

A View From the *Other Side*: Role of MRI in Assessing Valvular Regurgitation

Echo Florida 2017

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Q1

- How many randomized controlled trials have assessed the role of imaging in patients undergoing mitral valve surgery for MR?
 - 0
 - 1
 - 3
 - 5
 - 10



Q1

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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*



- Why would you quantify regurgitant lesions with MRI?
- How do you quantify regurgitant lesions with MRI?

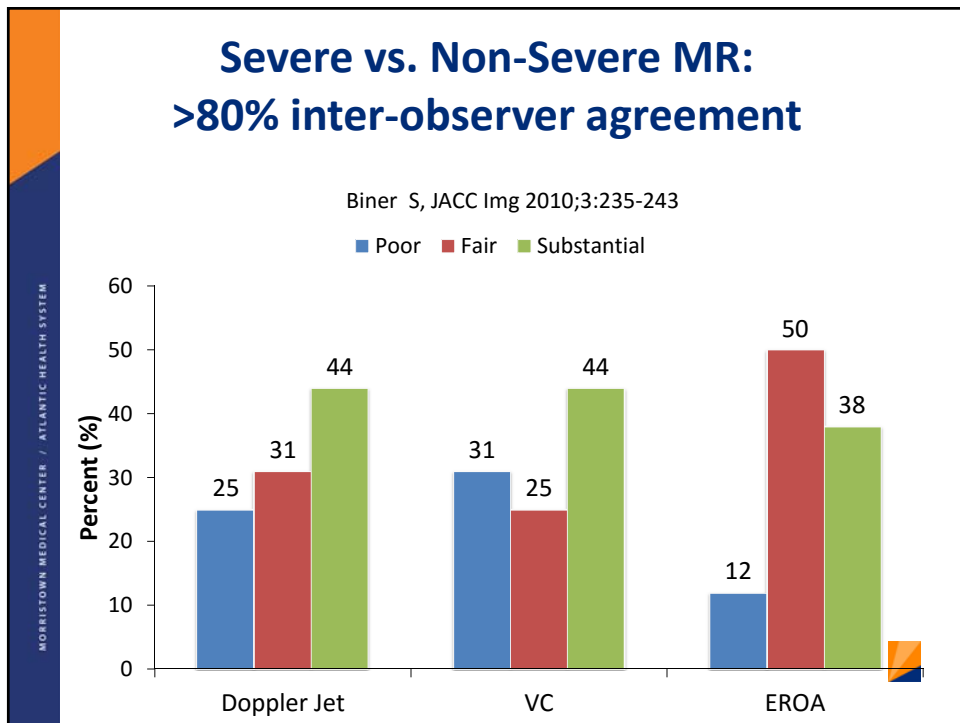
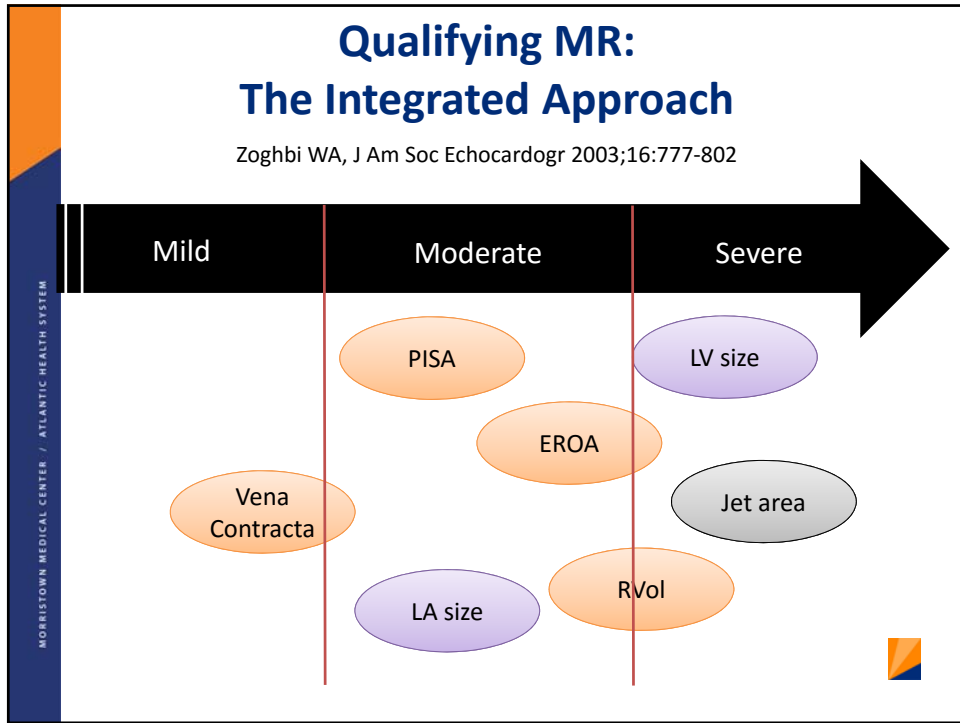


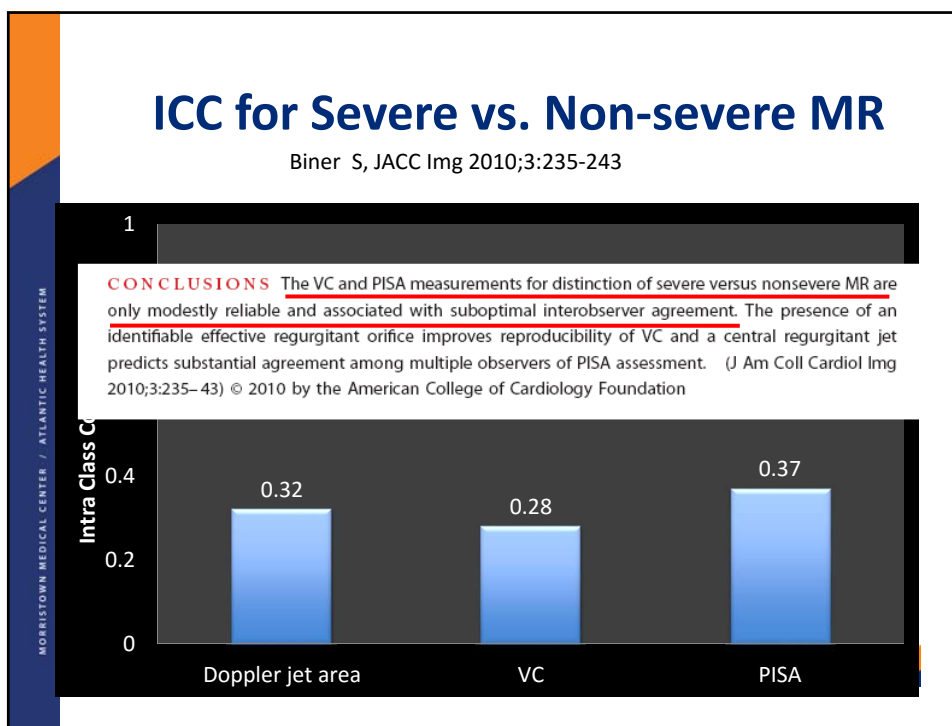
Is there a single reliable Echo parameter?

Table 8 Grading the severity of chronic MR by echocardiography

	MR severity*		
	Mild	Moderate	Severe
Structural			
MV morphology	None or mild leaflet abnormality (e.g., mild thickening, calcifications or prolapse, mild tenting)	Moderate leaflet abnormality or moderate tenting	Severe valve lesions (primary: flail leaflet, ruptured papillary muscle, severe retraction, large perforation; secondary: severe tenting, poor leaflet coaptation)
LV and LA size [†]	Usually normal	Normal or mild dilated	Dilated [†]
Qualitative Doppler			
Color flow jet area [‡]	Small, central, narrow, often brief	Variable	Large central jet (>50% of LA) or eccentric wall-impinging jet of variable size
Flow convergence [§]	Not visible, transient or small	Intermediate in size and duration	Large throughout systole
CWD jet	Faint/partial/parabolic	Dense but partial or parabolic	Holosystolic/dense/ triangular
Semiquantitative			
VCW (cm)	<0.3	Intermediate	≥0.7 (>0.8 for biplane) [¶]
Pulmonary vein flow [¶]	Systolic dominance (may be blunted in LV dysfunction or AF)	Normal or systolic blunting [¶]	Minimal to no systolic flow/ systolic flow reversal
Mitral inflow ^{**}	A-wave dominant	Variable	E-wave dominant (>1.2 m/sec)
Quantitative^{††, ‡‡}			
EROA, 2D PISA (cm ²)	<0.20	0.20-0.29	0.30-0.39
			≥0.40 (may be lower in secondary MR with elliptical ROA)
RVol (mL)	<30	30-44	45-59 ^{††}
			≥ 60 (may be lower in low flow conditions)
RF (%)	< 30	30-39	40-49
			≥50

ROA: Regurgitant orifice area






EDITORIAL COMMENT

Grading Severity of Mitral Regurgitation by Echocardiography: Science or Art?*




Paul A. Grayburn, MD, Paul Bhella, MD
Dallas, Texas

In closing, the ability to accurately distinguish nonsevere from severe MR is of critical importance for cardiologists as guidelines now recommend surgery for asymptomatic patients with severe MR. Biner et al. (3) demonstrated that even among experienced academic echocardiographers, intraobserver variability for common parameters used to grade MR severity is too high, implying that as a community, we struggle to accurately and reproducibly identify those who would benefit from surgery.



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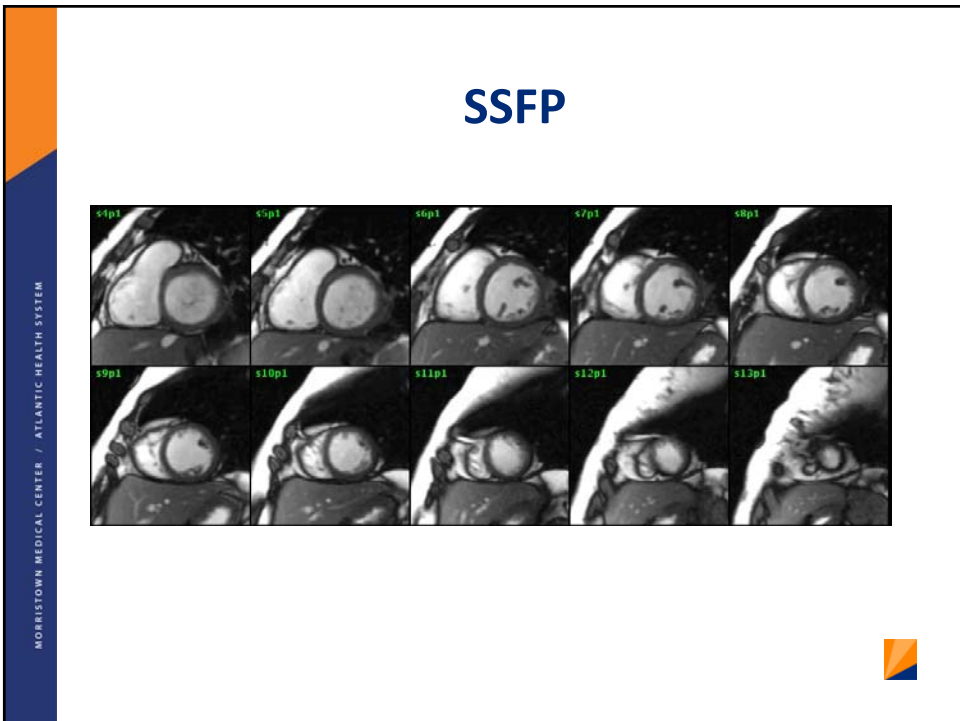
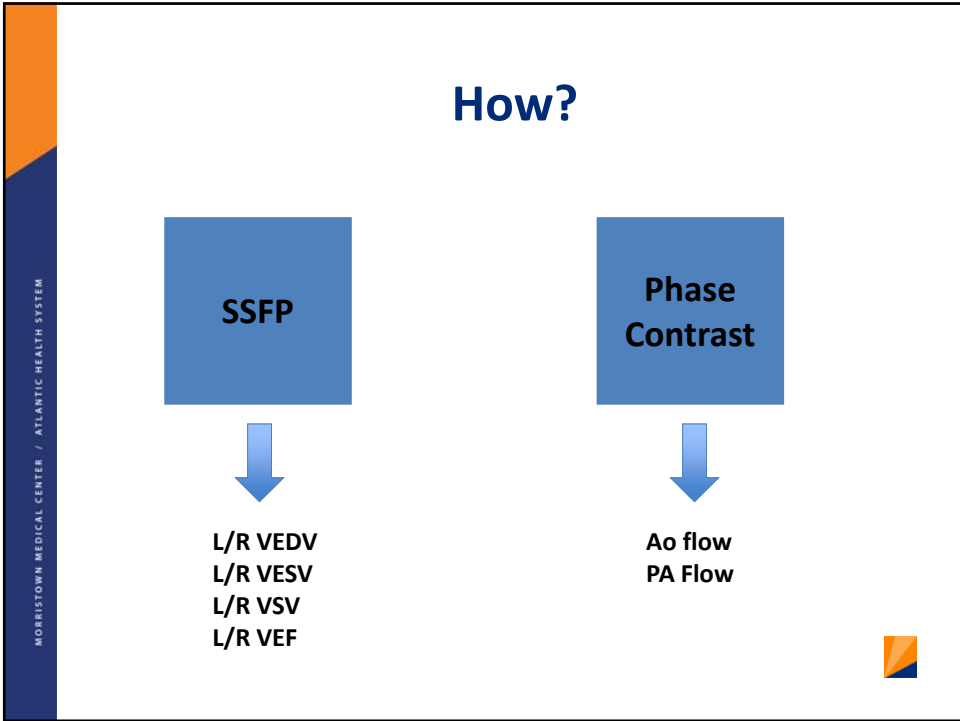
There is no accuracy without reproducibility (precision)

 ✓ Reproducible ✓ Accurate	 ✓ Reproducible ✗ Accurate	 ✗ Reproducible ✗ Accurate
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✗ Reproducible → Inaccurate

Advantages of MRI

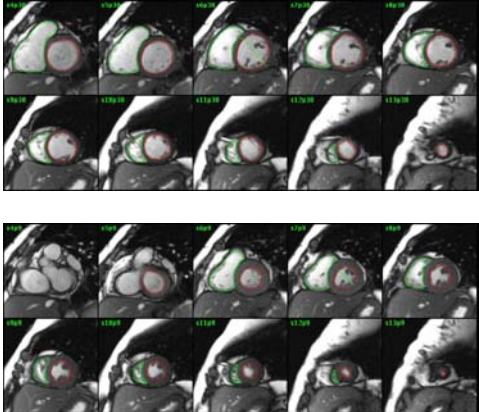
- Whole chest imaging
- Choose the plane of imaging
- Natural contrast between blood and muscle
- Accurate measurements of flow
- System of “checks and balances”



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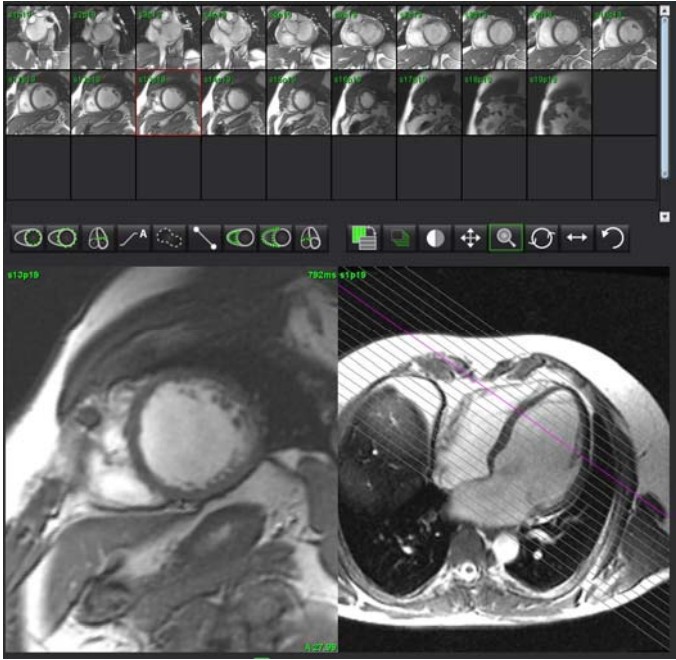
Biventricular quantification

- ✓ Excellent muscle/blood contrast
- ✓ Whole chest imaging
- ⊗ Geometric assumptions



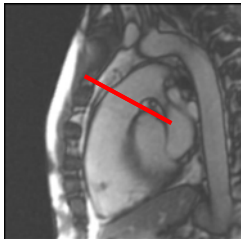
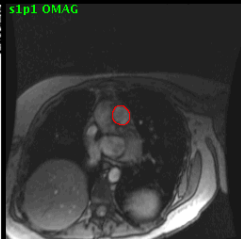
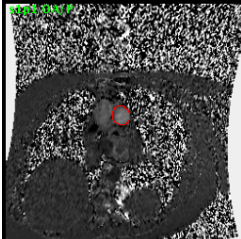
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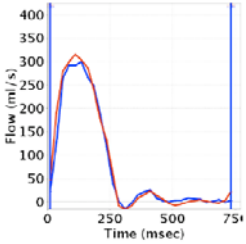
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Phase Contrast

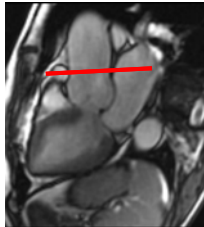
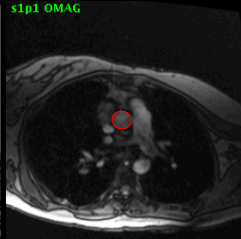
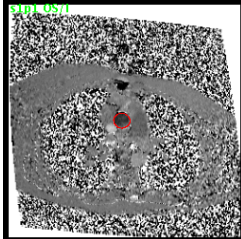


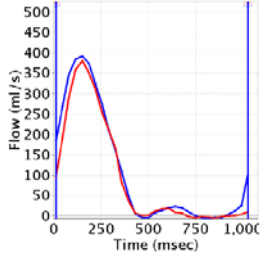


Time (msec)	Flow (ml/s)
0	0
50	250
100	300
150	320
200	250
250	100
300	50
350	20
400	30
450	20
500	10
550	15
600	10
650	10
700	10
750	10




Aortic Phase Contrast





Time (msec)	Flow (ml/s)
0	0
50	150
100	350
150	400
200	350
250	150
300	50
350	20
400	10
450	15
500	10
550	10
600	10
650	10
700	10
750	10
800	10
850	10
900	10
950	10
1000	10



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**No valve disease
No cardiac shunt**

LVSV = Ao flow = RVSV = PA flow

MR

LVSV ≠ Ao flow = RVSV = PA flow

MR RVol. = LVSV - PA
= LVSV - Ao
= LVSV - RVSV



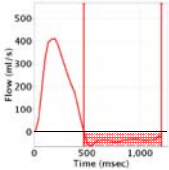
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**No valve disease
No cardiac shunt**


LVSV = Ao flow = RVSV = PA flow

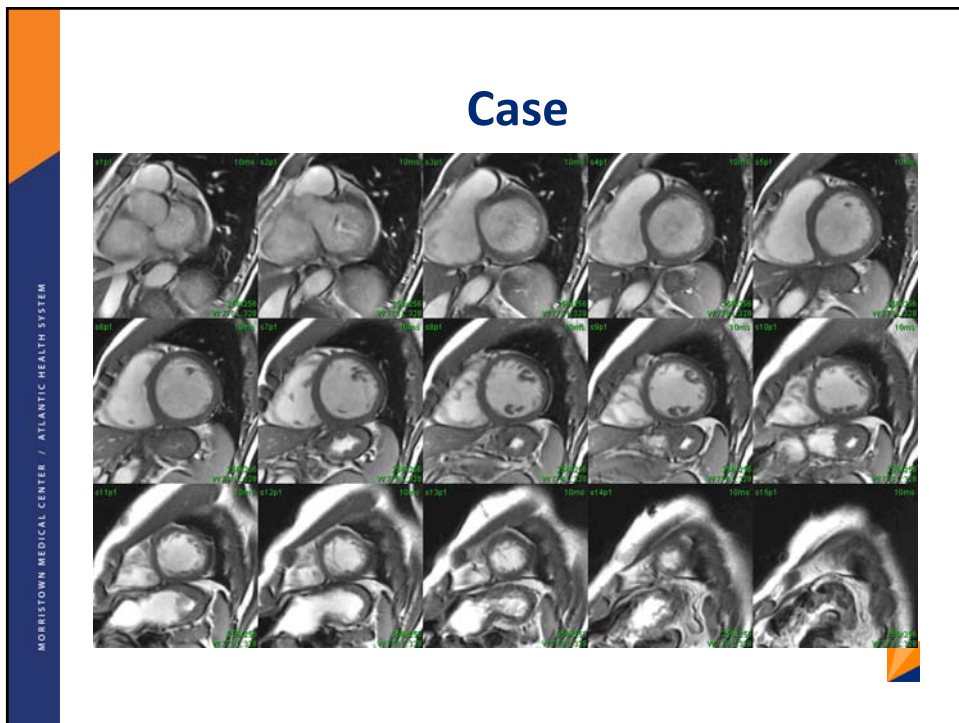
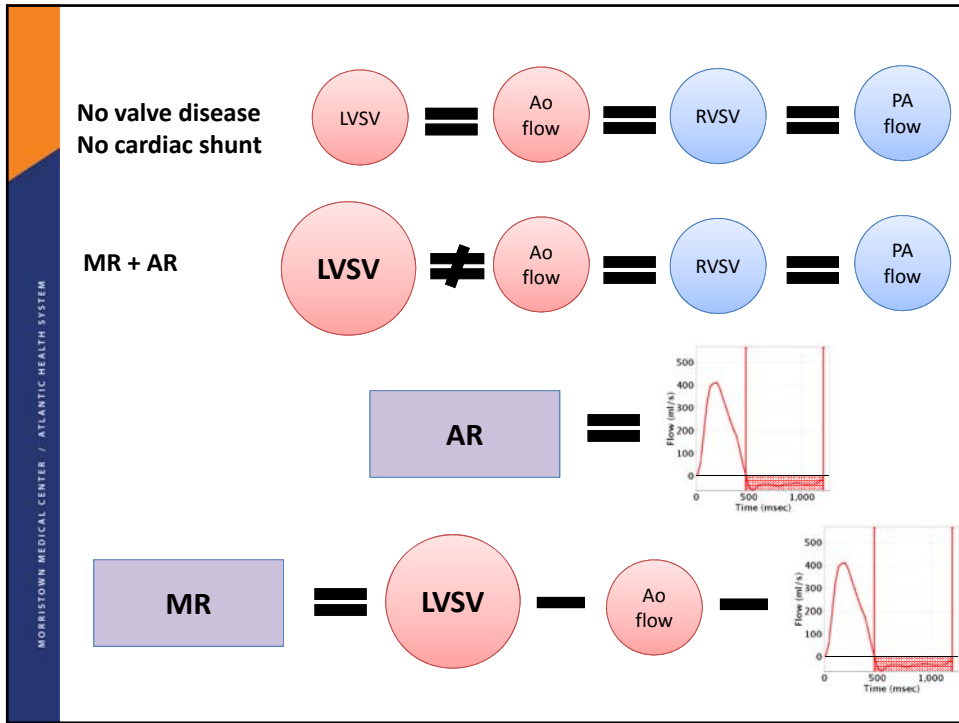
AR

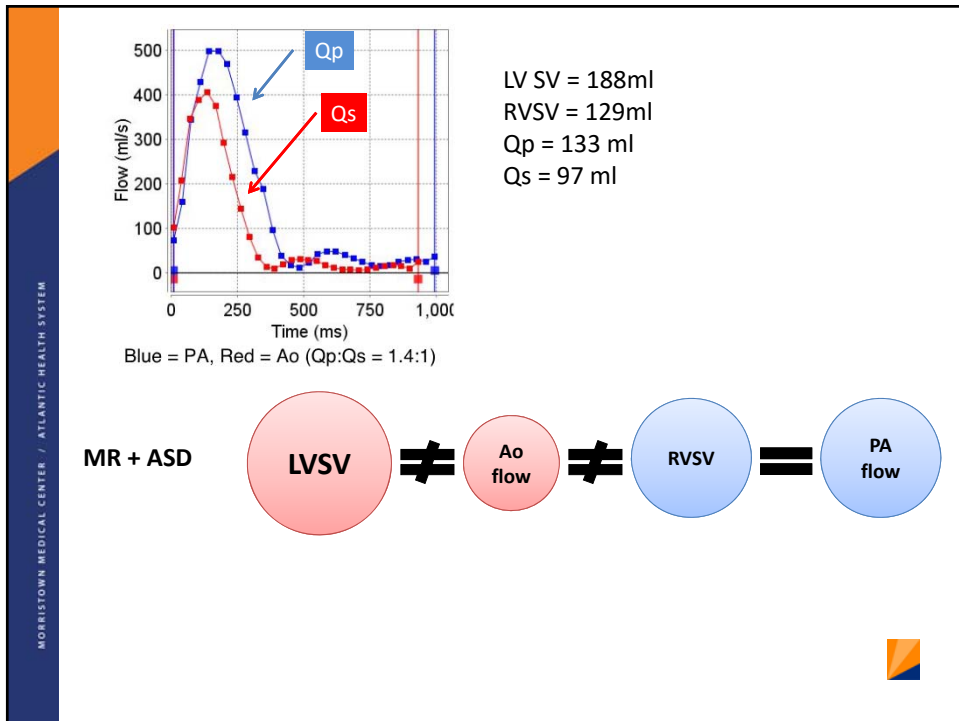
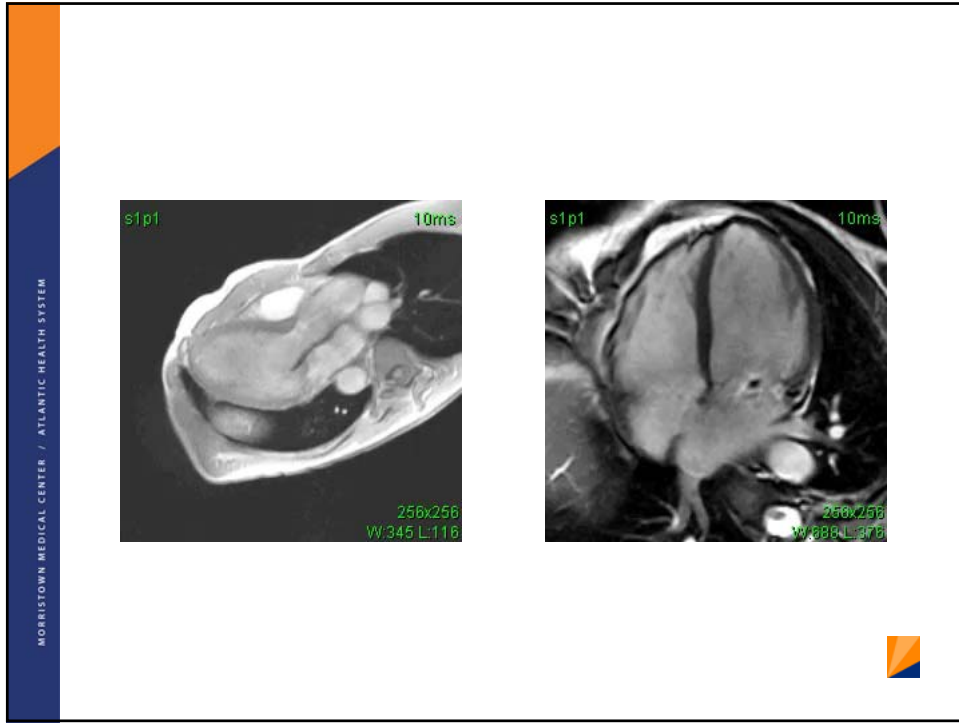
LVSV ≠ Ao flow = RVSV = PA flow

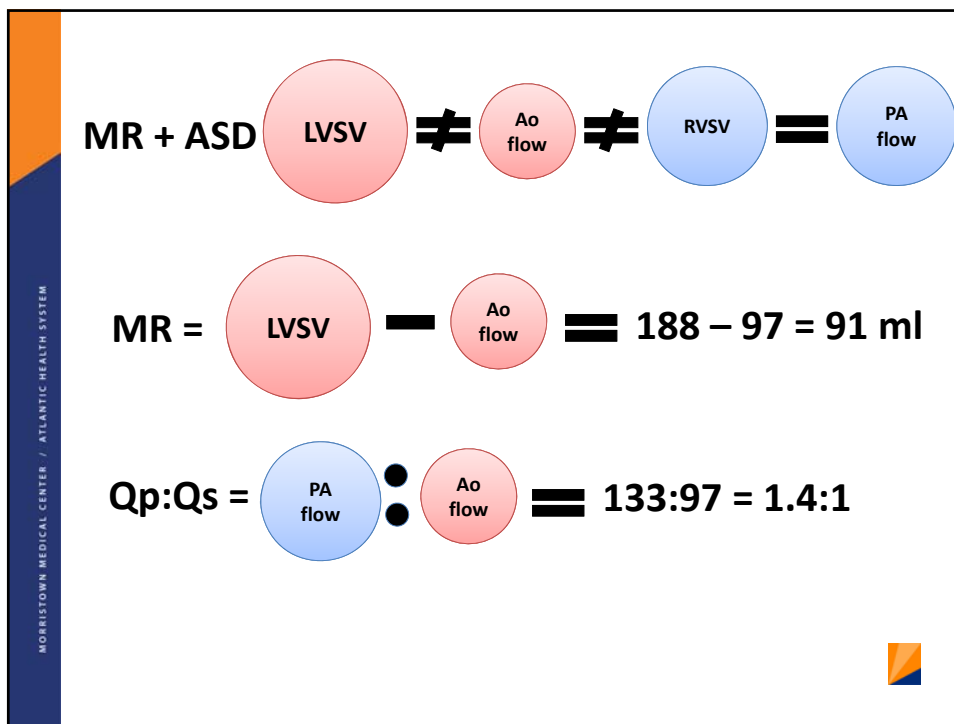
AR = 

AR RVol. = LVSV - PA
= LVSV - RVSV









Comparative Studies of Echo and MRI in Mitral Regurgitation

Study	Study Type	Yr	N	Absolute Agreement	Agreement if Severe
Cawley et al	Retrospective	2013	26	13/23 (57%)	5/12 (42%)
Uretsky et al	Prospective	2015	103	27/103 (36%)	13/60 (22%)
Lopez-Mattei et al	Retrospective	2016	70	44/70 (63%)	2/10 (20%)
Sachdev et al	Prospective	2016	50	23/50 (46%)	10/15 (66%)

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Gold Standard?



A large MRI machine is positioned on the left, and a smaller ultrasound machine is on the right. A large blue not-equal sign (\neq) is placed between them, suggesting that neither is the gold standard.

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CMR and Echo: Is there a reference standard?



A golden scale of justice is shown, with a small MRI machine on the left pan and a small ultrasound machine on the right pan, symbolizing the comparison of the two imaging modalities.

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Q2

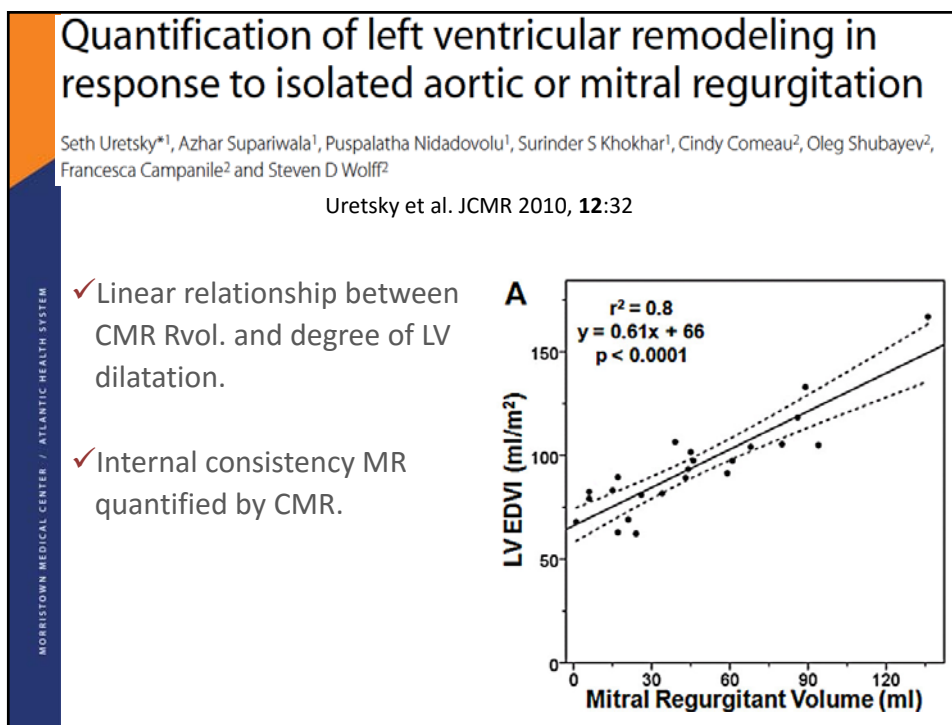
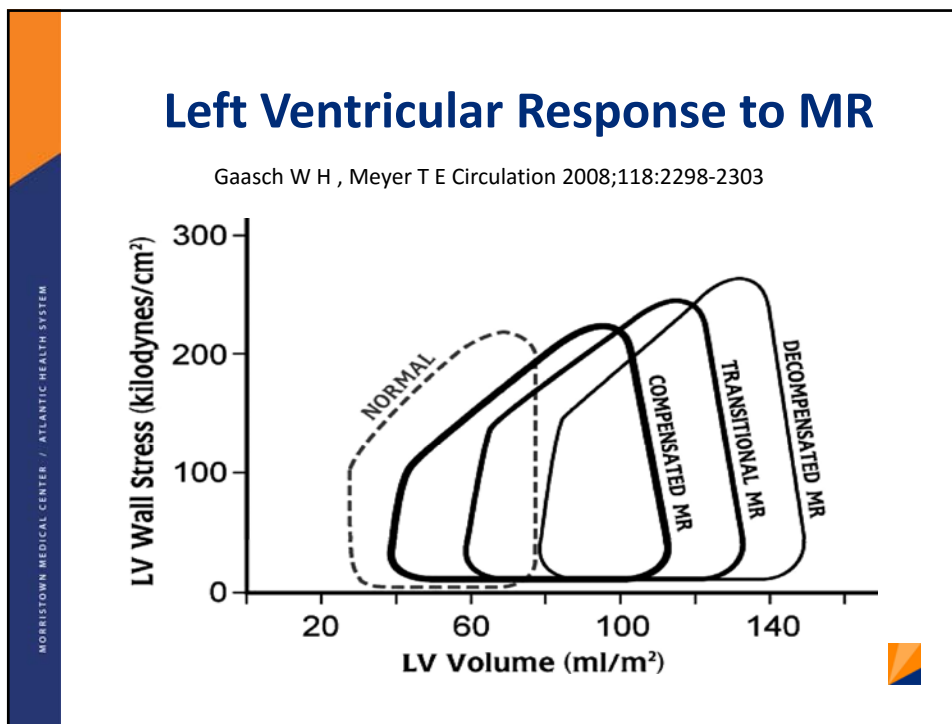
- What is the hemodynamic response of the left ventricle to MR?
 - No change in LV Volume
 - Increase in LV Volume
 - Decrease in LV Volume



Q2

- What is the hemodynamic response of the left ventricle to MR?
 - No change in LV Volume
 - **Increase in LV Volume**
 - Decrease in LV Volume





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↑ LV EDV ~ ↑ MR Severity

Uretsky et al. JCMR 2010, 12:32

- ✓ Linear relationship between CMR Rvol. and degree of LV dilatation.
- ✓ Internal consistency MR/CMR.
- ✓ MR quantification with CMR is reproducible and thus precise.

Intra-class correlation = 0.99, $p < 0.0001$

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EVEREST II: Negative LV Remodeling Post MV Surgery

Feldman T et al. *NEJM*;2011;364,1395-1406.

Parameter	Change
LVEDV (ml)	-40
LVESV (ml)	-6
LVEF (%)	-7
LVEDD (cm)	-0.6
LVESD (cm)	0

Discordance Between Echocardiography and MRI in the Assessment of Mitral Regurgitation Severity

A Prospective Multicenter Trial

Seth Uretsky, MD,* Linda Gillam, MD, MPH,* Roberto Lang, MD,† Farooq A. Chaudhry, MD,‡
 Edgar Argulian, MD, MPH,§ Azhar Supariwala, MD,§ Srinivasa Gurram, MD,§ Kavya Jain, MD,§ Marjorie Subero, MD,§
 James J. Jang, MD,|| Randy Cohen, MD,§ Steven D. Wolff, MD, PhD¶

(J Am Coll Cardiol 2015;65:1078-88)

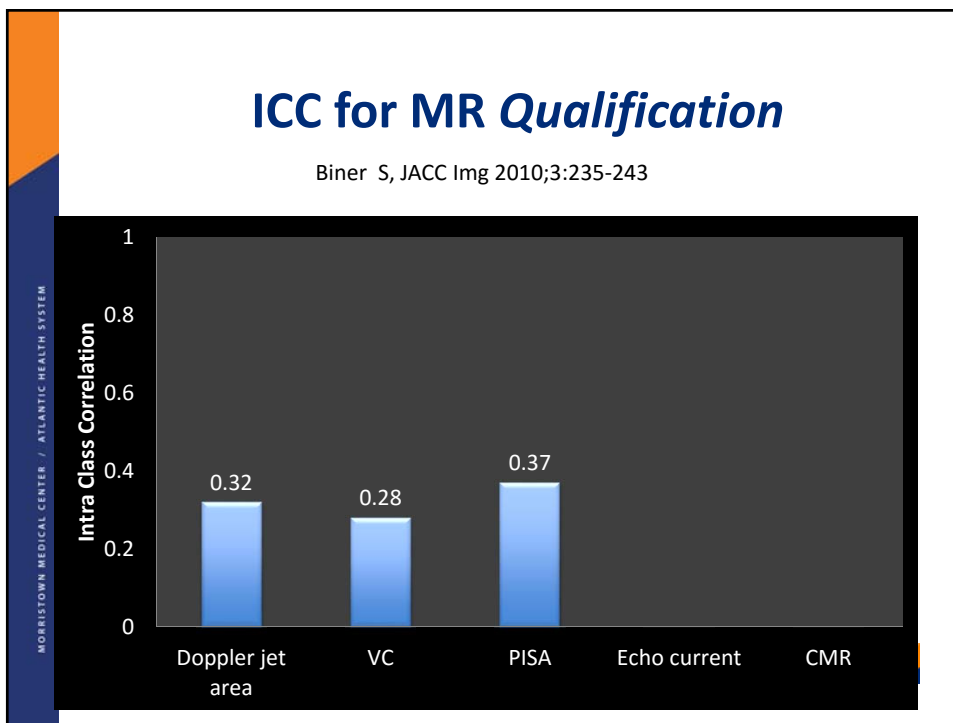
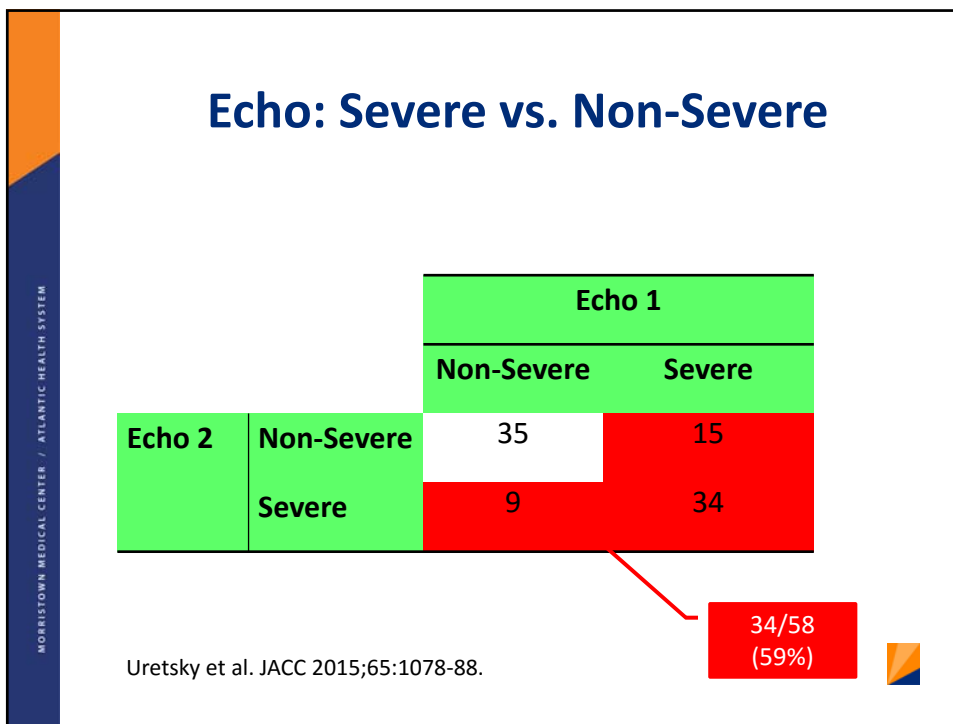
1. Determine the frequency of concordance/discordance between Echo and CMR.
1. Which modality better predicts the degree of post surgical LV remodeling?

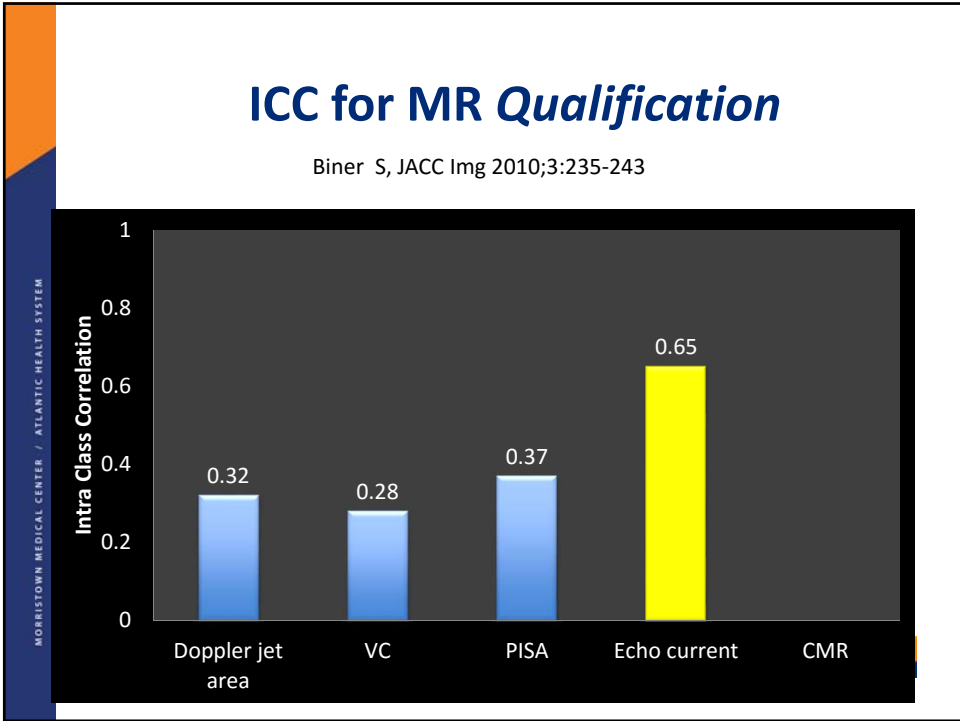
Echo: Poor Reproducibility for MR Severity

		Echo 1		
		Mild	Moderate	Severe
Echo 2	Mild	9	7	0
	Moderate	5	14	15
	Severe	0	9	34

ICC = 0.65, p < 0.0001

Uretsky et al. JACC 2015;65:1078-88.





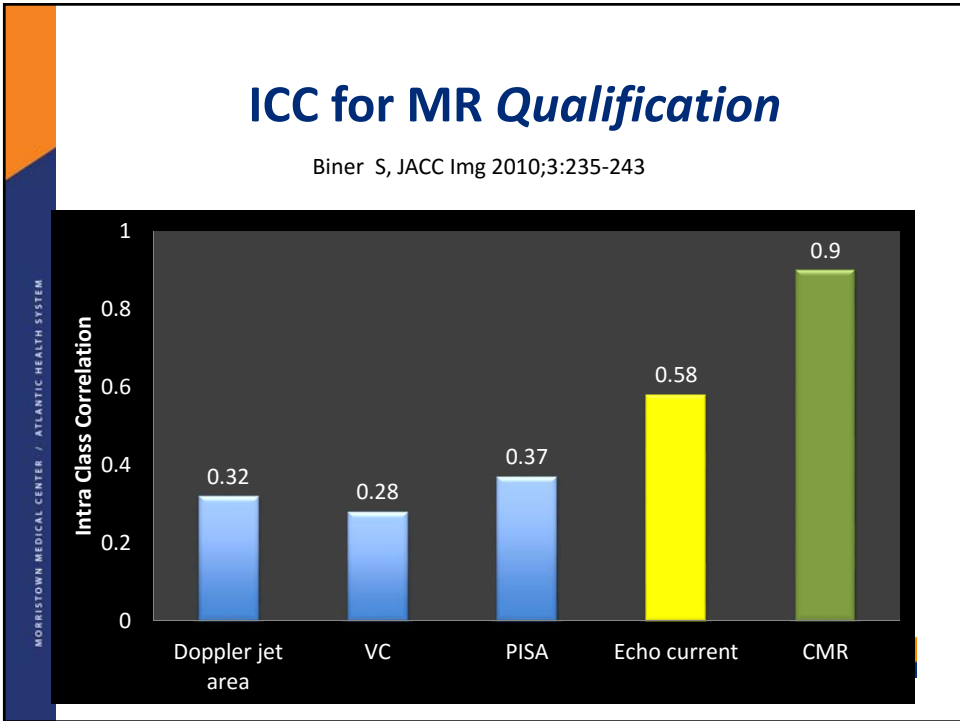
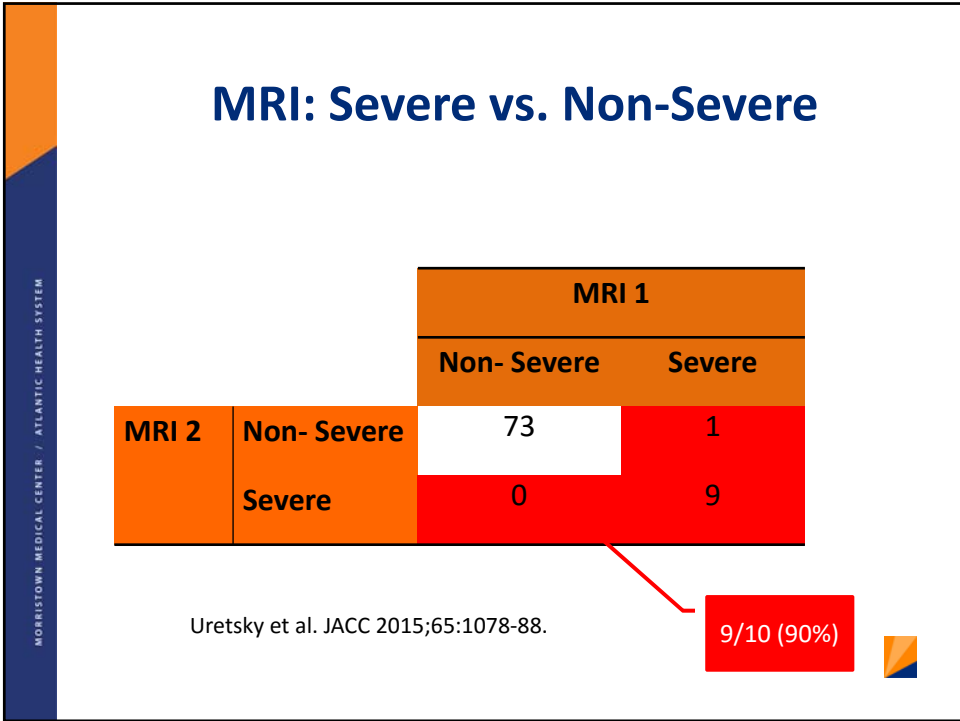
CMR: Highly Reproducible for MR Severity

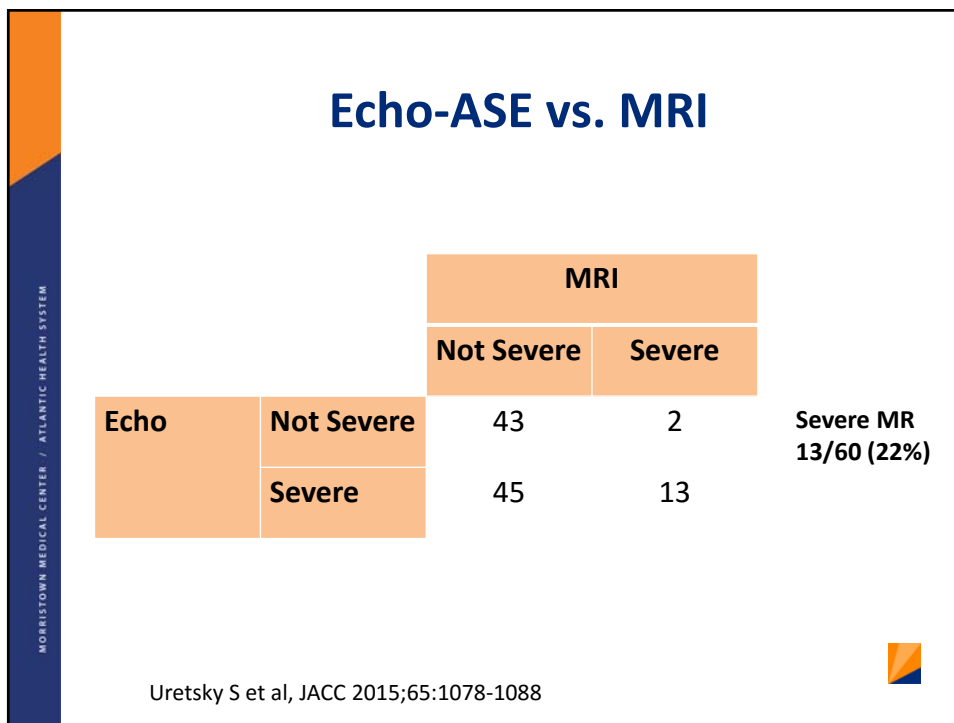
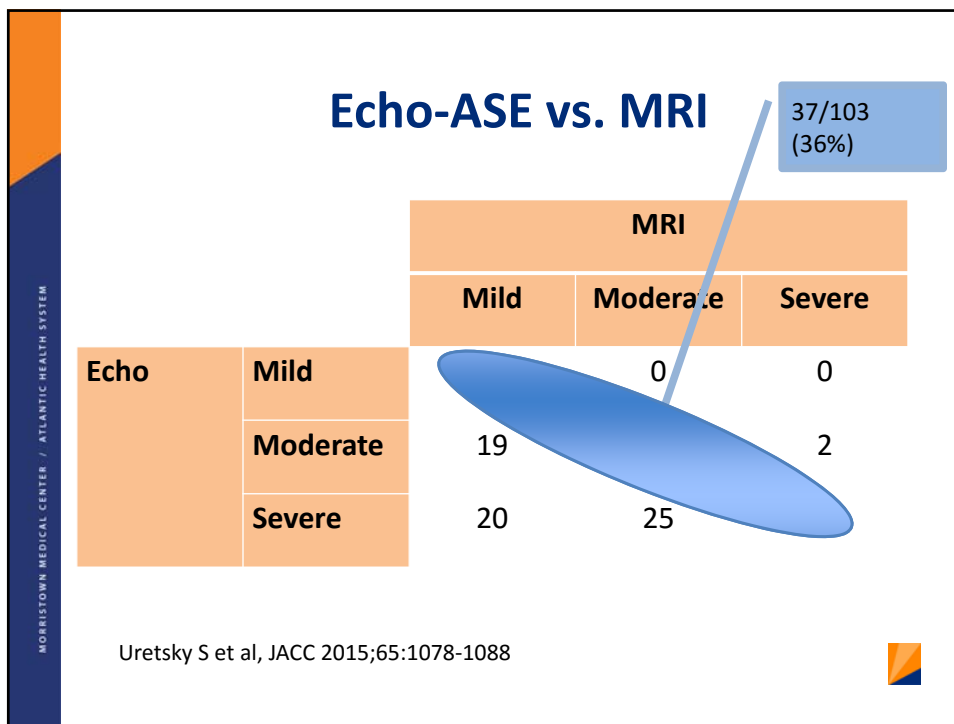
75/83 (90%)

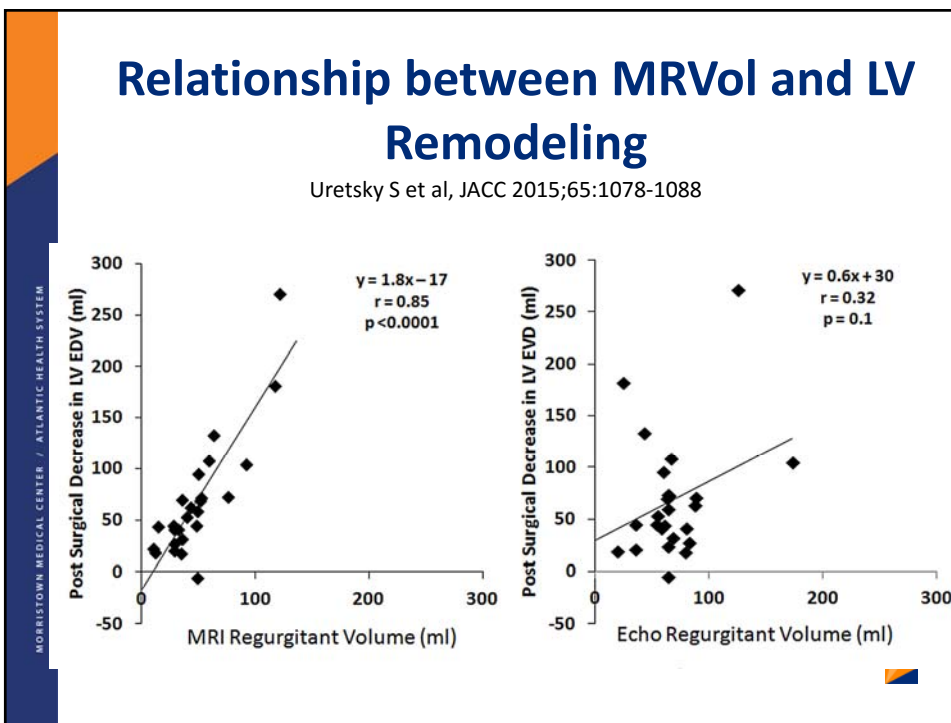
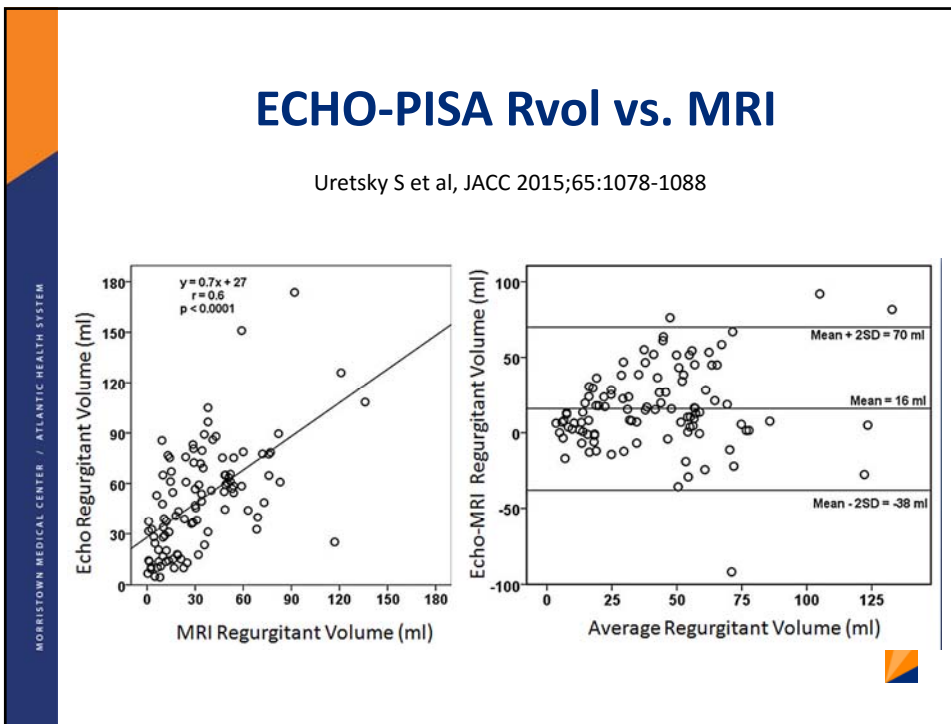
		CMR 1		
		Mild	Moderate	Severe
CMR 2	Mild	41	6	0
	Moderate	1	25	1
	Severe	0	0	9

ICC = 0.90, p < 0.0001

Uretsky et al. JACC 2015;65:1078-88.







Asymptomatic MR: Mean f/u 2.5yrs for Indication for MVS

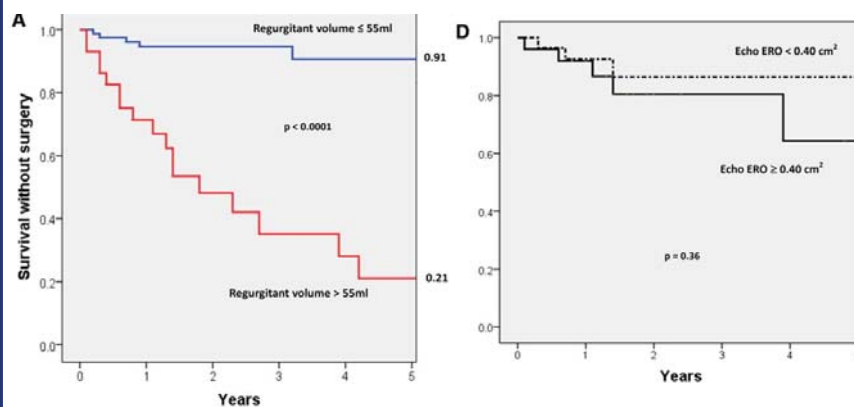
Myerson SG. et al. Circulation 2016

N = 109	Conservative	Surgical
MRI Rvol. (ml)	39 ± 20	66 ± 24
Echo Rvol. (ml)	74 ± 74	89 ± 36
EROA (cm ²)	0.58 ± 0.8	0.57 ± 0.3



Survival Without Surgery by Echo and MRI

Myerson SG. et al. Circulation 2016



Conclusion

- Echocardiographic techniques for quantifying MR suffer from high interobserver variability, MRI does not.
- There is significant discordance between Echo and MRI when quantifying MR.
- This discordance is significant in patients referred for surgery.
- Based on emerging data Rvol quantified by MRI may be more accurate than 2D Echo techniques.



Future Directions

- Many questions remain regarding non-invasive imaging for MR.
- Larger studies.
- 3D echo techniques.
- Outcomes!!!

