

# Evaluation of Mitral Regurgitation

## *New Concepts in Mitral valve Prolapse*

William A. Zoghbi MD, FASE, MACC

*Professor and Chairman, Department of Cardiology*

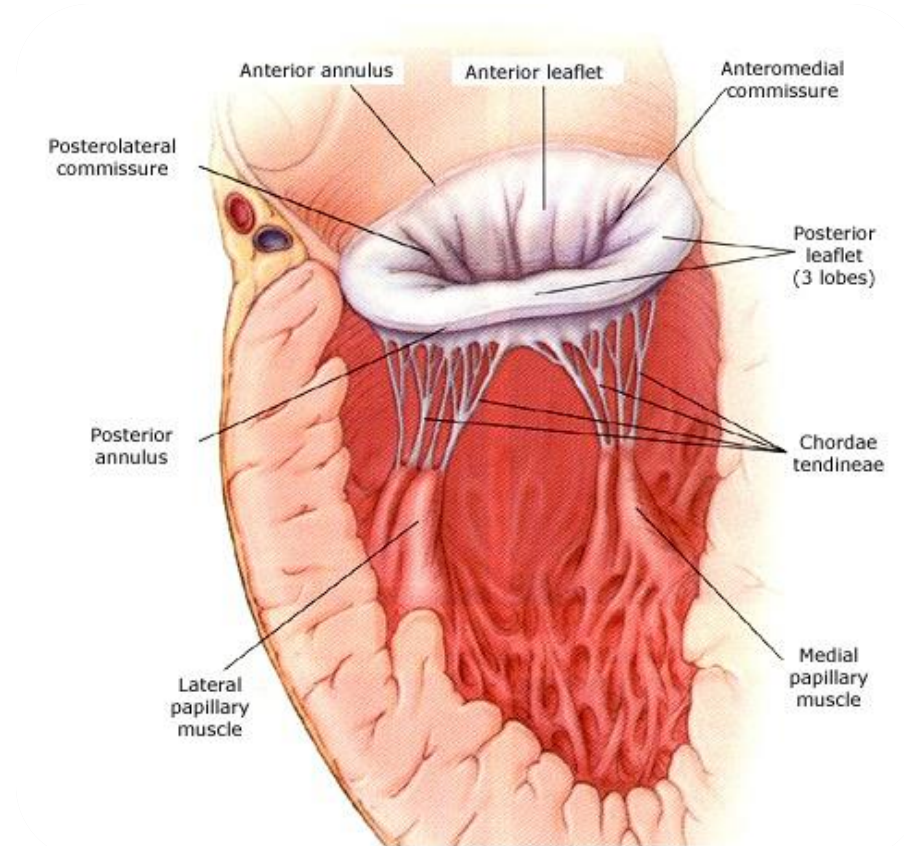
*Elkins Family Distinguished Chair in Cardiac Health*

*Houston Methodist Hospital*

# Mitral Valve Anatomy

## *A Complex Apparatus*

- Annulus
- Leaflets
- Chords
  - Primary, secondary & tertiary
- Papillary muscles
- Ventricular function geometry



## ASE GUIDELINES AND STANDARDS

# Recommendations for Noninvasive Evaluation of Native Valvular Regurgitation

## A Report from the American Society of Echocardiography Developed in Collaboration with the Society for Cardiovascular Magnetic Resonance

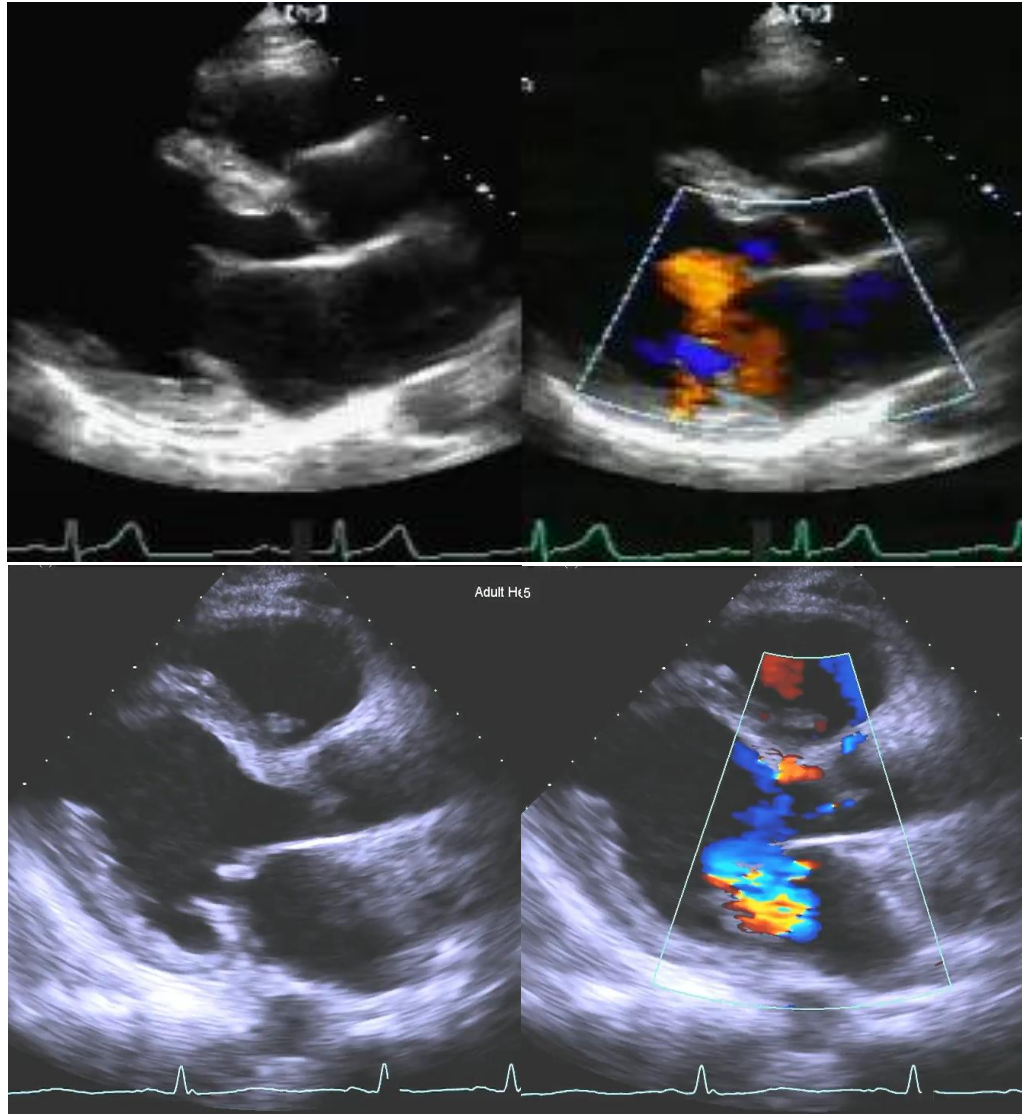
William A. Zoghbi, MD, FASE (Chair), David Adams, RCS, RDCS, FASE, Robert O. Bonow, MD, Maurice Enriquez-Sarano, MD, Elyse Foster, MD, FASE, Paul A. Grayburn, MD, FASE, Rebecca T. Hahn, MD, FASE, Yuchi Han, MD, MMSc,\* Judy Hung, MD, FASE, Roberto M. Lang, MD, FASE, Stephen H. Little, MD, FASE, Dipan J. Shah, MD, MMSc,\* Stanton Shernan, MD, FASE, Paaladinesh Thavendiranathan, MD, MSc, FASE,\* James D. Thomas, MD, FASE, and Neil J. Weissman, MD, FASE, *Houston and Dallas, Texas; Durham, North Carolina; Chicago, Illinois; Rochester, Minnesota; San Francisco, California; New York, New York; Philadelphia, Pennsylvania; Boston Massachusetts; Toronto, Ontario, Canada; and Washington, DC*

# ASE/SCMR Valvular Regurgitation Guidelines

## What is New?

- Emphasis on identification of Etiology/Mechanism of regurgitation
- 2D/3D TTE--an integrative approach & algorithms to assess severity
- Importance of Non-Holosystolic MR
- Role of CMR & CMR methodology
- Library of case studies on the web: [www.asecho.org/vrcases](http://www.asecho.org/vrcases)

# Valve Structure & Mechanism of MR



Primary

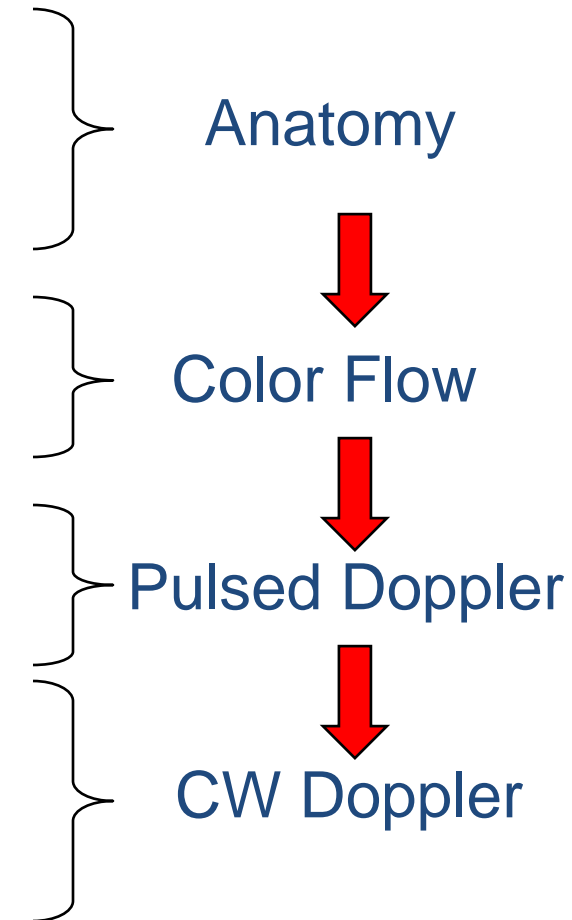
Secondary



# Mitral Regurgitation







## *Indicators of Severity*

- Mitral valve pathology
- LV/ LA size
- Color Doppler:  
Vena contracta, Jet Area, Flow convergence
- Mitral E; Pulmonary vein pattern
- Regurgitant flow/fraction
- CW density and contour



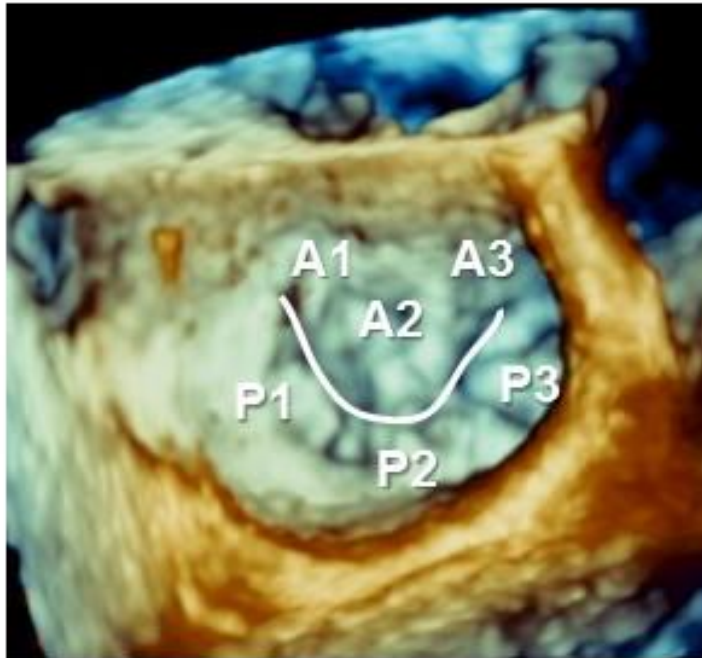
# Carpentier Classification of Mechanisms of MV Regurgitation

## Mitral Regurgitation

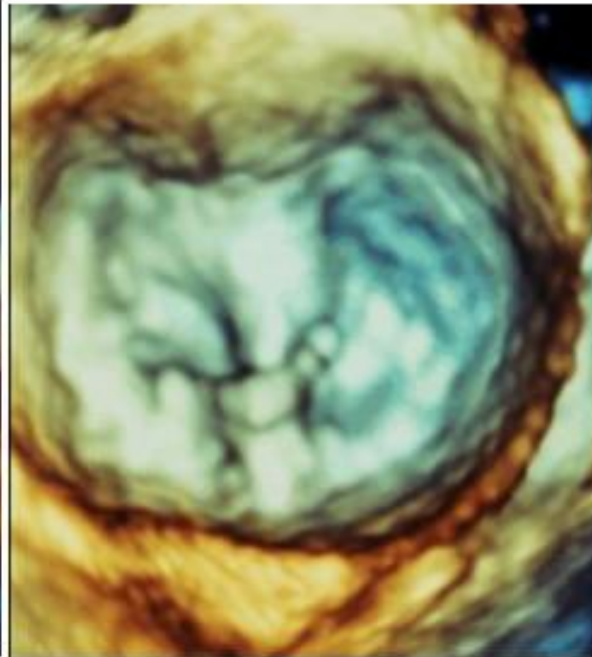
<b>Type I</b> Normal Leaflet Motion		<b>Type II</b> Excessive Leaflet Motion		<b>Type III</b> Restricted Leaflet Motion	
<b>Annular Dilation</b>	<b>Perforation</b>	<b>Prolapse</b>	<b>Flail</b>	<b>a</b> <b>Thickening/ Fusion</b>	<b>b</b> <b>LV/LA Dilation</b>
					

# 3D Echocardiography- MV

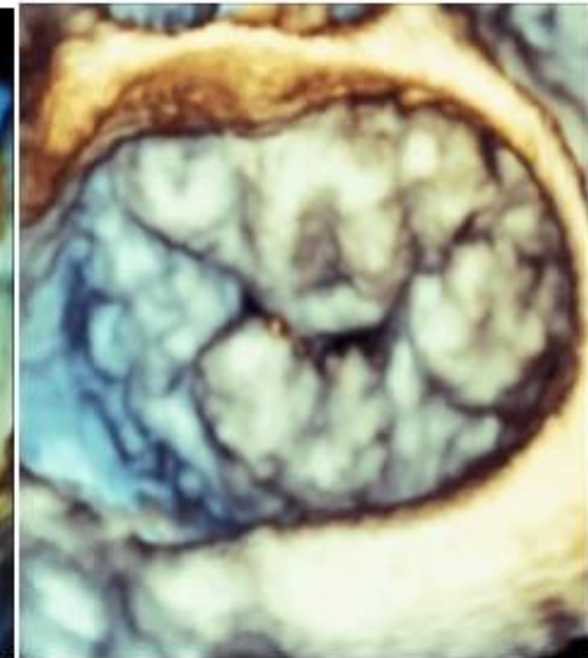
**Normal**



**Fibroelastic  
Deficiency**



**Barlow's  
Disease**





# Trans-illumination 3D Imaging



"Classic" 3D view

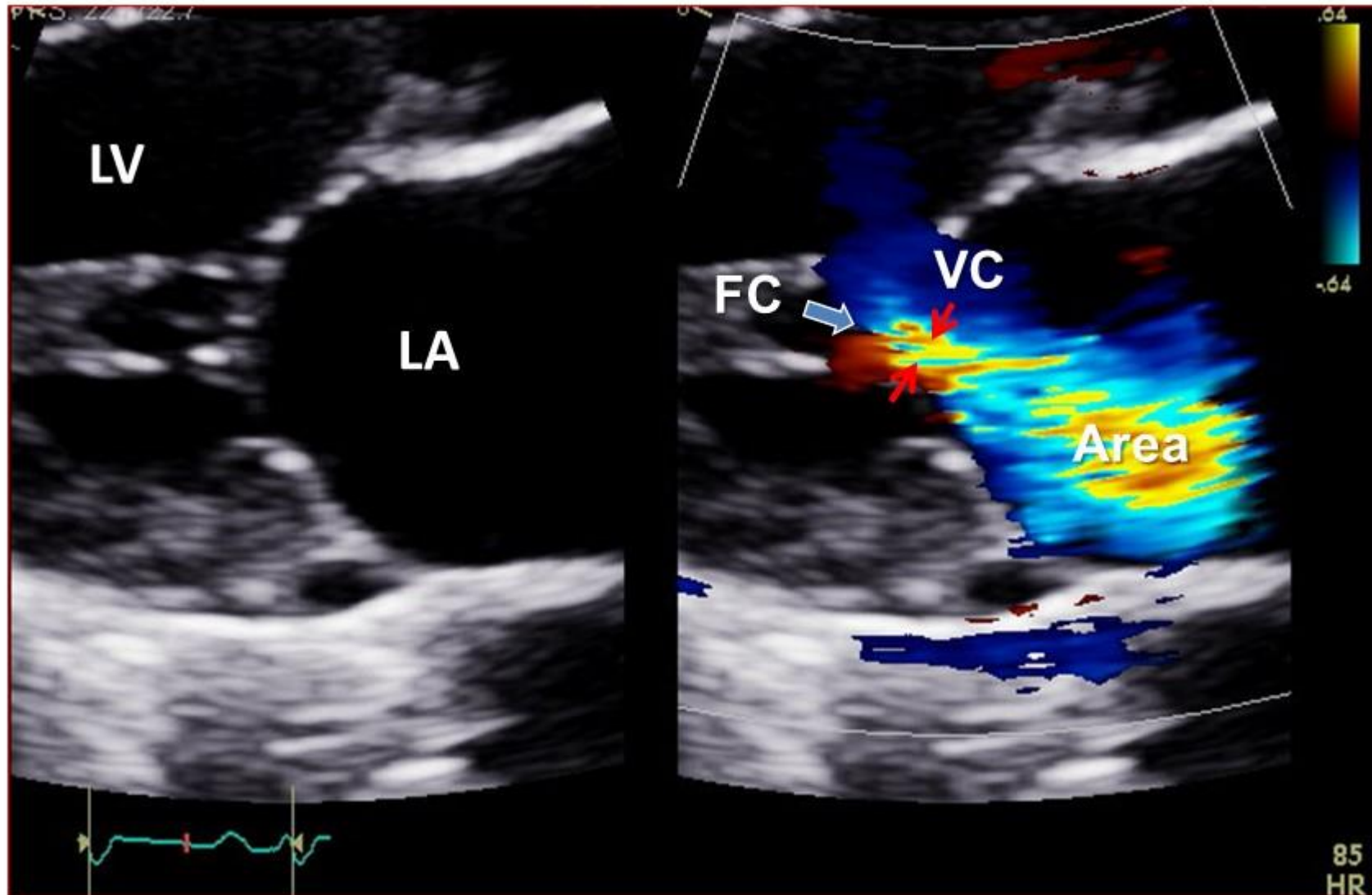


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A Flail MV

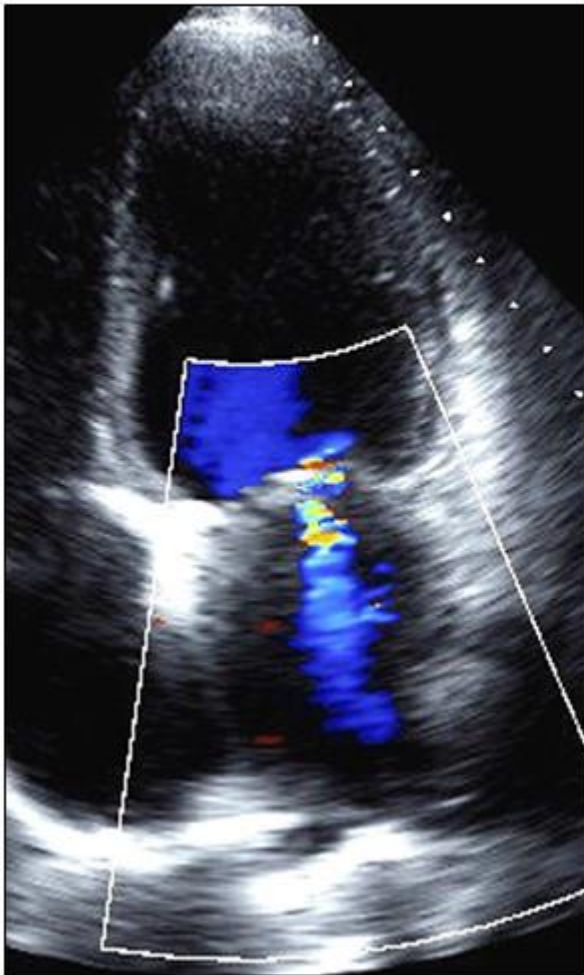
# Mitral Regurgitation- Color Doppler

## *3 Components of the Jet*

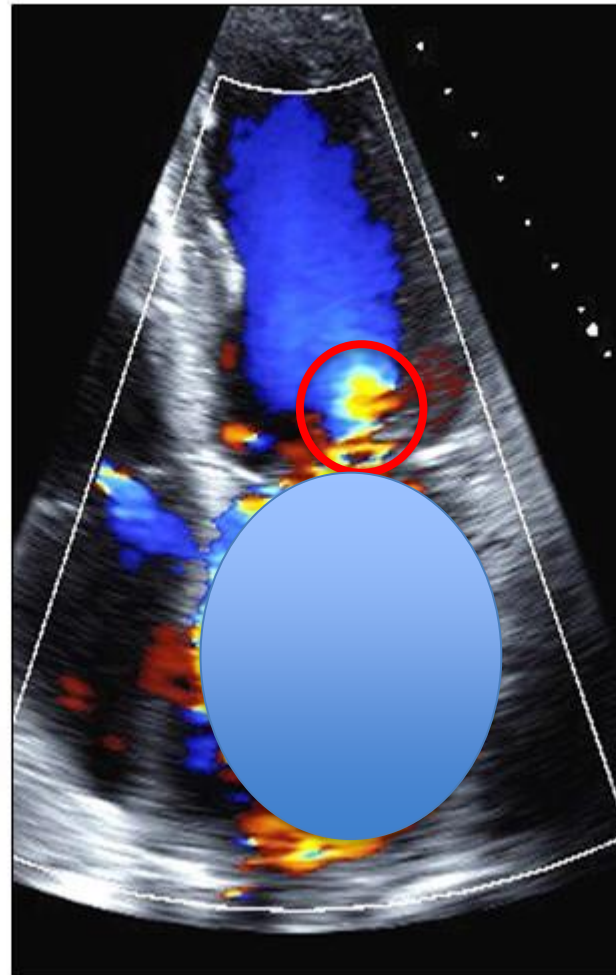


# Mitral Regurgitation

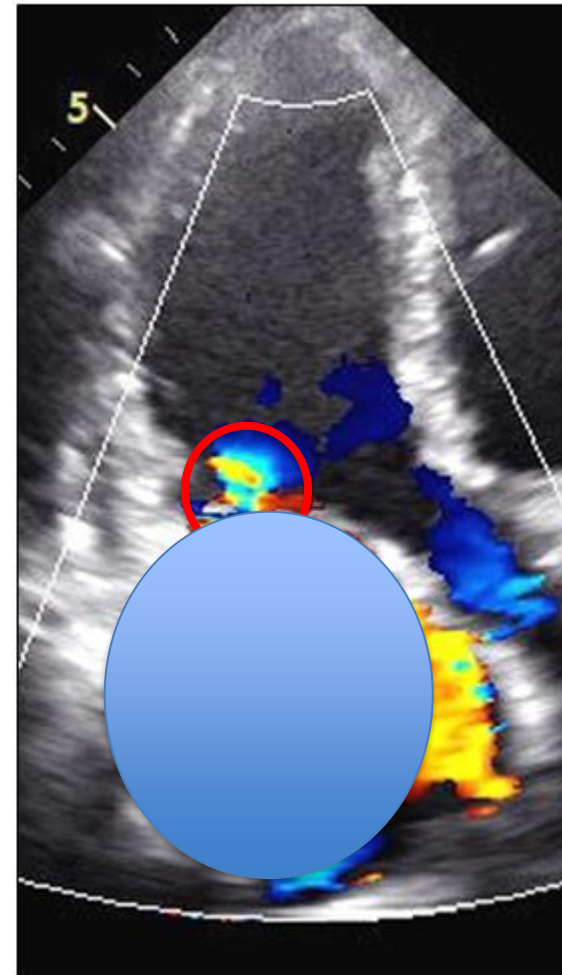
Mild Central



Severe Central



Severe Eccentric



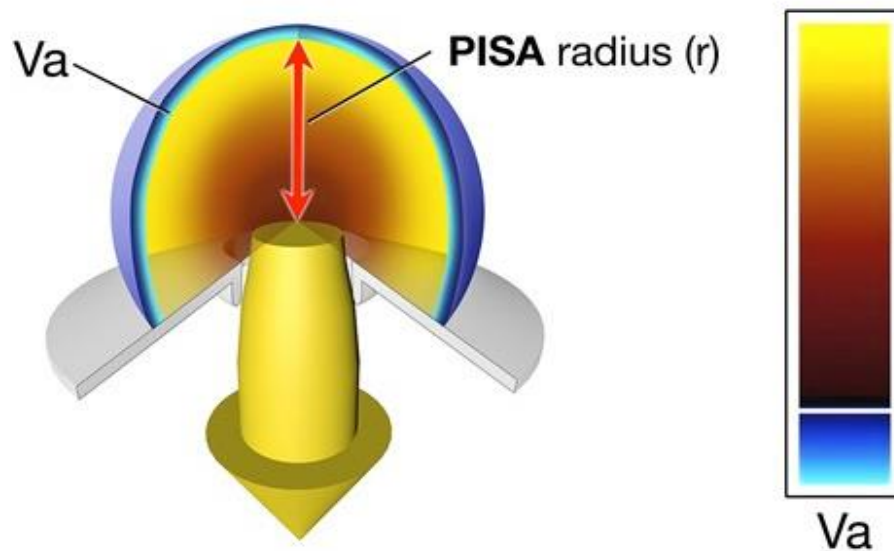
Flow Convergence &  
Vena Contracta  
evaluation are  
essential

Jet area alone is  
often misleading

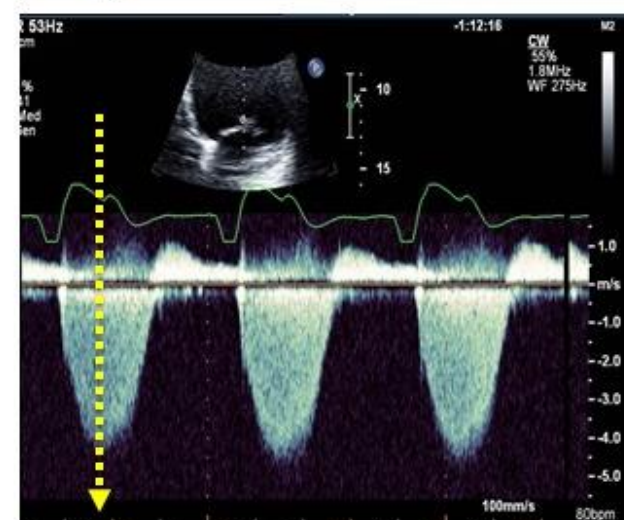
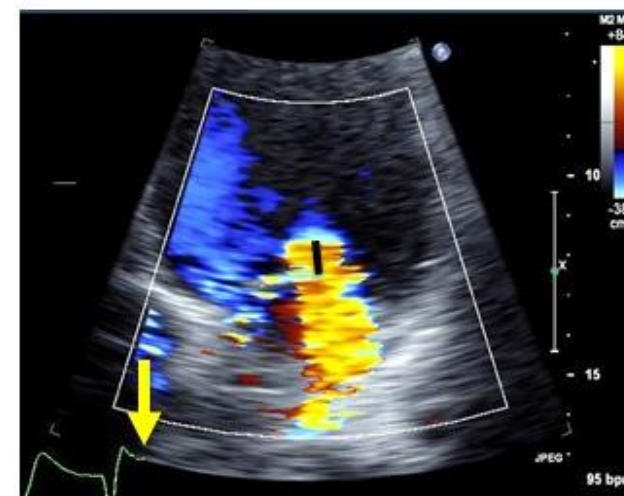


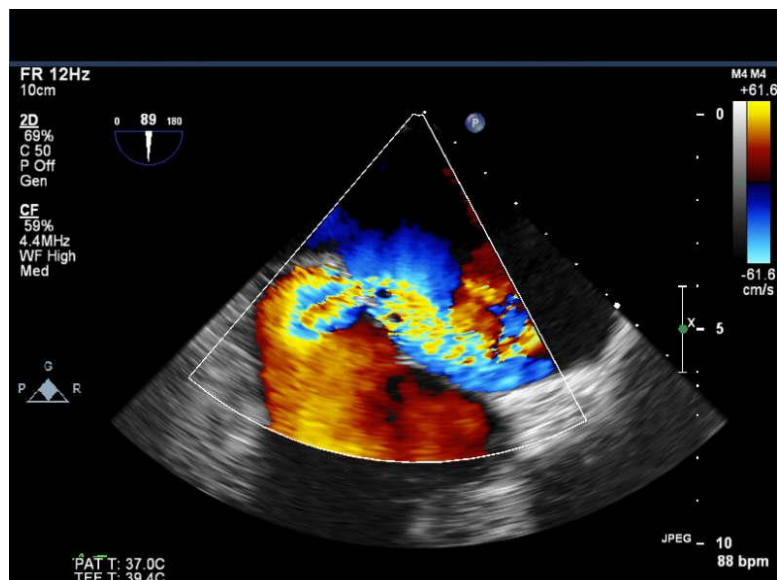
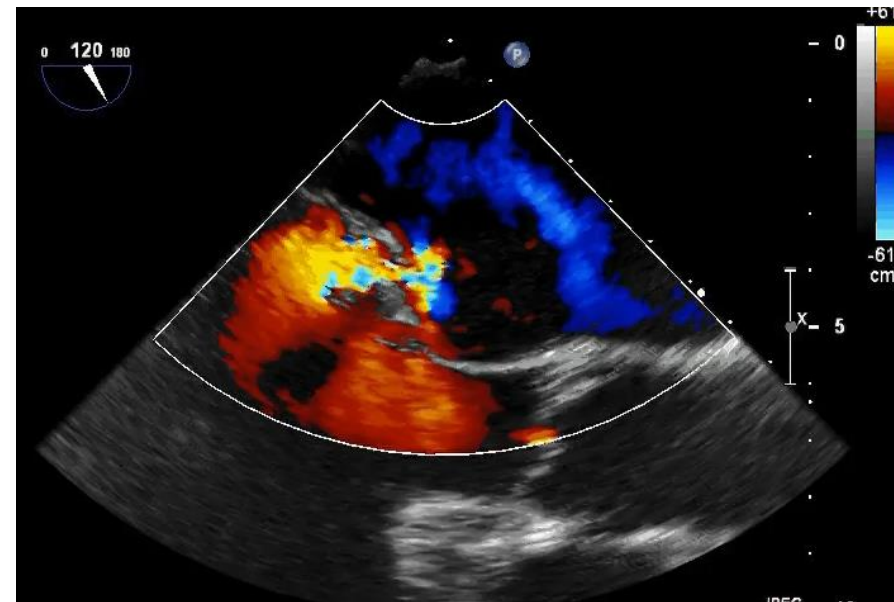
# Flow Convergence (PISA)

## Flow Convergence Method



$$\begin{aligned}\text{Reg Flow} &= 2\pi r^2 \times V_a \\ \text{EROA} &= \text{Reg Flow} / \text{PKV}_{\text{Reg}} \\ \text{R Vol} &= \text{EROA} \times \text{VTI}_{\text{Reg}}\end{aligned}$$





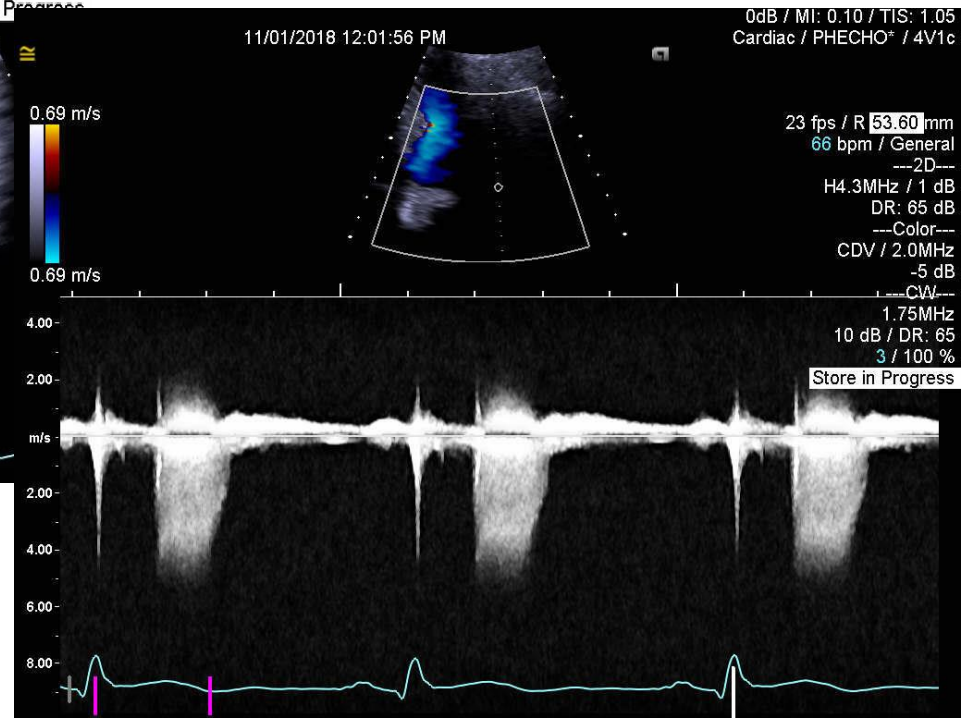
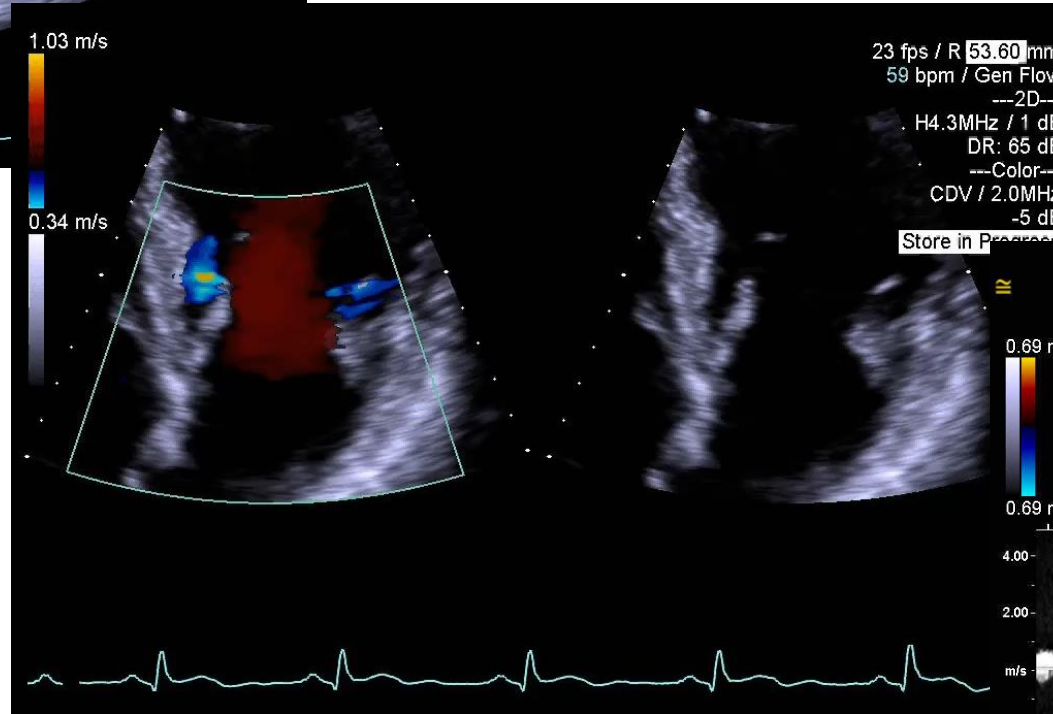
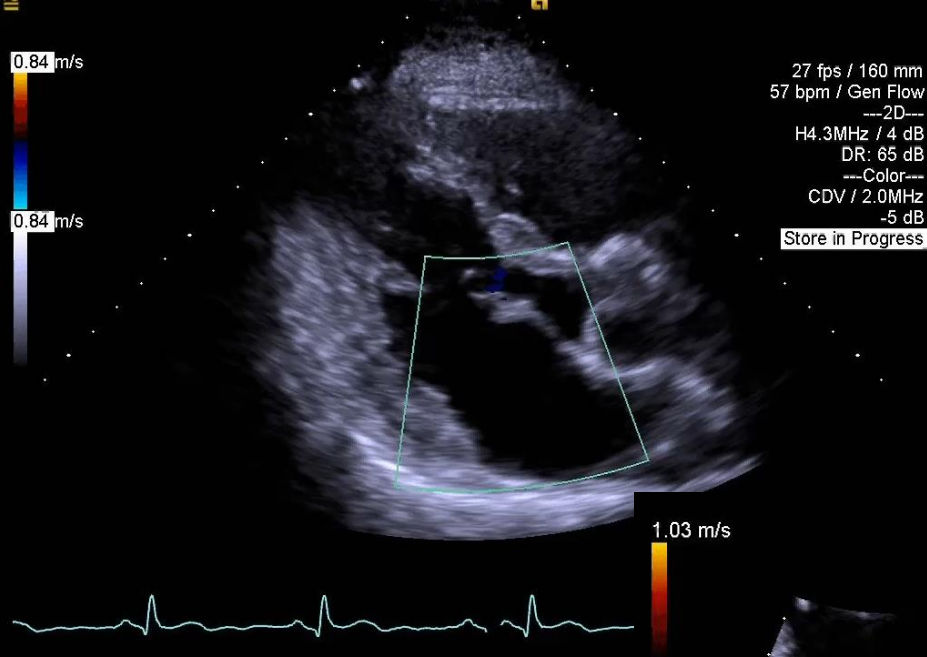
## Flow Convergence

- Use at least semi-quantitatively (always!)
- Assumptions of hemispheric geometry
- EORA may be underestimated in 2<sup>ary</sup> MR
- Less accurate in eccentric jets
- Caution in non-holosystolic MR

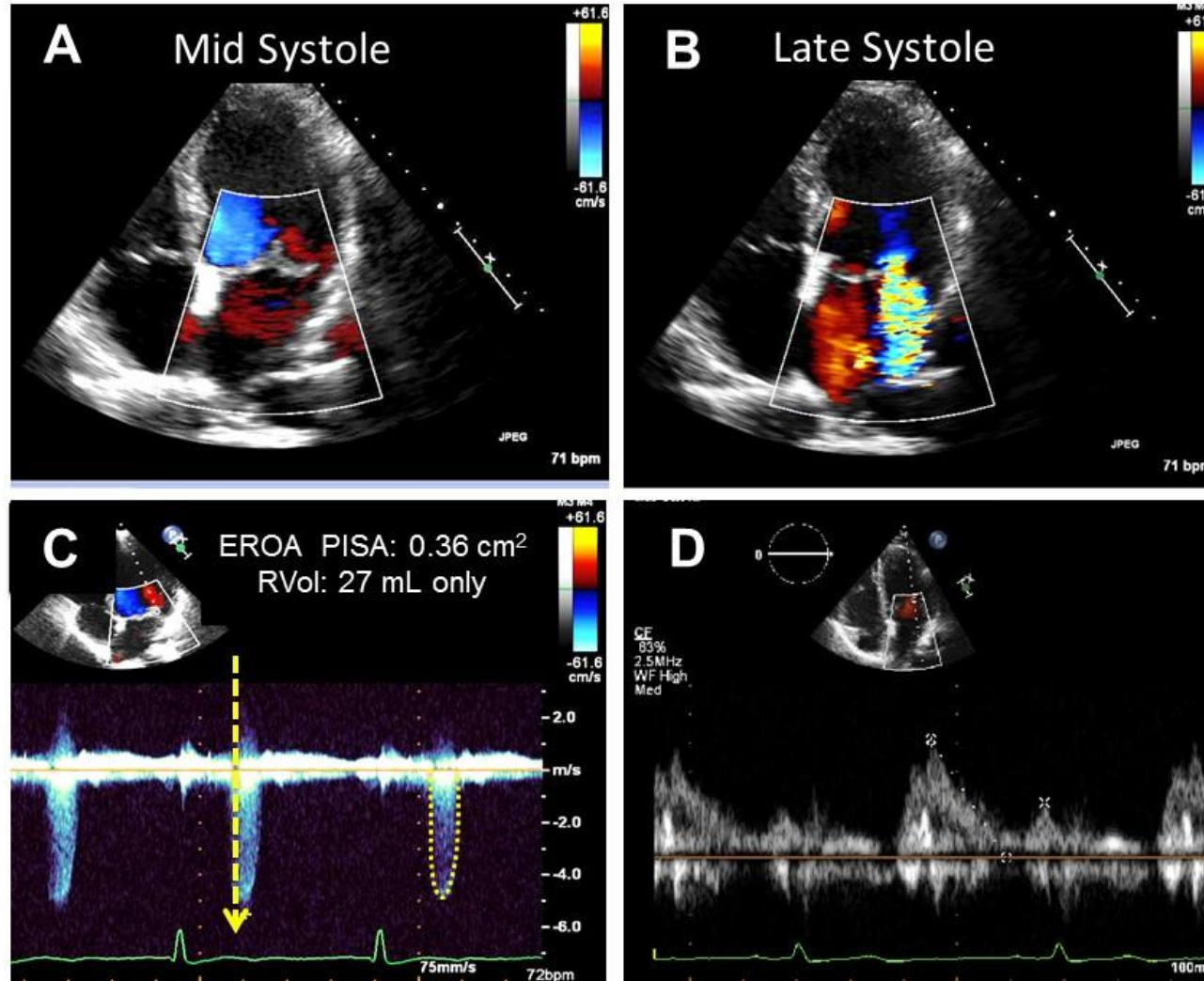


# Unique to the MV: Regurgitation may not be holosystolic

## Late Systolic MR

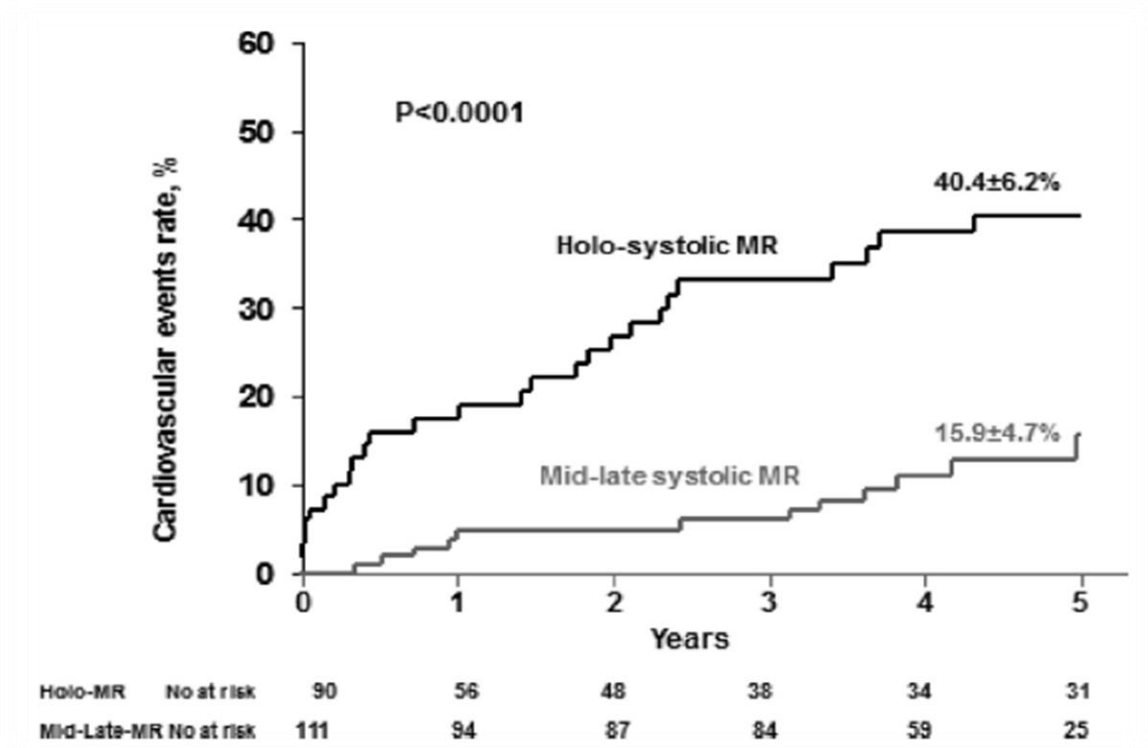
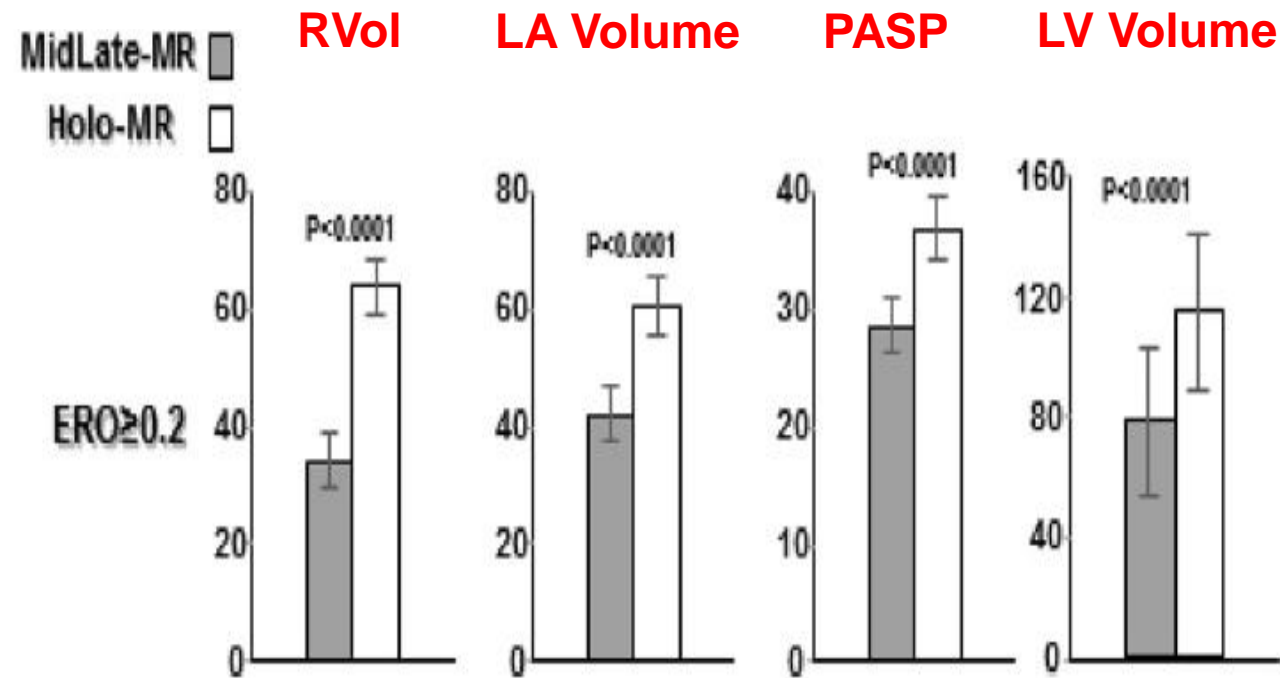


# Late Systolic MR Associated with MVP



**Cannot Use**  
Color Doppler Measures of  
severity (Jet area, VC, VCA,  
Flow Convergence, EROA)

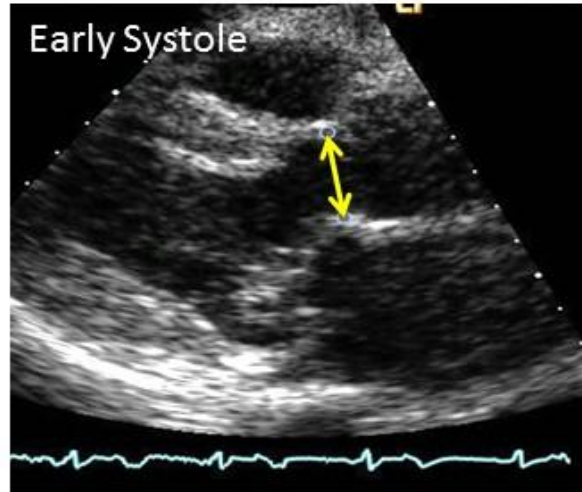
# Non-Holosystolic MR is Milder & has a Better Prognosis



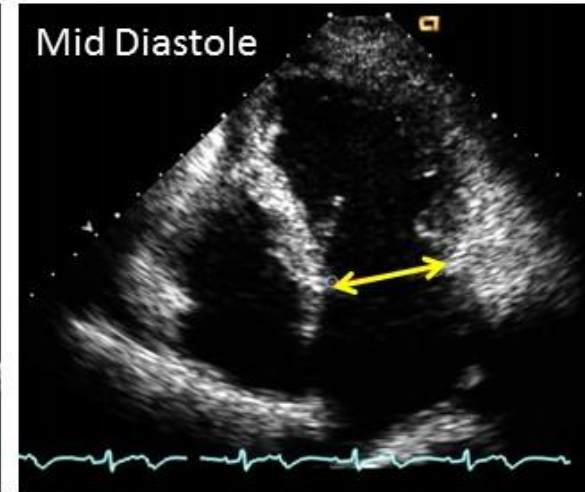
# Pulsed Doppler Volumetric Quantitation

Annular Diameter

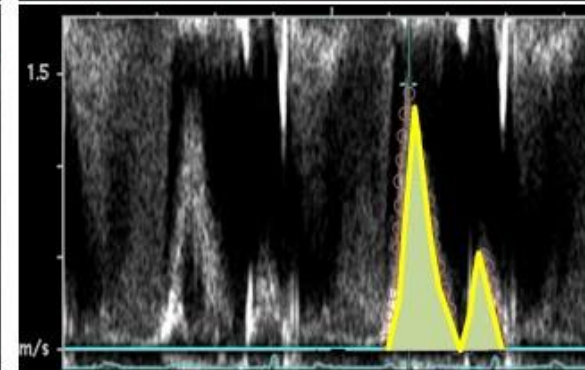
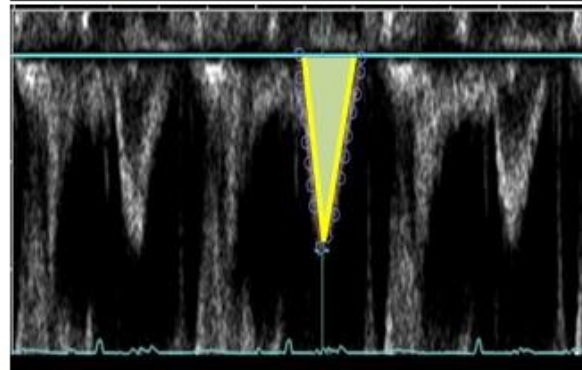
LV Outflow



Mitral Annulus



Velocity- PW



$$\begin{aligned}SV_{LVOT} &= CSA_{LVOT} * VTI_{LVOT} \\ &= 0.785 * d_{LVOT}^2 * VTI_{LVOT}\end{aligned}$$

$$\begin{aligned}SV_{MV} &= CSA_{MV} * VTI_{MV} \\ &= 0.785 * d_{MV}^2 * VTI_{MV}\end{aligned}$$



# Regurgitant Volume & Fraction

## **Advantages**

- Quantitative, valid in multiple jets and eccentric jets
- Provides both lesion severity and volume overload

## **Limitations**

- Needs training; Cumbersome; wide (20%) confidence limits
- Measurement of flow at MV annulus is less reliable in calcific MV and/or annulus





# MV Pathology by CMR

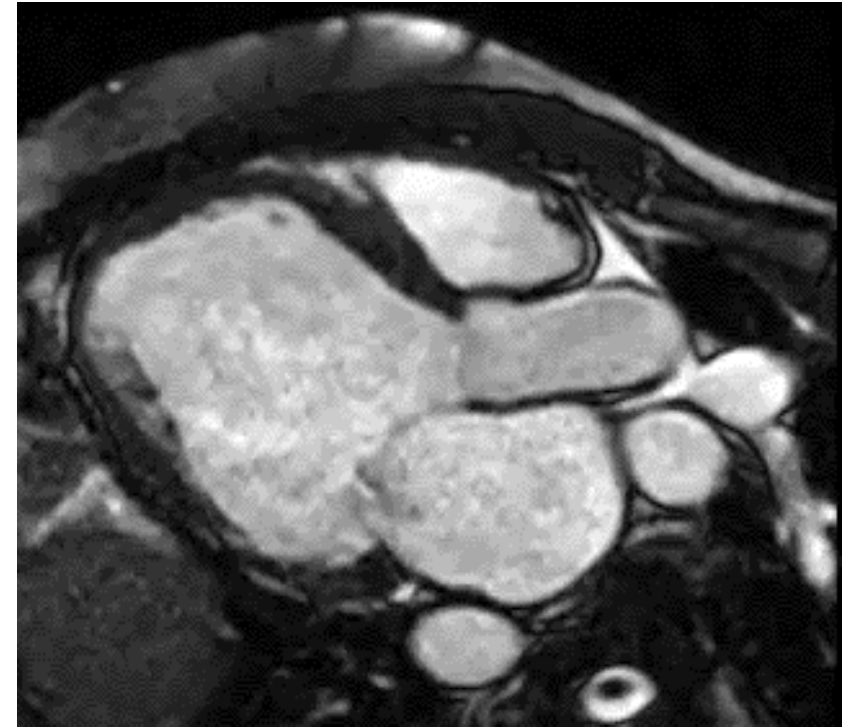
Barlow



Flail

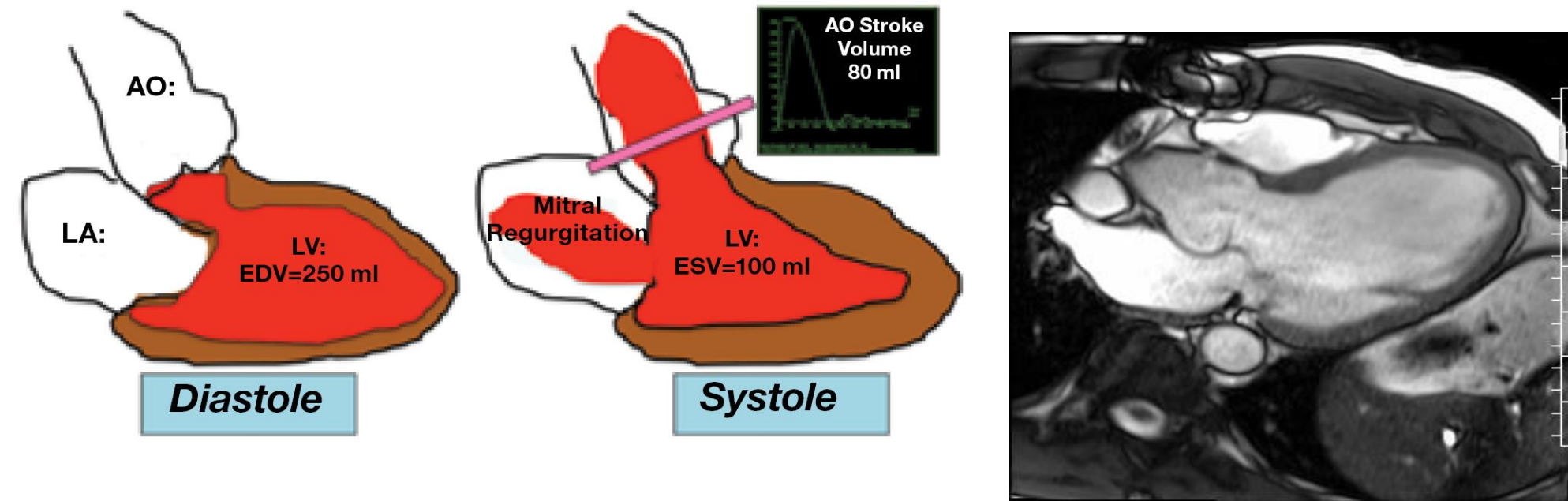


2<sup>nd</sup> MR



# CMR Quantification of MR Severity

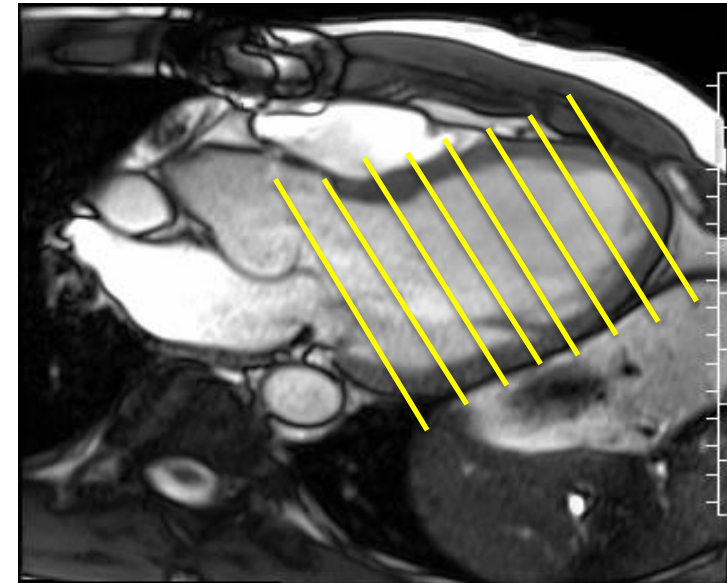
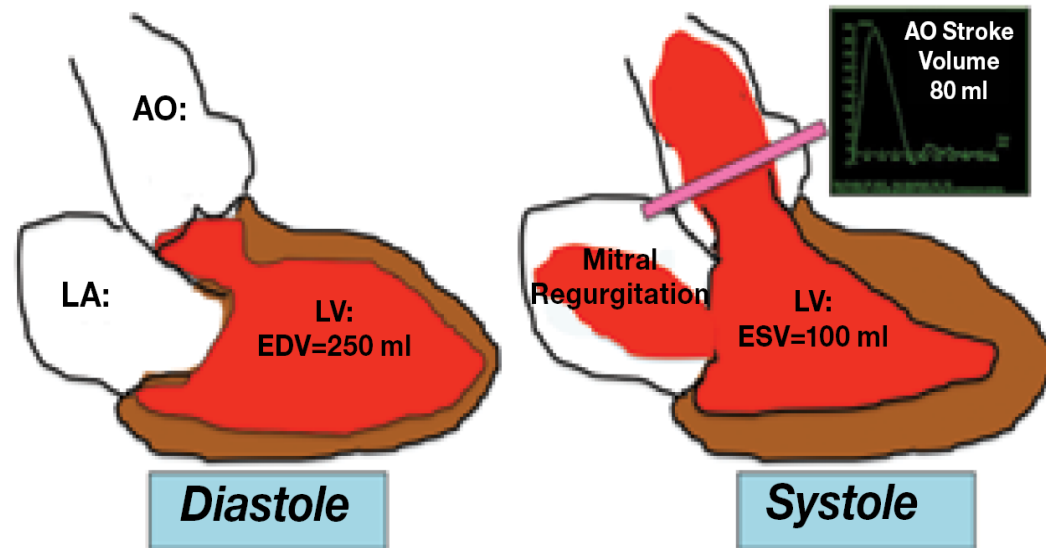
## *Indirect method*



**Mitral Reg Vol = LV stroke volume – Aortic stroke volume**

***Assessment of MR Severity dependent on volume comparisons***

# Variability in Quantitating Regurgitation is less for CMR *but...It is not Nil !*



- Slice thickness: 6-8 mm
- Error from choice of the last basal slice, worse with large LV (descent of the base)
- “pseudo MR” when there is no regurgitation: RF 10-15 %
- Poor breathhold, Atrial fibrillation (or heart rate variability) is an issue
- Susceptibility artifacts from ICDs...

# Which Additional Test after TTE in MR: TEE or CMR ?

## Favors TEE

- Mechanism of MR/MV structure/endocarditis
- Concomitant atrial fibrillation
- Presence of CMR susceptibility artifacts (ICDs etc.); Renal dysfunction
- Prosthetic valves
- When bedside exam is needed

## Favors CMR

- Eccentric Jets & multiple jets, when quantitation by echo is needed and difficult
- When Quantitation of MR (Rvol/RF) is needed, and difficult with TTE
- In 2<sup>nd</sup> MR, to assess myocardial viability



NEW RESEARCH PAPER

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# American Society of Echocardiography Algorithm for Degenerative Mitral Regurgitation

## Comparison With CMR

Seth Uretsky, MD,<sup>a</sup> Islamiyat Babs Animashaun, MBBS, MPH,<sup>a</sup> Sakul Sakul, MD, MPH,<sup>b</sup> Lillian Aldaia, MD,<sup>a</sup>  
Leo Marcoff, MD,<sup>a</sup> Konstantinos Koulogiannis, MD,<sup>a</sup> Edgar Argulian, MD,<sup>b</sup> Mark Rosenthal, MD,<sup>a</sup>  
Steven D. Wolff, MD, PhD,<sup>c</sup> Linda D. Gillam, MD, MPH<sup>a</sup>

JACC CV Img Feb 2022

EDITORIAL COMMENT

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# Challenges and Opportunities in Evaluating Severity of Degenerative Mitral Regurgitation

Details Matter\*

William A. Zoghbi, MD

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# Details Indeed Matter!

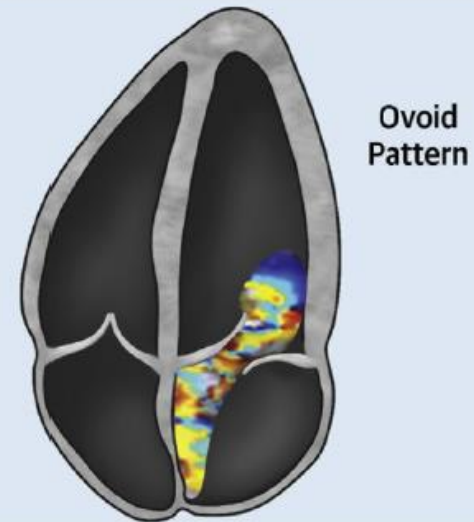
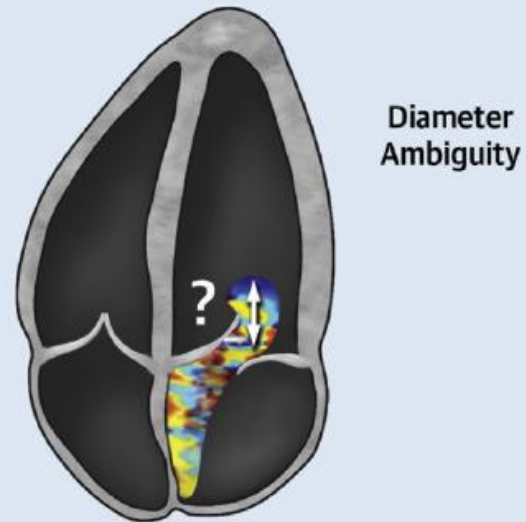
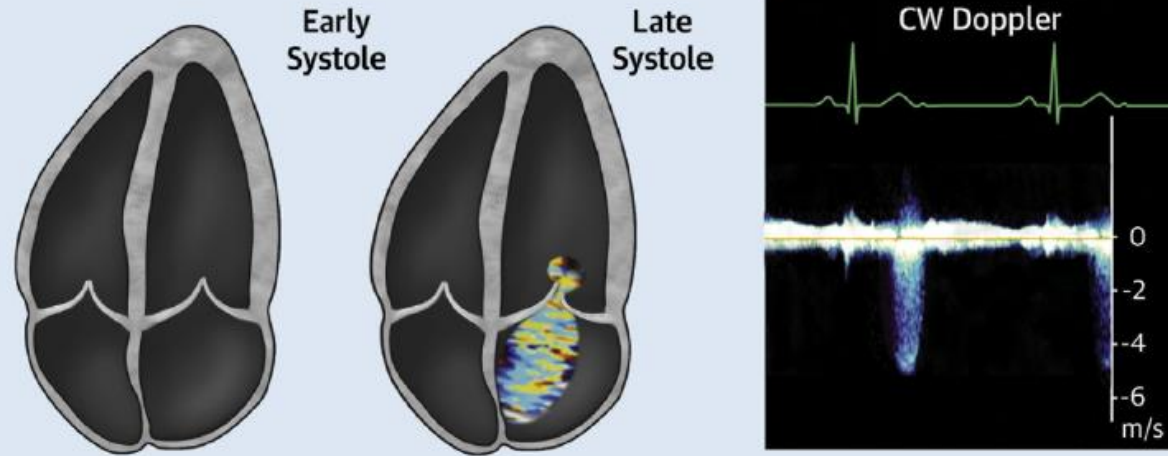
## Findings of concern regarding accuracy of The echocardiographic data:

- 20% of flail MV had mild MR
- 24% with a flow convergence radius  $>1$  cm had mild MR
- A VC diameter  $>0.7$  cm associated with mild MR in 25% of cases.
- 20% of patients with pulmonary vein reversal flow had mild MR.
- Normal LV and LA size in 20% with severe MR.
- Color Doppler more accurate in eccentric jets

All quantitative data measured with color Doppler alone,  
in all patients & Irrespective of Modifiers

## Conditions Leading to Overestimation of MR by Flow Convergence Method

### Non-Holosystolic MR

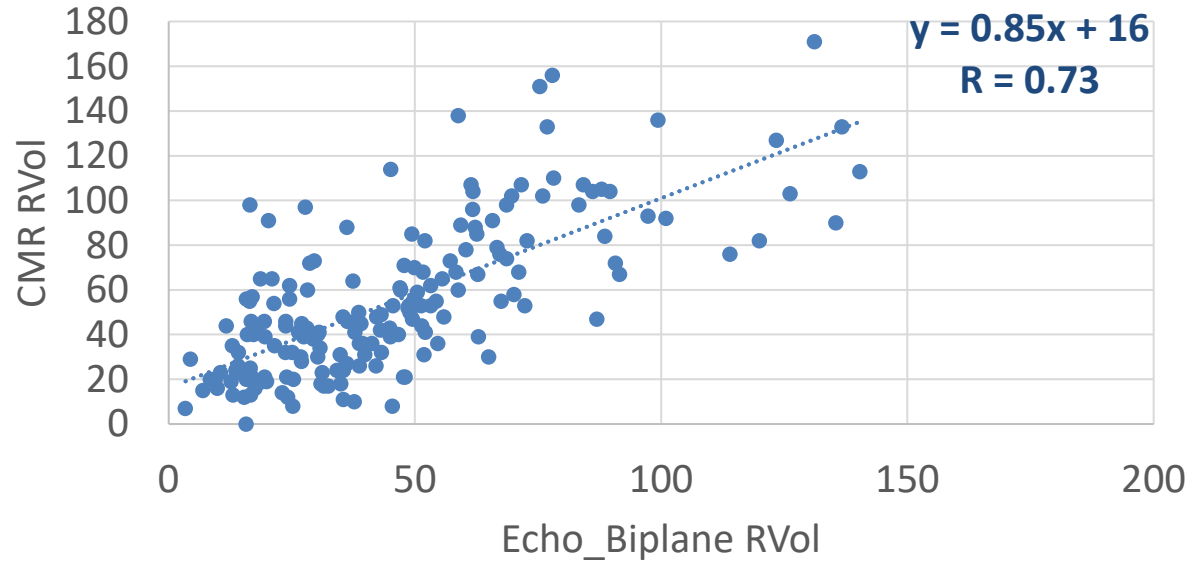


# Prospective Study of MR *Near Simultaneous Echo/CMR*

- **Aims:** Compare TTE and CMR in their ability to quantify MR severity and their relation to clinical outcomes.
- **Near simultaneous studies, < 4 hrs apart**
- **177 patients: MVP 42%, Flail 25%, 2<sup>nd</sup> MR 20%.**
- **MR Regurgitation severity:**
  - CMR RVol:  $\text{Total LV}_{sv} - \text{LVOT}_{sv}$
  - TTE RVol several methods



# Echo Biplane vs CMR



	CMR				
ECHO	Grade 1	Grade 2	Grade 3	Grade 4	Total
Grade 1	27	16	9	7	59
Grade 2	13	13	6	4	36
Grade 3	3	7	10	12	32
Grade 4	0	2	4	44	50
Total	43	38		67	177
Exact concordance	53%				
Two-grades concordance	86%				

# Echocardiography & CMR In Valvular Heart Disease

- Echocardiography & CMR are complementary Imaging Modalities Echo is the first line modality.
- Variability in MR assessment is less in CMR;
- Clinically significant discordance between Echo/CMR is infrequent (10-15%).
- Knowledge of each modality's advantages and limitations is crucial in their appropriate utilization and in understanding discrepancies

# Evaluation of Mitral Regurgitation

- Identification of Etiology/Mechanism of regurgitation
- 2D/3D TTE--an integrative approach & algorithms to assess severity
- Role of CMR
- Beware of MVP: non-Holosystolic MR for color Doppler; incorporate prolapse volume particularly in Barlow disease
- Library of case studies on the web:  
[www.asecho.org/vrcases](http://www.asecho.org/vrcases)