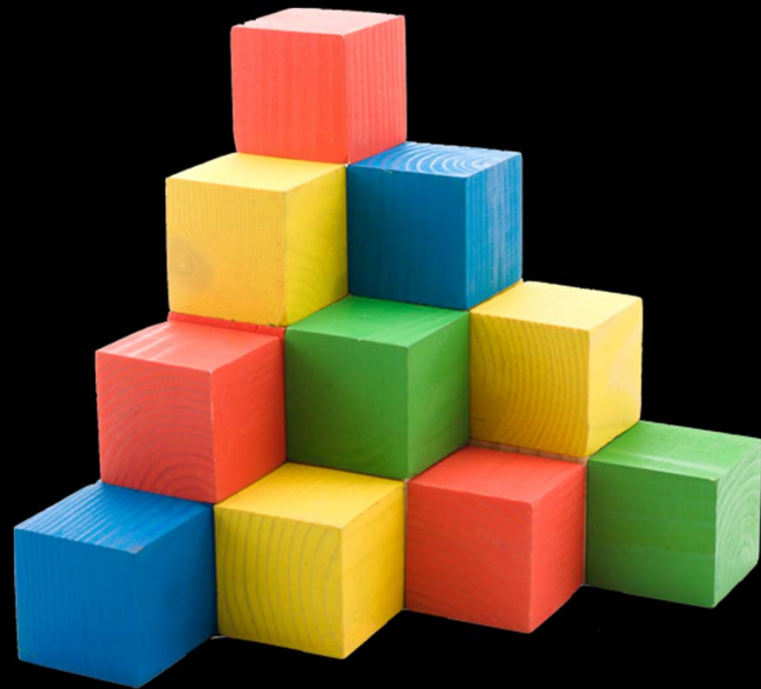
EROA 0.36cm²

62 bpm

Summary



- MV 3D datasets, easy to obtain + optimize
- Different analysis options
- Quantification
 - Better define pathology
 - Guide treatment





Thank You
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