/ Tricuspid Regurgitation /

Which indications for TriClip in 2021 ?

Benjamin Essayagh
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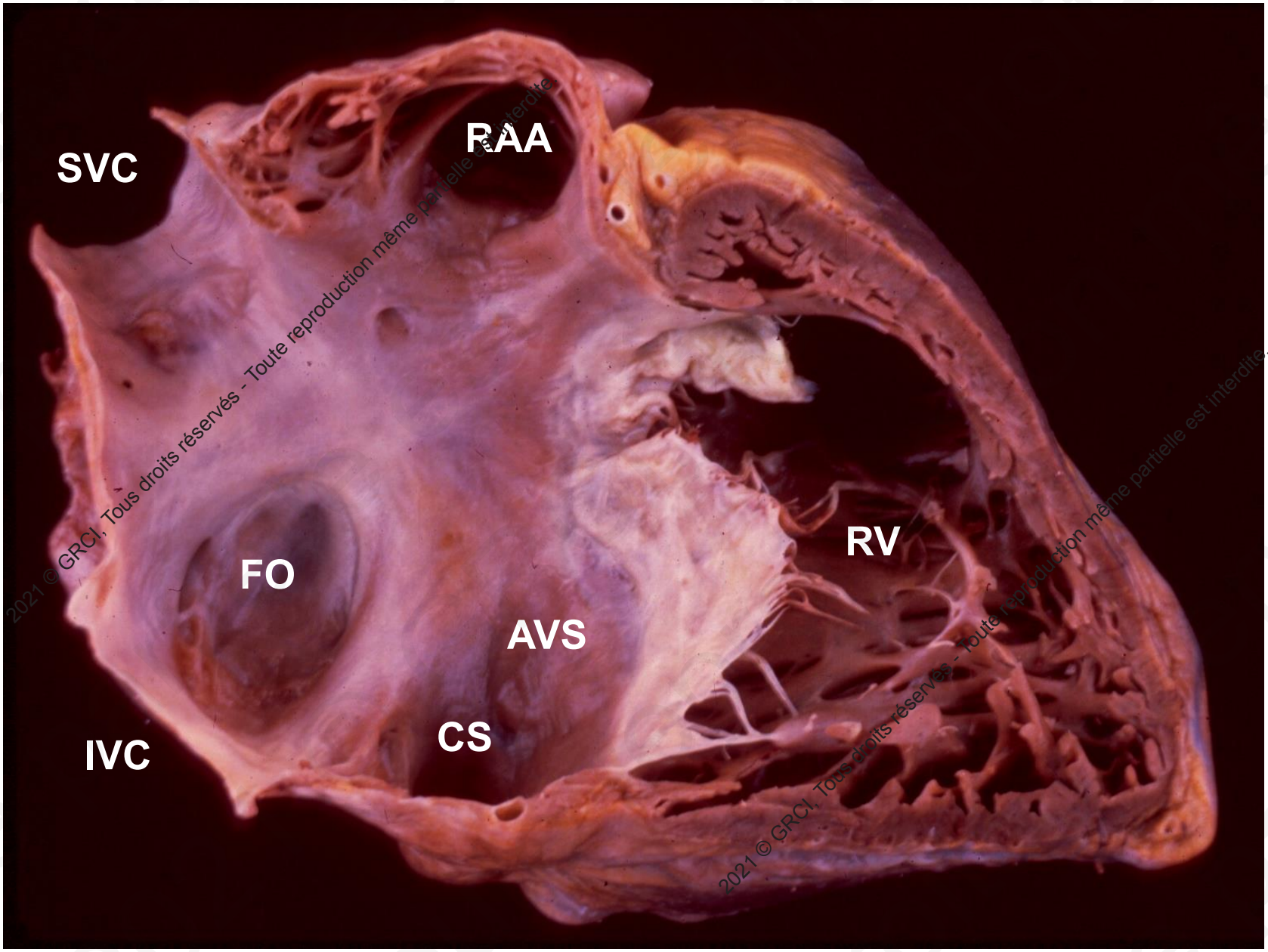
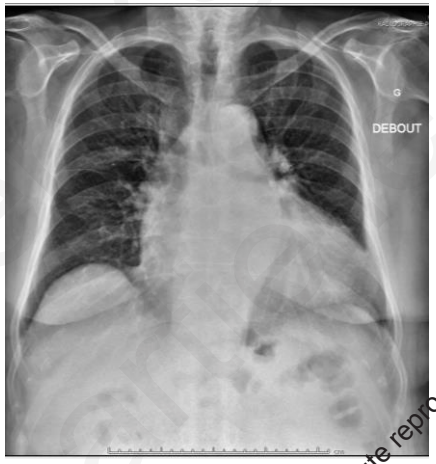
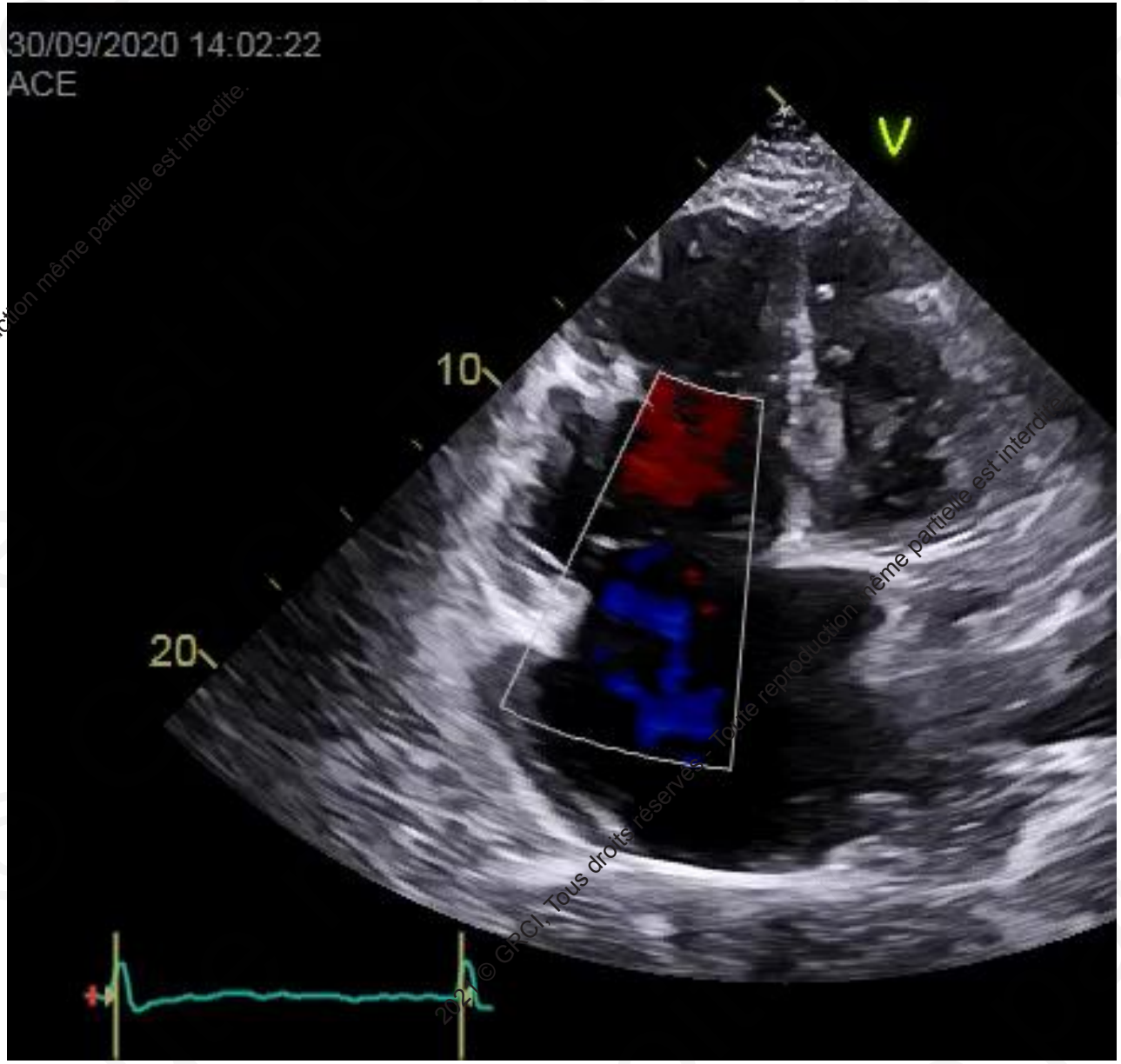
No disclosures







/ 75yo woman

/ Low activity level

/ Epigastric discomfort with walking

/ No murmur

/ HF with enlarged liver, HJR and cardiomegaly

/ What is the burden of tricuspid regurgitation? /

MAYO CLINIC

HÔPITAL DE CANNES

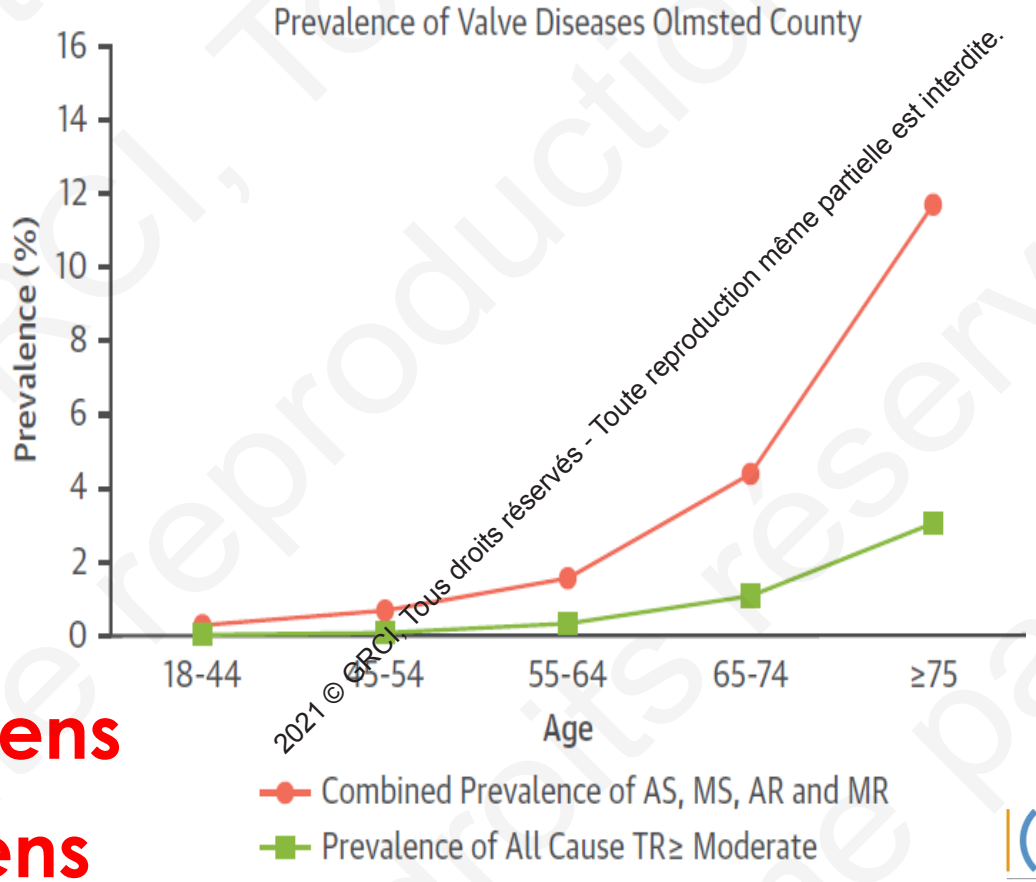
JACC: CARDIOVASCULAR IMAGING VOL. ■, NO. ■, 2018

PUBLISHED BY ELSEVIER

Burden of Tricuspid Regurgitation in Patients Diagnosed in the Community Setting

Yan Topilsky, MD,[a] Simon Maltais, MD,[b] Jose Medina Inojosa, MD,[c] Didem Oguz, MD,[c] Hector Michelena, MD,[c] Joseph Maalouf, MD,[c] Douglas W. Mahoney, MSc,[d] Maurice Enriquez-Sarano, MD[c]

Sex	Age Adjusted U.S. Burden
Female	0.59 (0.52-0.67)
Male	0.47 (0.39-0.55)
Overall	0.55 (0.50-0.60)



1.6 Million US citizens

3 Million EU citizens

Tricuspid regurgitation is frequent but rarely treated

USA: 1.6M

Moderate to severe TR prevalence

<8,000

Surgical procedures annually

Burden of Tricuspid Regurgitation in Patients Diagnosed in the Community Setting

Patients ever treated by Tricuspid Valve Surgery 2.4%

JACC: CARDIOVASCULAR IMAGING

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Burden of Tricuspid Regurgitation in Patients Diagnosed in the Community Setting

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FIGURE 3 Distribution Patterns of TR in the Community

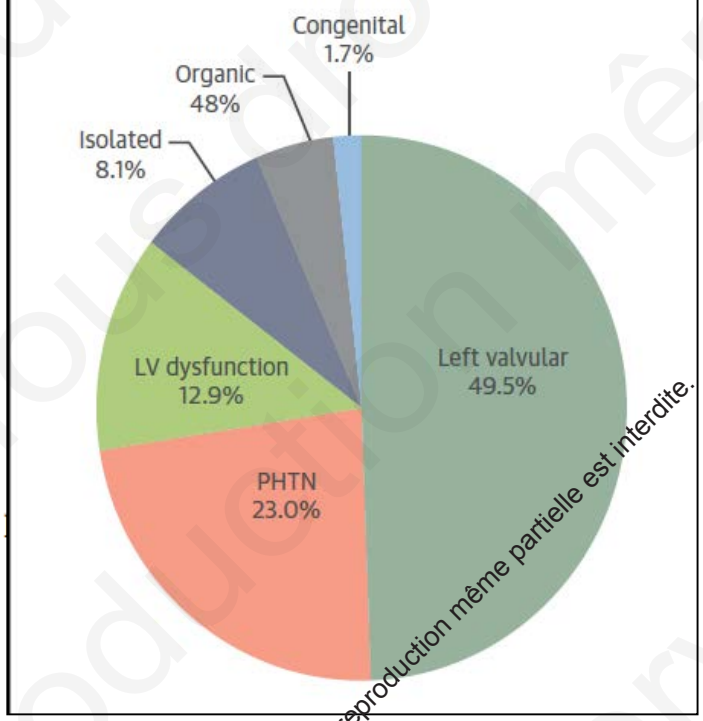
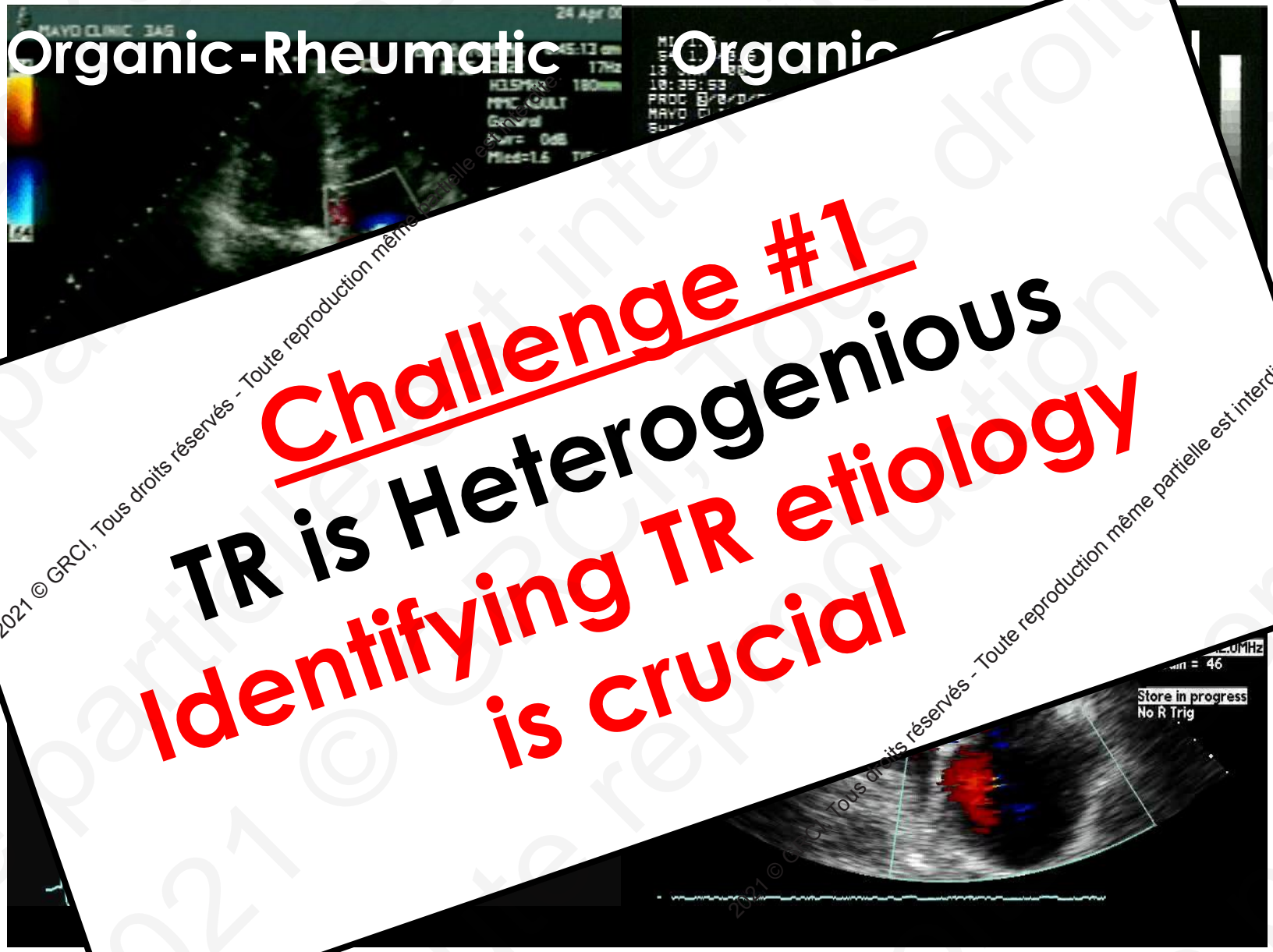


TABLE 2 Clinical and Echo Characteristics of the Different TR Subcategories

	Congenital (n = 18)	Organic (n = 53)	Associated With Left Valvular Disease (n = 542)	Associated With LV Systolic Dysfunction (n = 141)	Associated With PHTN (n = 252)	Isolated (n = 89)
Age, yrs	61 ± 22*†‡§‖	77 ± 13¶	79 ± 11¶	76 ± 12¶	75 ± 12¶	75 ± 15¶
Female	58	52	63§‖¶	40*‡‖	74‡§	72‡§
BMI, kg/m^2	25.6 ± 6	24.1 ± 6	25.6 ± 5	26.2 ± 6	28.8 ± 6	24.7 ± 6
AF	39*†‡§‖	58¶	65¶	63¶	68¶	68¶



Challenge #1

TR is Heterogenious

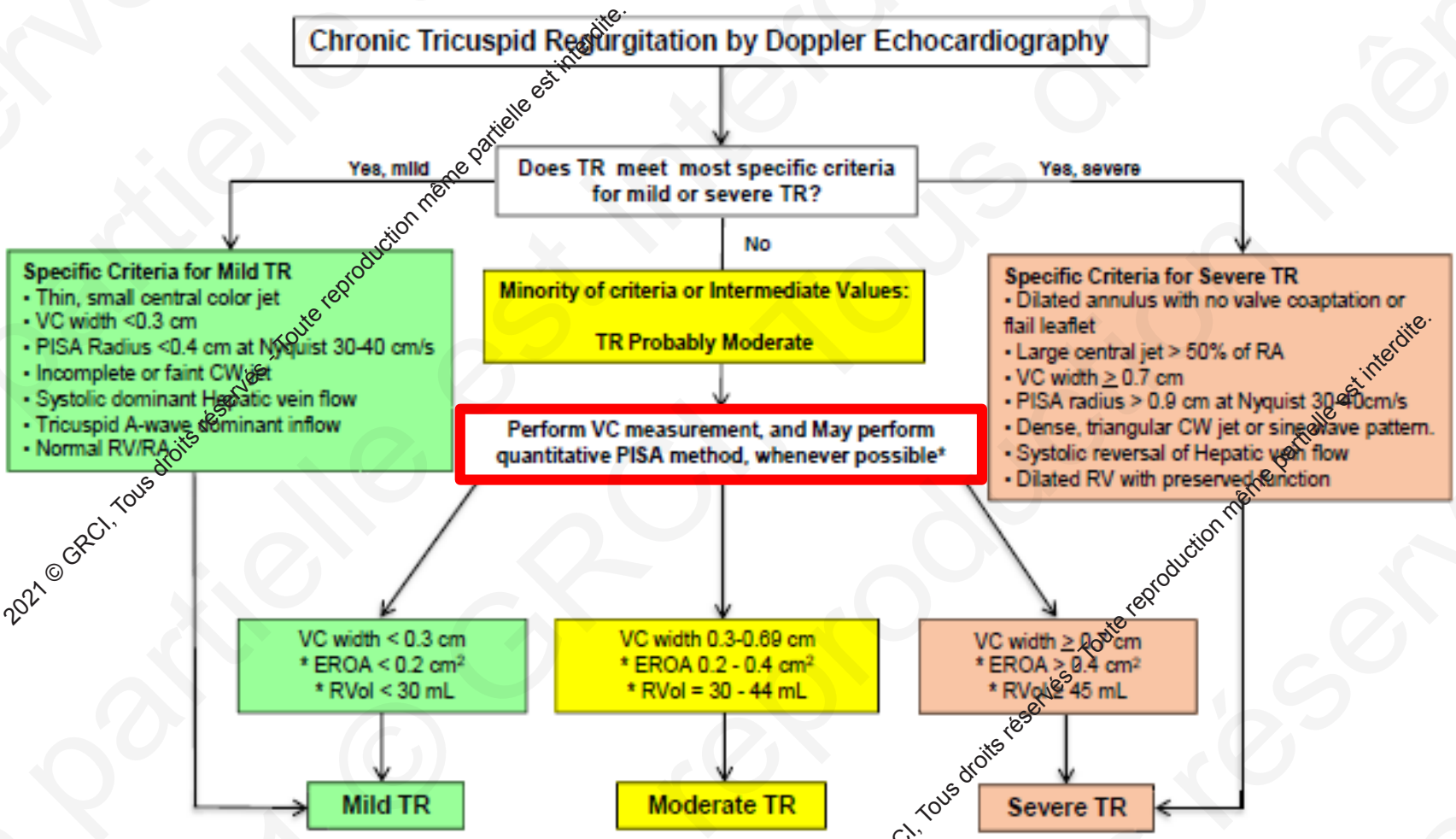
Identifying TR etiology is crucial

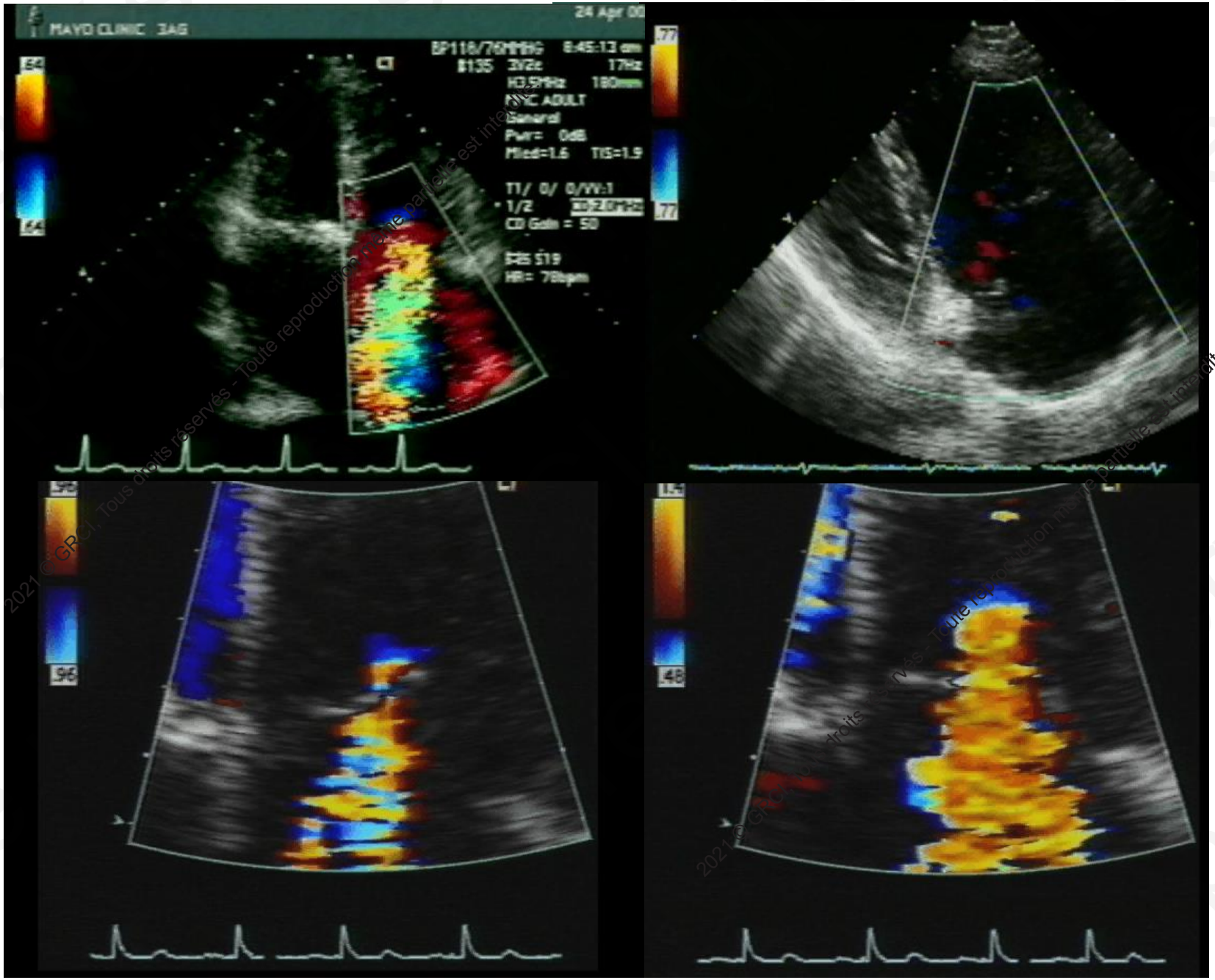
ASE GUIDELINES AND STANDARDS

Recommendations for Noninvasive Evaluation of Native Valvular Regurgitation

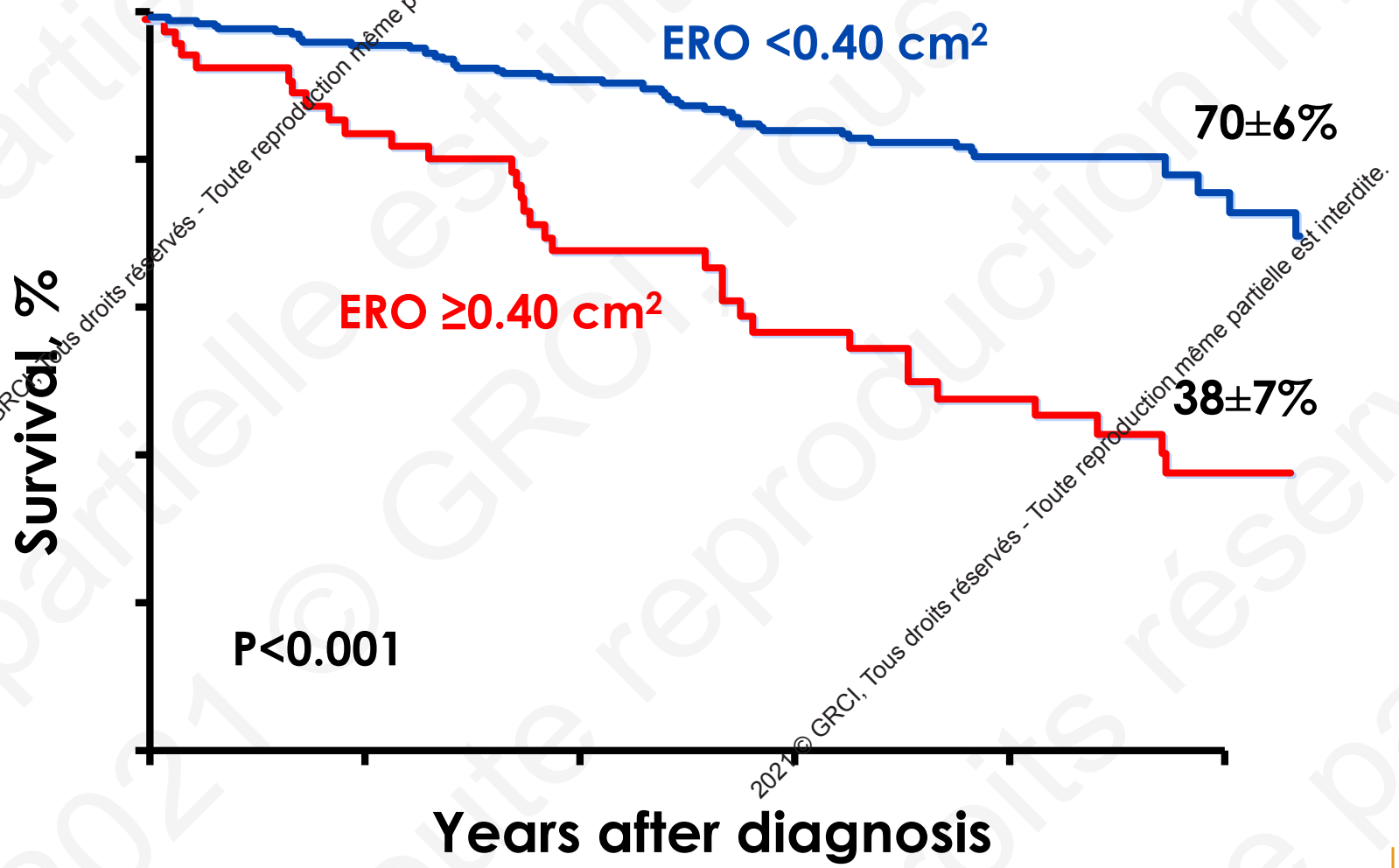
A Report from the American Society of Echocardiography Developed in Collaboration with the Society for Cardiovascular Magnetic Resonance

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*





Isolated TR Outcome



TR Severity Asse

ESC European Society of Cardiology

European He

Challenge #2

TR assessment is often imprecise

Quantifying TR is crucial to appropriate Imaging

Va			Torrential
VC (b		14–20 mm	≥21 mm
EROA	40–59 mm^2	60–79 mm^2	≥80 mm^2
3D VCA	75–94 mm^2	95–114 mm^2	≥115 mm^2

MAYO CLINIC

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TR Effect of respiration

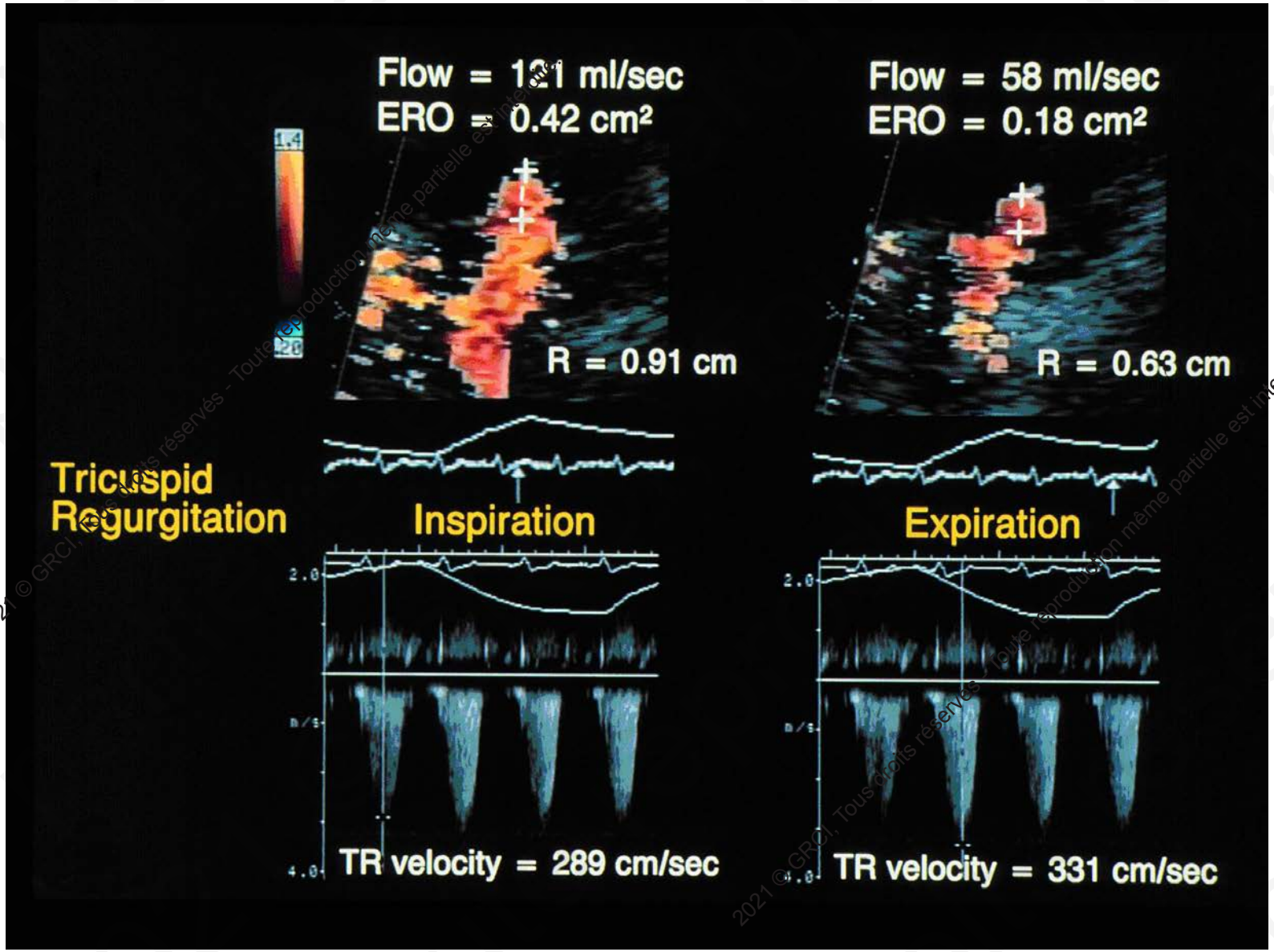
Pathophysiology of Tricuspid Regurgitation
Quantitative Doppler Echocardiographic Assessment of Respiratory Dependence

Yan Topilsky, MD; Christophe Tribouilloy, MD; Hector I. Michelena, MD; Sorin Pislaru, MD; Douglas W. Mahoney, MS; Maurice Enriquez-Sarano, MD

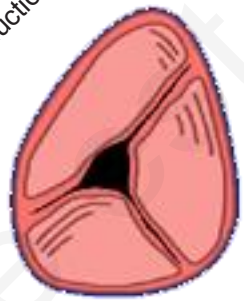
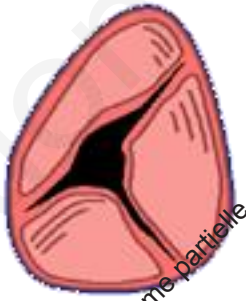
Background—Respiratory dependence of tricuspid regurgitation (TR), a long-held concept suggested by murmur variation, remains unproven and of unclear mechanisms.

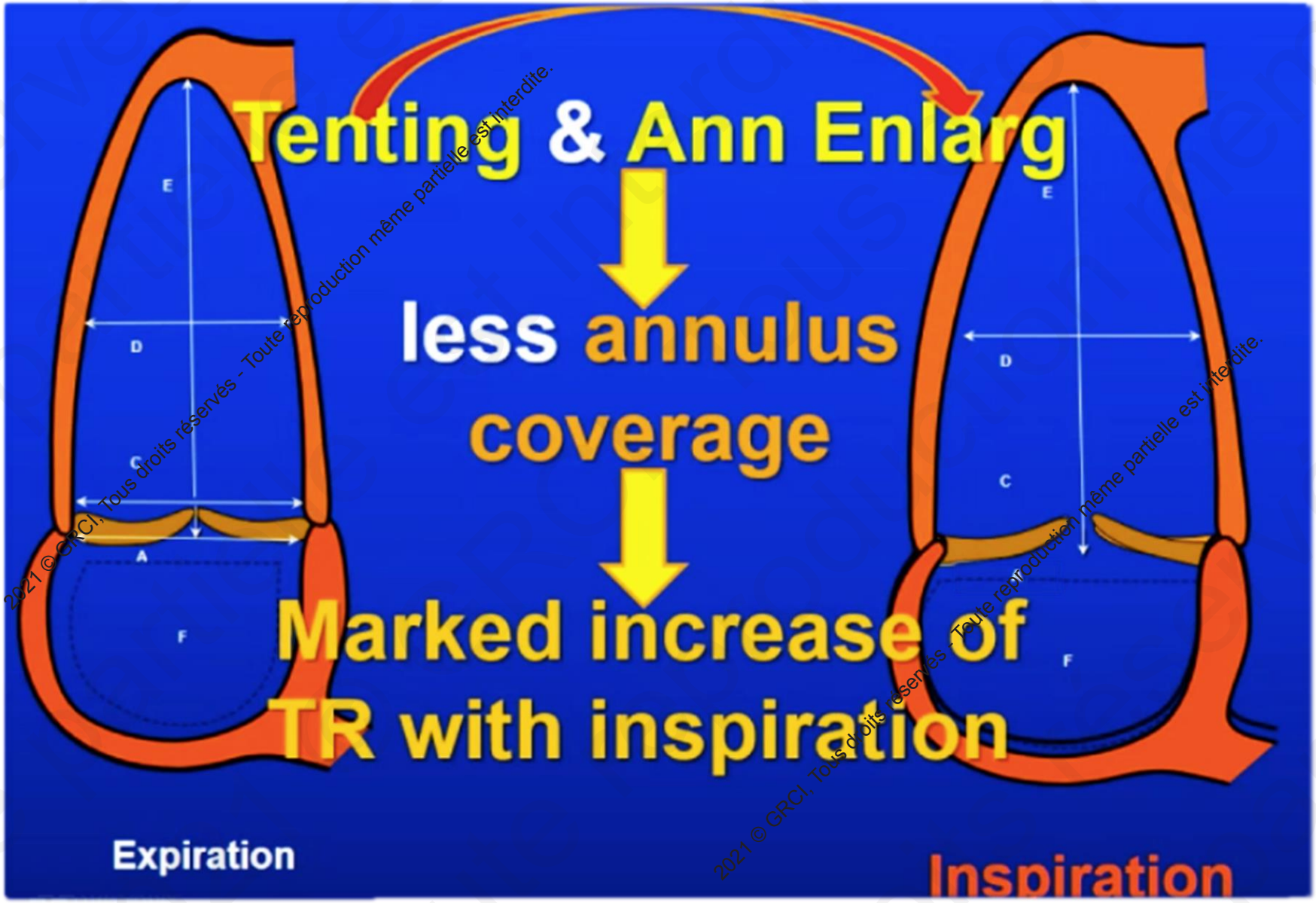
Methods and Results—In 41 patients with mild or greater TR (median age, 67 years), we performed triple Doppler echocardiographic quantification (TR severity, right ventricular, and right atrial quantification) with simultaneous respirometer recording of respiratory phases. Expiration to inspiration changes (median) affected TR peak velocity (−40 cm/s; 25th to 75th percentile, −60 to −30 cm/s), duration (−12 milliseconds; 25th to 75th percentile, −45 to milliseconds), and time-velocity integral (−17 cm; 25th to 75th percentile, −23.4 to −10 cm; all $P<0.001$), consistent with decreased TR driving force. Nevertheless, inspiratory TR augmentation was demonstrated by increased effective regurgitant orifice (0.21 cm^2; 25th to 75th percentile, 0.09 to 0.34 cm^2) and volume (18 mL per beat; 25th to 75th percentile, 10 to 25 mL per beat; all $P<0.001$) infrequently detected clinically (2 of 41, 5%). As a result of reduced TR driving force, regurgitant volume increased less than effective regurgitant orifice (120% [25th to 75th percentile, 78.6% to 169%] versus 169% [25th to 75th percentile, 12.9% to 226.1%]; $P<0.001$). During inspiration, right ventricular area increased (diastolic, 27.8 [25th to 75th percentile, 22.6 to 36.3] versus 26.5 [21.1 to 31.9]; $P<0.0001$) with widening of right ventricular shape (length-to-width ratio, 1.6 [25th to 75th percentile, 1.37 to 1.95] versus 1.7 [1.46 to 2.1]; $P<0.0001$), increased systolic annular diameter ($P=0.003$), valve tenting height ($P<0.0001$) and area ($P<0.0001$), and reduced valvular-to-annular ratio ($P=0.006$). Effective regurgitant orifice during inspiration was independently determined by inspiratory valvular-to-annular ratio ($P=0.026$) and inspiratory change in right ventricular length-to-width ratio ($P=0.008$) and valve tenting area ($P=0.015$).

Conclusions—TR is dynamic with almost universal respiratory changes of large magnitude and complex pathophysiology. During inspiration, a large increase in effective regurgitant orifice causes, despite a decline in regurgitant gradient, a notable increase in regurgitant volume. Effective regurgitant orifice changes are independently linked to inspiratory annular enlargement (decreased valvular coverage) and to inspiratory right ventricular shape widening with increased valvular tenting. These novel physiological insights into TR respiratory dependence underscore right-side heart plasticity and are important for clinical TR severity evaluation. (***Circulation.*** **2010;122:1505-1513.**)



TR Effect of respiration

	Exp		Insp
ERO		+187%	
Gradient		-24%	
R vol		+136%	



Tricuspid Regurgitation

Physiologically

Annular Plasticity &
Valve Tenting
cause TR variability

Pathologically

do these mechanisms play a role in functional TR **?**

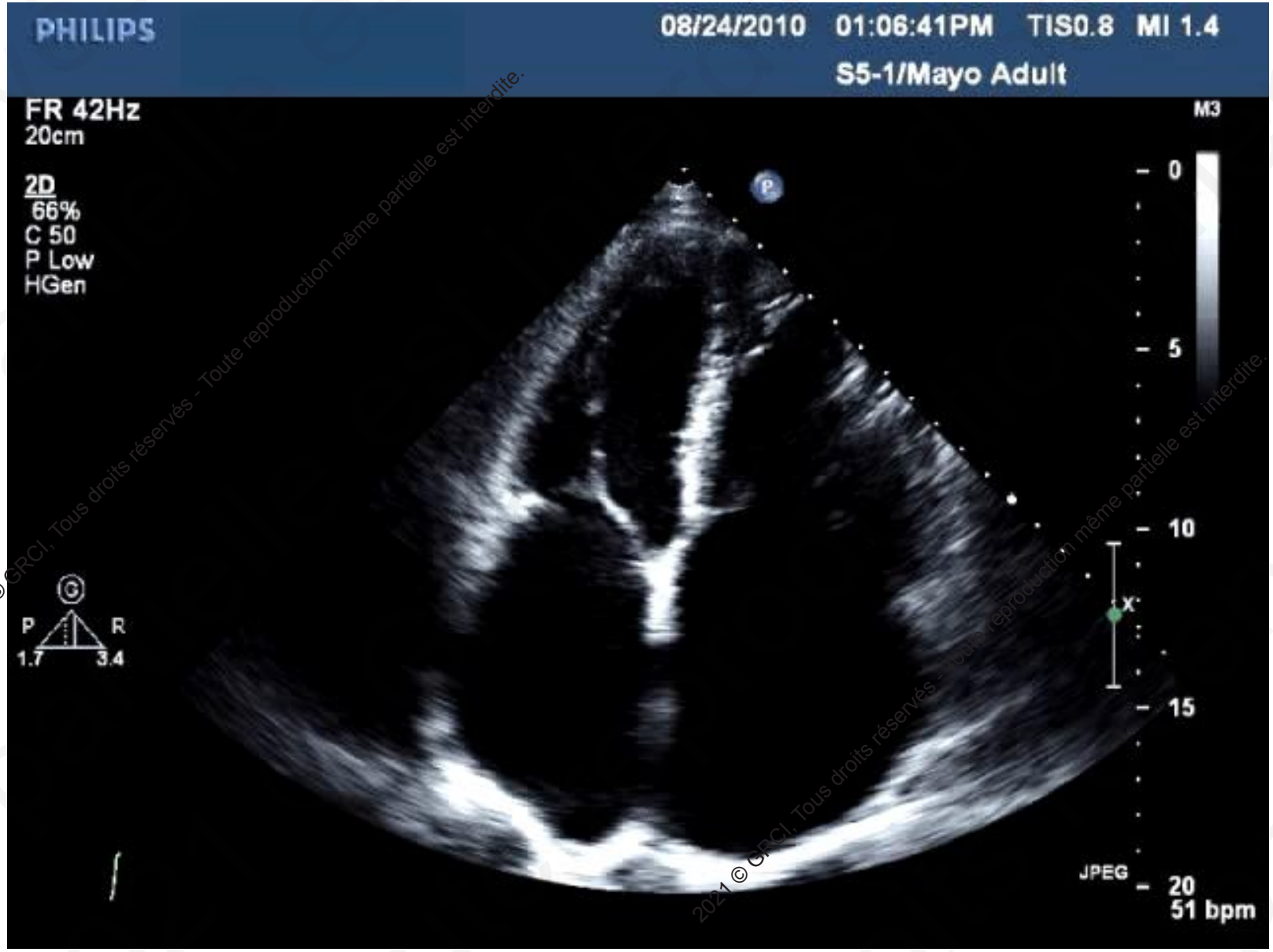
Clinical Context and Mechanism of Functional Tricuspid Regurgitation in Patients With and Without Pulmonary Hypertension

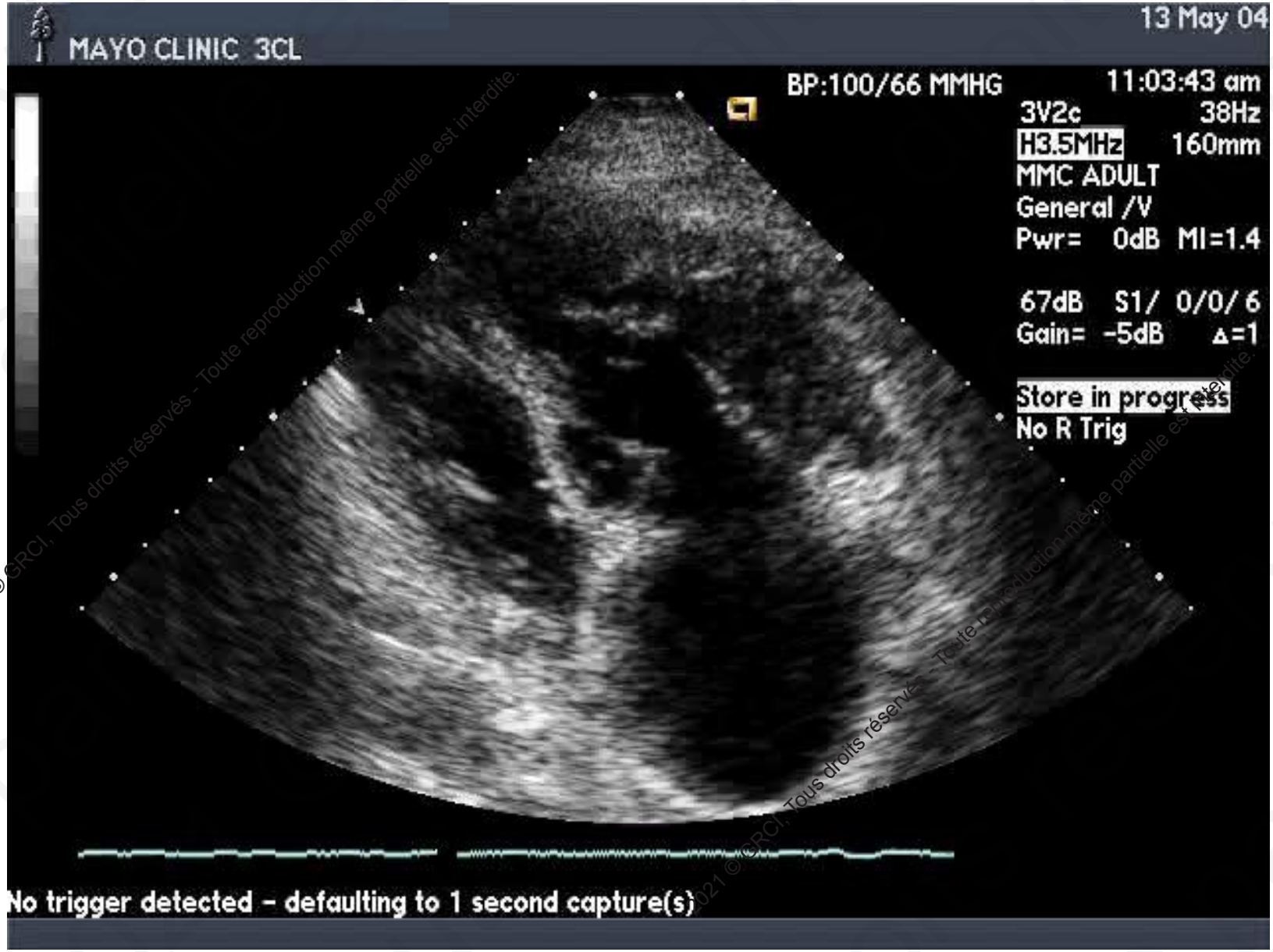
Yan Topilsky, MD; Amber Khanna, MD; Thierry Le Tourneau; MD; Soon Park; MD; Hector Michelena; MD; Rakesh Suri; MD, DPhil; Douglas W. Mahoney; MS; Maurice Enriquez-Sarano, MD

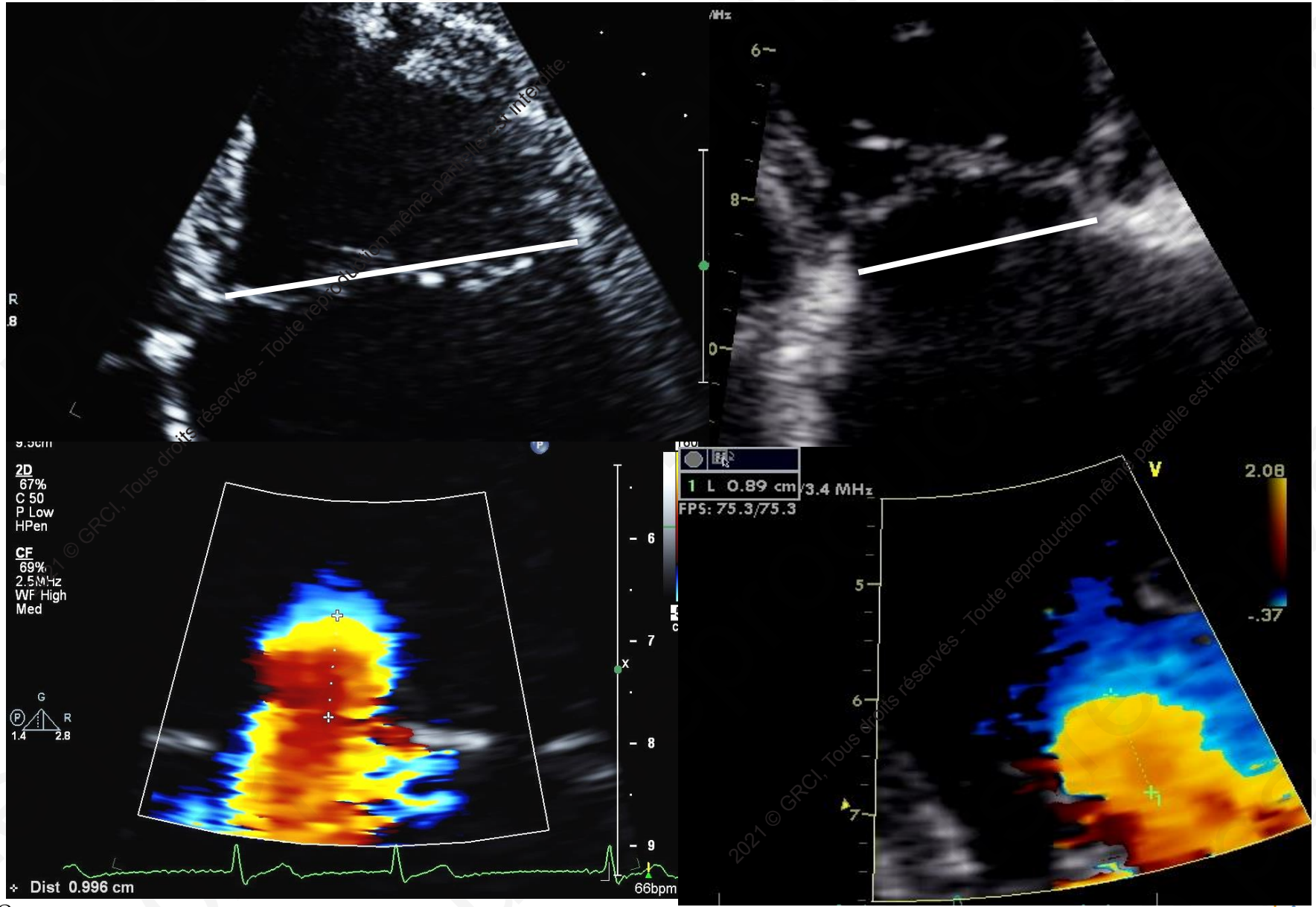
Background—Functional tricuspid regurgitation (FTR) with structurally normal valve is of poorly defined mechanisms. Prevalence and clinical context of idiopathic FTR (Id-FTR) (without overt TR cause) are unknown.

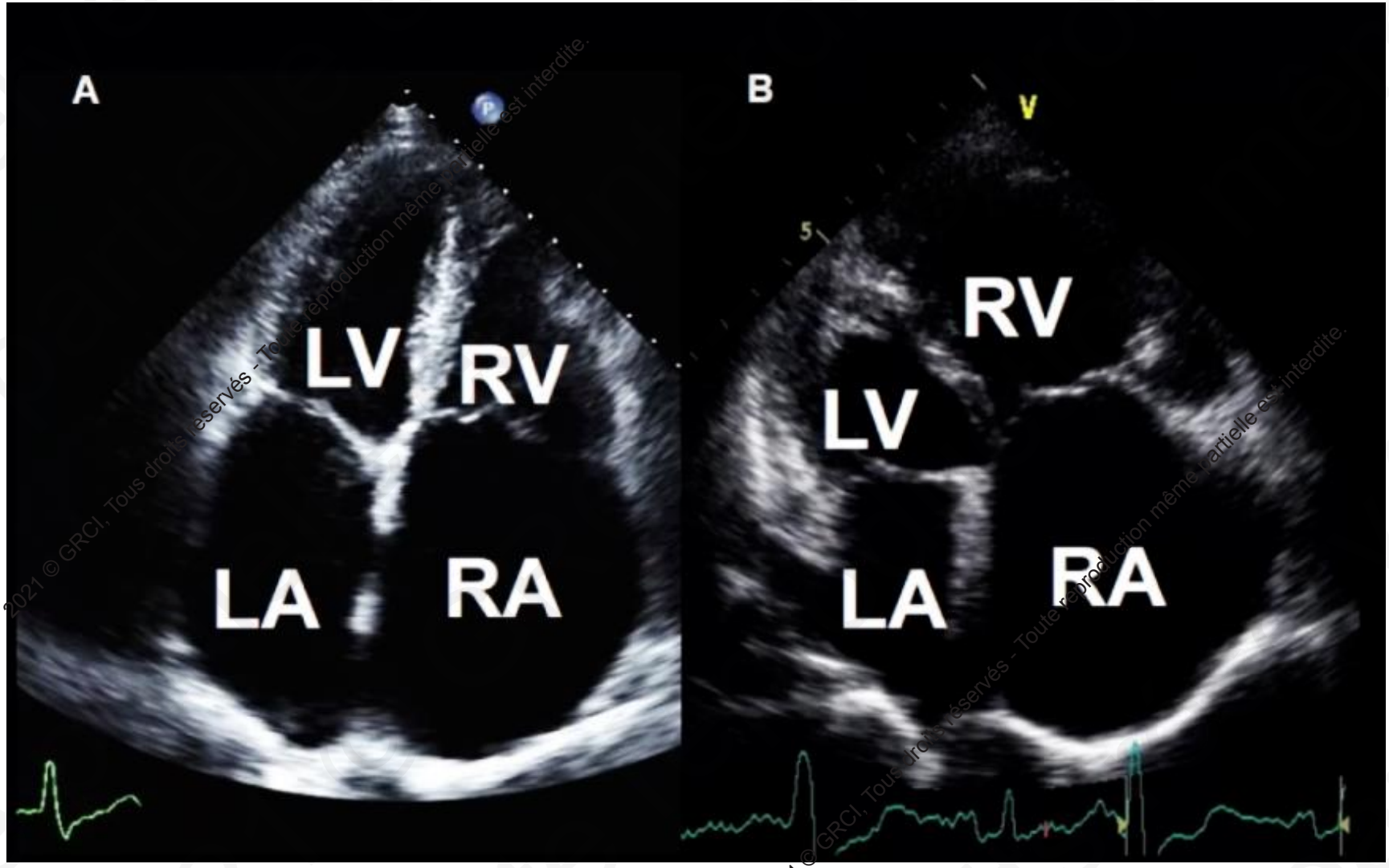
Methods and Results—To investigate prevalence, clinical context, and mechanisms specific to FTR types, Id-FTR versus pulmonary hypertension-related (PHTN-FTR, systolic pulmonary pressure ≥50 mm Hg), we analyzed 1161 patients with prospectively quantified TR. Id-FTR (prevalence 12%) was associated with aging and atrial fibrillation. For mechanistic purposes, we measured valvular and right ventricular (RV) remodeling in 141 Id-FTR matched to 140 PHTN-FTR and to 99 controls with trivial TR for age, sex, atrial fibrillation, and ejection fraction. PHTN-FTR and Id-FTR were also matched for TR effective-regurgitant-orifice (ERO). Id-FTR valvular alterations (versus controls) were largest annular area (3.53±0.6 versus 2.74±0.4 cm^2, $P<0.0001$) and lowest valvular/annular coverage ratio (1.06±0.1 versus 1.45±0.2, $P<0.0001$) but normal valve tenting height. PHTN-FTR had mild annular enlargement but excessive valve tenting height (0.8±0.3 versus 0.35±0.1 cm, $P<0.0001$). Valvular changes were linked to specific RV changes, largest basal dilatation, and normal length (RV conical deformation) in Id-FTR versus longest RV with elliptical/spherical deformation in PHTN-FTR. With increasing FTR severity (ERO ≥40 mm^2), changes specific to each FTR type were accentuated, and RV function (index of myocardial performance) was consistently reduced.

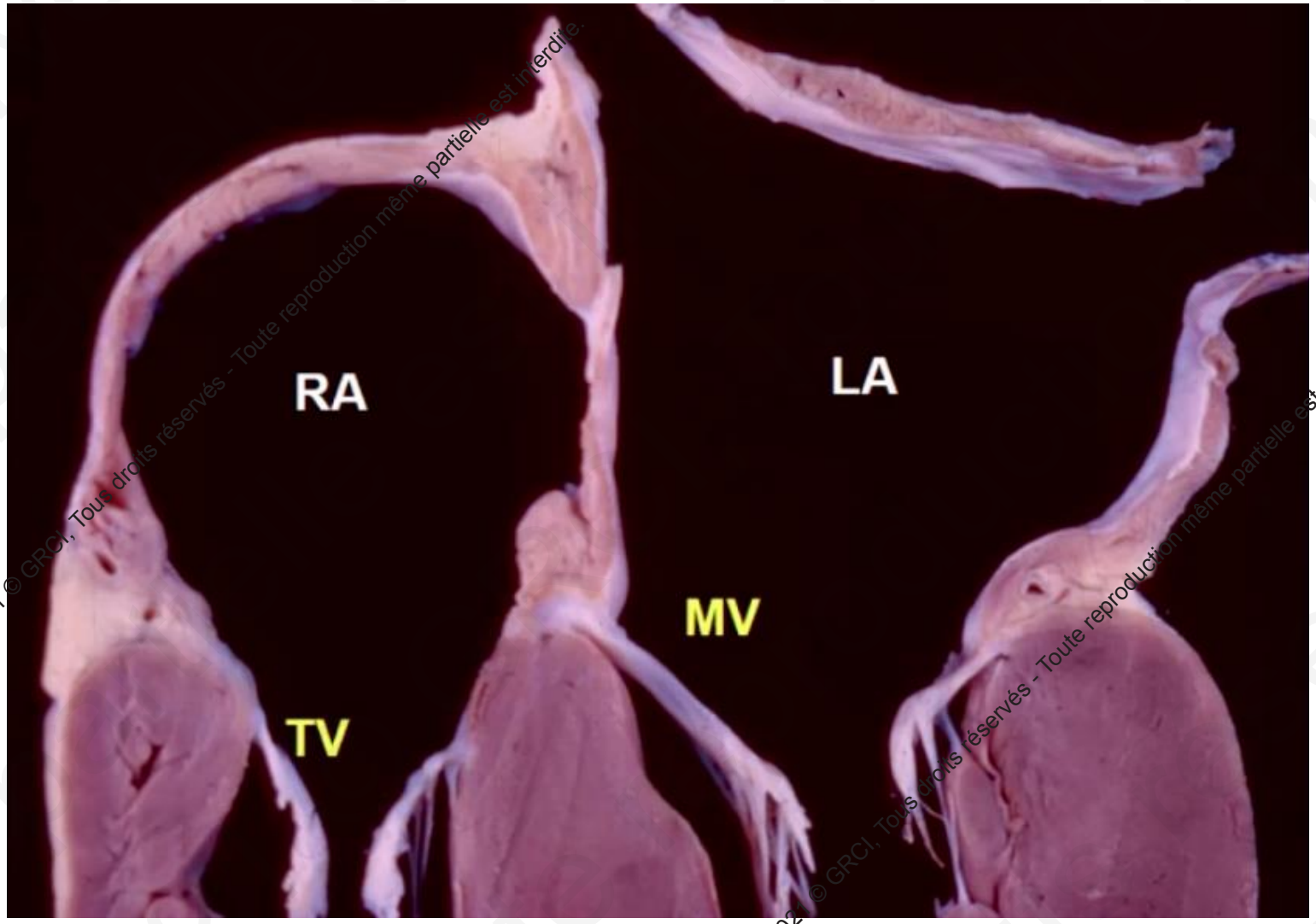
Conclusions—Id-FTR is frequent, linked to aging and atrial fibrillation, can be severe, and is of unique mechanism. In Id-FTR, excess annular and RV-basal enlargement exhausts valvular/annular coverage reserve, and RV conical deformation does not cause notable valvular tenting. Conversely, PHTN-FTR is determined by valvular tethering with tenting linked to RV elongation and elliptical/spherical deformation. These specific FTR-mechanisms may be important in considering surgical correction in FTR. (***Circ Cardiovasc Imaging*. 2012;5:314-323.)**



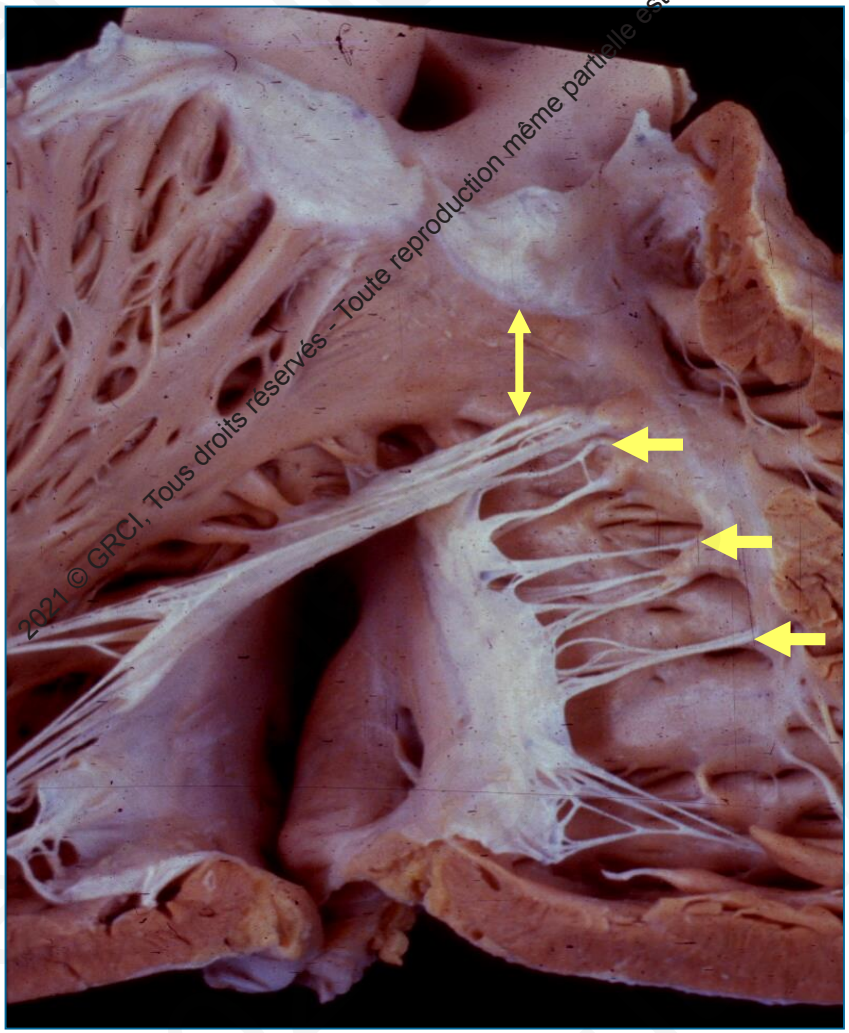


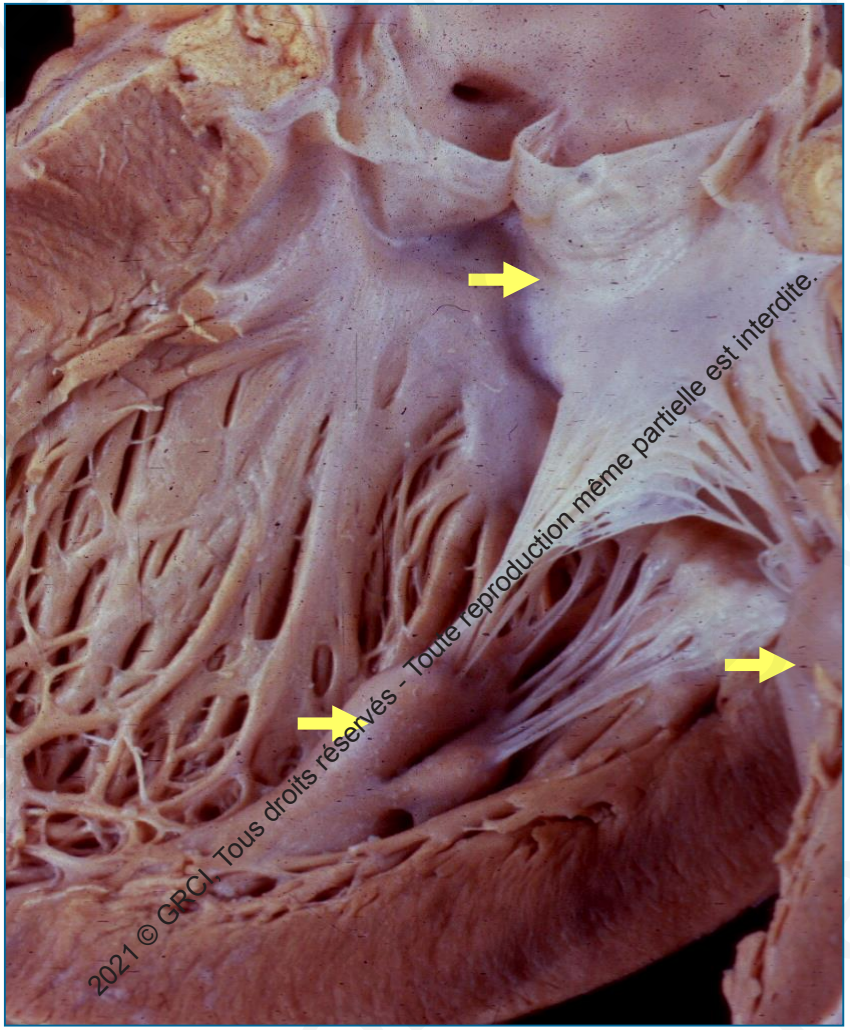






Atrio-ventricular valves





Cardiovascular Surgery

Tricuspid Valve Tethering Predicts Residual Tricuspid Regurgitation After Tricuspid Annuloplasty

Shota Fukuda, MD; Jong-Min Song, MD; A. Marc Gillinov, MD; Patrick M. McCarthy, MD; Masao Daimon, MD; Vorachai Kongsaerepong, MD; James D. Thomas, MD; Takahiro Shiota, MD

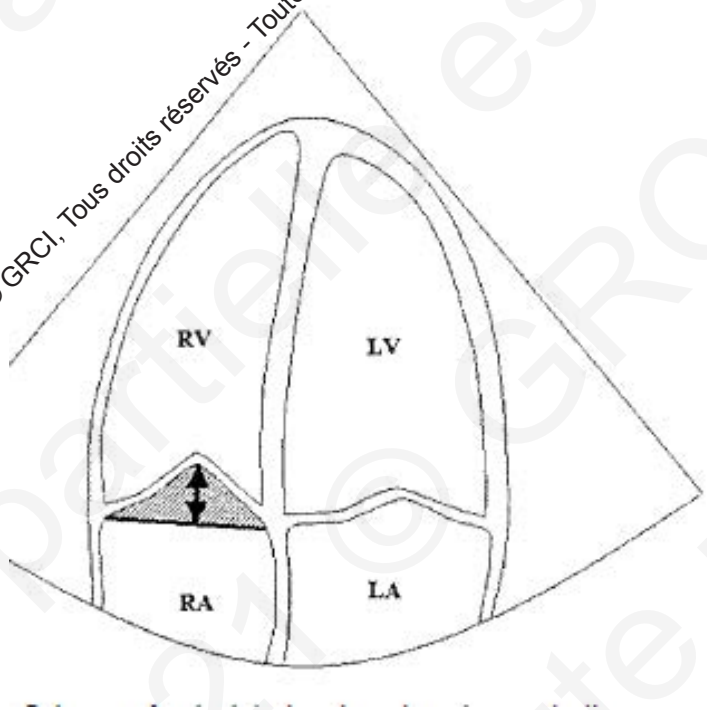
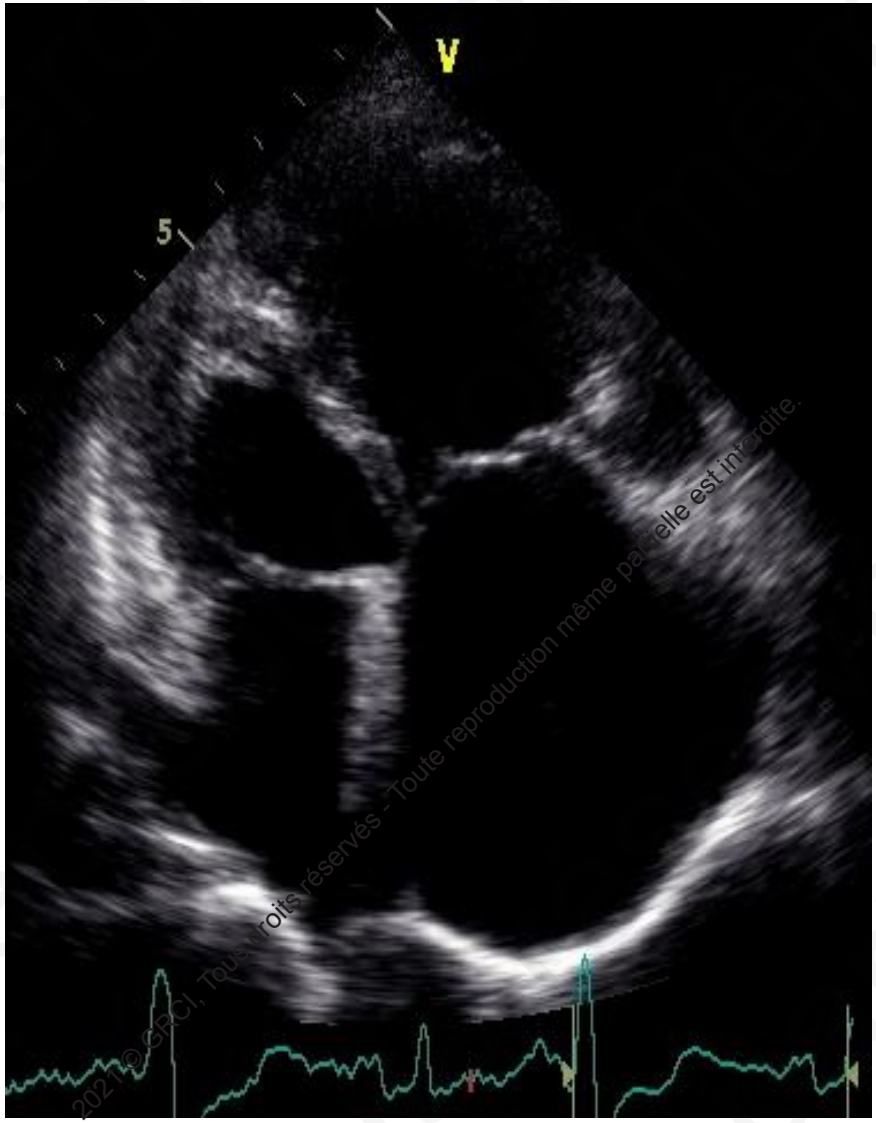


TABLE 1. Effect of Characteristic and Echocardiographic Findings on Residual TR After TV Annuloplasty

	r	Univariate *P*	Multivariate *P*
Age	0.28	<0.001	<0.001
LV ejection fraction	0.19	0.005	0.6
RV fractional area change	0.18	0.01	0.5
RA area	0.02	0.8	
RV systolic pressure	0.02	0.8	
TV annulus diameter	0.07	0.3	
TV tethering distance	0.57	<0.001	<0.001
TV tethering area	0.52	<0.001	0.4
Preoperative %TR	0.32	<0.001	<0.001

patients and 4 techniques of annuloplasty, we used 1-way ANOV. We used logistic regression to correlate variables of interest. Mul variate stepwise regression analysis was performed to identi factors of severity of residual TR (measured continuously as %TR



Challenge #2

TR assessment is often imprecise

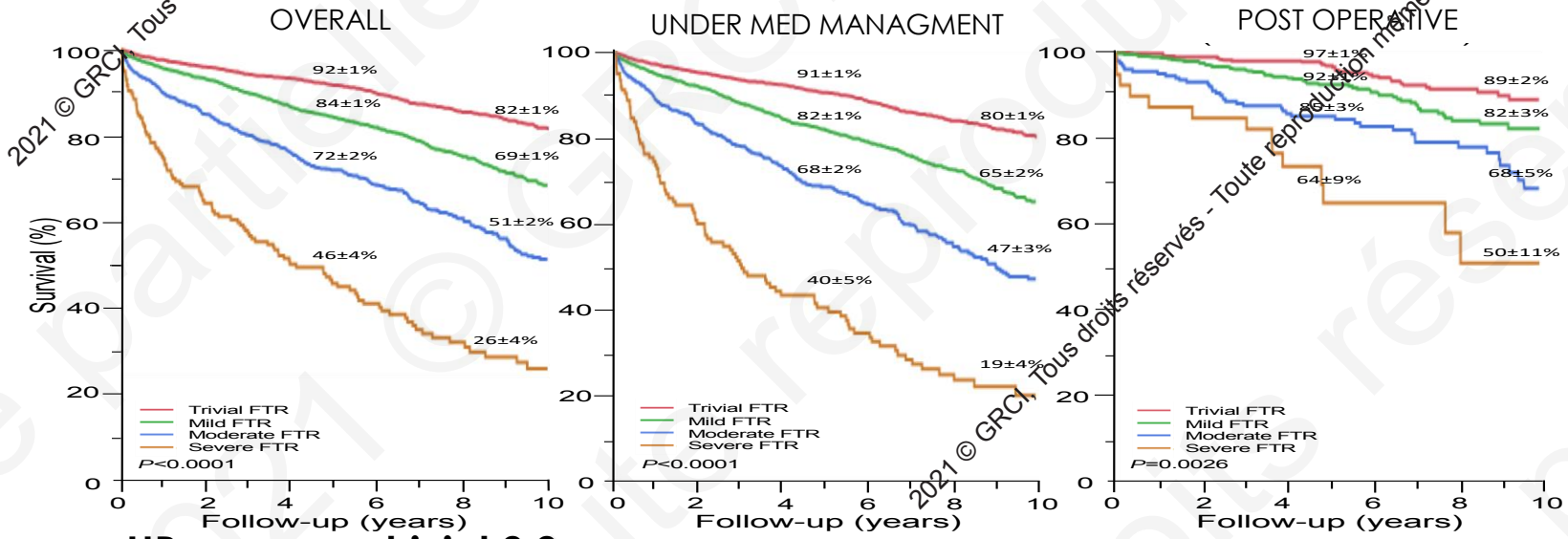
Addressing TR mechanism is crucial for treatment

ESC European Society of Cardiology
European Heart Journal (2020) **0**, 1–13
doi:10.1093/eurheartj/ehaa192

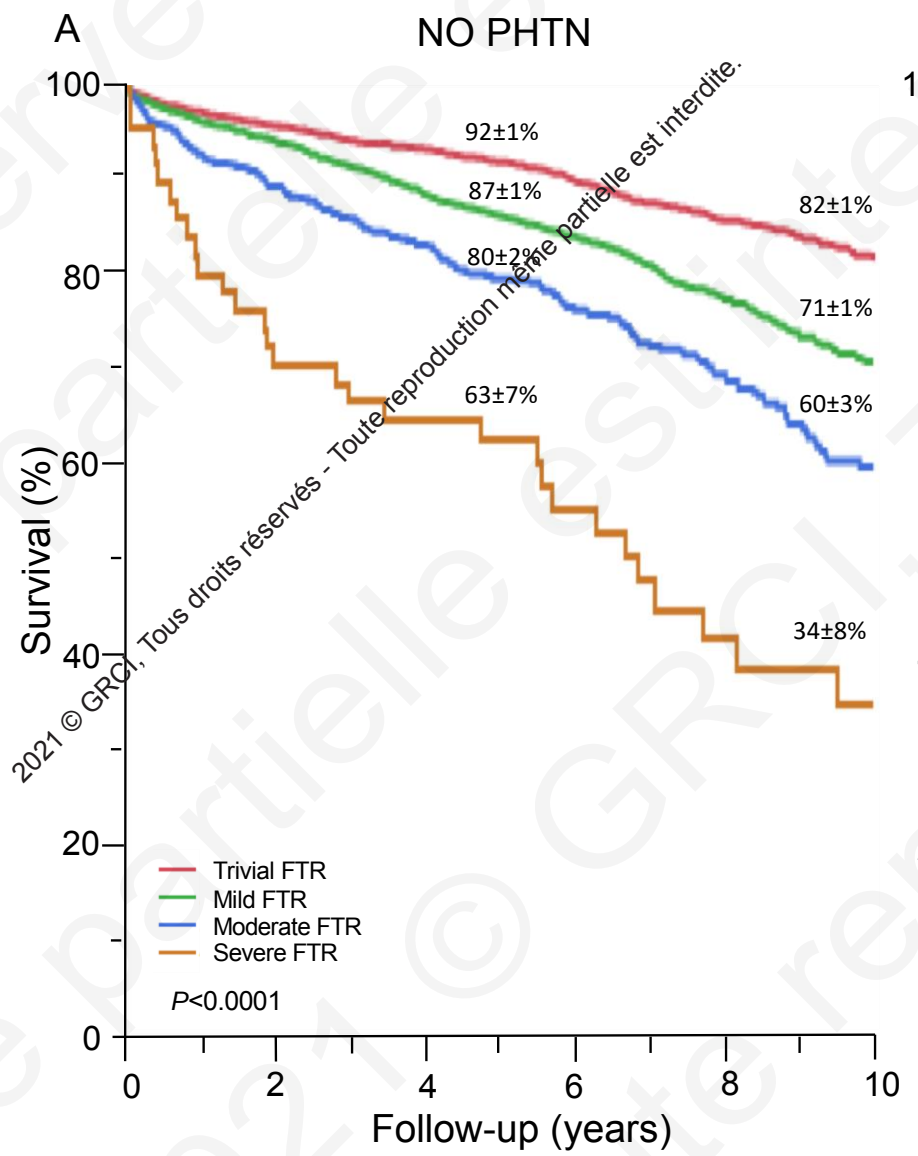
CLINICAL RESEARCH

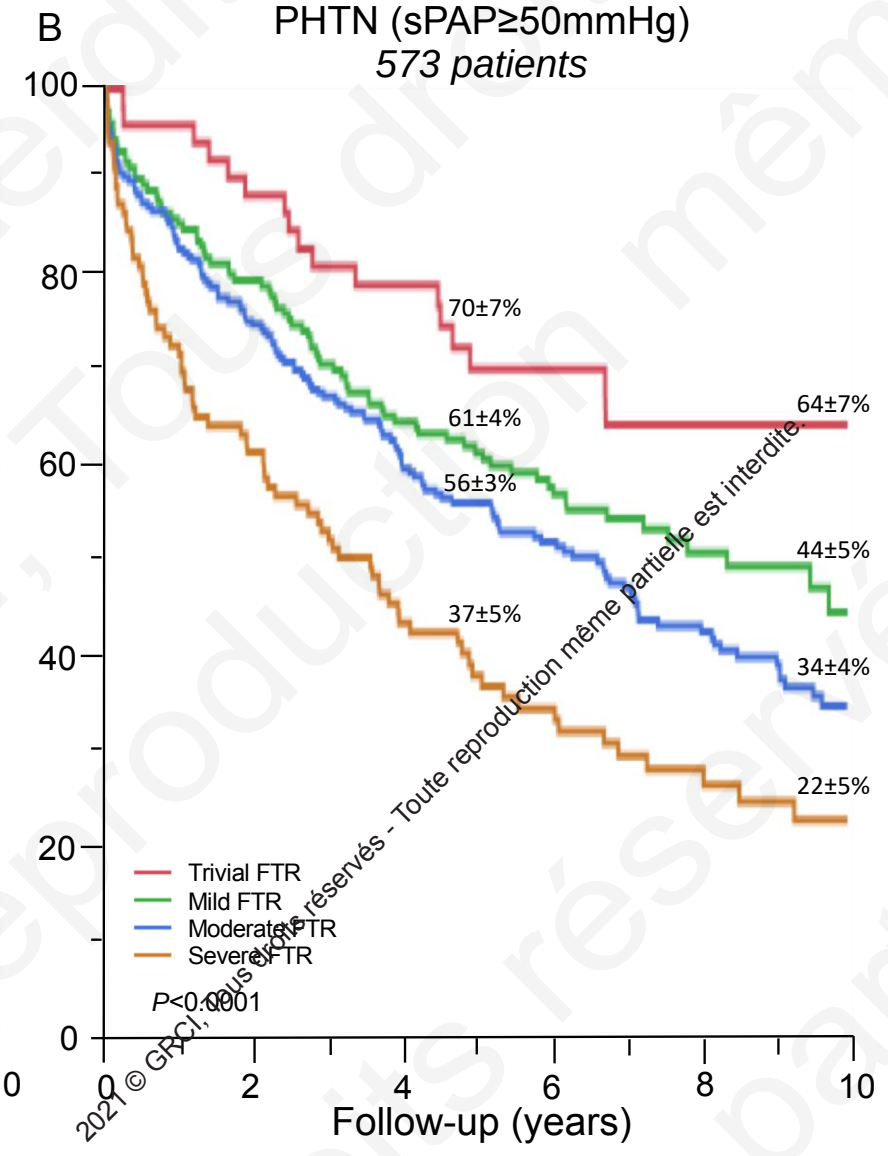
Functional tricuspid regurgitation of degenerative mitral valve disease: a crucial determinant of survival

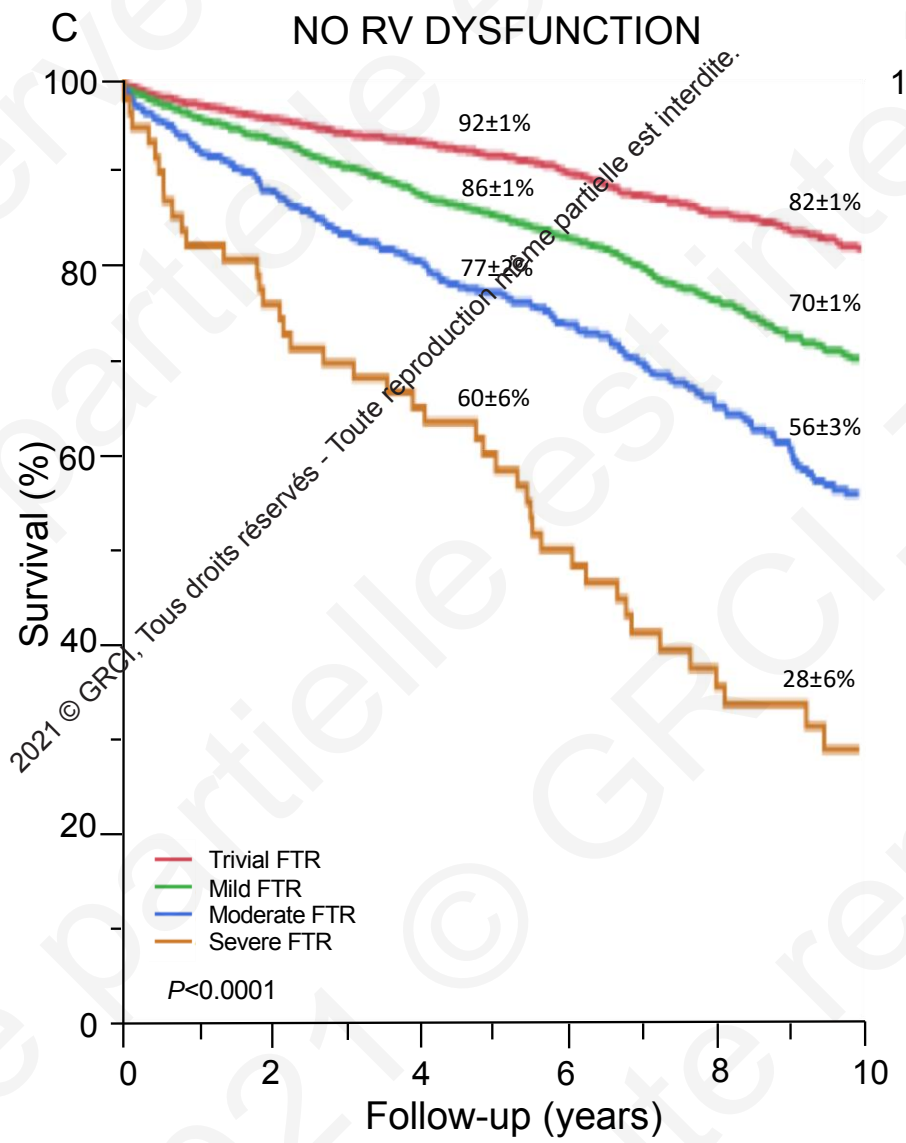
Benjamin Essayagh[1], Clémence Antoine [1], Giovanni Benfari [1], Joseph Maalouf [1], Hector I. Michelena [1], Juan A. Crestanello[1], Prabin Thapa [1], Jean-François Avierinos[2], and Maurice Enriquez-Sarano [1]*

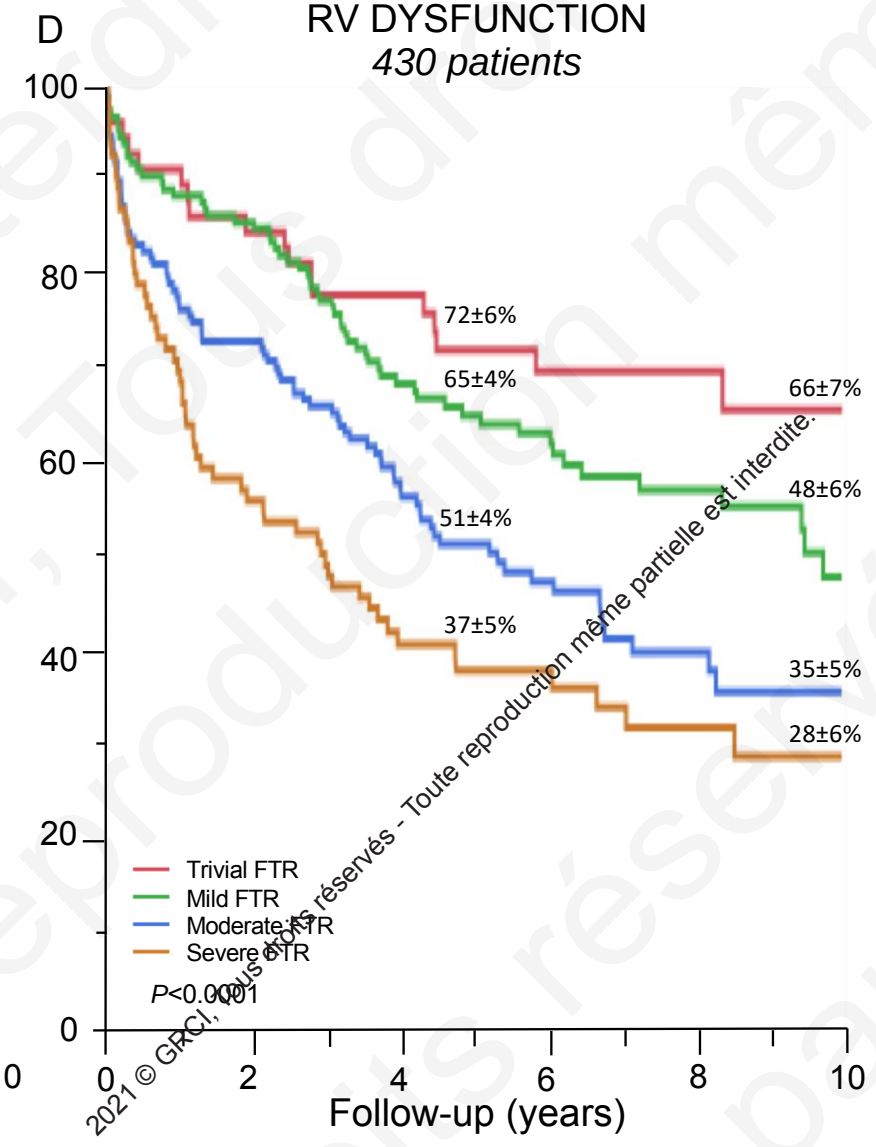


HR severe vs trivial 2.2





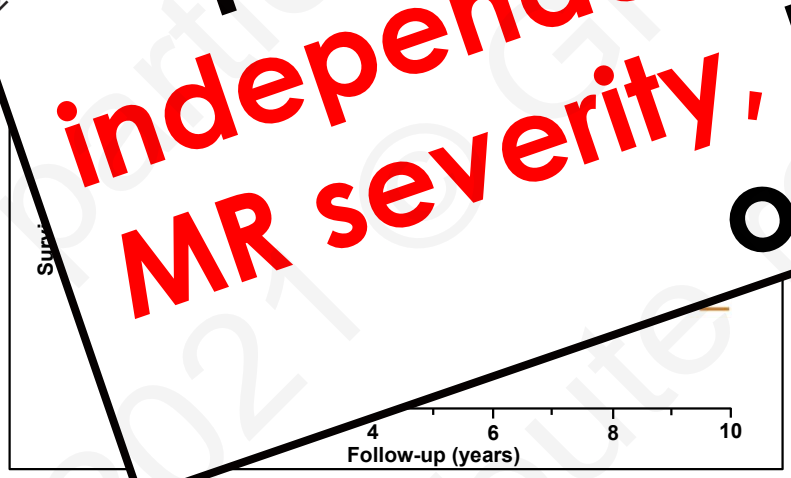




FUNCTIONAL TRICUSPID REGURGITATION

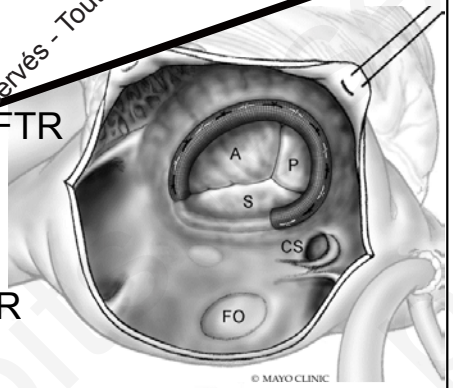
MORE SEVERE HEART FAILURE

↑ edema
↓ stroke



B. Essayagh *et al.*

With DMR surgery
6% moderate FTR
21% severe FTR



B. Essayagh *et al.*

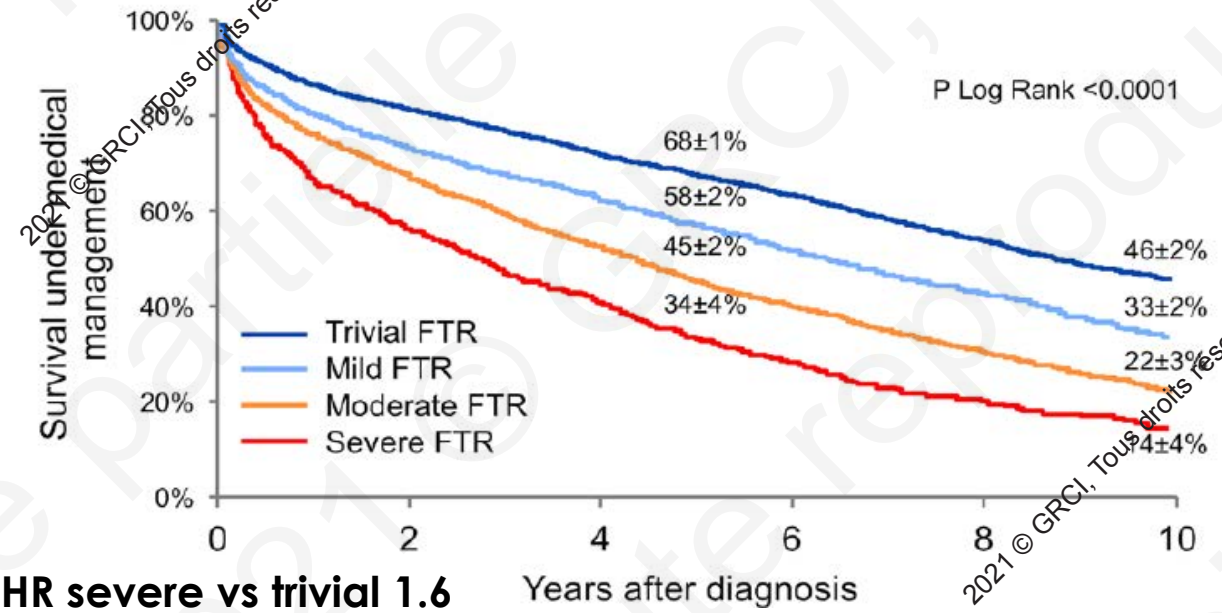
Challenge #3

TR is associated with poor clinical outcome *independent* of comorbidity, *MR severity*, RV dysfunction, or PHTN

Circulation

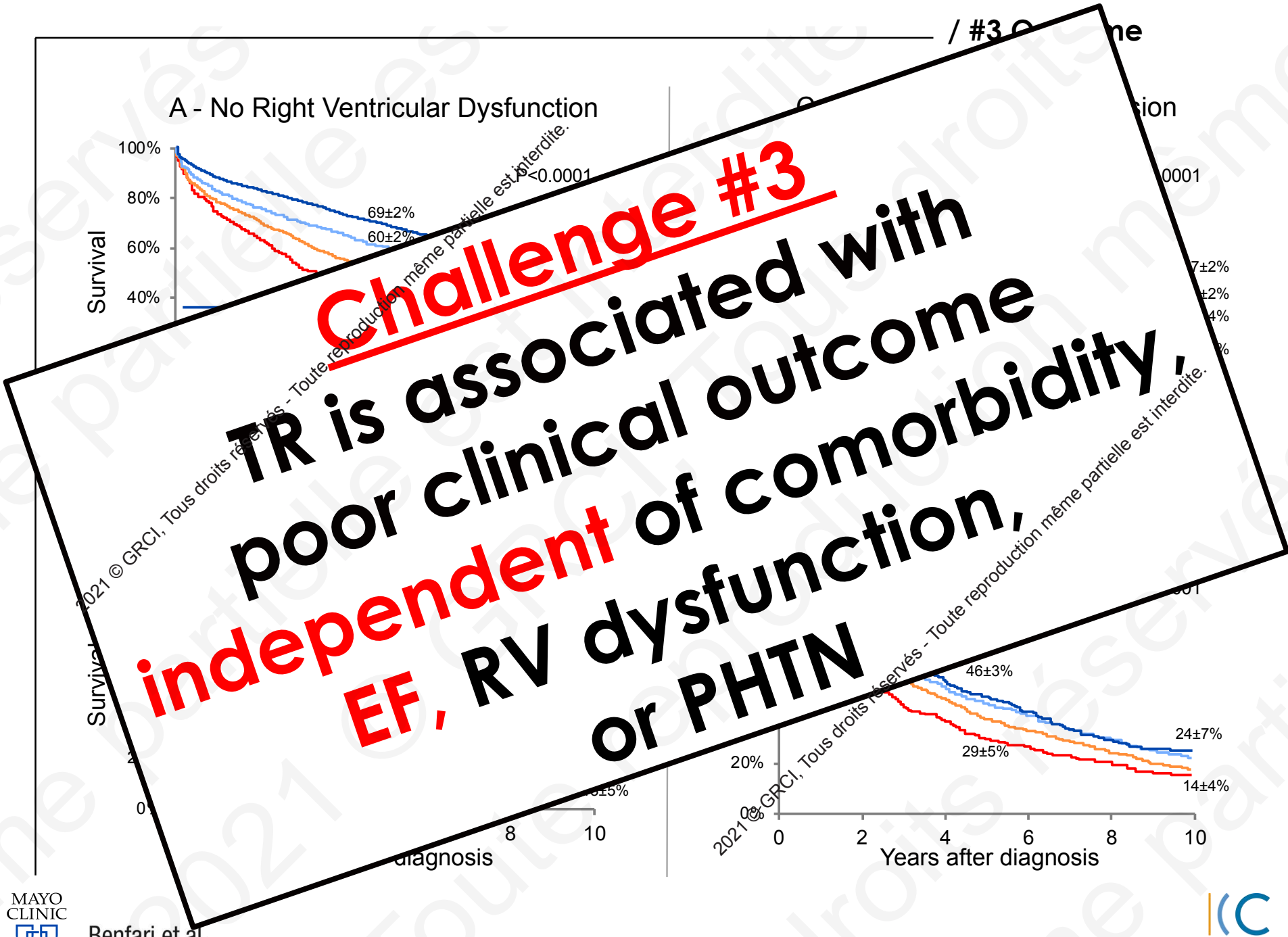
ORIGINAL RESEARCH ARTICLE

Excess Mortality Associated With Functional Tricuspid Regurgitation Complicating Heart Failure With Reduced Ejection Fraction



HR severe vs trivial 1.6

Giovanni Benfari, MD
Clemence Antoine, MD
Wayne L. Miller, MD, PhD
Prabin Thapa, BS
Yan Topilsky, MD
Andrea Rossi, MD
Hector I. Michelena, MD
Sorin Pislaru, MD
Maurice Enriquez-Sarano, MD



Benfari et al

Tricuspid Regurgitation

1- <u>TR is underdetected & undertreated</u>
unmet need for treatment requires **improved imaging**

2- <u>TR context & quantification</u> is the key quantification weakly validated but **strongly predictive of outcome**

3- <u>Severe TR is a target for treatment &
Moderate TR may warrant treatment?</u>
both adversely affects **clinical outcome** in all clinical contexts

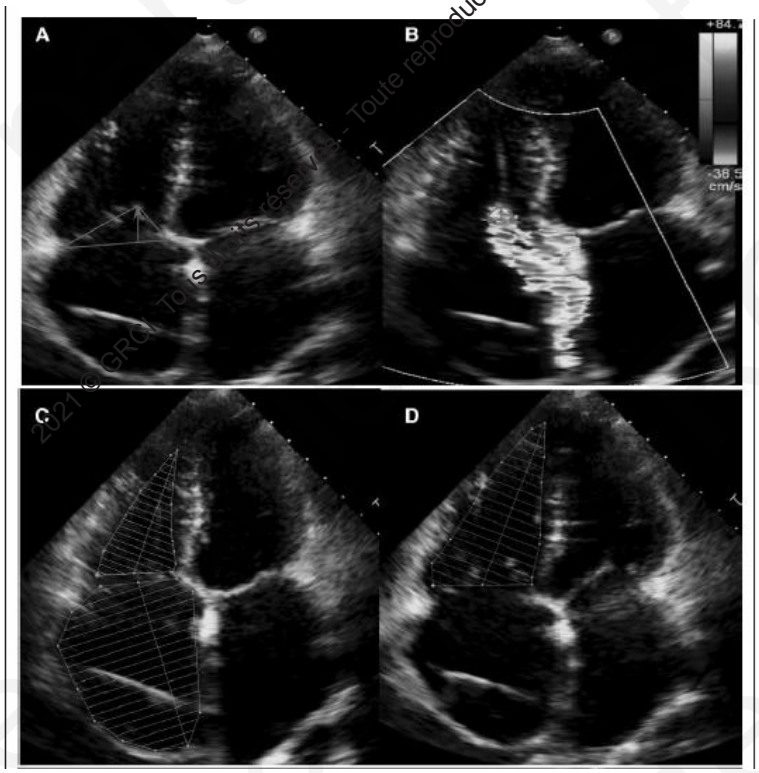
Tricuspid Regurgitation

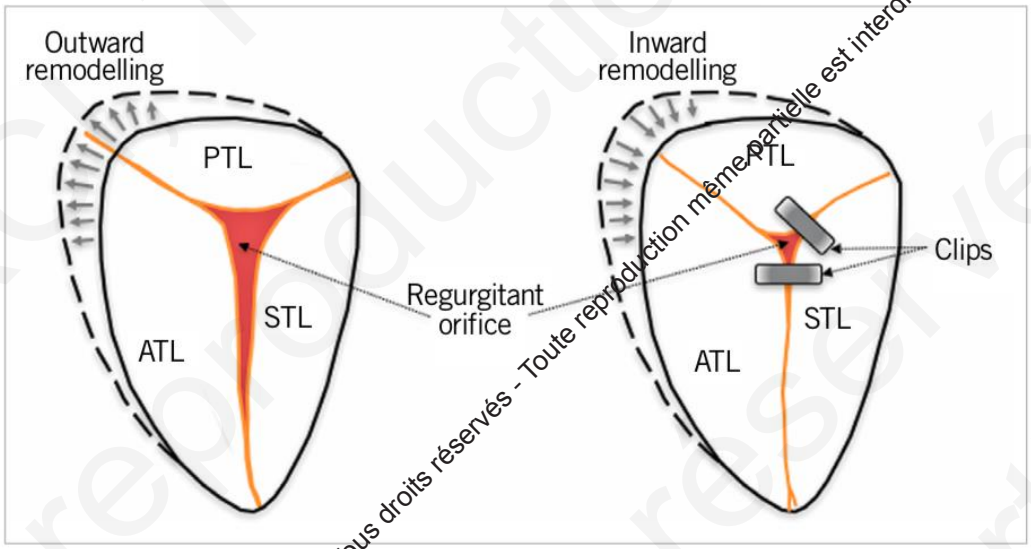
What about Tricuspid Treatment in 2021 ?

Tricuspid Clip

ORIGINAL RESEARCH ARTICLE

Transcatheter Treatment of Severe Tricuspid Regurgitation With the Edge-to-Edge MitraClip Technique





ORIGINAL RESEARCH ARTICLE

Transcatheter Treatment of Severe Tricuspid Regurgitation With the Edge-to-Edge MitraClip Technique

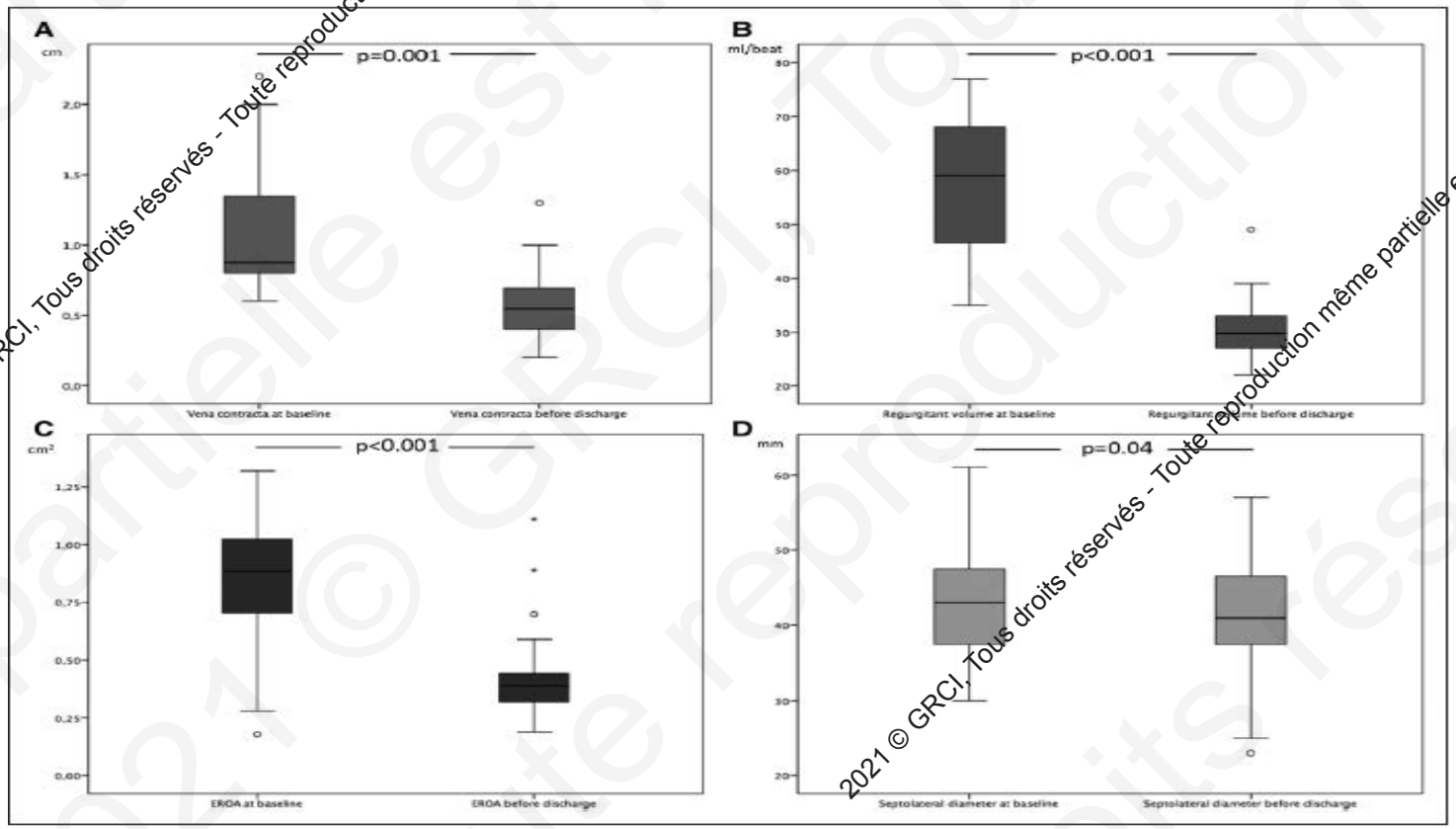
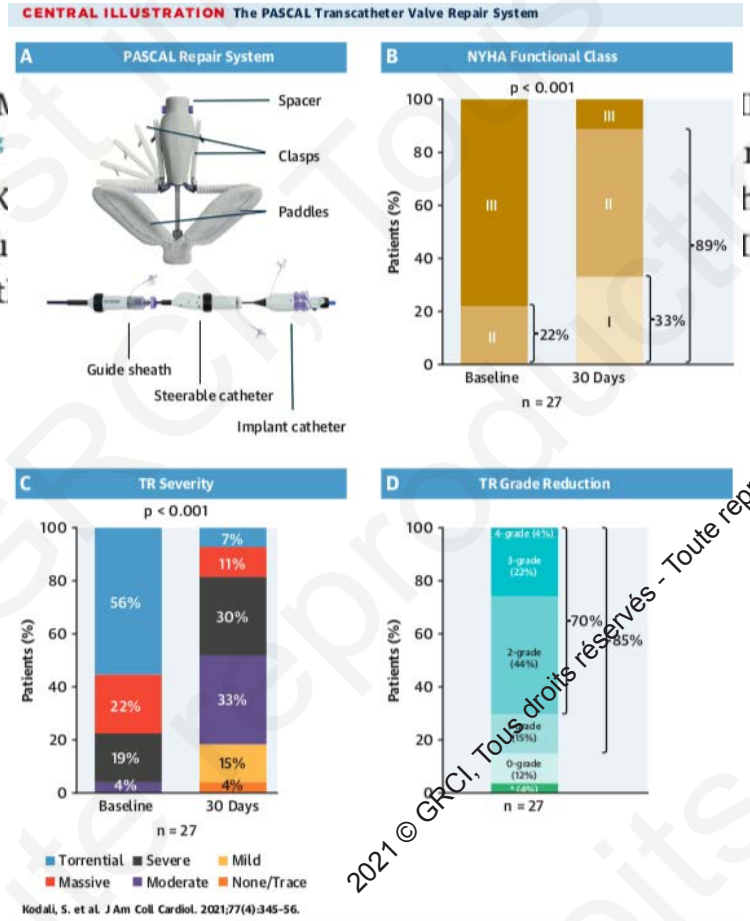


Figure 6. Boxplot diagrams of changes in tricuspid regurgitation defining echocardiographic parameters.
A, Vena contracta width at baseline and before discharge. **B,** Regurgitant volume at baseline and before discharge. **C,** Effective regurgitant orifice area at baseline and before discharge. **D,** Septolateral diameter at baseline and before discharge. *Statistical outlier.

Feasibility Study of the Transcatheter Valve Repair System for Severe Tricuspid Regurgitation

Susheel Kodali, MD,[a] Rebecca T. Hahn, M… ID,[d] Robert Smith, MD,[e]
D. Scott Lim, MD,[f] William A. Gray, MD,[g] …nos Koulogiannis, MD,[d]
Paul Grayburn, MD,[e] Dale Fowler, MD,[f] K… …har H. Deo, MBBS, PhD,[i]
Prashanthi Vandrangi, PhD,[i] Florian Deu… ID,[a] Ted Feldman, MD,[i]
Charles J. Davidson, MD,[h] on behalf of t…



Transcatheter Edge-to-Edge Repair for Treatment of Tricuspid Regurgitation

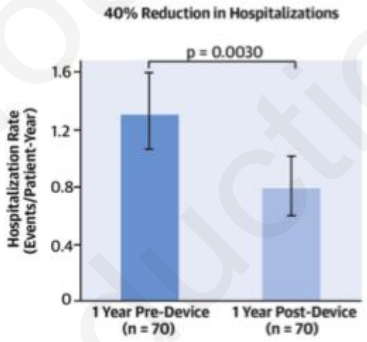
Philipp Lurz, MD, PhD,[a] Ralph Stepha , PhD,[d]
Paul Sorajja, MD,[e] Jörg Hausleiter, MI bauer, MD,[f]
Gilbert H.L. Tang, MD, MSc, MBA,[i] Pa
Abdellaziz Dahou, MD, PhD,[j] Rebecca MINATE
Investigators

CENTRAL ILLUSTRATION 1-Year Outcomes From the TRILUMINATE Trial

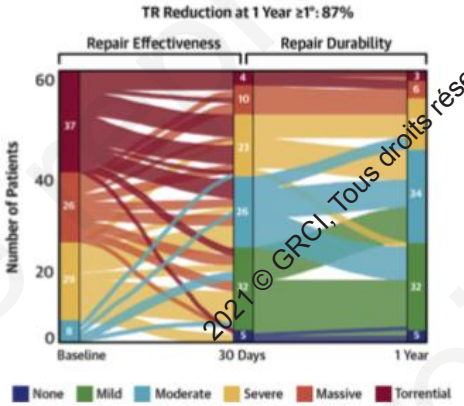
TRILUMINATE Study

Major Adverse Events: 7.1%
Cardiovascular Mortality: 4.8%

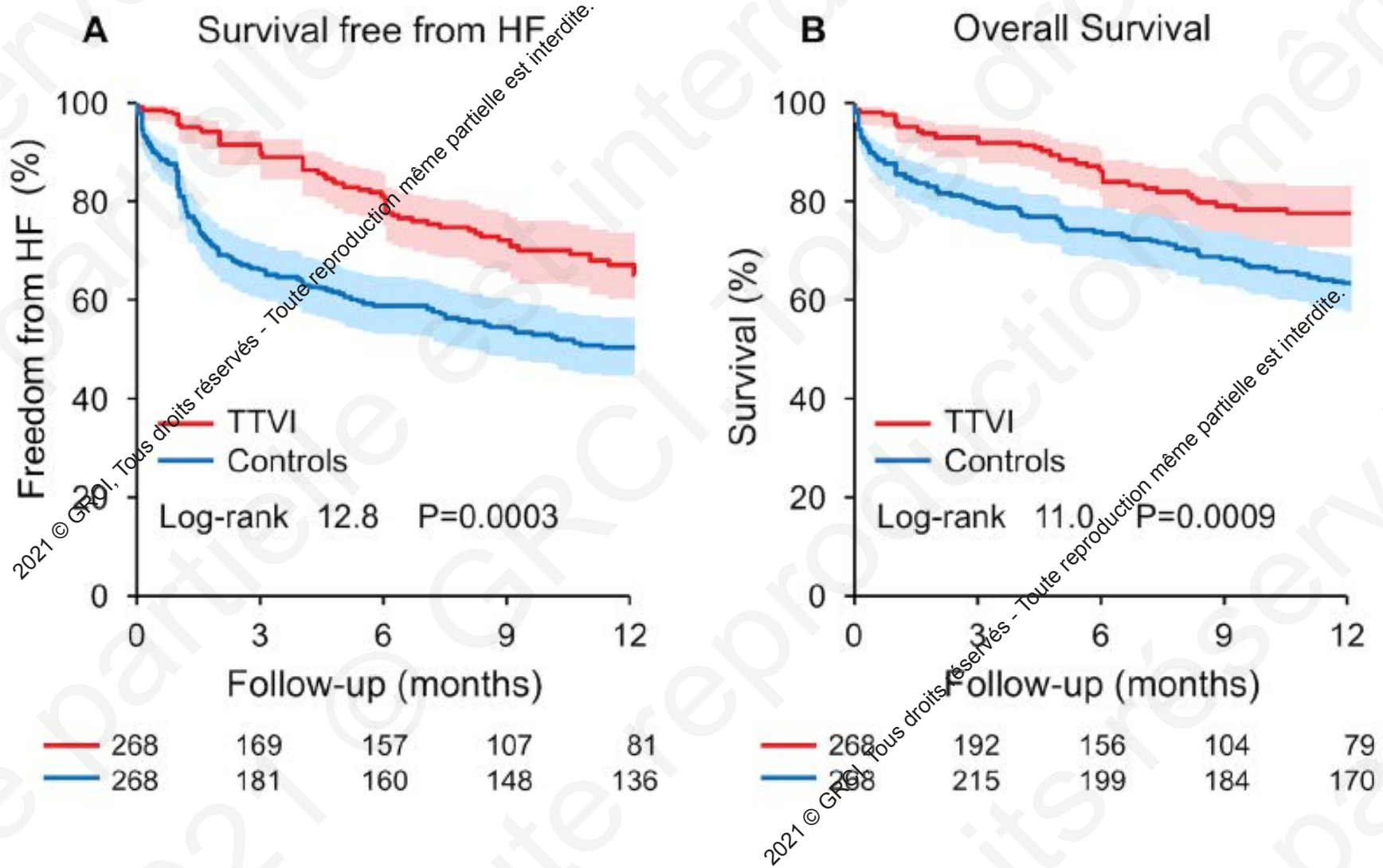
Clinical Implications



Durability of Repair



Lurz, P. et al. J Am Coll Cardiol. 2021;77(3):229-39.



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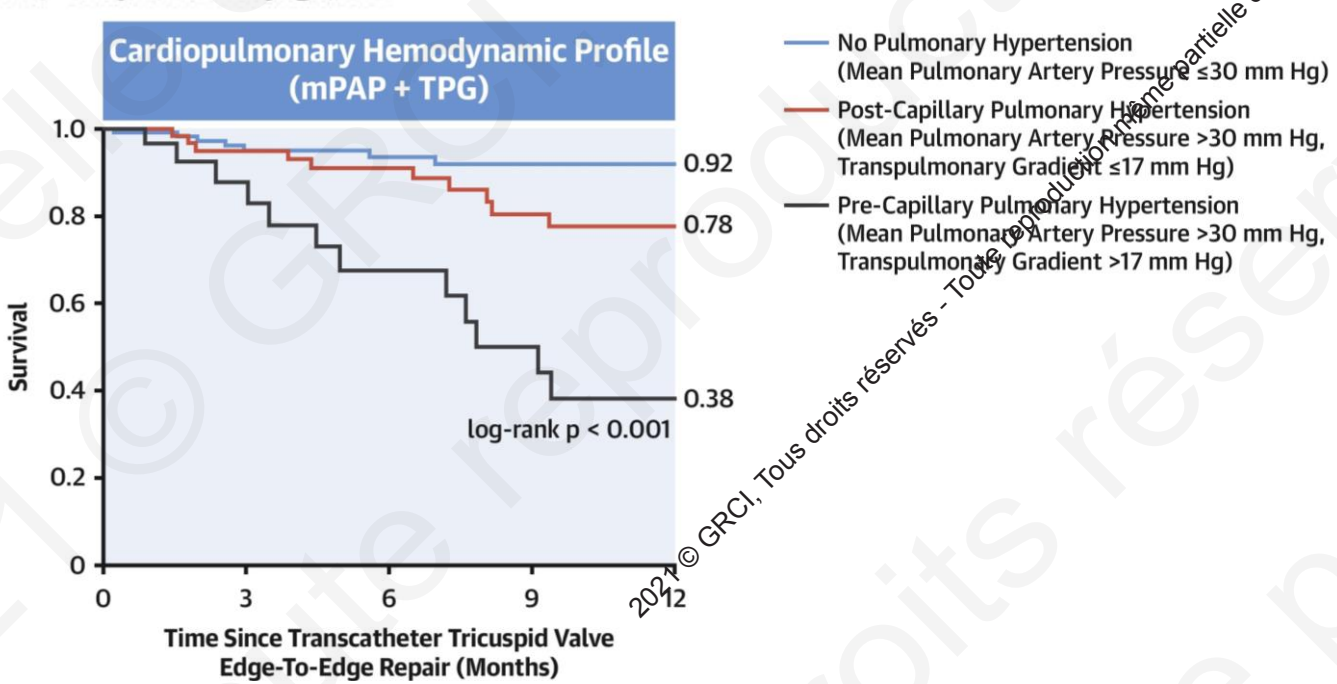
JACC: CARDIOVASCULAR INTERVENTIONS
VOL. ■, NO. ■, 2020

EDITORIAL COMMENT

Right-Heart Catheterization of Severe Functional Tricuspid Regurgitation

A Step Forward in Reducing its Pervasive Undertreatment?*

Gilles D. Dreyfus, MD, PhD,[a] Benjamin Essayagh, MD[b]



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Tricuspid Clip in 2021

1- TR severe or more
treating severe TR improves outcome

2- Functional TR with small coaptation defect (<4mm) and good leaflet mobility is a reasonable target for percutaneous repair

3- No PHTN-no tenting and to some extent preserved RV function showed best outcome

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MAYO CLINIC

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/ Tricuspid Regurgitation /

An imperious need to address undertreatment

/ Thank you /