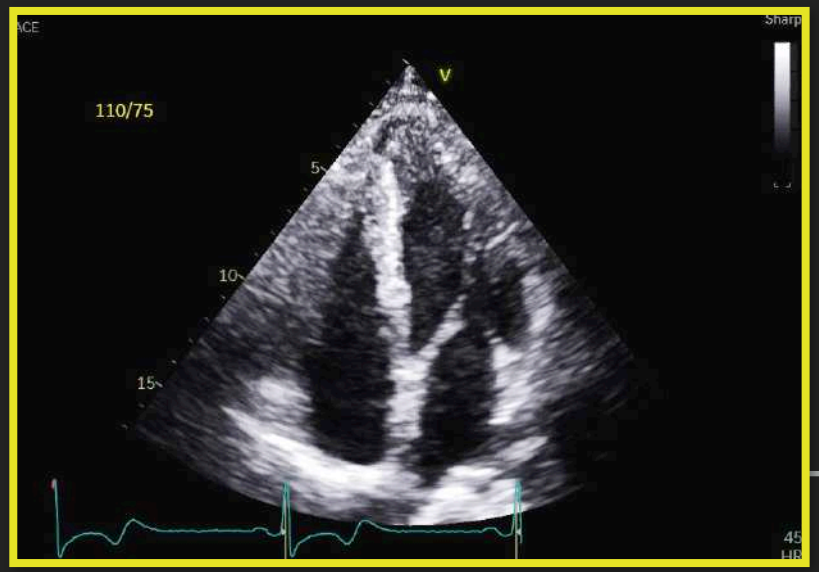
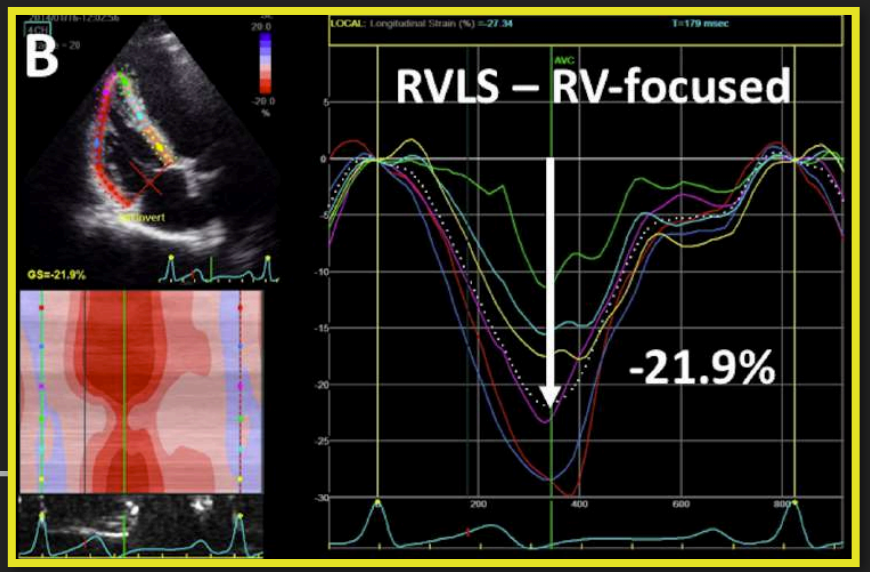
ECHO ASSESSMENT OF THE RV: THE BENEFIT OF RV STRAIN





CHRIS KRAMER BA, ACS, RDCS, FASE
ADVOCATE HEALTH
AURORA HEALTH CARE
MILWAUKEE, WISCONSIN
NO DISCLOSURES

The only animal Australians are afraid of? A bird. Here's why

By Lilit Marcus, CNN

4 minute read · Updated 4:11 AM EST, Mon February 24, 2025

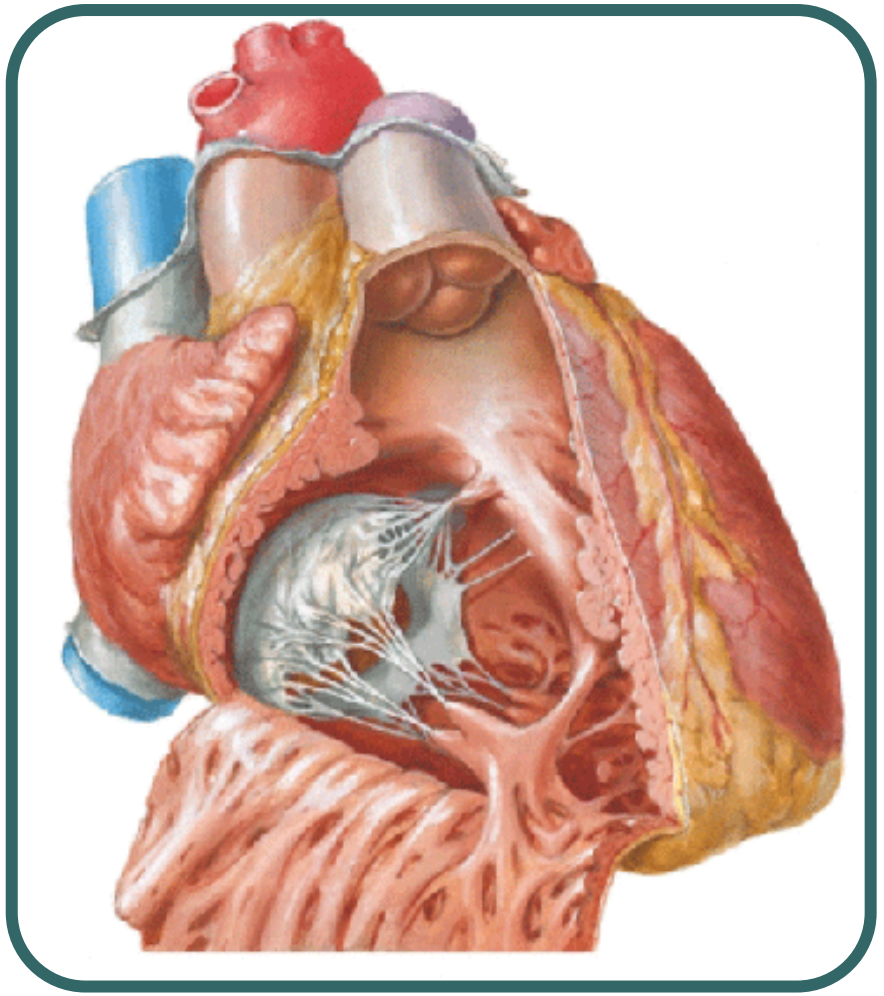
24 comments

This picture taken on April 7, 2024, shows a cassowary in Etty Bay, Queensland. David Gray/AFP/Getty Images

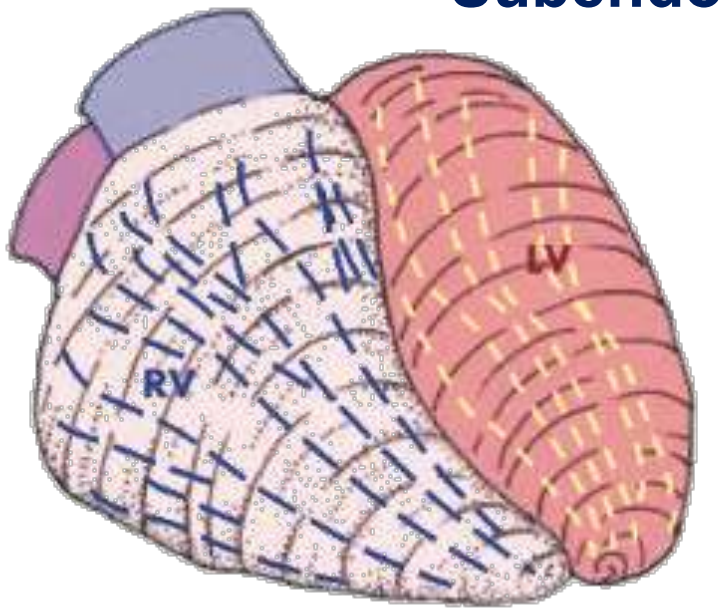
Editor's note: Sign up for Unlocking the World, CNN Travel's weekly newsletter. Get news about destinations, plus the latest in aviation, food and drink, and where to stay

RV Anatomy

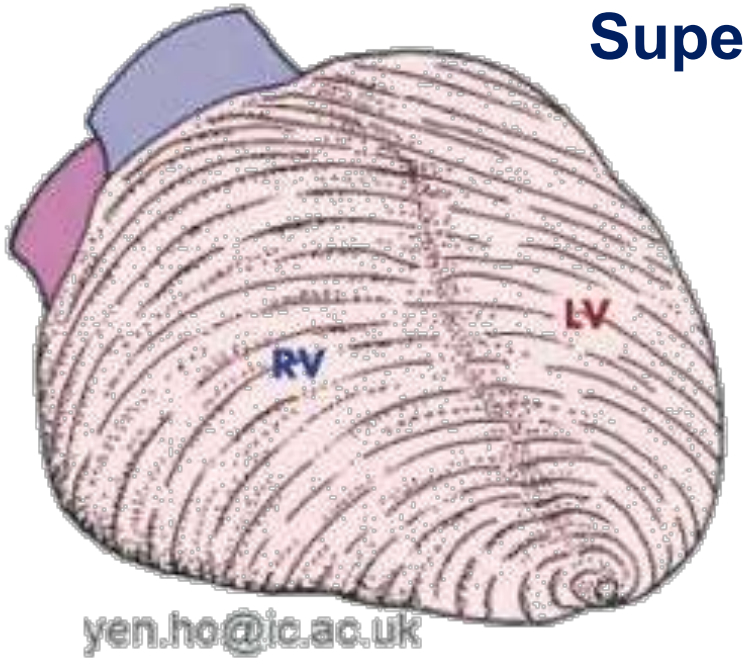
- Thin-walled, compliant chamber
- Complex crescent shape
- Low pulmonary resistance / afterload
- Sensitive to changes in afterload
  - RV dilatation
  - RV hypertrophy

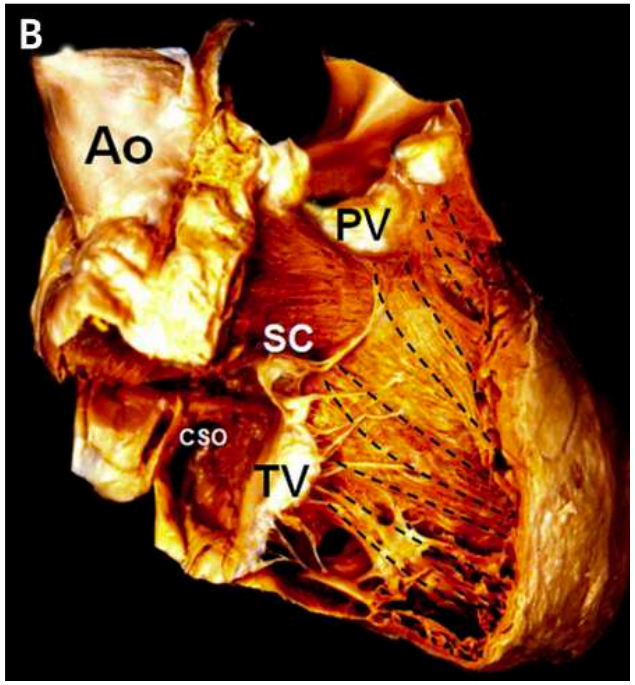


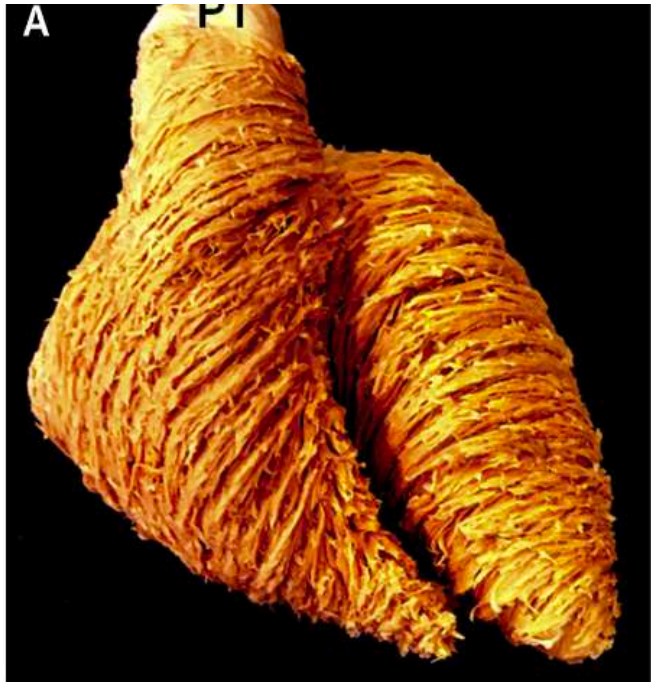
Subendocardial



Superficial



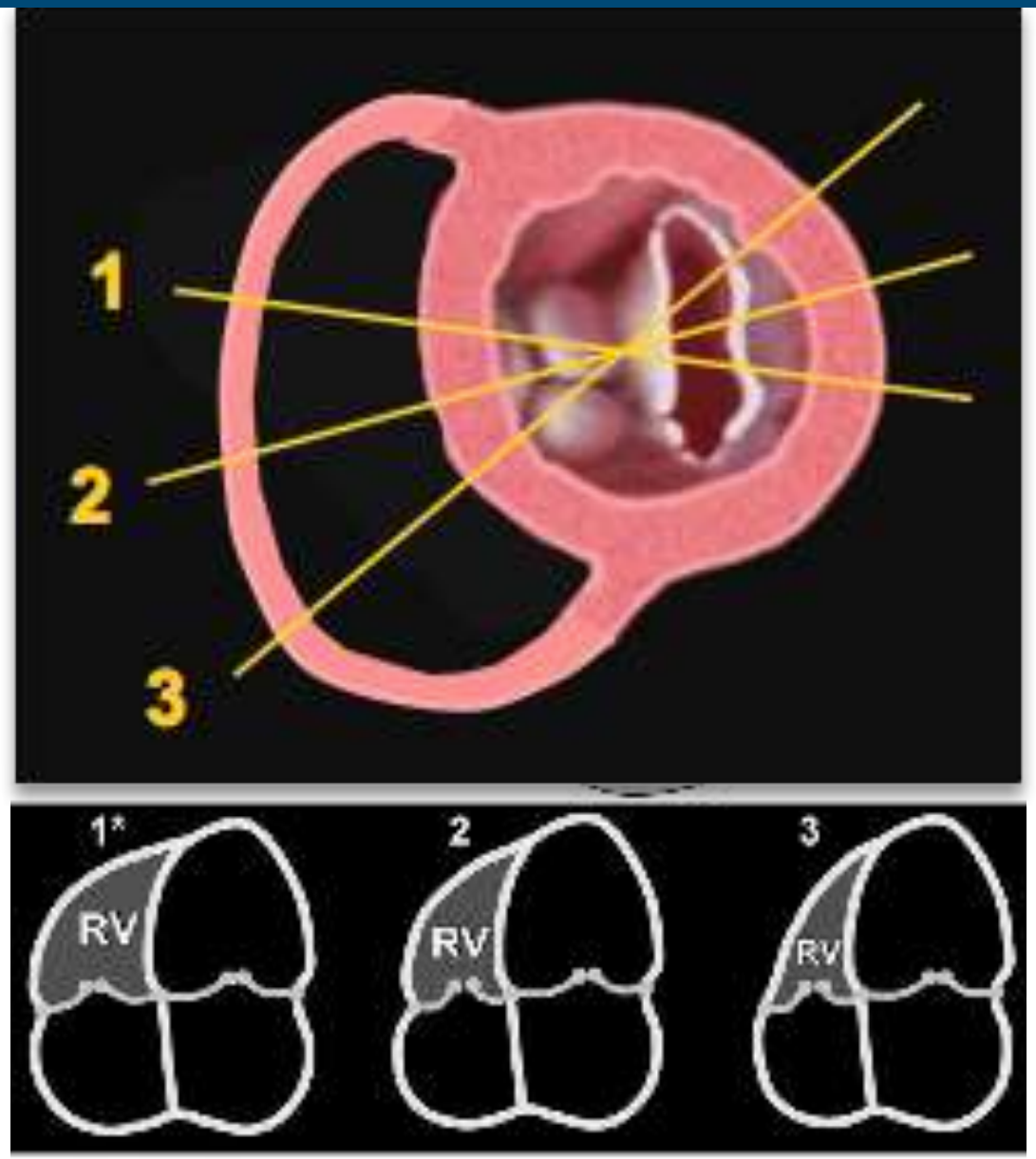




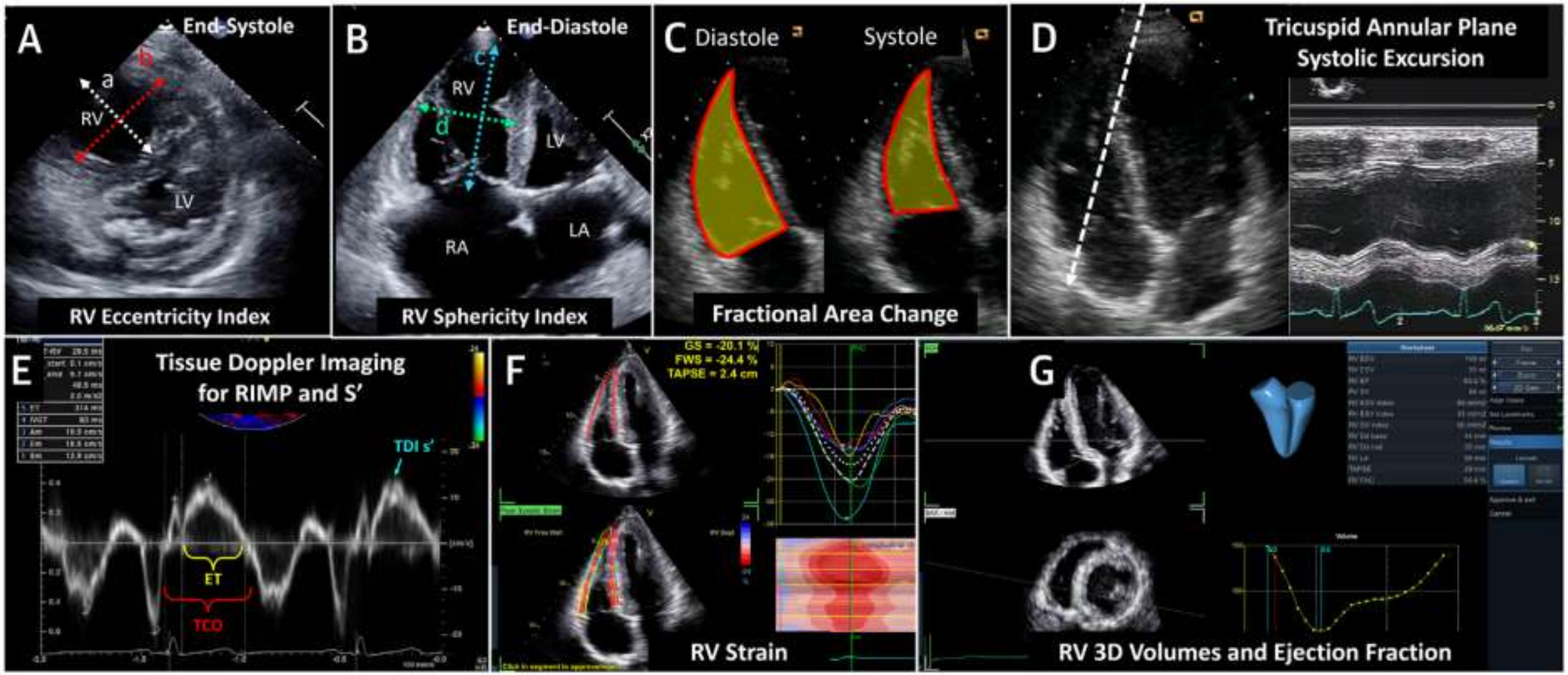
Ho SY. Heart 2006;92(Suppl I):i2–i13

Challenges with 2D Echocardiography

- Complex geometry
- Limited definition of RV endocardium due to heavy trabeculation
- Retrosternal position of RV can limit windows
- Operator-dependent
- Must include infundibulum (contains up to 25-30% of RV volume)
- Lack of standardization of normal values



Echocardiographic Parameters for the Assessment of Right Ventricular Function

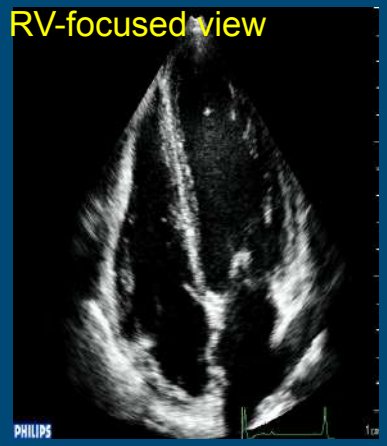


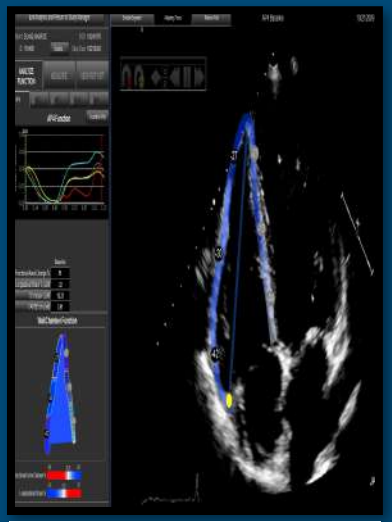
Challenges with 2D Parameters

2D Parameter	Pros	Cons
TAPSE	Reproducible Easy to use	Load dependent Angle dependent Assumes displacement of a single segment represents function of a complex 3D structure
Tei Index	Reproducible Not affected by complex geometry	Load dependent Unreliable in irregular heart rate Falsely low (more normal) when elevated RAP
2D longitudinal strain	Angle independent Improved signal to noise with speckle method Assumes displacement of entire RV	Load dependent

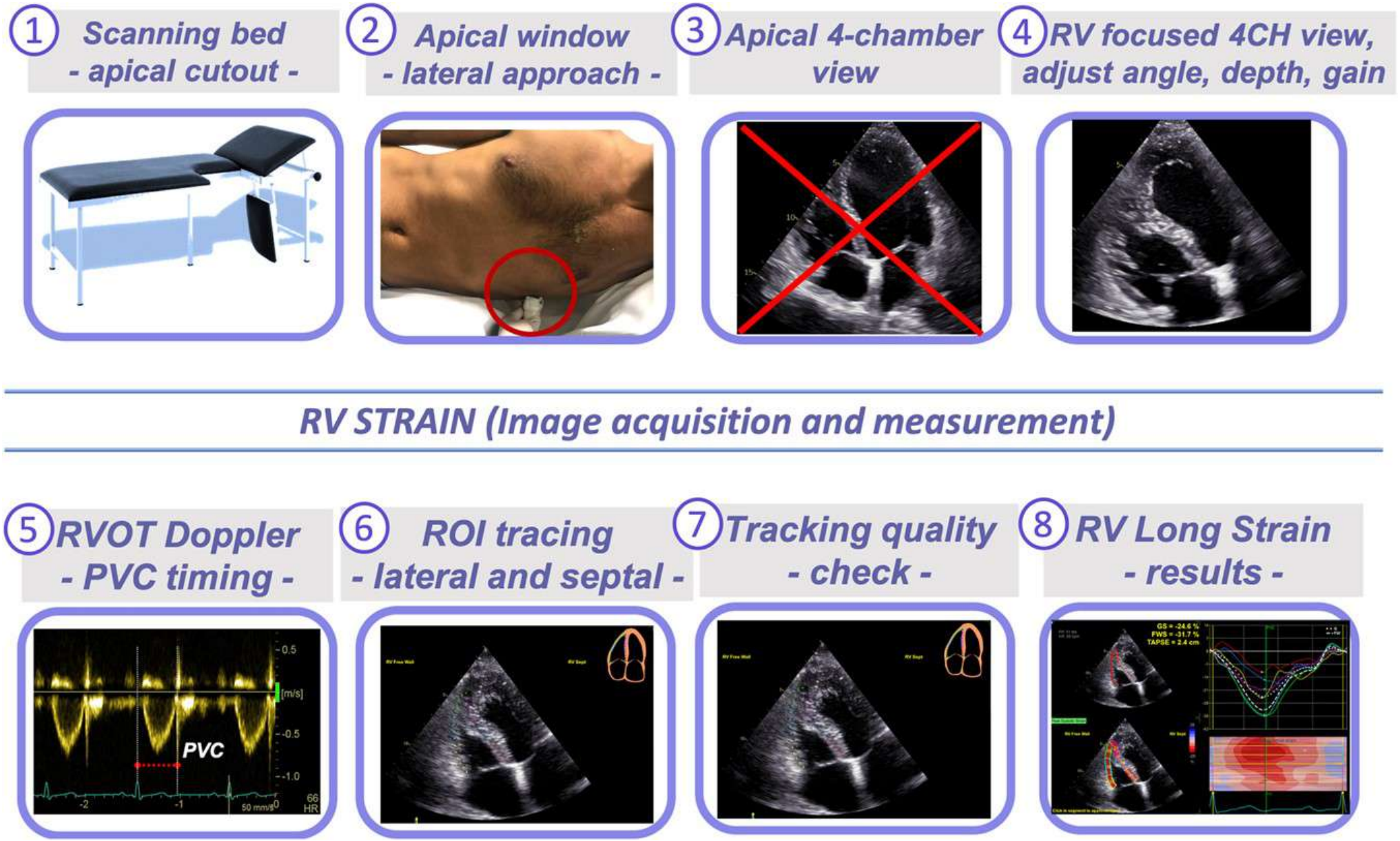
RV Function: RV Strain

- Defined as the % shortening of a region of interest relative to its original length
- Expressed as a negative %
- Free-wall + septal or free-wall alone
- The lower limit of normal for the RV free-wall longitudinal strain is -20
- Prognostic implications in pulmonary hypertension, heart failure, ischemic heart disease, ARVC



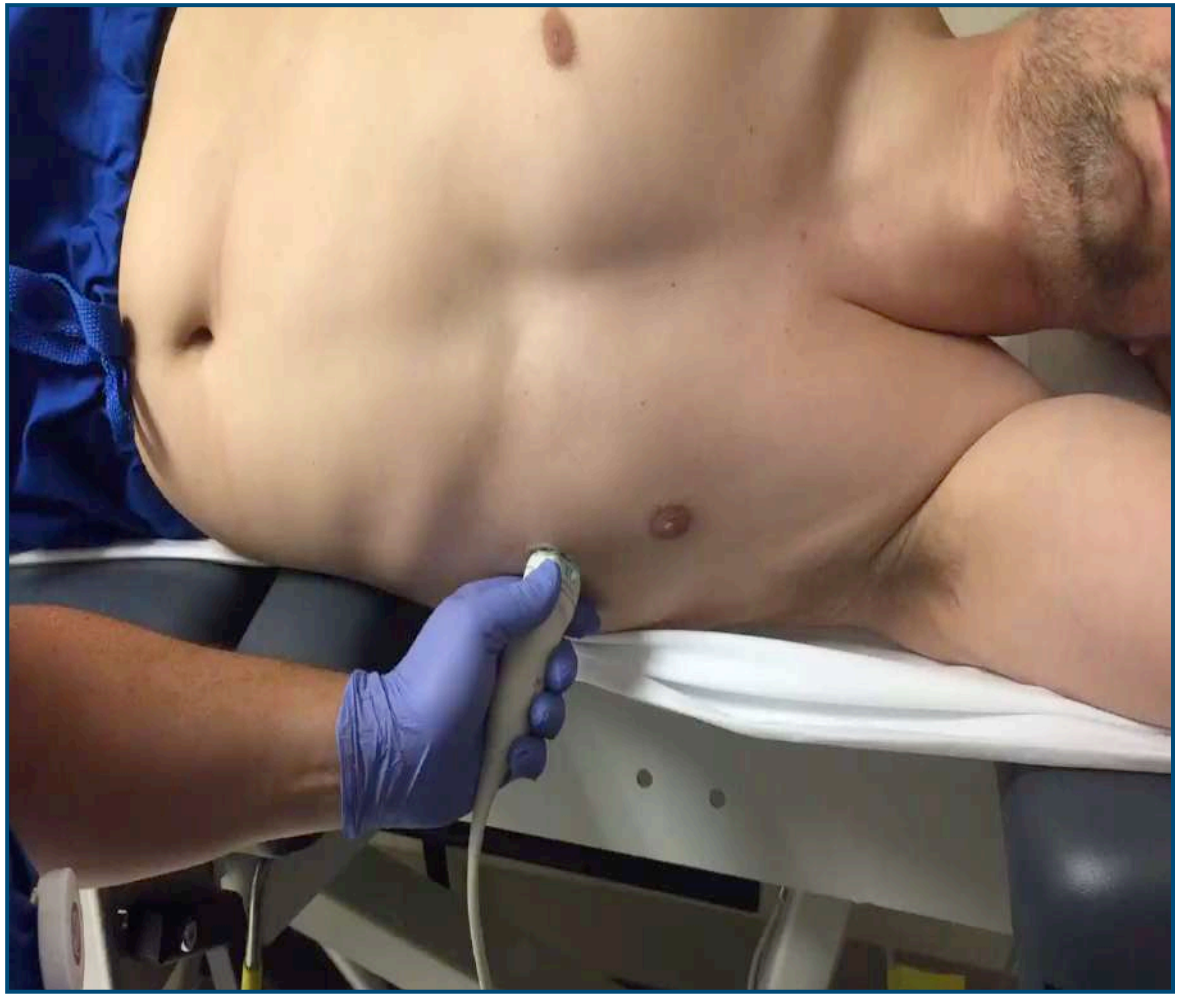


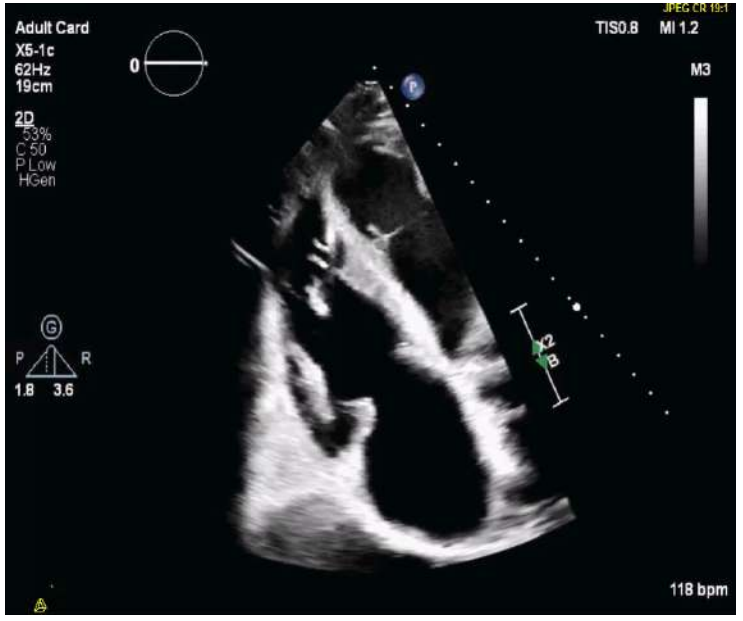
Longitudinal strain
= -33%



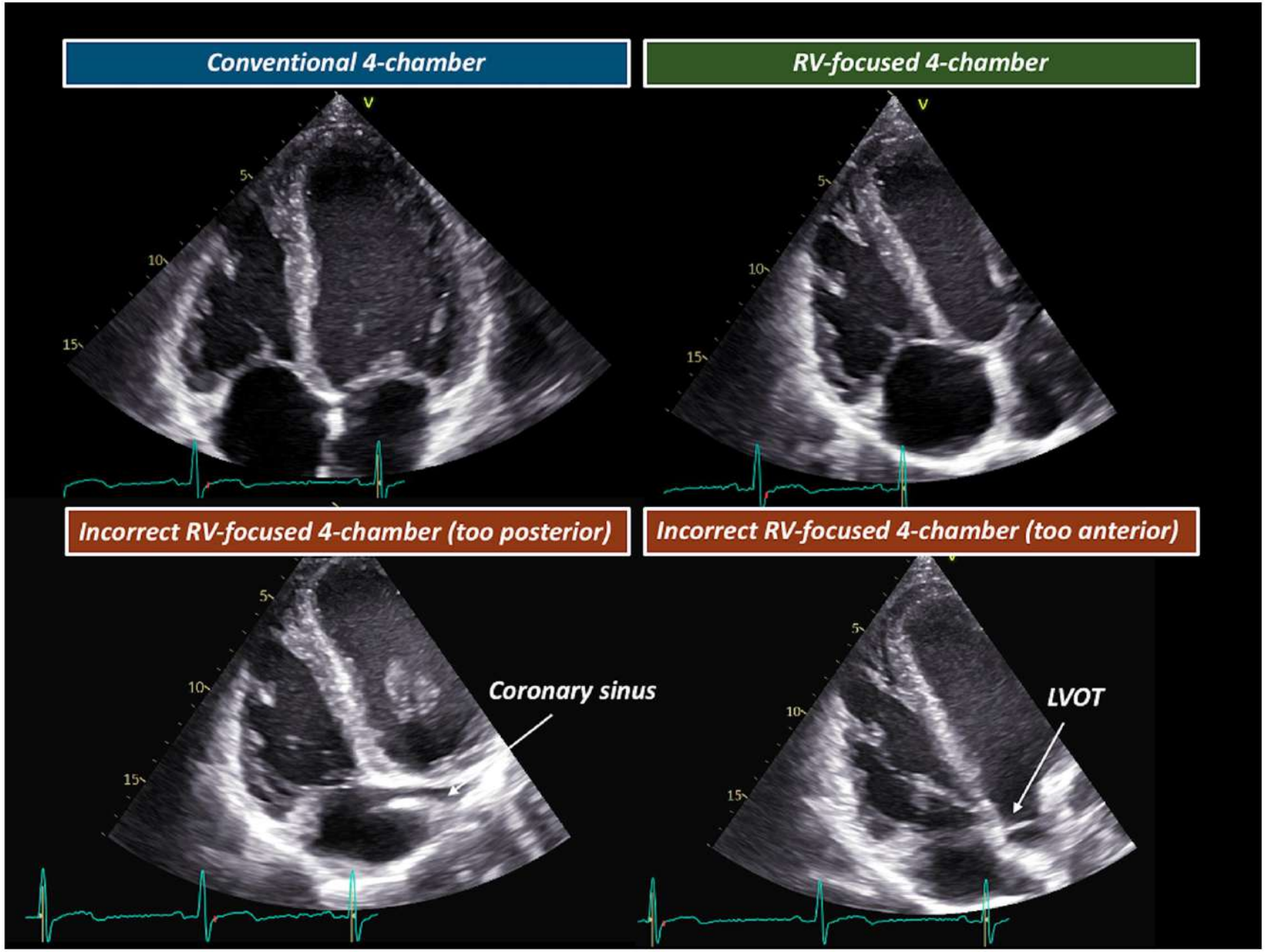
Adapted from: *Eur Heart J Cardiovasc Imaging*, Volume 21, Issue 8, August 2020, Pages 825–827.

The RV FOCUSED view



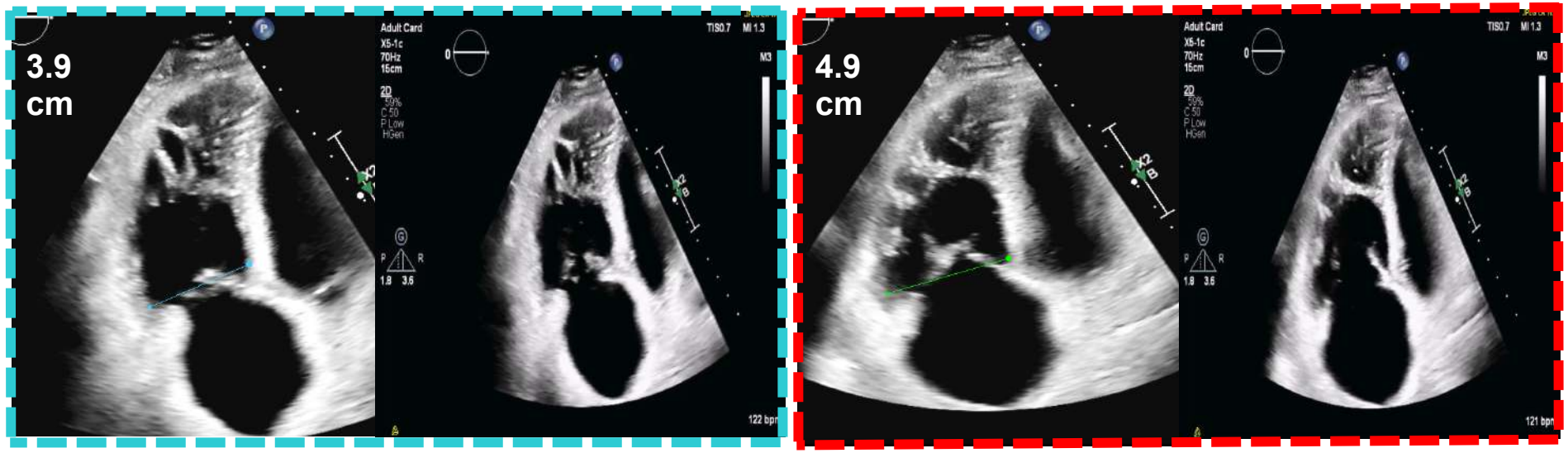


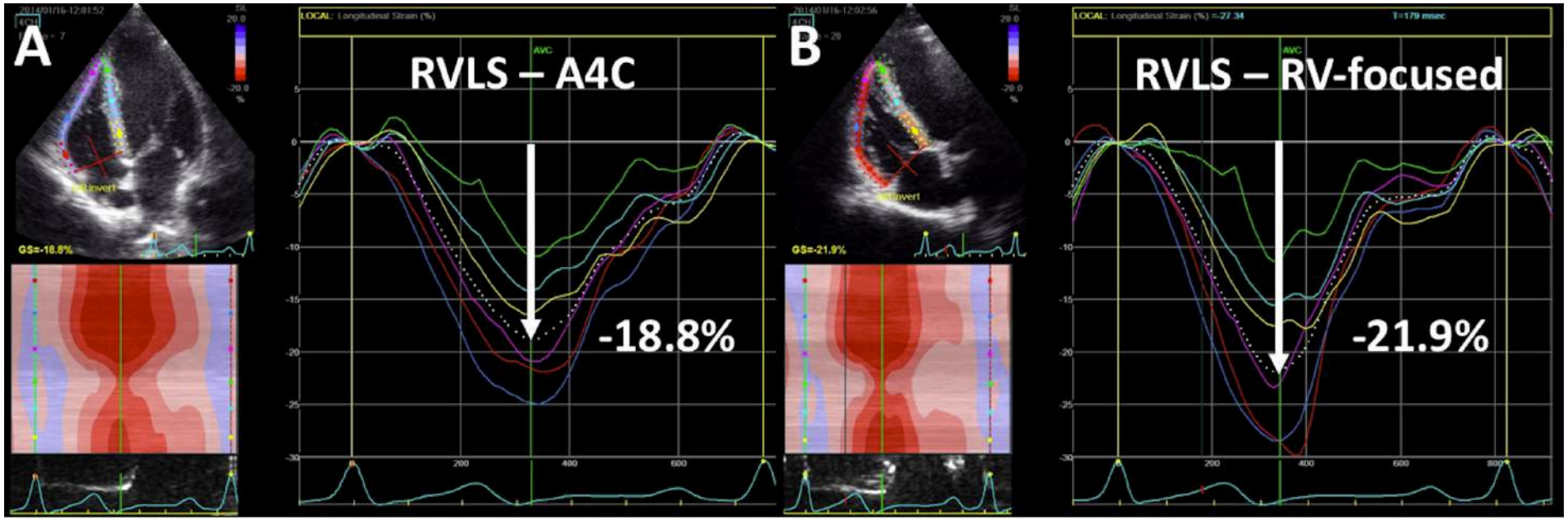
The RV focused view is performed to optimize the lateral RV free wall as well as permit us to perform inter-study comparisons



Adapted from; *Eur Heart J Cardiovasc Imaging*, Volume 23, Issue 7, July 2022, Pages 898–912.

The RV FOCUSED view





RV Strain Values

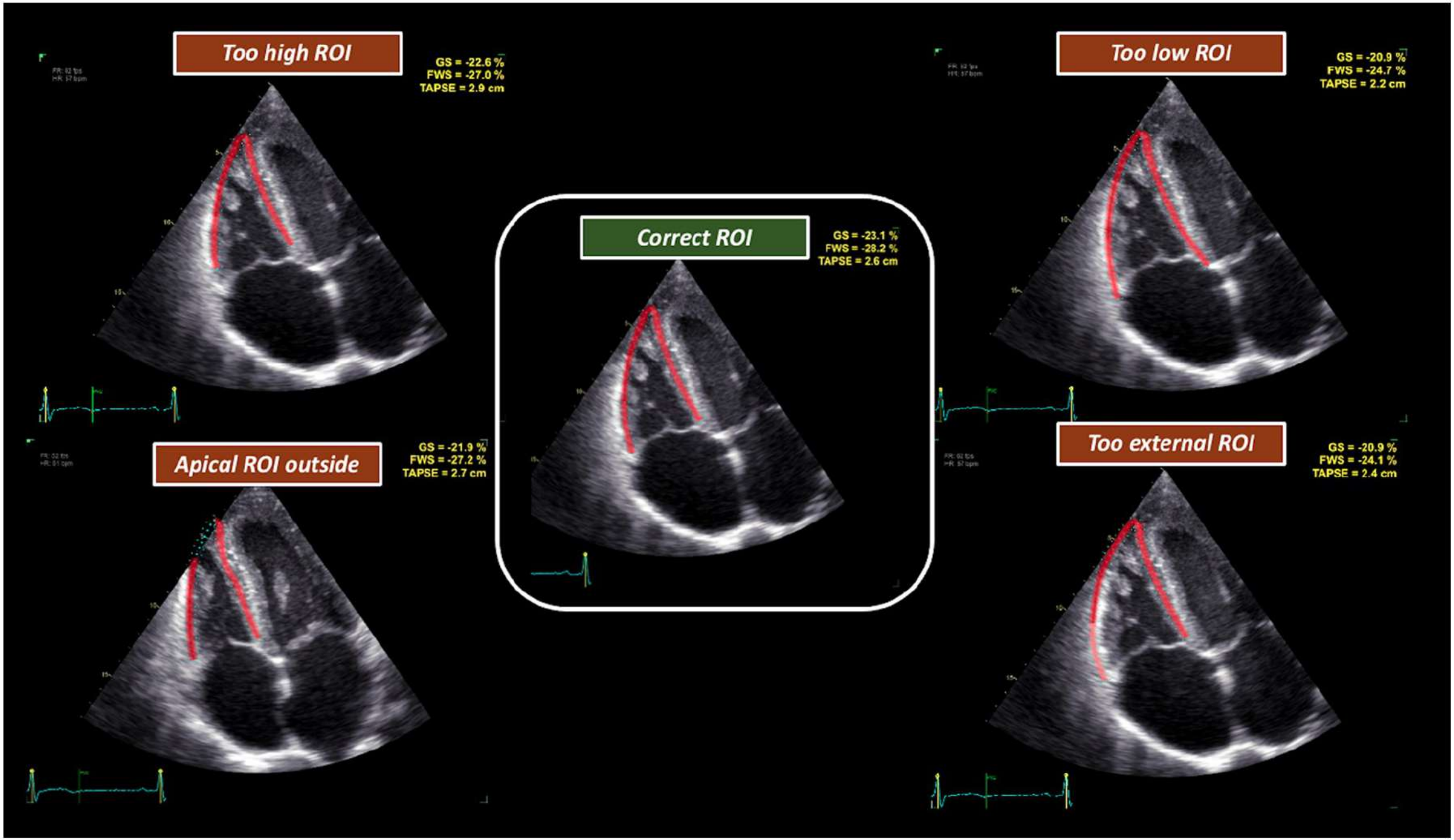
Reference ranges for RVLS by 2D speckle-tracking echocardiography

					Free wall three-segment RVLS (%)		Six-segment RVLS (%)	
Study (year of publication)	**Sample size**	**Women (%)**	**Ultrasound system(s)**	**Software**	**Average**	**LLN**	**Average**	**LLN**
Fine *et al.* (2013)[22]	186	61	Philips iE33, GE Vivid 7, Siemens Sequoia C512	Syngo VVI	−21.7 ± 4.2	−13.3	−20.4 ± 3.2	−14.0
Chia *et al.* (2014)[23]	136	47	GE Vivid 7	EchoPac	−27.3 ± 3.3	−20.7	−22.4 ± 2.4	−17.6
Morris *et al.* (2016)[24]	238	50	GE Vivid 7	EchoPac	−28.5 ± 4.8	−18.9	−24.5 ± 3.8	−16.9
Muraru *et al.* (2016)[15]	250	55	GE Vivid E9	EchoPac	−30.5 ± 3.9	−22.7	−25.8 ± 3.0	−19.8
McGhie *et al.* (2017)[25]	147	50	Philips iE33 or EPIQ7	TomTec	−25.4 ± 5.0	−15.4	NR	NR
Park *et al.* (2018)[26]	493	53	GE	EchoPac	−26.4 ± 4.2	−18.0	−21.5 ± 3.2	−15.1
Addetia *et al.* (2021)[27]	1913	49	Philips, Siemens, GE	TomTec	−28.3 ± 4.3	−20.0	−25.4 ± 3.8	−18.2

LLN[a], lowest level of normality; NR, not reported.

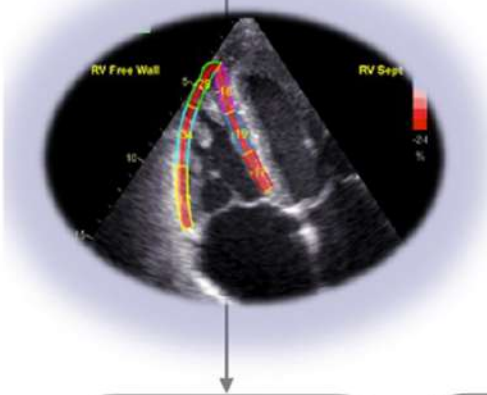
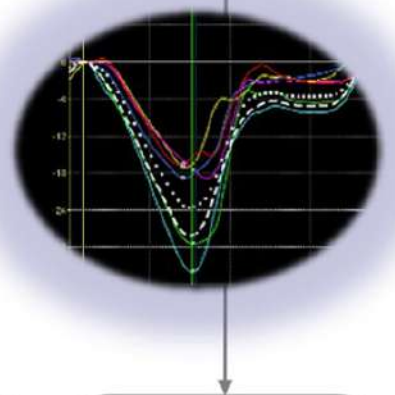
a As reported in the original publication or calculated as 2 SDs of the mean.

Adapted from: *Eur Heart J Cardiovasc Imaging*, Volume 21, Issue 8, August 2020, Pages 825–827.



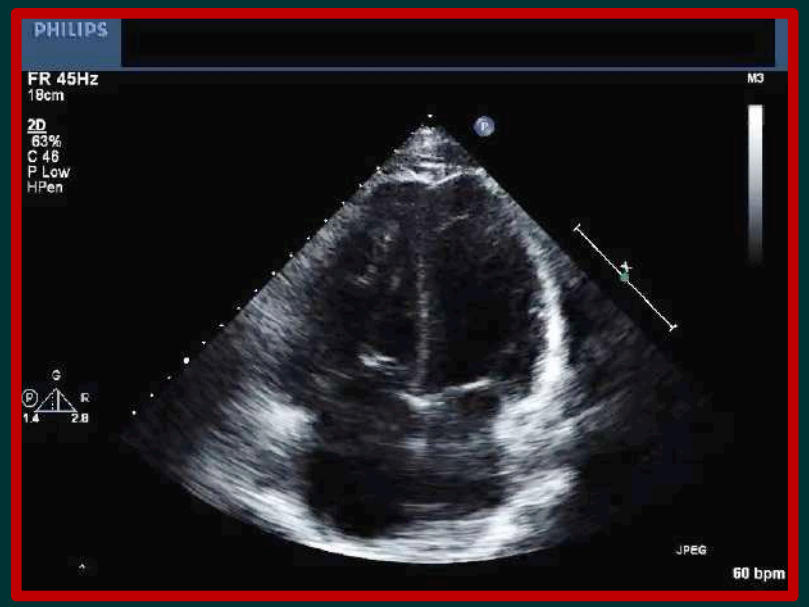
Adapted from; *Eur Heart J Cardiovasc Imaging*, Volume 23, Issue 7, July 2022, Pages 898–912.

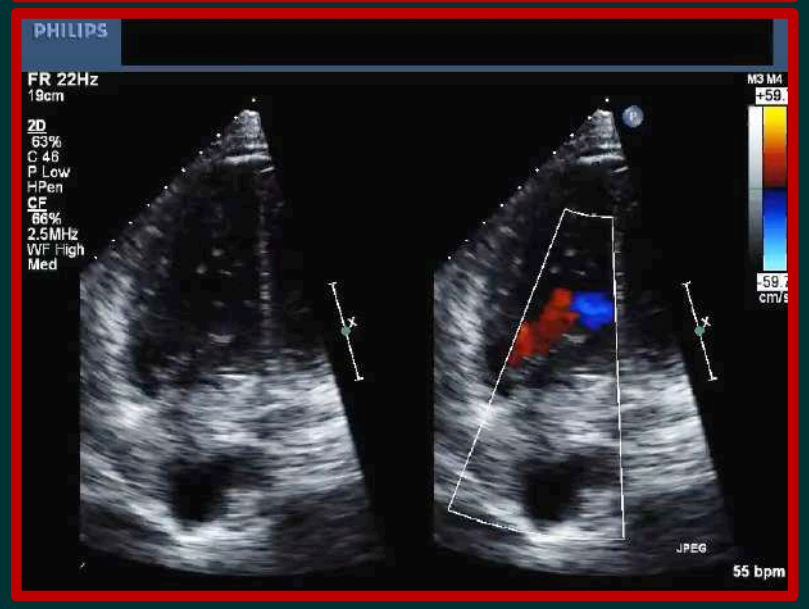
Clinical Indication for RV Systolic Function Assessment

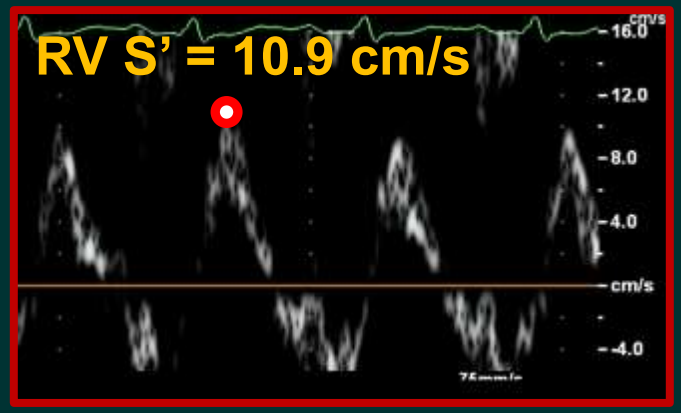
- **Heart Failure (HF)**
  - 
  - Predictive of CV death and rehospitalization in patients admitted for decompensated acute HF
- **Cardiomyopathies (CMP)**
  - Detects subtle RV involvement in CMP patients and predicts disease development in family relatives
- **Myocardial Infarction (MI)**
  - Predictive of survival and MACE after inferior AMI, better than TAPSE and FAC; additive to age, LVEF, TnI, RV infarction
- **Pulmonary Hypertension (PH)**
  - Superior to TAPSE for outcome prediction in PH of different etiologies and severities
- **Tricuspid Regurgitation (TR)**
  - Independently associated with all-cause mortality in significant TR; incremental to FAC and TAPSE
- **Congenital Heart Disease (CHD)**
  - 
  - Sensitive parameter of RV function in ToF; predictive of exercise capacity and postoperative RV function

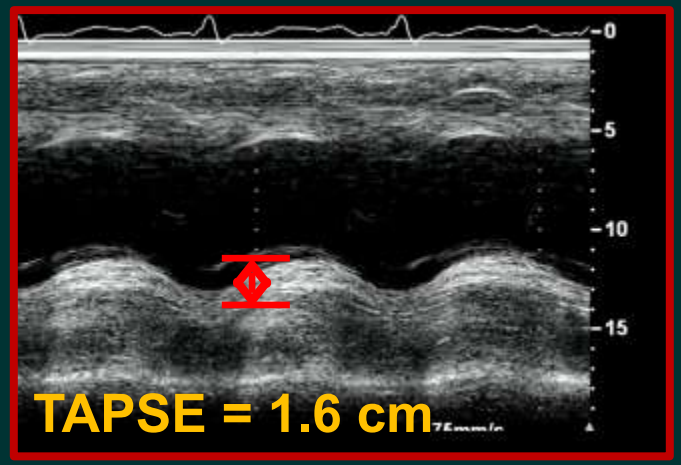
Additive Value of RV Longitudinal Strain to Conventional Parameters

Case: Severe TR and RV function



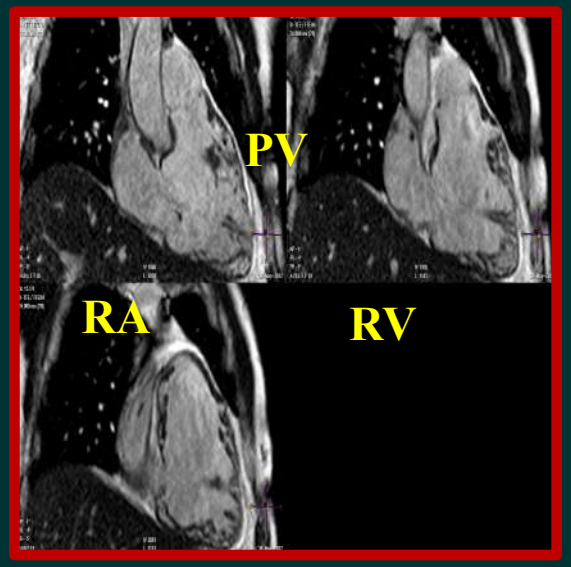


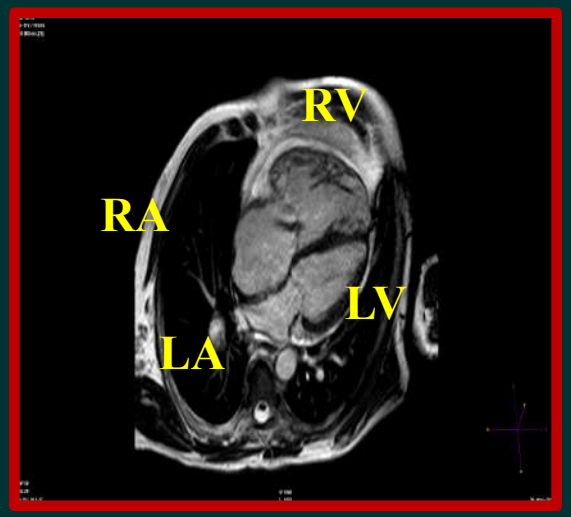




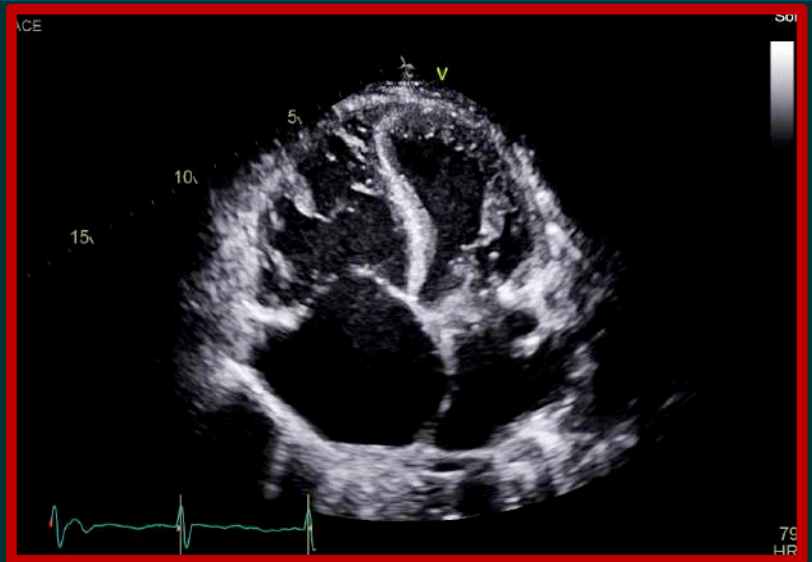
Longitudinal strain = -8%

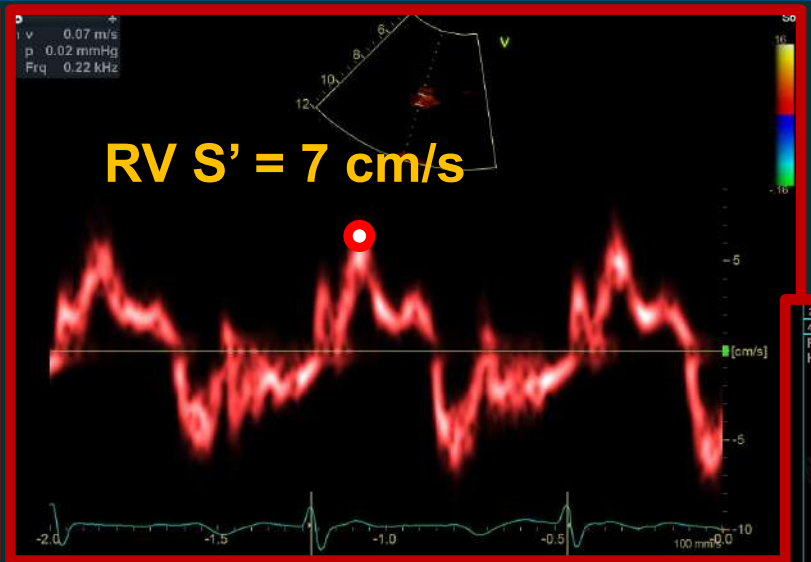
CMR

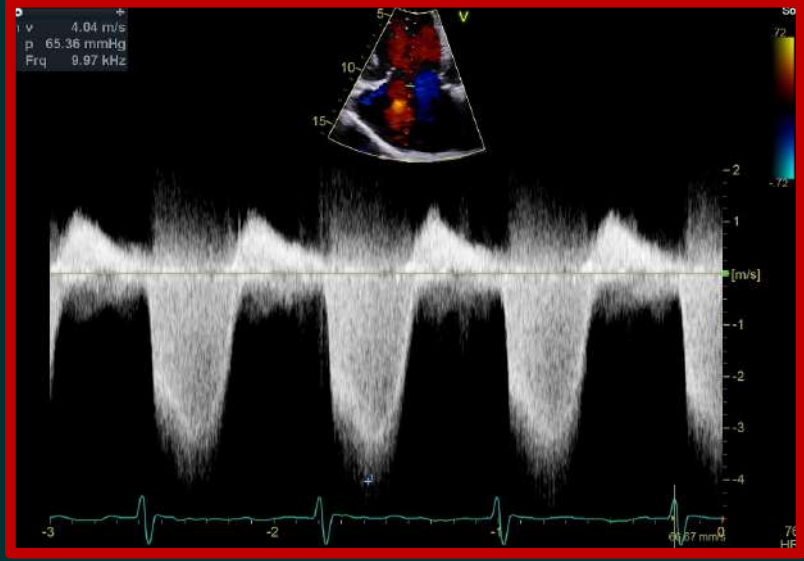


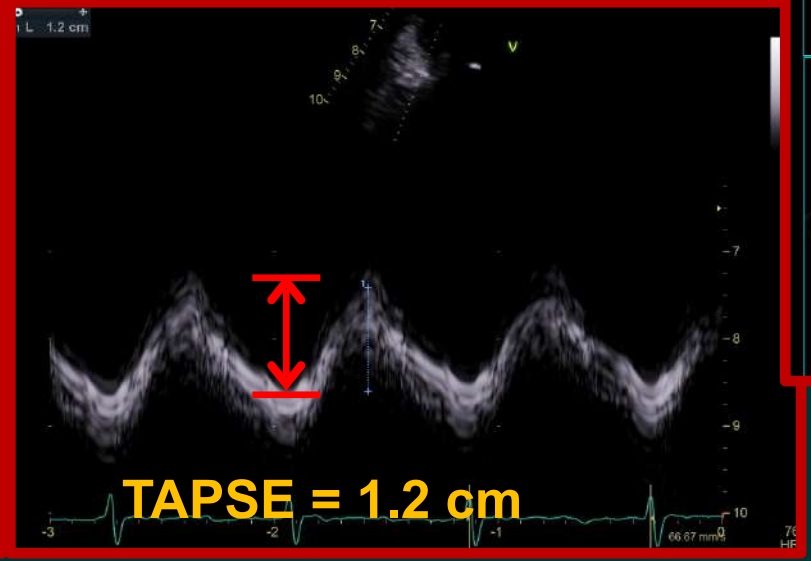


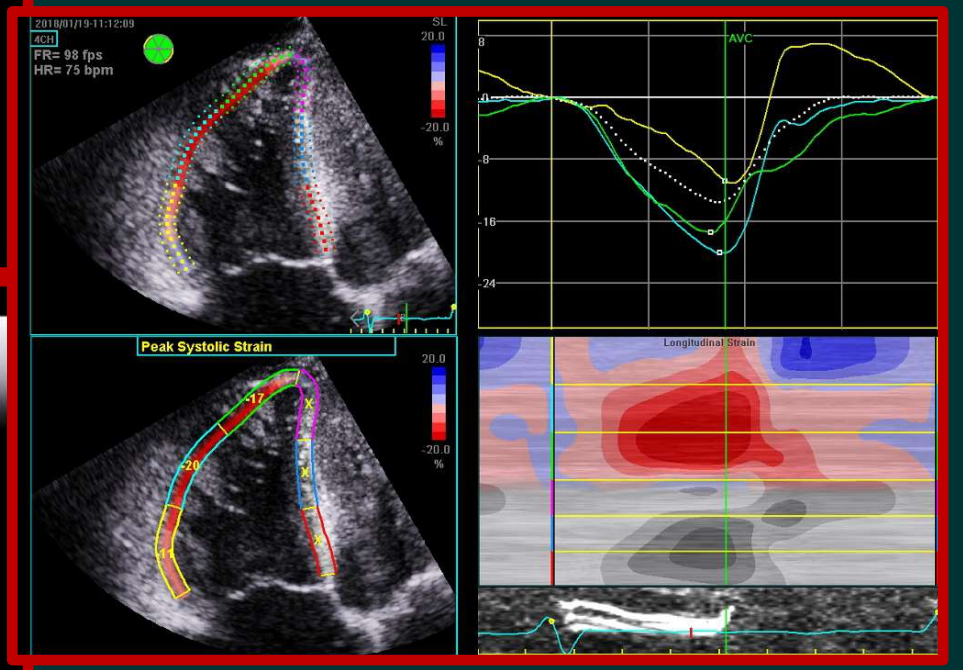
Case: PHTN and RV function





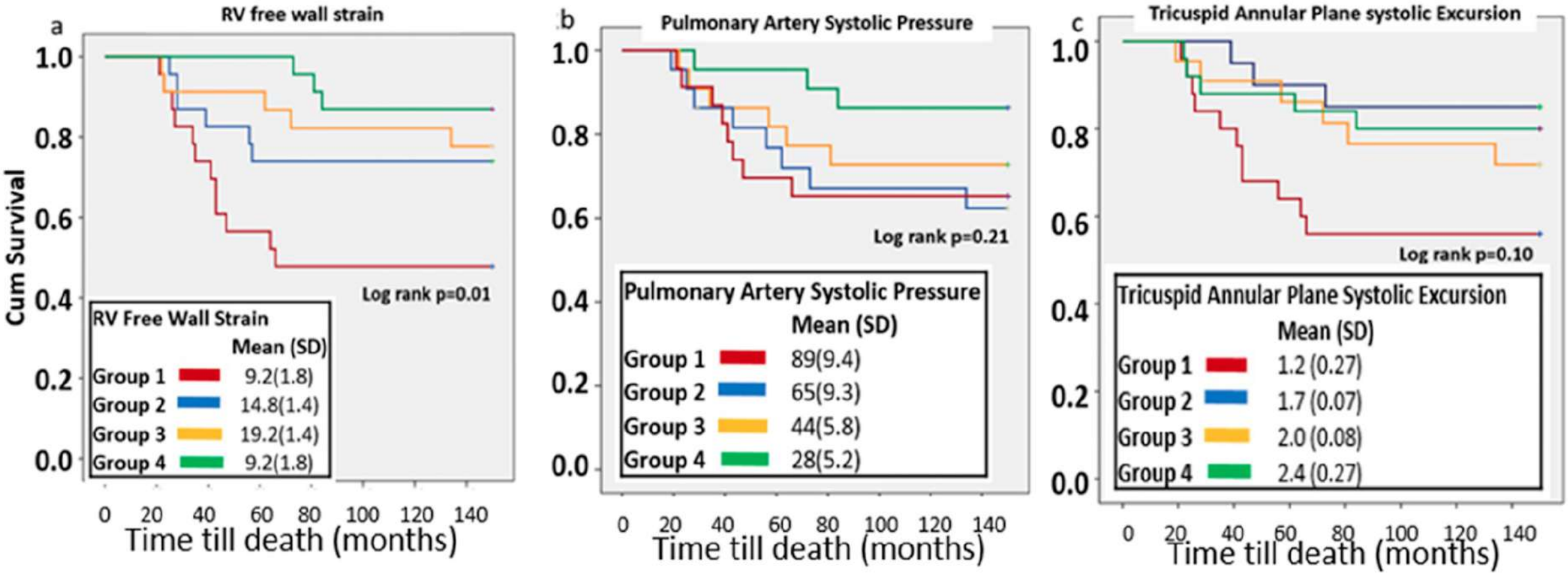






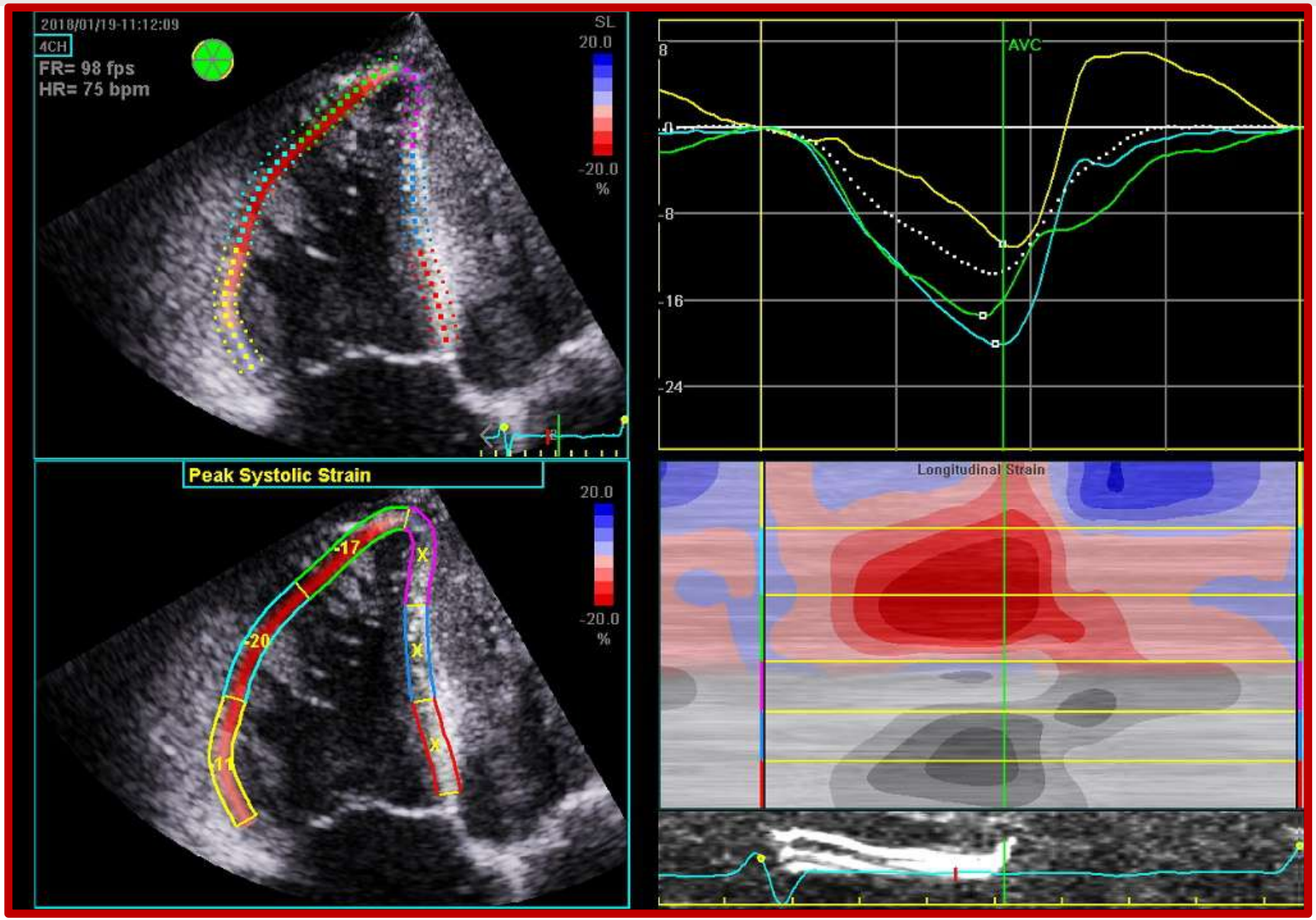
Longitudinal strain = -16%

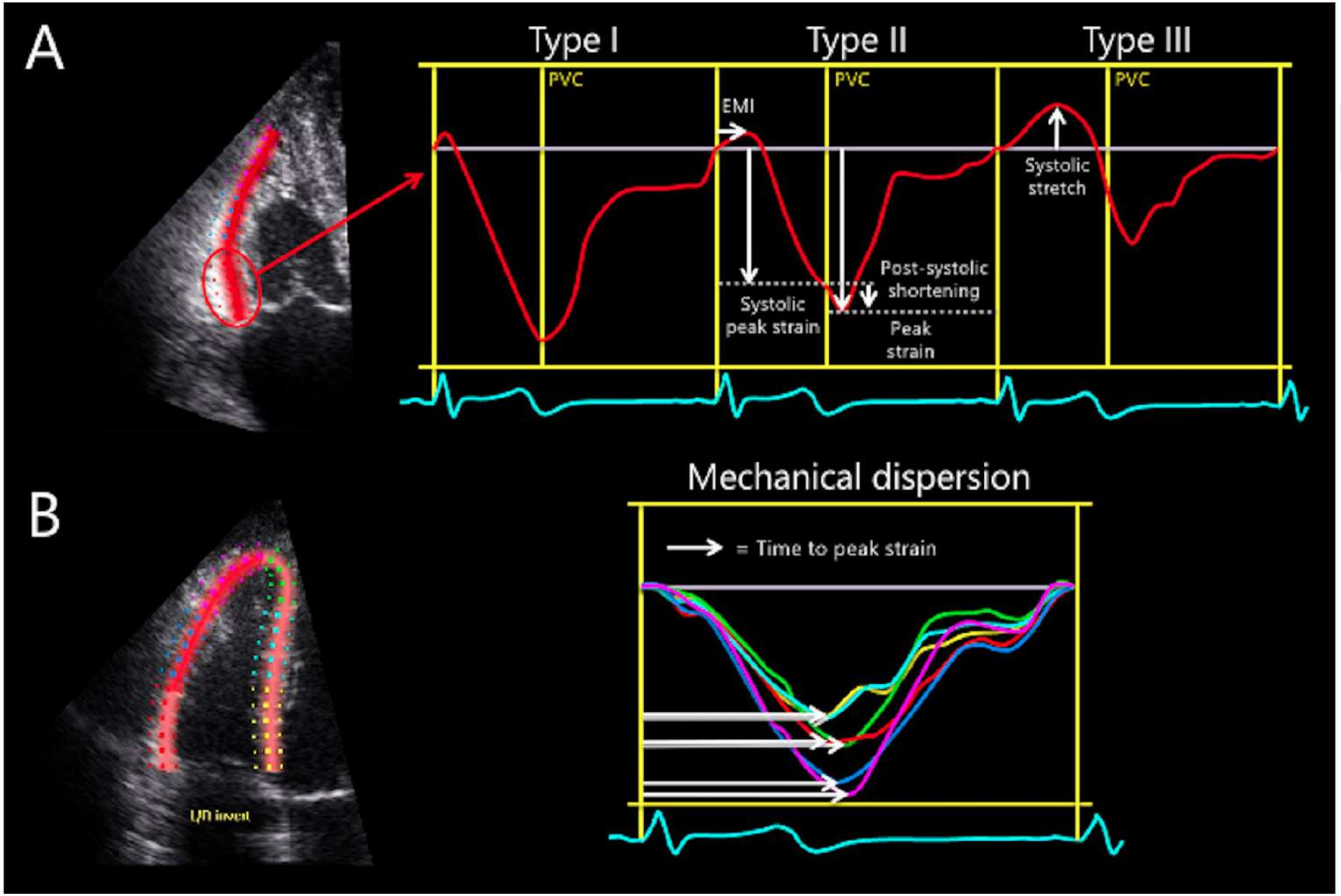
RVLS = Better predictive values compared to TAPSE



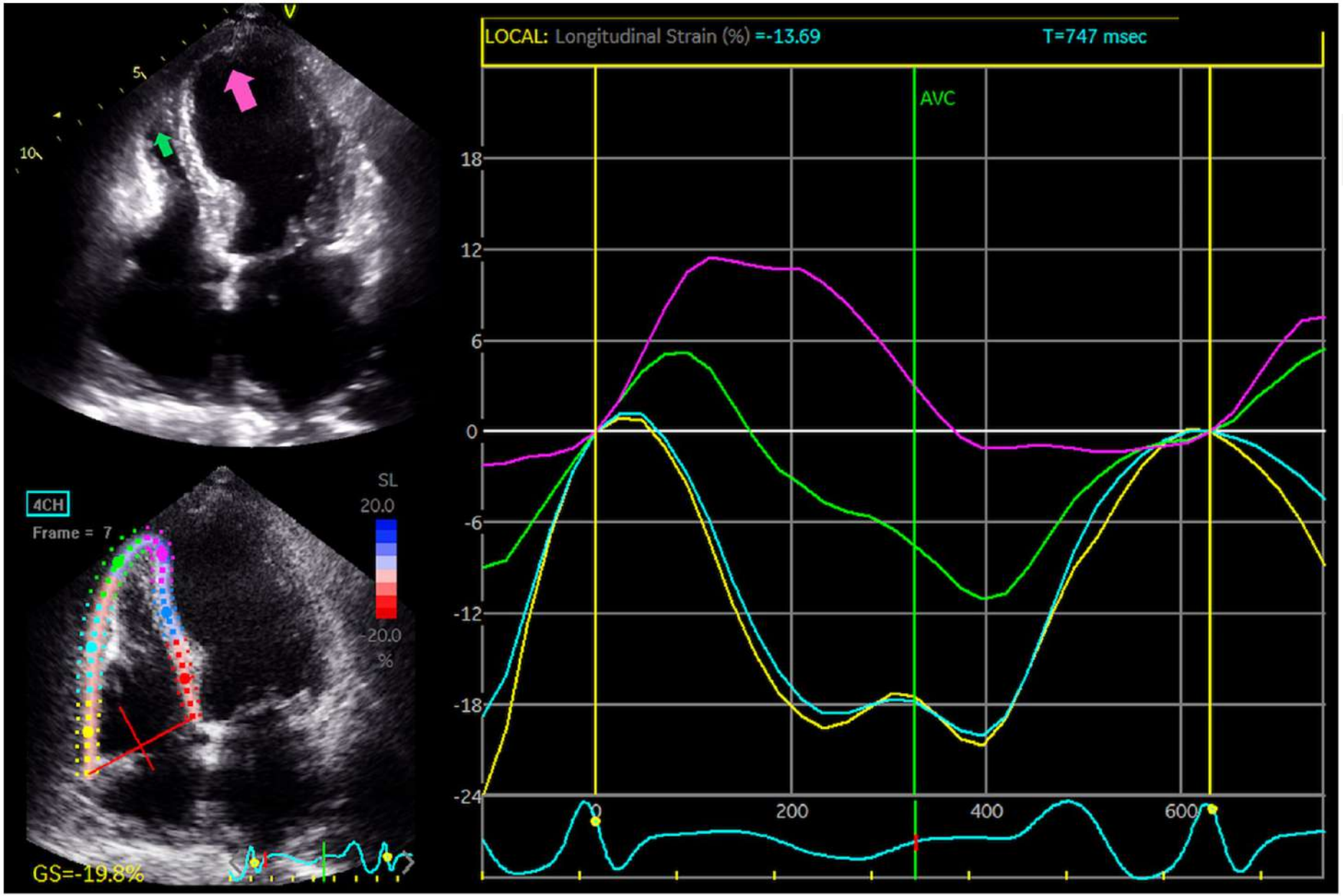
Adapted from: Wright L, Dwyer N, Wahi S, Marwick TH. Relative importance of baseline and longitudinal evaluation in the follow-up of vasodilator therapy in pulmonary arterial hypertension. JACC Cardiovasc Imaging 2019;12:2103–11.

Use Clinical Eye = Additional Info…





Adapted from Muraru, D. et al, EHJCVI;2022; 23,898–912.



Adapted from Muraru, D. et al, EHJCVI;2022; 23,898–912.

Limitations… Solutions

- Inter-vendor variability
  - Same machine, same software
  - Independent software
  - Both European and American Echo Societies working with vendors to standardize
- One view of RV
  - Future role of 3D strain
- RV Free wall strain vs Total RV strain debate
- Lack of prospective studies
  - More studies and higher sample size

ASE Guidelines (published March 2025)

GUIDELINES AND STANDARDS

Guidelines for the Echocardiographic Assessment of the Right Heart in Adults and Special Considerations in Pulmonary Hypertension: Recommendations from the American Society of Echocardiography

Monica Mukherjee, MD, MPH, FASE, Chair, Lawrence G. Rudski, MDCM, FASE, Co-Chair, Karima Addetia, MD, FASE, Jonathan Afilalo, MD, MSc, Michele D'Alto, MD, PhD, Benjamin H. Freed, MD, FASE, Lynsy B. Friend, ACS, RCS, FASE, Luna Gargani, MD, PhD, Julia Grapsa, MD, PhD, FASE, Paul M. Hassoun, MD, Lanqi Hua, RDCS, FASE, Jiwon Kim, MD, FASE, Valentina Mercurio, MD, PhD, Rajan Saggar, MD, and Anton Vonk-Noordegraaf, MD, PhD,

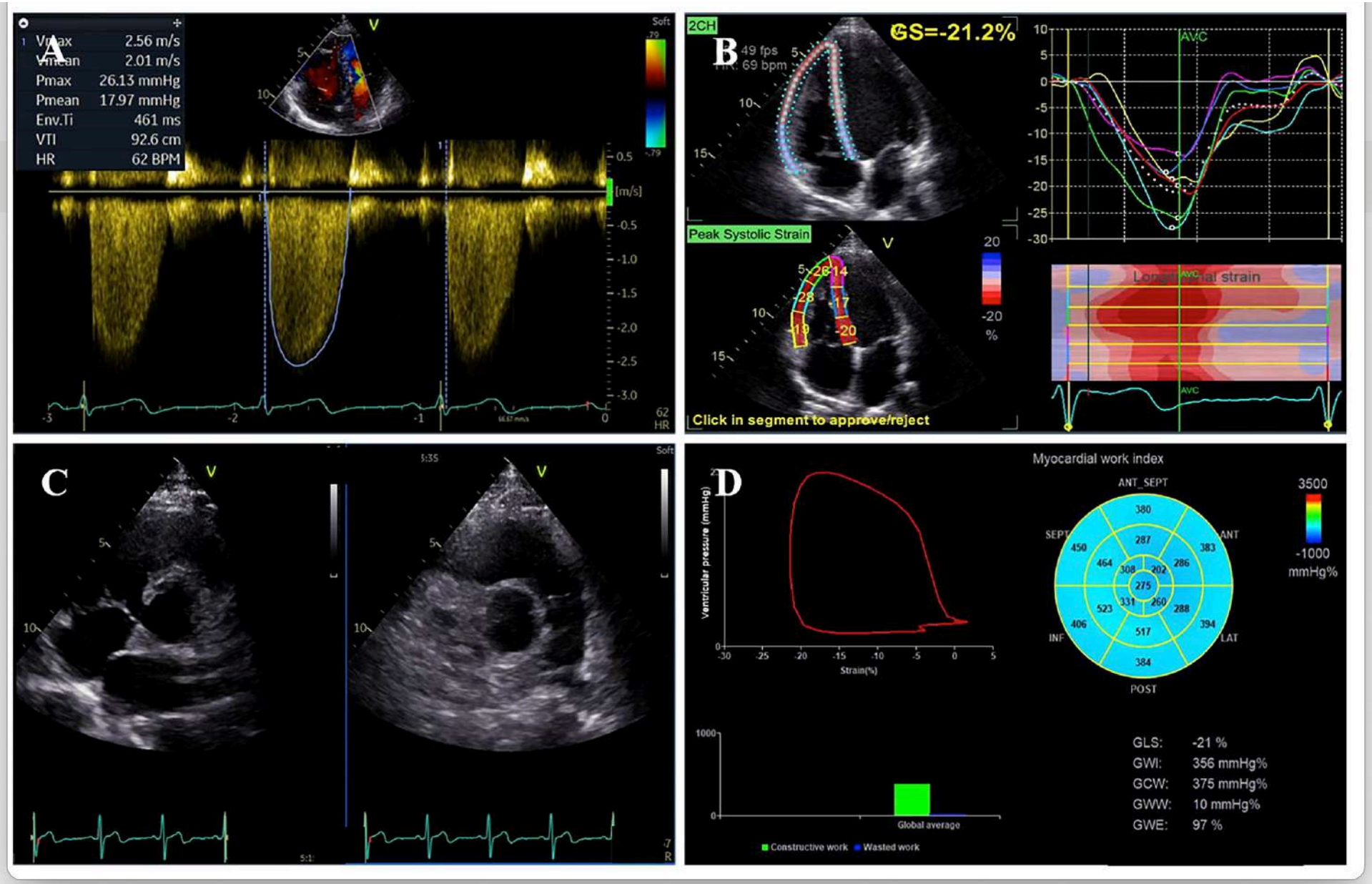
Baltimore, Maryland; Montreal, Quebec, Canada; Chicago, Illinois; Naples and Pisa, Italy; Lebanon, New Hampshire; London, United Kingdom; Boston, Massachusetts; New York, New York; Los Angeles, California; and Amsterdam, the Netherlands

Adapted from: JASE; 2025;38:3 pg 141-189.

Table 1 Summary of reference limits for recommended measures of right heart structure and function

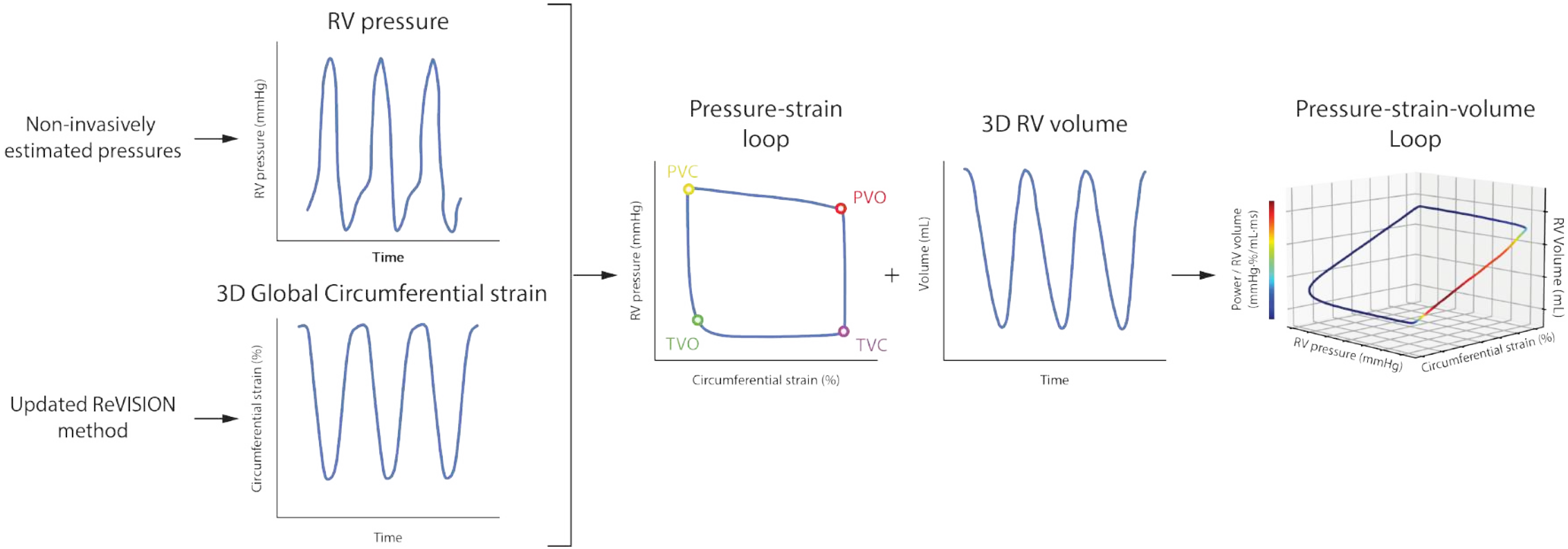
Variable	Normal Reference Value	Abnormality Grading		
		Mild	Moderate	Severe
Chamber dimension				
RA major dimension, cm	<5.4	≥5.4 to ≤5.8	>5.8 to ≤6.3	>6.3
RA minor dimension, cm	<4.2	≥4.2 to ≤4.7	>4.7 to ≤5.1	>5.1
RA area, cm^2	<19	≥19 to ≤22	>22 to ≤24	>24
RAV index (method of disks), mL/m^2	<30	≥30 to ≤36	>36 to ≤41	>41
RAV index (area-length method), mL/m^2	<33	≥33 to ≤38	>39 to ≤44	>44
RA end-systolic volume index (3D method), mL/m^2	<42	≥42 to ≤49	>49 to ≤57	>57
RA end-diastolic volume index (3D method), mL/m^2	<20	≥20 to ≤23	>23 to ≤27	>27
RV systolic function				
TAPSE, cm	>1.7	≤1.7 to ≥1.3	≤1.3 to >1.0	≤1.0
Tissue Doppler S′ velocity, cm/s	>9.5	≤9.5 to ≥7.2	≤7.2 to > 5.0	≤5.0
Tissue Doppler RV MPI	<0.55	≥0.55 to <0.62	≥0.62 to <0.70	≥0.70
Pulsed Doppler RV MPI	<0.40	≥0.40 to <0.49	≥0.49 to <0.57	≥0.57
FAC, %	>35	≤35 to >29	≤29 to >22	≤22
3D RVEF, %	>45	≤45 to <39	≤39 to ≥32	<32
RV longitudinal free wall strain (three segment), %*	>20	≤20 to <15	<15 to ≥11	<11
RV longitudinal global strain (six segment), %*	>17	≤17 to >13	≤13 to >9	≤9

Adapted from: JASE; 2025;38:3 pg 145.



Adapted from: Wu, J., et al. (2023). The non-invasive echocardiographic assessment of right ventricular myocardial work in a healthy population. Acta Cardiologica, 78(4), 423–432.

Noninvasive pressure-strain-volume loop and myocardial work indices



Global **M**yocardial **W**ork **I**ndex **(GMWI)** adjusted to **3D RV V**olume **(GMWIV)**

Constructive **M**yocardial **W**ork **I**ndex **(CMWI)** adjusted to **3D RV V**olume **(CMWIV)**

Global **W**asted **W**ork **(GWW)** adjusted to **3D RV V**olume **(GWWV)**

Myocardial **W**ork **E**fficiency **(MWE)** adjusted to **3D RV V**olume **(MWEV)**

PVC – pulmonary valve closure, TVO – tricuspid valve opening, TVC – tricuspid valve closure, PVO – pulmonary valve opening

The only animal Australians are afraid of? A bird. Here's why

By Lilit Marcus, CNN

4 minute read · Updated 4:11 AM EST, Mon February 24, 2025

24 comments

This picture taken on April 7, 2024, shows a cassowary in Etty Bay, Queensland. David Gray/AFP/Getty Images

Editor's note: Sign up for Unlocking the World, CNN Travel's weekly newsletter. Get news about destinations, plus the latest in aviation, food and drink, and where to stay

https://tenor.com/magpie-attack-gifs

Courtesy Mythic Australia

THANK YOU