

Quantification of TR: What we do and Can we do better?

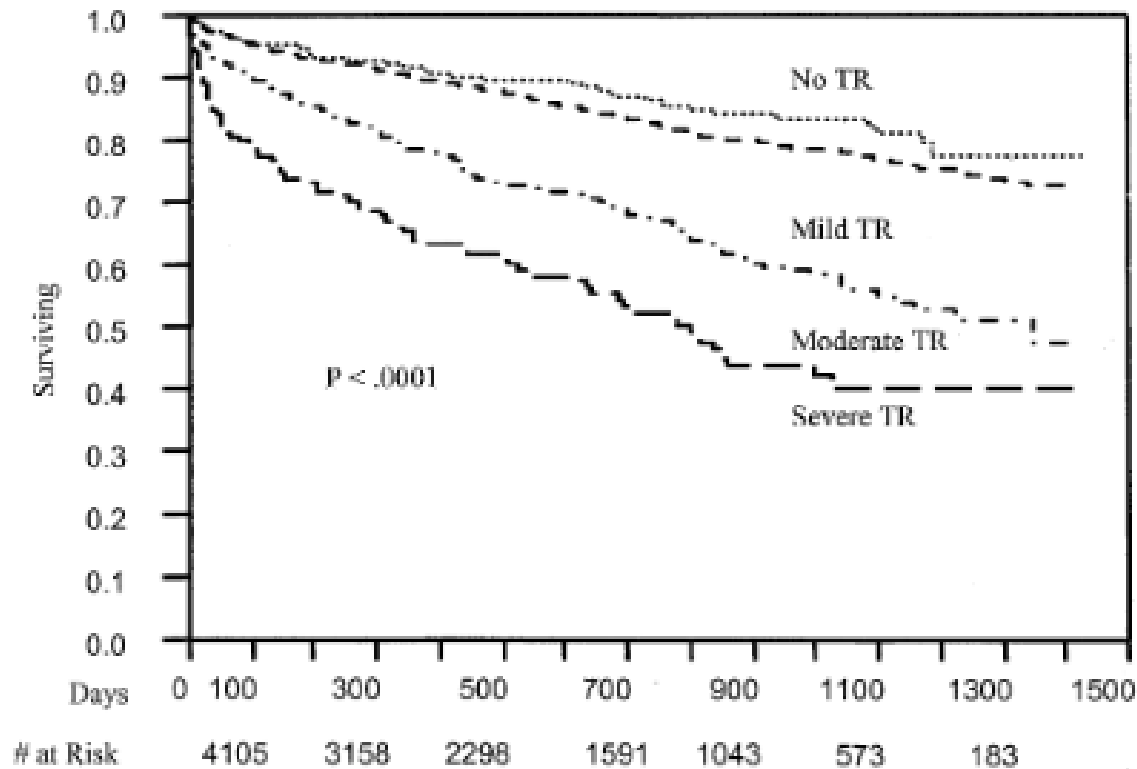
Prof. JL Zamorano

Hospital Universitario Ramón y Cajal

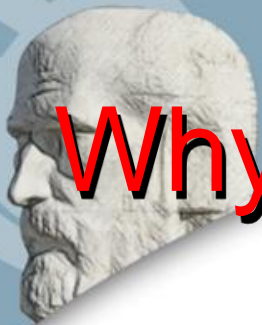




Should we forget TR ?



Nath J et al. Impact of tricuspid regurgitation on long-term survival. J Am Coll Cardiol. 2004; 43:405-409



Why is it difficult to quantify TR?

- ◆ The tricuspid valve is often neglected
- ◆ It has a complex & variable anatomy
- ◆ TR is load dependent
- ◆ No gold standard (invasive quantification has many limitations)
- ◆ Lack of outcome studies relating to TR quantification

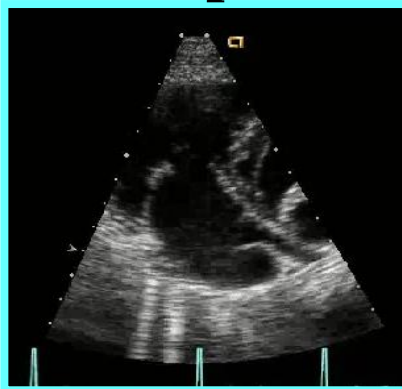
ETIOOLOGY

Functional TR

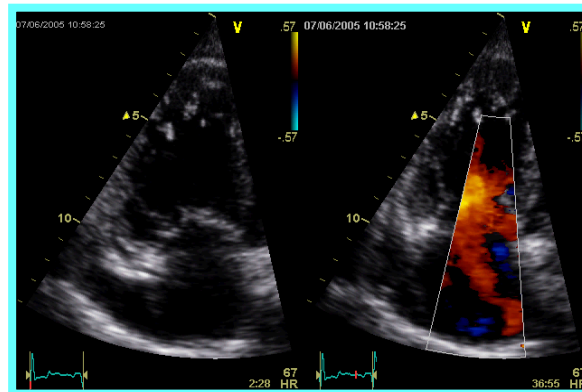
- The most common
- No structural lesion
 - RV pressure overload
 - RV volume overload

Primary TR

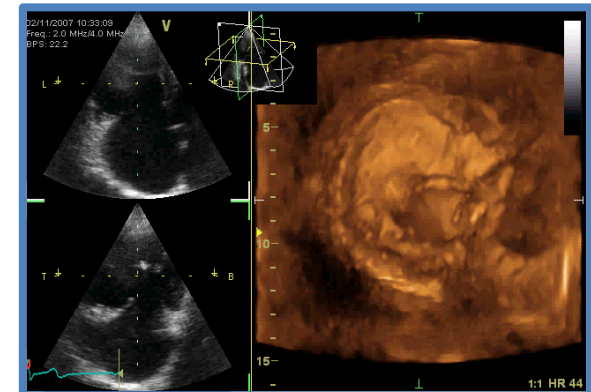
Prolapse



Organic TR

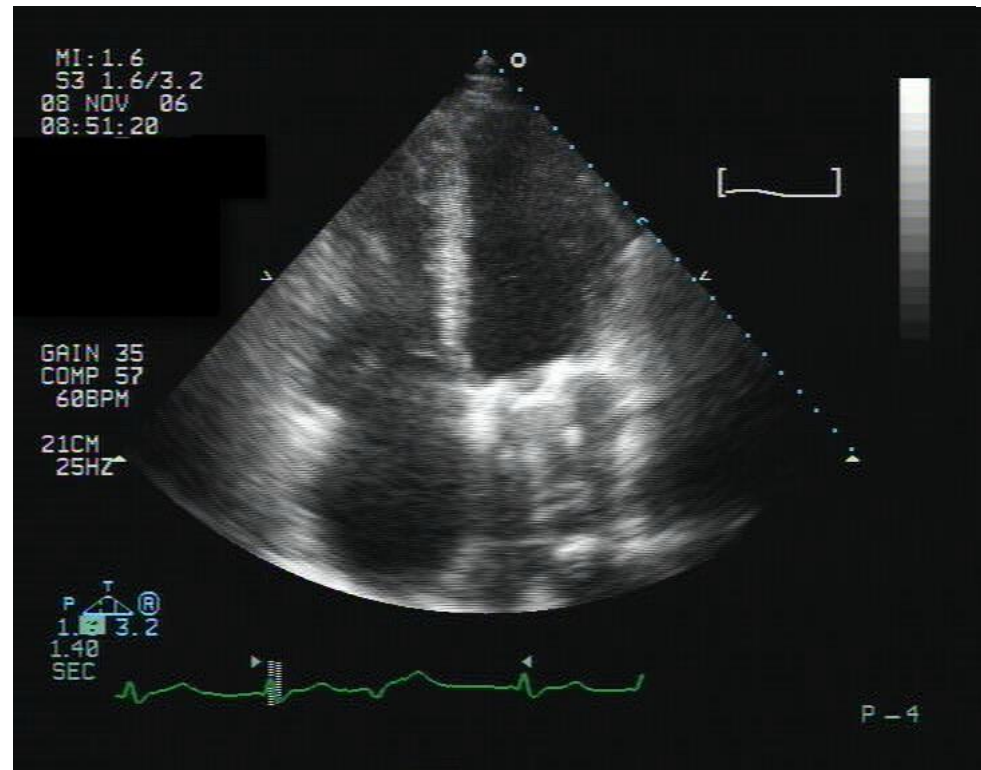


Carcinoid TV



2D Echo signs of TR severity

- ◆ RA, RV & IVC dilatation
- ◆ Paradoxical septal motion
- ◆ TV anatomy
- ◆ TV annulus



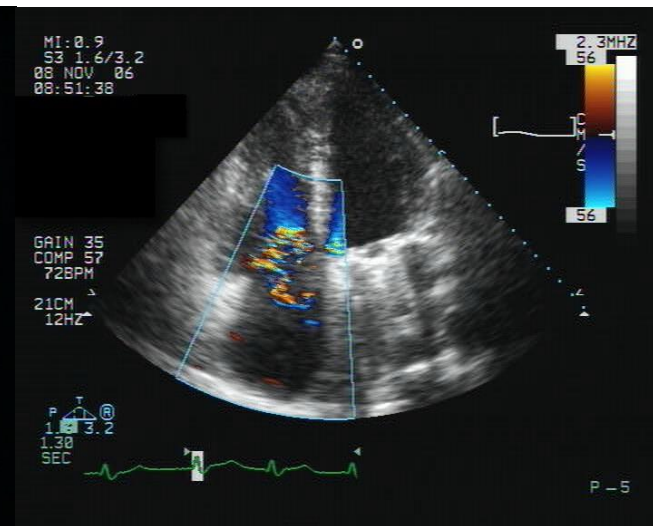
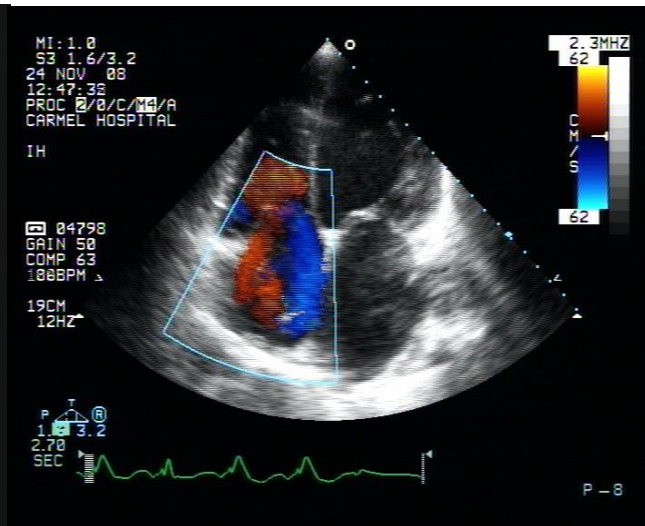
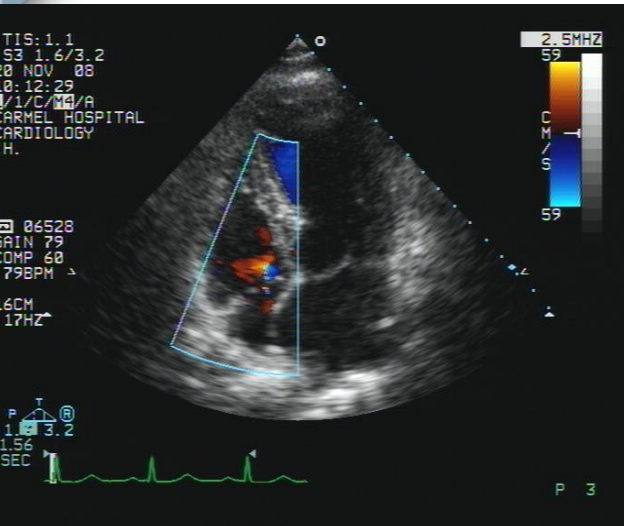
Color flow Doppler



Mild

moderate

severe



JA: $<5\text{cm}^2$

$5\text{cm}^2 - 10\text{cm}^2$

$>10\text{cm}^2$

JA/RAA: $<20\%$

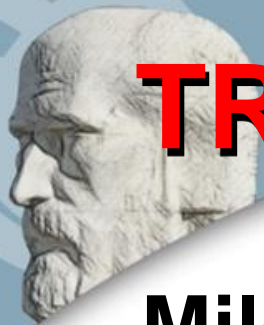
$20\% - 40\%$

$>40\%$



Limitations of color flow Doppler

- ◆ **Central Vs. eccentric jets**
- ◆ **Gain settings & aliasing velocity**
- ◆ **Loading conditions**
- ◆ **JA/RAA: RA enlargement with severe TR**
- ◆ **Considered less accurate than other quantitative methods (VC, PISA)**
- ◆ **Still...**

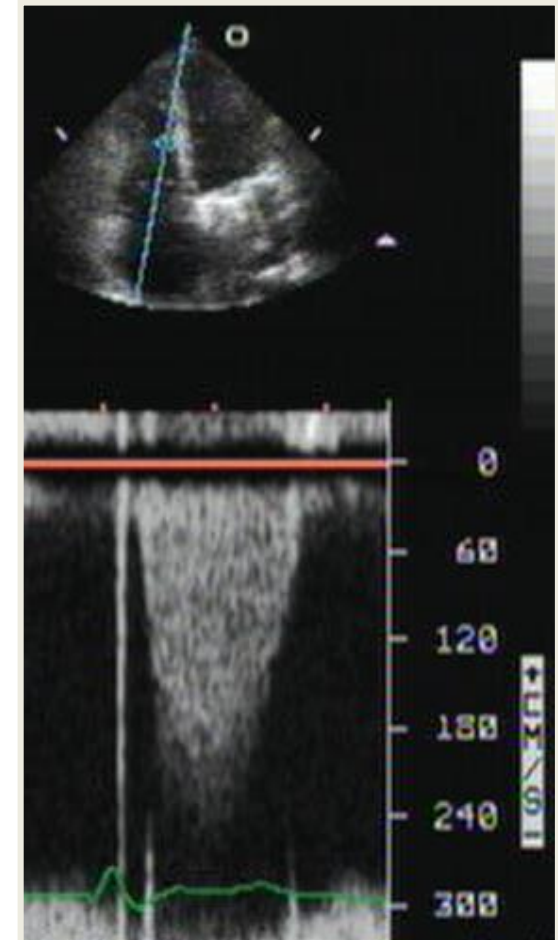
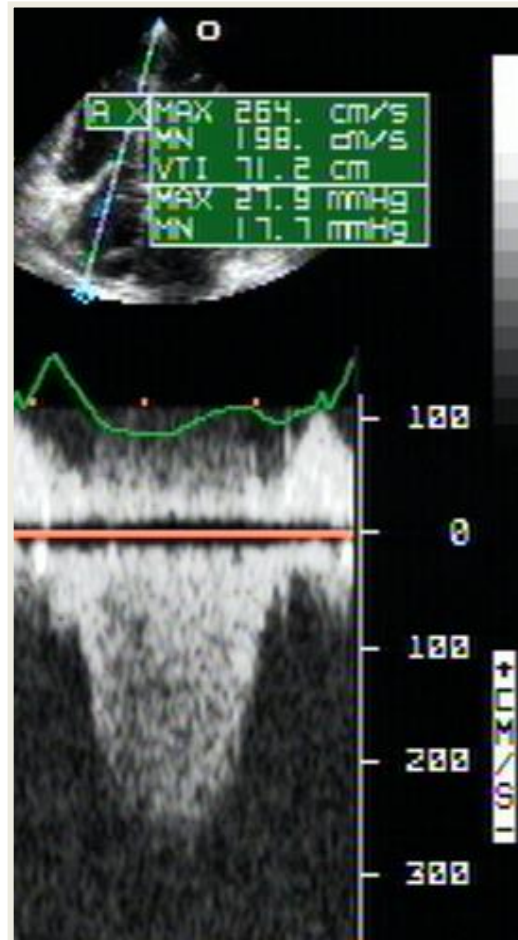
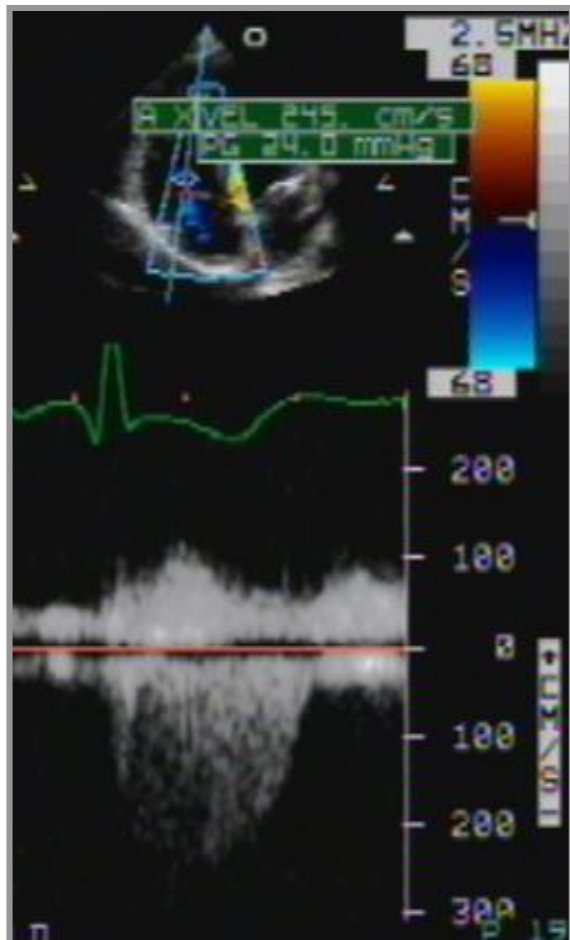


TR severity by CW Doppler

Mild

Moderate

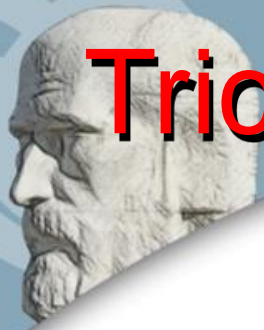
Severe





TR Jet – CW Doppler

- A **full CW Doppler envelope** indicates more severe TR than a faint signal
- A **triangular CW contour with an early peak velocity** indicates elevated RA pressure or prominent pressure wave in the RA due to severe TR
- **The velocity of TR does not reflect the severity of TR**
 - **Massive TR:** often associated with a low jet velocity = near equalization of RA and RV pressure
 - **Mild TR + severe pulmonary hypertension :** possible high velocity jet
- **SOME TIPS** !!



Tricuspid E-wave peak velocity (n=118)

- ◆ **$E \geq 65$ cm/sec identified severe TR**

sensitivity=73%

specificity=88%

Hepatic veins systolic flow reversal

reversal

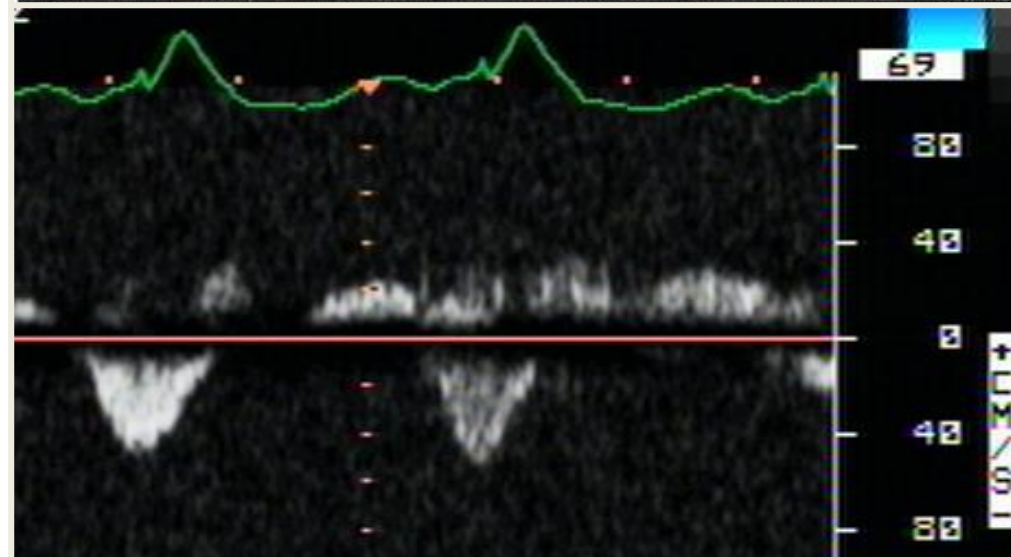
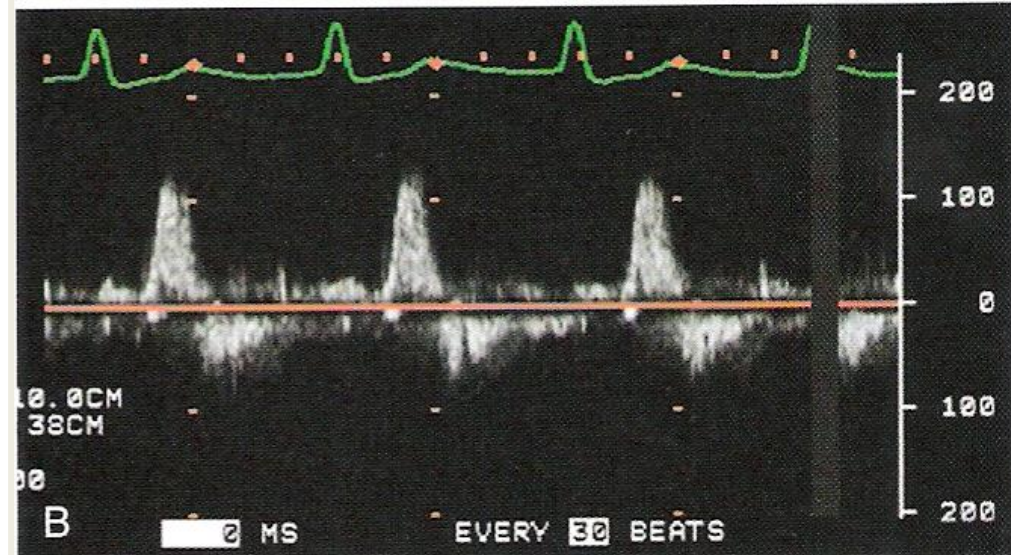
severe TR

Correlation with clinical TR:

- ◆ PPV=91%
- ◆ NPV=78%

moderate TR

Shapira et al, JASE 1998





Vena Contracta

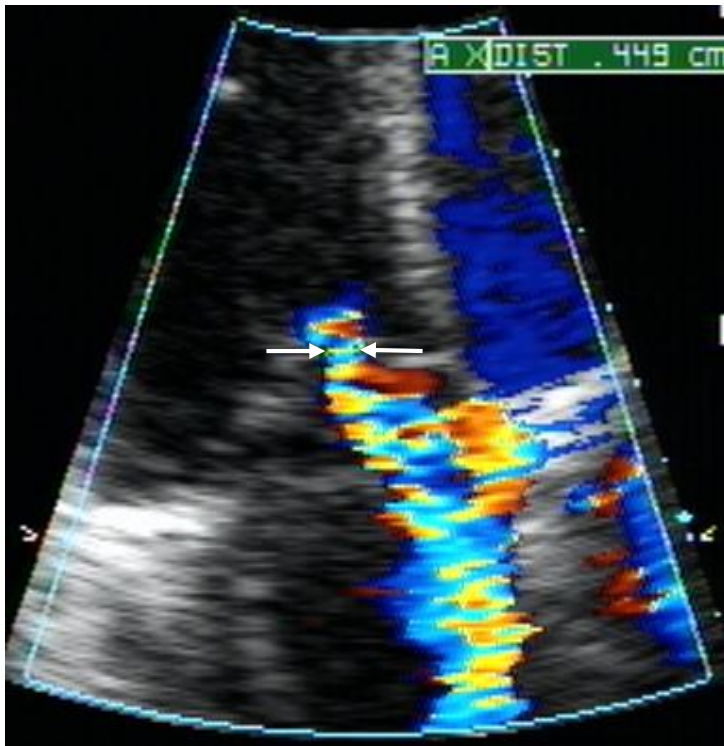
- ◆ **Apical 4CV or parasternal RV inflow view**
- ◆ **Optimize gain settings**
- ◆ **High aliasing velocity**
- ◆ **High frame rate**
- ◆ **Zoom in, mid systole**
- ◆ **Observe all 3 components of the regurgitant flow**

Vena Contracta

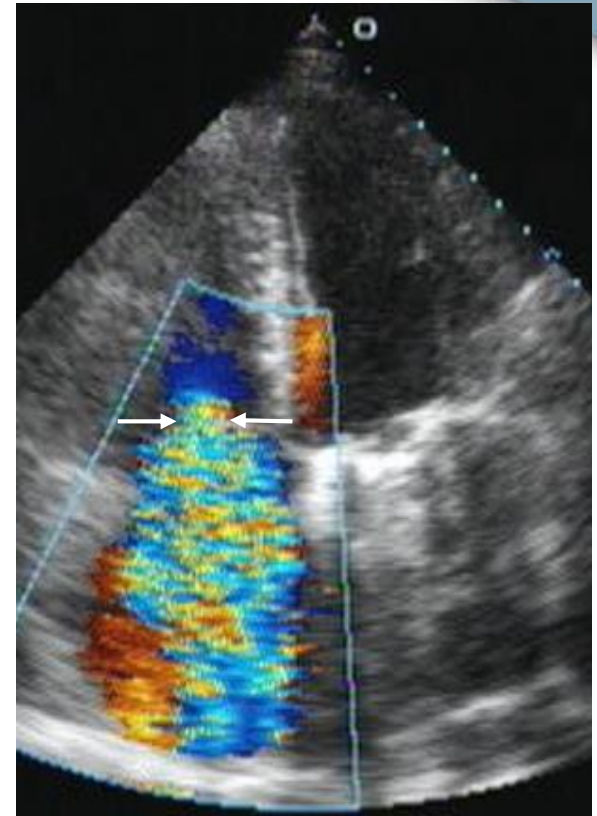
Mild TR: VC < 0.3?

Moderate TR: 0.3 ? < VC < 7mm

Severe TR: VC > 7mm

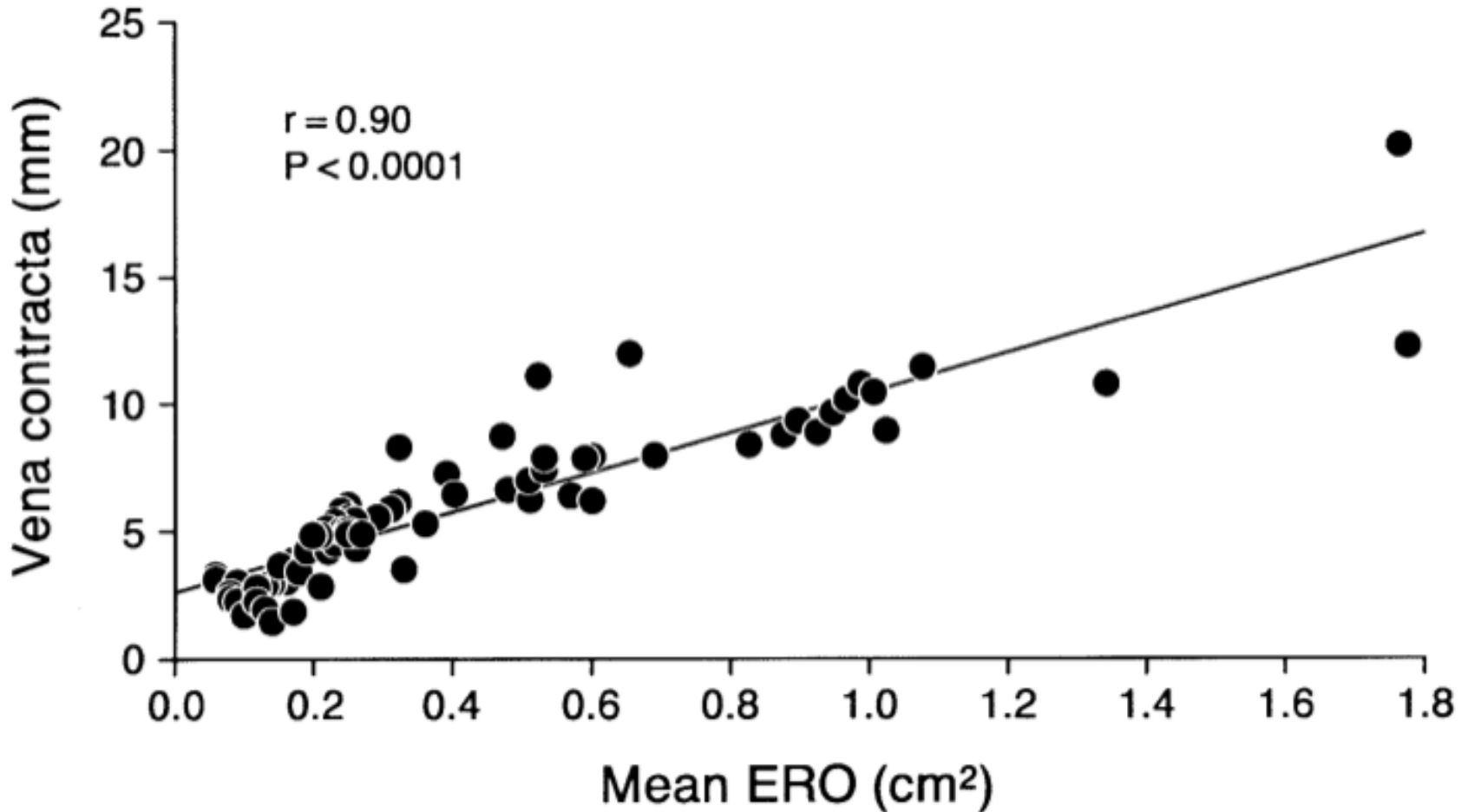


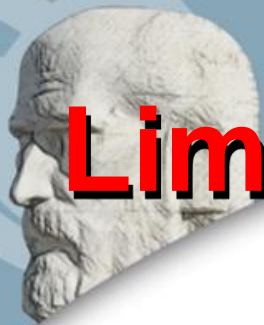
VC=4.5mm



VC=12mm

Vena Contracta Vs. PISA EROA (n=71)





Limitations of Vena Contracta

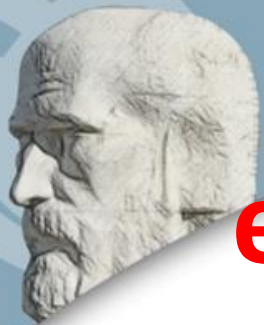
- ◆ **Small measurements (each pixel makes a difference...)**
- ◆ **Overlap in values for small/moderate/severe TR**
- ◆ **Non circular**
- ◆ **When there is more than one TR jet**
- ◆ **Is it really better than color jet area? (outcome studies?)**



Severity TR

Table 5 Grading the severity of TR

| Parameters | Mild | Moderate | Severe |
|------------------------------------|--------------------|-------------------|-----------------------------------------------------------------|
| Qualitative | | | |
| Tricuspid valve morphology | Normal/abnormal | Normal/abnormal | Abnormal/flail/large coaptation defect |
| Colour flow TR jet ^a | Small, central | Intermediate | Very large central jet or eccentric wall impinging jet |
| CW signal of TR jet | Faint/Parabolic | Dense/Parabolic | Dense/Triangular with early peaking (peak <2 m/s in massive TR) |
| Semi-quantitative | | | |
| VC width (mm) ^a | Not defined | <7 | ≥7 |
| PISA radius (mm) ^b | ≤5 | 6–9 | >9 |
| Hepatic vein flow ^c | Systolic dominance | Systolic blunting | Systolic flow reversal |
| Tricuspid inflow | Normal | Normal | E wave dominant (≥1 cm/s) ^d |
| Quantitative | | | |
| EROA (mm ²) | Not defined | Not defined | ≥40 |
| R Vol (mL) | Not defined | Not defined | ≥45 |
| + RA/RV/IVC dimension ^e | | | |



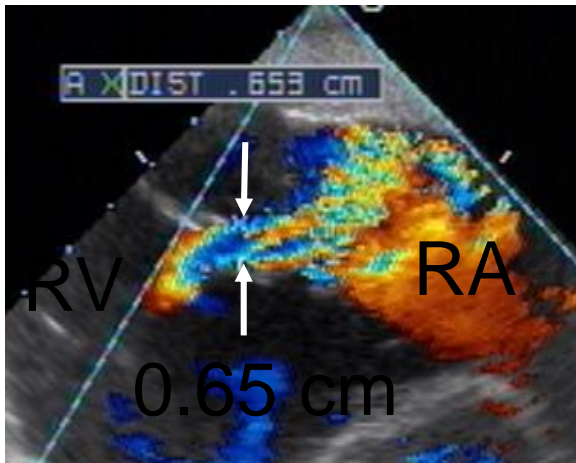
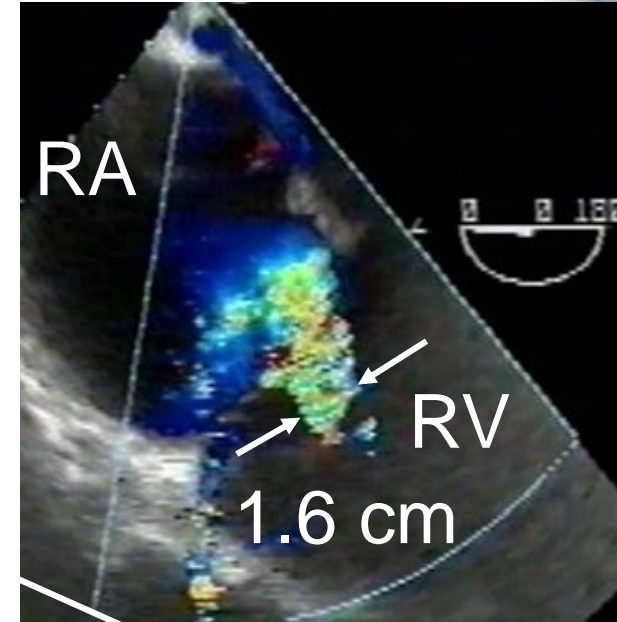
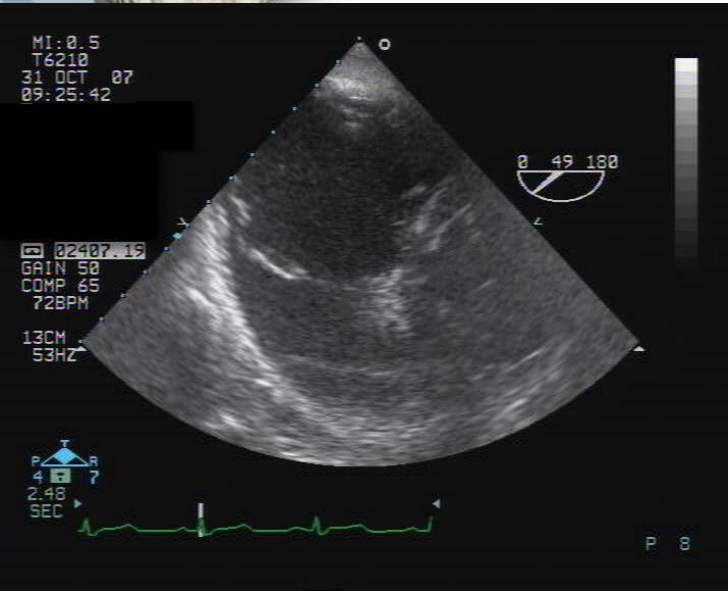
Echocardiography for evaluation of TR severity

| Parameter | Utility/Advantages | Limitations |
|-----------------------------------------------------|----------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------|
| RV/RA/IVC size | Enlargement sensitive for chronic significant TR. Normal size virtually excludes significant chronic TR. | Enlargement seen in other conditions. May be normal in acute significant TR. |
| TV leaflet alterations | Flail valve specific for significant TR | Other abnormalities do not imply significant TR |
| Paradoxical septal motion (volume overload pattern) | Simple sign of severe TR | Not specific for TR |
| Jet area-Color flow | Simple, quick screen for TR | Subject to technical and hemodynamic factors. Underestimates severity in eccentric jets |
| Vena contracta width | Simple, quantitative, separates mild from severe TR | Intermediate values require further confirmation |
| PISA method | Quantitative | Validated in only a few studies |
| Flow quantitation -PW | Quantitative | Not validated for determining TR regurgitant fraction |
| Jet profile -CW | Simple, readily available | Qualitative, complementary data |
| Peak tricuspid E velocity | Simple, usually increased in severe TR | Depends on RA pressure and RV relaxation, TV area, and atrial fibrillation; Complementary data only |
| Hepatic vein flow | Simple; Systolic flow reversal is sensitive for severe TR | Influenced by RA pressure, atrial fibrillation. |

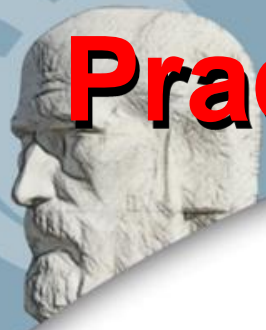
CW, Continuous wave Doppler; *EROA*, effective orifice regurgitant area; *IVC*, inferior vena cava; *PISA*, proximal isovelocity surface area; *PW*, pulsed wave Doppler; *RA*, right atrium; *RV*, right ventricle; *TV*, tricuspid valve; *TR*, tricuspid regurgitation.

Recommendations for Evaluation of the Severity of Native Valvular Regurgitation with Two-dimensional and Doppler Echocardiography

Non Circular Vena Contracta



3D VENA CONTRACTA



Practical Estimation of TR by PISA

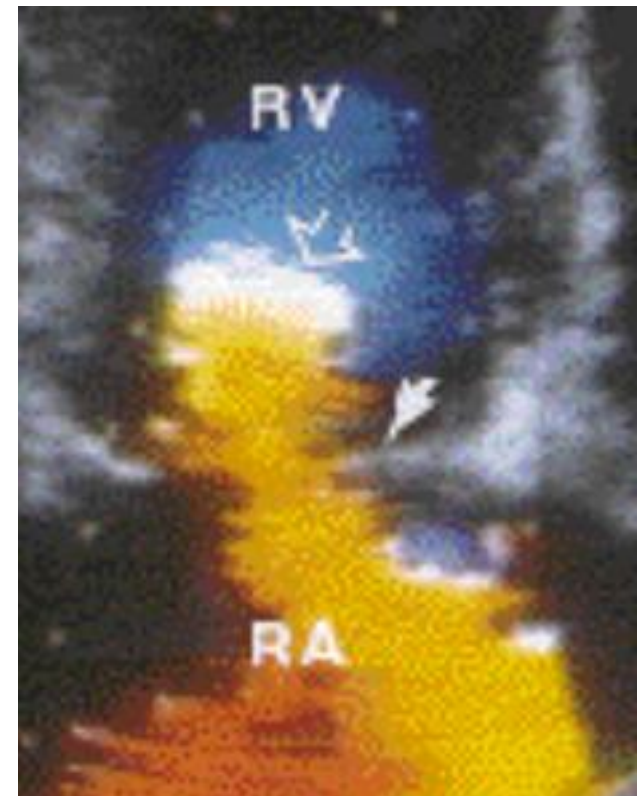
At $V_{ng} = 28$ cm/sec:

- ◆ Mild TR: $r < 0.5$ cm
- ◆ Moderate TR: 0.6 cm $< r < 0.9$ cm
- ◆ Severe TR: $r > 0.9$ cm



Problems with PISA

- ◆ Localizing the regurgitant orifice
- ◆ Irregular rhythms
- ◆ Biological variability



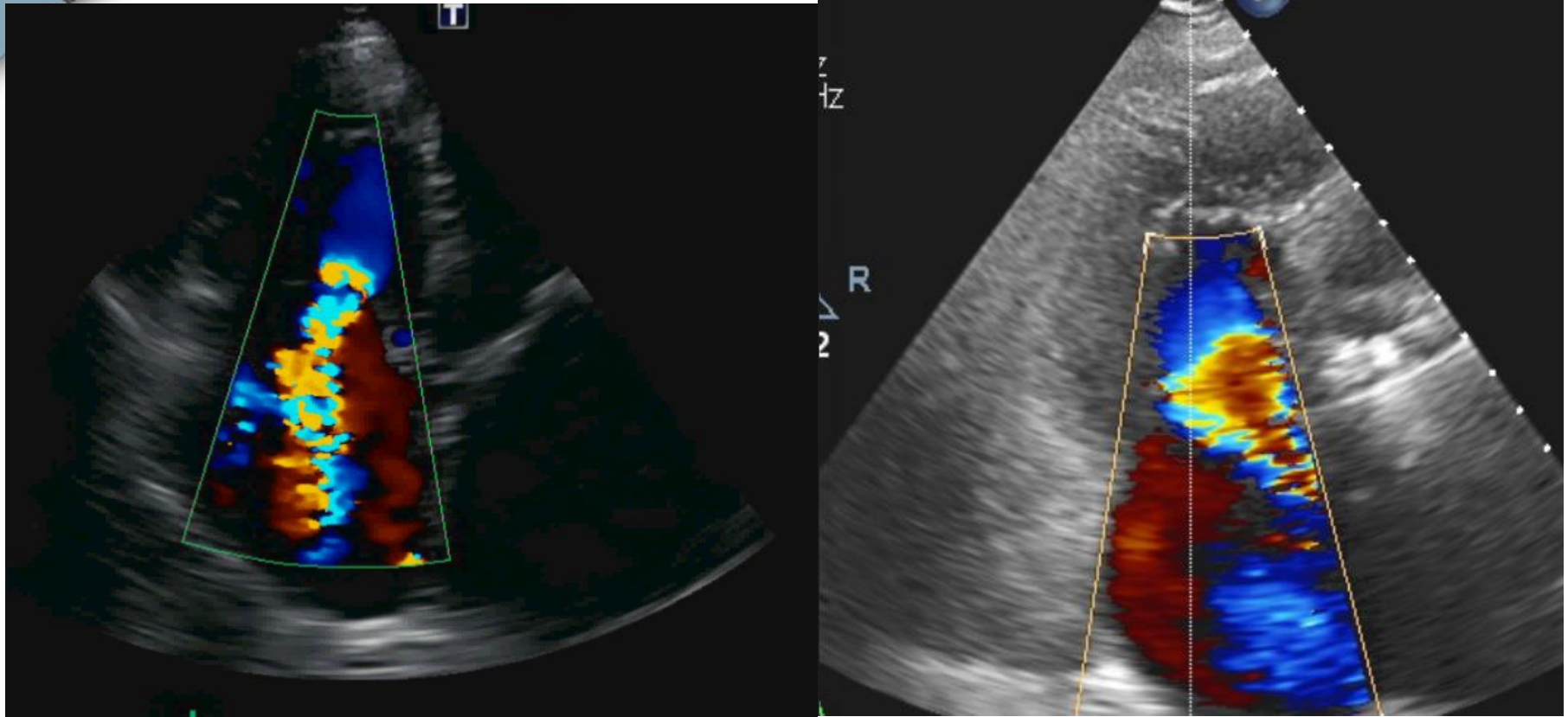


Echocardiographic detection of clinical TR

| | Sensitivity | Specificity |
|------------------------------------------------|--------------------|--------------------|
| Jet area $\geq 9\text{cm}^2$ | 92% | 71% |
| JA/RAA $\geq 37\%$ | 66% | 61% |
| VC $\geq 8\text{mm}$ | 71% | 71% |
| HV systolic flow reversal | 82% | 89% |



Severe TR both cases.
Is it the same?





New classification

Table 1

Proposed expansion of the 'Severe' grade

| Variable | Mild | Moderate | Severe | Massive | Torrential |
|------------------------------------------|---------------------|-----------------------|-----------------------|------------------------|----------------------|
| VC (biplane) | <3 mm | 3-6.9 mm | 7-13 mm | 14-20 mm | ≥21 mm |
| EROA (PISA) | <20 mm ² | 20-39 mm ² | 40-59 mm ² | 60-79 mm ² | ≥80 mm ² |
| 3D VCA or quantitative EROA ^a | | | 75-94 mm ² | 95-114 mm ² | ≥115 mm ² |

VC, vena contracta; EROA, effective regurgitant orifice area; 3D VCA, three-dimensional vena contracta area.

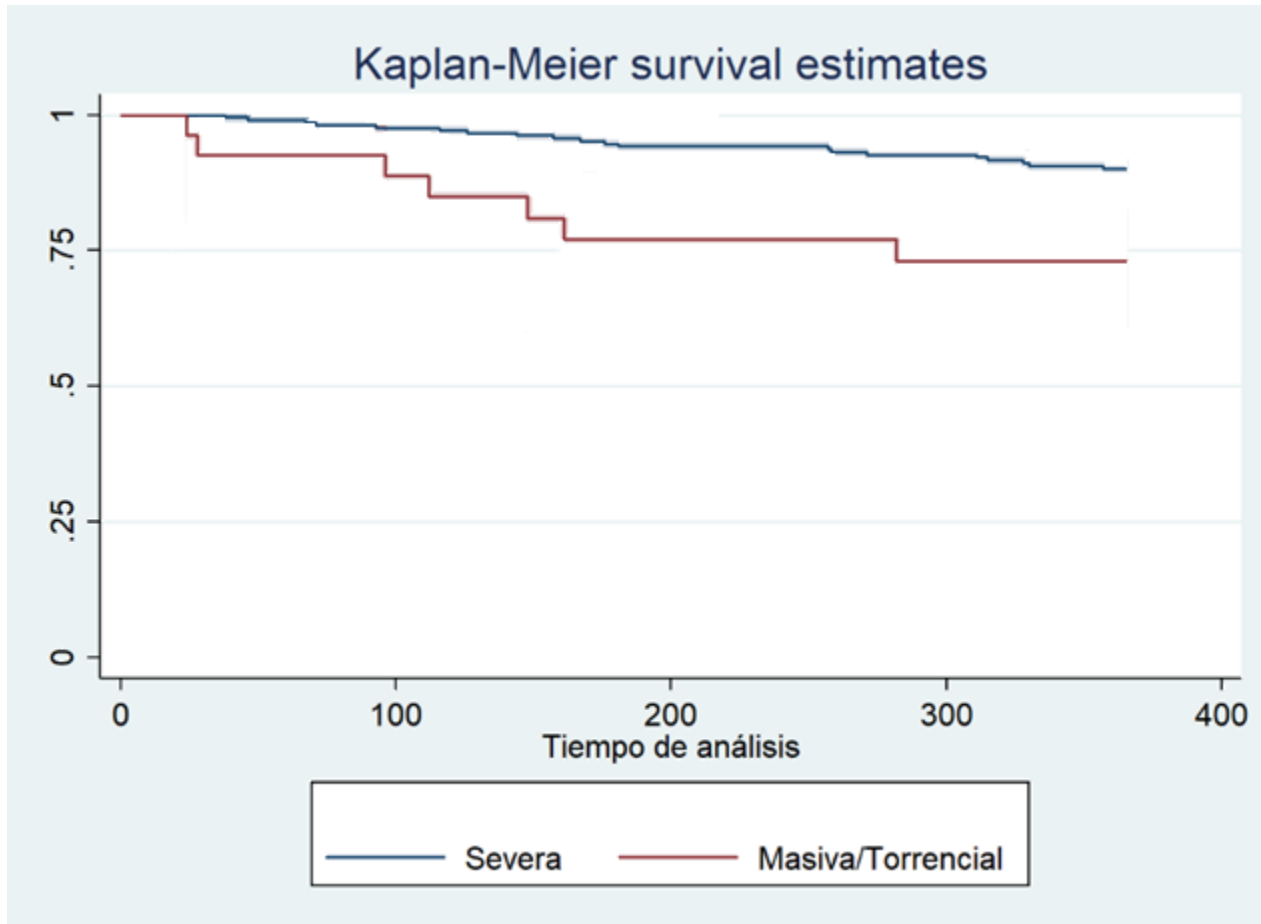
^a 3D VCA and quantitative Doppler EROA cut-offs may be larger than PISA EROA.

Hahn R, Zamorano JL.

Eur Heart J Cardiovasc Imaging. 2017 Dec 1;18(12):1342-1343

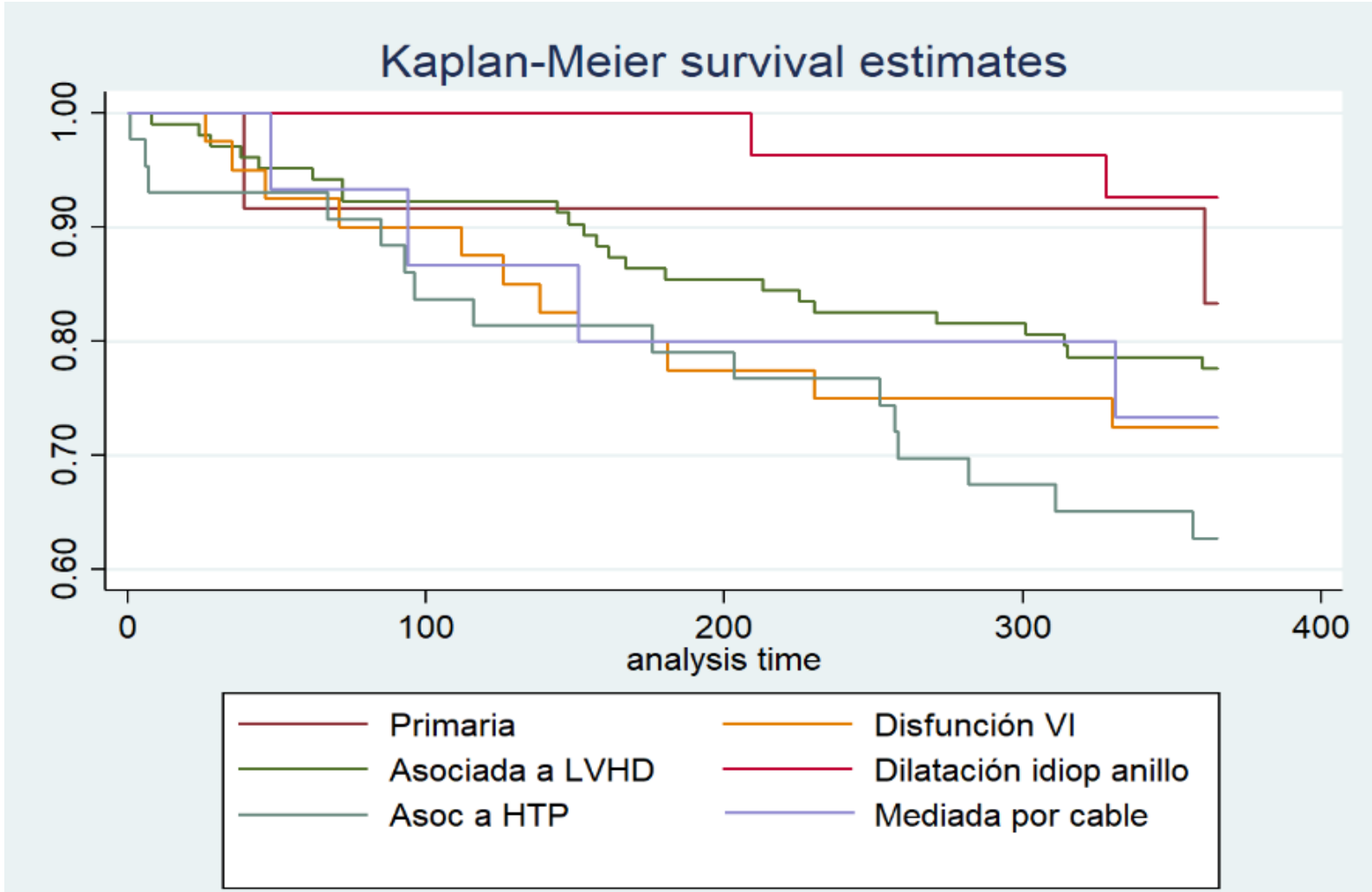


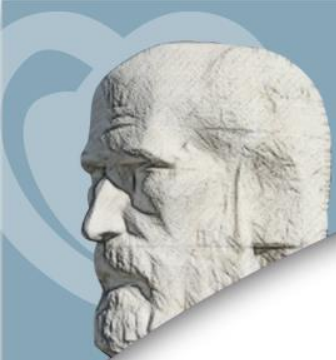
No doubt... Is not the same





Mortality rate at 1 year

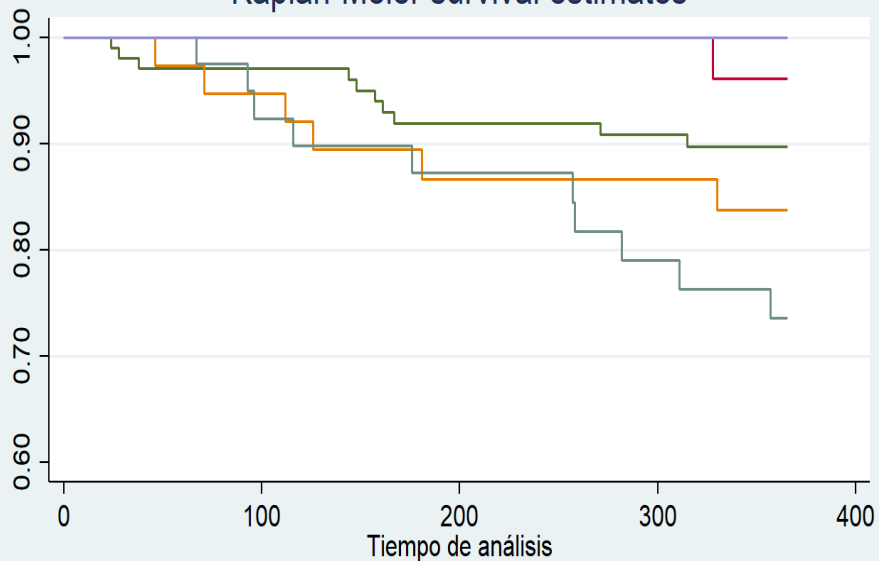




Mortality at 1 year

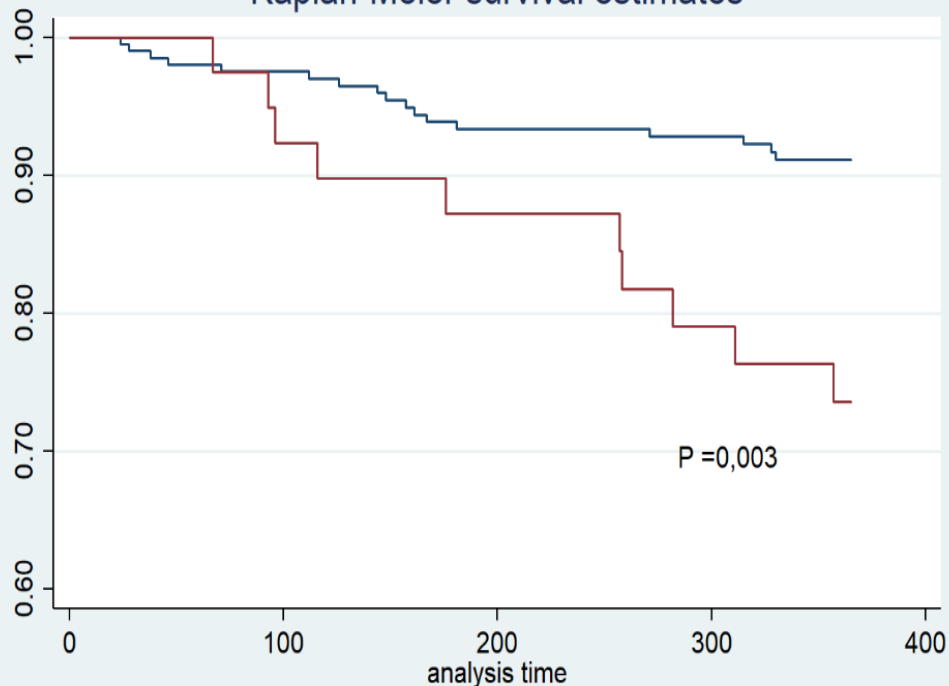
Mortality at 1 year all vs Pulm. HT

Kaplan-Meier survival estimates

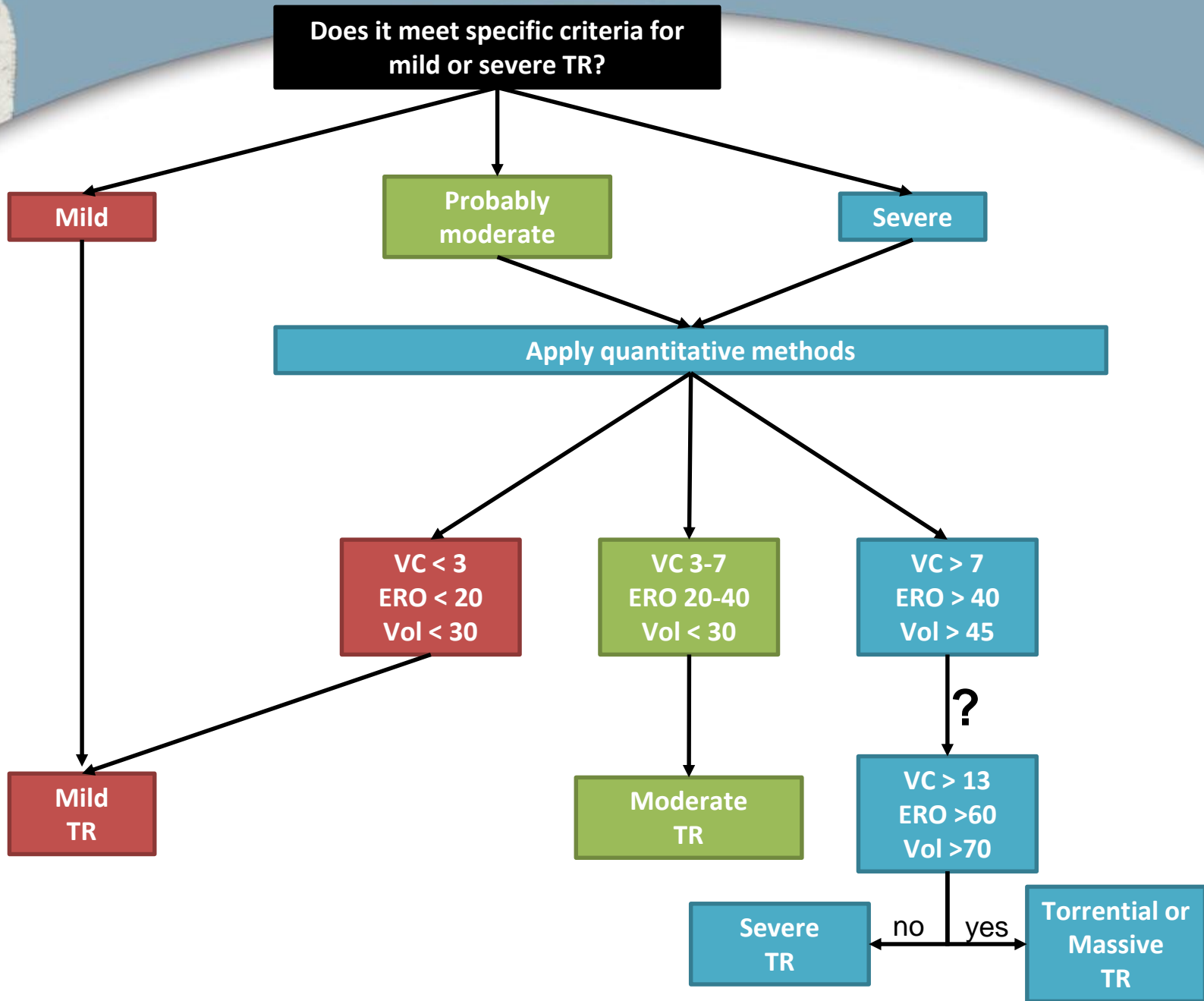


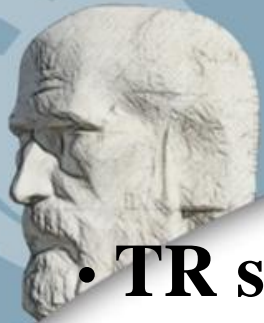
- Primaria
- Cardiopatía valvular izq
- HTP
- Disfunción VI
- Mediadas por dispositivo
- Dilatación idiop Anillo

Kaplan-Meier survival estimates



- Resto de etiologías
- Secundaria a HTP





CONCLUSIONS

- TR severity assessment should be performed in an **integrative** manner +++ using qualitative and quantitative parameters
- **Vena Contracta Width** ++ / EROA (R Vol) ++
- **Serial assessments** of TR are recommended because TR severity can be affected by multiple factors, such as volume status and afterload
- Severe TR: role of **RV shape and function** analysis.
- Severe or...Massive / Torrential