

Respiratory Variation in Tricuspid Regurgitation Peak Systolic Velocity A Sign of Severe Tricuspid Regurgitation

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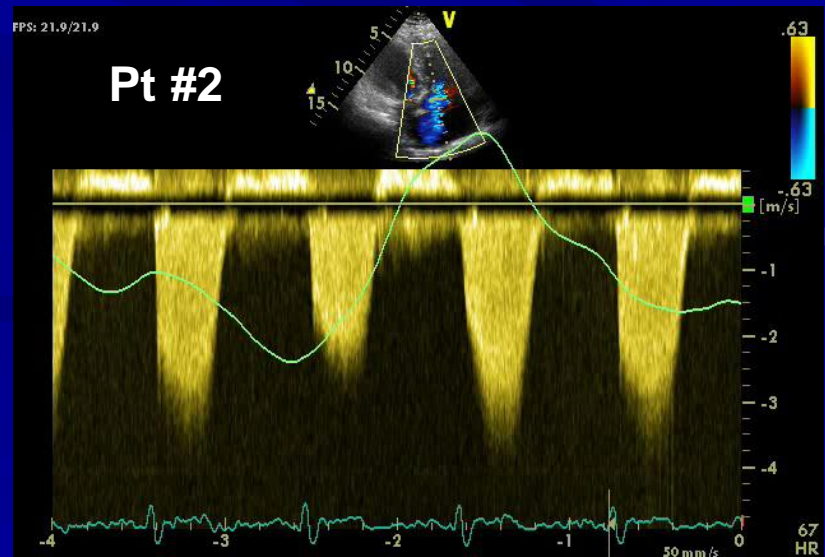
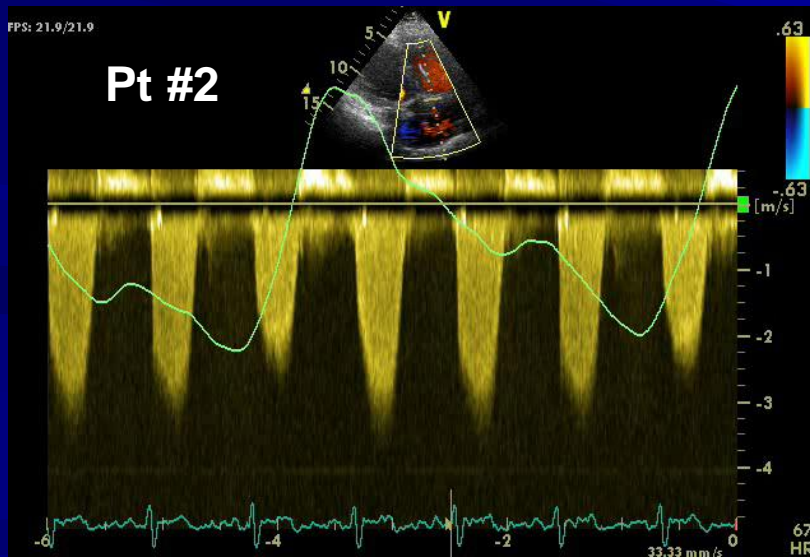
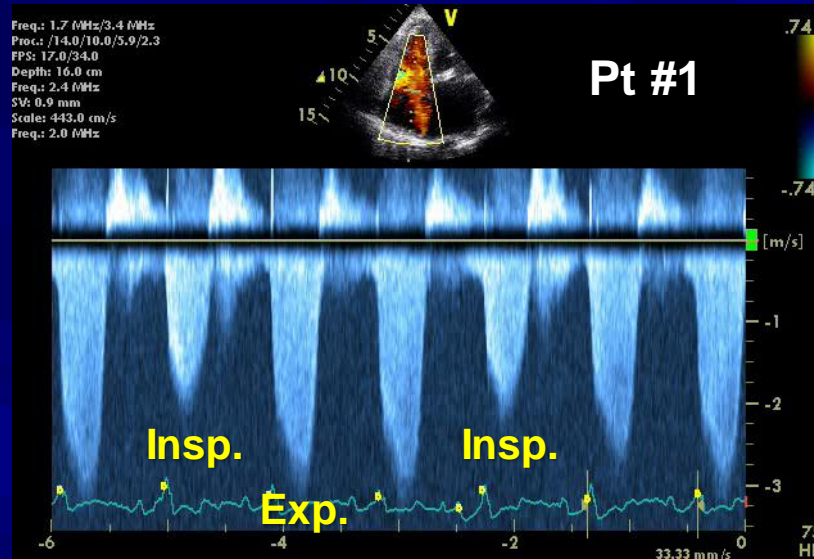
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Background

- Multiple echocardiographic signs of severe tricuspid regurgitation (TR) ASE Guidelines, *JASE* 2003;16:777
- Nevertheless, the diagnosis of severe TR is occasionally overlooked
- We observed that pts with **severe TR** often have large **changes in peak TR systolic velocities during respiration** (CW Doppler)
 - Diagnostic value of this finding – unclear

Respiratory Variation – TR Velocity Example



Objectives

- To determine the magnitude of respiratory changes in peak TR systolic velocities in pts with variable degrees of TR
- To assess the diagnostic value of this echocardiographic sign in the evaluation of TR severity
 - Is this finding a marker of severe TR?
- Among patients with severe TR, to examine whether excessive respiratory changes in TR velocities are indicative of more severe degrees of TR.

Methods

Patients

- Retrospective study – echo lab database (22 mo)
- Detection of patients with **moderate** or **severe** TR
 - Dx of **severe TR**
 - Color flow imaging *and*
 - **Hepatic venous systolic flow reversal** (gold standard)
- Inclusion criteria for current analysis
 - **Regular heart rhythm** (sinus rhythm or pacing)
 - ≥ 1 CW Doppler strip with ≥ 4 **consecutive TR signals**
- Study pts
 - All pts with severe TR during study period
 - Consecutive pts with moderate TR (matched # of pts; 9 mo)

Data Collection and Analysis

- Review of echocardiographic studies
- Measurement of **maximal** and **minimal TR velocities** in consecutive cardiac cycles
 - Calculation of **Δ velocities** within each TR Doppler strip
 - If multiple Doppler strips available \rightarrow maximal ΔV
- Receiver operating characteristics (**ROC**) analysis
 - Diagnostic value of ΔV for detecting severe TR
- Sensitivity / specificity / PPV / NPV of ΔV – Dx of severe TR
 - Various ΔV cutoffs
- Subgroup analysis – pts with severe TR +/- $\Delta V \uparrow$
 - Does $\Delta V \uparrow$ identify a specific subgroup of pts with severe TR?

Results

Patient Characteristics – Severe vs. Moderate TR

	Severe TR n = 68	Moderate TR n = 68	P
Age, yrs	70 ± 12	69 ± 14	0.45
Male, n (%)	30 (44)	24 (35)	0.29
HR, bpm	73 ± 16	75 ± 16	0.39
Pacemaker*, %	29 (43)	3 (4)	<0.001
LVEF, %	47 ± 20	54 ± 18	0.04
MR†, %	25 (37)	16 (24)	0.09

* ± Active pacing; † moderate or severe

Right Heart

Severe TR vs. Moderate TR

	Severe TR n = 68	Moderate TR n = 68	P
RV enlargement*, n (%)	23 (34)	6 (9)	<0.001
RV end-diastolic area cm ²	29.4 ± 7.5	22.7 ± 7.7	<0.001
RV dysfunction*, n (%)	16 (24)	9 (13)	0.12
RA enlargement*, n (%)	40 (59)	6 (9)	<0.001
RA end-systolic area, cm ²	29.2 ± 8.8	20.4 ± 5.8	<0.001
Organic TV disease, n (%)	3 (4)	1 (1.5)	0.31
RA pressure, mmHg	16 ± 5	10 ± 5	<0.001
PA systolic pressure, mmHg	60 ± 16	54 ± 17	0.04

* Moderate or severe

TR velocities in patients with severe or moderate TR

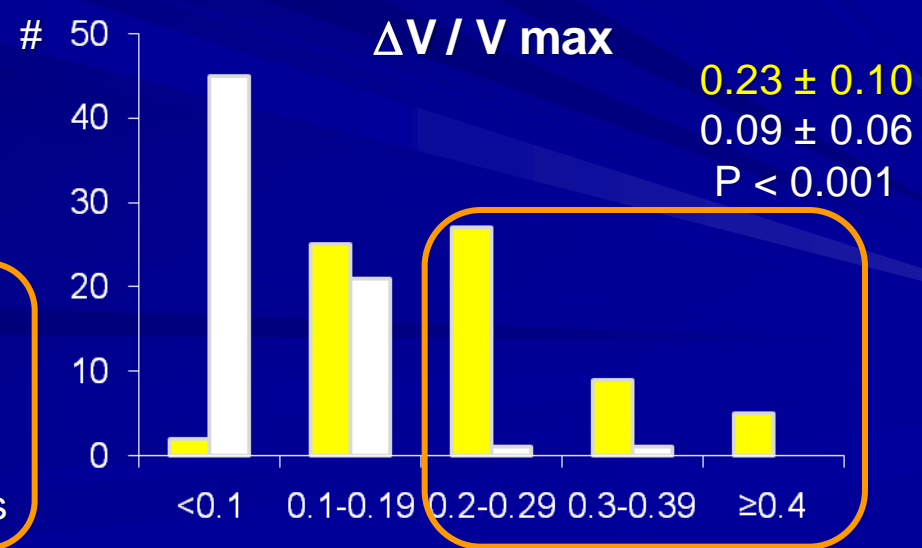
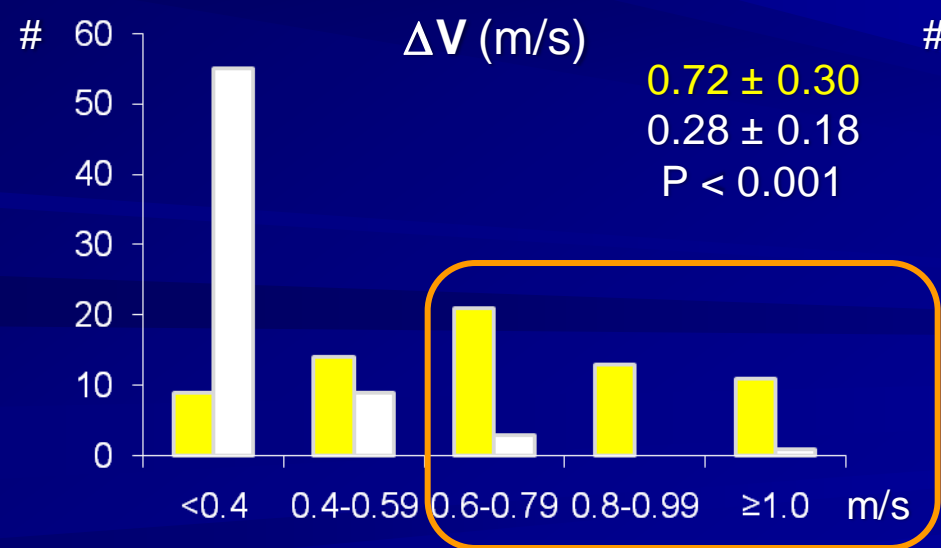
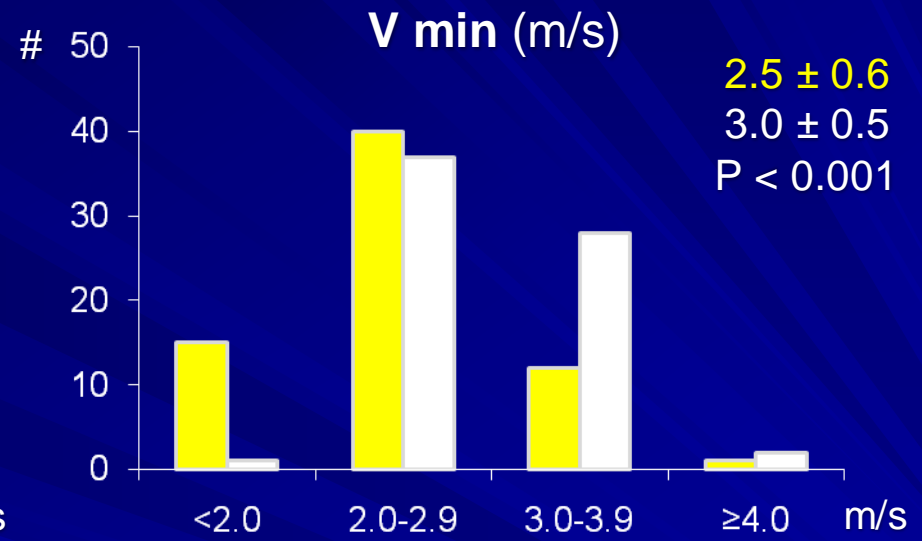
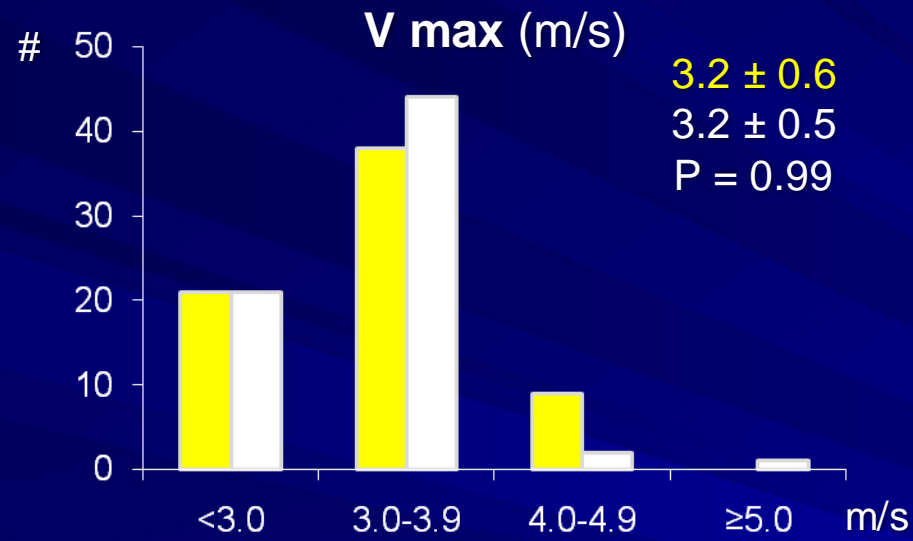
	Severe TR n = 68	Moderate TR n = 68	P
Maximal (expiratory) velocities, m/s	3.2 ± 0.6	3.2 ± 0.5	0.99
Minimal (inspiratory) velocities, m/s	2.5 ± 0.6	3 ± 0.5	<0.001
Difference in velocities ^a , m/s	0.72 ± 0.30	0.28 ± 0.18	<0.001
Relative difference in velocities ^b	0.23 ± 0.10	0.09 ± 0.06	<0.001

^aMaximal (expiratory) minus minimal (inspiratory) velocities.

^bDifference in velocities divided by maximal (expiratory) velocity.

Δ TR Systolic Velocities

Severe ■ vs. Moderate ■ TR



ΔV Velocities - Hemodynamic Correlations

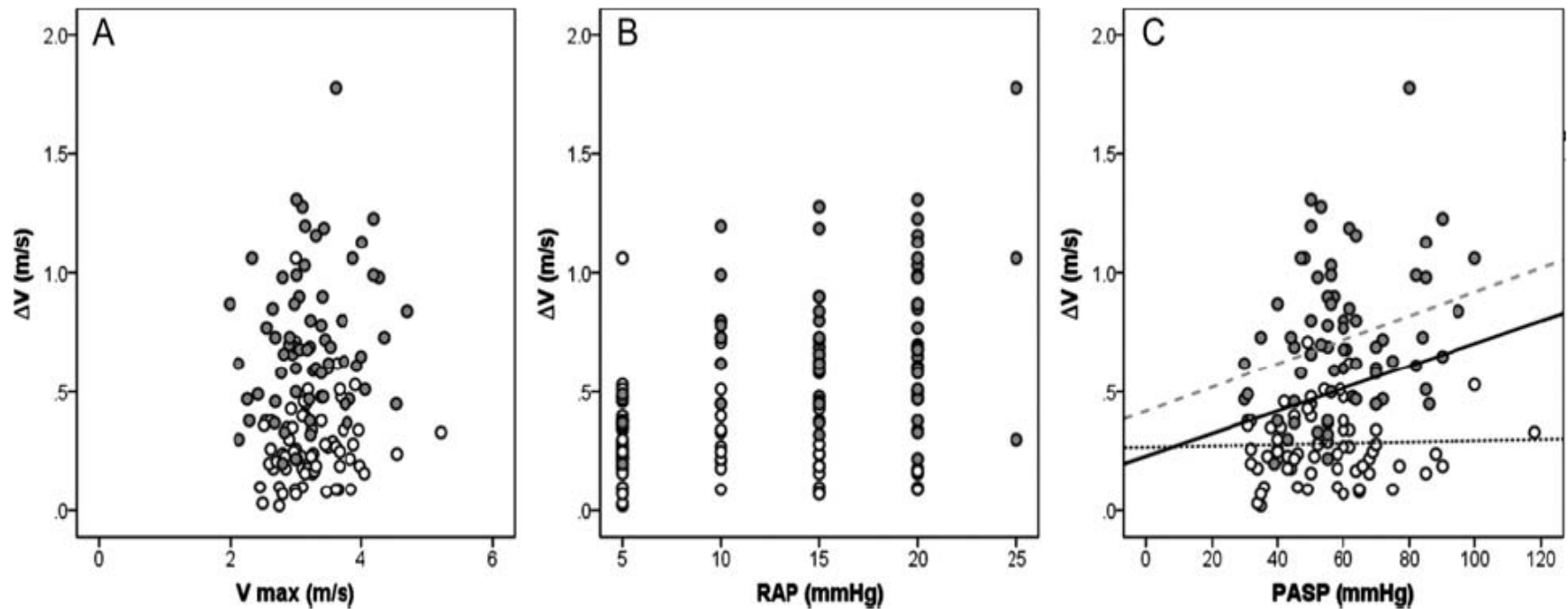


Figure 3 Relationship between maximal TR velocities (V_{max}) (A), RA pressure (RAP) (B), pulmonary artery systolic pressure (PASP) (C) and ΔV . Patients with severe TR are marked in grey circles and patients with moderate TR in white circles. The correlations between PASP and ΔV are presented in solid black (all patients), dashed grey (patients with severe TR), and dotted black lines (patients with moderate TR).

ROC Analysis

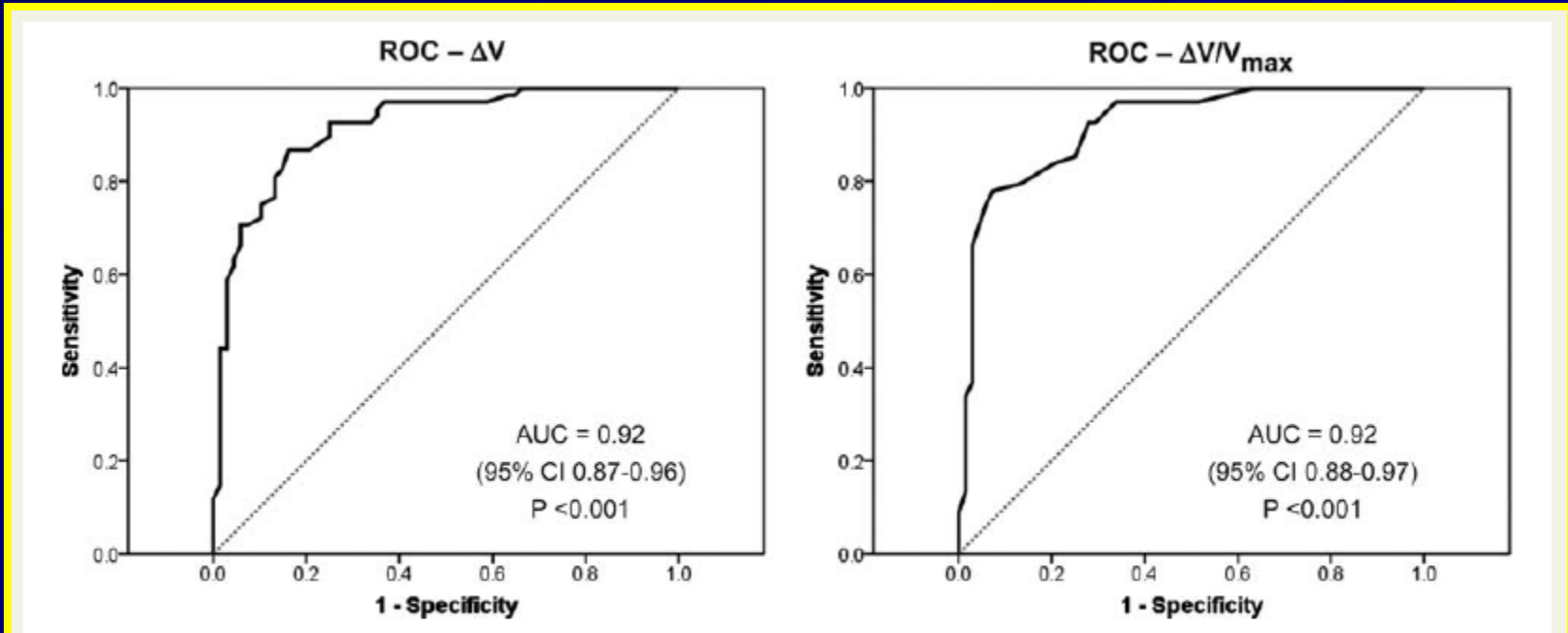


Figure 4 Receiver-operating characteristics (ROC) analysis describing the diagnostic performance of the respiratory difference in TR velocities (ΔV) (left) and relative difference in velocities ($\Delta V/V_{max}$) (right) in diagnosing severe TR. AUC, area under the curve; CI, confidence interval.

Δ TR Systolic Velocity

Diagnostic Value of Various ΔV Cutoffs

ΔV cutoff (m/s)	Sens.	Spec.	PPV	NPV	Accuracy
≥ 0.4	0.87	0.79	0.81	0.86	0.83
≥ 0.5	0.74	0.90	0.88	0.77	0.82
≥ 0.6	0.66	0.94	0.92	0.74	0.80
≥ 0.7	0.46	0.97	0.94	0.64	0.71
≥ 0.8	0.35	0.99	0.96	0.60	0.67

Subgroup Analysis – Severe TR

High vs. Low Δ Velocities

	$\Delta V \geq 0.6$ m/s n = 45	$\Delta V < 0.6$ m/s n = 23	P
ΔV , m/s	0.87 \pm 0.25	0.43 \pm 0.11	<0.001
TR gradient (max), mmHg	46 \pm 15	41 \pm 14	0.18
RA pressure, mmHg	17 \pm 4	15 \pm 6	0.22
PA systolic pressure, mmHg	63 \pm 13	56 \pm 15	0.10
RV enlargement*, n (%)	20 (44)	3 (13)	0.008
RA enlargement*, n (%)	27 (60)	13 (57)	0.78
TV malcoaptation, n (%)	37 (82)	14 (61)	0.05
Severe [†] , n (%)	21 (47)	6 (26)	0.08

* Moderate or severe; [†]insp. + exp. malcoaptation in multiple views

Summary

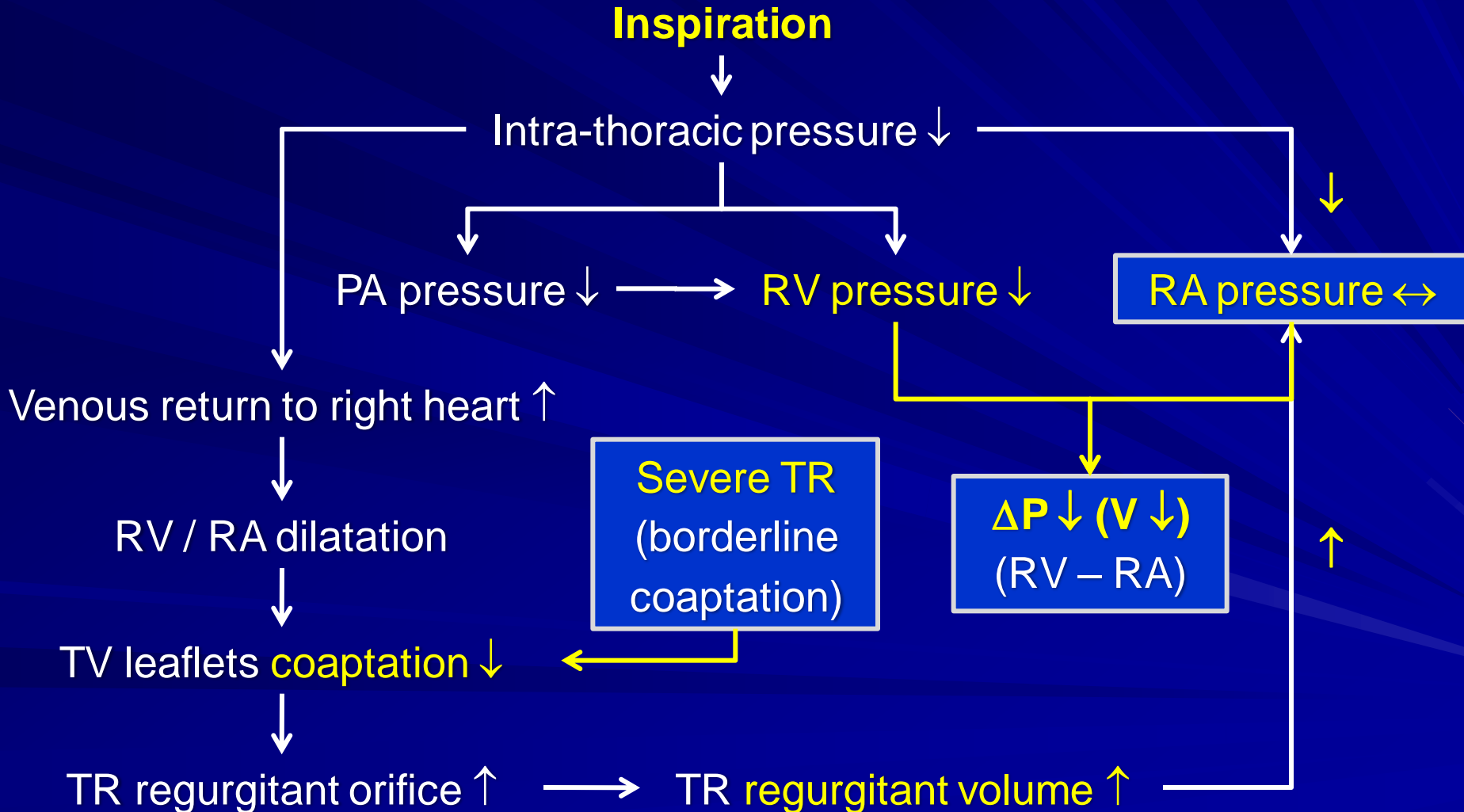
- Prominent respiratory changes are frequently observed in pts with severe TR
 - Infrequent in pts with lesser degrees of TR
- $\Delta V \uparrow (\geq 0.6 \text{ m/s})$ -highly specific for severe TR, with a high (0.90%) positive predictive value for diagnosing this haemodynamic abnormality
- Within pts with severe TR – $\Delta V \uparrow$ identifies a subgroup of pts with more severe TR

Study Limitations

- Retrospective analysis
- Referral / selection bias
 - Pts referred for echocardiography (tertiary center)
 - Adequate TR Doppler strips (≥ 4 TR signals)
 - Regular rhythm (accuracy in irregular rhythms?)
- TR severity and the right heart chambers were assessed qualitatively, without the use of quantitative methods
 - Routine clinical practice in our echocardiography laboratory
- No respiration monitoring \rightarrow assumptions:
 - Velocities \downarrow = inspiration, velocities \uparrow = expiration
 - + Inspiration during Doppler strip

Hypothesis

Respiration-Dependent TR Hemodynamics



Δ Velocities - Hemodynamic Correlations

