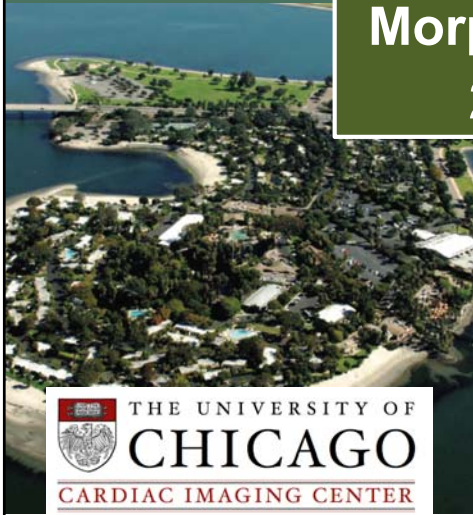


State-of-the-Art
ECHOCARDIOGRAPHY

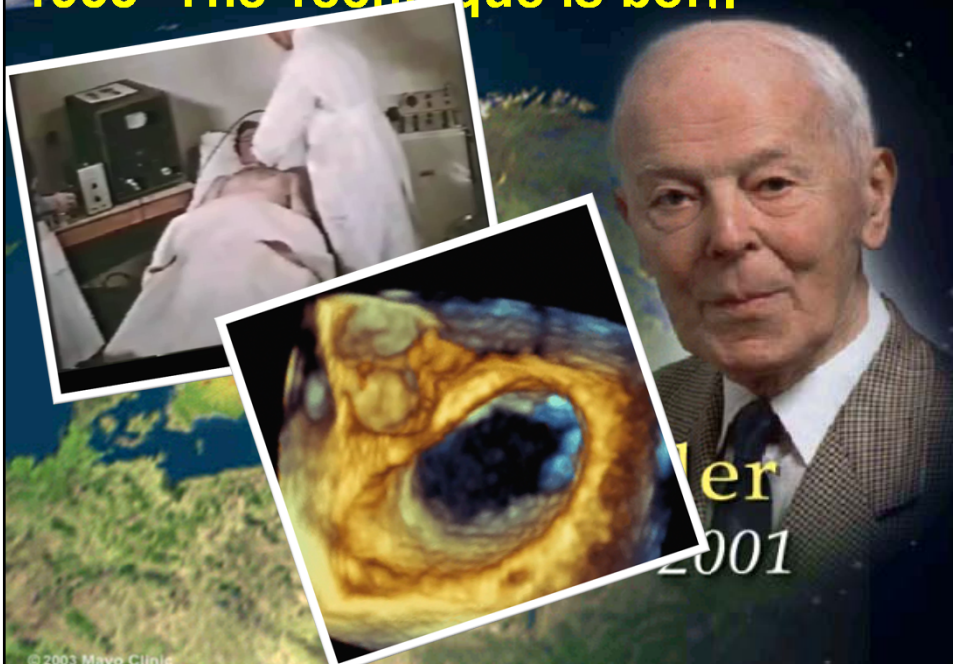
31st
ANNUAL

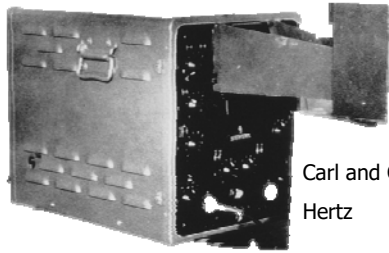
Morphology of the MV
2D, 3D and 4D



Roberto M Lang, MD

1953- The Technique is born

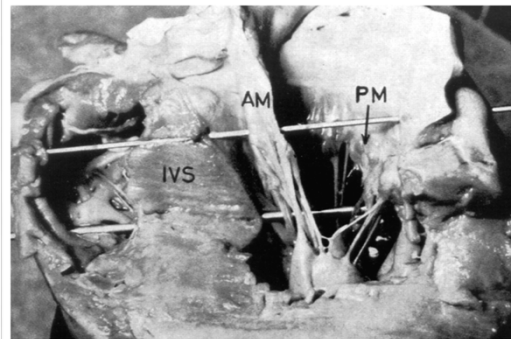
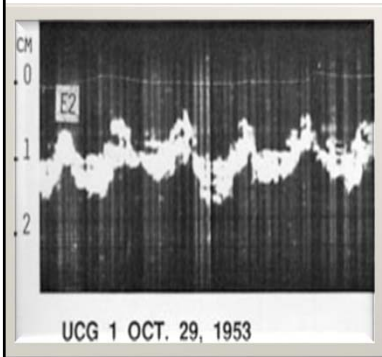




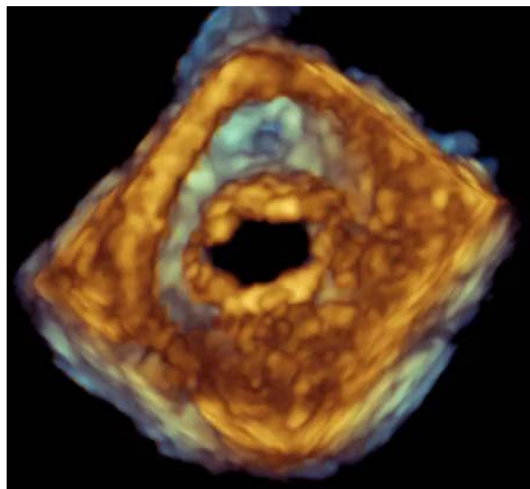
Carl and Gustav Hertz



Ultrasonic reflectoscope for material testing

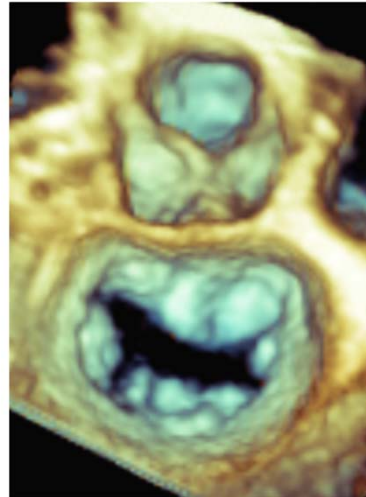
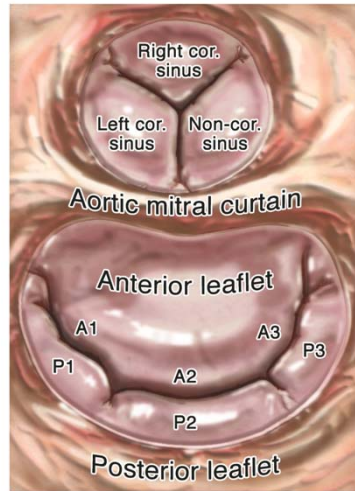


Matrix TEE Probe: 2007



Sugeng L, Shernan SK, Salgo IS, Weinert L, Shook D, Raman J, Jeevanandam V, DuPont F, Settlemier S, Savord B, Fox J, Mor-Avi V, Lang RM. *J Am Coll Cardiol* 2008 August 5;52(6):446-449.

Surgeon's View of the MV

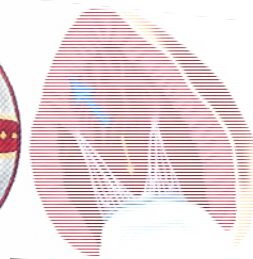


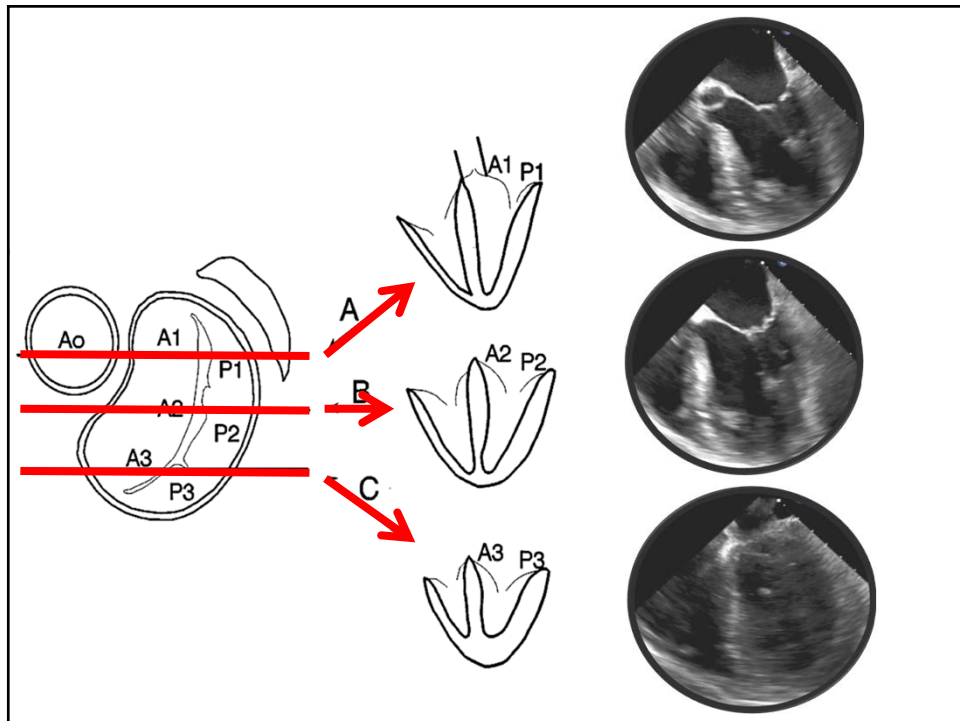
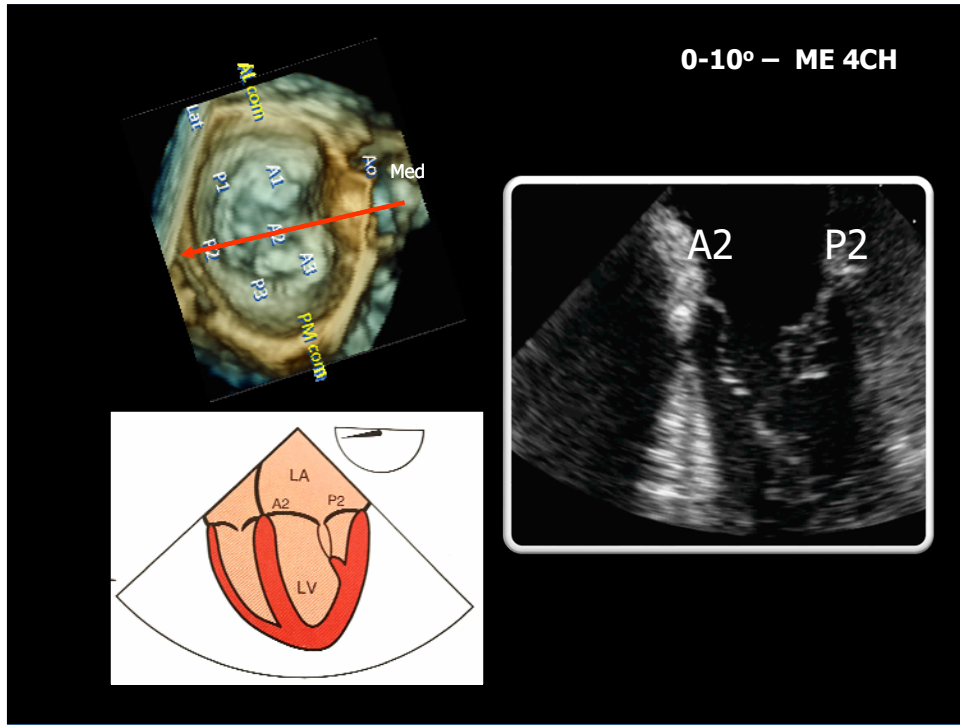
Lang RM, Tsang W, Weinert L, Mor-Avi V, Chandra S. J Am Coll Cardiol 2011 November 1;5 8(19):1933-1944.

The Mitre typically worn by popes and cardinals

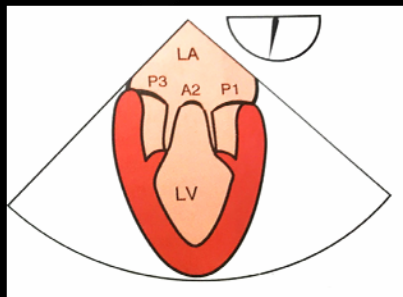
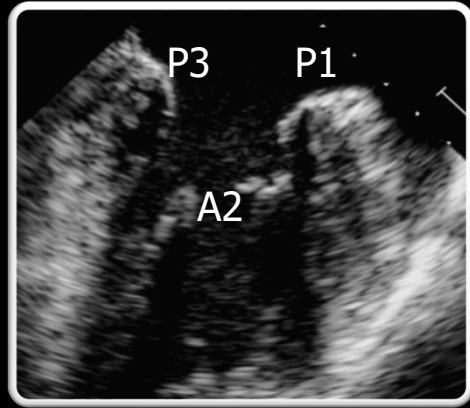
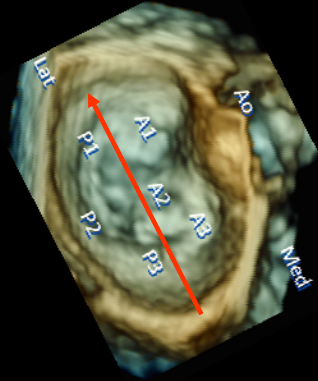


Andreas Vesalius
De Humani Corporis
Fabrica
1543

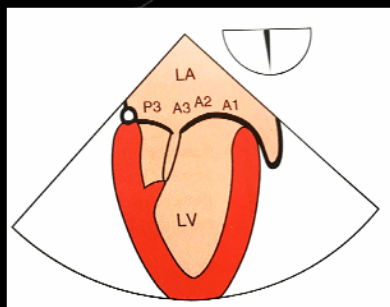
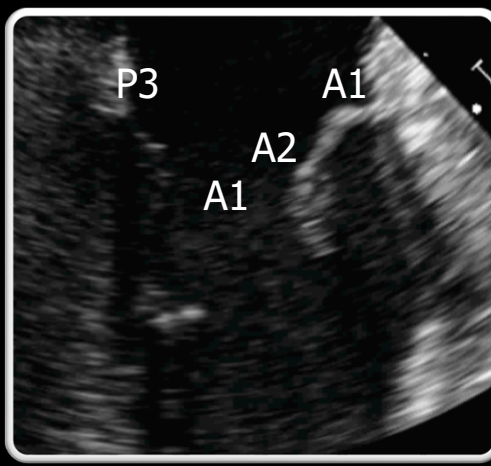
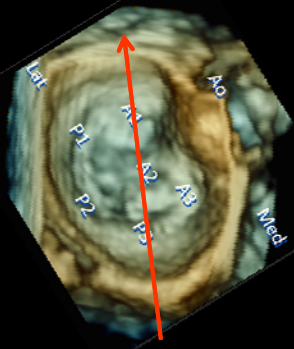




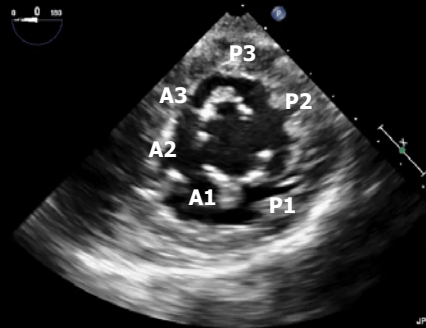
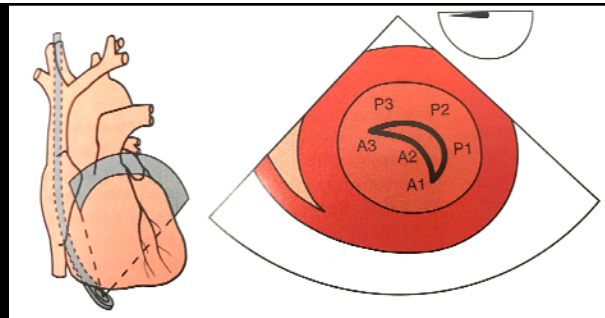
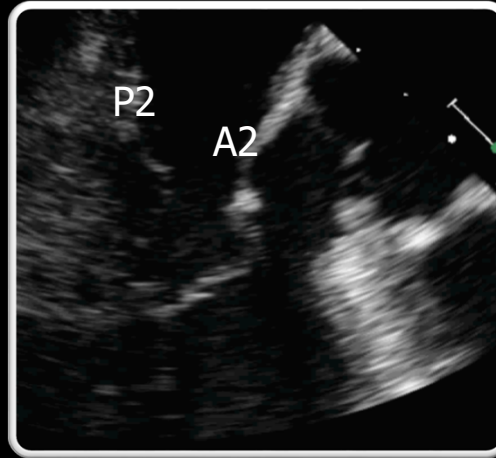
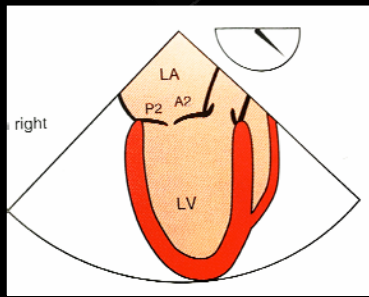
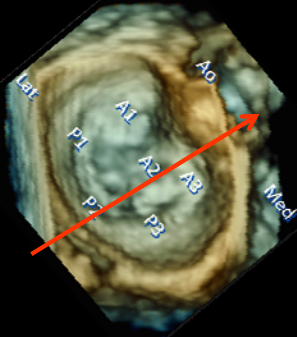
50-70° – Commissural



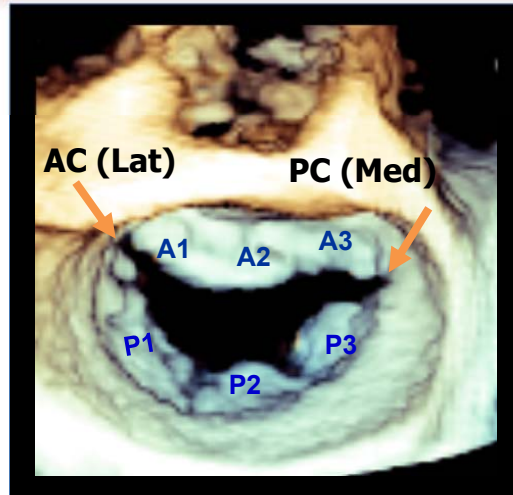
80-100° – ME 2CH



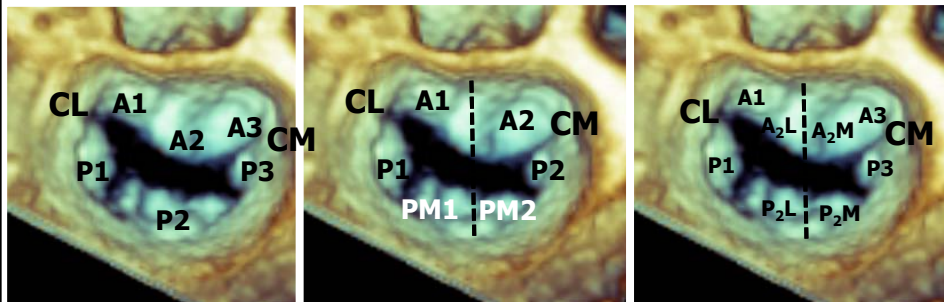
125-135° - ME Long axis



MV: 3D



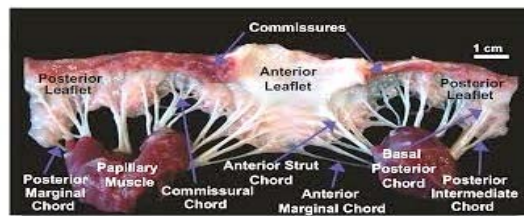
Classification Schemes

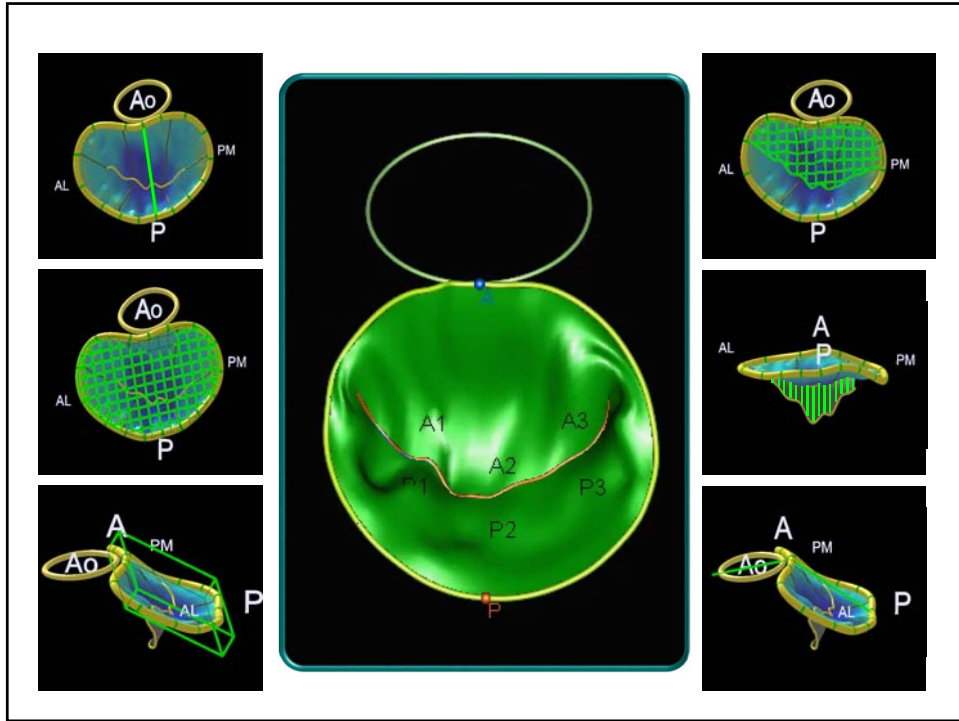


Carpentier

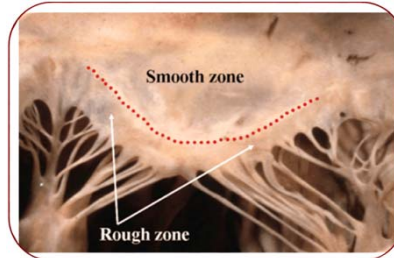
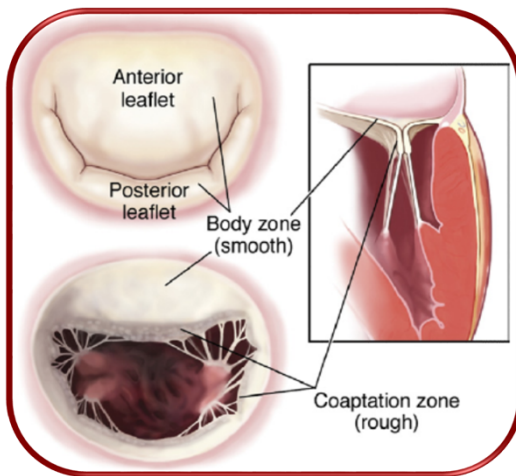
modified Duran

modified Carpentier

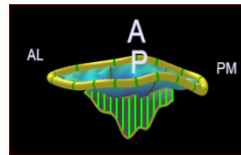
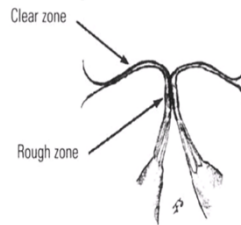




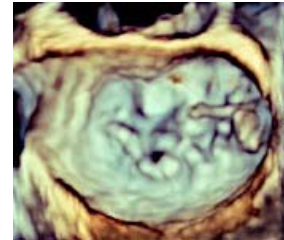
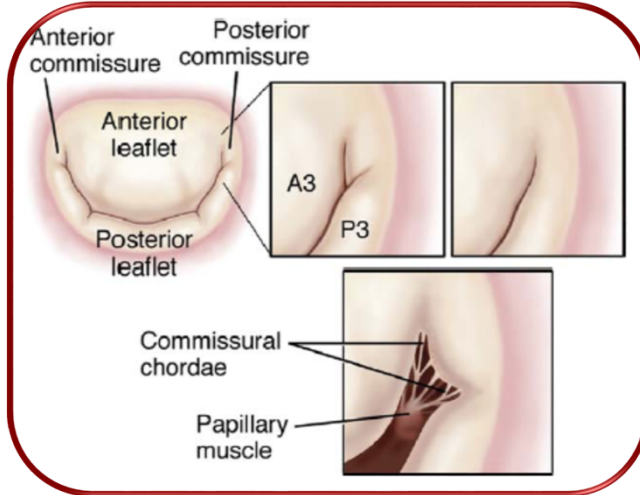
Coaptation Zone



“Coaptation Reserve”

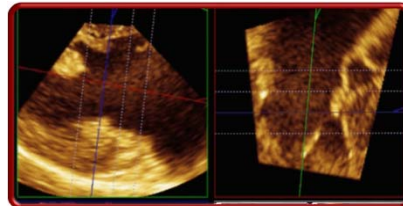
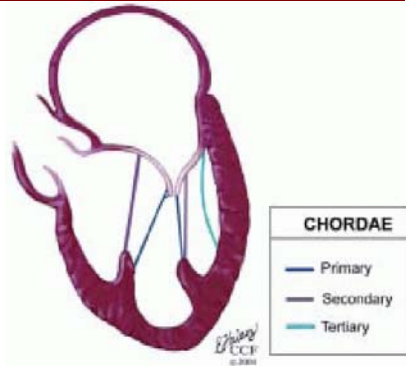
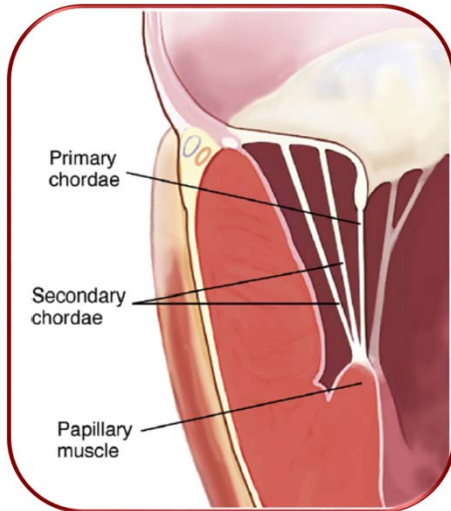


Anterior and Posterior Commissures



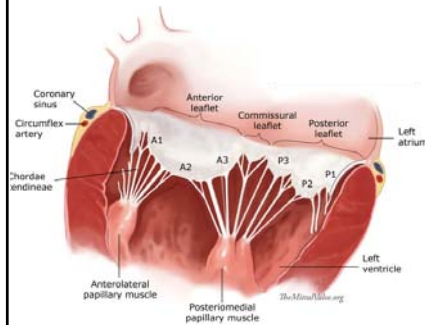
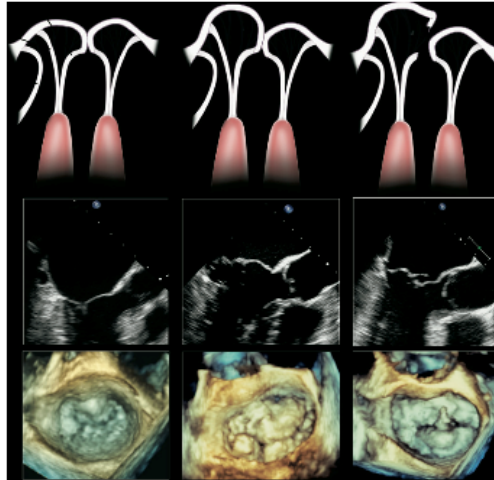
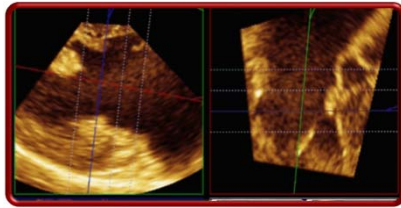
Journal of Cardiothoracic and Vascular Anesthesia, Vol 23, No 4 (August), 2009: pp 531-543

Primary, Secondary and Tertiary Chordae

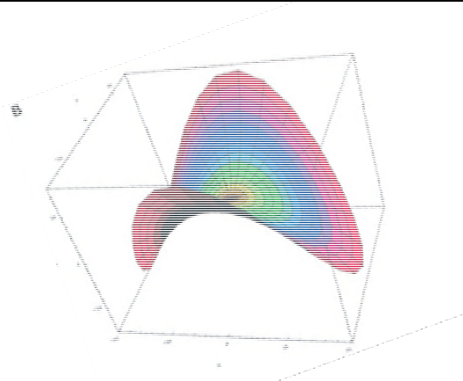
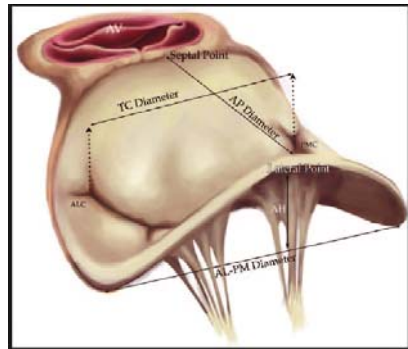


Journal of Cardiothoracic and Vascular Anesthesia, Vol 23, No 4 (August), 2009: pp 531-543

Primary, Secondary and Tertiary Chordae

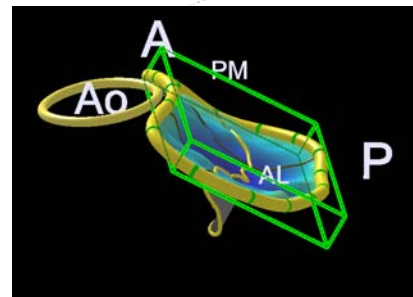


JACC: CARDIOVASCULAR IMAGING, VOL. 1, NO. 2, 2008
MARCH 2008:221-37

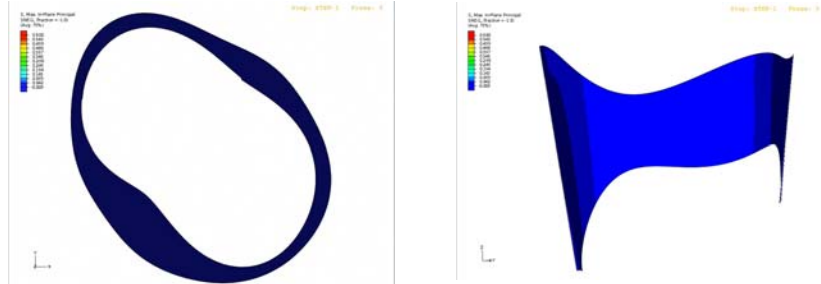


Effect of Annular Shape on Leaflet Curvature in Reducing Mitral Leaflet Stress

Salgo I et al Circulation 2002; 106:711-717



MV Leaflet Stress

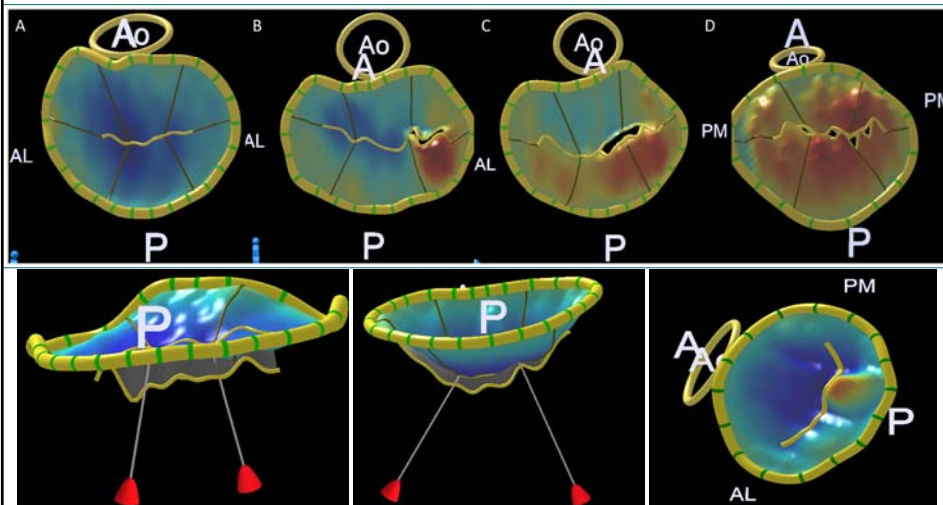


Aortic-Mitral Angle




[Caiani and Votta, www.surgaid.org]



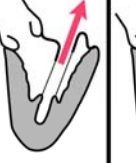
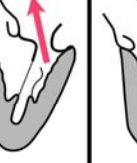
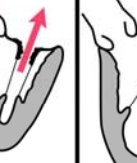




MV Parametric Maps



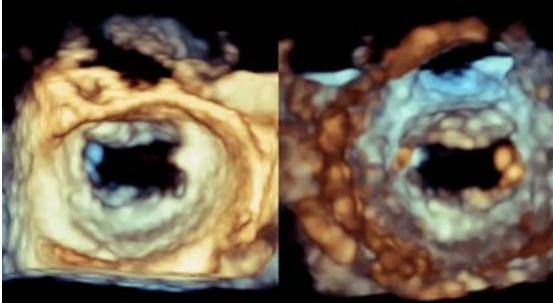
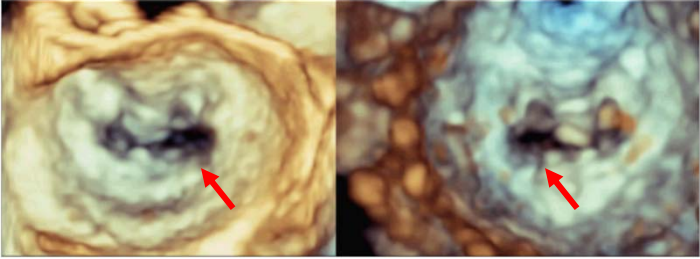
Tsang W, Lang RM., *J Am Soc Echocardiogr* 2011;24:860-7.



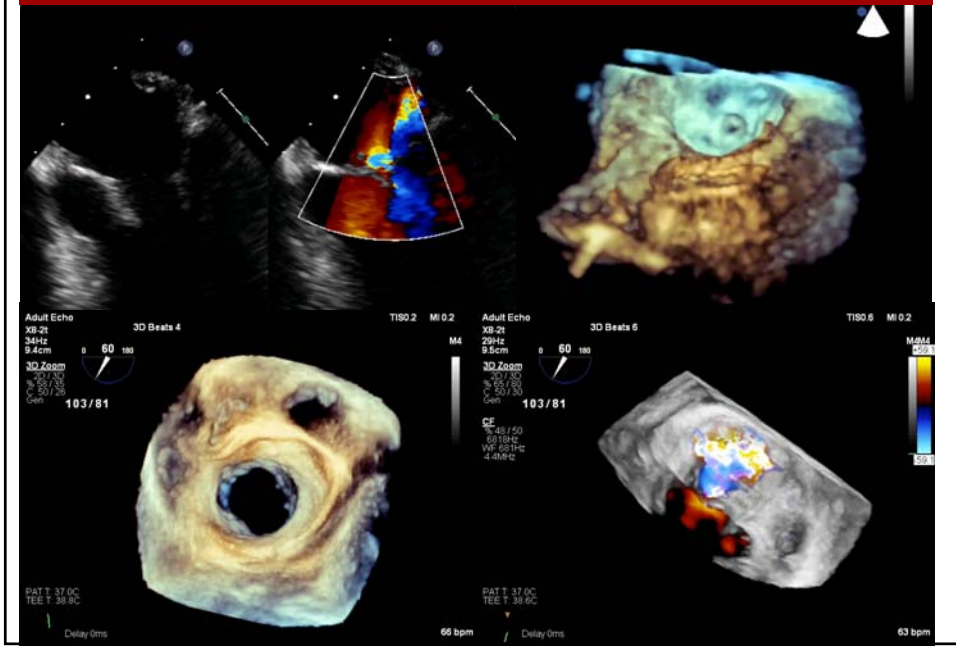
Carpentier's Functional Classification

Type I Normal Leaflet Motion		Type II Excessive Leaflet Motion		Type III Restricted Leaflet Motion	
Annular Dilation	Perforation	Prolapse	Flail	a Thickening/ Fusion	b LV/LA Dilation
					
					

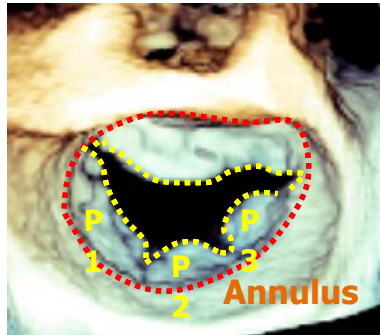
Type I: Normal Leaflet Motion

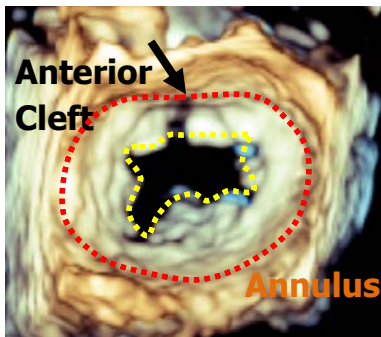
Type I: Normal Leaflet Motion

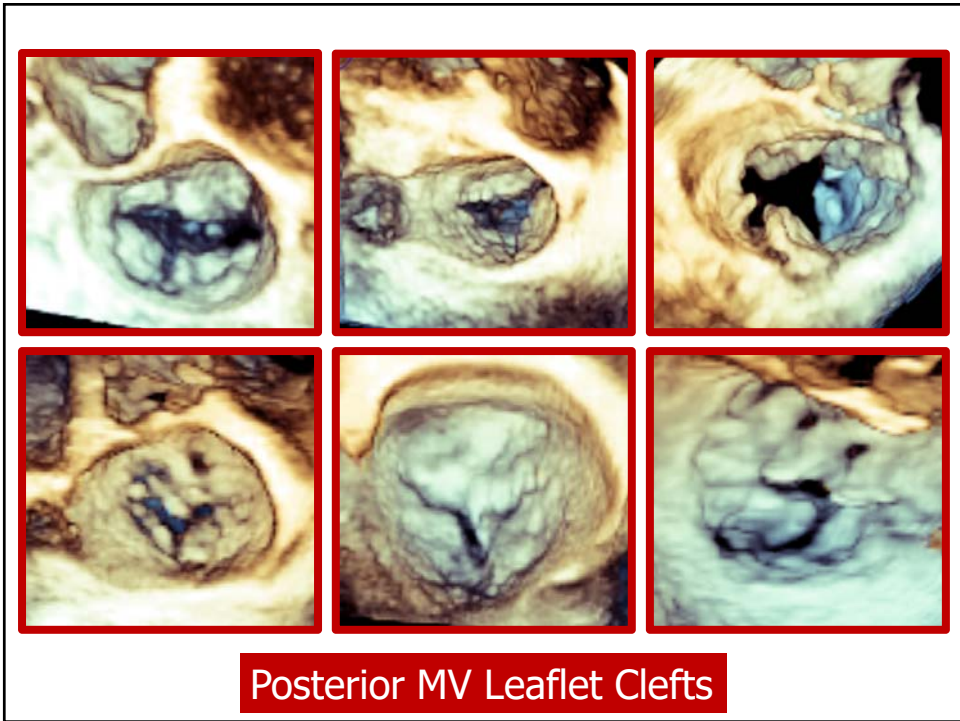


Type I:
Normal
Leaflet
Motion



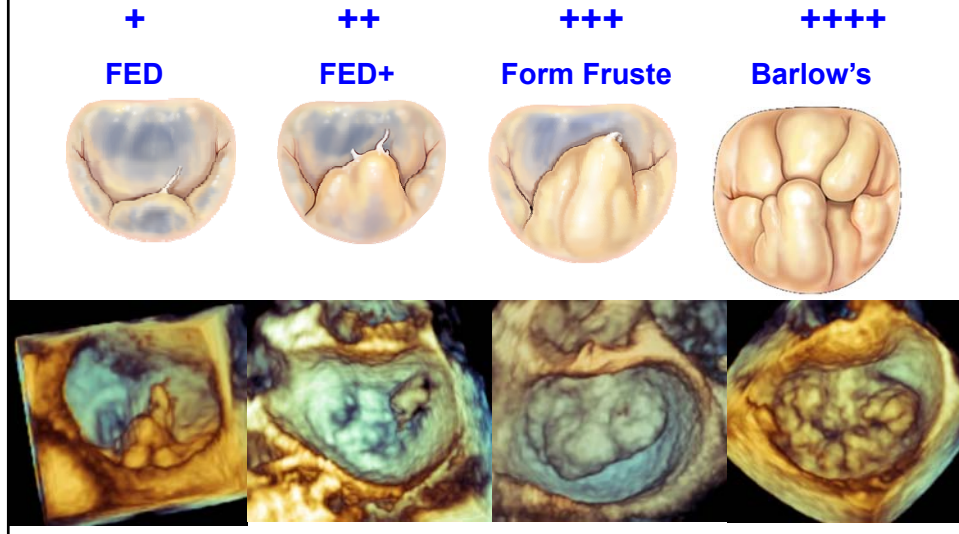
Indentation
vs.
Cleft



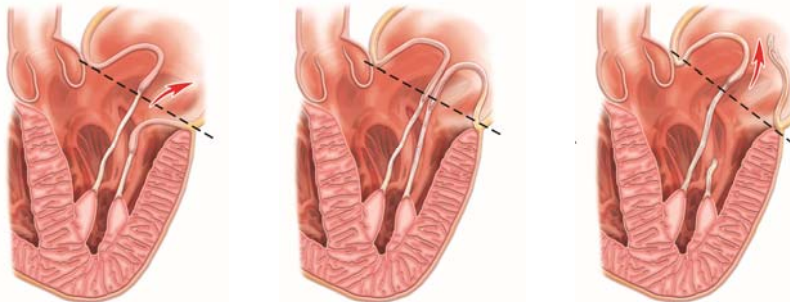


Type II: Degenerative MV Disease

Excess Tissue



Degenerative MV Disease

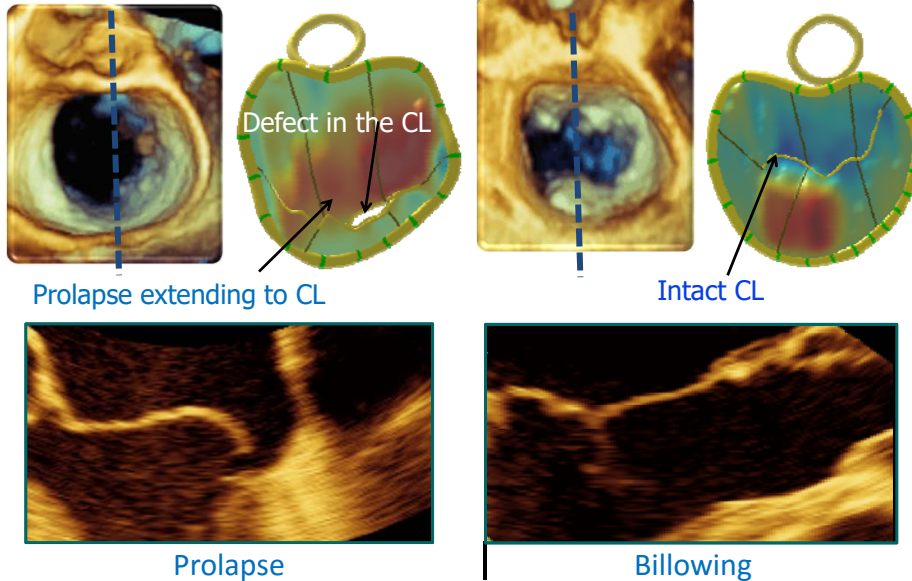


Prolapse: Free edge of the leaflet above the plane of the annulus at end-systole. Disruption of coaptation.

Billowing: Systolic protrusion of leaflet body above the annulus plane. Free leaflet edge remaining at or below the annular plane during end-systole.

Lang RM, Tsang W, Weinert L, Mor-Avi V, Chandra S. J Am Coll Cardiol 2011 November 1;58(19):1933-1944.

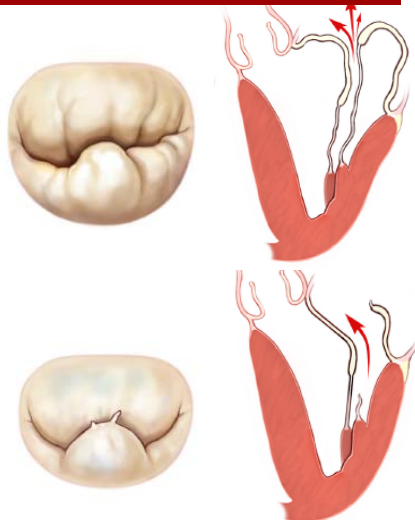
3D Definition for Billowing and Prolapse



Addetia K, Lang RM et. al. J Am Soc Echocardiogr. 2014 Jan;27(1):8-16

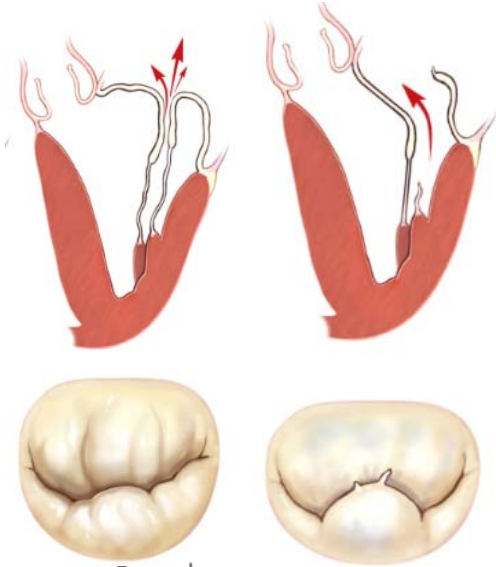
Type II: Fibroelastic Deficiency

- **Etiology (cause):**
fibroelastic deficiency
- **Lesions (result of the disease):** chordal elongation and/or rupture, annular dilatation
- **Leaflet dysfunction (which result from the lesions):** Type II = excess motion of the margins of the leaflets in relation to the annular plane



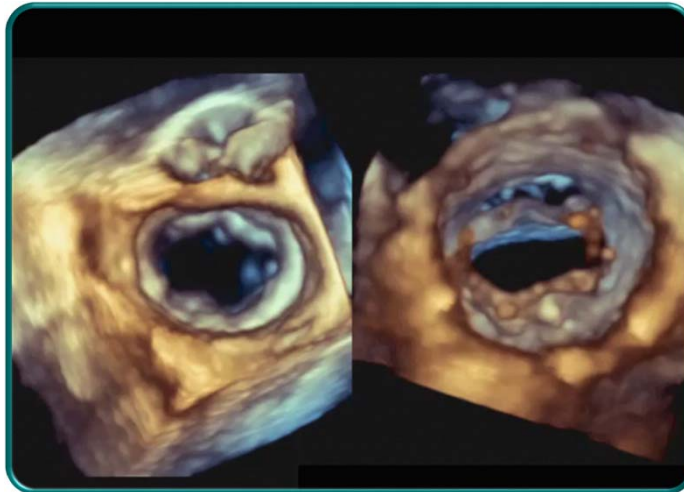
- **Older individuals**
- **Short Hx of MR**

Type II: Fibroelastic Deficiency



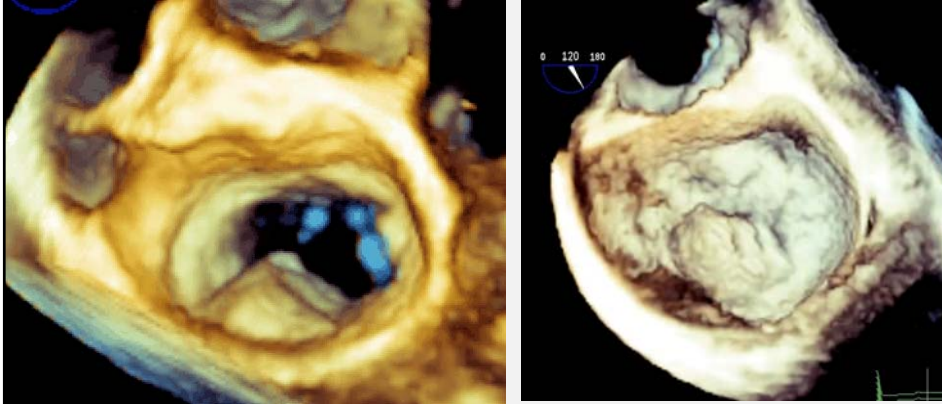
- Older individuals
- Short Hx of MR
- Rupture or elongation of a single chord
- Remaining segments are normal
- Posterior annulus may be dilated

Type II: Fibroelastic Deficiency



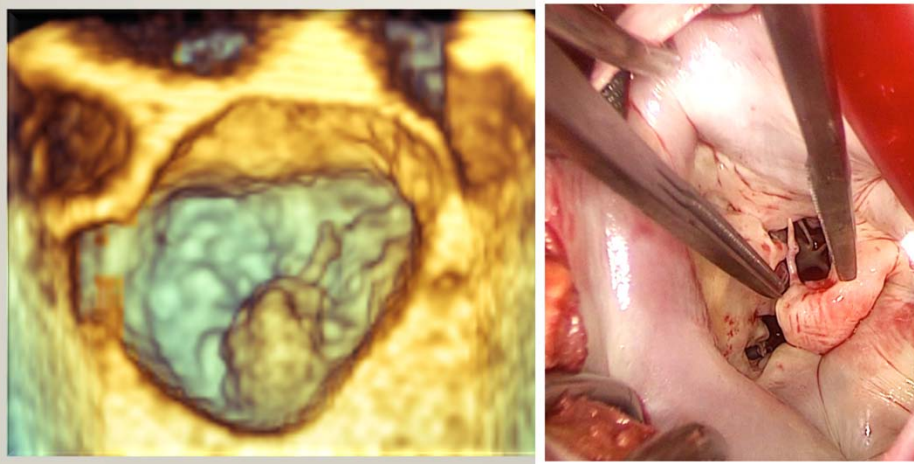
P2 - Prolapse

P2 Prolapse



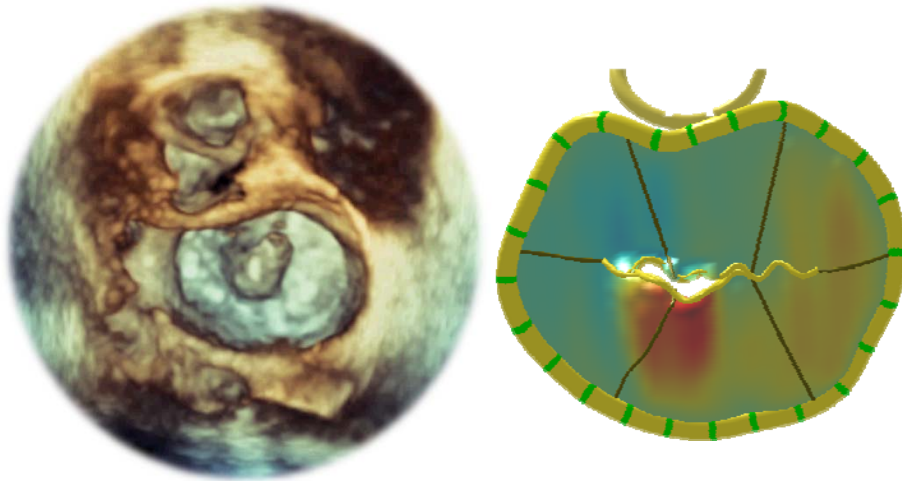
Fibroelastic Deficiency

Flail MV: Ruptured chords

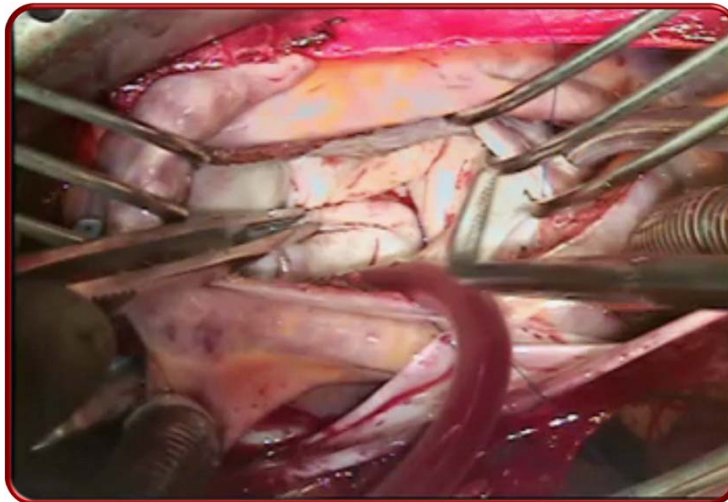


Chandra S., *Circ Cardiovasc Imaging* 2011 January; 4(1):24-32.

Type II: Fibroelastic Deficiency



Type II: Fibroelastic Deficiency

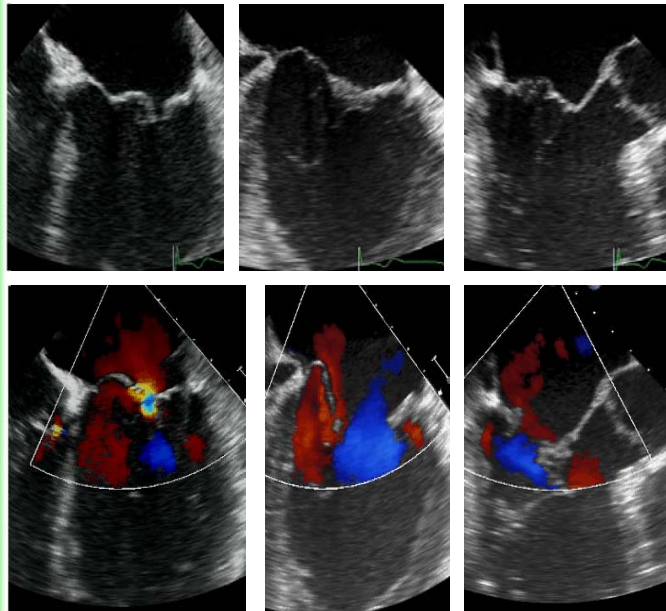


Flail MV: Ruptured chords

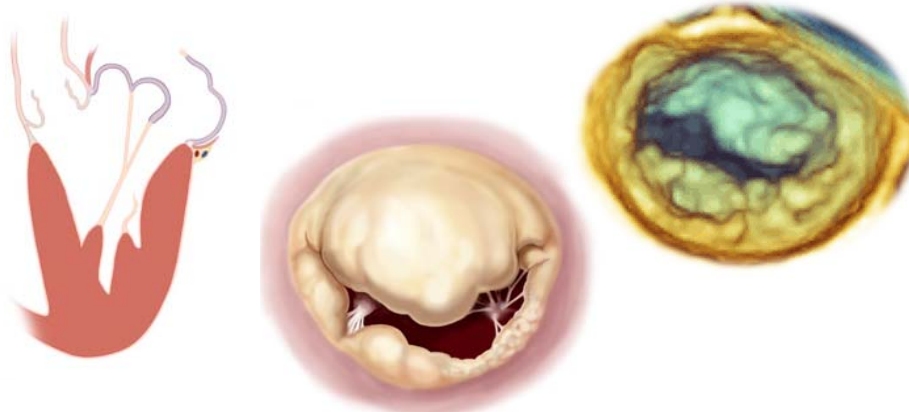
Type II: Barlow's Prolapse

Case History

42year-old woman who complains of decreased exercise capacity of recent duration.

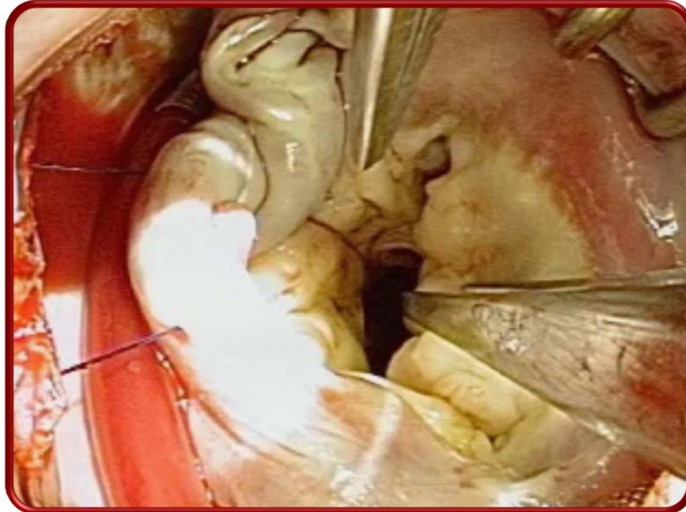


Type II: Barlow's Prolapse



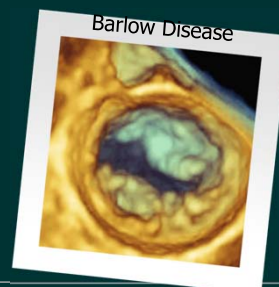
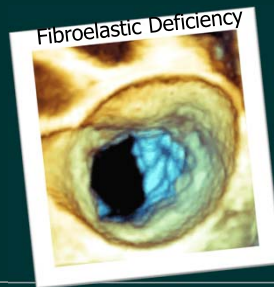
Excess leaflet tissue with billowing, thickened leaflets and chordae, large annulus

Barlow's Prolapse

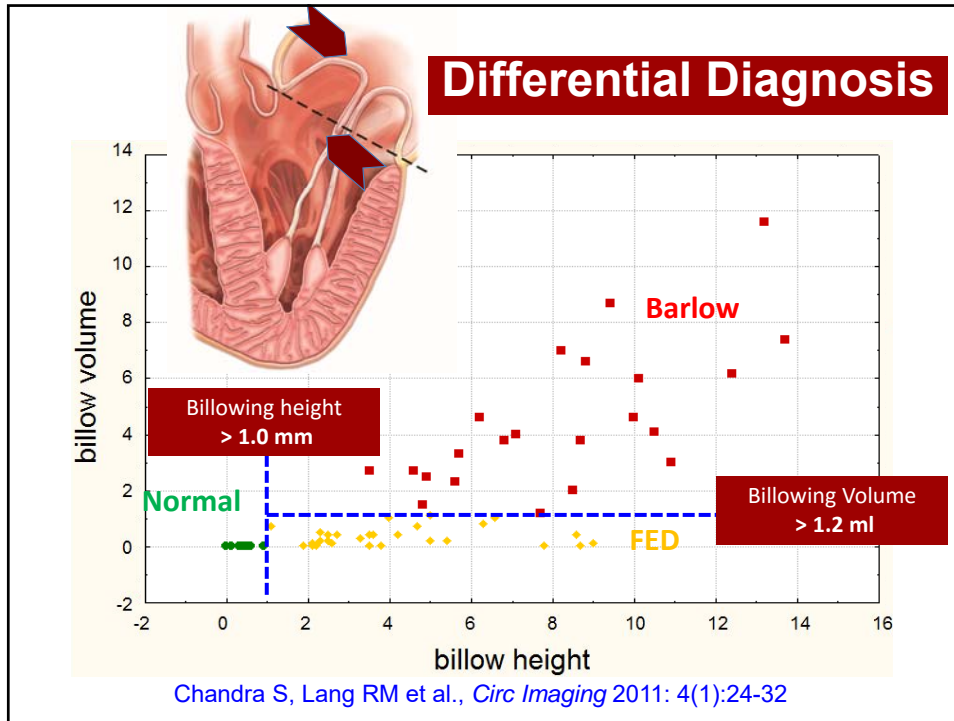


Fibroelastic Deficiency vs. Barlow Disease

Carpentier et.al. J Thorac Cardiovasc Surg 1980



Age at diagnosis	>60 years	<60 years
History of MR	<5 years	>10 years
Annular Dilatation	<32 mm	>36 mm
Leaflet Tissue	Thin and transparent without excess tissue	Thickened with diffuse excess tissue
Segmental Distribution	Usually single segment	Multisegmental
Chordae	Thin and ruptured	Irregular and elongated



Carpentier Correction

- Leaflet resection (*reduction in MV area*)
- Rigid or semi-rigid annuloplast ring (*distortion of the subvalvular chordae*)

Repaired mitral valve

Ao

A

AL

PM

American Correction

- **Mitral Valve not resected**
- **Full flexible ring**
- **Artificial chordae**

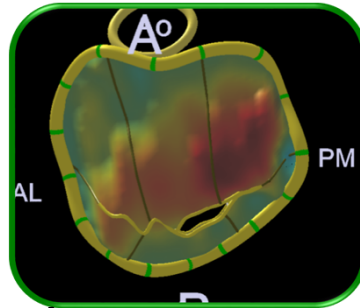
Can three-dimensional echocardiography accurately predict complexity of mitral valve repair?

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

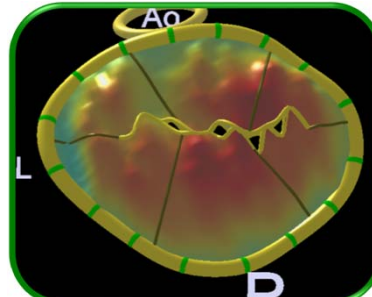
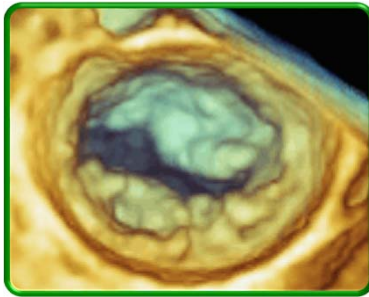
Standard Repair		Prediction of Complexity of MV Repair
No or single leaflet resection		Multisegment Involvement
Sliding-plasty		Anterior Leaflet Prolapse
Cleft Closure		Scarcity of leaflet tissue
Chordal or commissural repair techniques		Severe Calcification
Complex Repairs		Prolapsing Height
Bi-leaflet repair techniques		Annular Dilatation > 50 mm
Multiple resections required		
Patch augmentation		

European Journal of Cardio-Thoracic Surgery 2012;41:518-524
Lang RM et al. J Am Coll Cardiol 2011

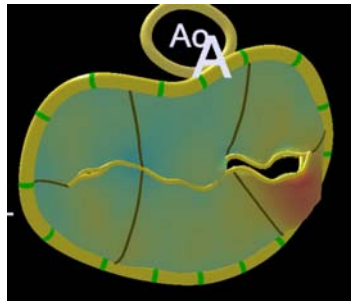
Anterior Leaflet Prolapse



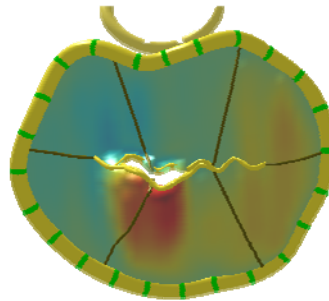
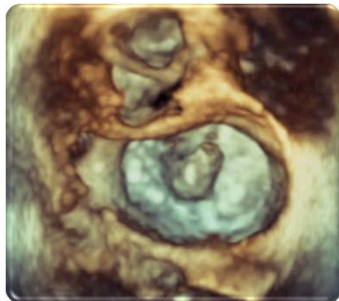
Barlows Prolapse



Medial Commissure

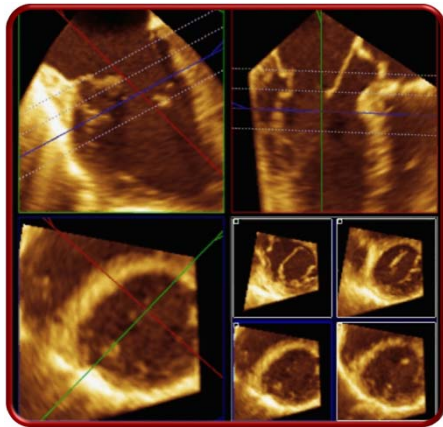


P2 Flail

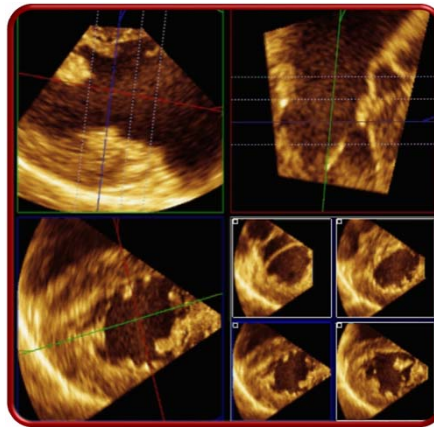


Sub-Mitral Apparatus

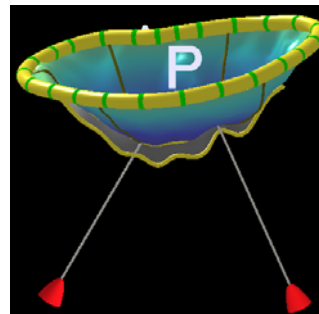
Mid-esophageal



Transgastric

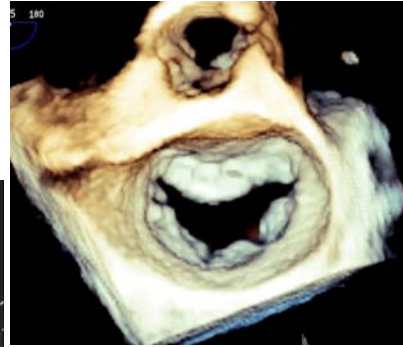
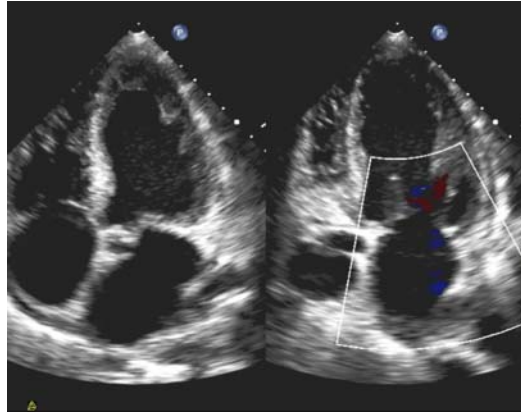


Obase and Lang RM, J AM Soc Echocardiogr 2015;28:1302-8

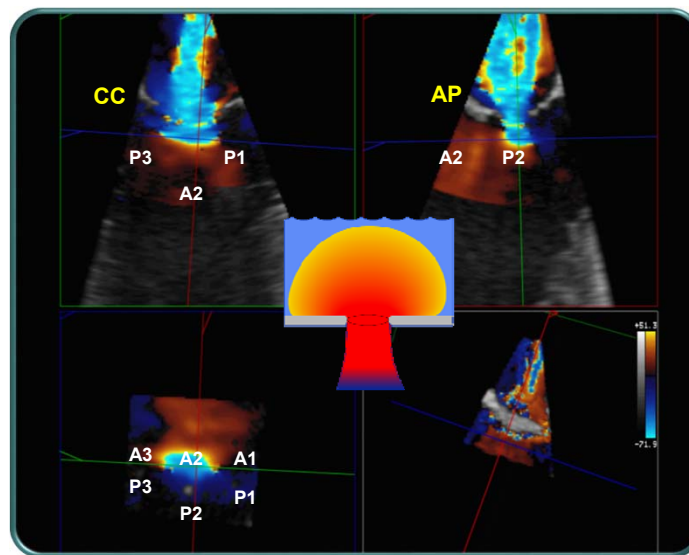


Functional MR

Functional MR



Challenging the Hemispheric Assumption of Flow Convergence



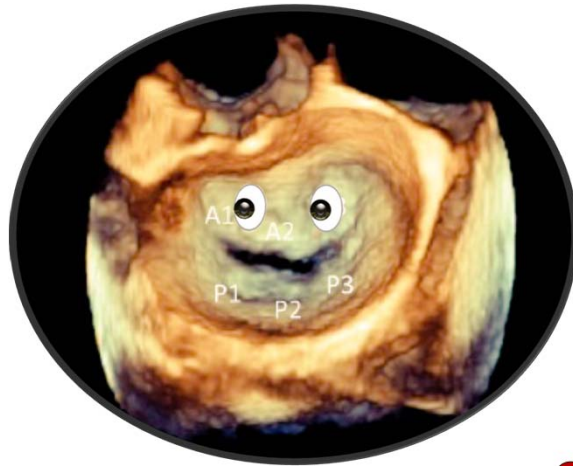
Promises and Perspectives Valves

Where have we been?


- Rapid dissemination and integration into clinical practice
- Mechanistic insight into MV disease
- Volumetric quantification
- Guidance of percutaneous procedures

Where are we going?


- Quantification of regurgitant lesions
- Automation measurements
- Outcome measures
- Custom prosthesis (printing)
- Other valves (Aortic, Tricuspid)



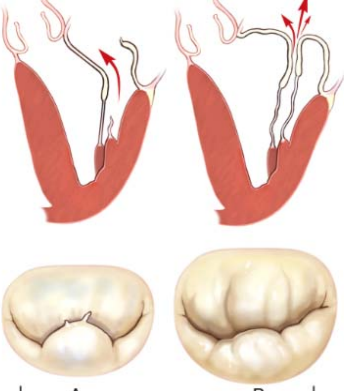
Thanks for your attention




Carpentier's Functional Classification



Type I
Normal Leaflet motion





Type II
Excess Leaflet motion



Type III
Restricted Opening IIIa
Restricted Closure IIIb

Functional MR

Veronesi F, Lang RM et al., *J Am Soc Echocardiogr* 2008; 21(4):347-354