

# Evaluation of Mitral Regurgitation

## *New Concepts in Mitral valve Prolapse*

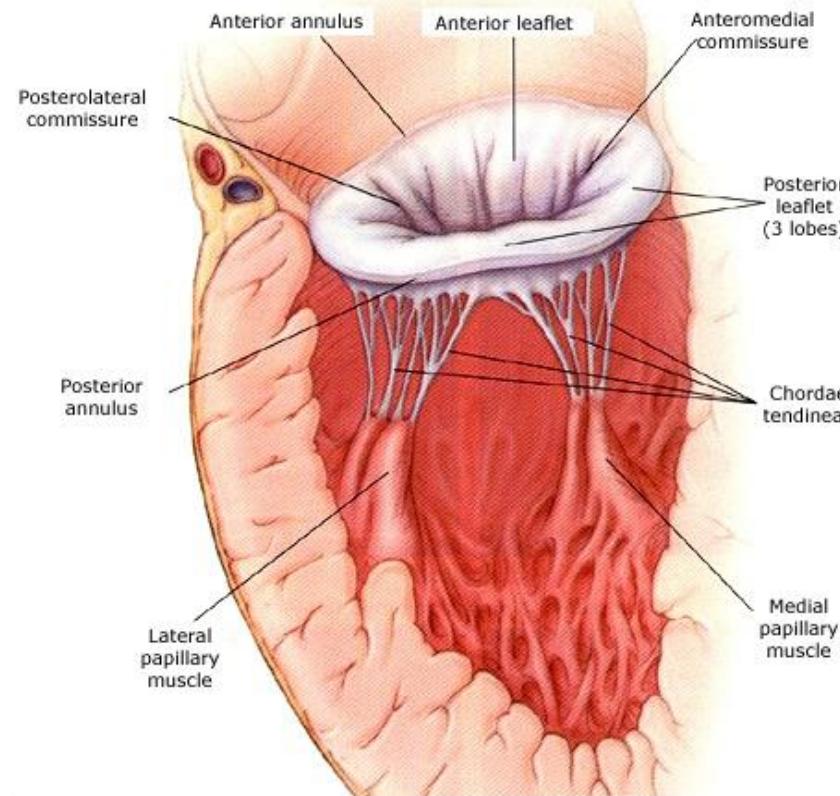
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Elkins Family Distinguished Chair in Cardiac Health  
Houston Methodist Hospital*

# 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

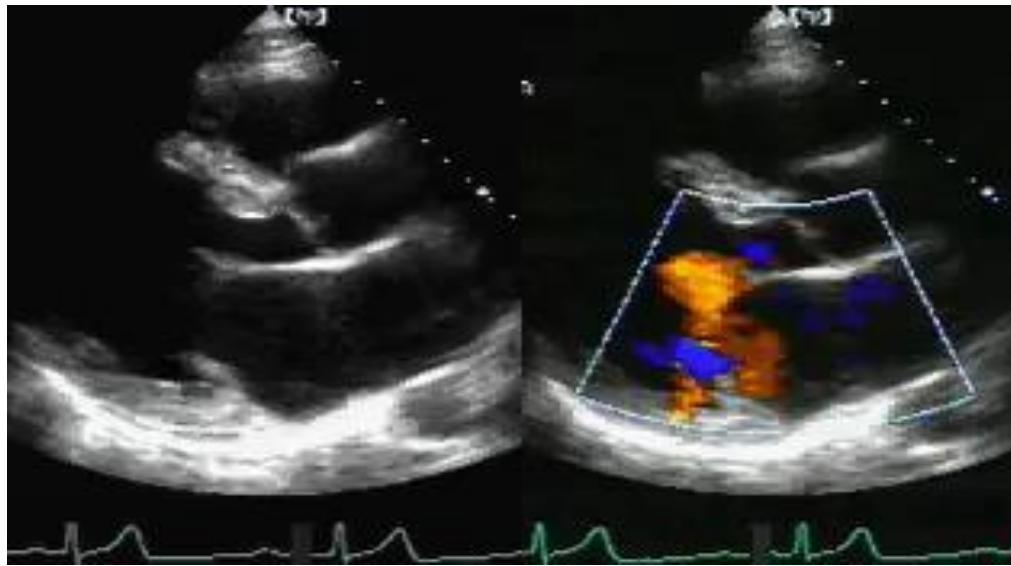
A Report from the American Society of Echocardiography  
Developed in Collaboration with the Society for Cardiovascular Magnetic Resonance

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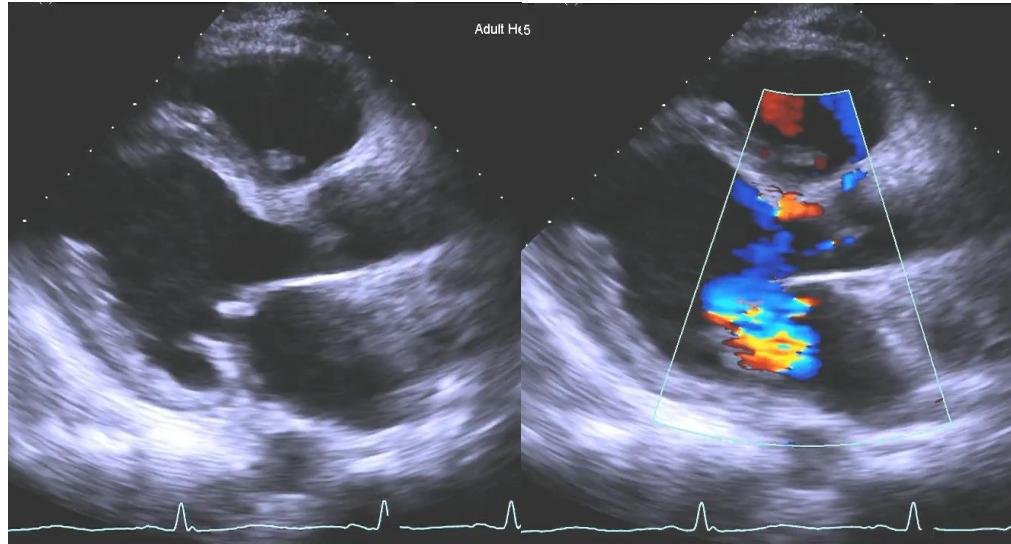
## What is New?

- 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

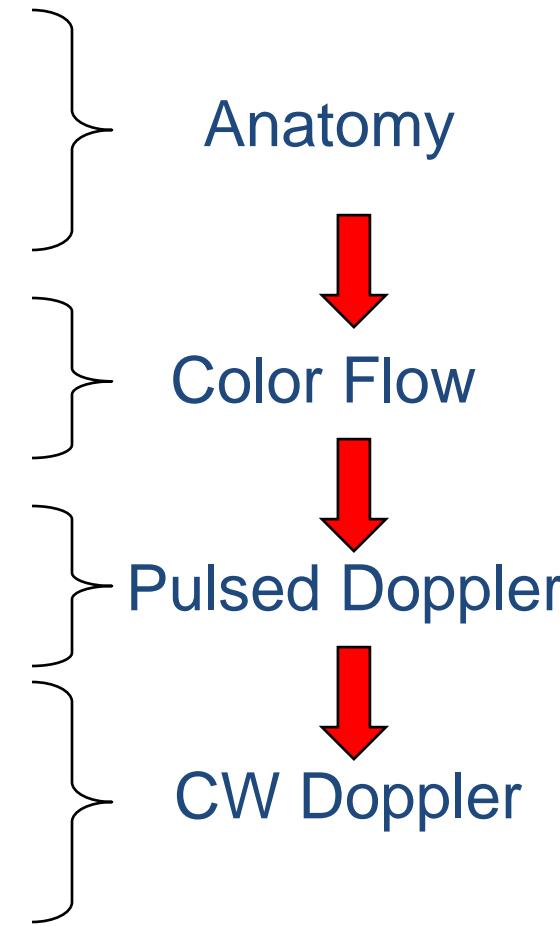


Secondary

# Mitral Regurgitation

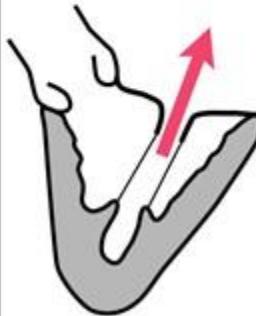
## *Indicators of Severity*

- 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

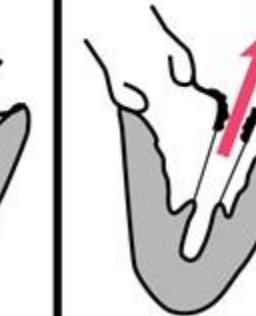
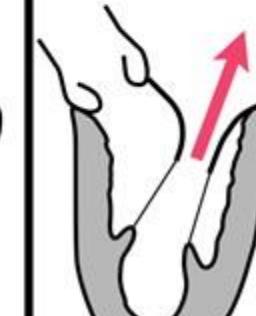


# Carpentier Classification of Mechanisms of MV Regurgitation

## Mitral Regurgitation

Type I Normal Leaflet Motion	Type II Excessive Leaflet Motion	Type III Restricted Leaflet Motion
Annular Dilation	Perforation	Prolapse
		

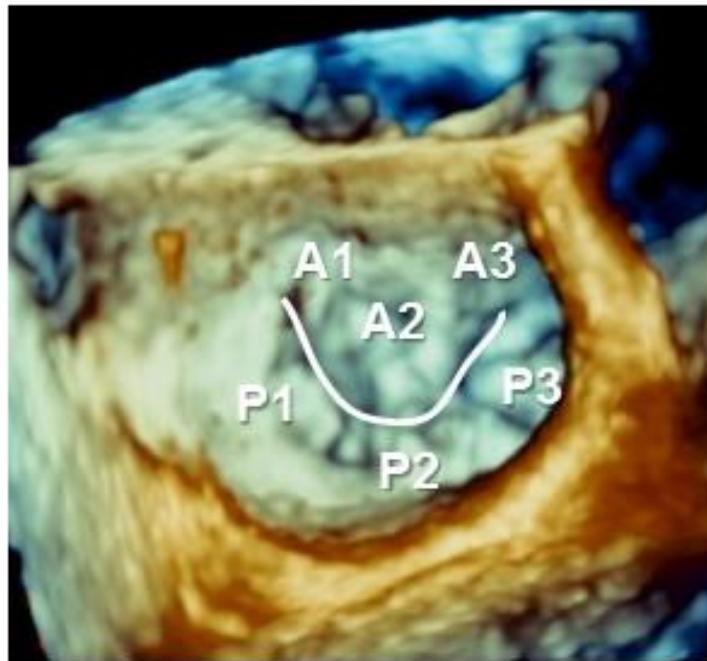
  

	
a Thickening/ Fusion	b LV/LA Dilation

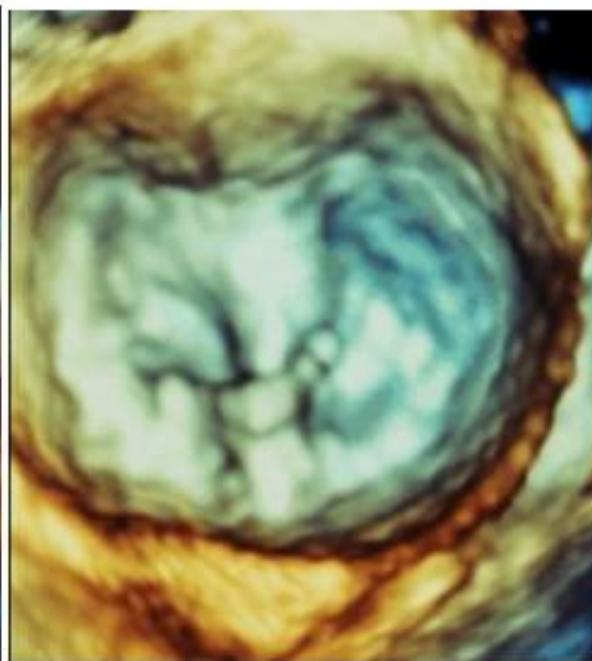
Zoghbi W et al JASE March 2017

# 3D Echocardiography- MV

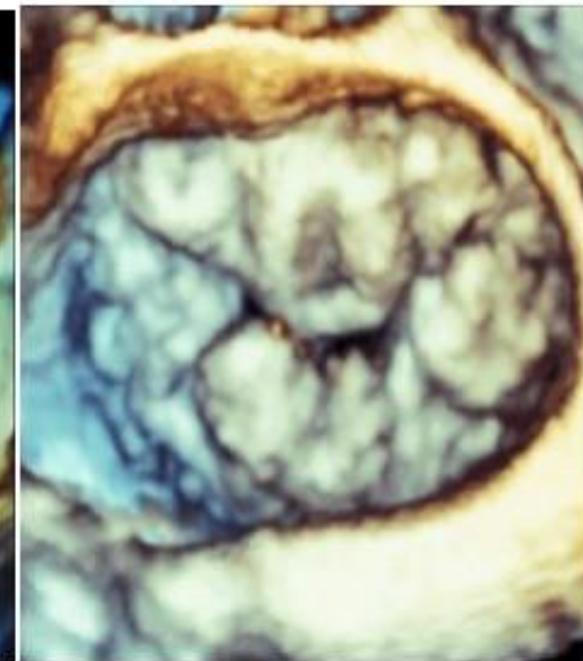
**Normal**



**Fibroelastic Deficiency**



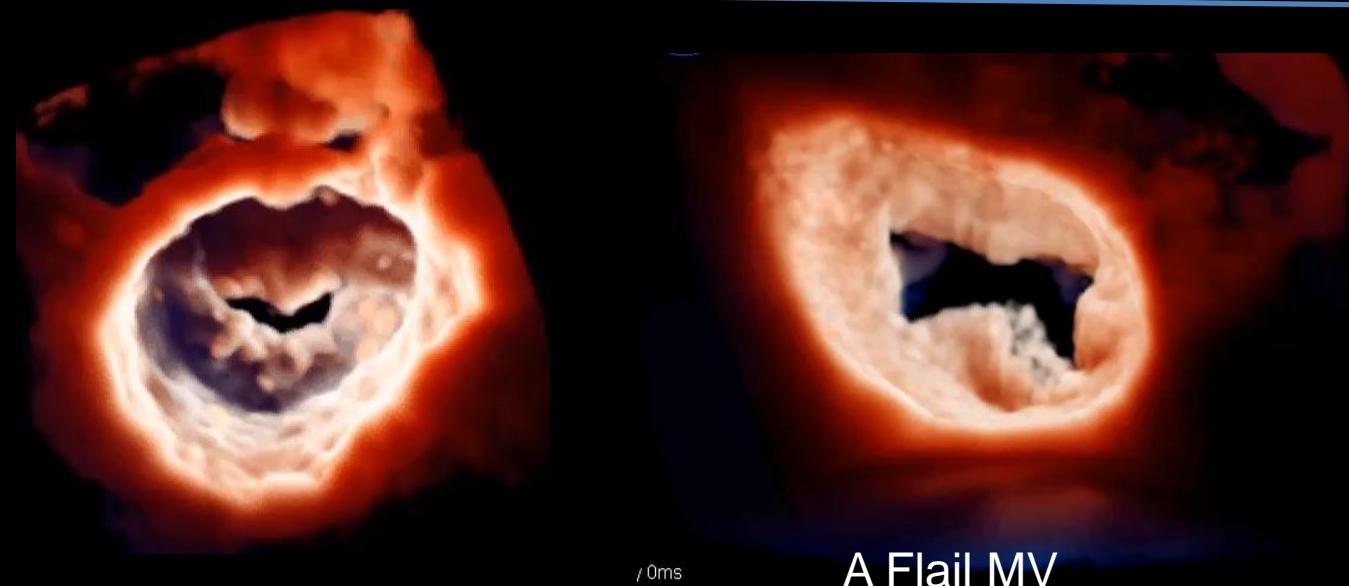
**Barlow's Disease**



# Trans-illumination 3D Imaging



“Classic” 3D view

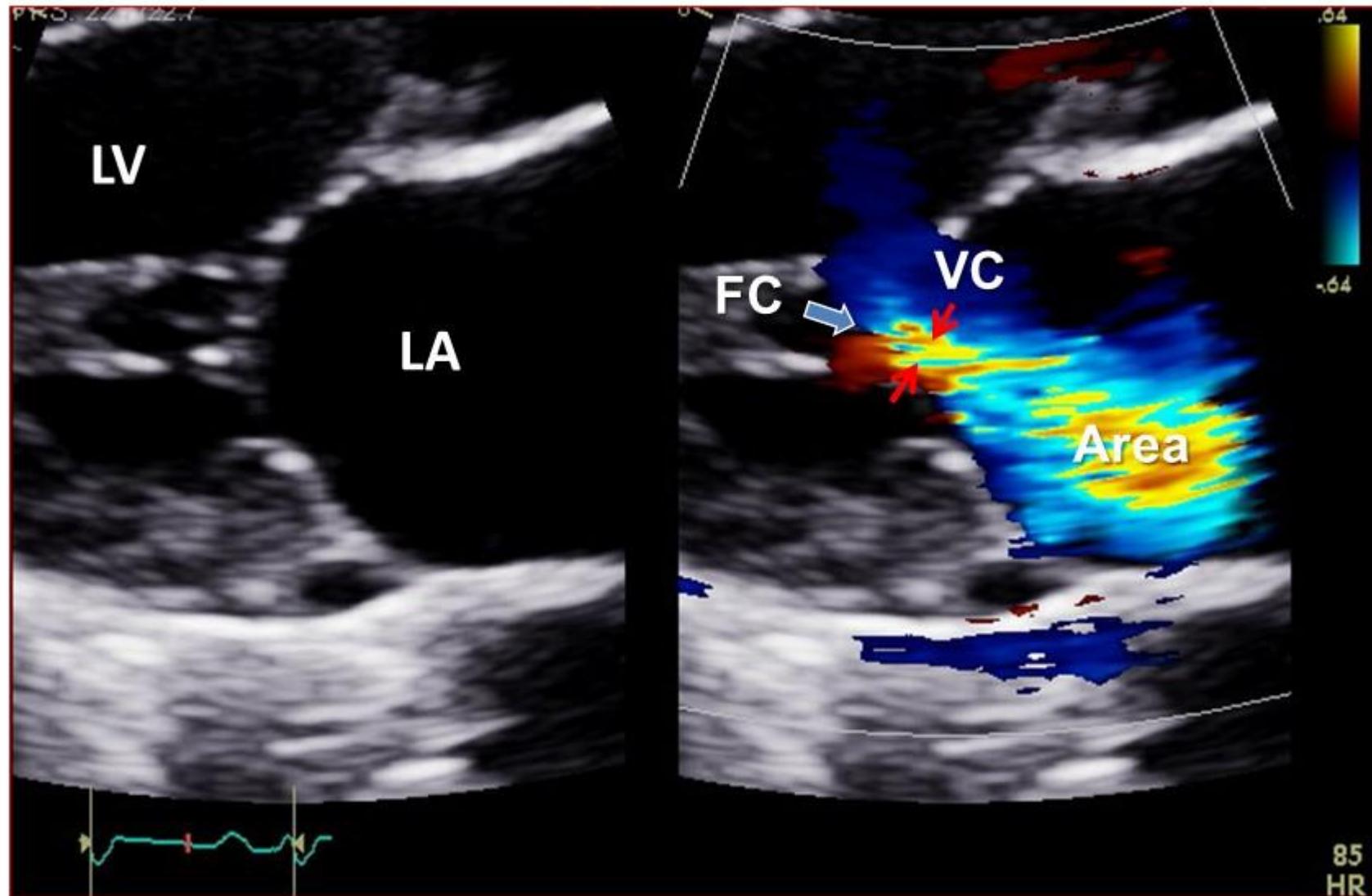


/ 0ms

A Flail MV

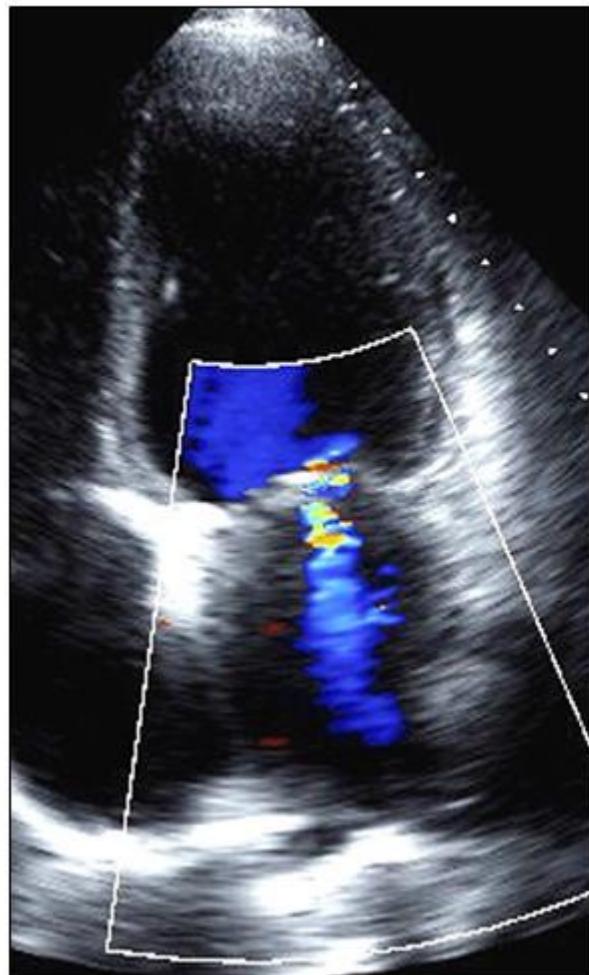
# Mitral Regurgitation- Color Doppler

## 3 Components of the Jet

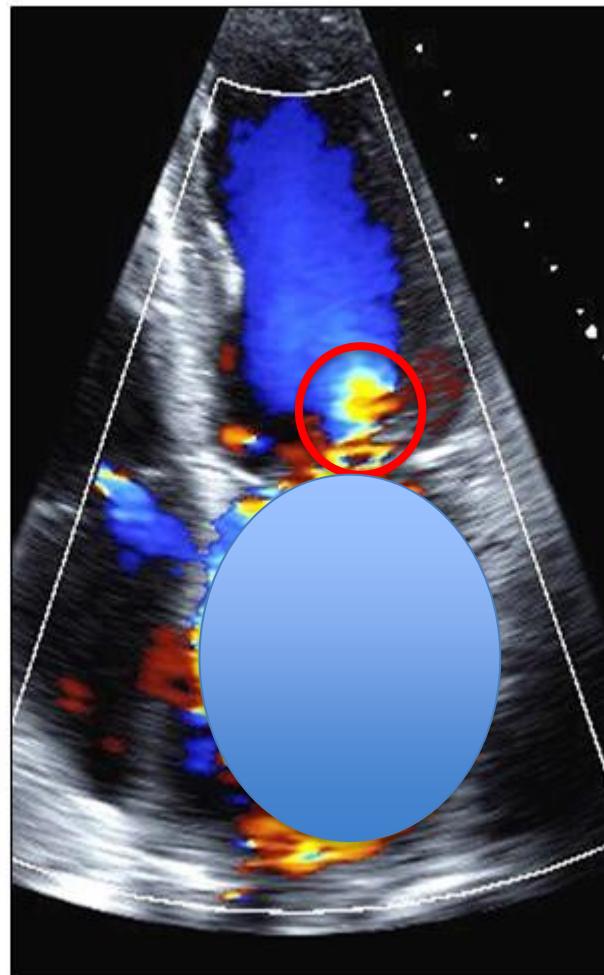


# Mitral Regurgitation

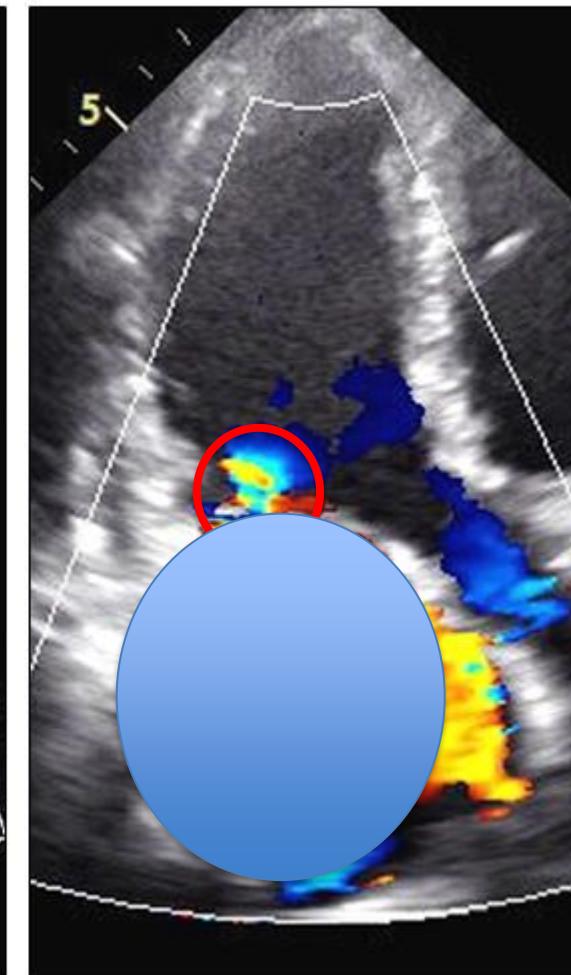
Mild Central



Severe Central



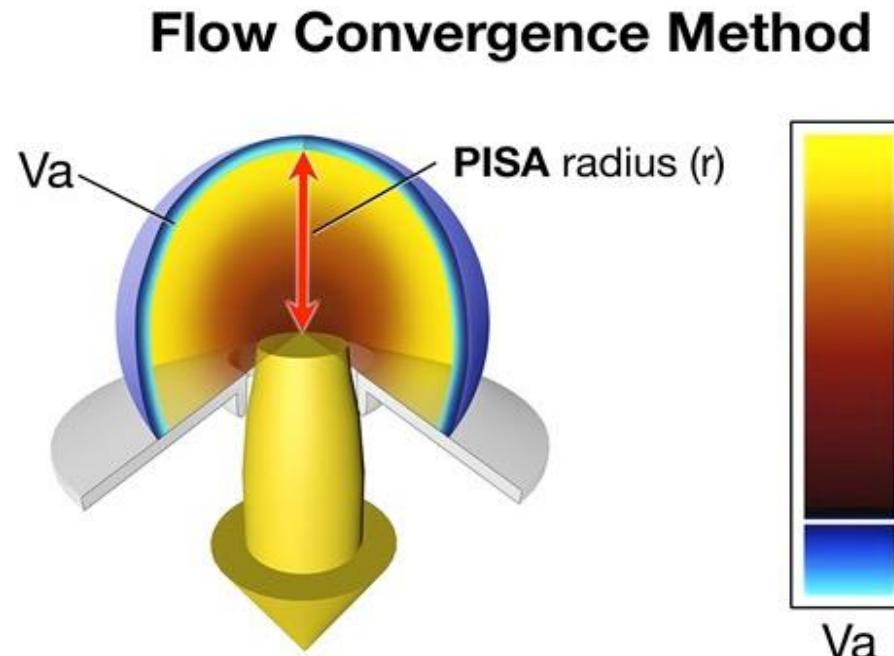
Severe Eccentric



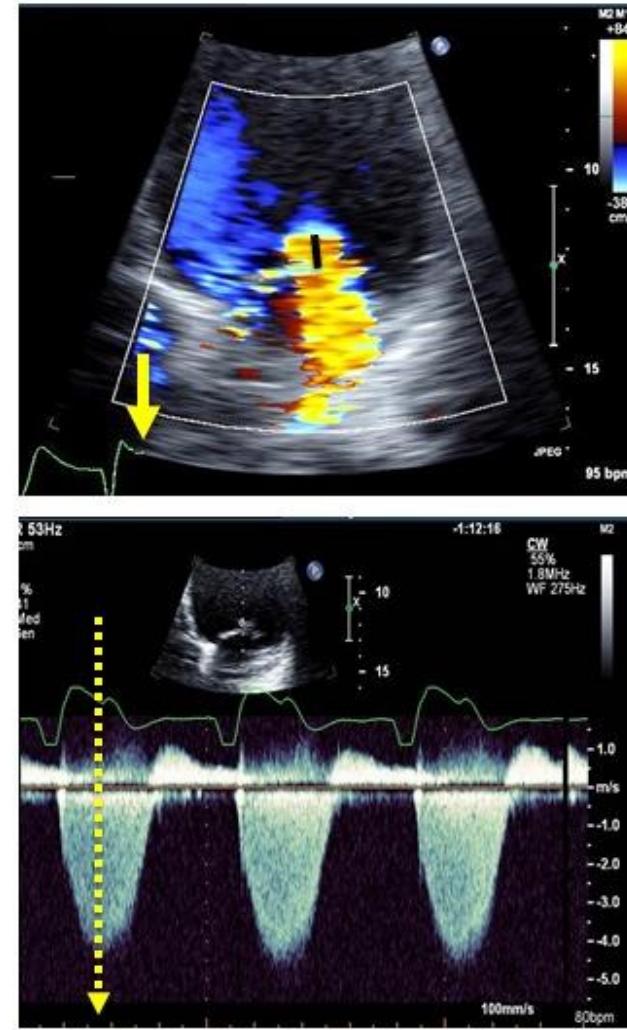
Flow Convergence &  
Vena Contracta  
evaluation are  
essential

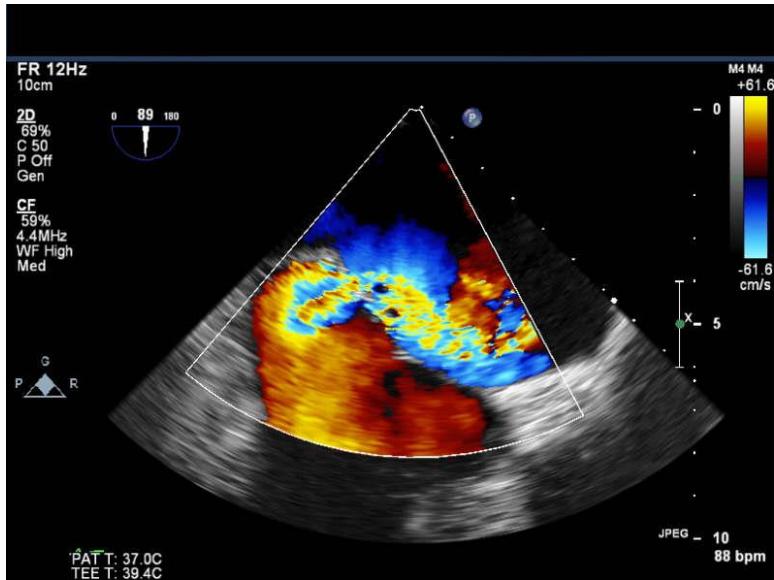
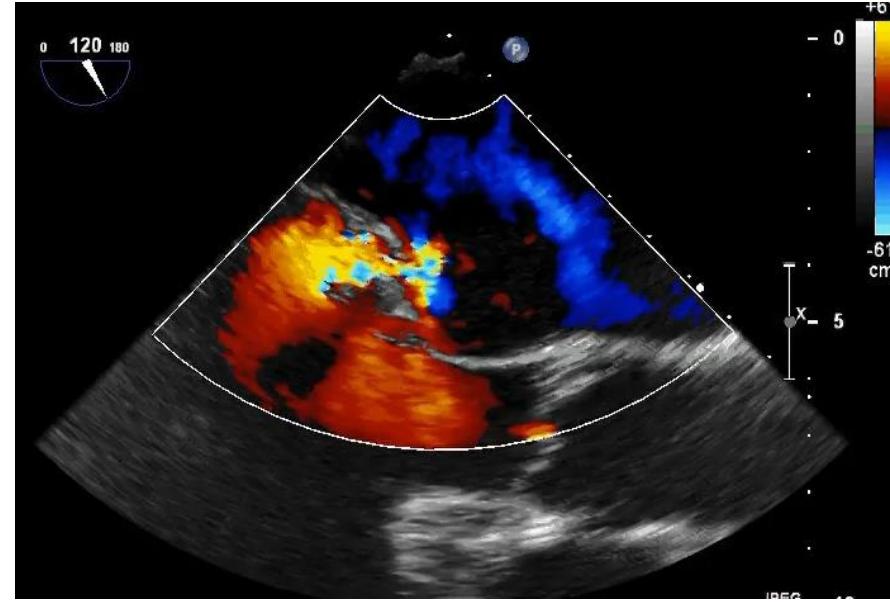
Jet area alone is  
often misleading

# Flow Convergence (PISA)



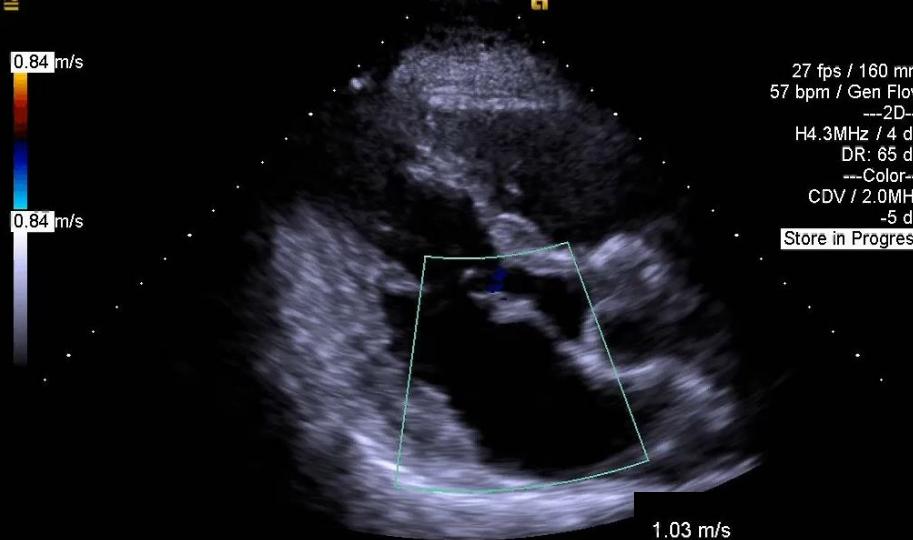
$$\text{Reg Flow} = 2\pi r^2 \times \text{Va}$$
$$\text{EROA} = \text{Reg Flow}/\text{PKV}_{\text{Reg}}$$
$$\text{R Vol} = \text{EROA} \times \text{VTI}_{\text{Reg}}$$





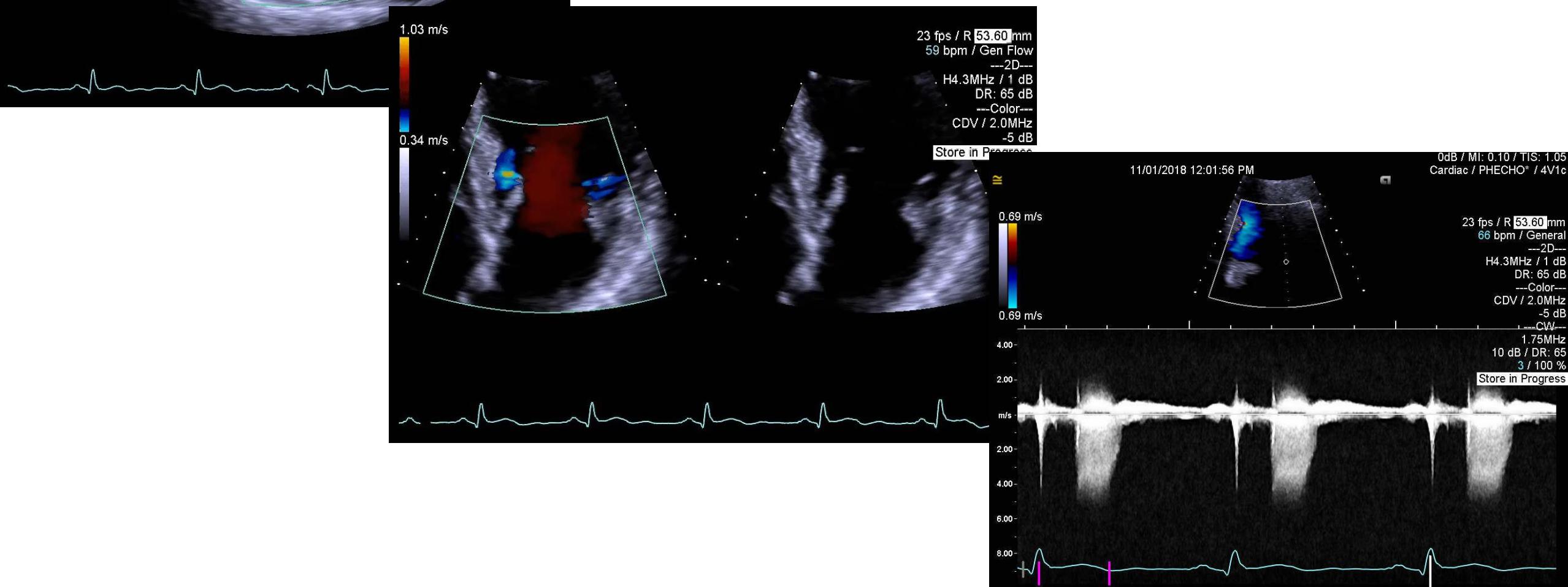
## Flow Convergence

- 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

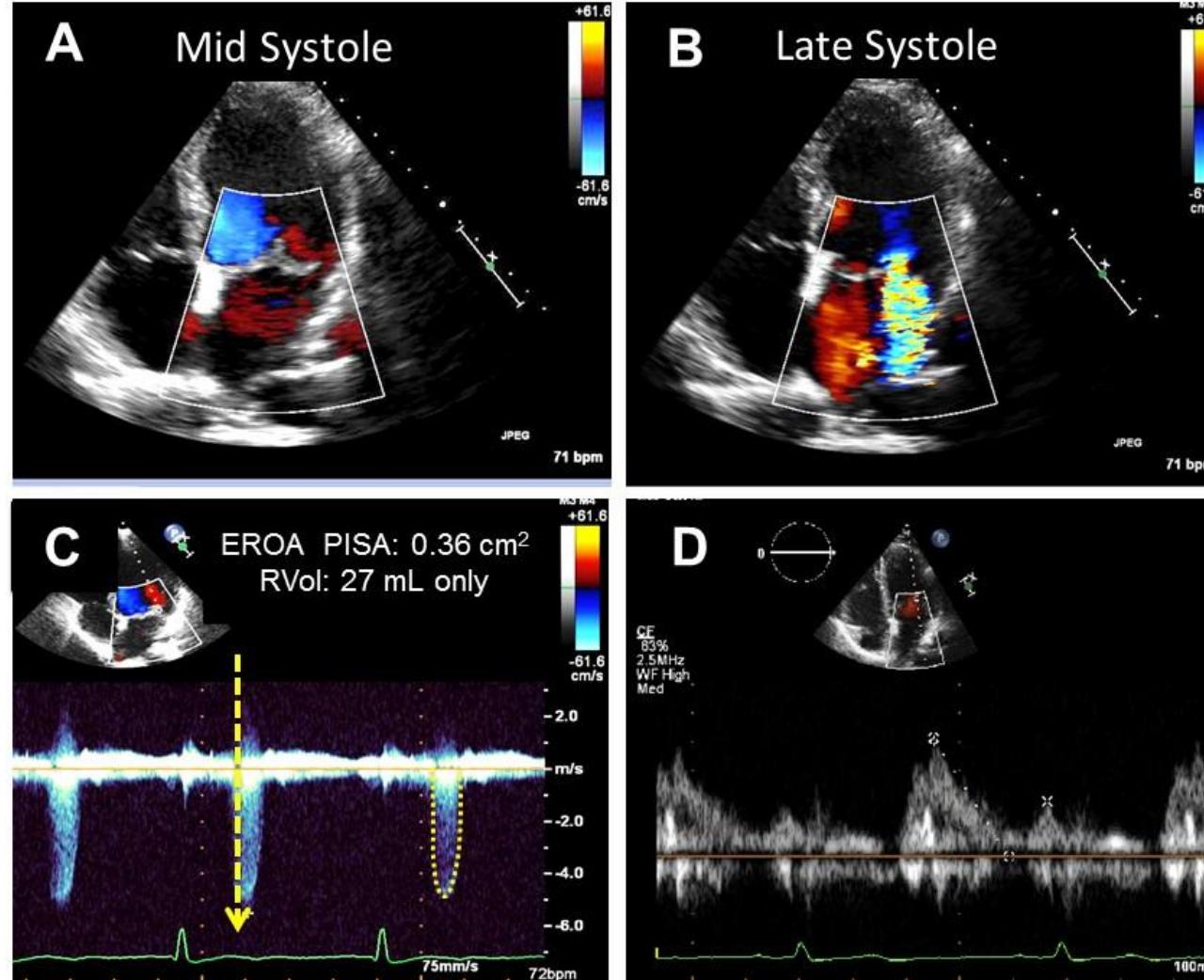


# Unique to the MV: Regurgitation may not be holosystolic

Late Systolic MR

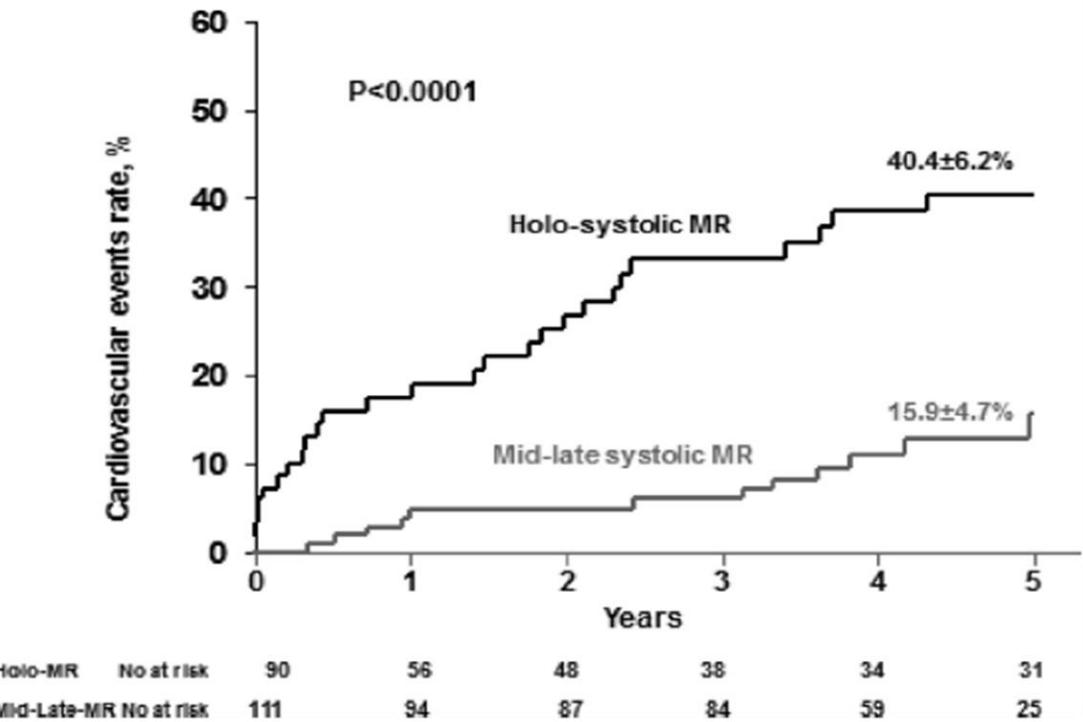
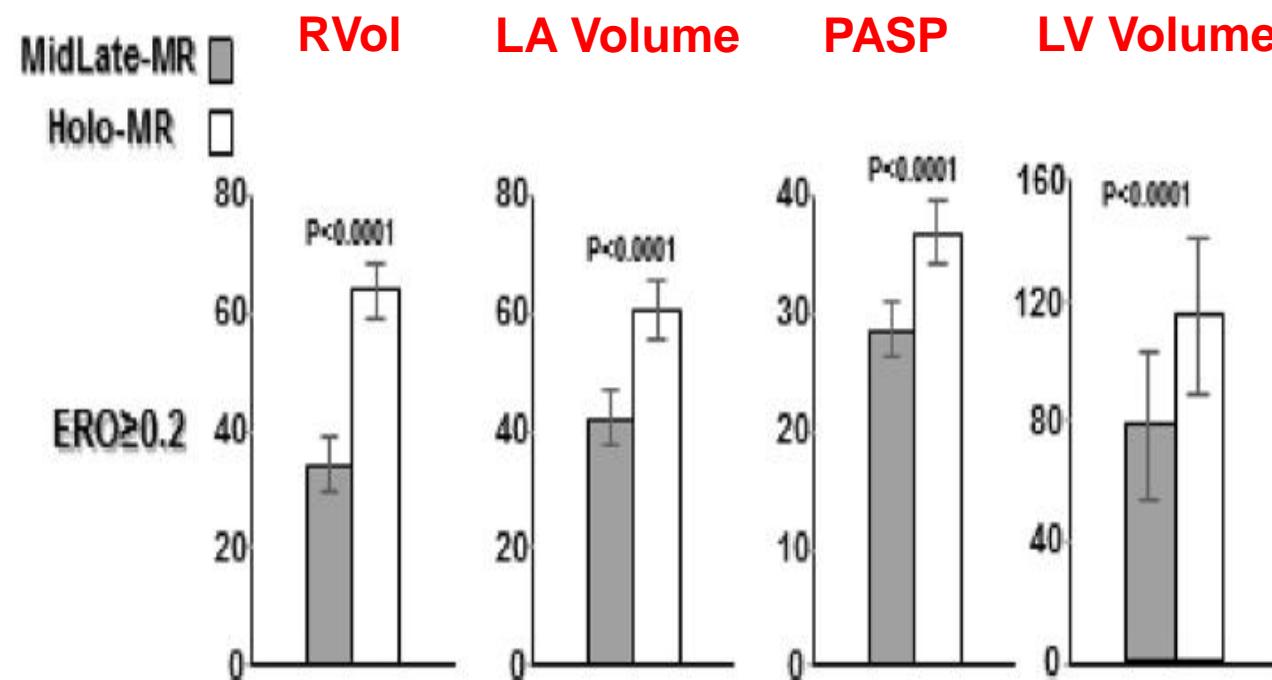


# Late Systolic MR Associated with MVP

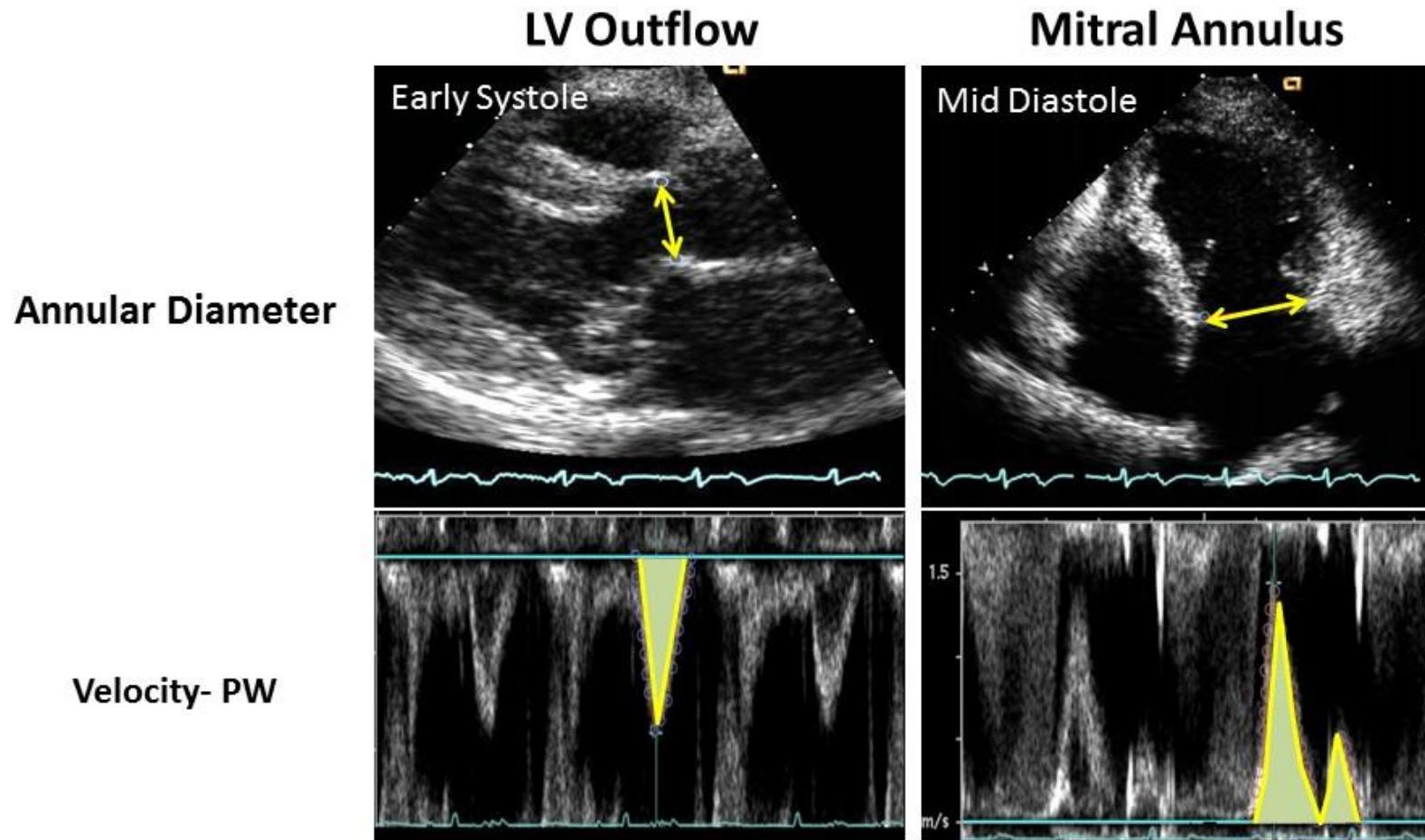


**Cannot Use**  
Color Doppler Measures of  
severity (Jet area, VC, VCA,  
Flow Convergence, EROA)

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



# Pulsed Doppler Volumetric Quantitation



$$\begin{aligned} \text{SV}_{\text{LVOT}} &= \text{CSA}_{\text{LVOT}} * \text{VTI}_{\text{LVOT}} \\ &= 0.785 * d^2_{\text{LVOT}} * \text{VTI}_{\text{LVOT}} \end{aligned}$$

$$\begin{aligned} \text{SV}_{\text{MV}} &= \text{CSA}_{\text{MV}} * \text{VTI}_{\text{MV}} \\ &= 0.785 * d^2_{\text{MV}} * \text{VTI}_{\text{MV}} \end{aligned}$$

# Regurgitant Volume & Fraction

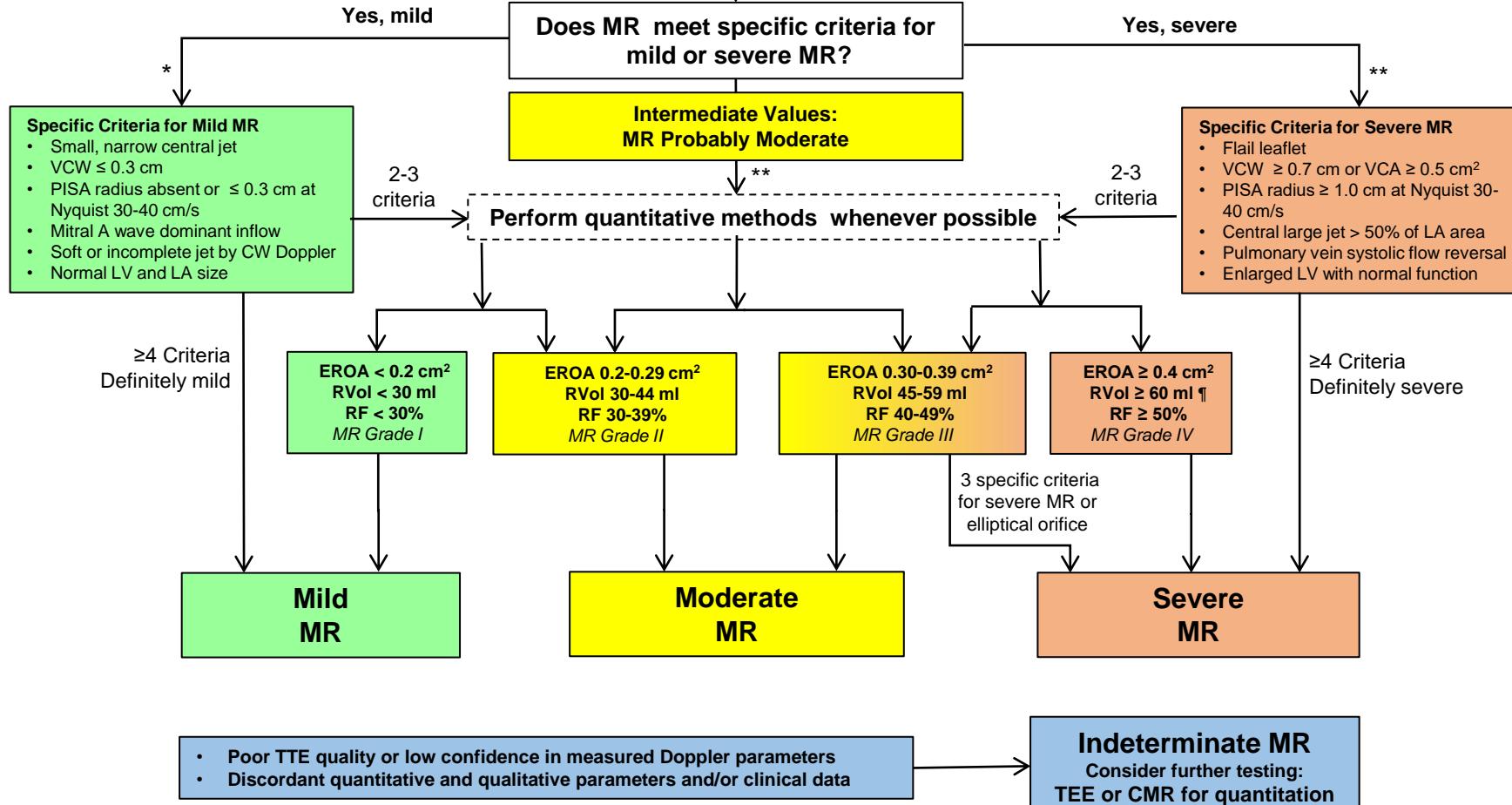
## **Advantages**

- 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

## Chronic Mitral Regurgitation by Doppler Echocardiography



\* Beware of underestimation of MR severity in eccentric, wall impinging jets; quantitation is advised

\*\* All values for EROA by PISA assume holosystolic MR; single frame EROA by PISA, VCW, and VCA overestimate non-holosystolic MR

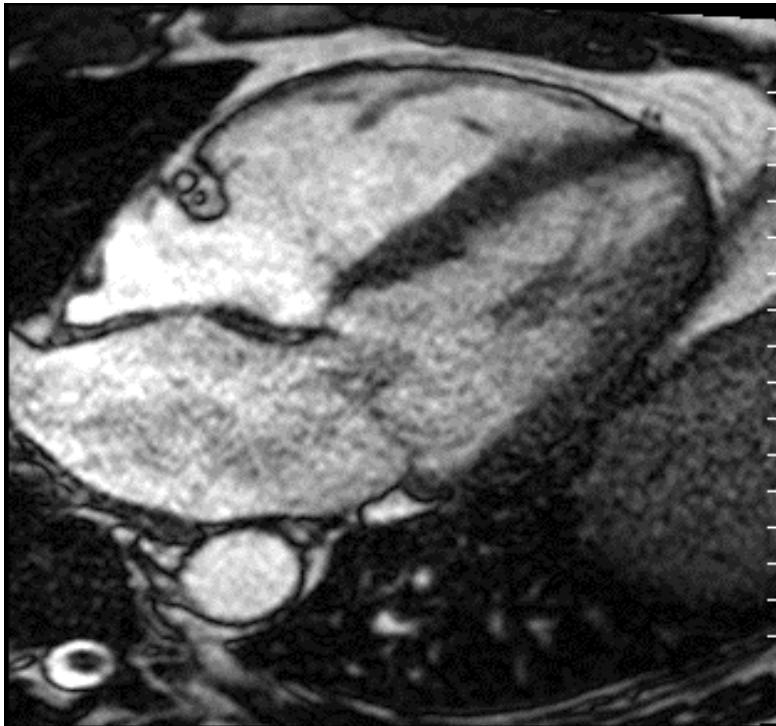
¶ Regurgitant volume for severe MR may be lower in low flow conditions.

# MV Pathology by CMR

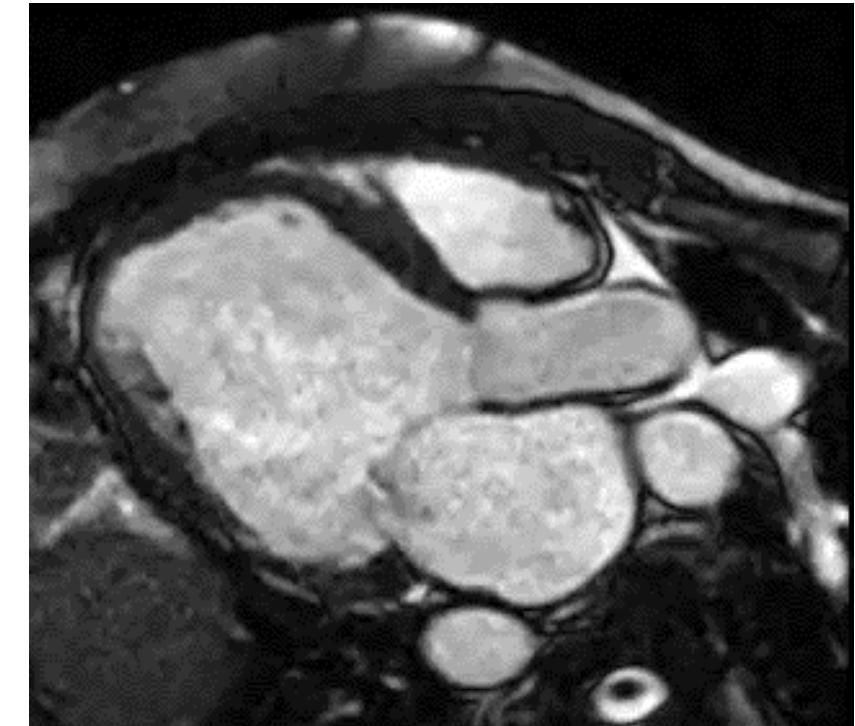
Barlow



Flail

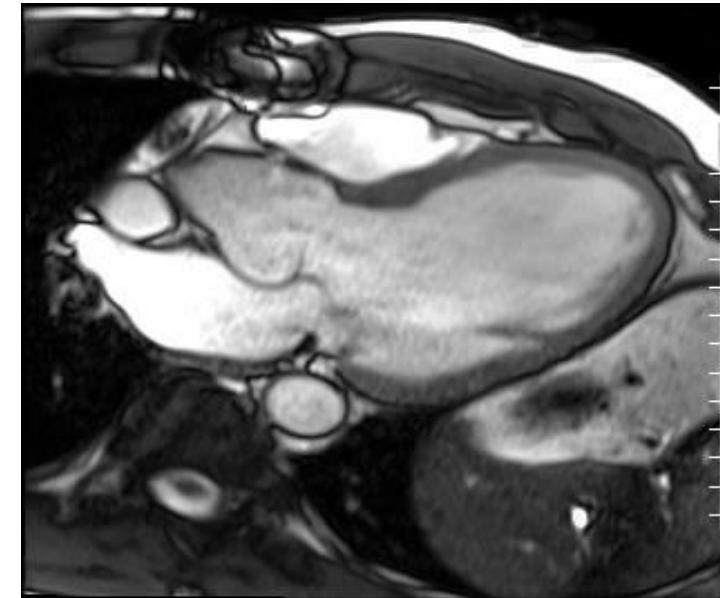
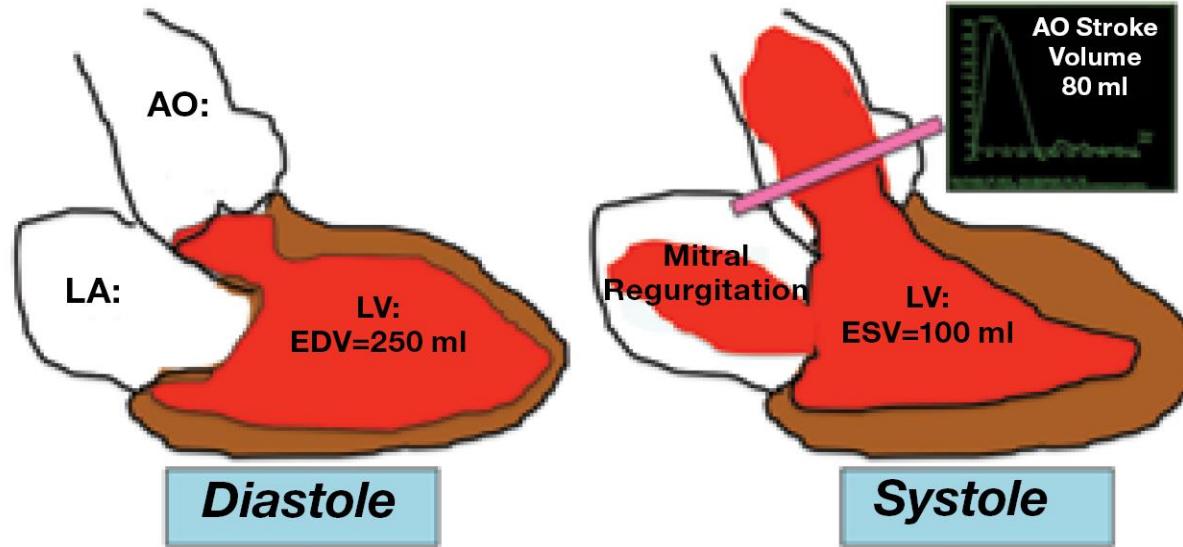


2<sup>nd</sup> MR



# CMR Quantification of MR Severity

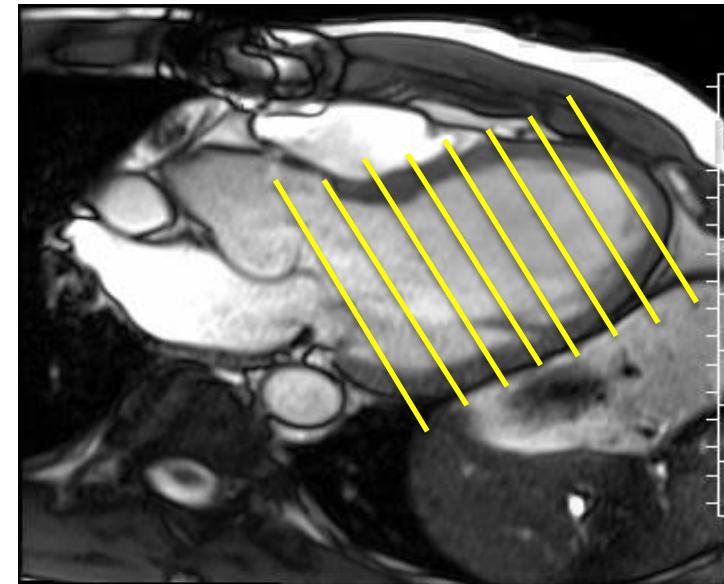
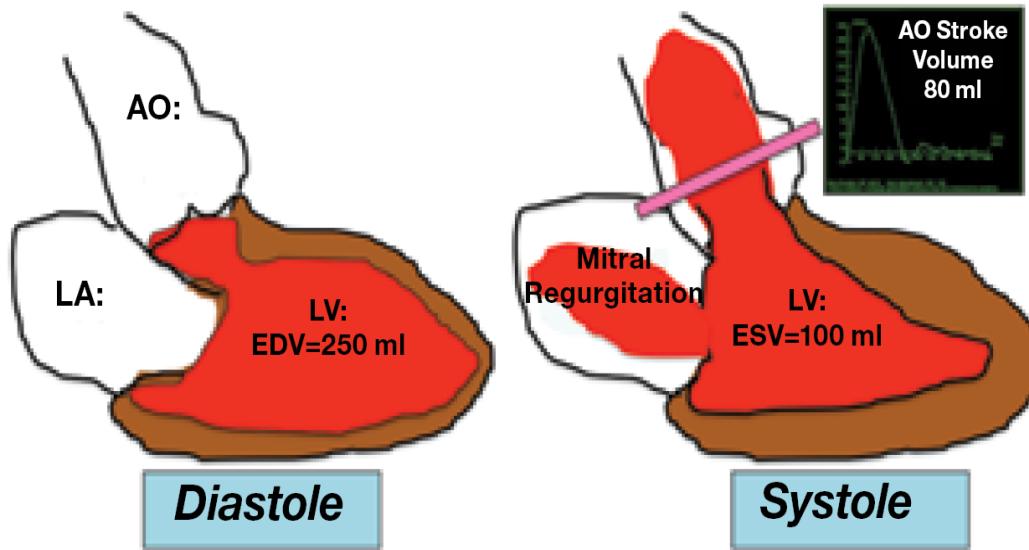
## *Indirect method*



**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

# 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>

**EDITORIAL COMMENT**

# Challenges and Opportunities in Evaluating Severity of Degenerative Mitral Regurgitation

**Details Matter\***

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JACC CV Img Feb 2022

# Details Indeed Matter!

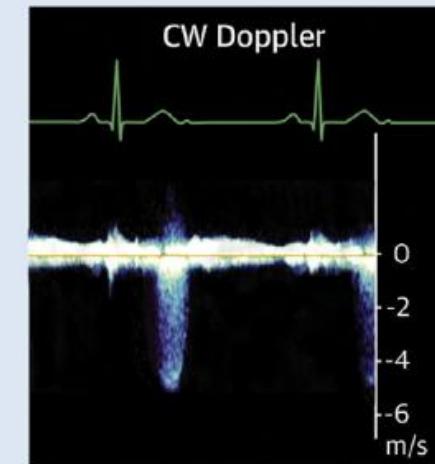
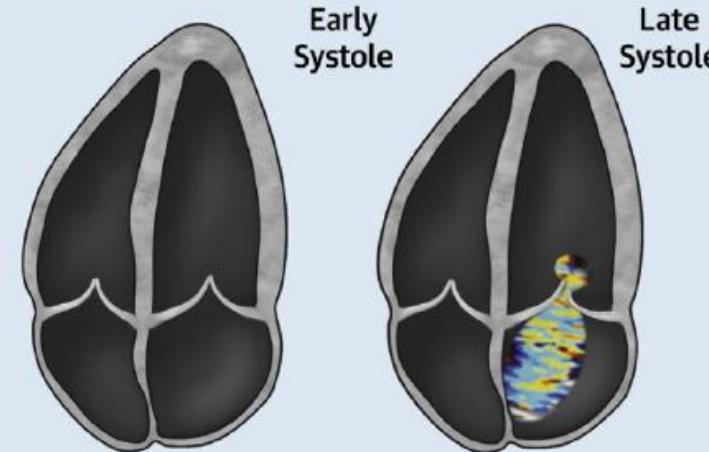
## Findings of concern regarding accuracy of The echocardiographic data:

- 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

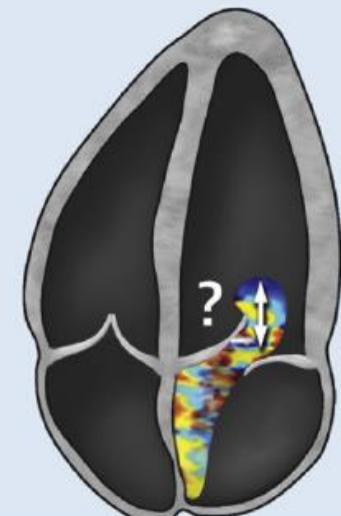
All quantitative data measured with color Doppler alone,  
in all patients & Irrespective of Modifiers

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

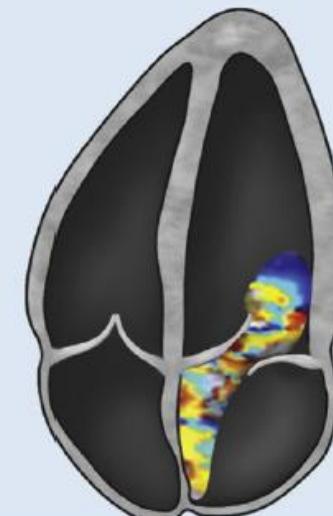
### Non-Holosystolic MR



Diameter Ambiguity



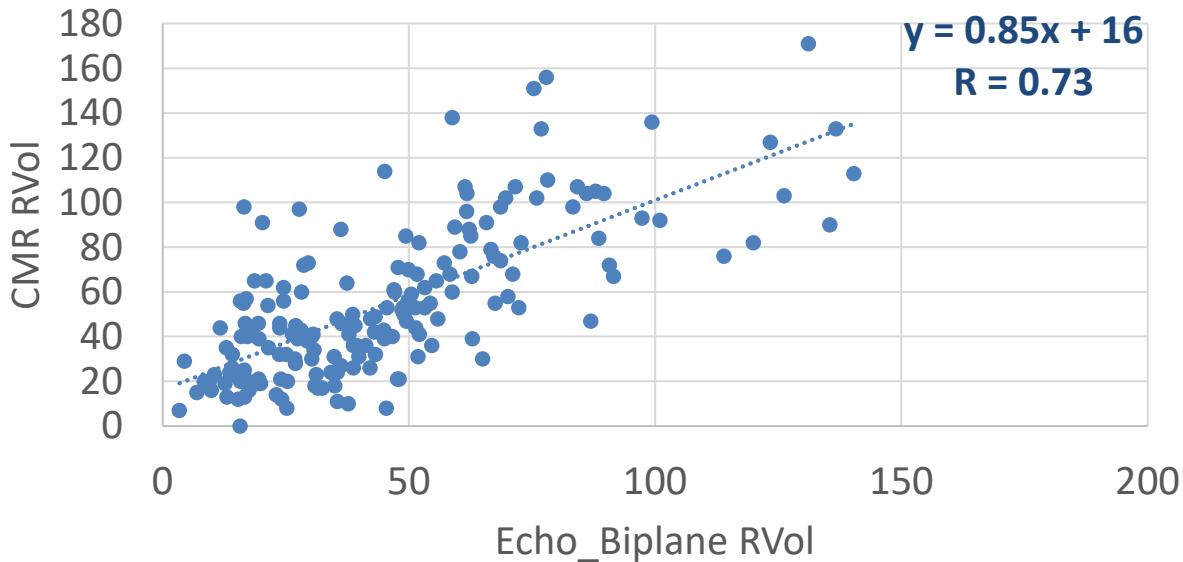
Ovoid Pattern



# 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: Total LVsv – LVOTsv
  - TTE RVol several methods

# Echo Biplane vs CMR



ECHO	CMR				Total
	Grade 1	Grade 2	Grade 3	Grade 4	
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)