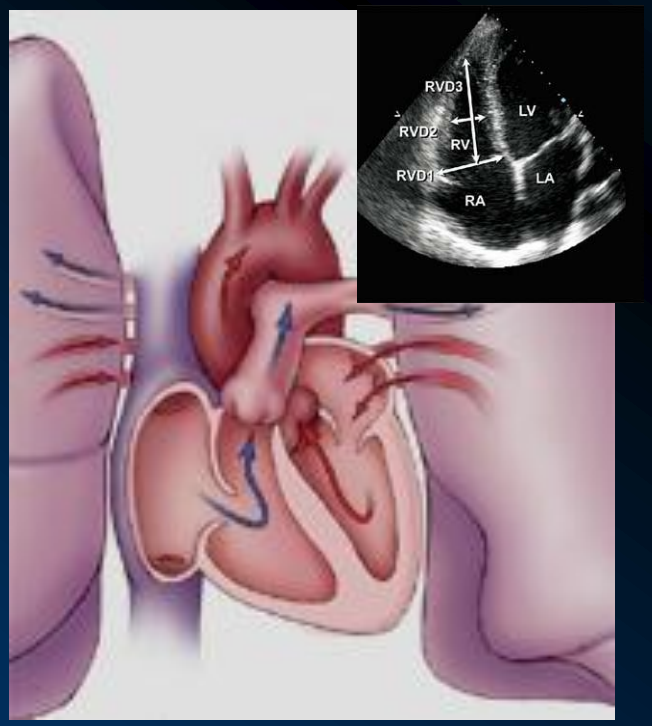
ANCE – ROMA 2015



Ventricolo destro e Circolo Polmonare: Come Studiarli?

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Echo and Pulmonary Hypertension

ARTICLE IN PRESS

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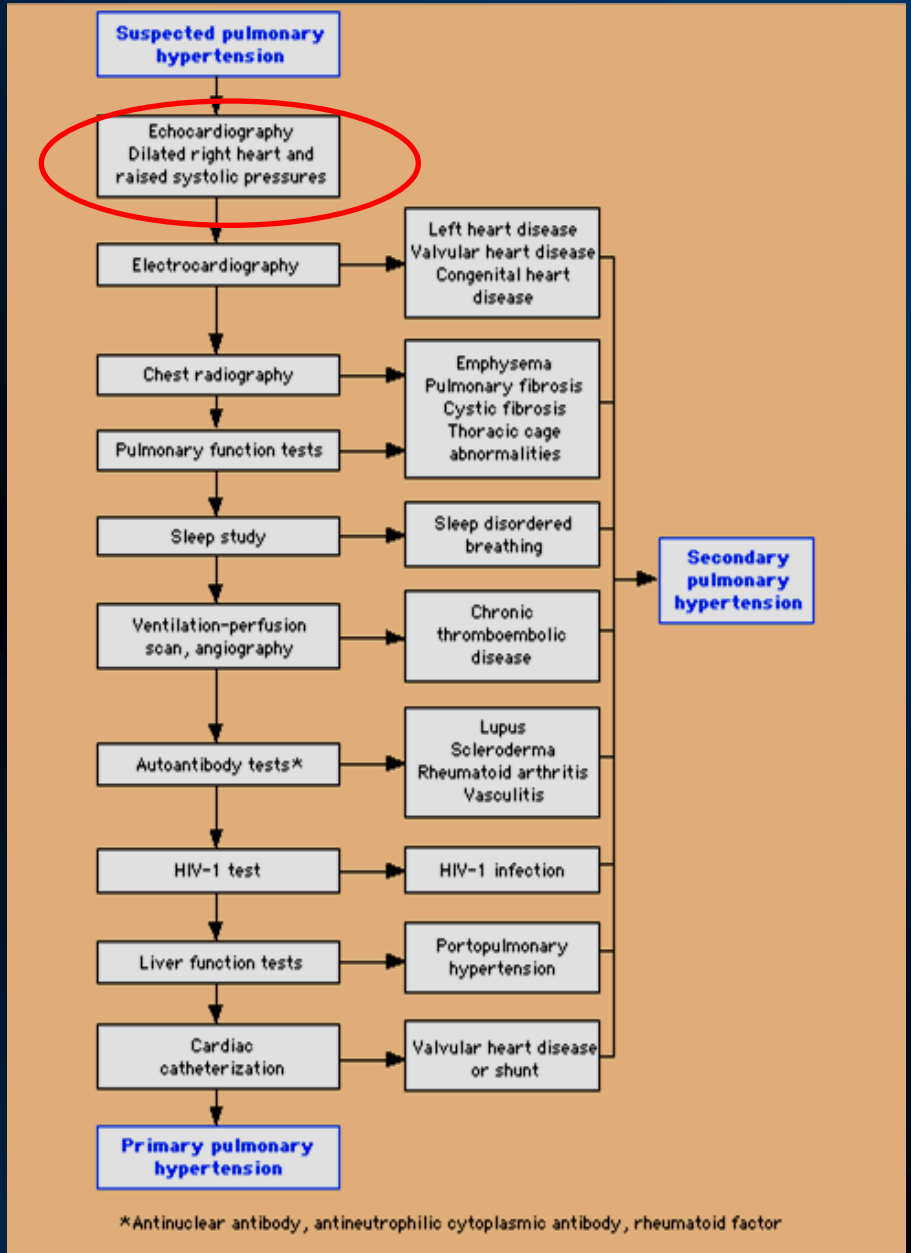
EXPERT CONSENSUS DOCUMENT

ACCF/AHA 2009 Expert Consensus Document on Pulmonary Hypertension

A Report of the American College of Cardiology Foundation Task Force on Expert Consensus Documents and the American Heart Association

Developed in Collaboration With the American College of Chest Physicians; American Thoracic Society, Inc.; and the Pulmonary Hypertension Association

" Echocardiography is a pivotal screening test in PH…."



SYMPOSIUM REVIEW ARTICLE

Cardiopulmonary Coupling in Chronic Obstructive Pulmonary Disease

The Role of Imaging

Farbod N. Rahaghi, MD, PhD, Edwin J.R. van Beek, MD, PhD,† and George R. Washko, MD**

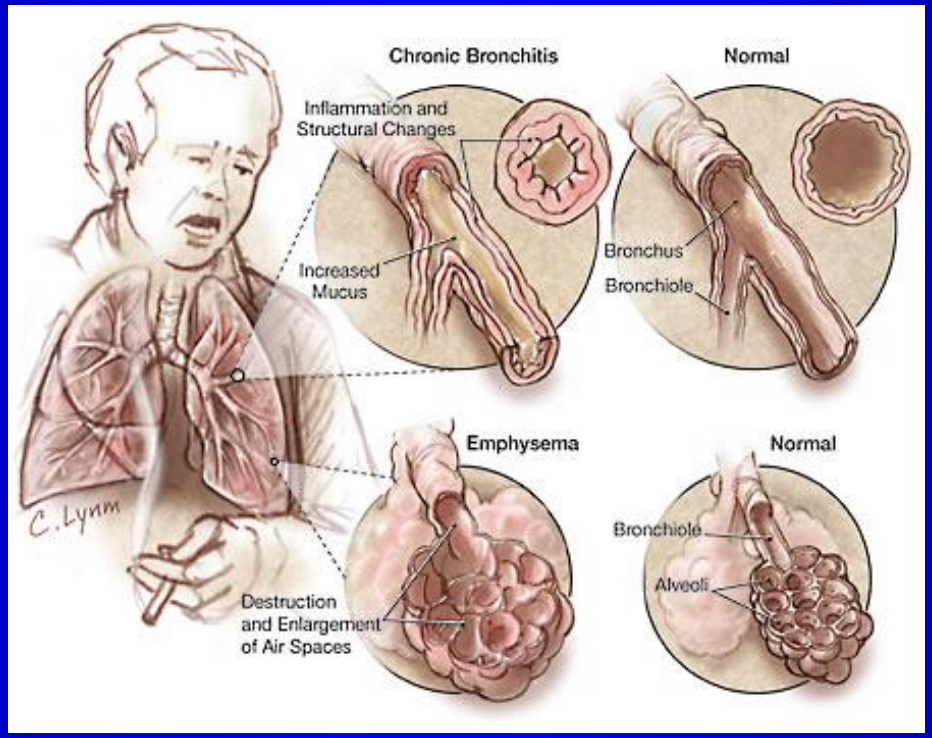


Table 3: Various approaches to the diagnosis of PH in COPD.

Modality	Advantages	Disadvantages
ECG	Noninvasive, cheap, and readily available. High specificity for RVH. ECG may reveal other findings such LAE, LVH, or old MI that suggests an alternative cause of PH	Absence of RVH does not rule out PH.
CXR	Non-invasive, cheap, and readily available. An ↑ in the diameter of the right descending pulmonary artery to >16 mm on the PA projection, combined with an ↑ in the diameter of the left descending pulmonary artery of >18 mm on the left lateral projection, has a high sensitivity of 98% for PH	Normal-sized pulmonary artery does not rule out PH.
BNP	Requires only a blood draw, is cheap and readily available.	↑ BNP also correlated with lower PaO_2 suggesting that BNP can also be released in response to hypoxia. More studies are needed.
eNO	Non-invasive.	Expensive, not widely available and has been tested in only one study.
ECHO	High NPV of sPAP or RV abnormalities (93% and 96%, resp.) makes it an excellent screening test. Moreover, it provides additional data for example, LVEF, LV filling pressures, valvular function.	Hyperinflation may preclude optimal visualization of the heart. Although the NPV is high enough to exclude PH, the presence of a high sPAP or RV abnormalities requires confirmation by RHC.
Chest CT	Non-invasive, widely available. High PPV of 95%-96% for PH. LAE could suggest left heart dysfunction.	Expensive. Radiation exposure. Normal sized pulmonary artery does not rule out PH.
Cardiac MRI	Non-invasive, does not involve ionizing radiation, and is not affected by hyperinflation.	Expensive, not widely available and in some cases claustrophobia can be a problem.
RHC	"Gold standard" Confirms diagnosis. Determines severity. Distinguishes occult LV dysfunction from hyperinflation when PAWP is ↑. Measures CO and allows calculation of PVR. Determines responsiveness to O_2.	Invasive. Interpretation of pressures may be difficult when there are large respiratory swings.

PH: pulmonary hypertension, EKG: electrocardiography, RVH: right ventricular hypertrophy, LAE: left atrial enlargement, LVH: left ventricular hypertrophy, MI: myocardial infarction, CXR: chest X-ray, BNP: brain natriuretic peptide, PaO_2: arterial oxygen tension, eNO: exhaled nitric oxide, NPV: negative predictive value, ECHO: echocardiography, sPAP: systolic pulmonary artery pressure, RV: right ventricular, LVEF: left ventricular ejection fraction, LV: left ventricular, RHC: right heart catheterization, CT: computerized axial tomography, PPV: positive predictive value, MRI: magnetic resonance imaging, CO: cardiac output, PVR: pulmonary vascular resistance, PAWP: pulmonary artery wedge pressure, RAP: right atrial pressure, O_2: oxygen.

Echo and Pulmonary Hypertension

The Different Clinical Scenarios

Classificazione Clinica Ipertensione Polmonare
3° Revisione 2008 – Dana Point

1. Ipertensione Arteriosa Polmonare

1.1 Idiopatica
1.2 Ereditaria (BMPR-II ; ALK-1; …)
1.3 indotta da farmaci e sost tossiche
1.4 associata a :
- malattie del connettivo
- infezione HIV
- ipertensione portale
- Cardiopatie congenite
- Schistosomiasi
- Anemia emolitica cronica

1.5 Ipertensione persistente neonato

Pre-capillare

1A. Mal veno-occlusiva polmonare e/o emangiomatosi capillare polmonare

2. IP secondaria a cardiopatie sin

2.2 Disfunzione sistolica/diastolica
2.3 Valvulopatie

Post-capillare

3. IP secondaria a pneumopatie/ipossiemia

3.1 BPCO
3.2 Interstiziopatie
3.3 Forme miste ostruttive/restrittive
3.4 Apnee notturne
3.5 Disordini da ipoventilazione alveolare
3.6 Esposizione cronica alte altitudini
3.7 Alterazioni dello sviluppo

Pre-capillare

4. IP cronica tromboembolica

Pre-capillare

5. IP legata a meccanismi non chiari e/o multifattoriali

5.1 Malattie Ematologiche: mal mieloproliferative croniche
5.2 Patologie sistemiche: sarcoidosi, istiocitosi, linfangioleiomiomatosi
5.3 Disordini metabolici: glicogenopatie
5.4 Altro: ostruz tumorali, fibrosi mediastinica

Pre-capillare

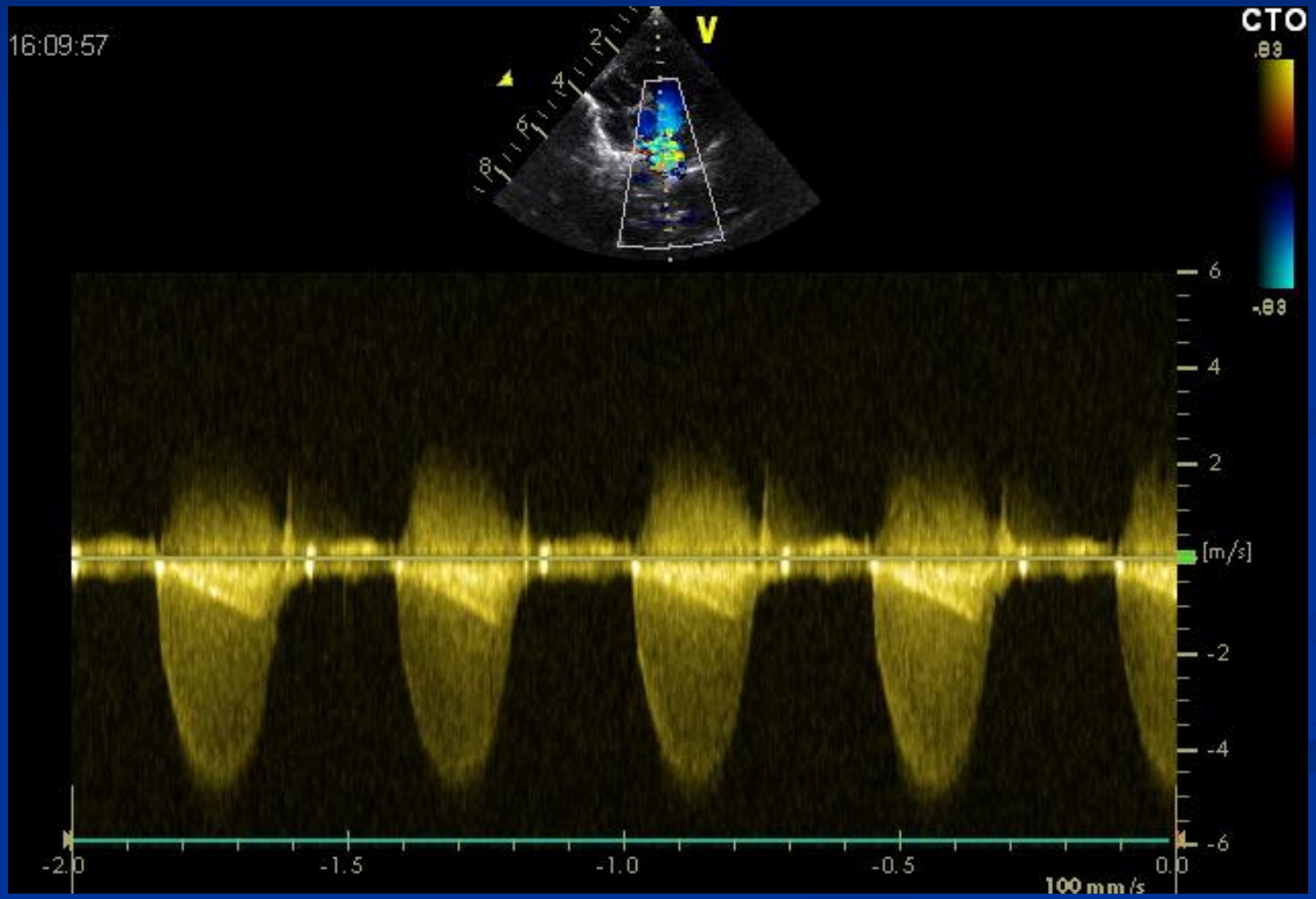
Ipertensione Polmonare

Sovraccarico di Volume e/o di Pressione

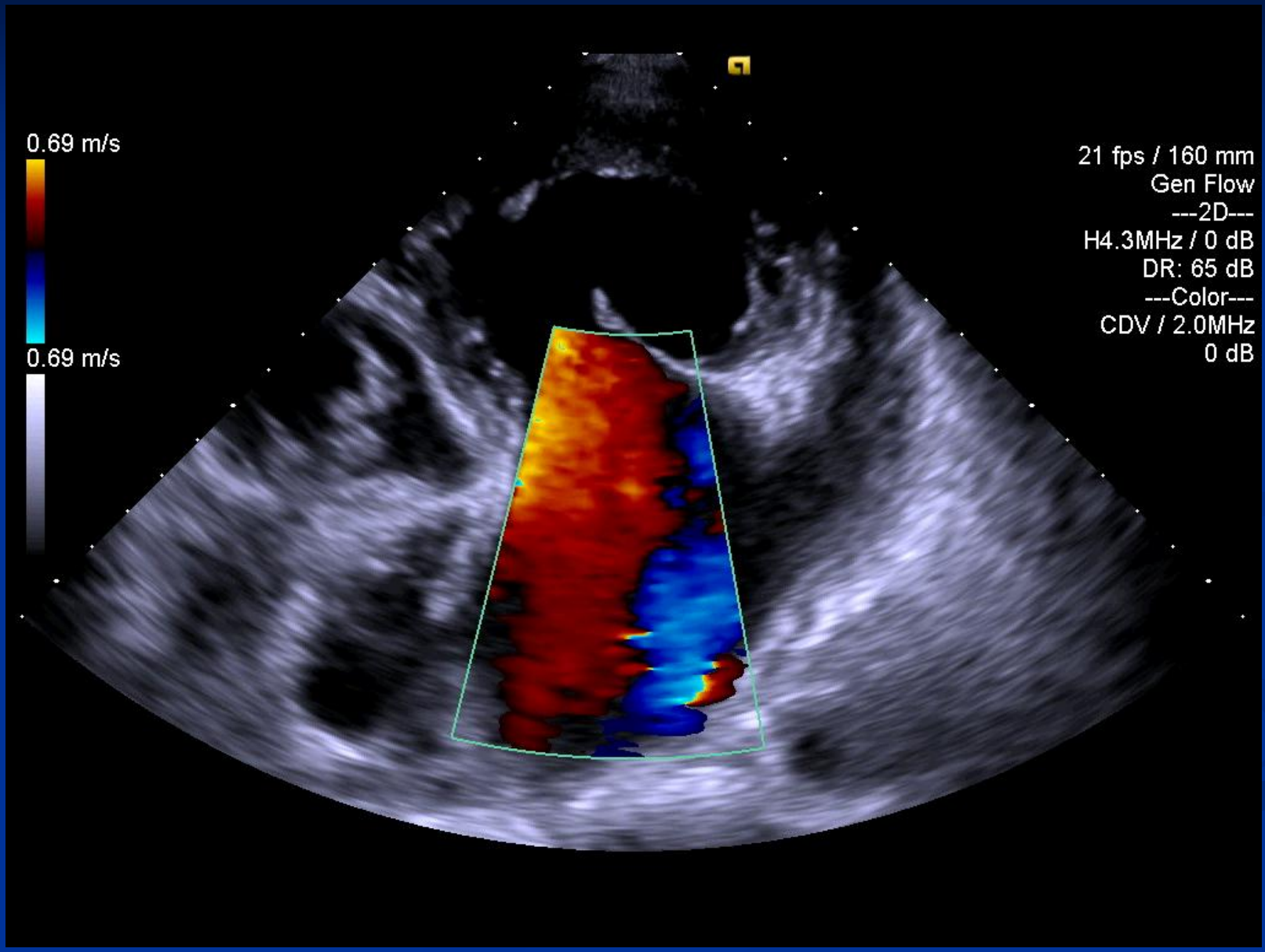
Volume and pressure overload

- Volume overload due to shunts, most often atrial or ventricular septal defects
- Pressure overload due to left atrial hypertension
  - Mitral stenosis and regurgitation
  - Left ventricular systolic and diastolic dysfunction
  - Constrictive pericarditis
- Pressure overload due to pulmonary venous obstruction
  - Pulmonary venoocclusive disease

VD: sovraccarico di Pressione congenito…!!



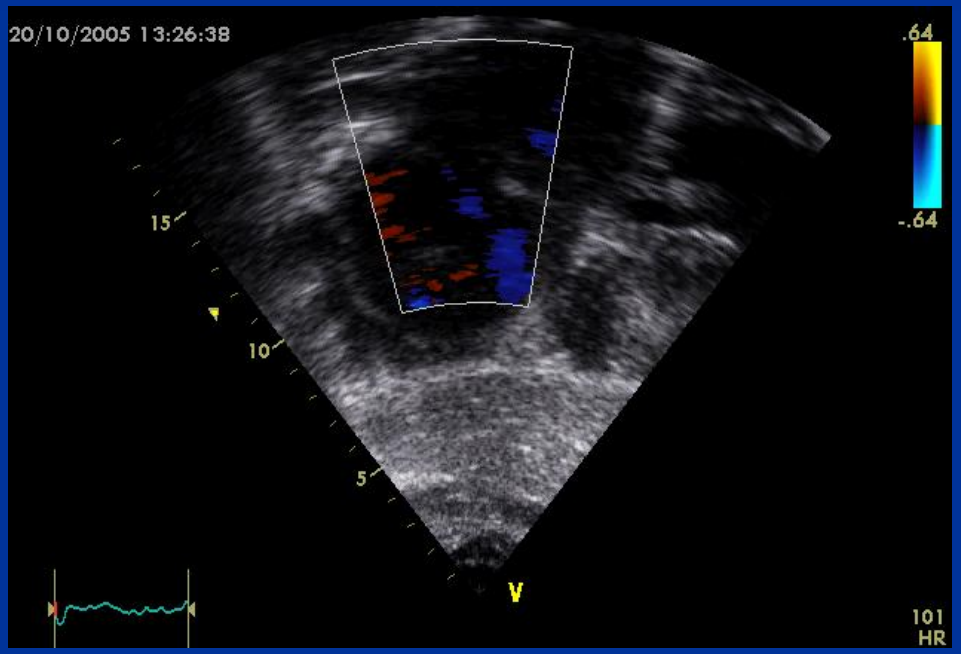
VD: sovraccarico di Pressione congenito…!!



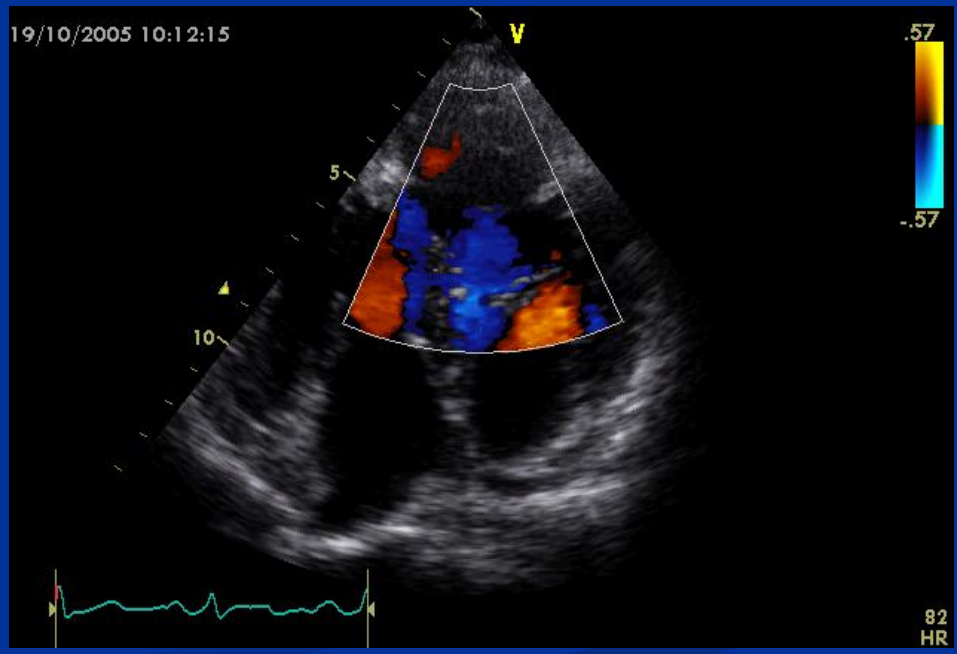
Cardiopatie Congenite

Shunts Intracardiaci

↑ Volume Ematico Polmonare



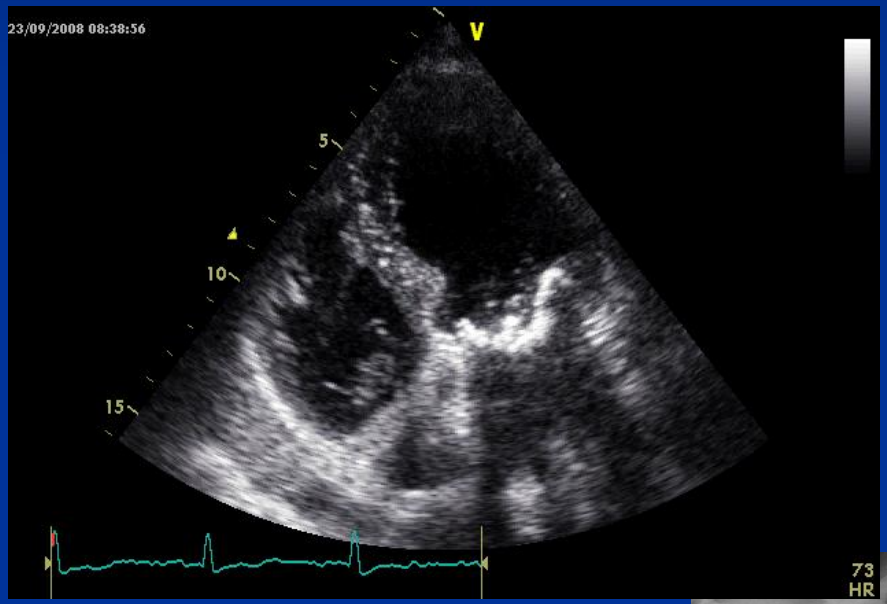
DIA

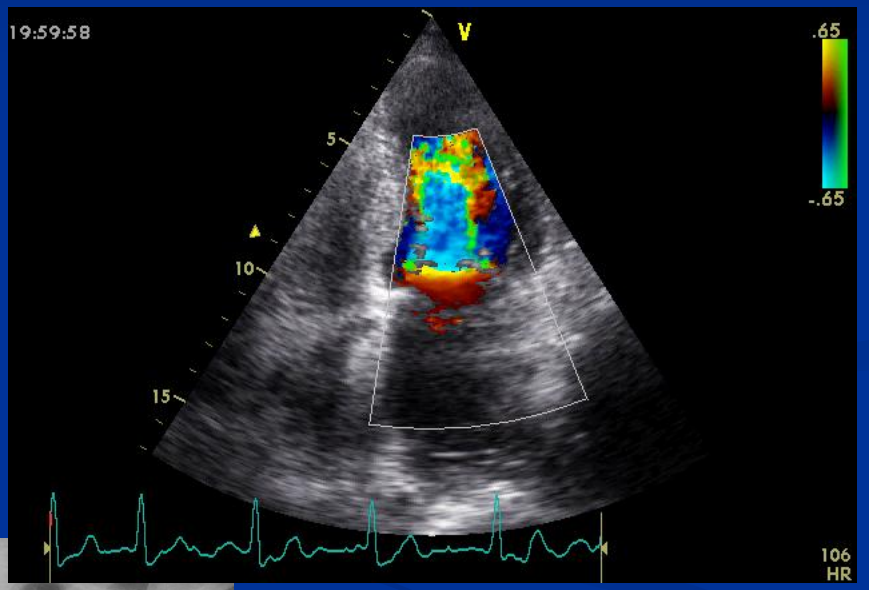


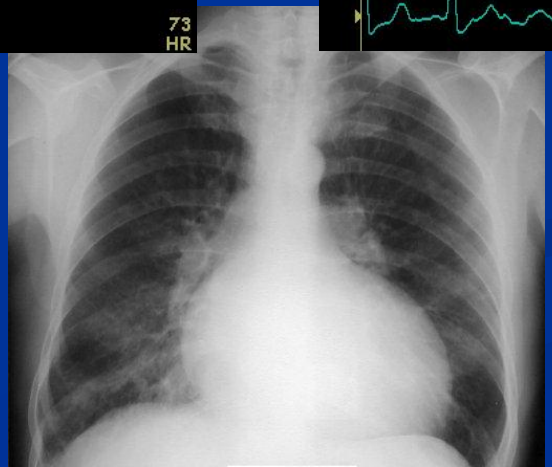
DIV

Valvulopatia Mitralica

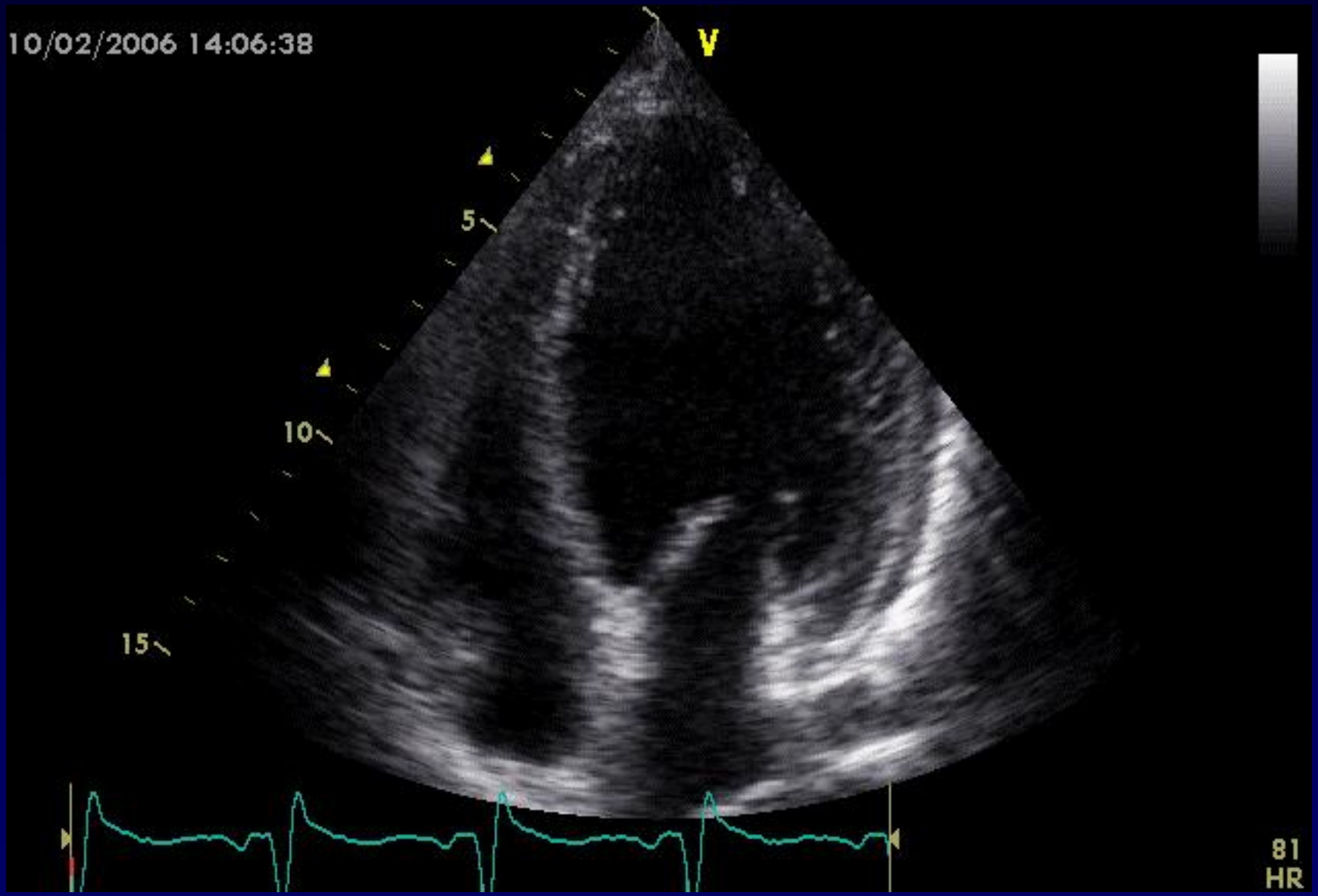
Pressione Atriale e Venosa Polmonare



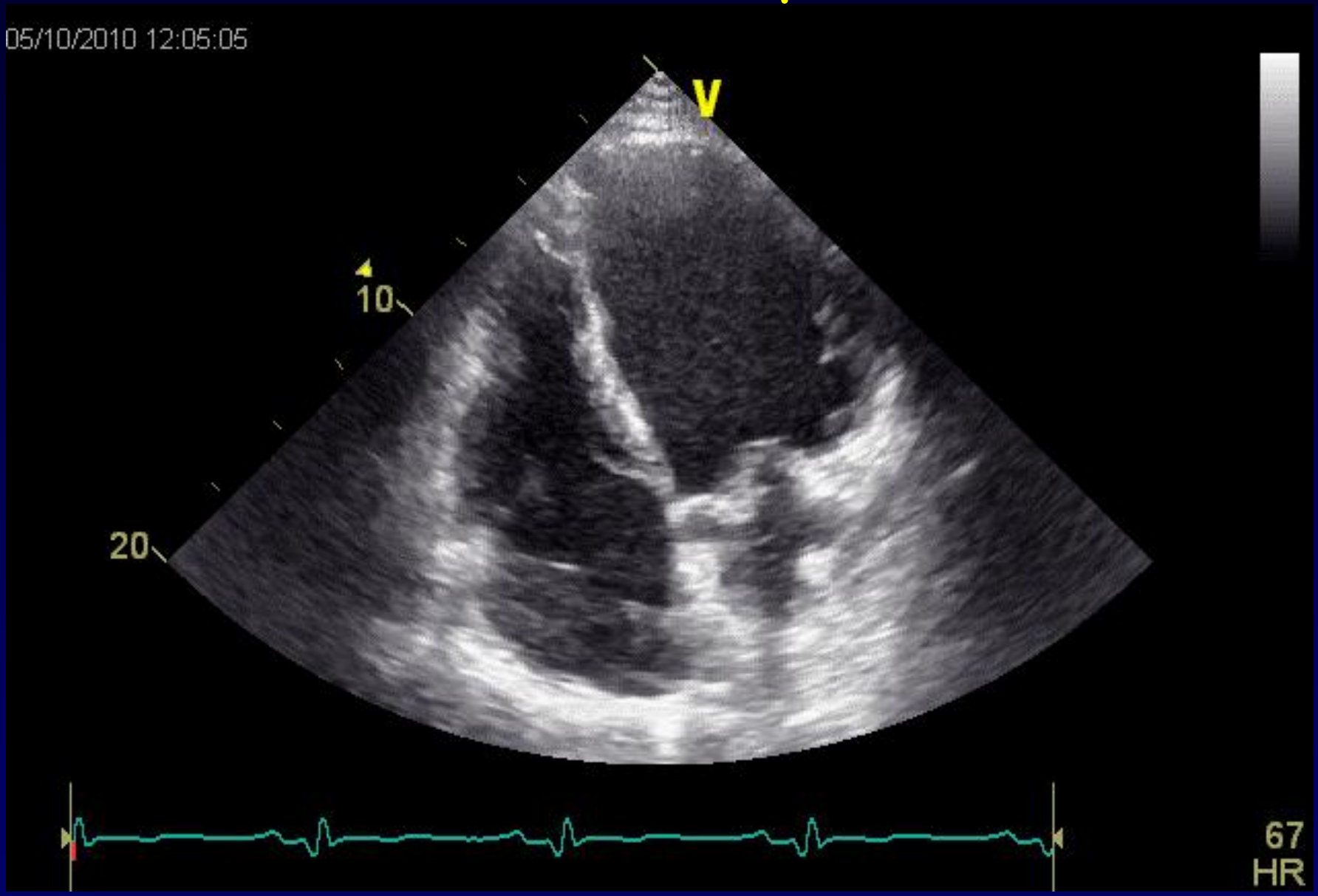




Dilatativa – VD normocontrattile

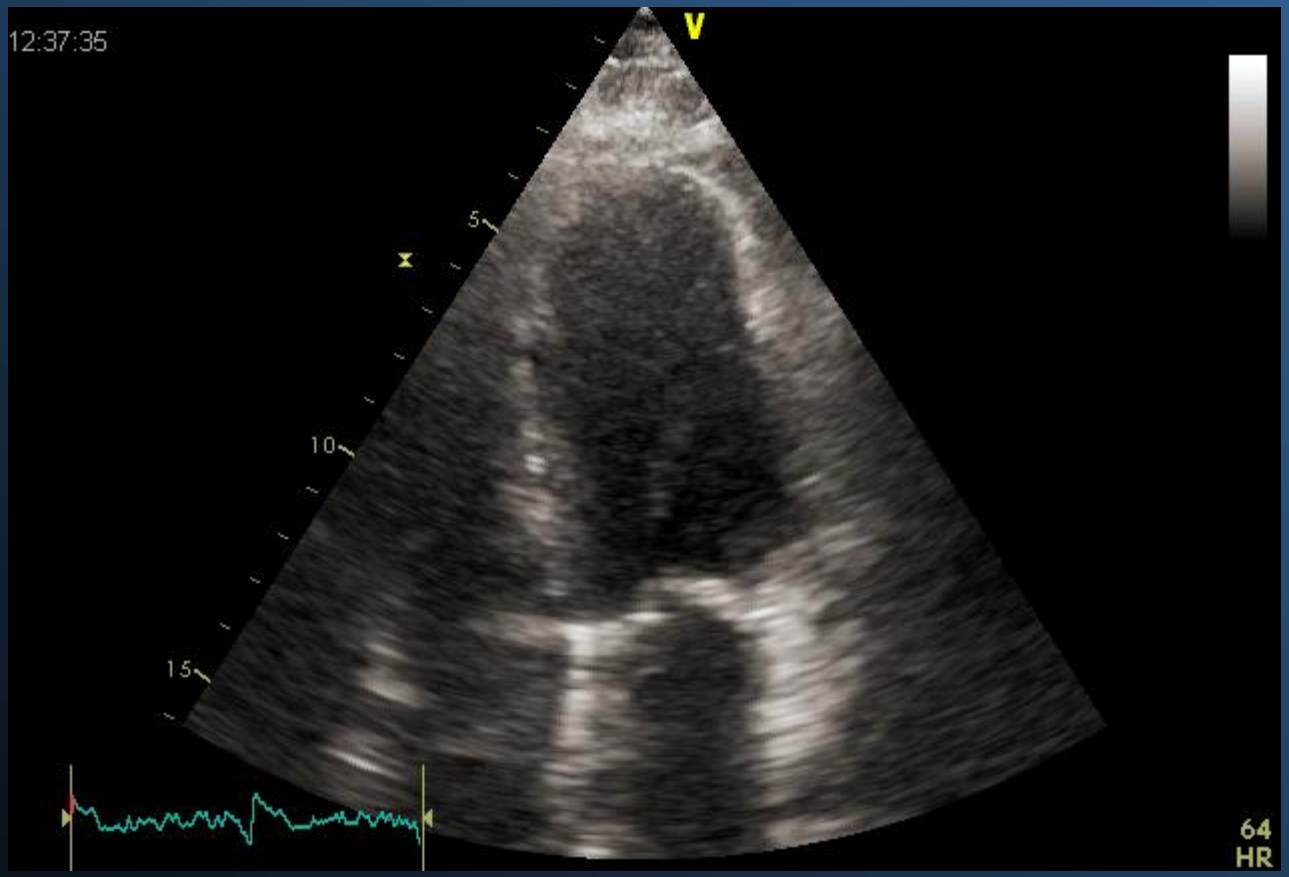


Dilatativa – VD ipocinetico



Scompenso Diastolico

Pressione Atriale e Venosa Polmonare



Right Versus Left Ventricular Failure

Differences, Similarities, and Interactions

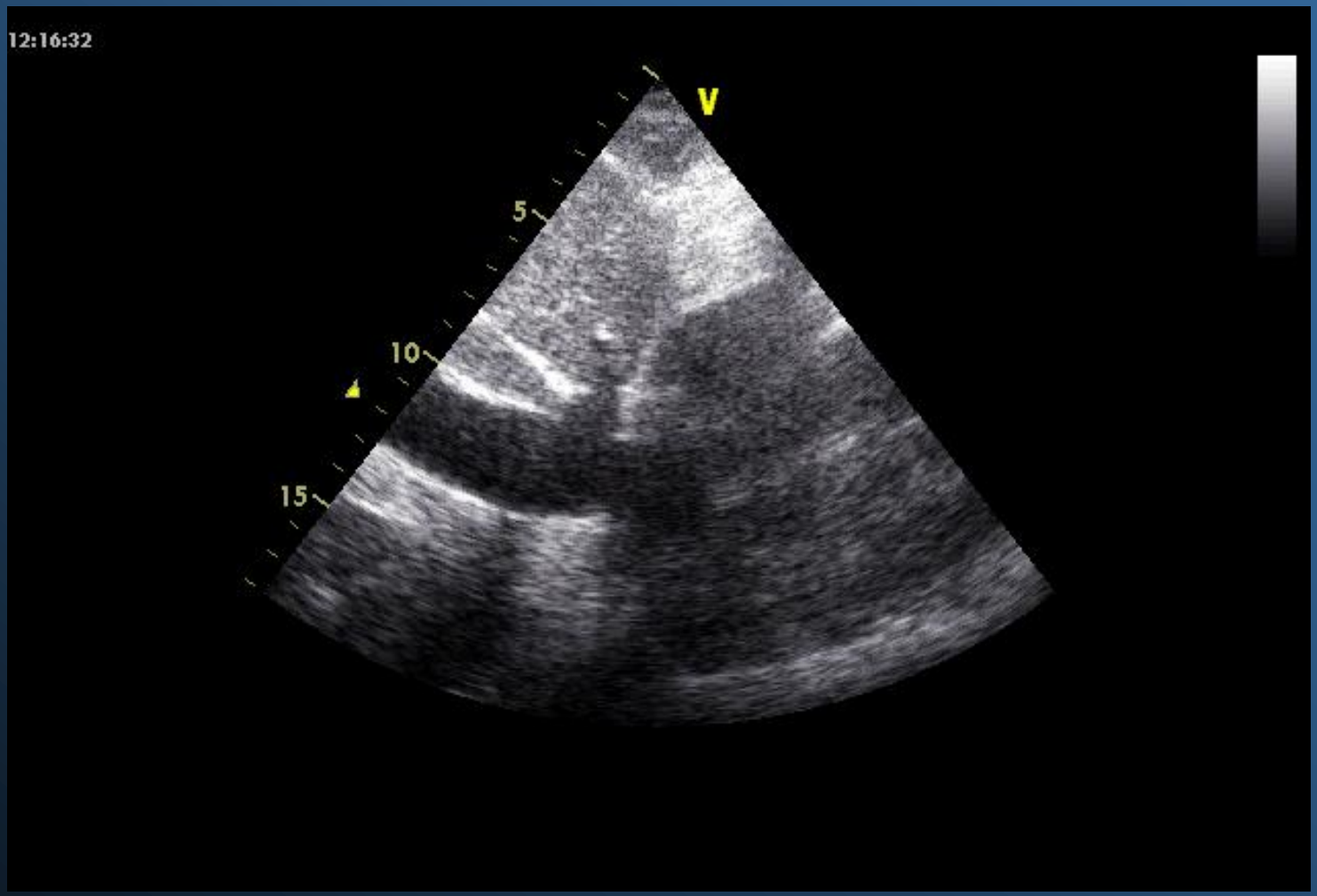
Mark K. Friedberg, MD; Andrew N. Redington, MB BS, MRCP(UK), MD, FRCP(UK), FRCPC

Circulation. 2014;129:1033-1044

Table 1. Differences Between the Left and Right Ventricles Under Normal Conditions

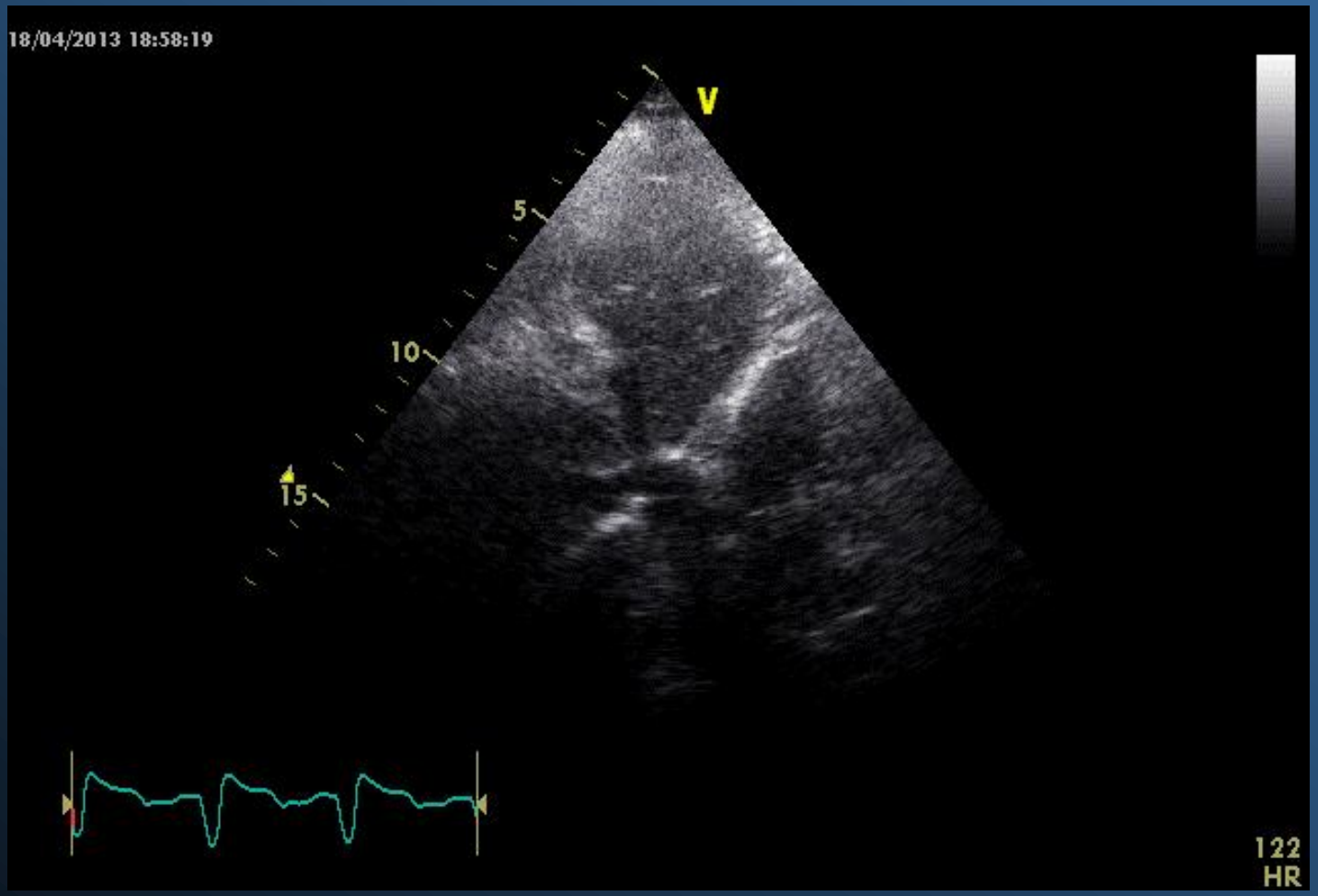
	Left Ventricle	Right Ventricle
Evolutionary development	Early	Late
Embryological origin	Primary heart field	Secondary heart field
Morphological characteristics	Bullet shape; prolate ellipsoid	Complex, crescentic
Myocardial characteristics	Thick smooth walls; fine trabeculations	Thin, heavily trabeculated walls
Myocardial architecture	Predominant radial myocyte orientation in the midlayers; subendocardial myocytes follow right-hand helix configuration; subepicardial myocytes form left-hand helix	Predominant longitudinal myocyte orientation; angulated intrusion of superficial myocytes toward the endocardium
Physiological pump conditions	High-resistance, high pressure pump; dominant radial thickening and contraction during ejection	Low-resistance, low-capacitance pump; peristaltic-like motion from inflow to outflow during ejection
Flow characteristics	Well-defined isovolumic contraction and relaxation; no hangout period	No or minimal isovolumic periods; hangout period

Paziente "PIENO"



Volume periferico **INTRA VASCOLARE**

Paziente VUOTO



Volume periferico **INTRA VASCOLARE**

RA PRESSURE

In patient being ventilated using positive pressure, the degree of IVC collapse cannot be used to reliably estimate RA pressure.

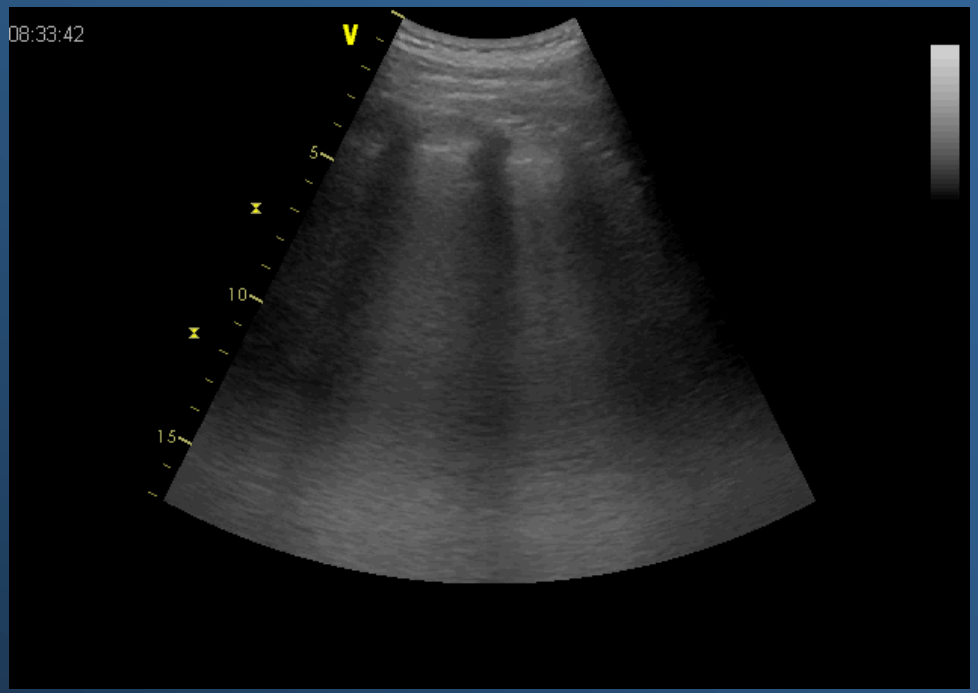
Vuoto non ventilato = VCI < 9 mm; collasso > 50%

Vuoto in NIV = VCI < 15 mm; collasso > 18 %

Sindrome interstiziale

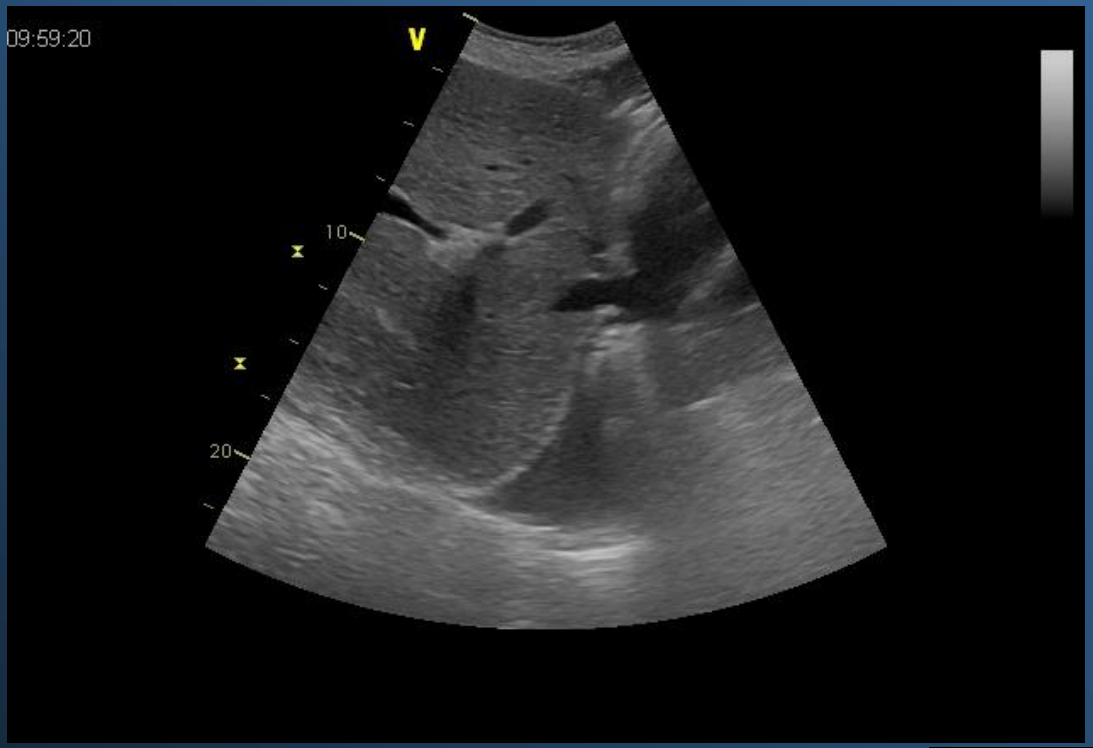
(pura semeiotica artefattuale)

Polmone "dry"



Polmone "wet"

PATOLOGIA PLEURO-POLMONARE



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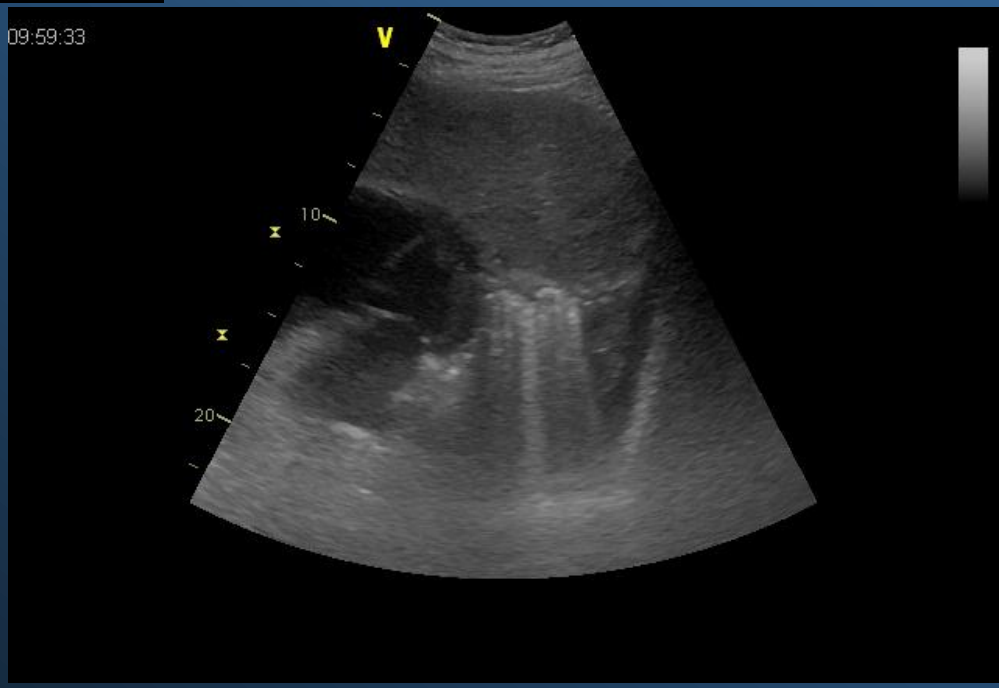


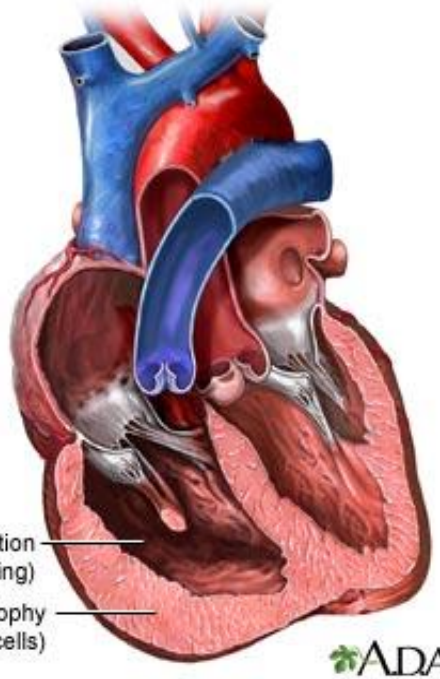
Ecocardiogramma ed Ipertensione Polmonare

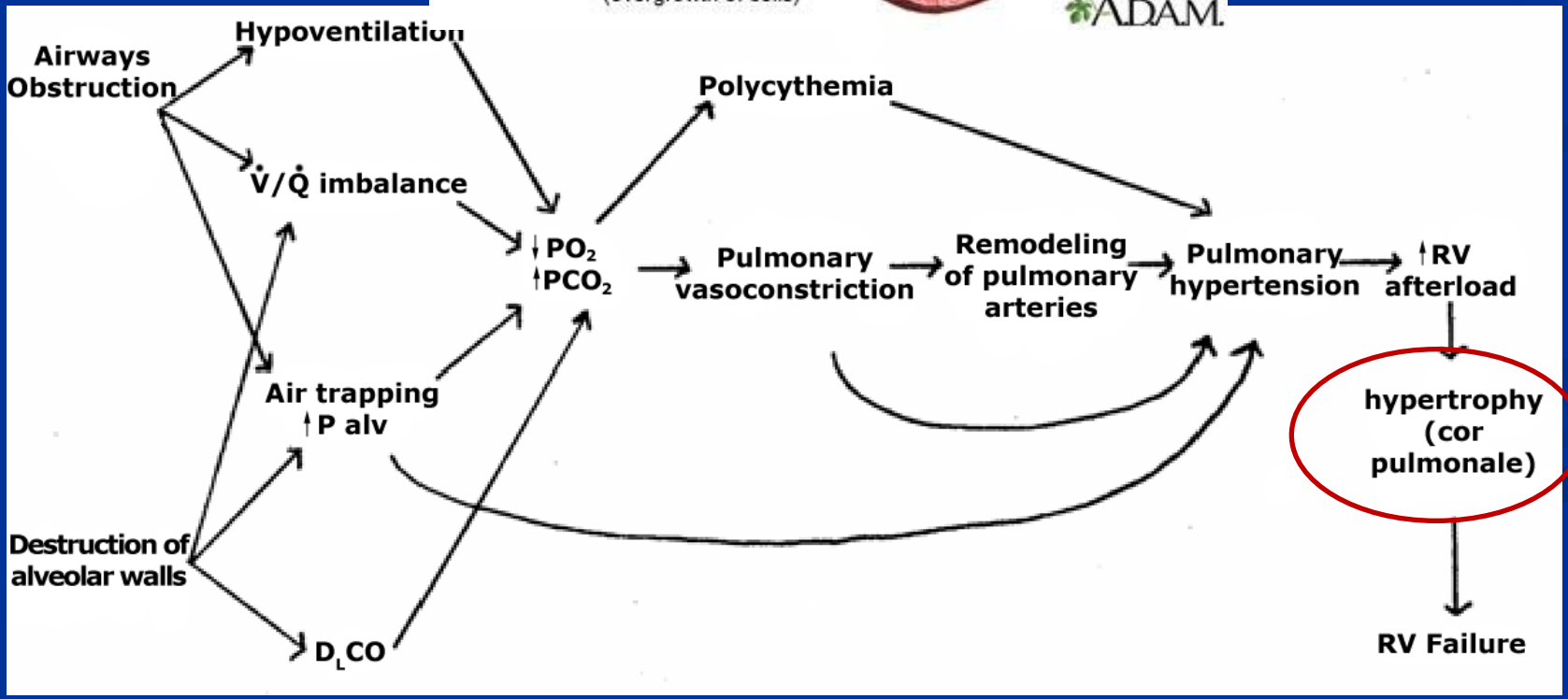
Aumentate Resistenze Polmonari da Ipossia Cronica

Hypoxic vasoconstriction

- Chronic obstructive pulmonary disease
- Hypoventilation disorders
  - Sleep apnea syndrome with obesity or pharyngeal obstruction
  - Neuromuscular diseases and damage to central respiratory center
  - Severe kyphoscoliosis
- Residence at high altitude

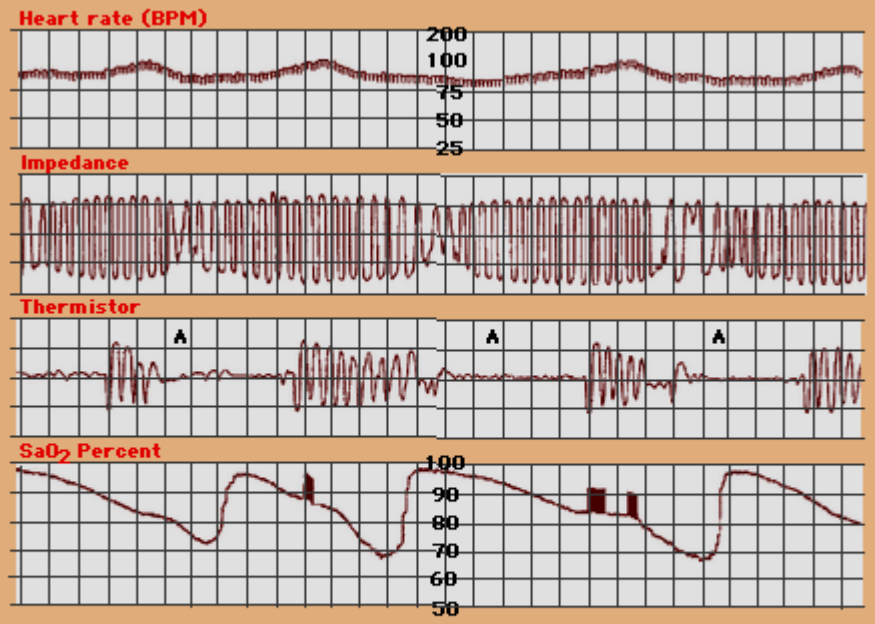
Cor pulmonale, or right-sided heart failure, is an enlargement of the right ventricle due to high blood pressure in the arteries of the lungs usually caused by chronic lung disease





Sindrome Disventilatoria (OSAS)

Pickwickian syndrome



Home sleep tracing Typical tracing from a 4 channel cardiopulmonary recording performed at home. The parameters measured include pulse rate, chest wall impedance, airflow, and oxygen saturation. Obstructive apneas are denoted by the letter A.

Ecocardiogramma ed Ipertensione Polmonare

↑ Resistenze Polmonari per Riduzione del Letto Vascolare Polmonare

Decreased area of the pulmonary vascular bed

Obstruction of large pulmonary arteries, most often pulmonary emboli

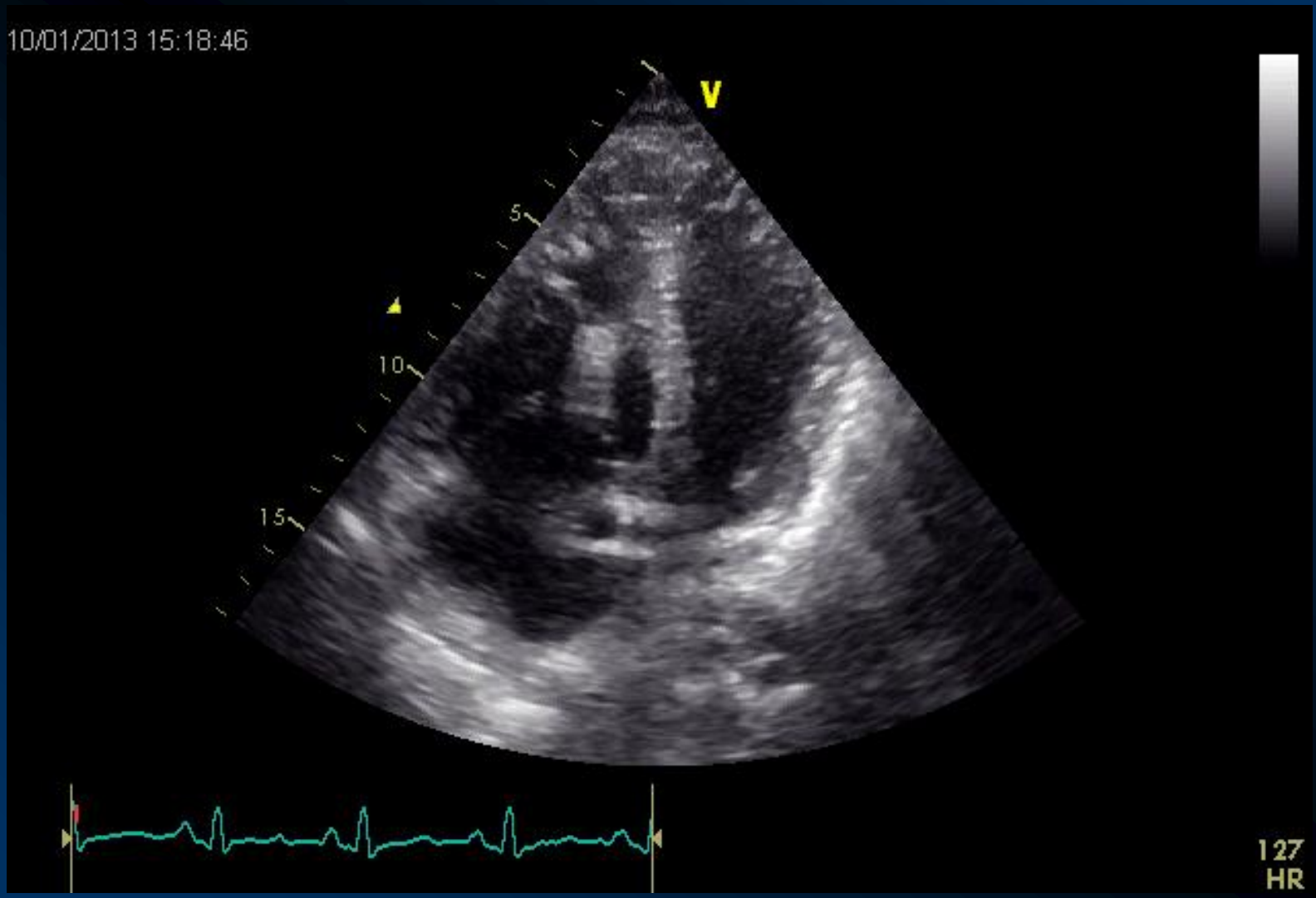
Obstruction and obliteration of pulmonary arteries

Collagen vascular diseases including scleroderma, CREST syndrome, Systemic lupus erythematosus, and rheumatoid arthritis

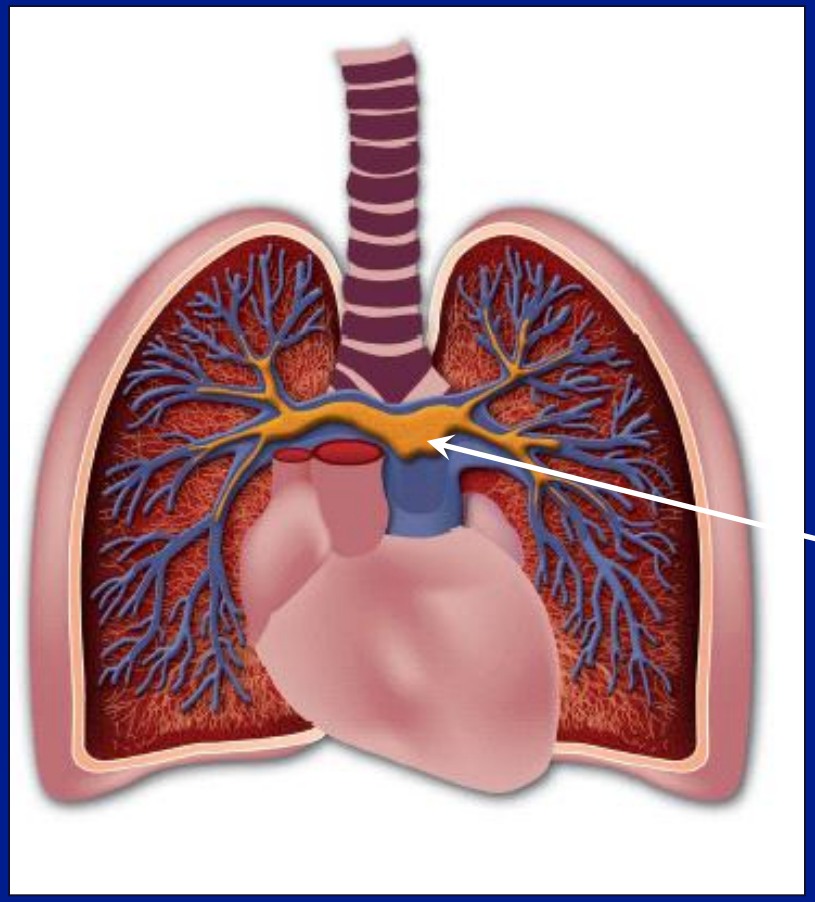
Vasculitis including Wegener's granulomatosis and polyarteritis nodosa

Miscellaneous — sarcoidosis, lymphangitic spread of carcinoma, pulmonary resection, parasitic or HIV infection, fibrotic reactions, acute interstitial pneumonitis (Hamman-Rich syndrome), intravenous drug abuse, hemoglobinopathies

Embolia Polmonare

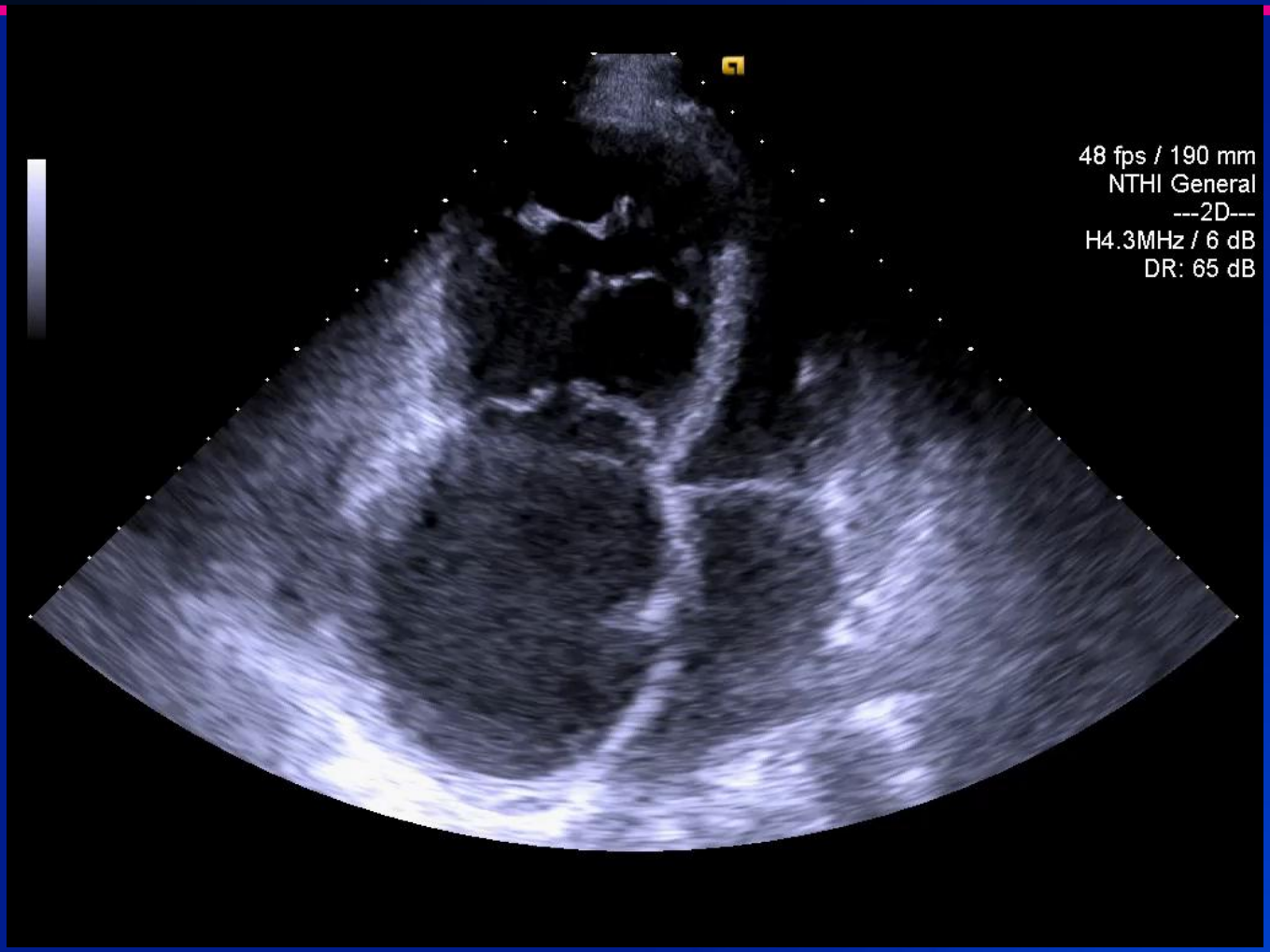


Chronic thromboembolic pulmonary hypertension (CTEPH)



Organised thrombotic material in pulmonary arteries

CTPH: diagnosis



European Journal of Echocardiography (2010) **11**, 81–96
doi:10.1093/ejechocard/jep234

REVIEW PAPER

The echocardiographic assessment of the right ventricle: what to do in 2010?

Ruxandra Jurcut[1]*, Sorin Giusca[1,2], André La Gerche[2], Simona Vasile[1], Carmen Ginghina[1], and Jens-Uwe Voigt[2]

Echocardiography is the modality of choice for the assessment of morphology and function of the RV in clinical practice:

- non-invasive
- obtained in short time
- widely available and relatively inexpensive
- no side effects
- performed at the bedside for the sickest patients and in patients with PMK/ICD

GUIDELINES AND STANDARDS

Guidelines for the Echocardiographic Assessment of the Right Heart in Adults: A Report from the American Society of Echocardiography

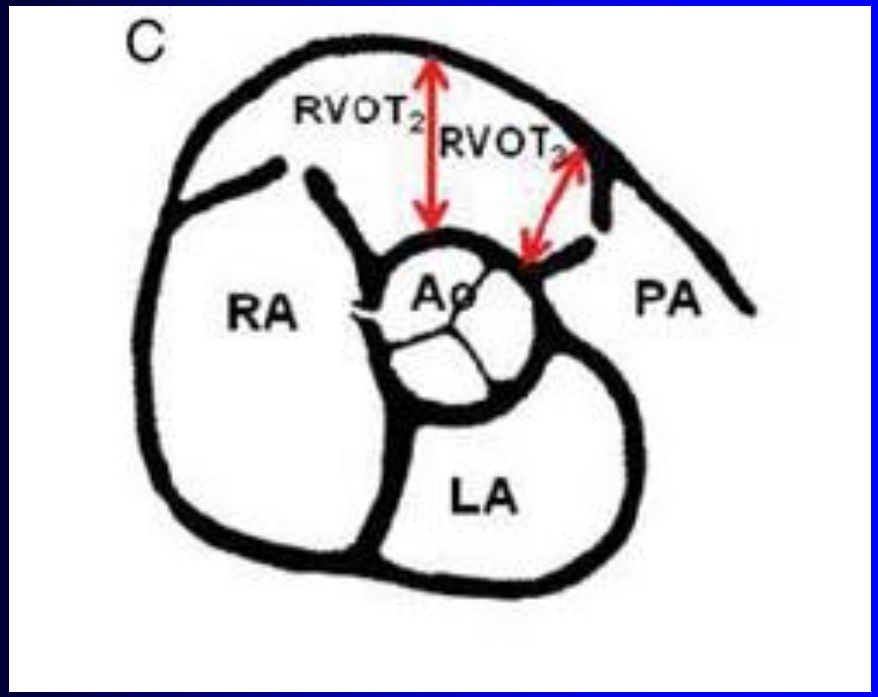
Endorsed by the European Association of Echocardiography, a registered branch of the European Society of Cardiology, and the Canadian Society of Echocardiography

Lawrence G. Rudski, MD, FASE, Chair, Wyman W. Lai, MD, MPH, FASE, Jonathan Afilalo, MD, Msc, Lanqi Hua, RDCS, FASE, Mark D. Handschumacher, BSc, Krishnaswamy Chandrasekaran, MD, FASE, Scott D. Solomon, MD, Eric K. Louie, MD, and Nelson B. Schiller, MD, *Montreal, Quebec, Canada; New York, New York; Boston, Massachusetts; Phoenix, Arizona; London, United Kingdom; San Francisco, California*

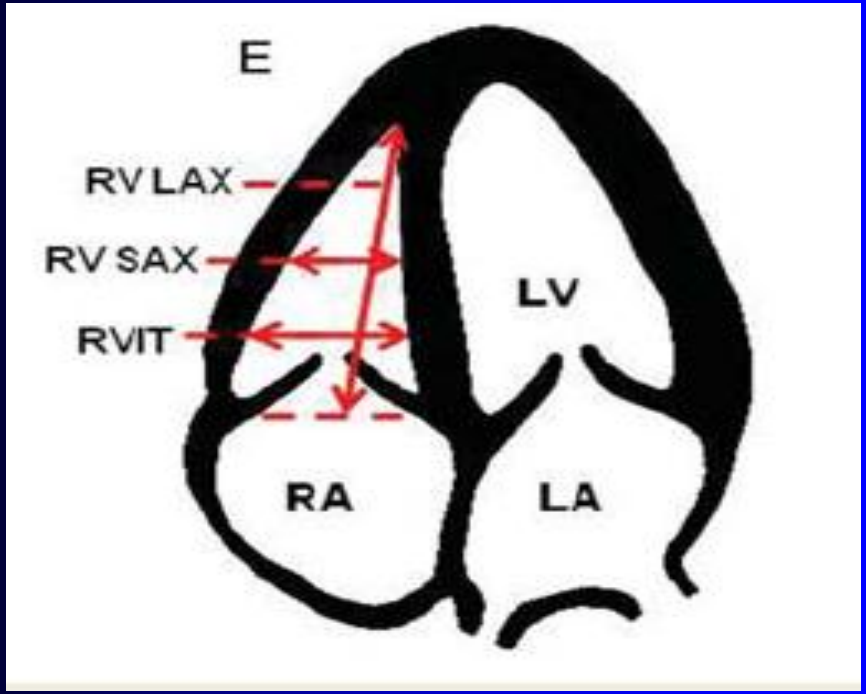
(J Am Soc Echocardiogr 2010;23:685-713.)

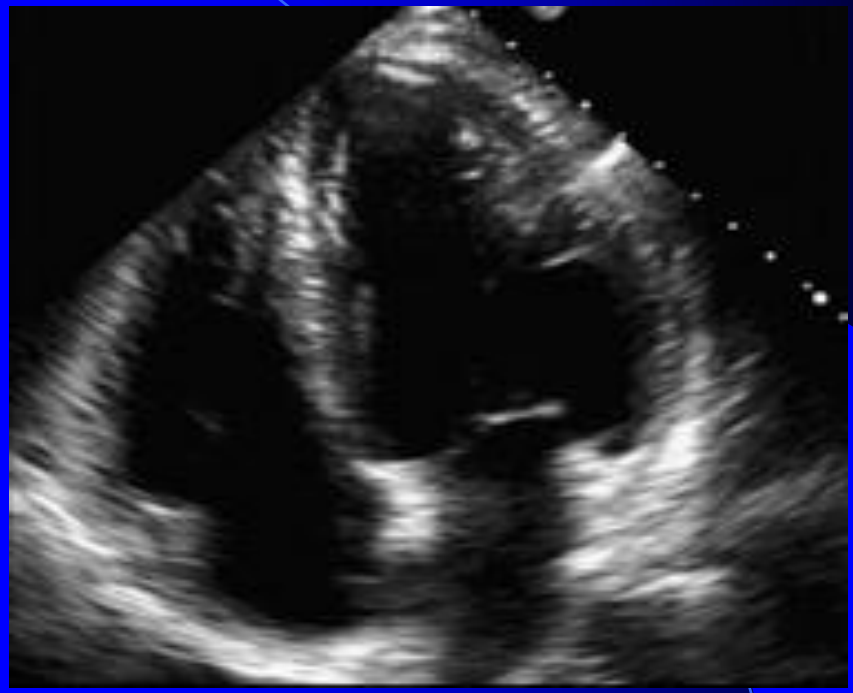
Keywords: Right ventricle, Echocardiography, Right atrium, Guidelines

PARASTERNAL SHORT AXIS VIEW AT THE BASE OF THE HEART



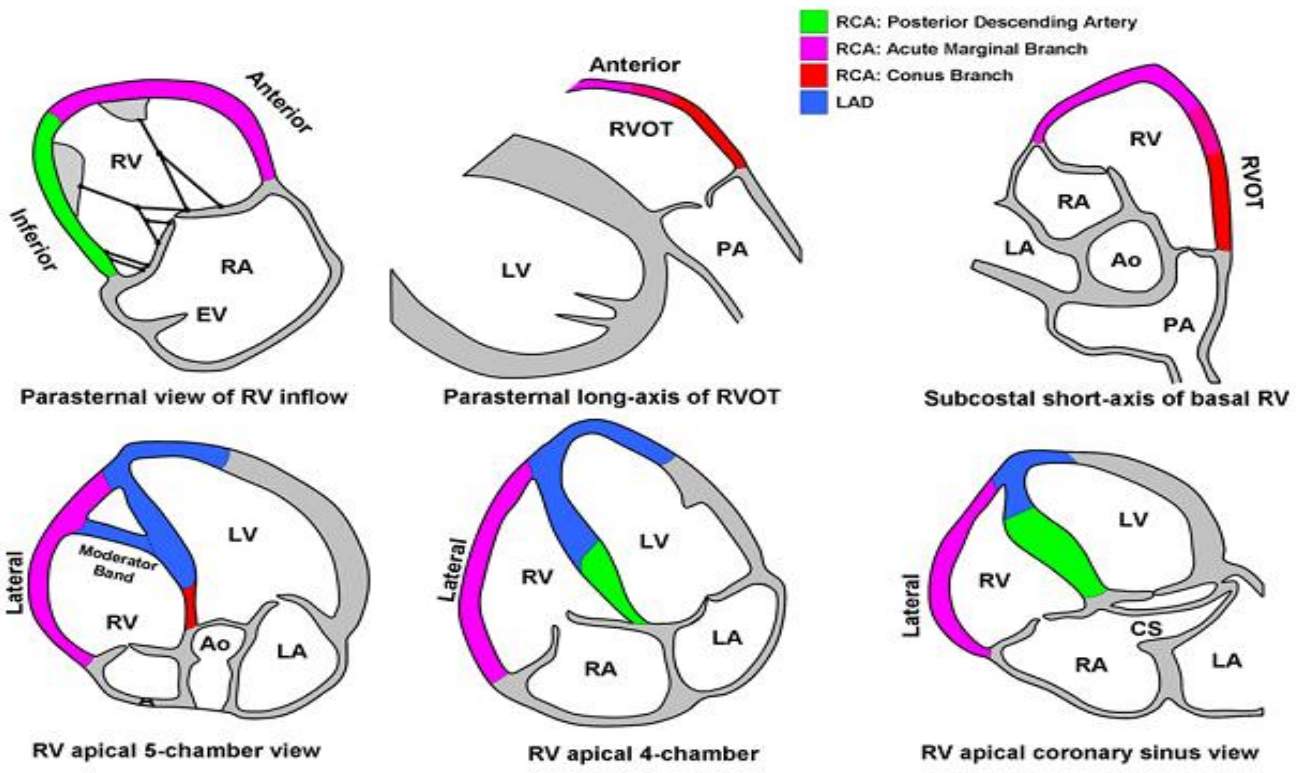
APICAL FOUR CHAMBER VIEW





ANATOMY OF THE RV

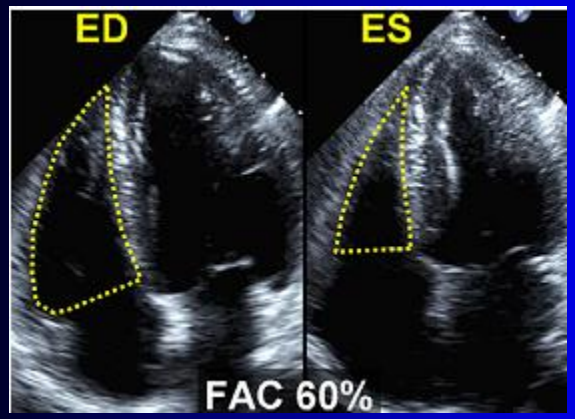
CORONARY SUPPLY

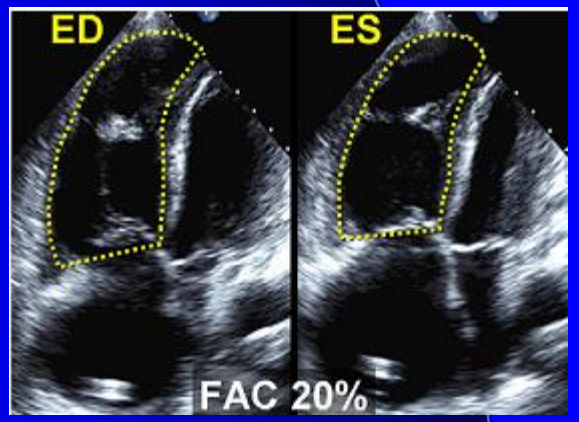


RIGHT VENTRICULAR FRACTIONAL AREA CHANGE (RVFAC)

RVFAC (%) = (RVEDA – RVESA)/RVEDA

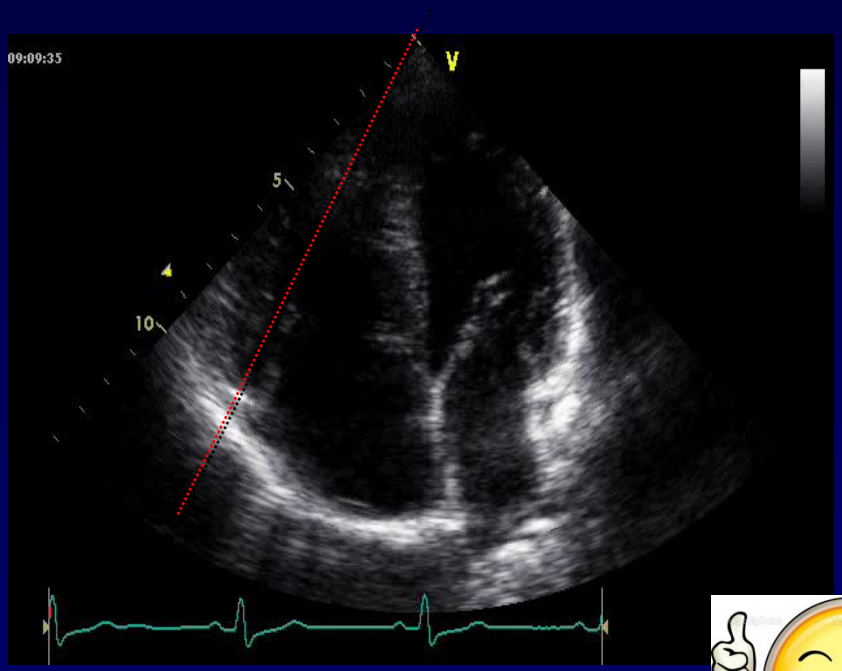
Lower reference value of normal systolic function of 35%

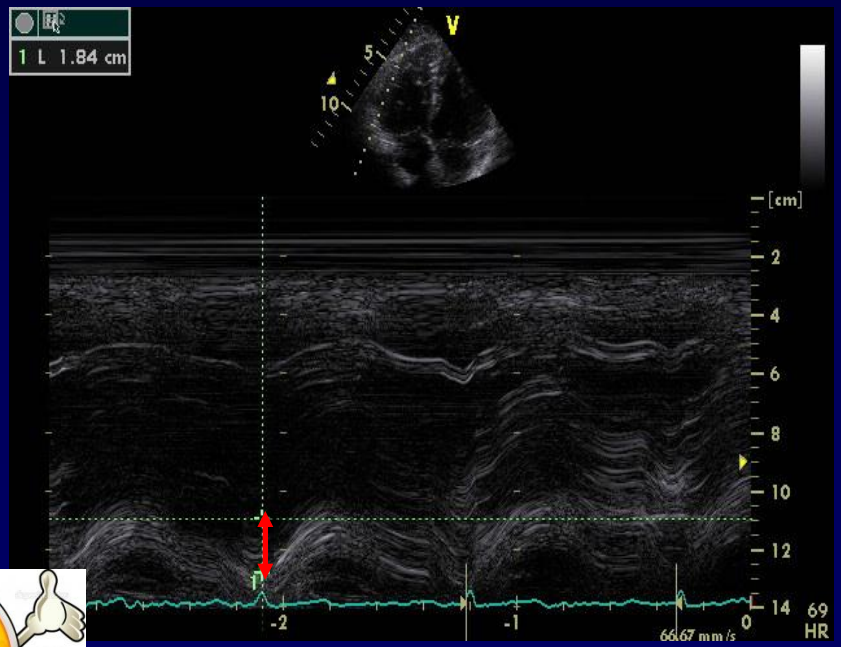




La Funzione Ventricolare Destra

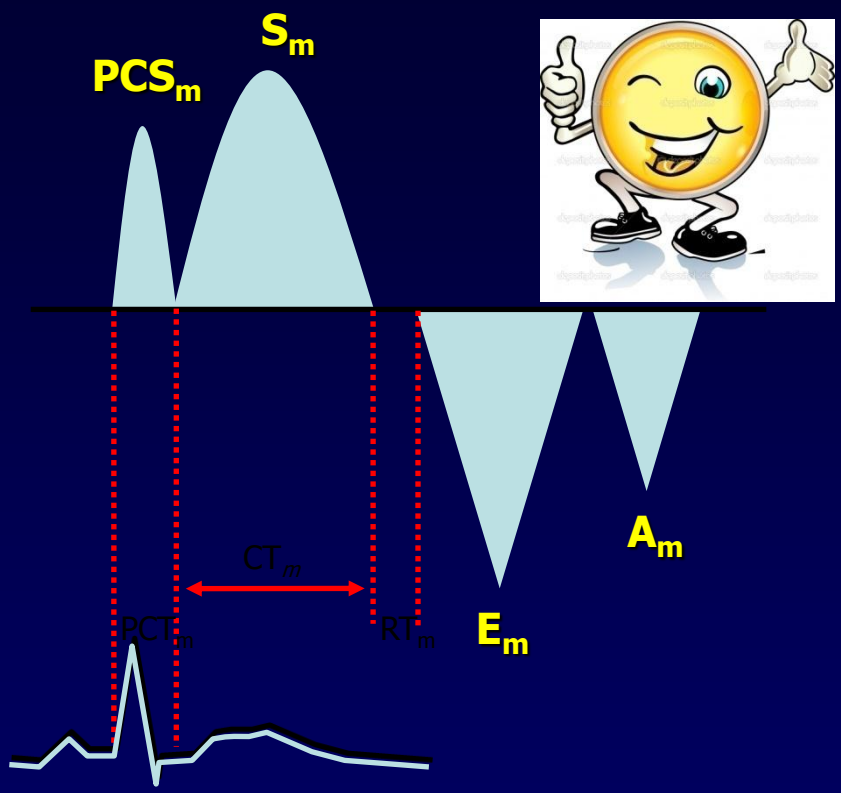
Tricuspid Anulus Plane Systolic Excursion TAPSE (vn >15 mm)

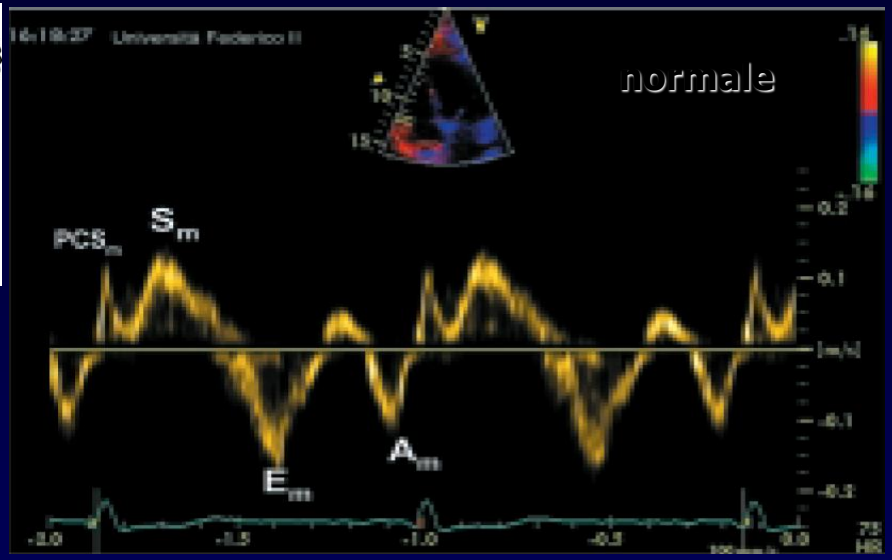




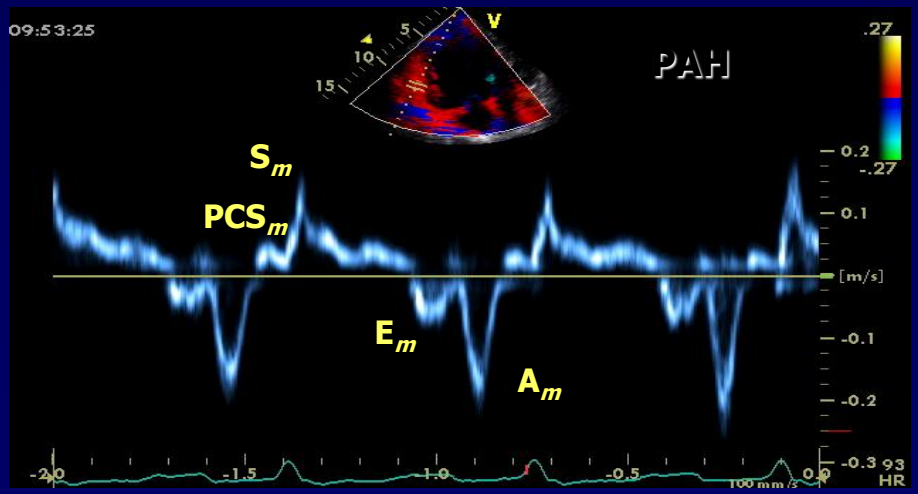
Kaul S et al, Am Heart J 1984;107:526-31

Doppler Myocardial Imaging

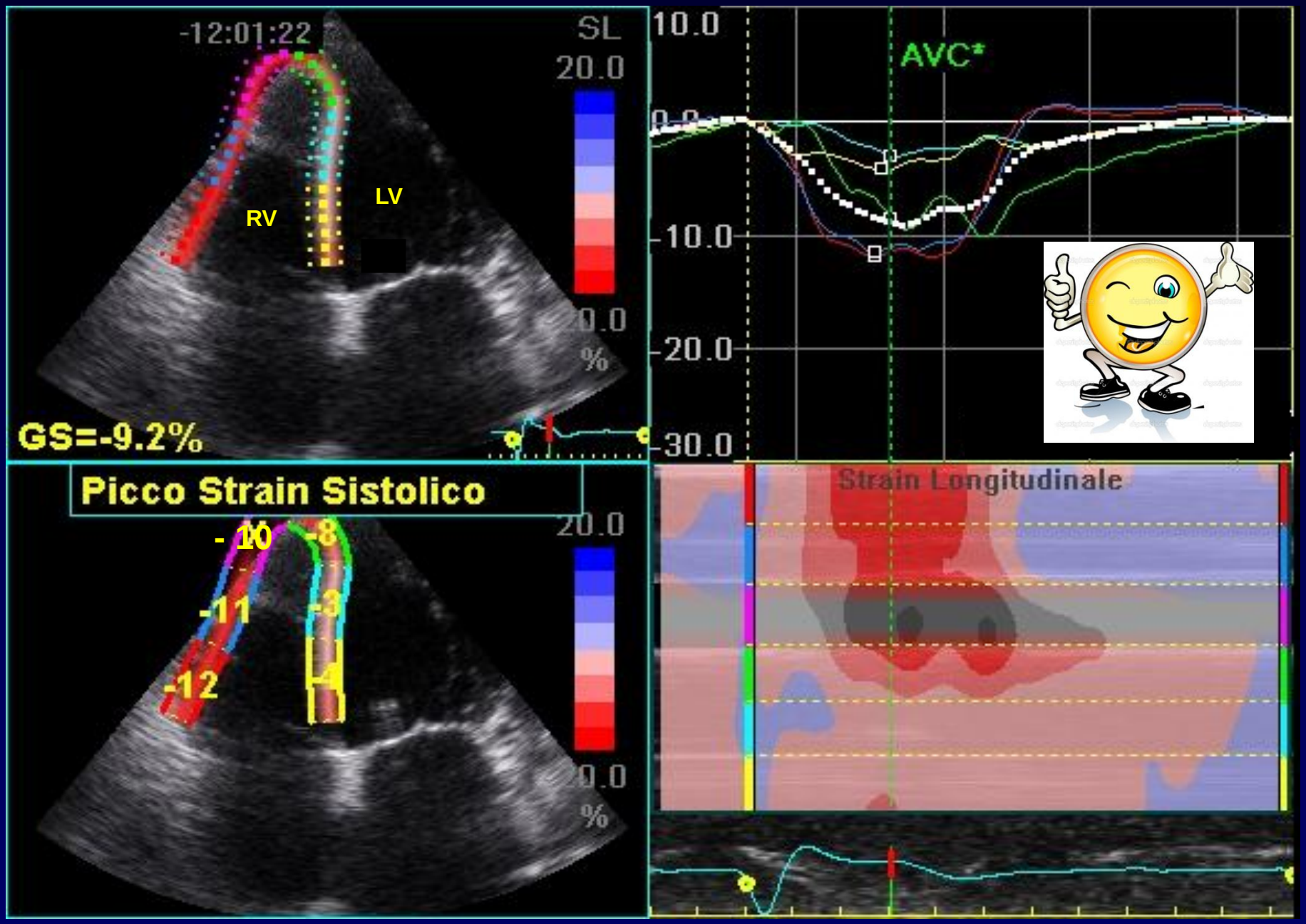




Un valore di $\underline{S_m}$ <10.8 cm/sec: significativo peggioramento della prognosi in 139 pz con CHF sintomatica.



Meluzin J Eur J Echocardiogr 2003;4:262-72



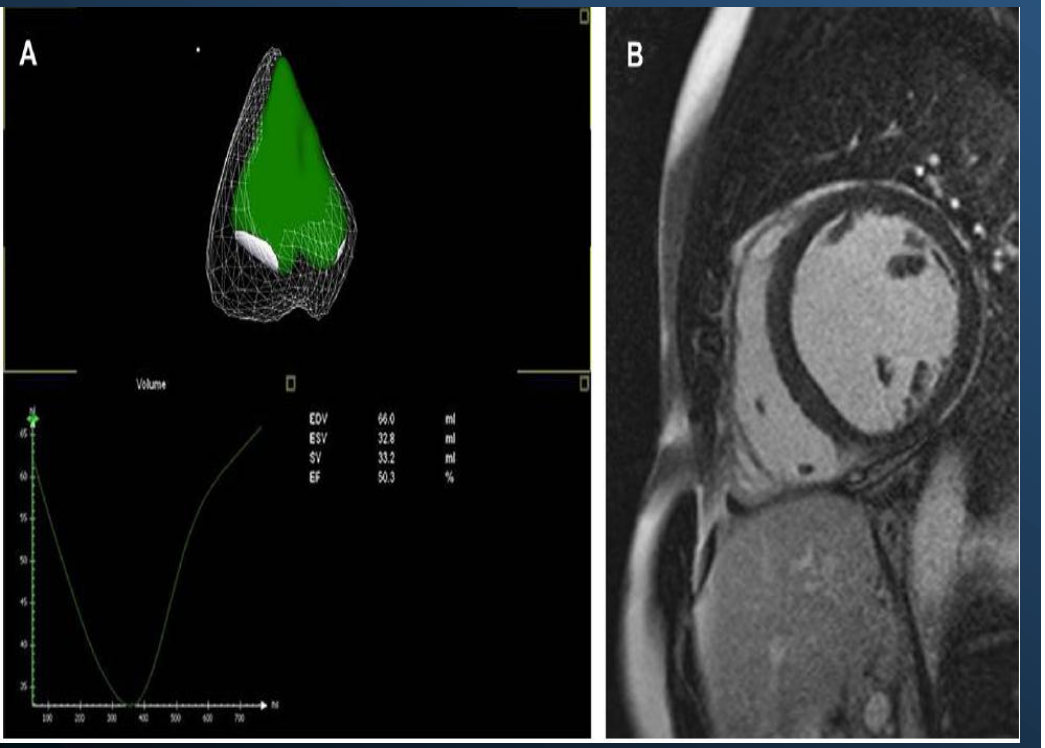
D'Andrea A,et al. Pacing and Elechtrophysiology 2009

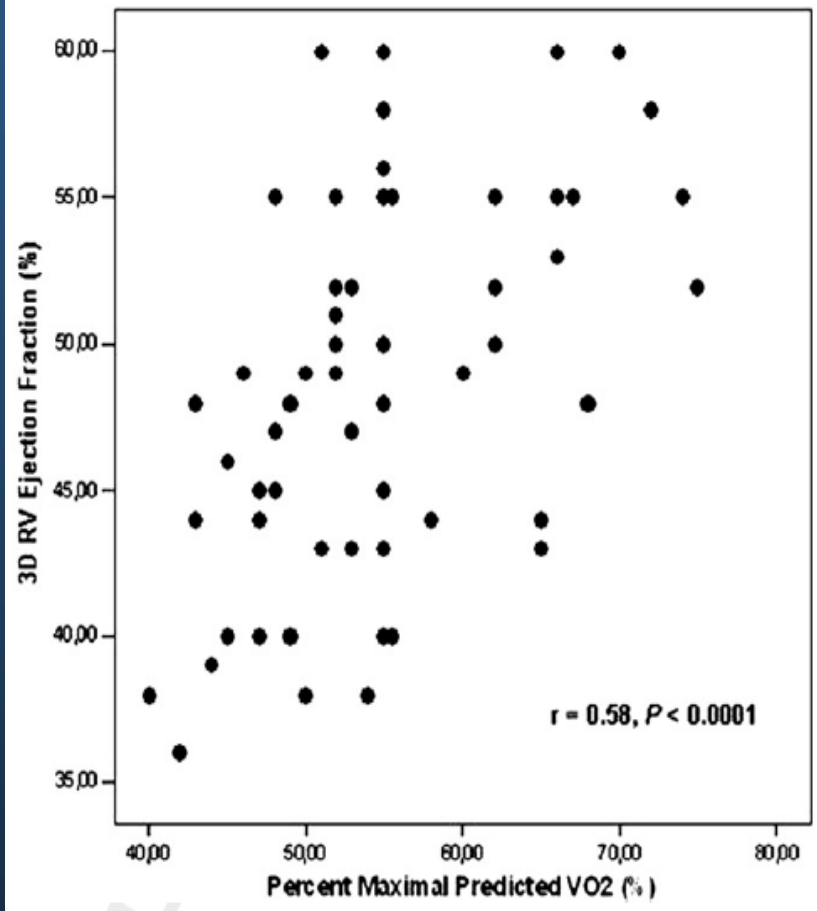
Journal of Cardiac Failure Vol. ■ No. ■ 2011

Clinical Investigation

Right Ventricular Ejection Fraction and Left Ventricular Dyssynchrony by 3D Echo Correlate With Functional Impairment in Patients With Dilated Cardiomyopathy

ANTONELLO D'ANDREA, MD, FESC,[1] RITA GRAVINO, MD,[1] LUCIA RIEGLER, MD,[1] GEMMA SALERNO, MD,[1] RAFFAELLA SCARAFILE, MD,[1] MASSIMO ROMANO, MD,[2] SERGIO CUOMO, MD, FESC,[1] LUCA DEL VISCOVO, MD,[3] ILARIA FERRARA, MD,[1] MARIA LUISA DE RIMINI, MD,[4] PIETRO MUTO, MD,[4] GIUSEPPE LIMONGELLI, MD, FESC,[1] GIUSEPPE PACILEO, MD,[1] EDUARDO BOSSONE, MD-FACC,[5] MARIA GIOVANNA RUSSO, MD,[1] AND RAFFAELE CALABRÒ, MD[1]





RA SIZE

1. Maximal long axis distance:

From the the centre of tricuspid annulus to the centre of the superior RA wall, parallel to the interatrial septum.

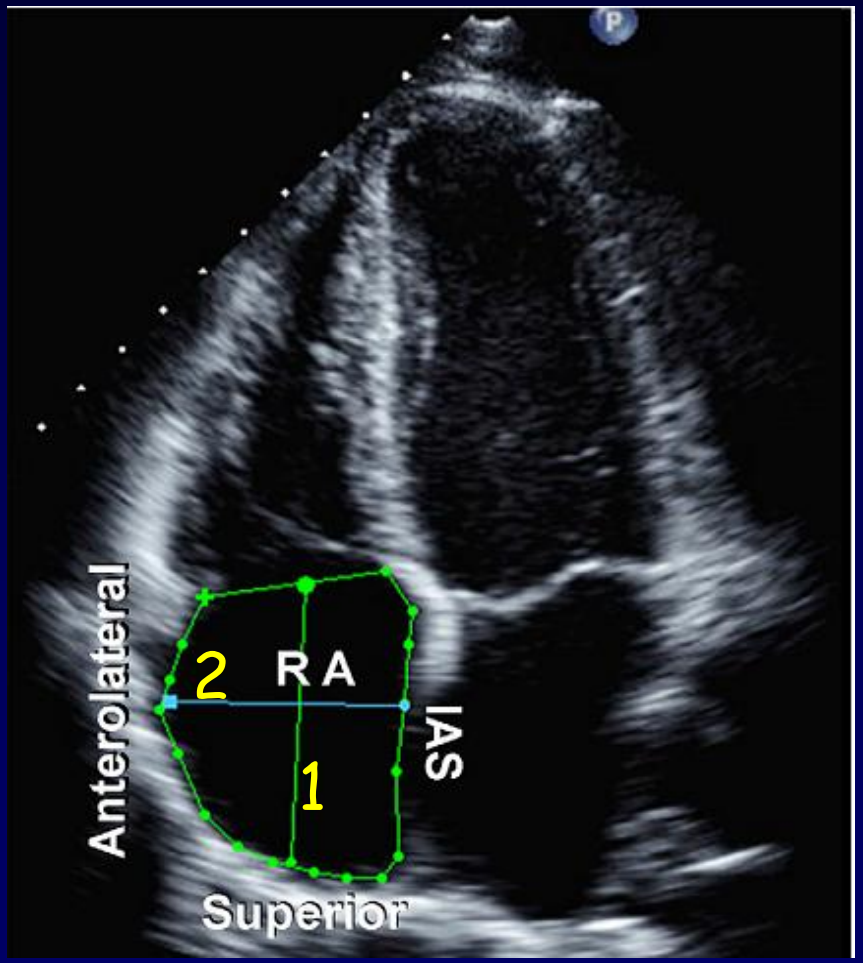
UPPER REFERENCE LIMIT 5,3 cm

2. Mid RA minor distance:

From the mid level of the RA free wall to the interatrial septum , perpenducular to the long axis.

UPPER REFERENCE LIMIT 4,4 cm

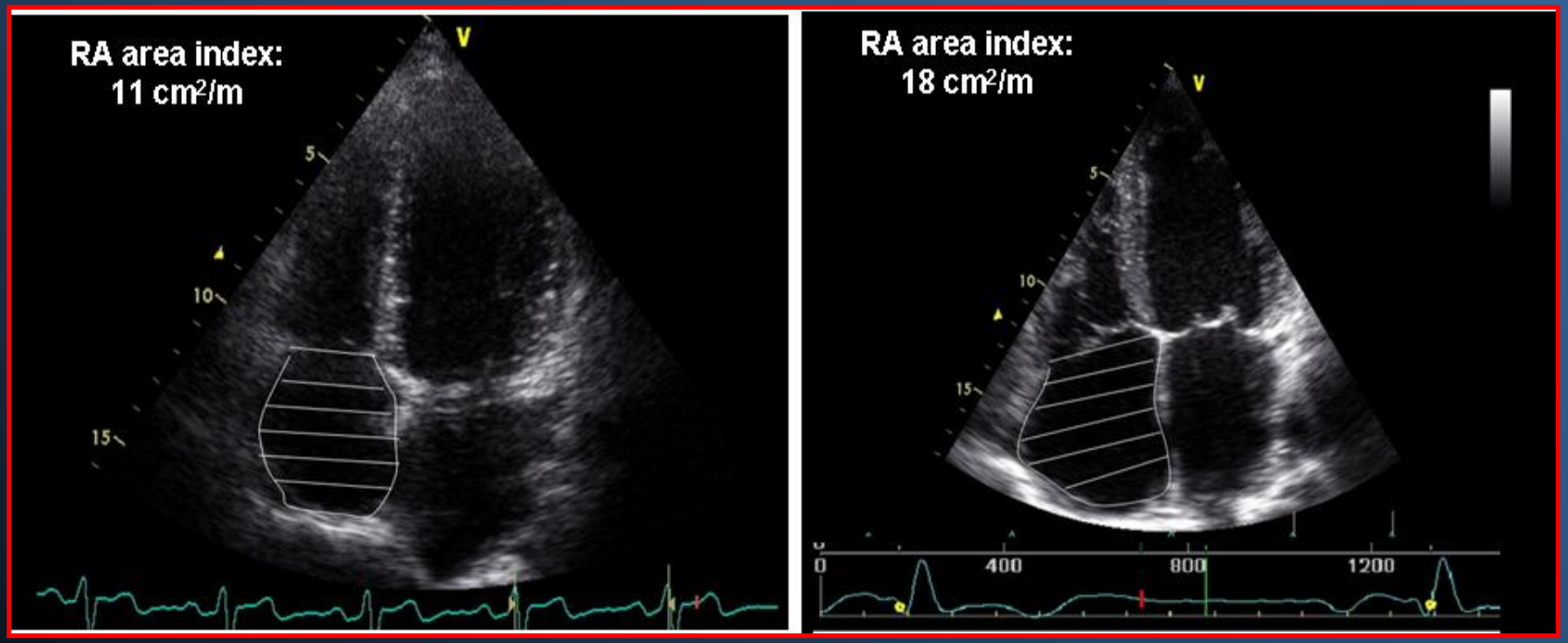
Routine RA Volume measurement are not recommended because of the paucity of standardized data.



RESULTS

Control Group

DCM



D'Andrea A et al.
Eur J Heart Failure 2010

Echocardiography in Pulmonary Arterial Hypertension: from Diagnosis to Prognosis

Eduardo Bossone, MD, PhD, Antonello D'Andrea, MD, PhD, Michele D'Alto, MD, Rodolfo Citro, MD, Paola Argiento, MD, PhD, Francesco Ferrara, MD, Antonio Cittadini, MD, PhD, Melvyn Rubenfire, MD, and Robert Naeije, MD, PhD, *Milan, Salerno, and Naples, Italy; Ann Arbor, Michigan; Brussels, Belgium*

Pulmonary arterial hypertension is most often diagnosed in its advanced stages because of the nonspecific nature of early symptoms and signs. Although clinical assessment is essential when evaluating patients with suspected pulmonary arterial hypertension, echocardiography is a key screening tool in the diagnostic algorithm. It provides an estimate of pulmonary artery pressure, either at rest or during exercise, and is useful in ruling out secondary causes of pulmonary hypertension. In addition, echocardiography is valuable in assessing prognosis and treatment options, monitoring the efficacy of specific therapeutic interventions, and detecting the preclinical stages of disease. (J Am Soc Echocardiogr 2012;■:■-■.)

Table 3 Doppler echocardiographic indices for the evaluation of patients with clinical suspicion of PH[7,8]

Key indices (cutoff)	Additional indices (cutoff)	Complementary indices (cutoff)	Research tools
Pulmonary hemodynamics			
SPAP = 4 × TRV^2 + RAP[9-12] (TRV > 2.8–2.9 msec: SPAP 36 mm Hg)	MPAP = TVI_{TR} + RAP[13] (≥25 mm Hg)	AT_{RVOT} (<100 msec) $\log_{10}$ (EPSPAP) = −0.004(PAAT) + 2.1[15]	PVCAP = SV/4 × (TRV^2 − PRV^2)[14] (<0.8 mL/mm Hg predicts mortality in PAH patients)
RAP = IVC size and collapsibility[16] (>2.1 cm, collapse < 50%: RAP 15 mm Hg)		RV IVRT' (by DTI; >65 msec: SPAP > 40 mm Hg; <59 msec: RAP > 8 mm Hg)	
MPAP = 4 × PRV^2 + RAP[17,18] (≥25 mm Hg)	MPAP = 0.61 × SPAP + 2 mm Hg[19]	MPAP = 90 − 0.62 × AT_{RVOT}[20] MPAP = 79 − 0.45 × AT_{RVOT}	
DPAP = 4 × (PRV ED)^2 + RAP			
PVR = TRV/TVI_{RVOT} (cm) × 10 + 0.16[21] (>0.2: PVR > 2 WU; <0.15: normal PVR)	PVR = SPAP/(HR × TVI_{RVOT})[22] (>0.076: indexed PVR > 15 RU)	FVE_{RVOT}[23] (midsystolic "notch")	
PCWP = 1.9 + 1.24 × E/E'[24] (E/E' >15: PCWP > 15 mm Hg)	LAVi[25] (>31 mL/m^2)		
Impaired RV systolic function			
TAPSE (<16 mm)	Tei index: (IVRT + IVCT)/ET (>0.40 by PW Doppler; >0.55 by DTI)		3D RV EF (<44%)
RV FAC (<35%)			RV LPSS[26] (≥ −19%)
S'-wave velocity by DTI (<10 cm/sec)			

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International Journal of Cardiology

journal homepage: www.elsevier.com/locate/ijcard

Accuracy and precision of echocardiography versus right heart catheterization for the assessment of pulmonary hypertension☆

Michele D'Alto [a,*,1], Emanuele Romeo [a], Paola Argiento [a], Antonello D'Andrea [a], Rebecca Vanderpool [b], Anna Correra [a], Eduardo Bossone [c], Berardo Sarubbi [a], Raffaele Calabrò [a], Maria Giovanna Russo [a], Robert Naeije [b]

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[b] Department of Physiology, Faculty of Medicine, Erasme Academic Hospital, Université Libre de Brussels, Bruxelles, Belgium
[c] Cardiology and Cardiac Surgery, University Hospital "Scuola Medica Salernitana", Salerno, Italy

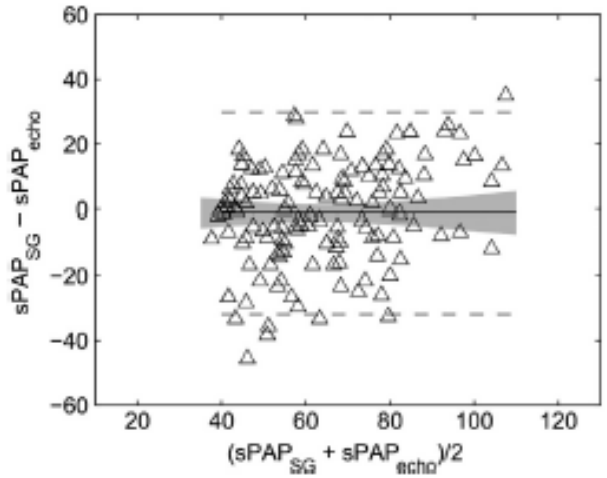


Fig. 1. Bland–Altman analysis demonstrating near-absence of bias but moderate agreement between echocardiographic and right heart catheterization estimates of systolic pulmonary artery pressure in 152 patients. The shaded area represents the confidence interval on the difference between the means, and dashed lines: *mean* ± 2*SD*.

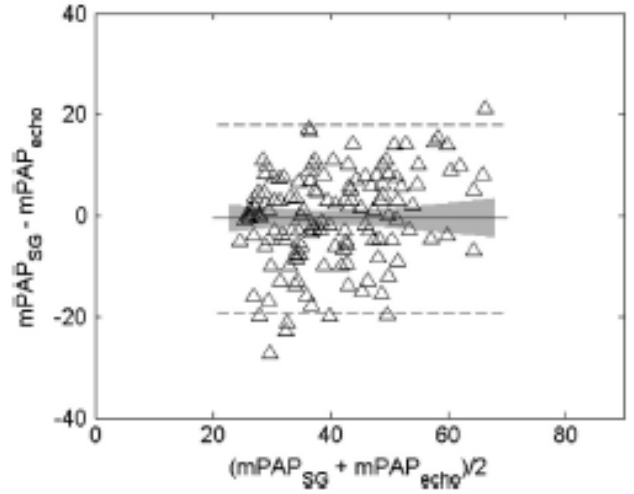
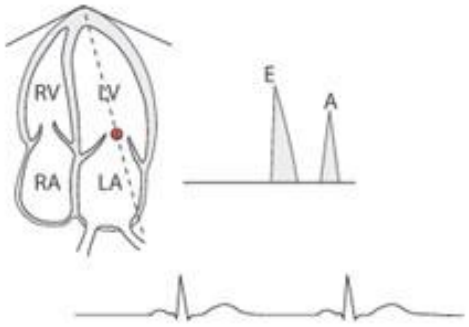
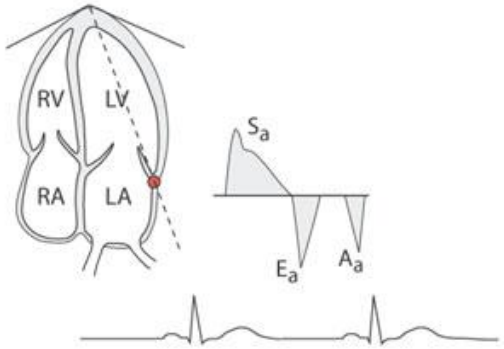


Fig. 2. Bland–Altman analysis demonstrating near-absence of bias but moderate agreement between echocardiographic and right heart catheterization estimates of mean pulmonary artery pressure in 152 patients. The shaded area represents the confidence interval on the difference between the means, and dashed lines: *mean* ± 2*SD*.

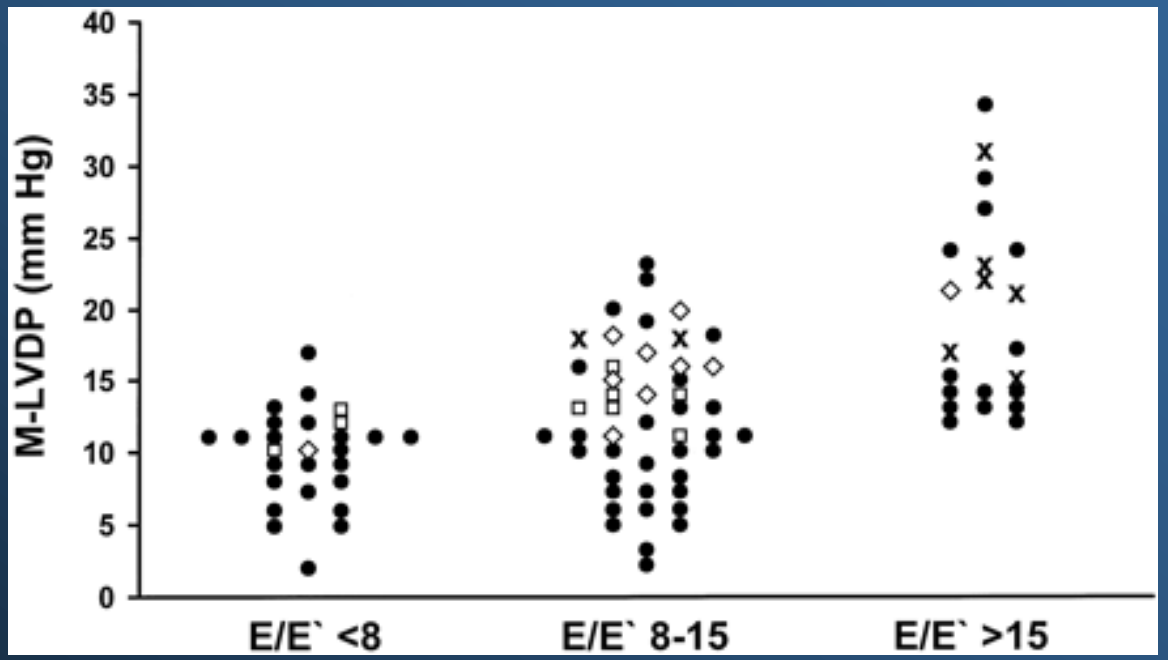
E / Ea ratio



E Flussimetrico Mitralico



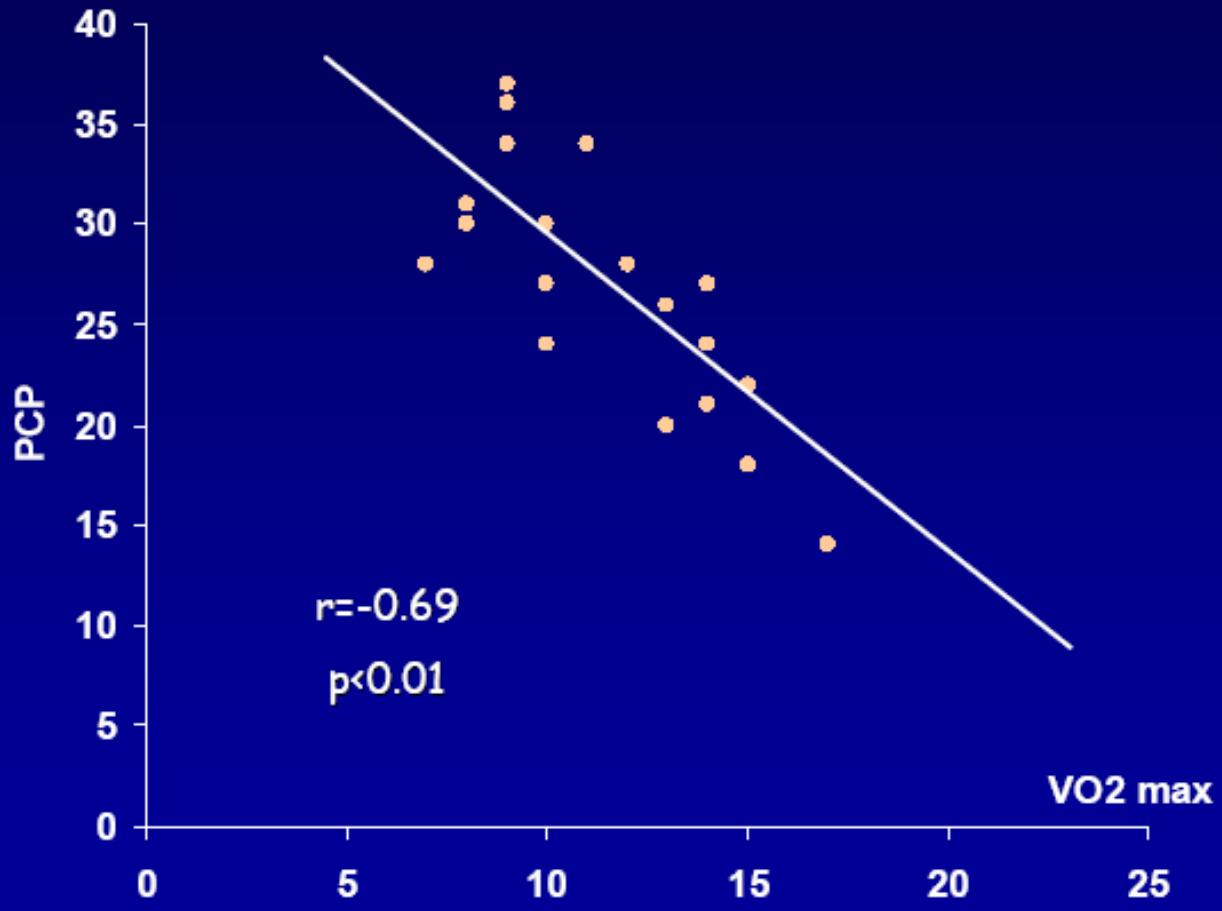
Ea Anulus Mitralico



Omnem Circulation 2003

Relazione fra pressione capillare polmonare e VO2 max

Szlachcic Am J Cardiol 1985



Pulmonary Pressures in Healthy Subjects: the Age Impact..!!

D'Andrea A, Bossone E, Grunig E, et al. CHEST 2014

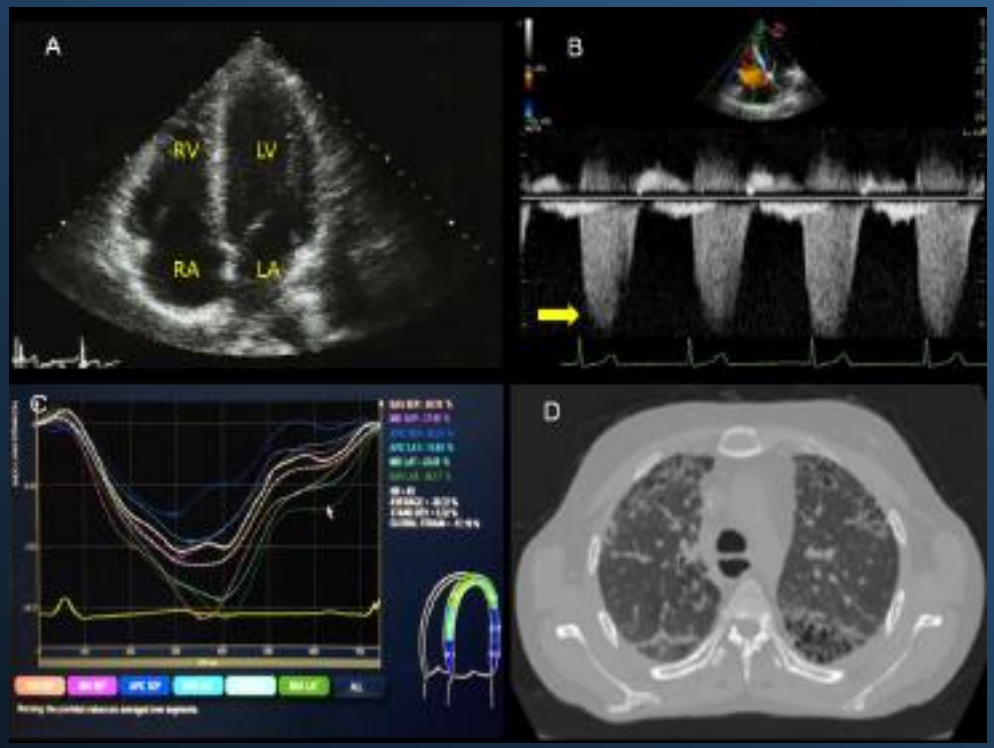
DOI: 10.1111/echo.12992

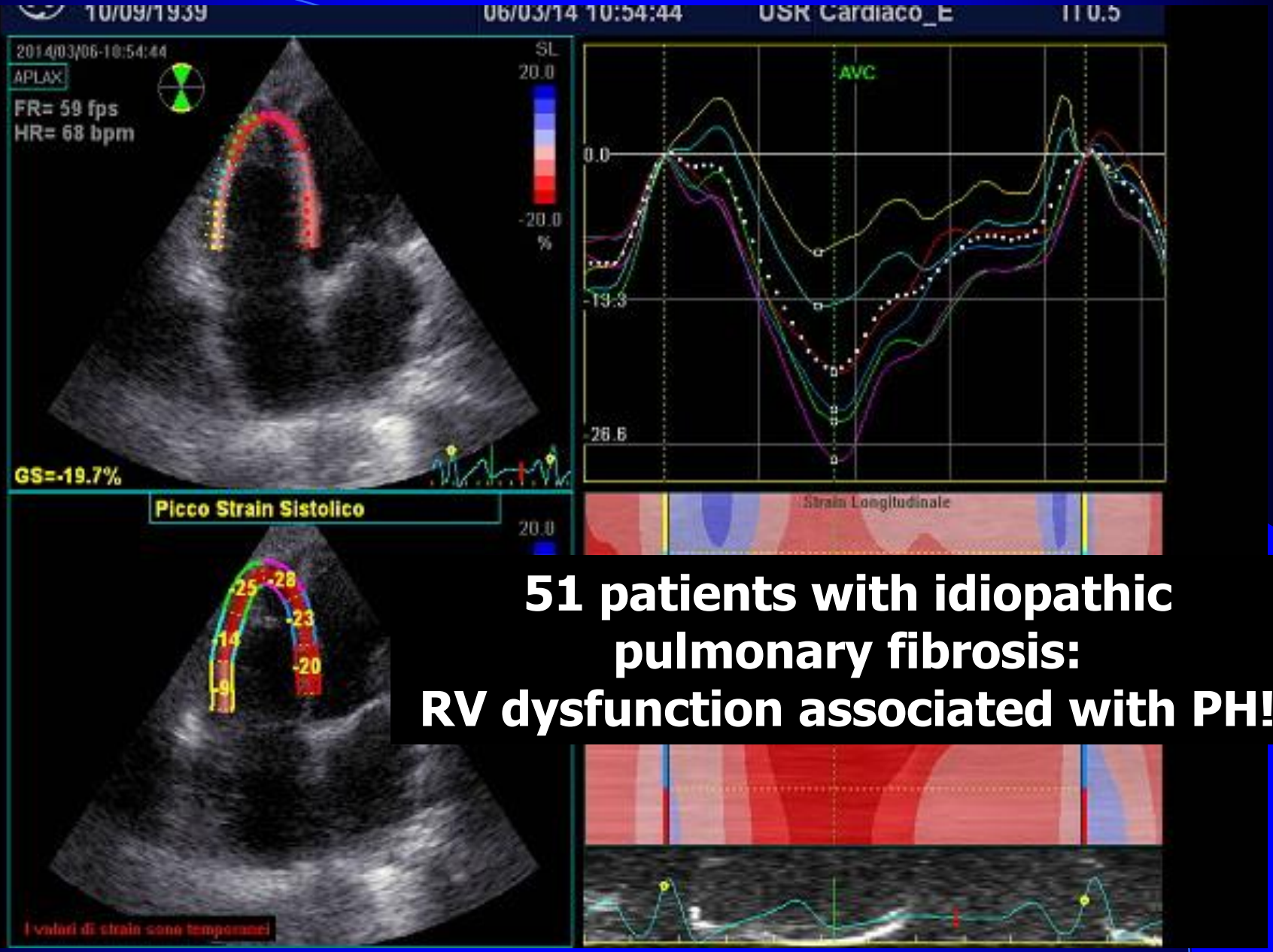
Echocardiography

ORIGINAL INVESTIGATION

Right Ventricular Structure and Function in Idiopathic Pulmonary Fibrosis with or without Pulmonary Hypertension

Antonello D'Andrea, M.D., Ph.D.,* Anna Stanziola, M.D.,† Enza Di Palma, M.D.,* Maria Martino, M.D.,† Michele D'Alto, M.D.,* Santo Dellegrottaglie, M.D.,‡ Rosangela Cocchia, M.D.,* Lucia Riegler, M.D.,* Meredyth Vanessa Betancourt Cordido, M.D.,* Maurizia Lanza, M.D.,† Marco Maglione, M.D.,§ Veronica Diana, M.D.,* Raffaele Calabrò, M.D.,* Maria Giovanna Russo, M.D.,* Mani Vannan, M.D.,¶ and Eduardo Bossone, M.D., Ph.D.**





51 patients with idiopathic pulmonary fibrosis: RV dysfunction associated with PH!

D'Andrea A, Bossone E. Euroecho 2014

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Right Ventricular Dysfunction and Remodeling in Chronic Obstructive Pulmonary Disease Without Pulmonary Hypertension

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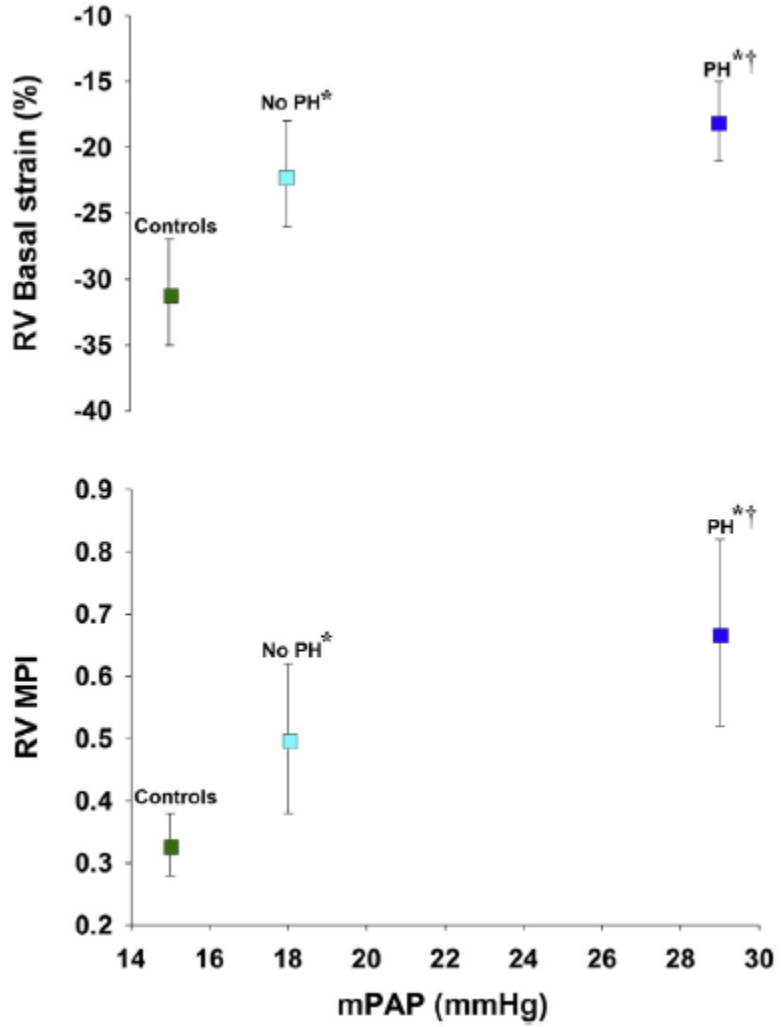
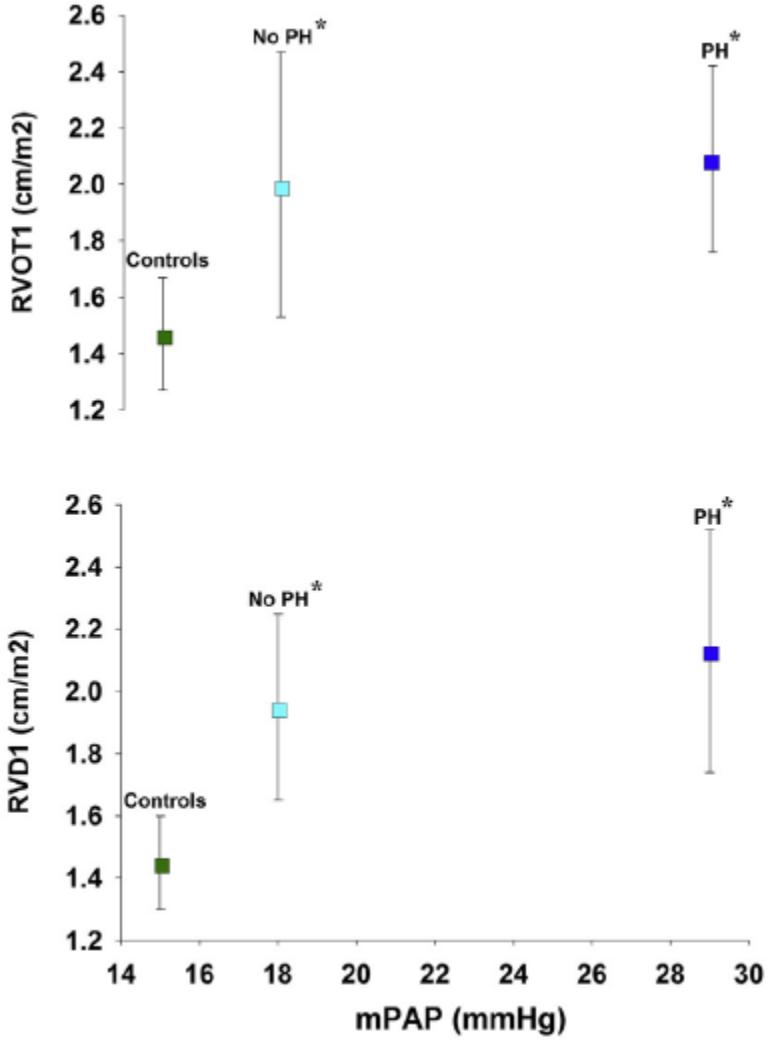
Table 3 Echocardiographic Data for 98 Patients With COPD With and Without PH and 34 Healthy Controls

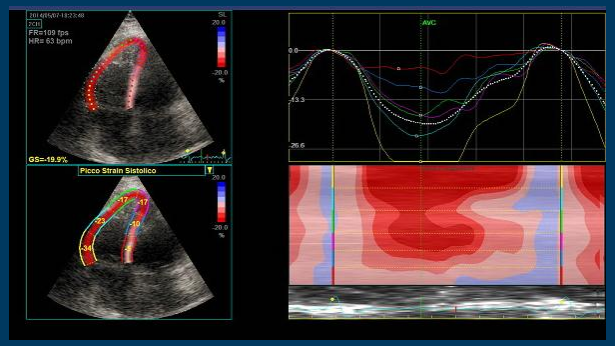
Variables	Healthy Controls (n = 34)	Patients With COPD (n = 98)		p Value (Analysis of Variance)
		No PH (n = 72)	PH (n = 26)	
RV global function				
RV myocardial performance index	0.33 ± 0.05	0.50 ± 0.12*	0.67 ± 0.15*†	<0.01
RV systolic function				
RV basal longitudinal strain (%)	−31 ± 4	−22 ± 4*	−18 ± 3*†	<0.01
TDI RV isovolumic acceleration (m/s^2)	3.1 ± 0.7	2.0 ± 0.4*	1.6 ± 0.5*†	<0.01
TAPSE (mm)	27 ± 3	22 ± 3*	19 ± 4*†	<0.01
TDI tricuspid annular displacement (mm)	26 ± 5	22 ± 3*	18 ± 4*†	<0.01
RV fractional area change (%)	47 ± 8	39 ± 8*	34 ± 8*†	<0.01
RV fractional shortening (%)	50 ± 13	40 ± 14*	38 ± 10*	<0.01
TDI tricuspid annular systolic velocity (cm/s)	15.2 ± 3.1	12.8 ± 2.2*	12.8 ± 2.6*	<0.01
TDI RV basal systolic velocity (cm/s)	11.5 ± 1.6	9.1 ± 1.1*	8.5 ± 0.7*	<0.01
Three-dimensional RV ejection fraction (%)	58 ± 4	50 ± 5*	46 ± 6*†	<0.01
RV geometry				
RV outflow tract wall thickness (mm)	3.5 ± 0.5	5.5 ± 1.0*	6.6 ± 1.1*†	<0.01
RV outflow tract 1 proximal (cm/m^2)‡	1.47 ± 0.2	2.00 ± 0.47*	2.09 ± 0.33*	<0.01
RV outflow tract 2 distal (cm/m^2)‡	1.24 ± 0.11	1.39 ± 0.18*	1.42 ± 0.19*	<0.01
RV hypertrophy (%)	0	42*	92*†	<0.01
RV dimension 1 base (cm/m^2)‡	1.45 ± 0.15	1.95 ± 0.30*	2.13 ± 0.39*†	<0.01
RV dimension 2 mid (cm/m^2)‡	1.15 ± 0.17	1.42 ± 0.31*	1.52 ± 0.34*	<0.01
RV dimension 3 base apex (cm/m^2)‡	4.04 ± 0.29	4.56 ± 0.43*	4.69 ± 0.57*	<0.01

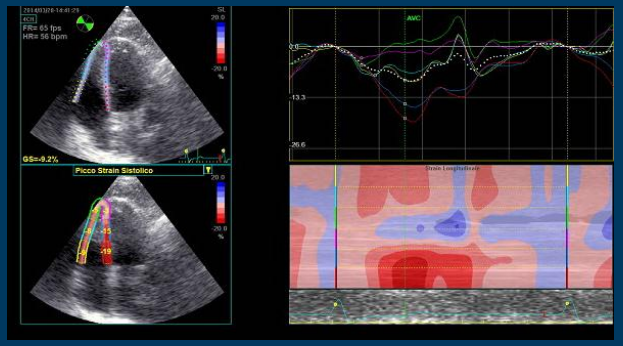
Values are mean ± SD or %. *Significantly different ($p < 0.01$) from controls. †Significantly different ($p < 0.01$) from no PH. ‡Indexed for body surface area.
TAPSE = tricuspid annular plane systolic excursion; TDI = tissue Doppler imaging; other abbreviations as in Tables 1 and 2.

RV dysfunction even before PH !!



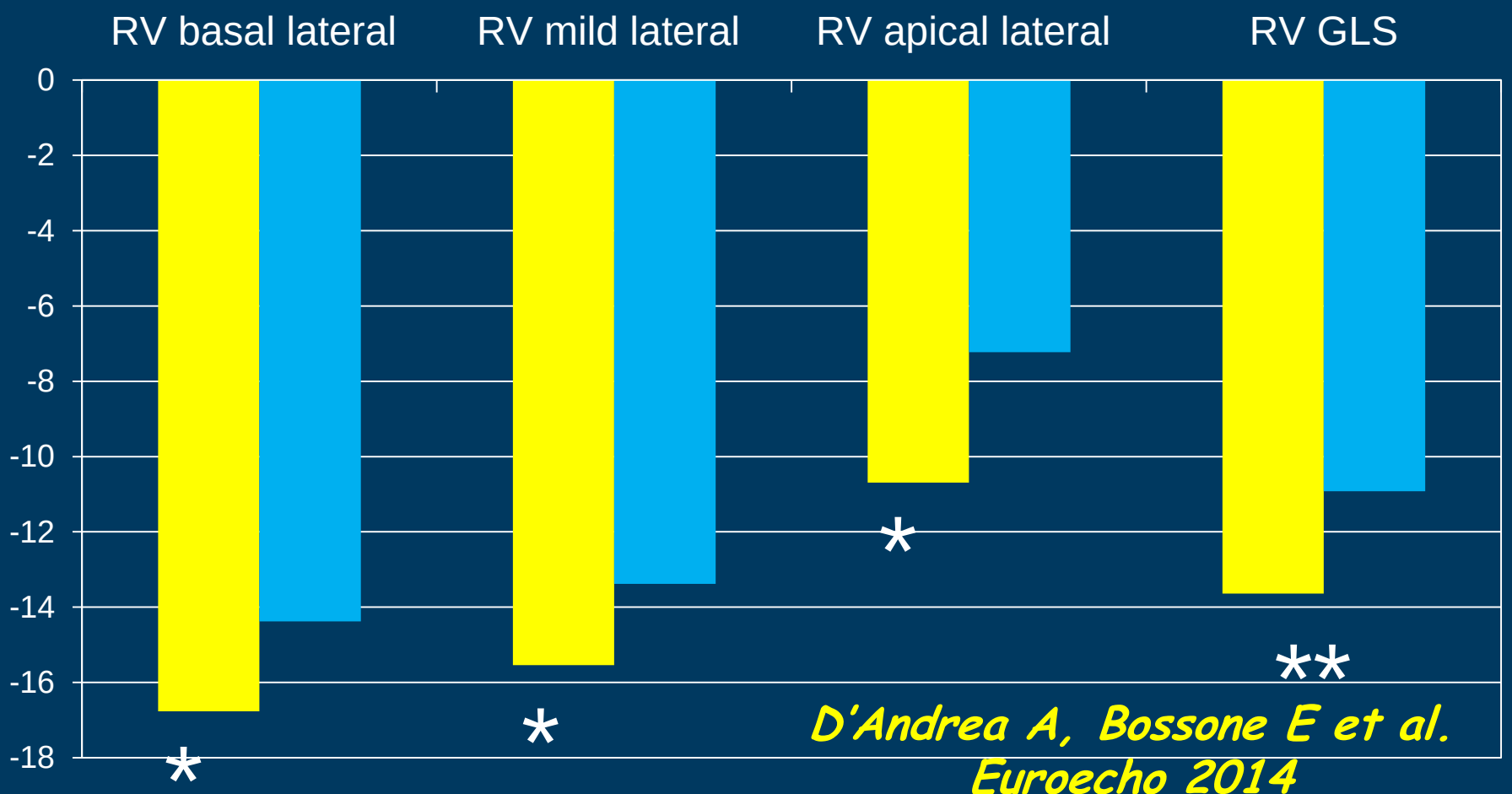






RESULTS

RV 2D-STE



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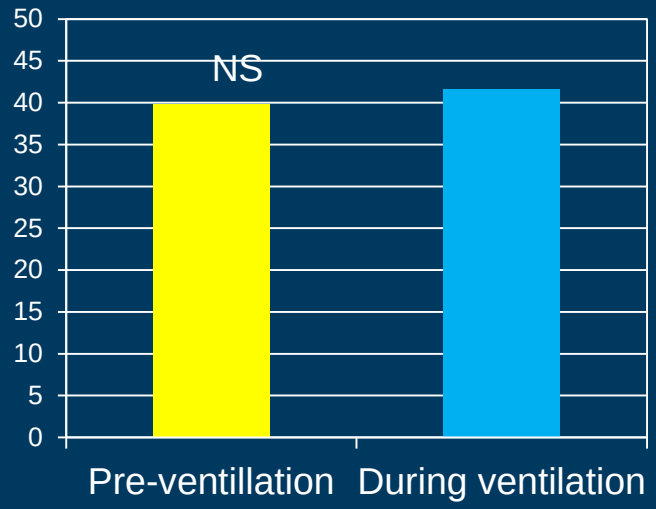
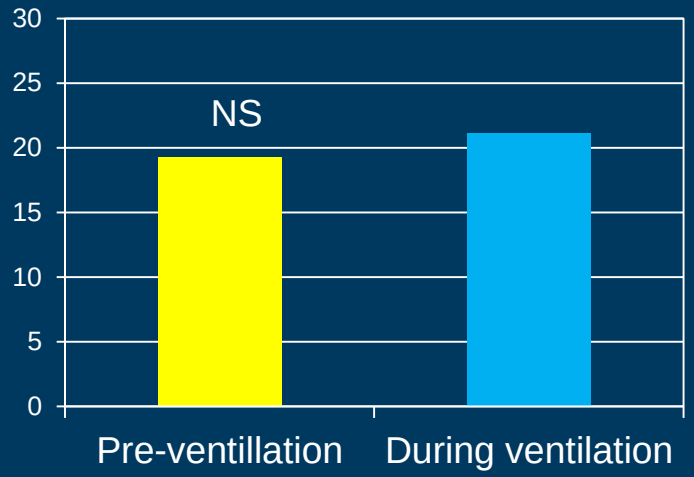
RESULTS

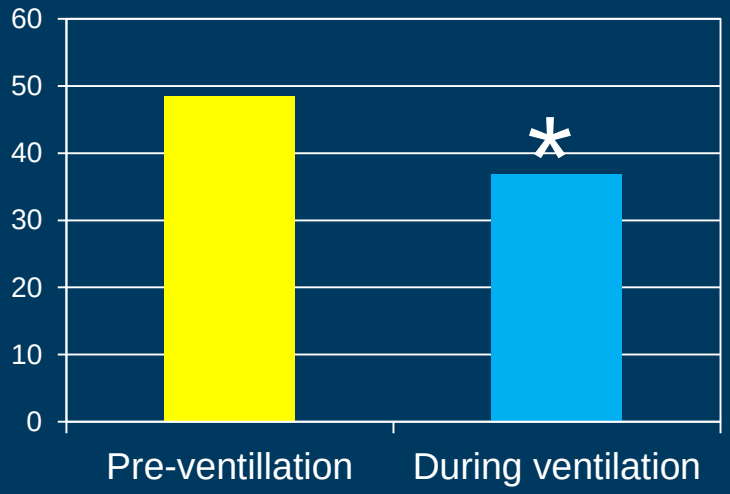
RA diameter

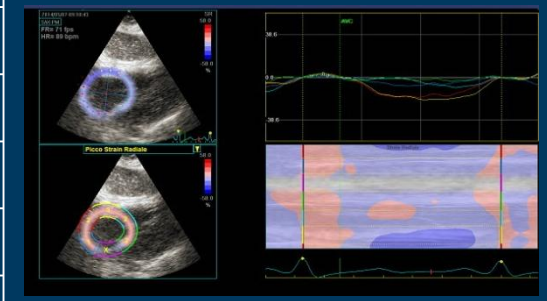


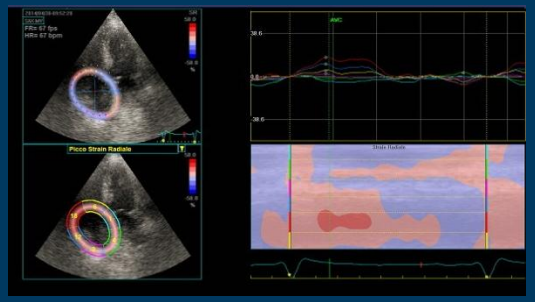
RA area



RA lateral wall 2D-STE







D'Andrea A, Bossone E et al. Euroecho 2014

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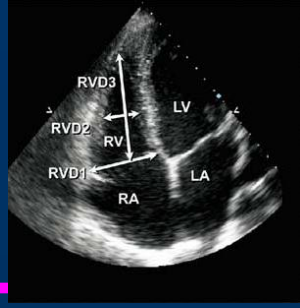
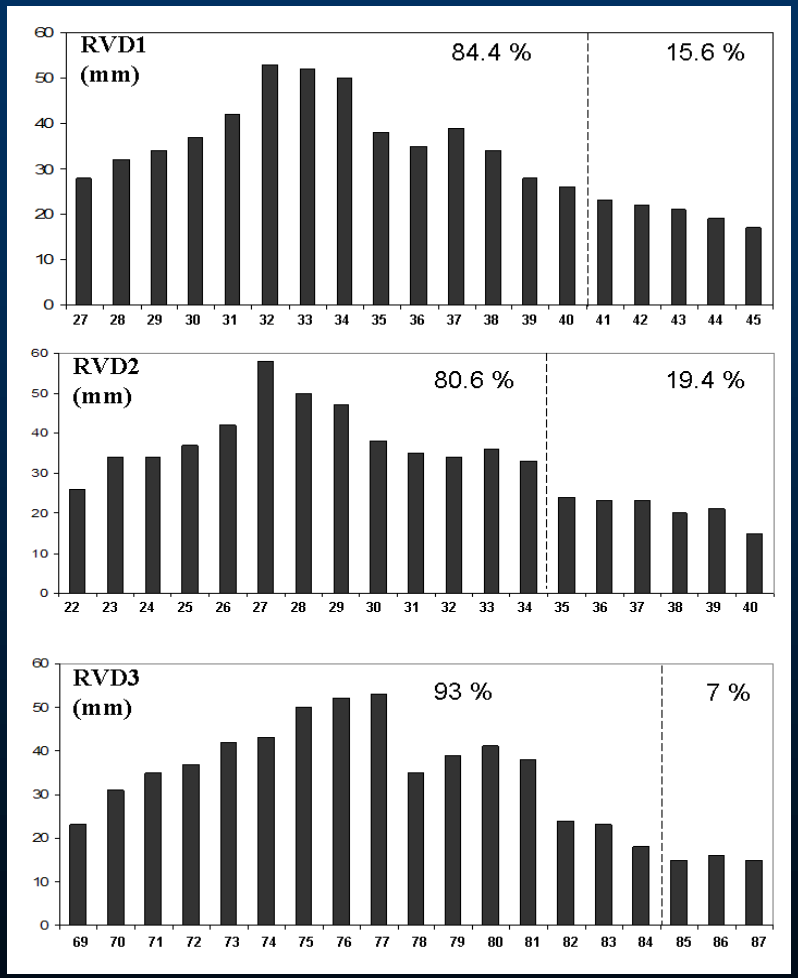
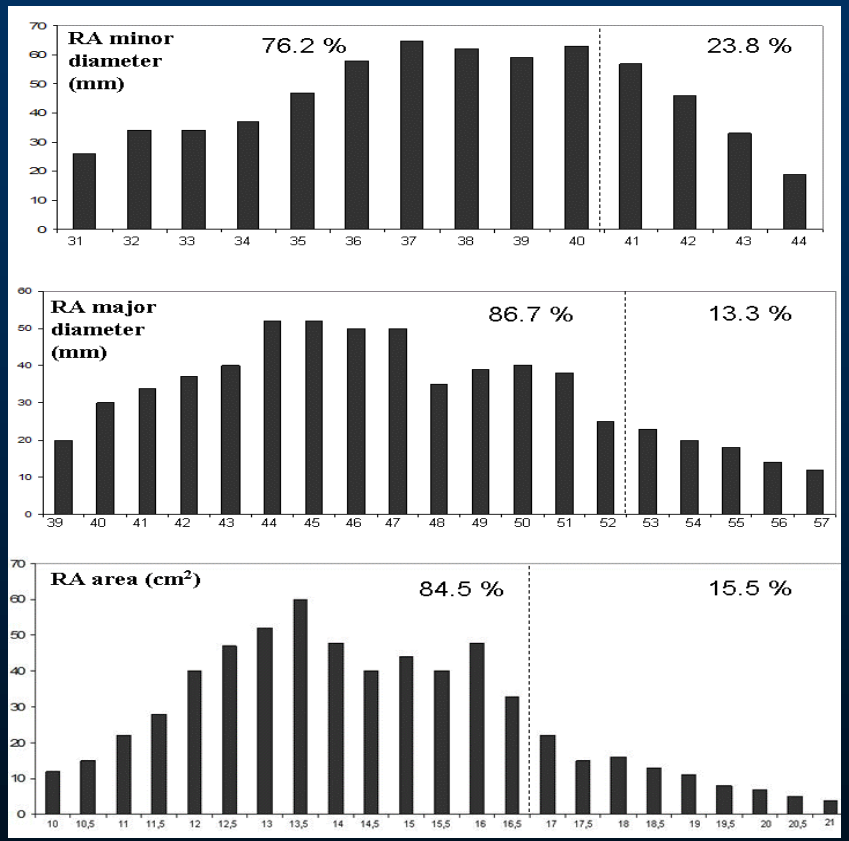
Range of right heart measurements in top-level athletes: The training impact

Antonello D'Andrea [a,c,*], Lucia Riegler [a,c], Enrica Golia [a,c], Rosangela Cocchia [a,c], Raffaella Scarafile [a,c], Gemma Salerno [a,c], Enrica Pezzullo [a,c], Luigi Nunziata [a,c], Rodolfo Citro [b], Sergio Cuomo [a,c], Pio Caso [a,c], Giovanni Di Salvo [a,c], Antonello Cittadini [a,c], Maria Giovanna Russo [a,c], Raffaele Calabrò [a,c], Eduardo Bossone [d]







D'Andrea A. et al.
Int J Cardiol 2011

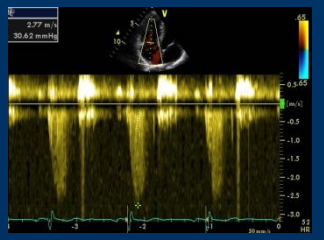
D'Andrea A. et al.
CHEST 2010

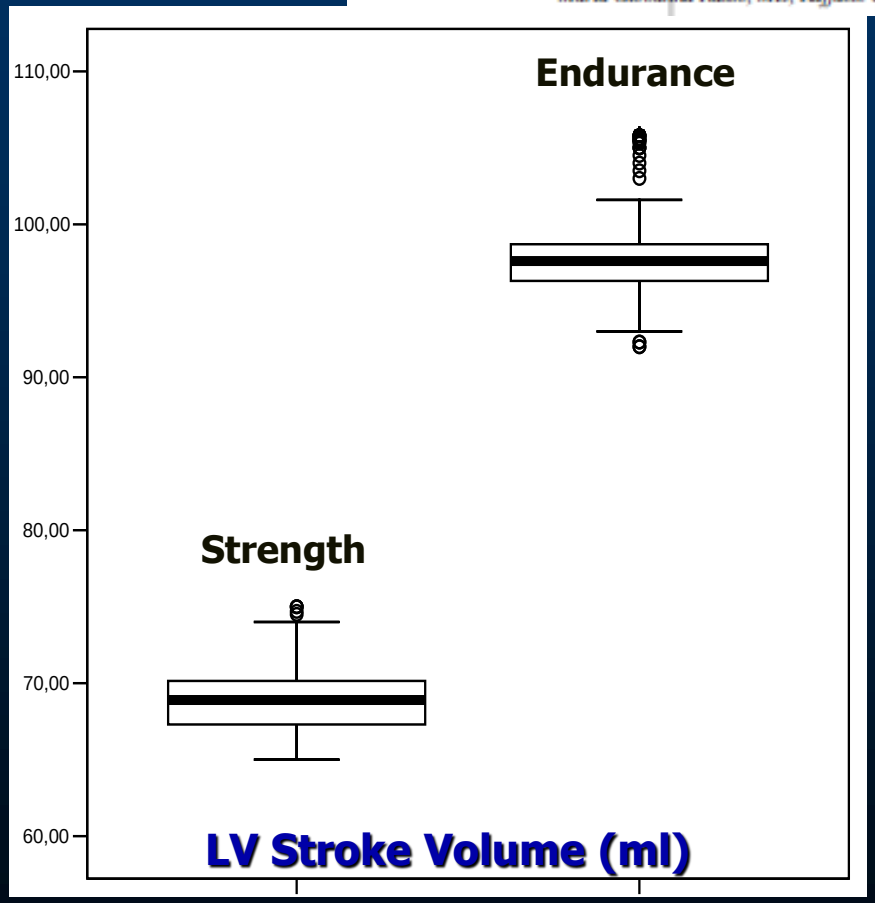
CHEST Original Research

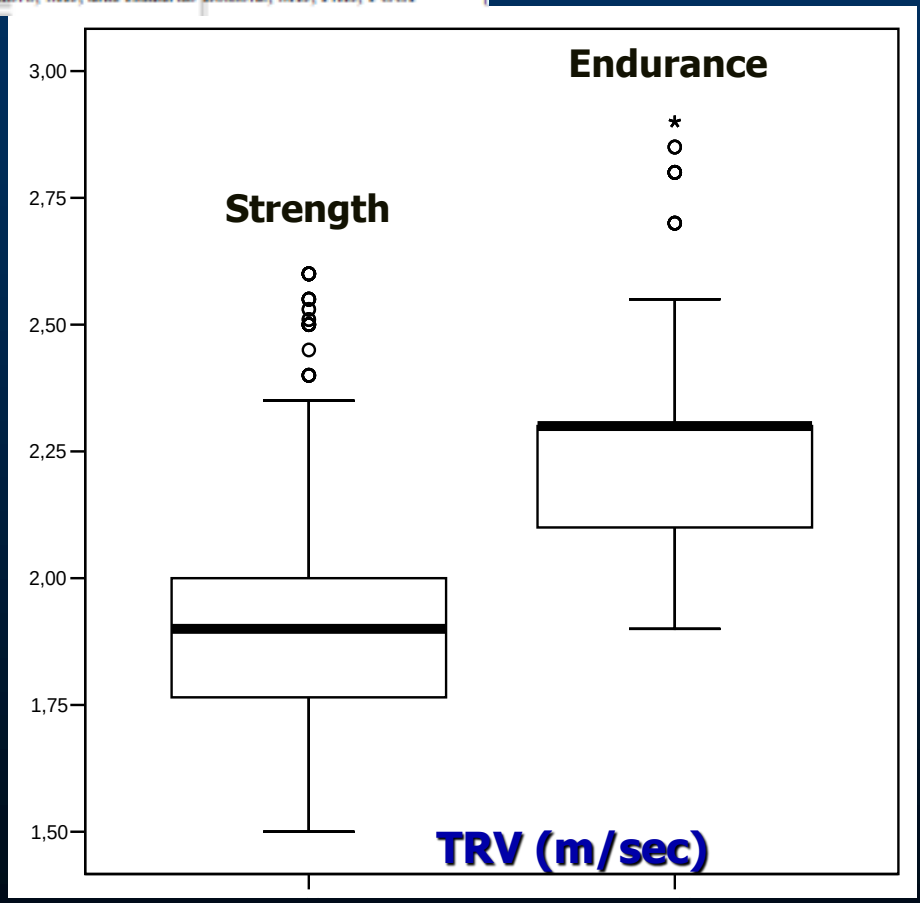
Range in Pulmonary Artery Systolic Pressure Among Highly Trained Athletes

Pulmonary Artery Systolic Pressure in Athletes

Antonello D'Andrea, MD, PhD; Robert Naeije, MD; Michele D'Alto, MD; Paola Argiento, MD; Enrica Golia, MD; Rosangela Cocchia, MD; Lucia Riegler, MD; Raffaella Scarafile, MD; Giuseppe Limongelli, MD; Giovanni Di Salvo, MD; Rodolfo Citro, MD; Pio Caso, MD; Maria Giovanna Russo, MD; Raffaele Calabrò, MD; and Eduardo Bossone, MD, PhD, FCCP

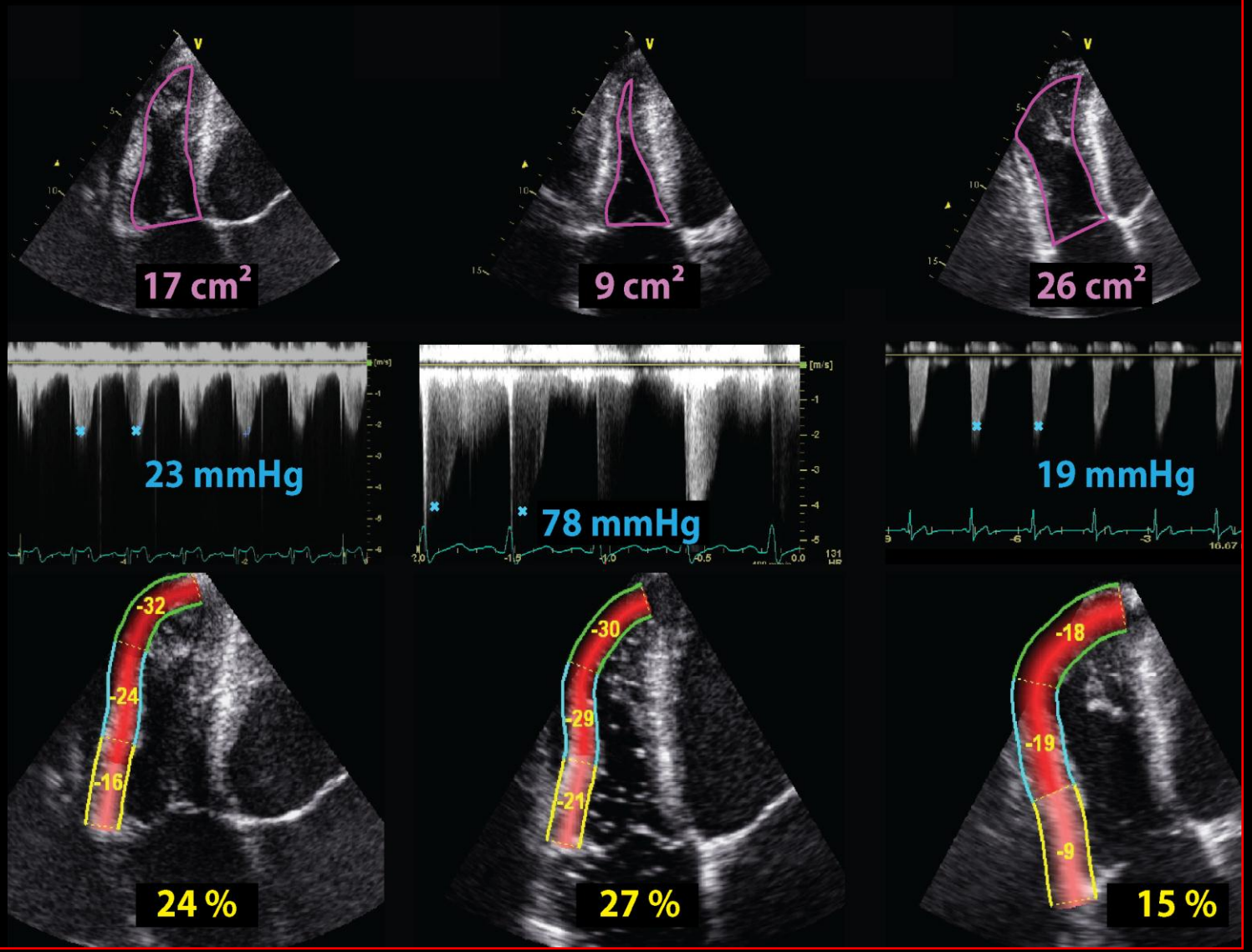






PASP Upper limit: 40 mmHg

Effect of Exercise on RV

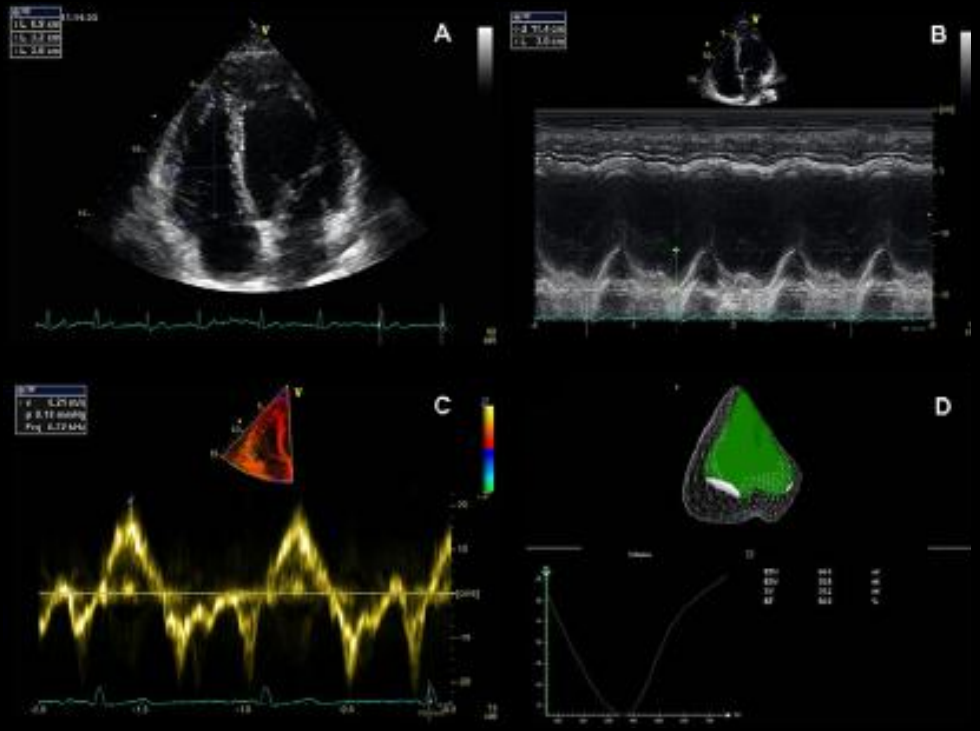


D'Andrea A, La Gerche A, Bossone E. Echocardiography 2014.

Right Ventricular Morphology and Function in Top-Level Athletes: A Three-Dimensional Echocardiographic Study

Antonello D'Andrea, MD, FESC, Lucia Riegler, MD, Salvatore Morra, MD, Raffaella Scarafile, MD, Gemma Salerno, MD, Rosangela Cocchia, MD, Enrica Golia, MD, Francesca Martone, MD, Giovanni Di Salvo, MD, FESC, Giuseppe Limongelli, MD, FESC, Giuseppe Pacileo, MD, Eduardo Bossone, MD, PhD, FESC, FACC, Raffaele Calabrò, MD, and Maria Giovanna Russo, MD,
Naples and Milan, Italy

D'Andrea A. et al - JASE 2012



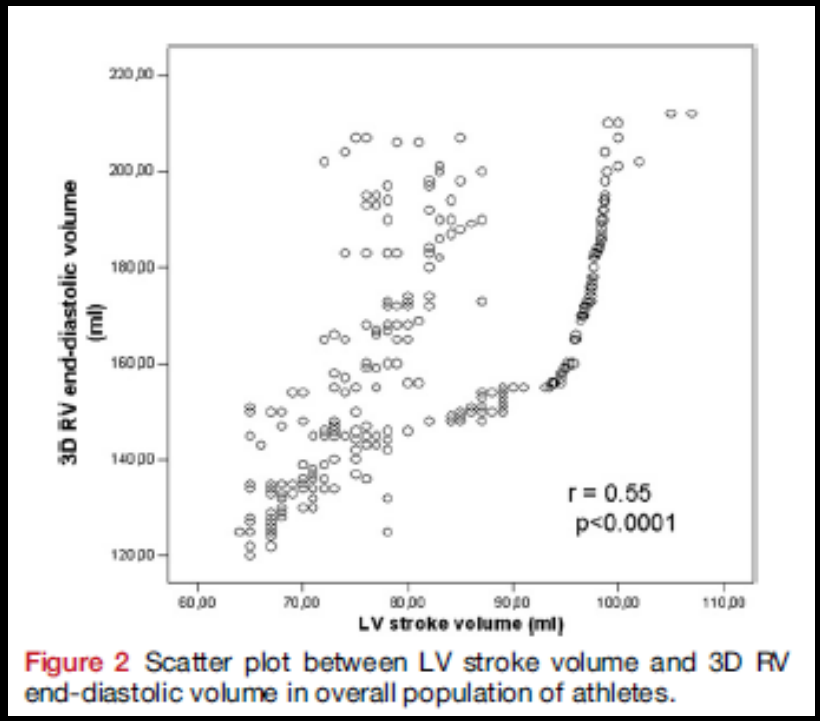


Figure 2 Scatter plot between LV stroke volume and 3D RV end-diastolic volume in overall population of athletes.

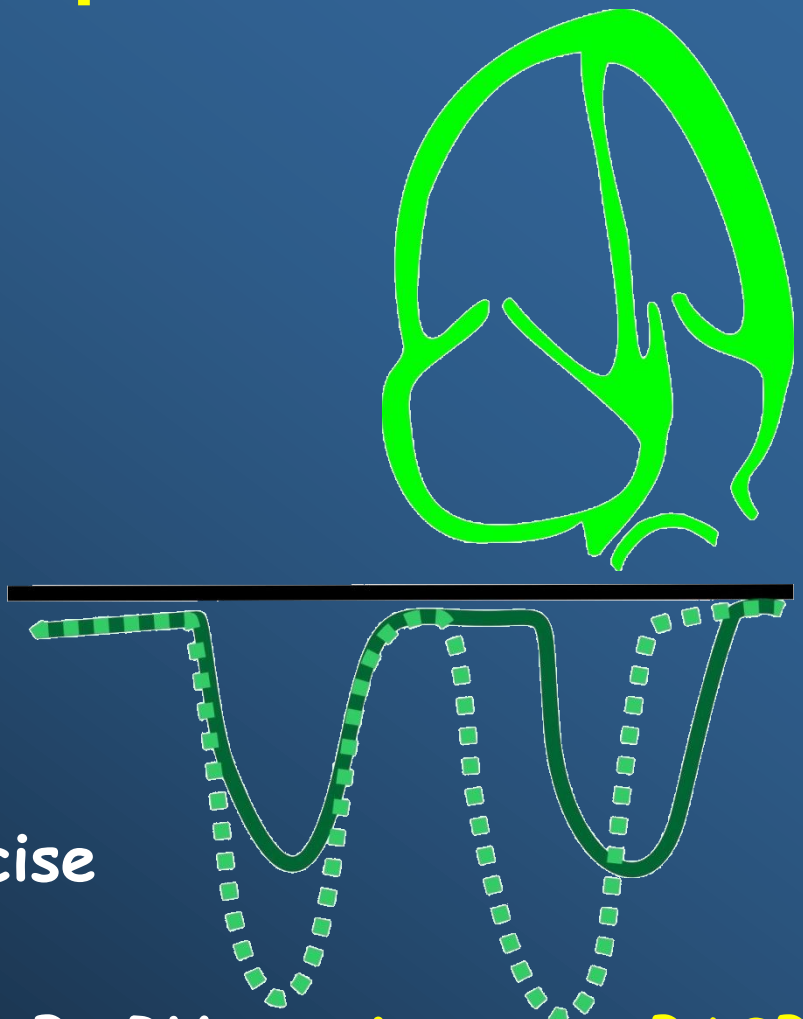
Assessment and Prognostic Relevance of Right Ventricular Contractile Reserve in Patients with Severe Pulmonary Hypertension

Running title: *Grünig et al.; RV reserve in pulmonary hypertension*

Ekkehard Grünig, MD[1*]; Henning Tiede, MD MSc[2*], Esi Otuwa Enyimayew[1*], Nicola Ehlken[1], BSc; Hans-Jürgen Seyfarth, MD[3]; Eduardo Bossone, MD[4]; Antonello D´Andrea, MD[5]; Robert Naeije, MD[6]; Horst Olschewski, MD[7]; Silvia Ulrich, MD[8]; Christian Nagel, MD[1]; Michael Halank, MD[9*]; Christine Fischer, PhD[10*]

Circulation
2014

Right ventricular contractile reserve and pulmonary arterial pressure



During exercise

A: RV can not increase PASP during exercise

B: RV can increase PASP during exercise

Survival depends on PASP response

Numbers at risk [n]

Time [years]	0	1	2	3	4
>30mmHg	56	47	42	31	16
≤30mmHg	65	57	47	26	11

Indici di Prognosi Sfavorevole

- **Clinici:**
  - Classe III-IV nonostante epoprostenolo
- **6MWT:**
  - <250 m in basale (o <380 m dopo epoprostenolo)
  - >10% di desaturazione
- **Echo:**
  - Indice di eccentricità (VS "empty")
  - Area AD
  - Versamento pericardico (almeno moderato)
  - Tei index (>0.88)
  - TAPSE < 14 mm
- **Cath:**
  - RAP >20 mmHg
  - CI < 2 l/min
  - SVO2 <63%
- **Biochimica:**
  - BNP (>150 pg/ml)
  - Troponina

Sciomer S. Italian Heart J October 2005