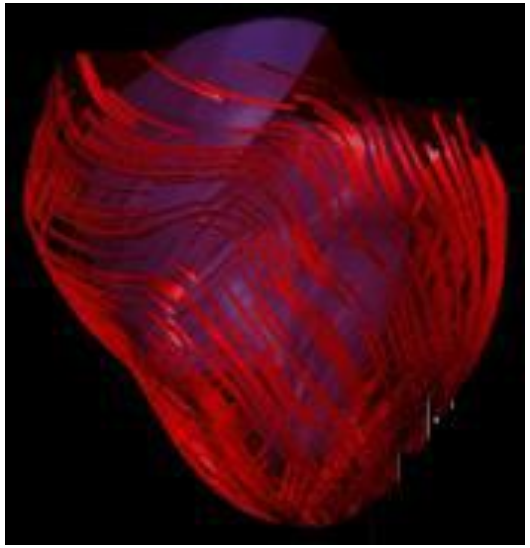
Assessment of the Right Heart



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Research Support and Disclosures

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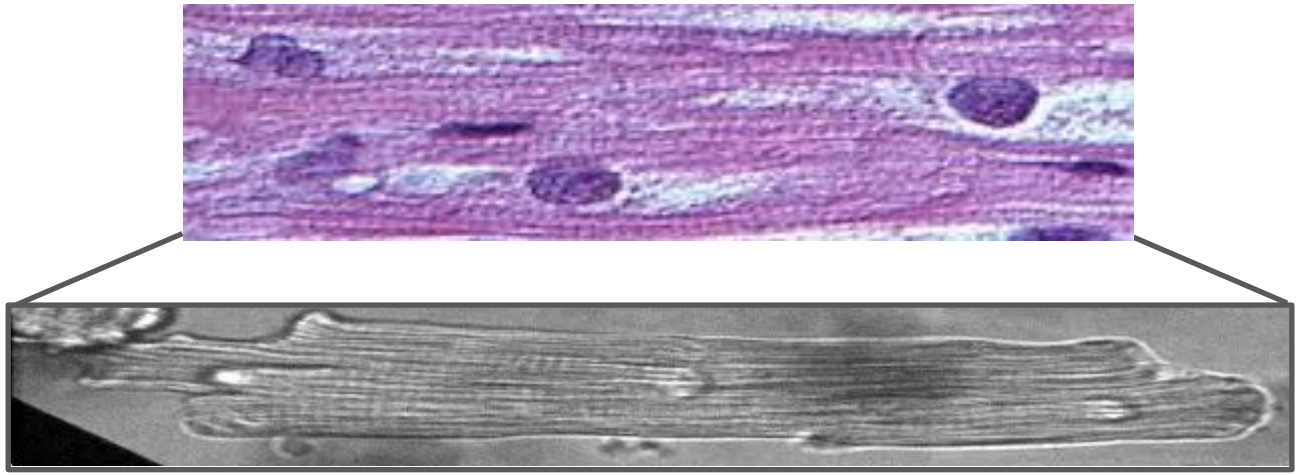
Scientific Advisory Board:

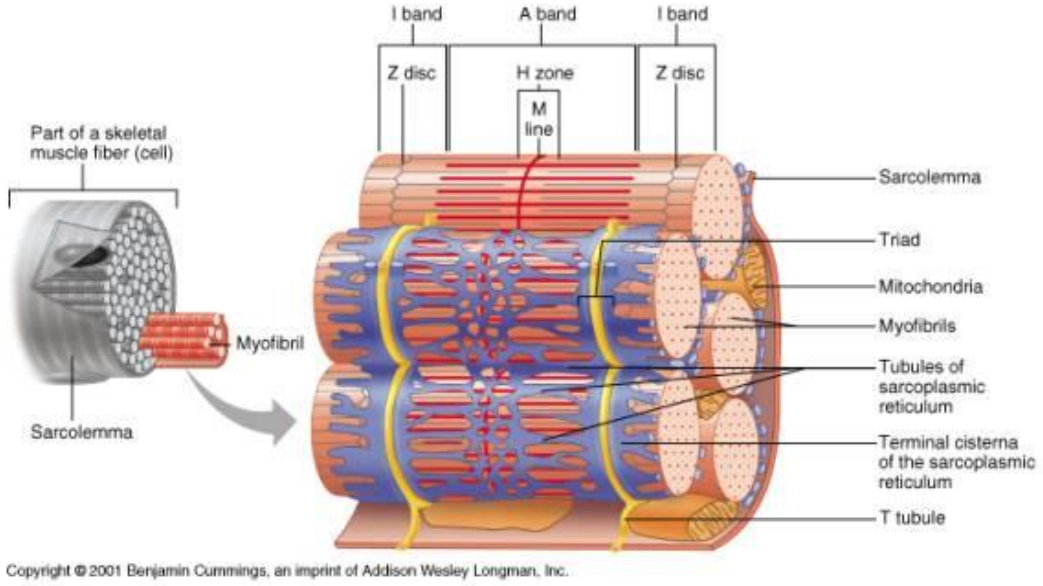
- BioMarin Pharma Inc.
- Regeneron

Characteristics of the LV and RV

Characteristics	Right Ventricle	Left Ventricle
End-diastolic Volume (mL/m^2)	75±15	66±12
Ejection Fraction (%)	45-60	55-70
Normal End-diastolic Thickness (mm)	0.5	1.1
Mass (g/m^2)	26±5	88±12
Systolic/Diastolic Pressure (mm Hg)	25/5	120/80
Elastance (mm Hg/mL)	1.3±0.8	5.5±1.2
Stroke Work (g/m^2 per beat)	8±2	50±20
Myocardial Blood Flow (ml/min/g)	0.4	1.0

Myocyte Function





Dynamic Morphometrics

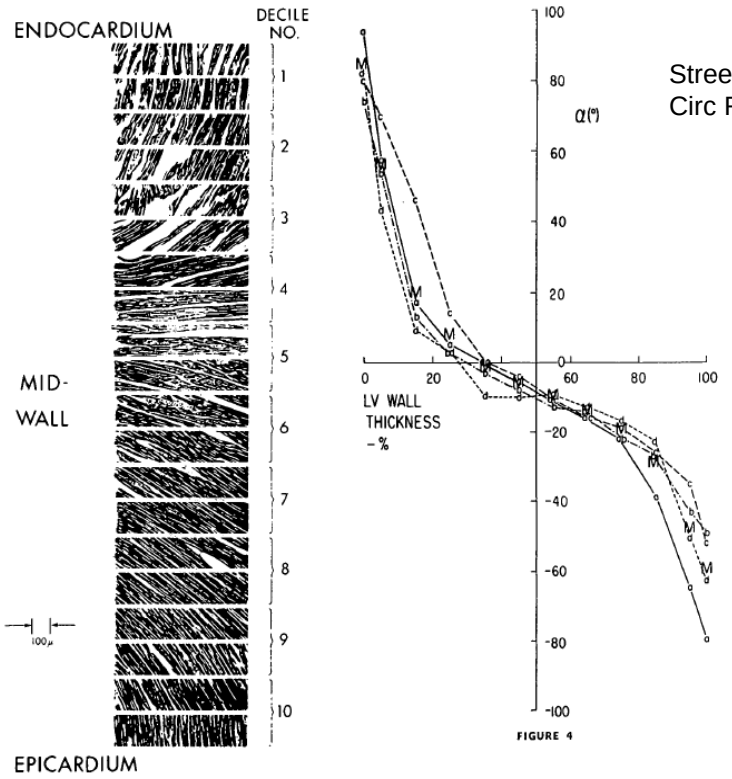
Myocyte shortening: 15%

Myocyte thickening: 8%

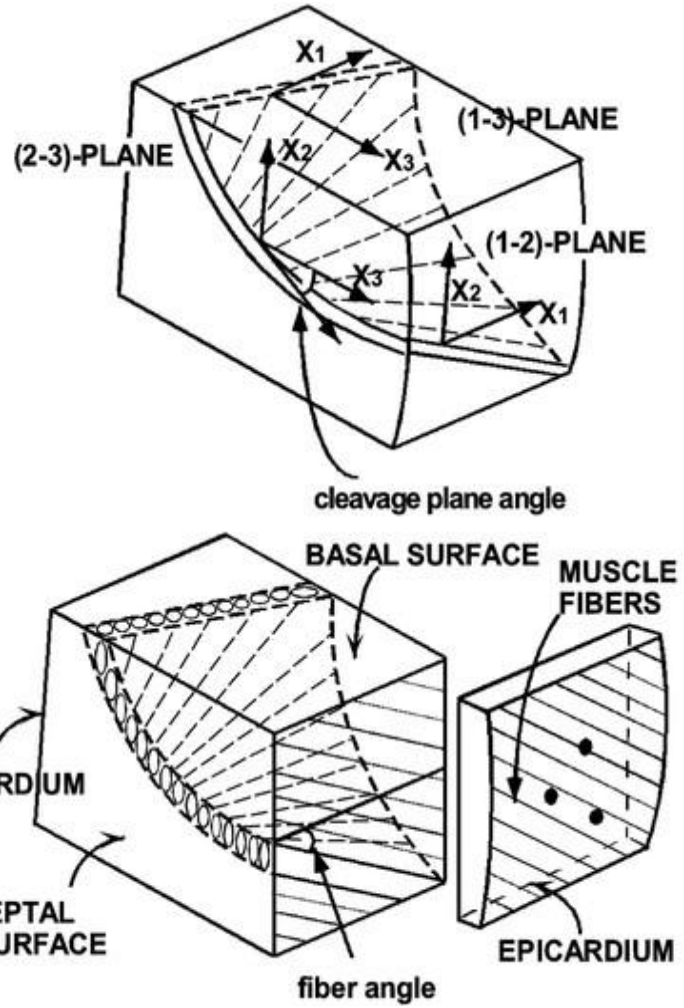
Wall thickening: 30-50% (for LV)

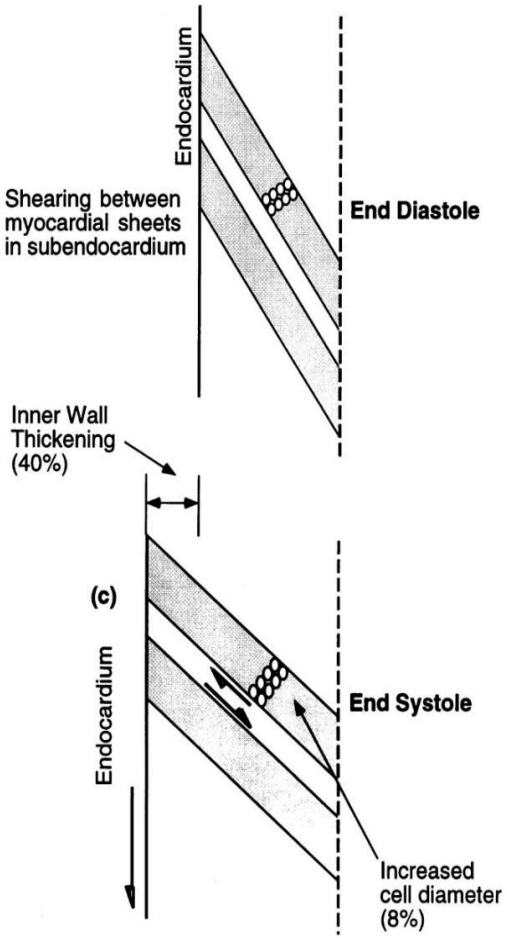
Ejection Fraction:
LVEF 55-70%, RVEF 45-60%

Making the Most of Myocyte Function with Tilted Sheets



Streeter DD, et al.
Circ Res 1969;24:339



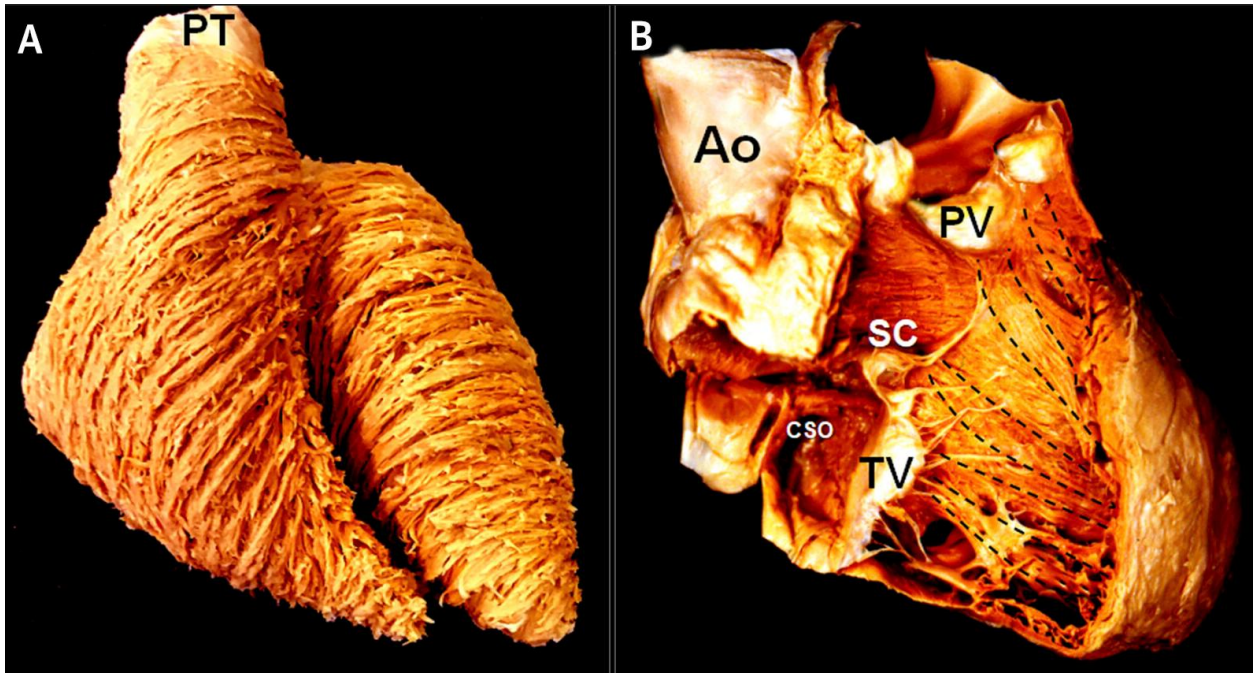


Buckberg G, JTCS 2002:863

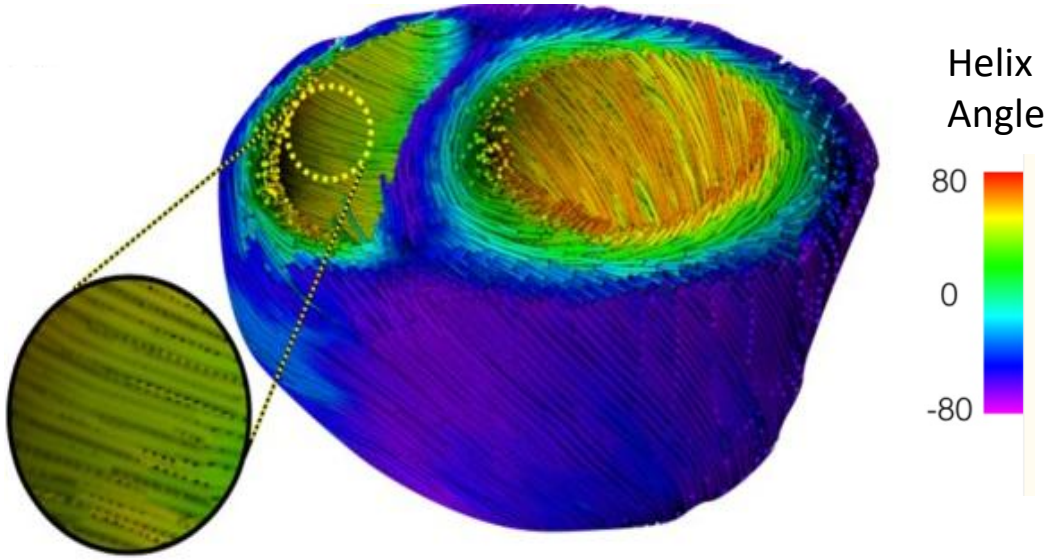
Y Takayama et al. Am J Physiol 2002;282:H1510

IJ LeGrice et al. Circ Res. 1995;77:182

RV Doesn’t Work the Same Way



Sanz J, et al., JACC 2019;73:1463



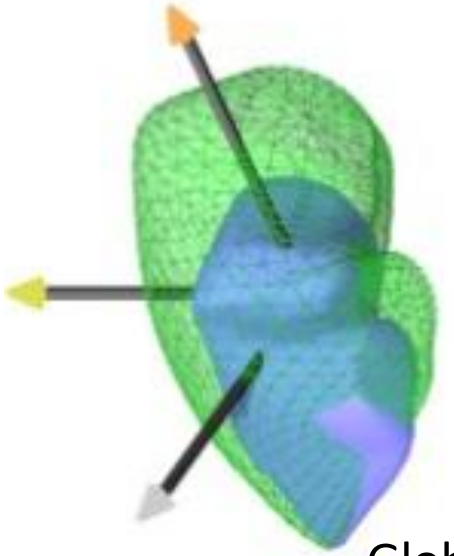
Gomez AD, et al., J Biomech Eng 2017;139:0810041

Geometric Concepts for Ventricular Function

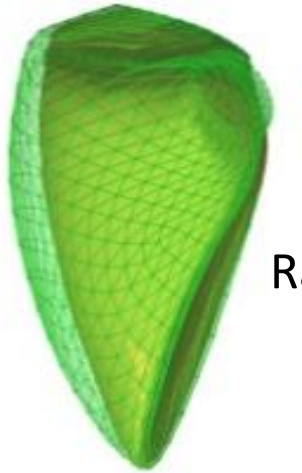
Left Ventricle

Right Ventricle

Longitudinal



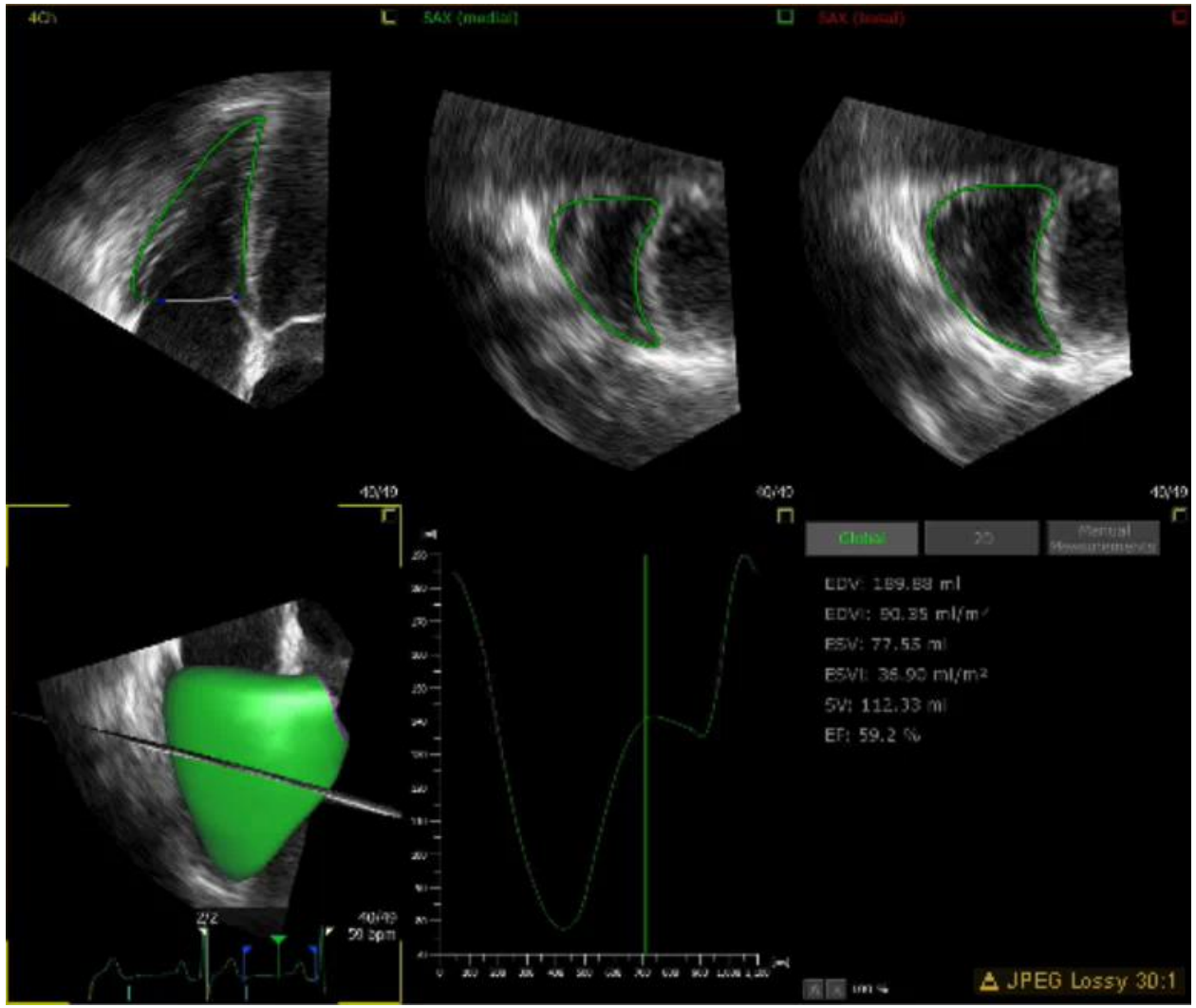
Global



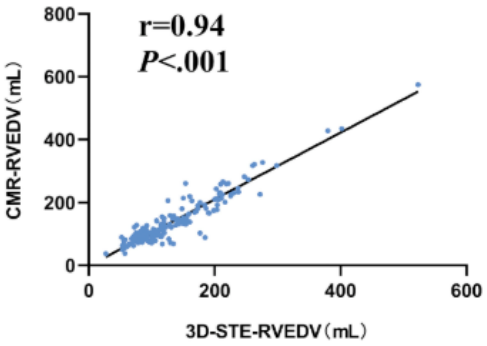
Radial

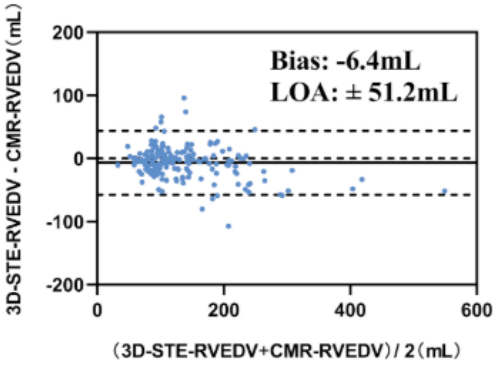
Kovacs A, et al., Heart Fail Rev 2019;24:511

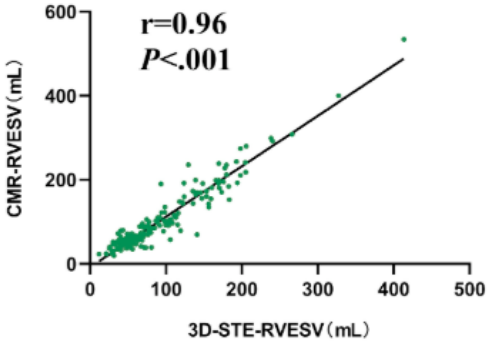
Is 3D Volumetric Assessment All We Need?

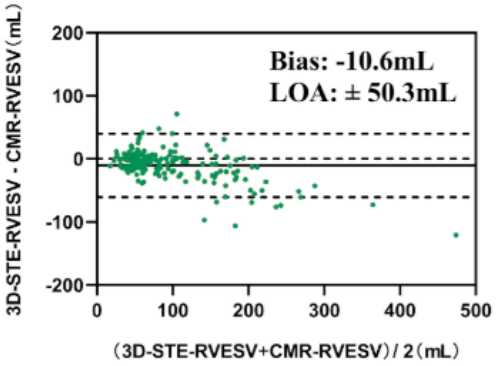


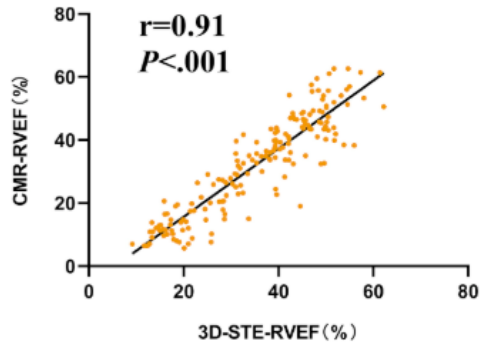
Courtesy of L Sugeng

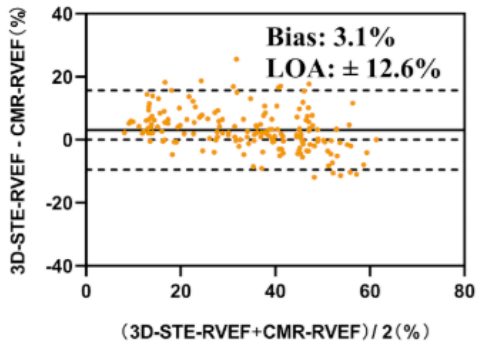












Li Y, et al. J Am Soc Echocardiog 2021;34:472

Imaging Assessment of the Periodic Pump

Muscle Squeeze

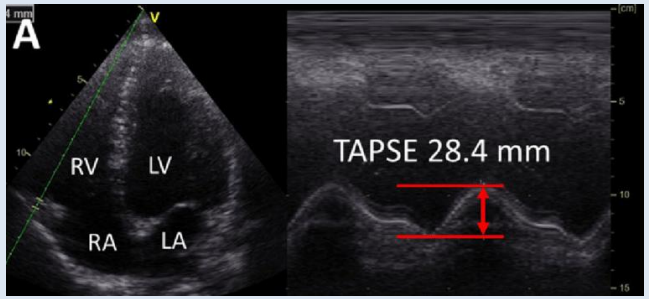
dp/dt
Tissue Doppler
Strain
Strain rate
Isovolumic acceleration
~~Torsion & Twist~~

Volume (±pressure)

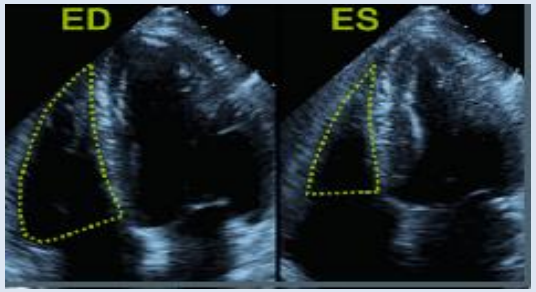
Ejection fraction
FAC
Stroke volume
Stroke work
ESV-ESP relation
~~Shortening fraction~~

Assessment of RV Function by Echocardiography

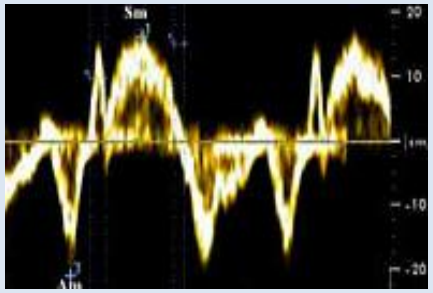
TAPSE



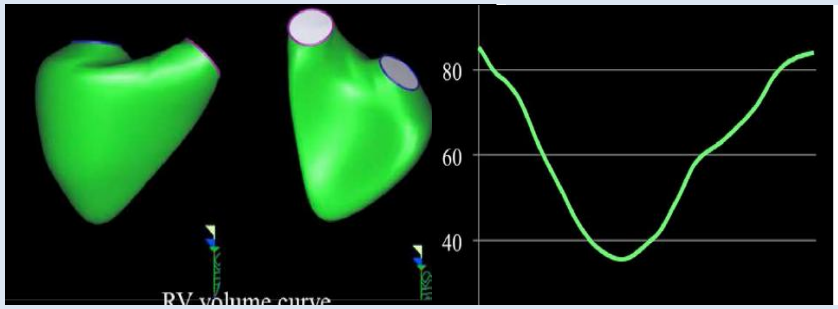
Fractional Area Change



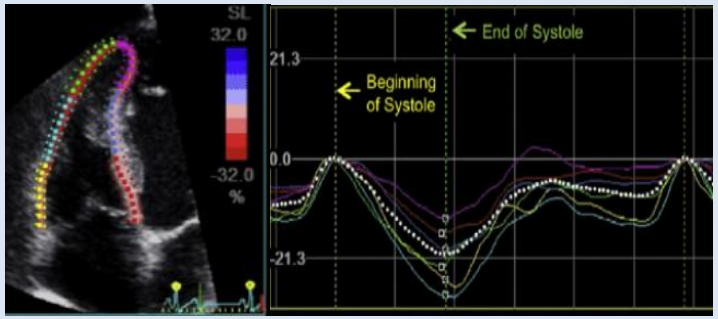
Systolic Velocity



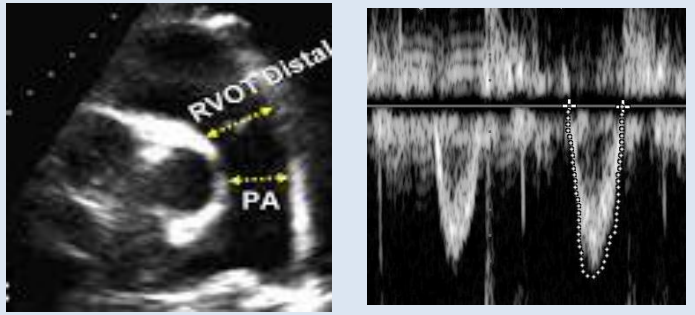
3D RVEF



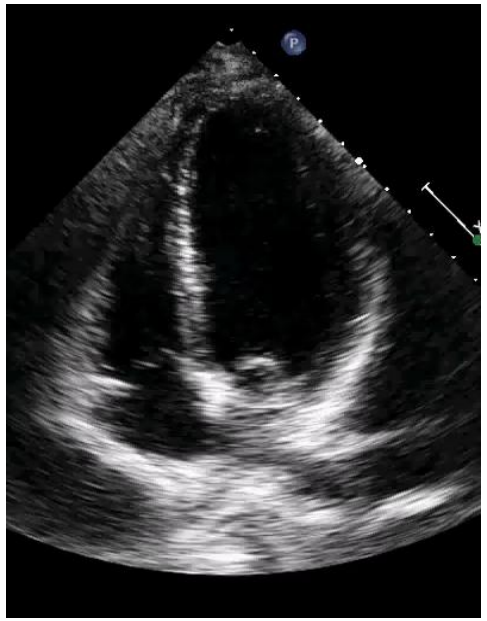
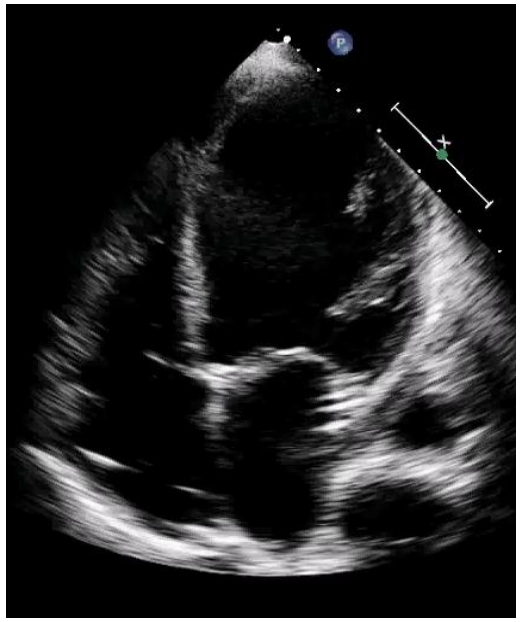
RV Strain



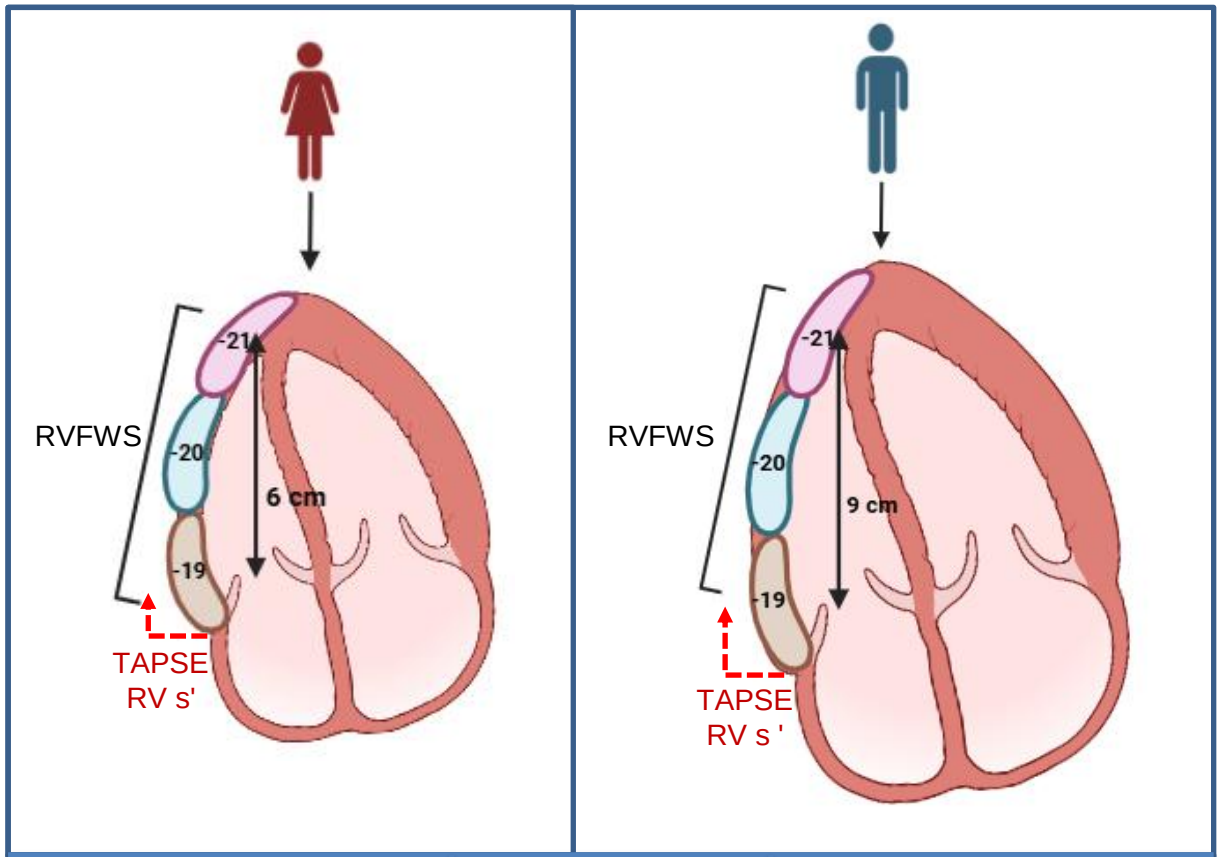
Stroke Volume



RV Function by Echocardiography: Expect Discongruence

	Normal	RV dysfunction	RV enlargement Normal function	RV enlargement & dysfunction
				
RVEF or FAC	normal	↓↓	↓↓	↓↓↓↓
Stroke volume	normal	↓↓	normal	↓
Strain or S’	normal	↓↓	normal	↓

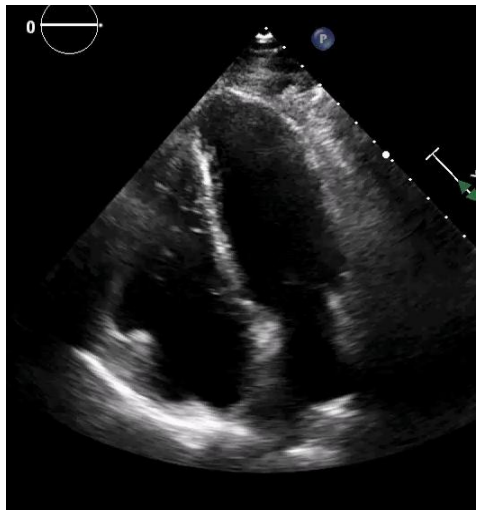
Congruency in RV Deformation vs Displacement

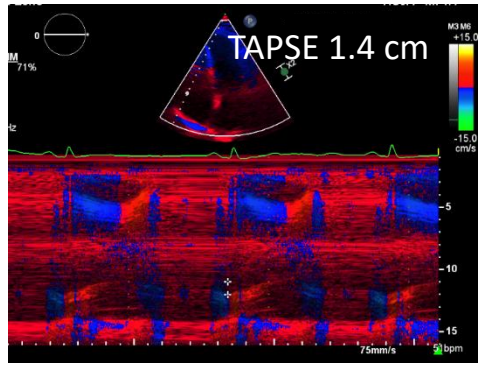


-20.0	**RVFWS**	-20.0
1.2 cm	**TAPSE**	1.8 cm
0.20	**TAPSE/RV length**	0.20
8 cm/s	**RV S'**	12 cm/s
1.3 s^{-1}	**RV S'/RV length**	1.3 s^{-1}

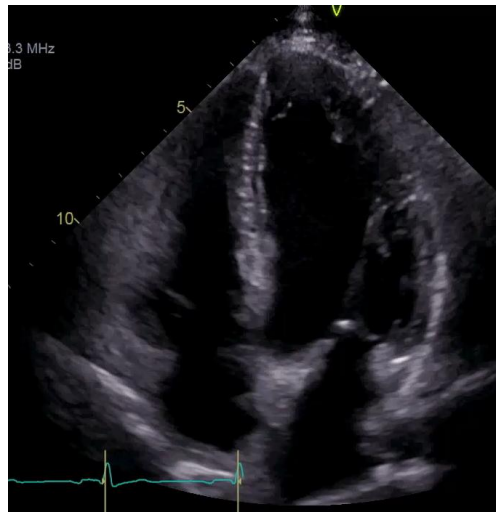
Huang J, et al. Am Soc Echocardiogr 2025 (in press)

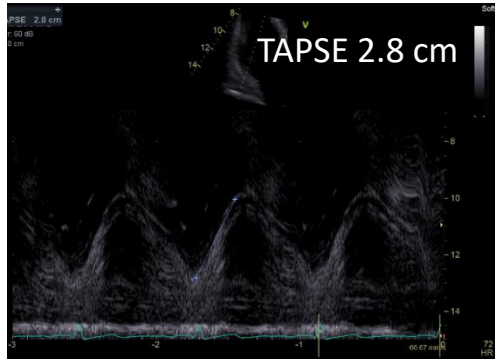
74 y.o. Female





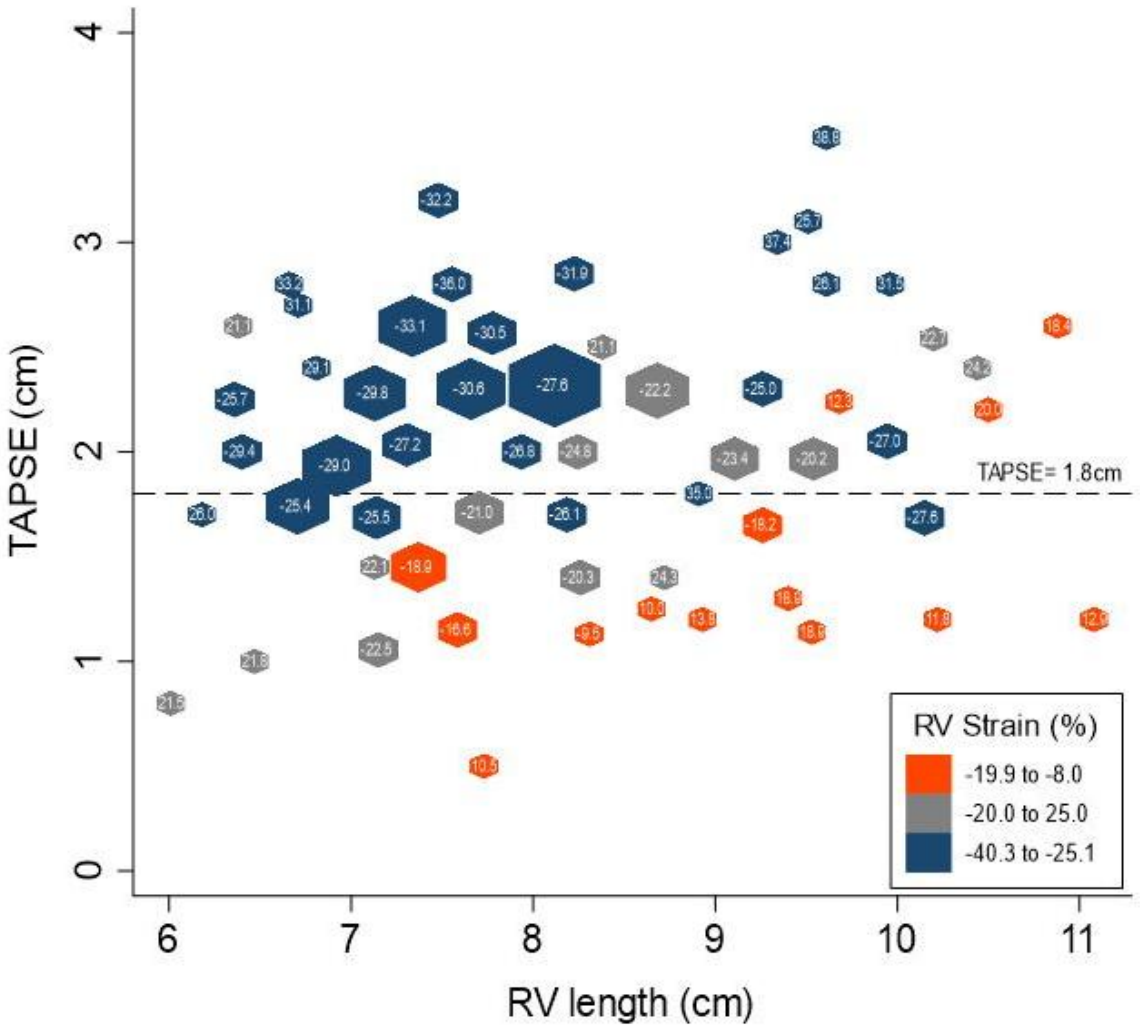
72 y.o. Male

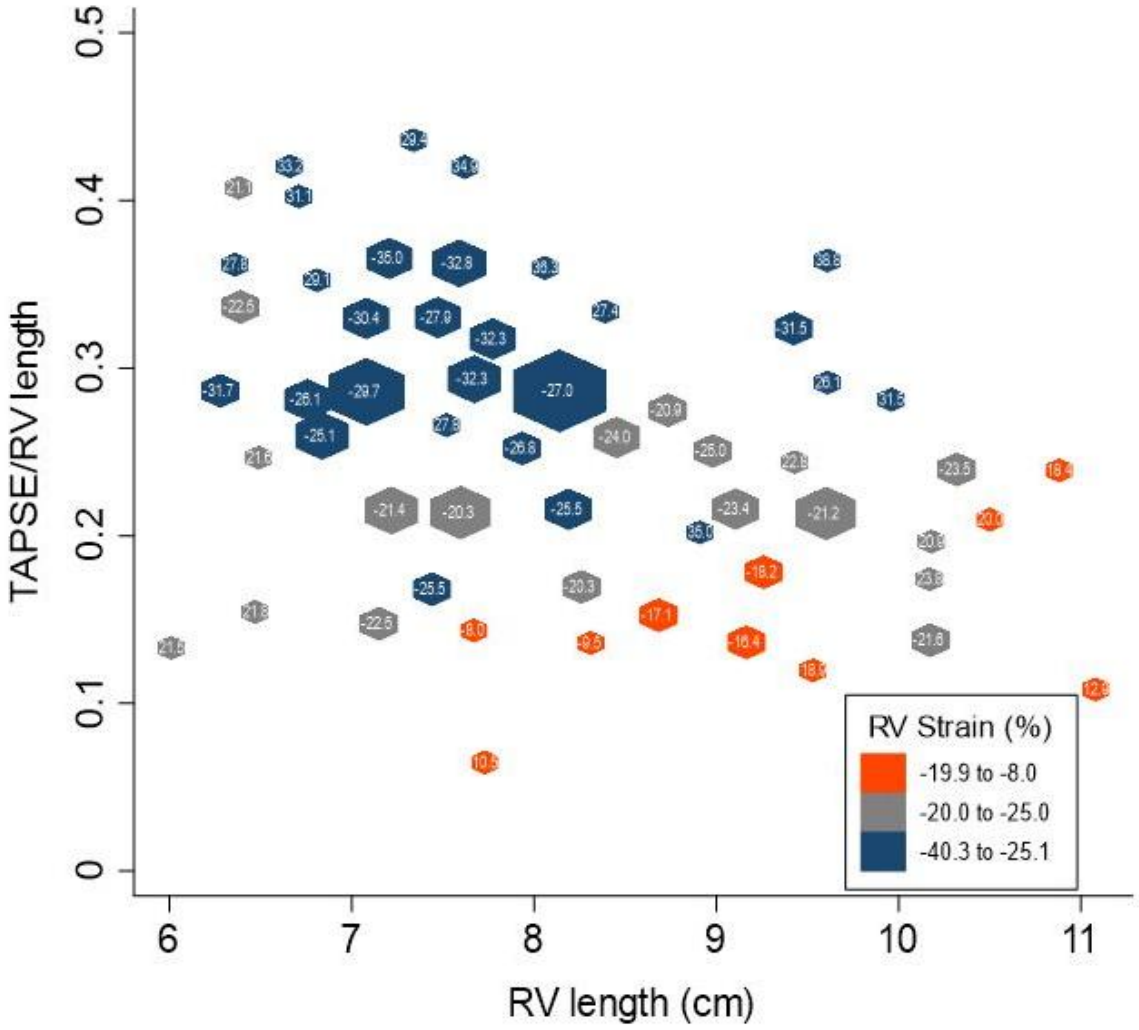




RV Free Wall Strain = 25%

Impact of Normalizing TAPSE and S' to RV Length





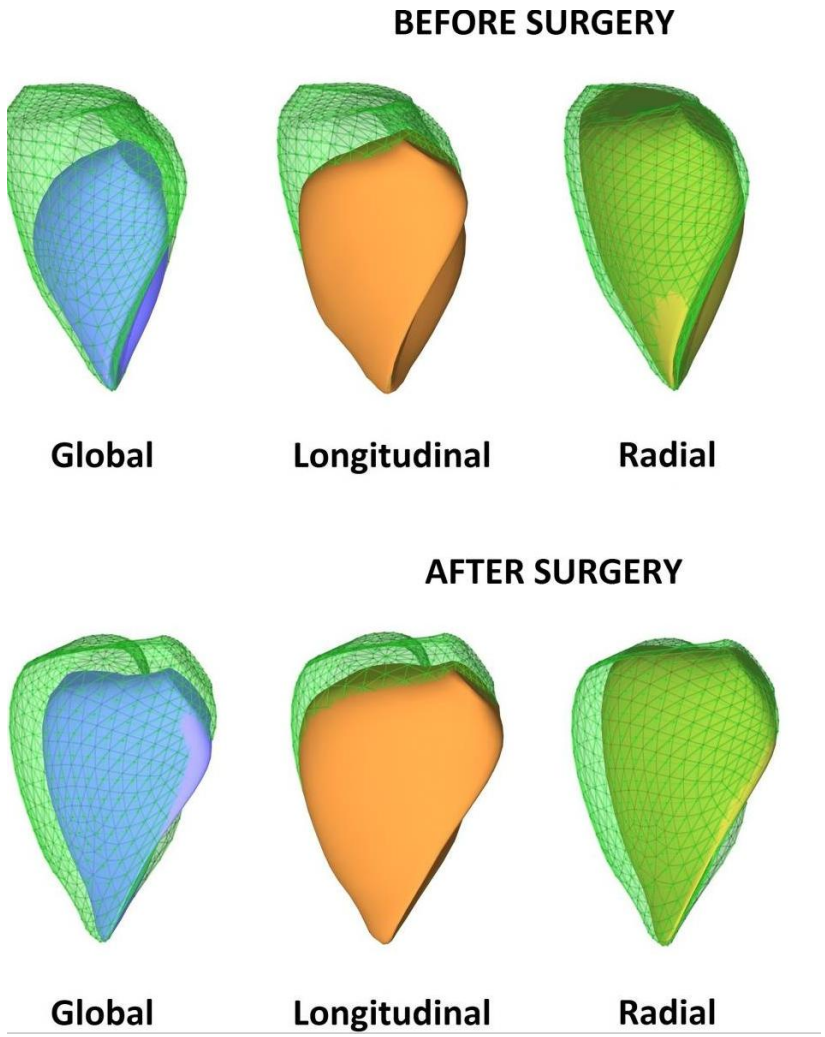
Huang J, et al. Am Soc Echocardiogr 2025 (in press)

Problems with Longitudinal Assessment Post-pericardiotomy

Table 3
Results of Conventional and 3D Echocardiography

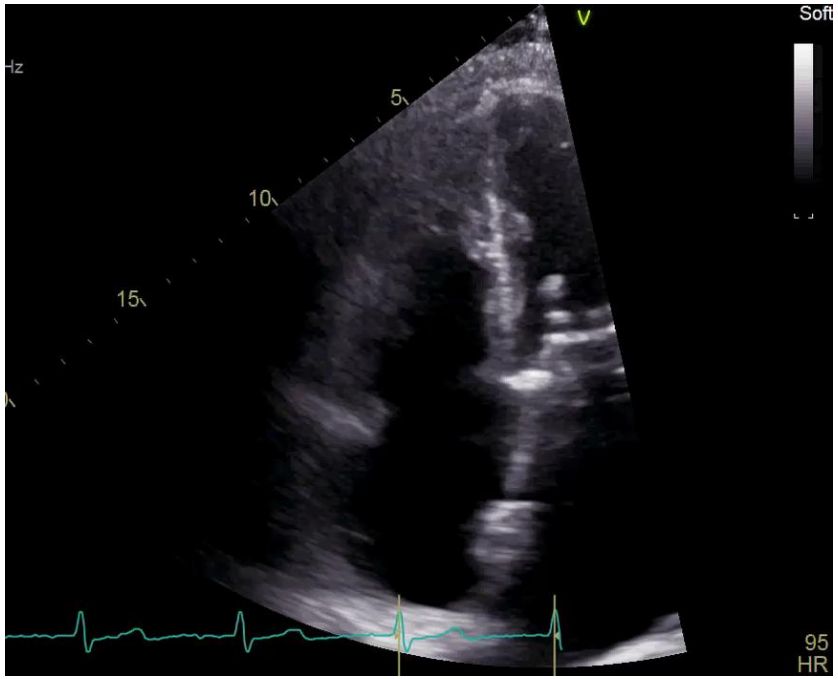
	TTE		
	In the Week Before Surgery	4 to 5 Days After Surgery	p Value
Right ventricular systolic function			
TAPSE (mm)	25 ± 3	12 ± 2	<0.001*
RV S' (mm/s^1)	13 ± 3	8 ± 3	<0.001*
RIMP	0.48 ± 0.14	0.48 ± 0.15	0.81
IVA (m/s^2)	4.0 ± 0.5	4.1 ± 0.4	0.38
RV EDD basal (mm)	37 ± 4	39 ± 6	0.052
RV EDD midcavity (mm)	27 ± 4	29 ± 5	0.086
RV FS (%)	29 ± 11	42 ± 9	<0.001*
RV FAC (%)	45 ± 3	50 ± 5	<0.001*
Right ventricular 3-dimensional analysis			
RV EDV (ml)	136 ± 17	139 ± 21	0.31
RV ESV (ml)	73 ± 12	75 ± 12	0.27
RV stroke volume (mL)	62 ± 9	64 ± 11	0.50
RV EF (%)	46 ± 3	45 ± 3	0.58
Left ventricular systolic function			
LVEF	61 ± 3	61 ± 3	0.56
Left ventricular diastolic function			
LV E/E' ratio	10 ± 2	12 ± 4	0.008*
Left ventricular eccentricity index			
LVEI ES	1.01 ± 0.12	1.01 ± 0.12	0.98
LVEI ED	1.07 ± 0.10	1.05 ± 0.12	0.31

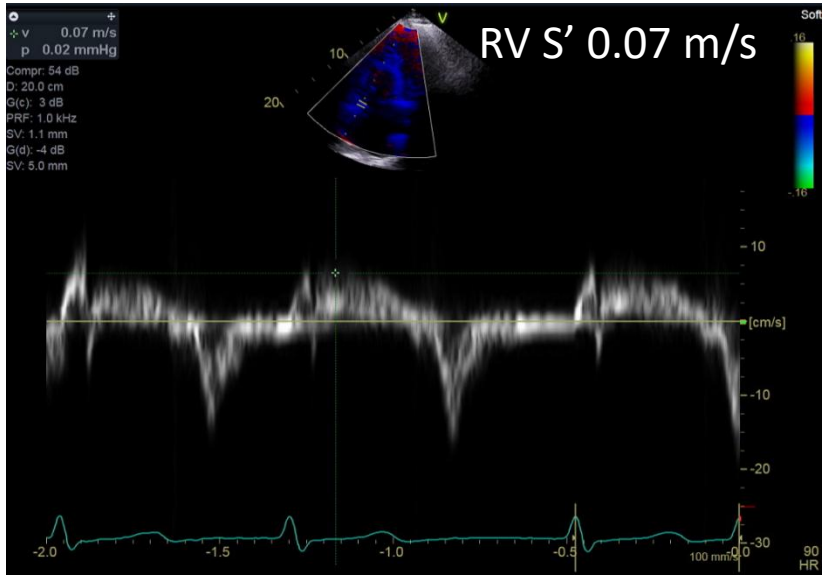
Donauer M, et al., JCVA 2020;34:708

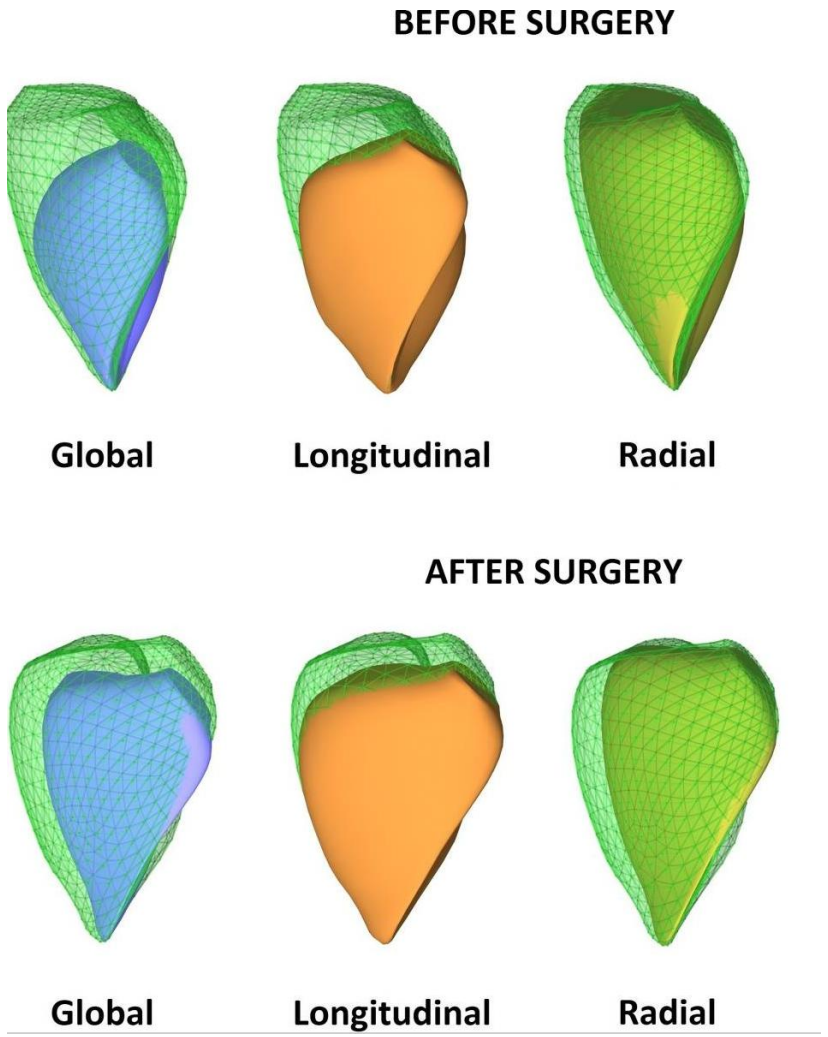


Kovacs A, et al., Heart Fail Rev 2019;24:511

Problems with Longitudinal Assessment Post-pericardiotomy

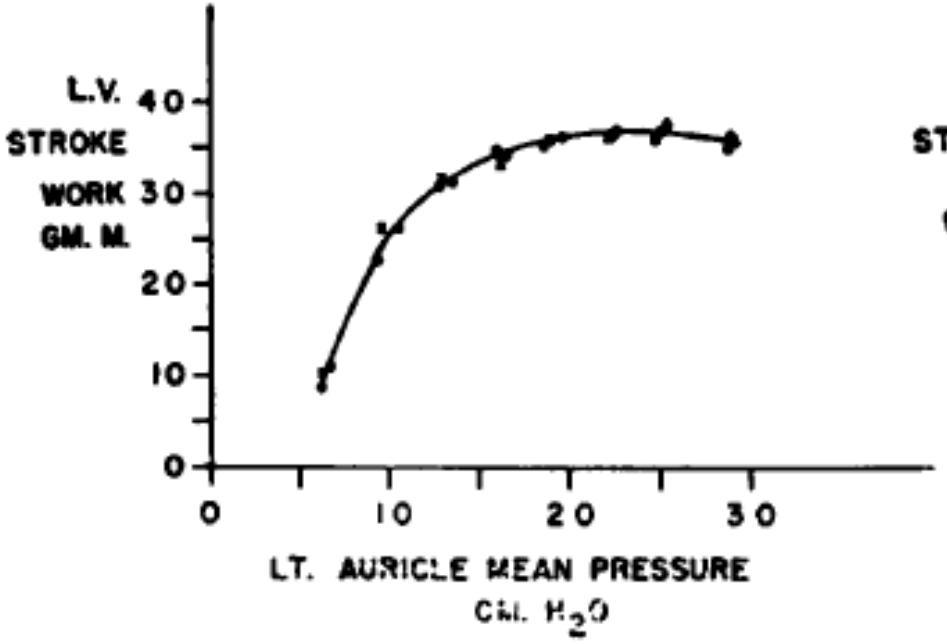


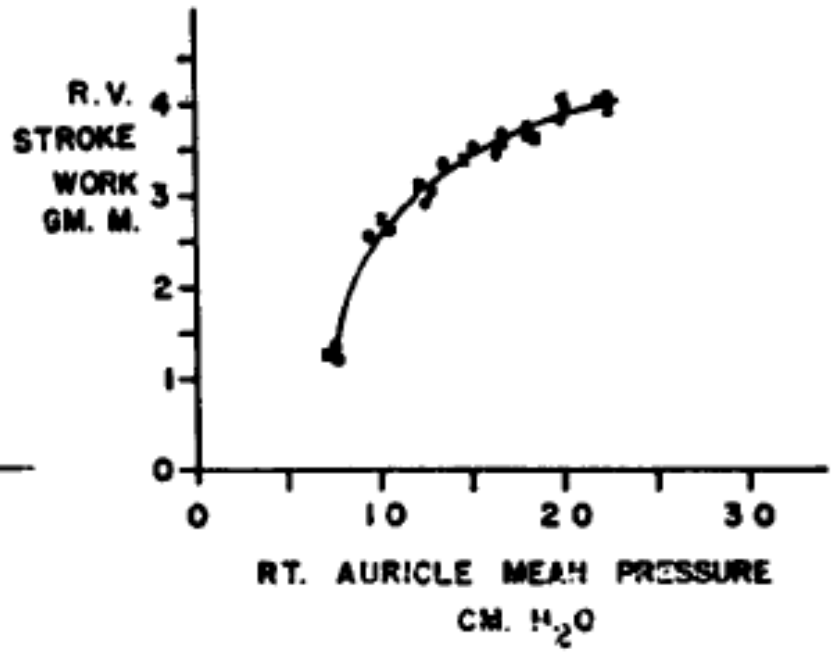




Kovacs A, et al., Heart Fail Rev 2019;24:511

RV Function and Preload (Frank-Starling goes Dextro)

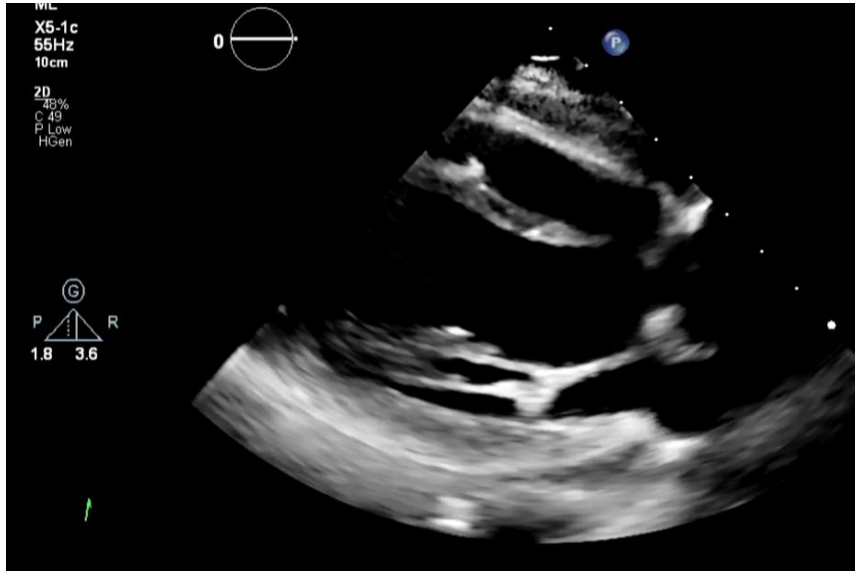


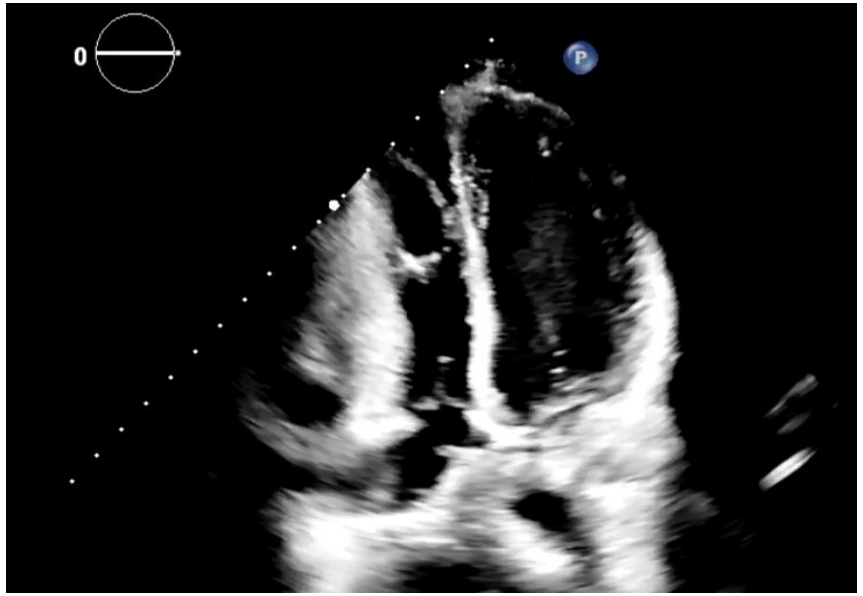


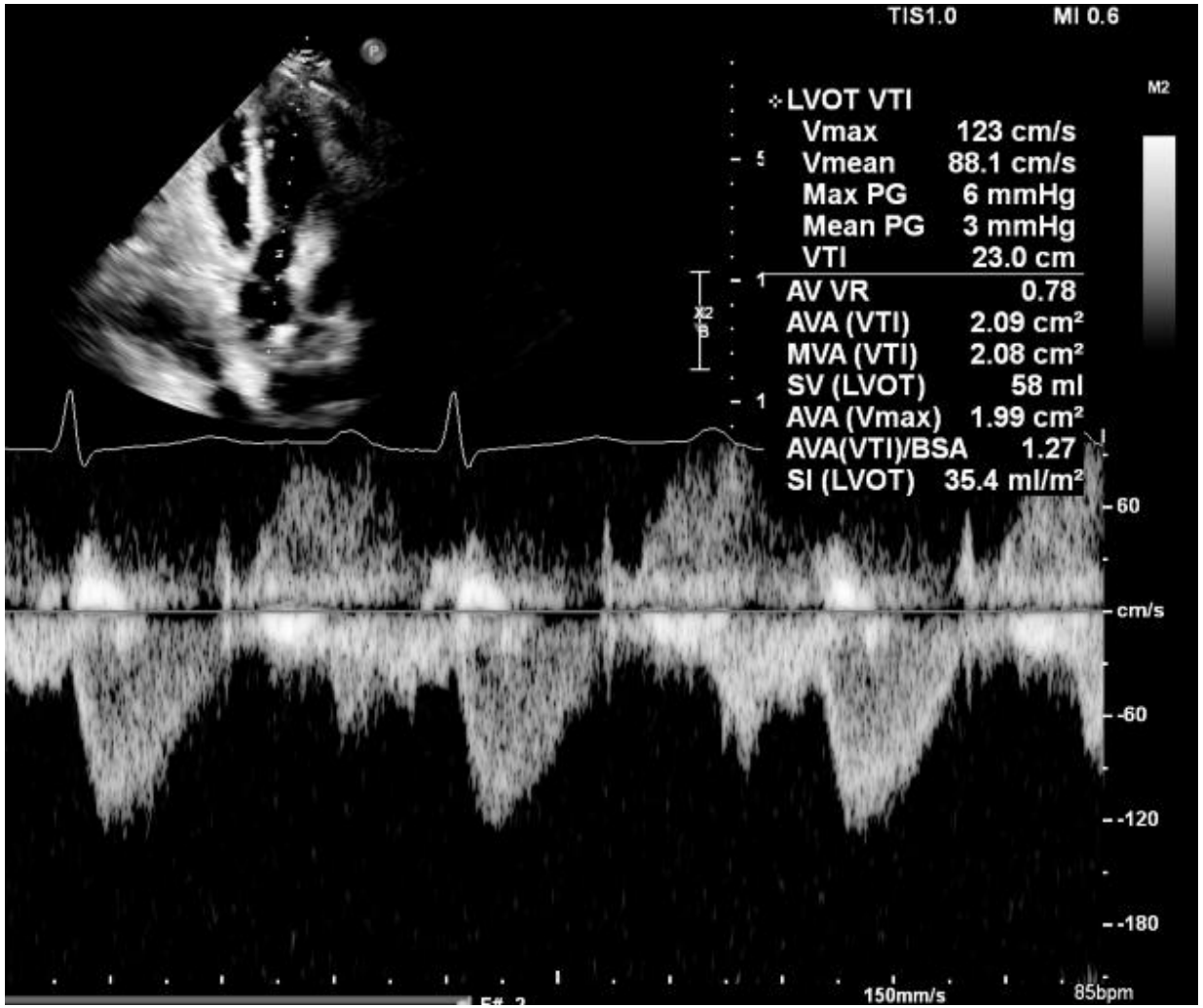
Sarnoff SA, et al., Circulation 1954;9:706

- Intravascular volume status
- Tricuspid stenosis
- Tamponade physiology
- Tachycardia
- PEEP
- Others (keep vigilant)

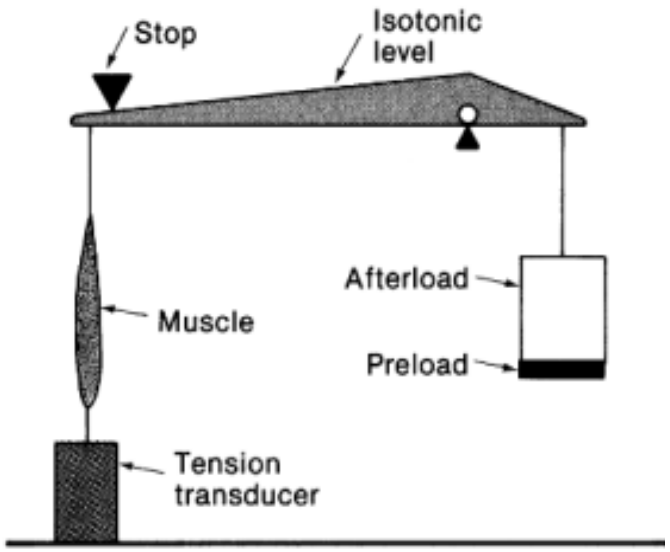
RV Preload Reduction from Pectus ECR

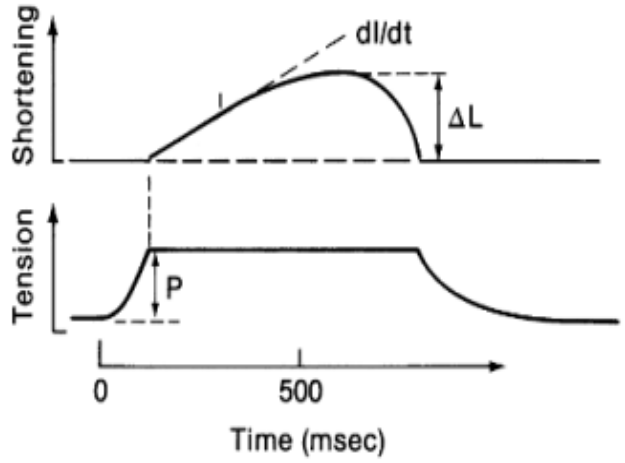


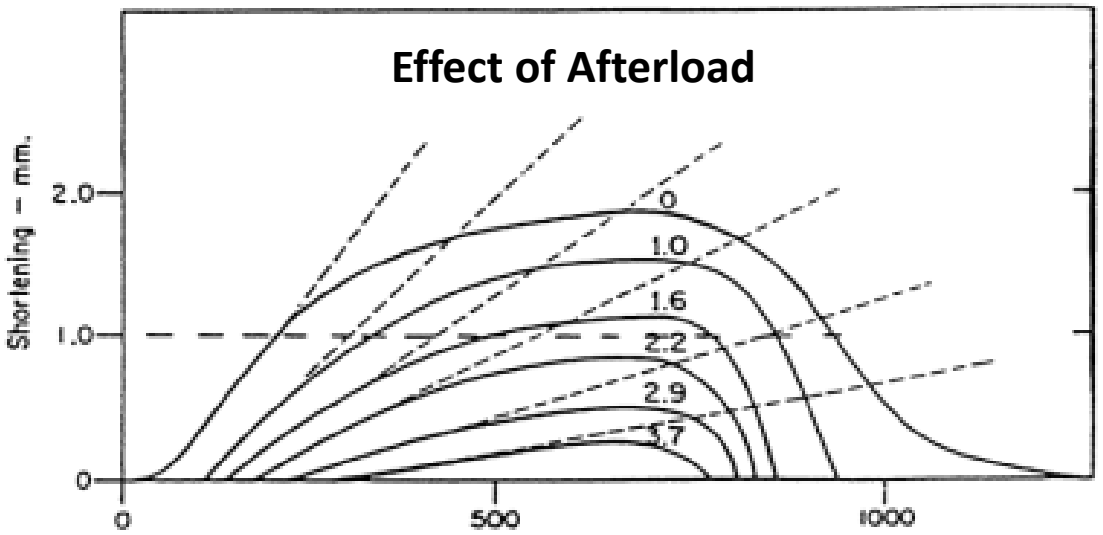


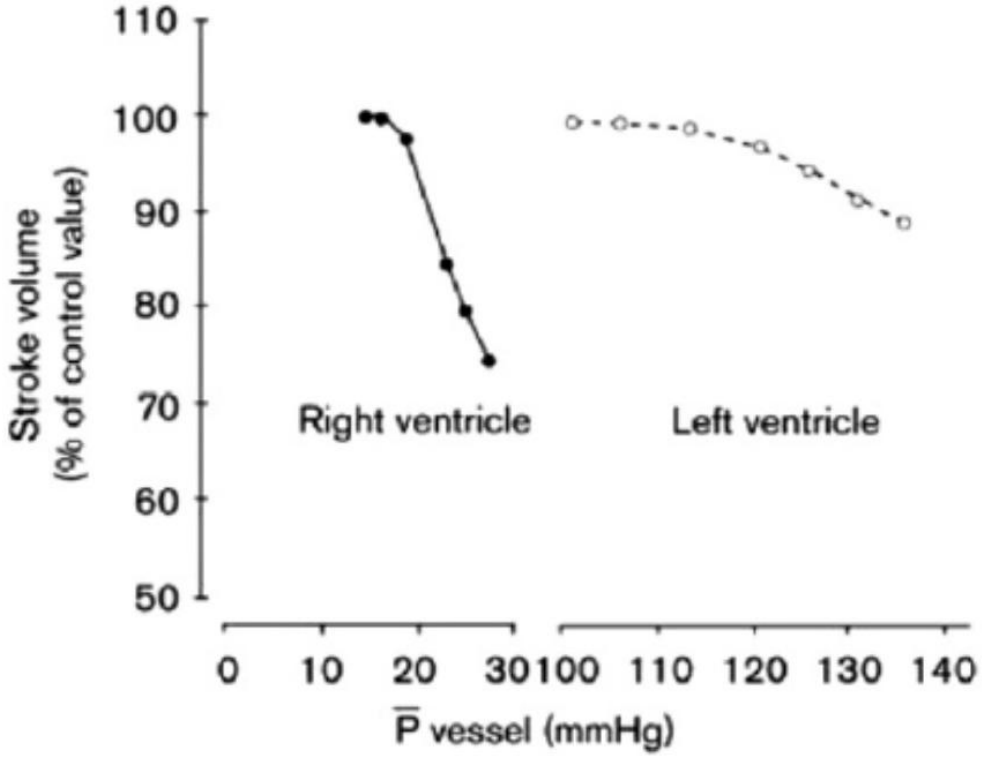


Afterload and Myocardial Dysfunction



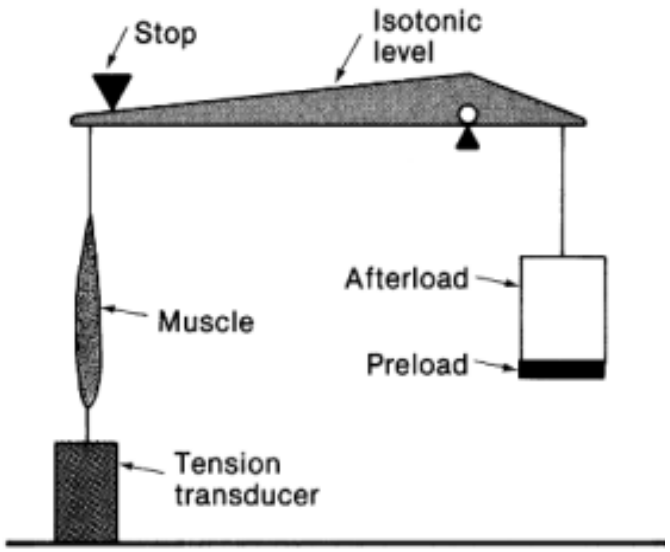


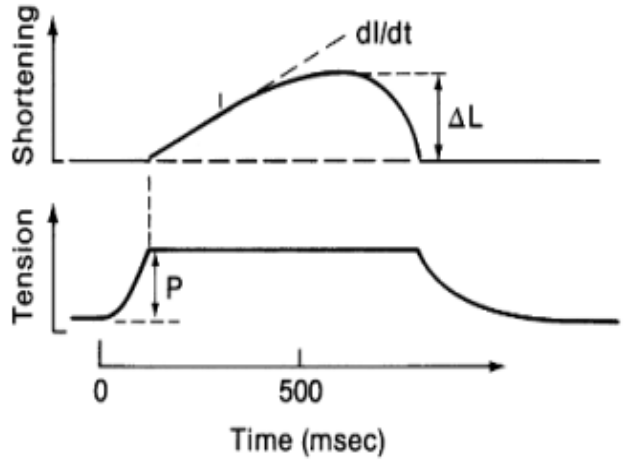


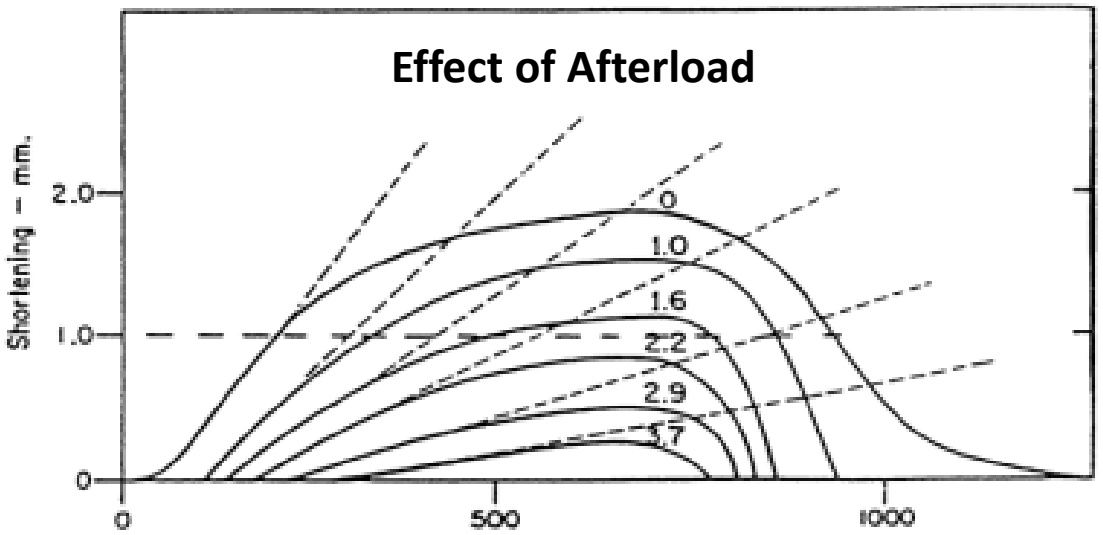


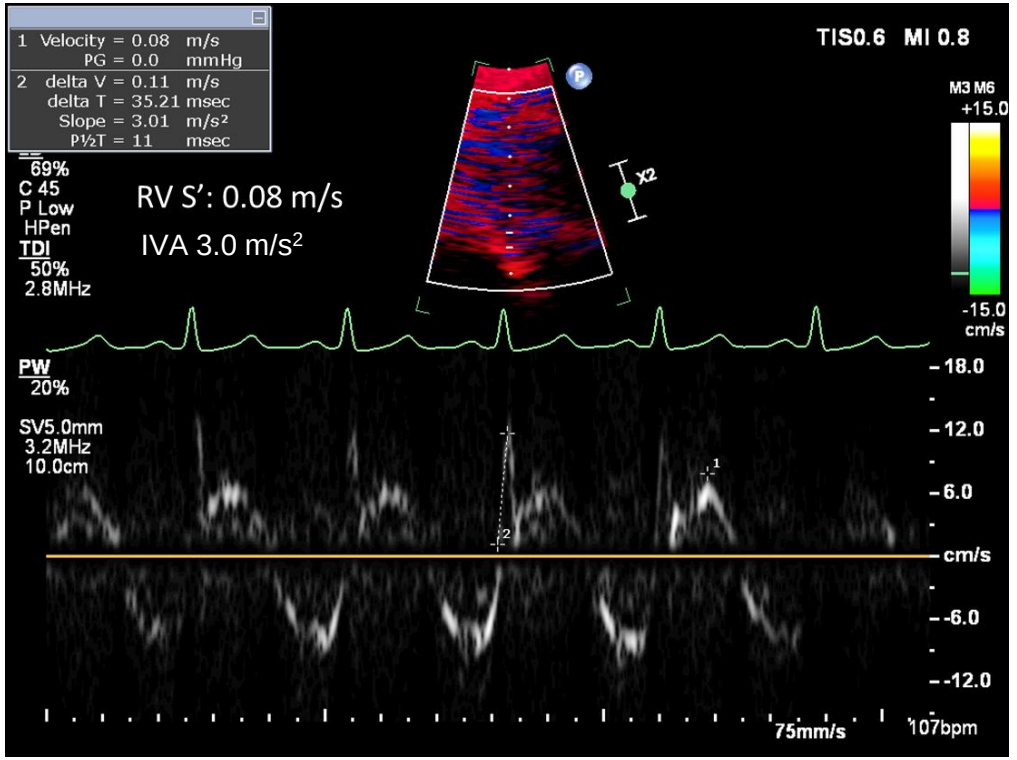
Sonnenblick EH, et al. Am J Physiol 1962;205:931

Afterload and Myocardial Dysfunction



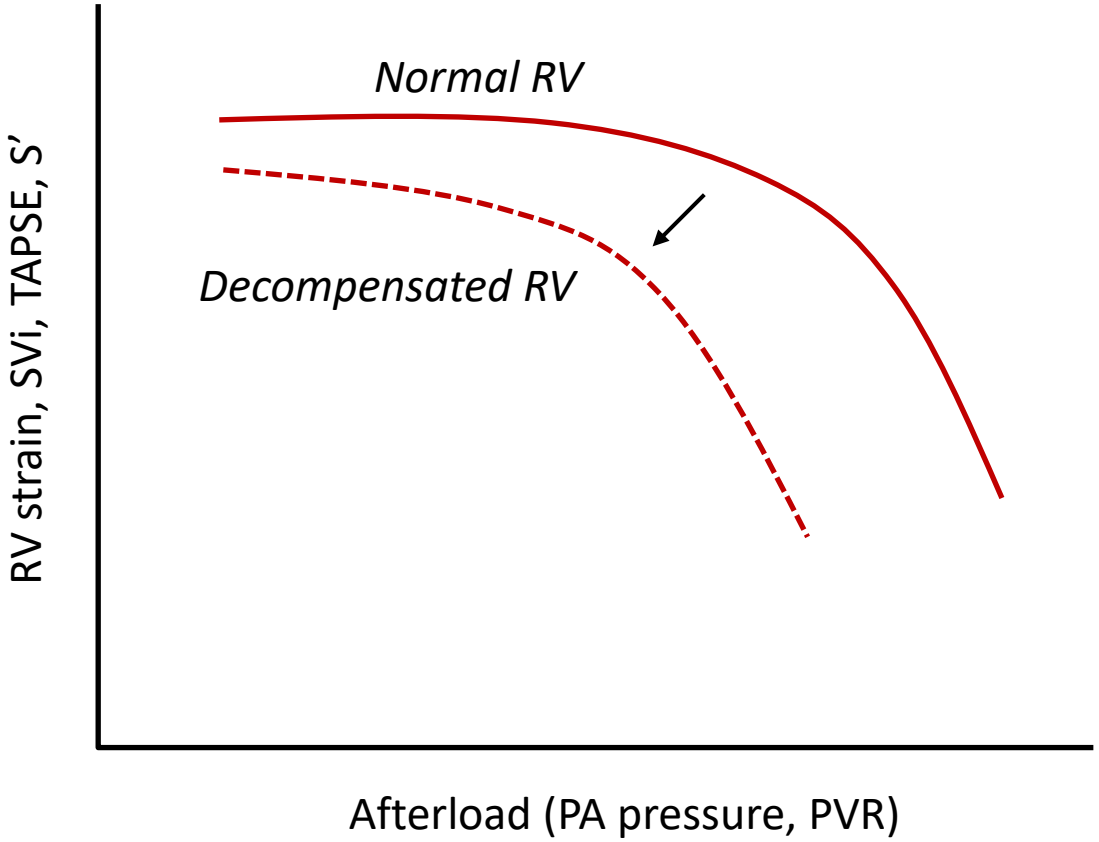




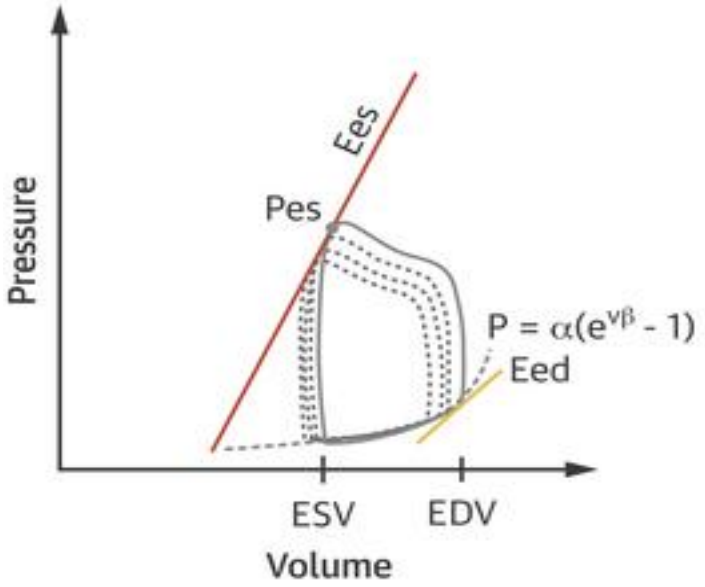


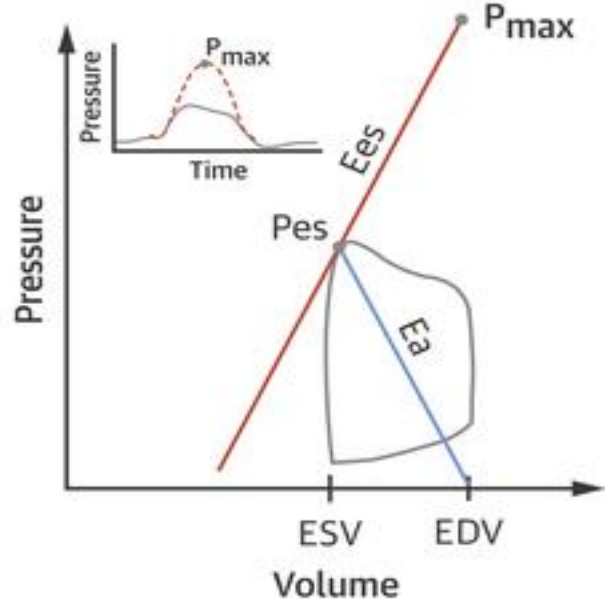
Sonnenblick EH, et al. Am J Physiol 1962;205:931

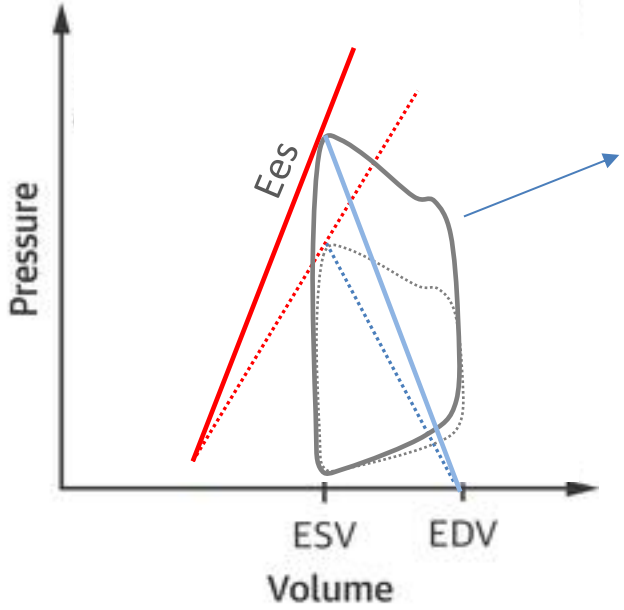
The Pressure Loaded RV



Sanz J, et al., JACC 2019;73:1463

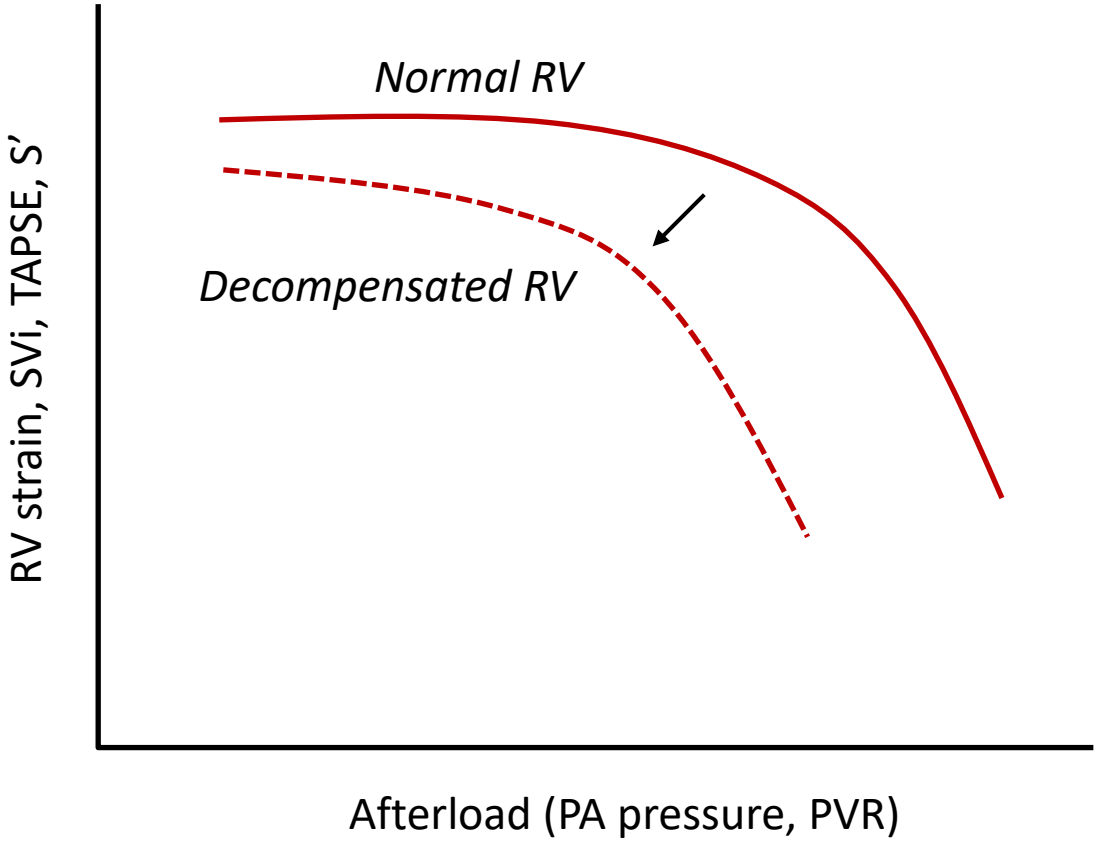


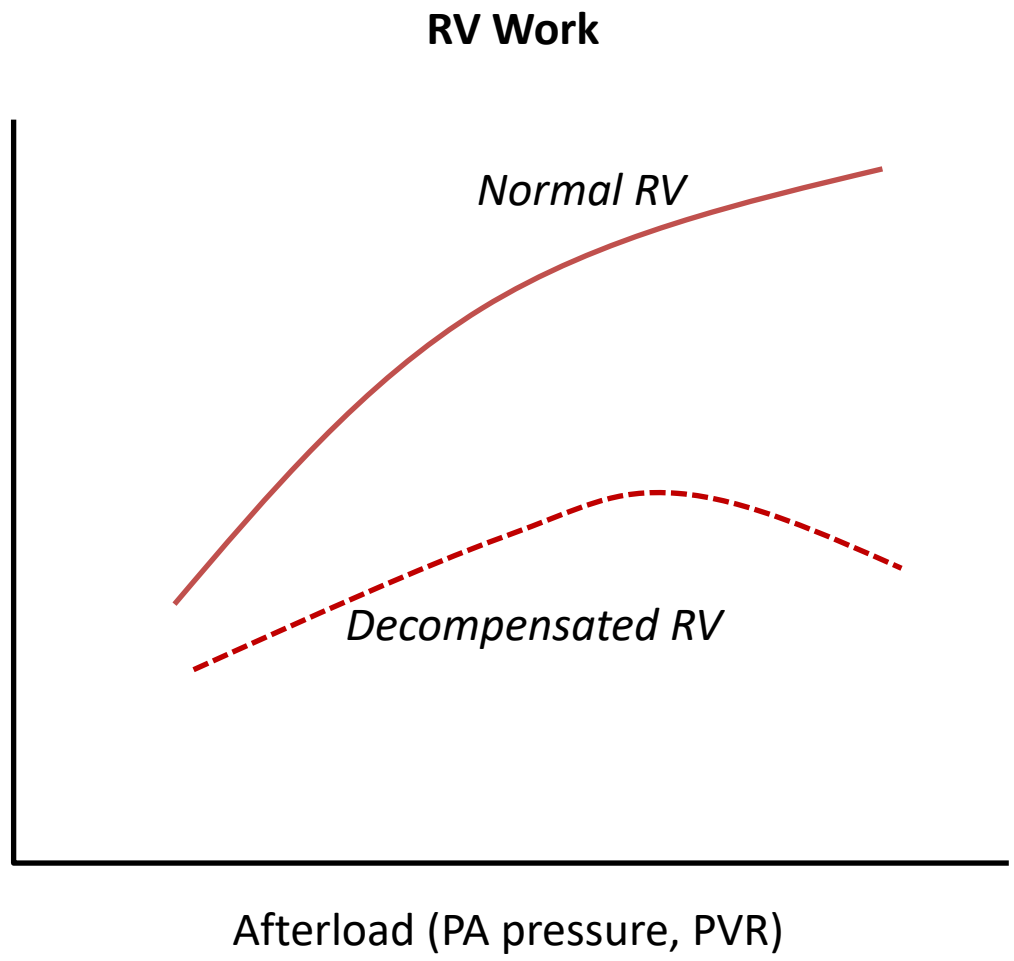




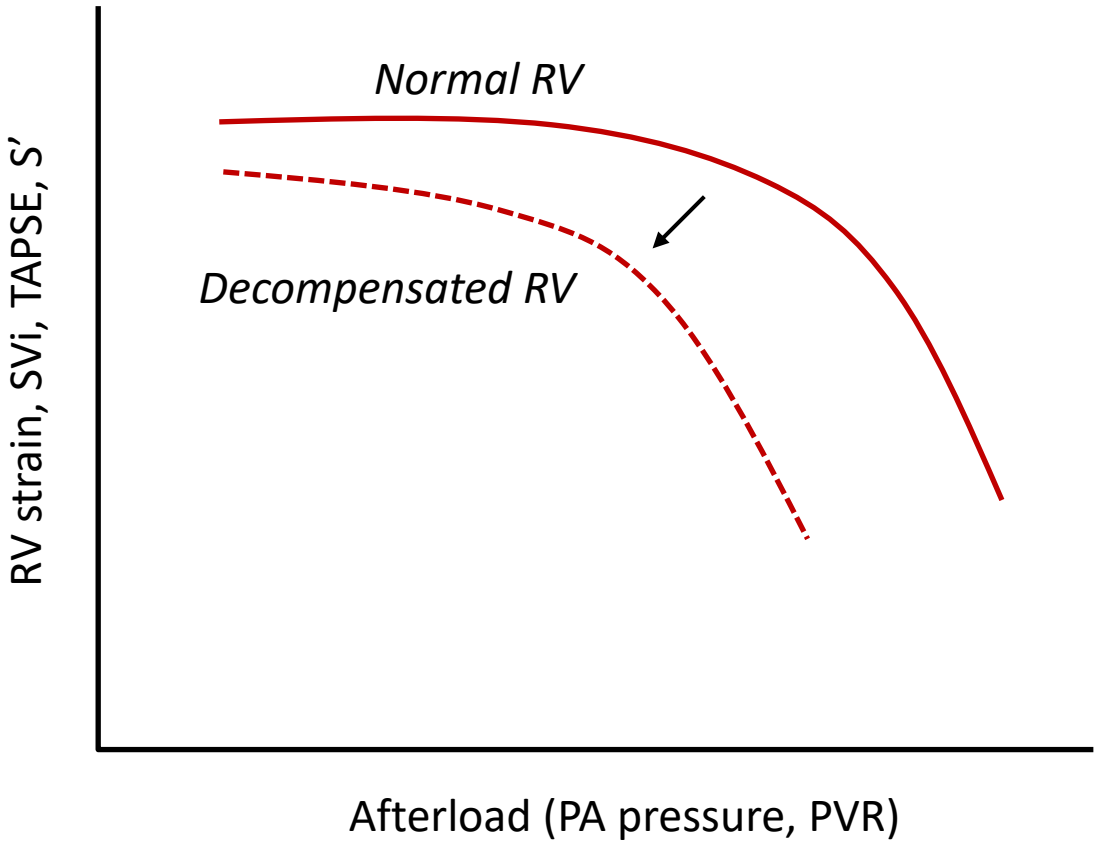
Coupling: Ees/Ea
Work = AUC

The Pressure Loaded RV

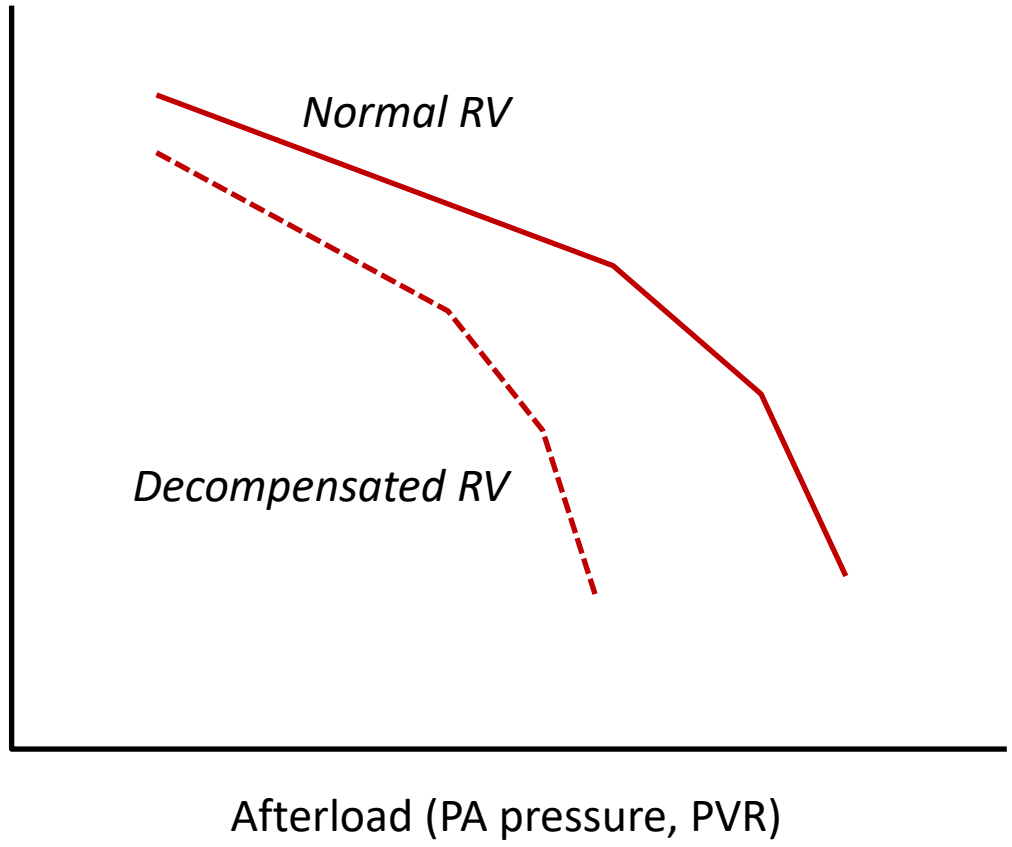




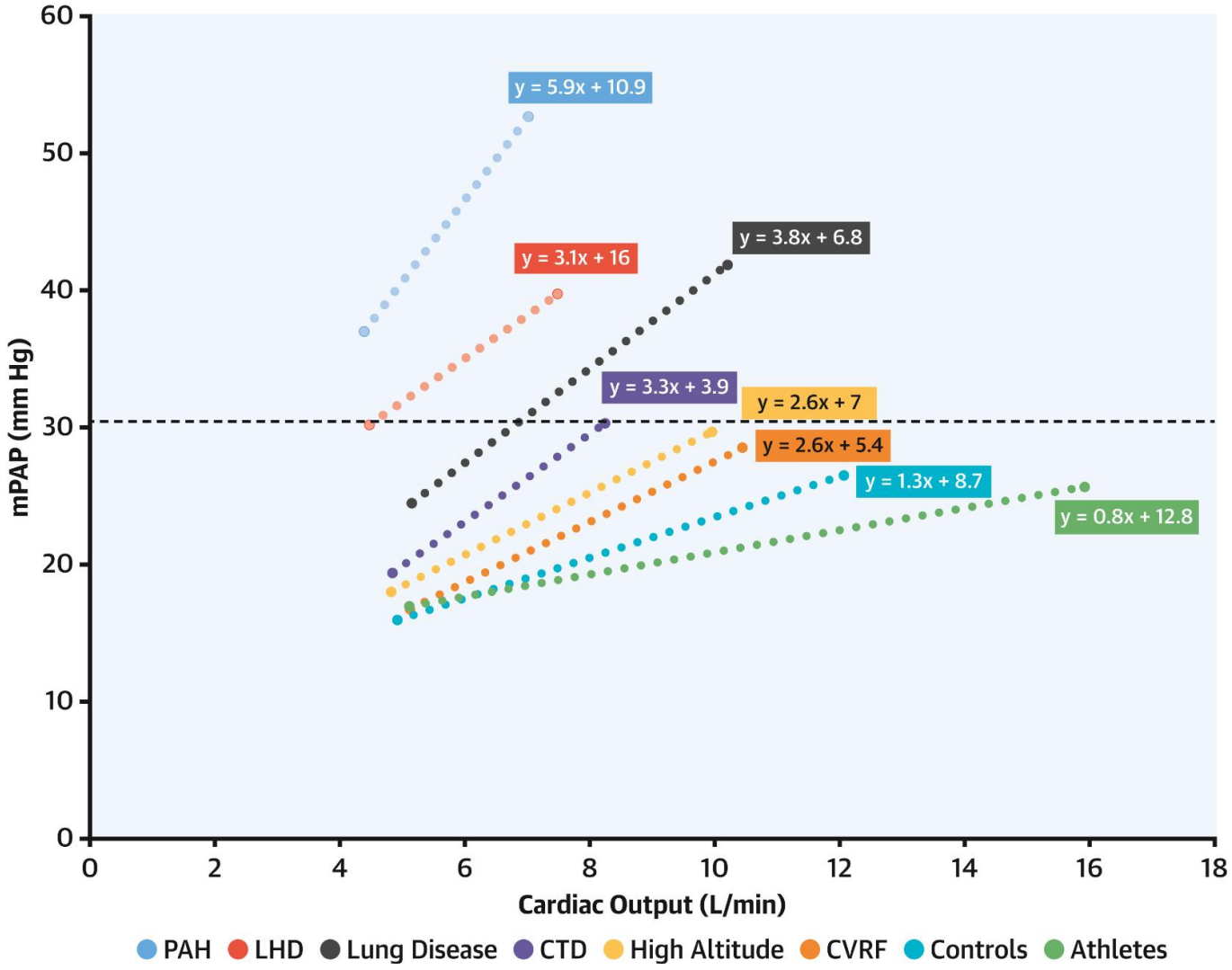
The Pressure Loaded RV



RV "coupling index" = TAPSE/PASP

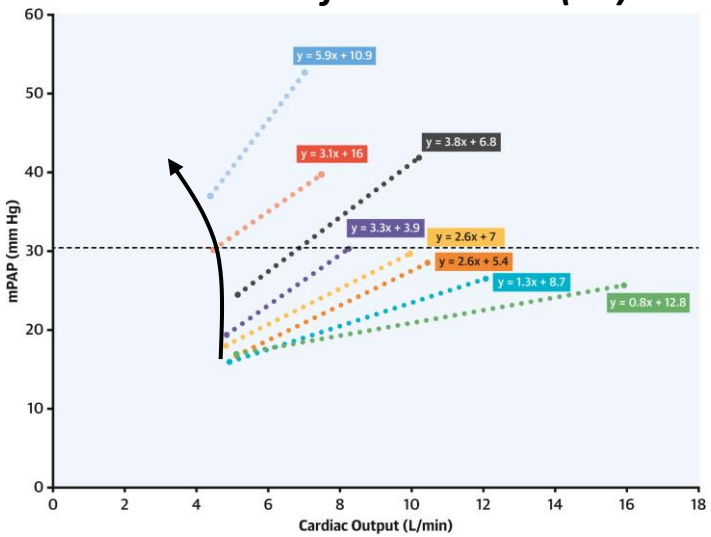


Stress Echo for Investigating RV Dysfunction

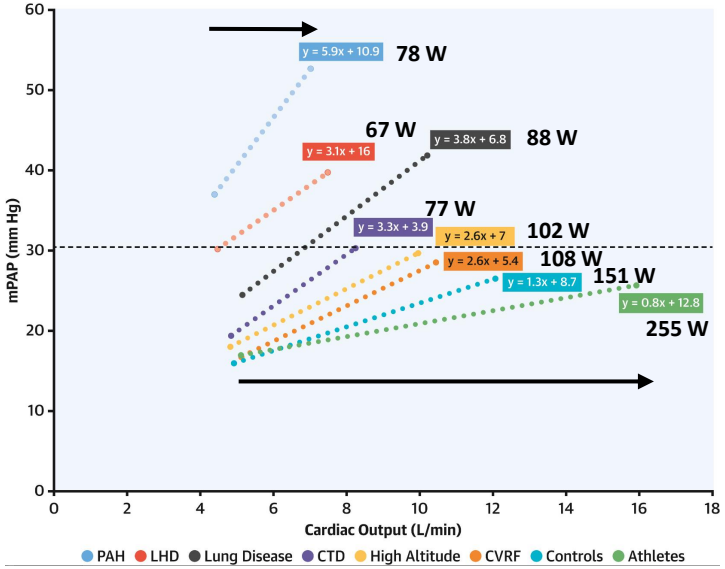


Gargani L, et al. JACC 2023;82:1973

Rest PASP influences C.O. (SV)

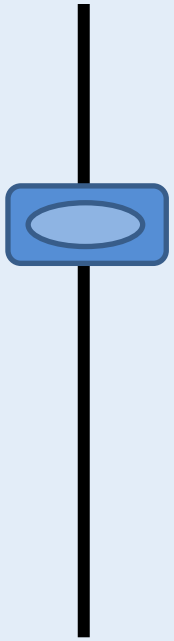


↑ Resistance, ↓ exercise and recruitable C.O.



Summary

Expert



Competent

Understands applications *and* limitations of new echo technology and the physiologic influences of function

Knowledge and reporting of new technologies (3D, strain)

Knowledge, reporting, and problem solving for standard RV measures