



Congresso
Novas Fronteiras em Cardiologia
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Hotel Vila Galé Ericeira



Hipertensão Pulmonar

Preditores de Mortalidade

Rui Plácido

9 | Fevereiro | 2013

Hipertensão Pulmonar

Condição hemodinâmica e fisiopatológica caracterizada por uma pressão arterial pulmonar média ≥ 25 mmHg em repouso obtida por cateterismo cardíaco direito.

Multiplicidade de condições clínicas

Hipertensão Pulmonar

Condição hemodinâmica e fisiopatológica caracterizada por uma pressão arterial pulmonar média ≥ 25 mmHg em repouso obtida por cateterismo cardíaco direito.

Classificação Clínica Dana Point, 2008

1 Pulmonary arterial hypertension (PAH)

- 1.1 Idiopathic
- 1.2 Heritable
 - 1.2.1 BMPR2
 - 1.2.2 ALK1, endoglin (with or without hereditary haemorrhagic telangiectasia)
 - 1.2.3 Unknown
- 1.3 Drugs and toxins induced
- 1.4 Associated with (APAH)
 - 1.4.1 Connective tissue diseases
 - 1.4.2 HIV infection
 - 1.4.3 Portal hypertension
 - 1.4.4 Congenital heart disease
 - 1.4.5 Schistosomiasis
 - 1.4.6 Chronic haemolytic anaemia
- 1.5 Persistent pulmonary hypertension of the newborn

1' Pulmonary veno-occlusive disease and/or pulmonary capillary haemangiomatosis

2 Pulmonary hypertension due to left heart disease

- 2.1 Systolic dysfunction
- 2.2 Diastolic dysfunction
- 2.3 Valvular disease

3 Pulmonary hypertension due to lung diseases and/or hypoxia

- 3.1 Chronic obstructive pulmonary disease
- 3.2 Interstitial lung disease
- 3.3 Other pulmonary diseases with mixed restrictive and obstructive pattern
- 3.4 Sleep-disordered breathing
- 3.5 Alveolar hypoventilation disorders
- 3.6 Chronic exposure to high altitude
- 3.7 Developmental abnormalities

4 Chronic thromboembolic pulmonary hypertension

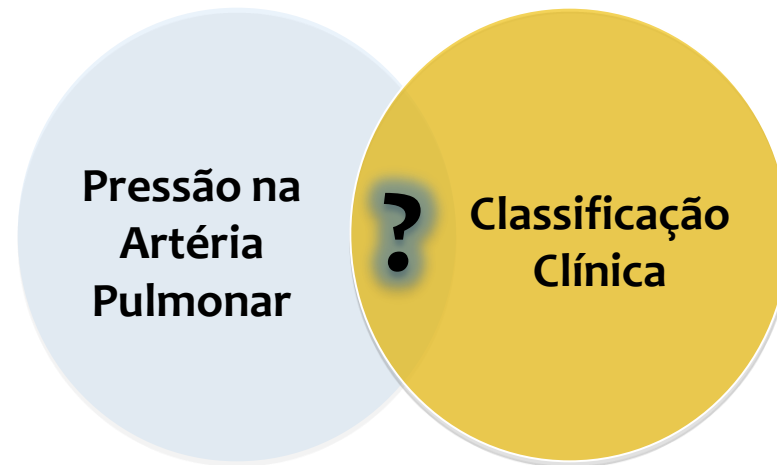
5 PH with unclear and/or multifactorial mechanisms

- 5.1 Haematological disorders: myeloproliferative disorders, splenectomy.
 - 5.2 Systemic disorders: sarcoidosis, pulmonary Langerhans cell histiocytosis, lymphangioleiomyomatosis, neurofibromatosis, vasculitis
 - 5.3 Metabolic disorders: glycogen storage disease, Gaucher disease, thyroid disorders
 - 5.4 Others: tumoural obstruction, fibrosing mediastinitis, chronic renal failure on dialysis
-

Hipertensão Pulmonar

Condição hemodinâmica e fisiopatológica caracterizada por uma pressão arterial pulmonar média ≥ 25 mmHg em repouso obtida por cateterismo cardíaco direito.

Taxa significativa de mortalidade / morbidade devido a insuficiência cardíaca direita



Fisiopatologia
Diagnóstico
Terapêutica
Prognóstico

Qual O Papel Da Imagiologia Na Abordagem Do Doente Com Hipertensão Pulmonar?

- 1** Diagnóstico
- 2** Definição etiológica (classificação clínica)
- 3** Prognóstico

Qual O Papel Da Imagiologia Na Abordagem Do Doente Com Hipertensão Pulmonar?

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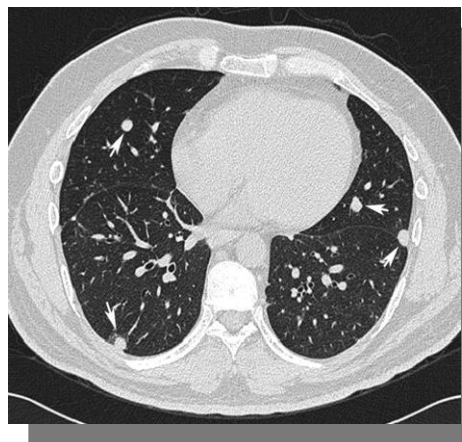
Qual O Papel Da Imagiologia Na Abordagem Do Doente Com Hipertensão Pulmonar?

Radiografia torácica



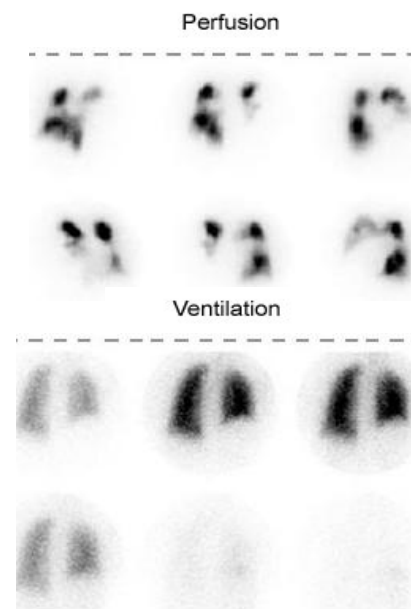
Fibrose pulmonar

TC tórax



Sarcoidose

Cintigrafia pulmonar V/P



Tromboembolismo pulmonar

Imagiologia Não-Invasiva na Hipertensão Pulmonar

Prognóstico

**VENTRÍCULO
DIREITO**

**VASCULATURA
PULMONAR**

Ecocardiografia

Área da AD

Derrame
pericárdio

S'
tricúspide

TAPSE

Regurgitação
tricúspide

Fracção de
área do VD

Diâmetros do
VD

Strain sistólico da
parede livre do VD

Índice de
excentricidade do VE

Dessincronia
do VD

Índice de *Tei*
do VD

Ecocardiografia

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do VD

Índice de *Tei*
do VD

Ecocardiografia



Guidelines for the diagnosis and treatment of pulmonary hypertension

Table 15 Parameters with established importance for assessing disease severity, stability and prognosis in PAH (adapted from McLaughlin and McGoon⁹⁴)

Better prognosis	Determinants of prognosis	Worse prognosis
No	Clinical evidence of RV failure	Yes
Slow	Rate of progression of symptoms	Rapid
No	Syncope	Yes
I, II	WHO-FC	IV
Longer (>500 m) ^a	6MWT	Shorter (<300 m)
Peak O ₂ consumption >15 mL/min/kg	Cardio-pulmonary exercise testing	Peak O ₂ consumption <12 mL/min/kg
Normal or near-normal	BNP/NT-proBNP plasma levels	Very elevated and rising
No pericardial effusion TAPSE ^b >2.0 cm	Echocardiographic findings ^b	Pericardial effusion TAPSE ^b <1.5 cm
RAP <8 mmHg and CI ≥2.5 L/min/m ²	Haemodynamics	RAP >15 mmHg or CI ≤2.0 L/min/m ²

^aDepending on age.

^bTAPSE and pericardial effusion have been selected because they can be measured in the majority of the patients.

BNP = brain natriuretic peptide; CI = cardiac index; 6MWT = 6-minute walking test; RAP = right atrial pressure; TAPSE = tricuspid annular plane systolic excursion; WHO-FC = WHO functional class.

Ecocardiografia

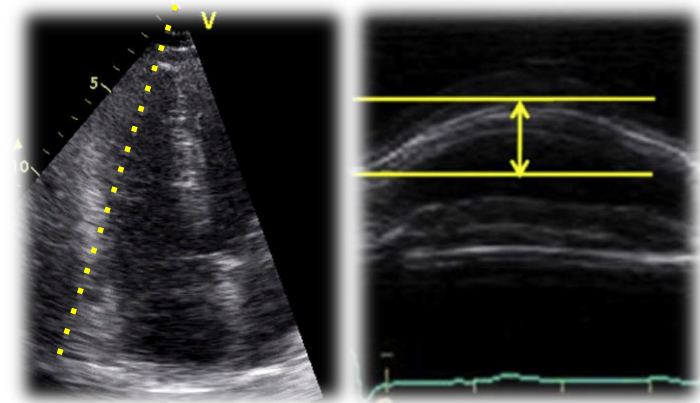
TAPSE

Função sistólica
longitudinal do VD



Função sistólica
global do VD

O VD ejecta o sangue primariamente por encurtamento das fibras longitudinais



Am Heart J. 1984 Mar;107(3):526-31.

Assessment of right ventricular function using two-dimensional echocardiography.

Kaul S, Tei C, Hopkins JM, Shah PM.

Abstract

With the use of two-dimensional echocardiography (2DE), we analyzed apical and subcostal four-chamber views for evaluation of right ventricular (RV) function in 30 individuals as compared to RV ejection fraction (RVEF) obtained by radionuclide angiography. In addition to previously reported parameters of changes in areas and chords, a new simple measurement of tricuspid annular excursion was correlated with RVEF. **A close correlation was noted between tricuspid annular plane systolic excursion (TAPSE) and RVEF ($r = 0.92$).** The RV end-diastolic area (RVEDA) and percentage of systolic change in area in the apical four-chamber view also showed close correlation with RVEF ($r = -0.76$ and 0.81); however, the entire RV endocardium could only be traced in about half of our patients. The end-diastolic transverse chord length and the percentage of systolic change in chord length in the apical view showed a poor correlation with RVEF. The correlation between RVEF and both areas and chords measured in the subcostal view was poor. It is concluded that the measurement of TAPSE offers a simple echocardiographic parameter which reflects RVEF. This measurement is not dependent on either geometric assumptions or traceable endocardial edges. When the endocardial outlines could be traced, the apical four-chamber view was superior to the subcostal view in assessment of RV function.

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Respiratory and Critical Care Medicine®

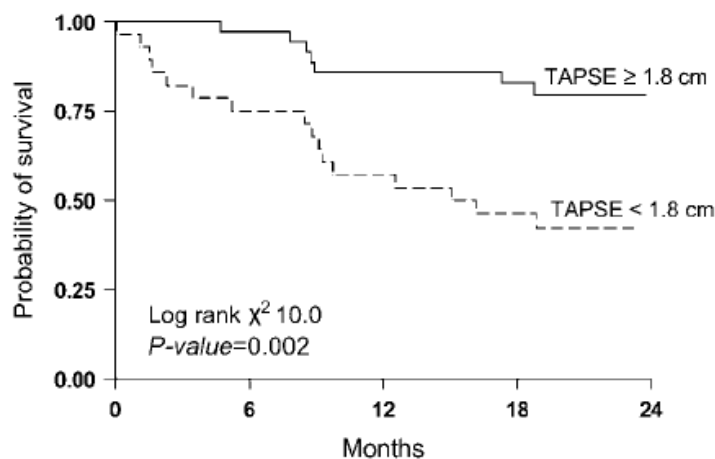
Tricuspid Annular Displacement Predicts Survival in Pulmonary Hypertension

Paul R. Forfia, Micah R. Fisher, Stephen C. Mathai, Traci Houston-Harris, Anna R. Hemnes, Barry A. Borlaug, Elzbieta Chamera, Mary C. Corretti, Hunter C. Champion, Theodore P. Abraham, Reda E. Girgis, and Paul M. Hassoun

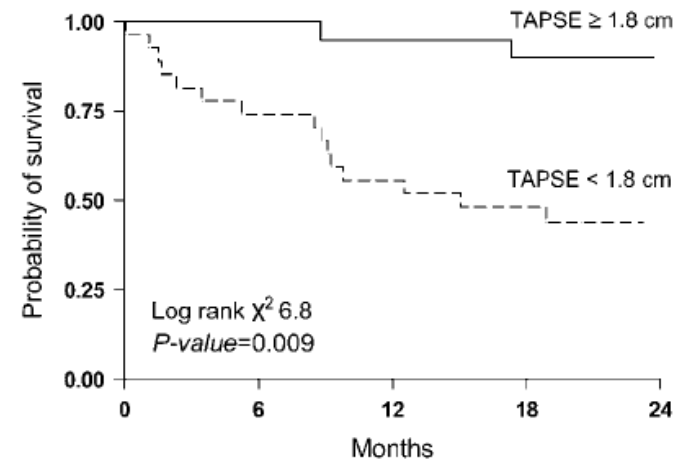
Divisions of Cardiology and Pulmonary and Critical Care Medicine, Department of Medicine, Johns Hopkins University, Baltimore, Maryland

- 63 doentes com HTP
- **TAPSE < 18 mm** associou-se:
- ↑ gravidade da disfunção sistólica do VD
(↓ IC; ↓ fracção área VD).
- Pior prognóstico (morte de qualquer causa).

A Overall cohort



B PAH only



TAPSE ≥ 1.8 cm (N)	35	34	30	29	23	TAPSE ≥ 1.8 cm (N)	17	17	16	15	15
TAPSE < 1.8 cm (N)	28	21	16	13	10	TAPSE < 1.8 cm (N)	30	23	18	16	13



International Journal of
CARDIOLOGY

Prognostic relevance of the echocardiographic assessment of right ventricular function in patients with idiopathic pulmonary arterial hypertension

Stefano Ghio ^{a,*}, Catherine Klersy ^b, Giulia Magrini ^a, Andrea Maria D'Armini ^c, Laura Scelsi ^a, Claudia Raineri ^a, Michele Pasotti ^a, Alessandra Serio ^a, Carlo Campana ^a, Mario Viganò ^c

Received 4 September 2008; received in revised form 1 November 2008; accepted 11 November 2008

Available online 12 December 2008

- A TAPSE provou ser o melhor parâmetro ecocardiográfico na predição de mortalidade ou necessidade de transplante pulmonar.
- TAPSE ≤ 15 mm associada a um risco cerca de 3 x superior de mortalidade.

- 59 dts consecutivos com HAP idiop.
- **Objectivo:** avaliar prospectivamente o valor prognóstico de vários índices ecocardiográficos de função do VD em doentes com HAP idiop.
- Classe III/IV OMS
- *Follow-up* médio: 52 meses
- 21 óbitos.
- 2 transplantes pulmonares

Echocardiographic characteristics.

RV diameter (mm)
RV free wall thickness (mm)
Diastolic RV area (cm²)
RV fractional area change (%)
Moderate to severe tricuspid regurgitation, N (%)
TAPSE (mm)
Transtricuspid gradient (mmHg)
Tei index
IVC diameter (mm)
IVC collapsibility >50%, N (%)
SVC flow velocity pattern (normal/X/Y) (%)
LV diastolic eccentricity index, median (IQR)
LV end diastolic volume (ml)
LV ejection fraction (%)
Pericardial effusion, N (%)

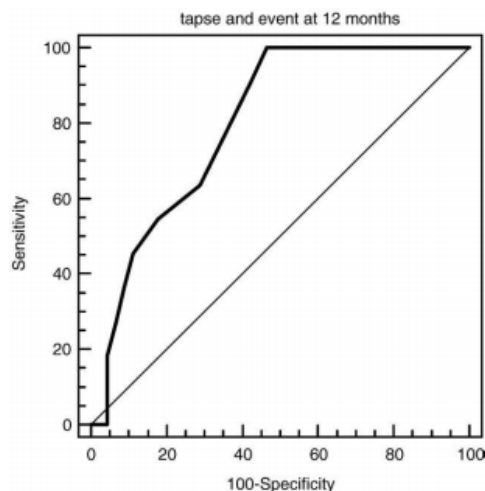
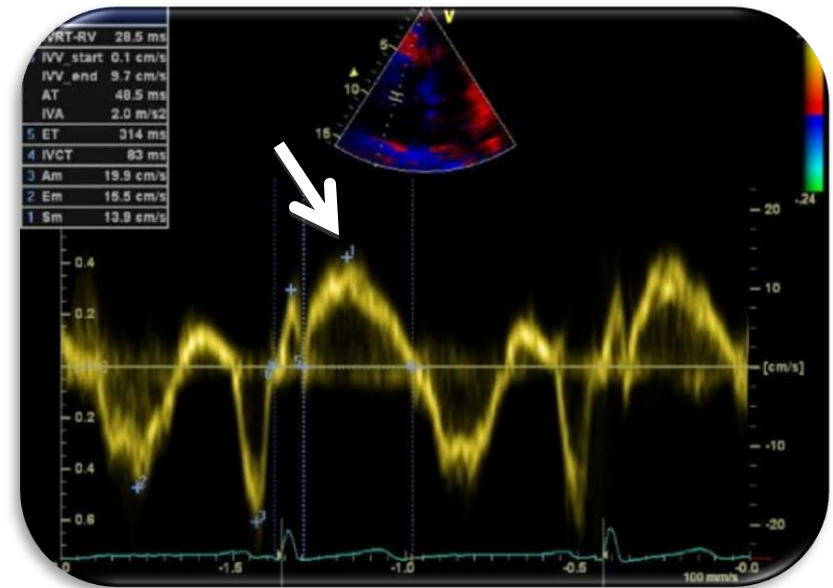
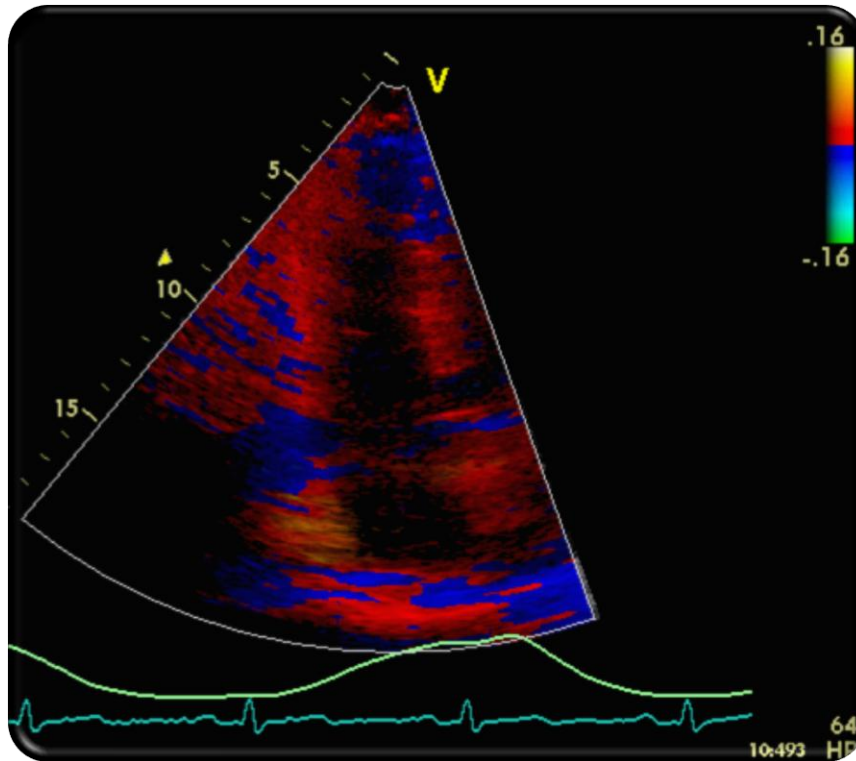


Fig. 1. Receiver-operating characteristic (ROC) curve analysis for identifying the optimal cut-off of TAPSE for events at 12 months. Area under the ROC curve 0.80, 95%CI 0.67–0.89; optimal cut-off: TAPSE ≤ 15 (sensitivity 100%; specificity 53%).

LIMITAÇÕES

- Depende das condições de carga do VD (pseudonormal na presença de sobrecarga de volume)



Eur J Echocardiography (2003) 4, 262–271
doi:10.1016/S1525-2167(02)00171-3

Prognostic Importance of the Right Ventricular Function Assessed by Doppler Tissue Imaging

J. Meluzín¹, L. Špinarová¹, L. Dušek², J. Toman¹, P. Hude¹ and J. Krejčí¹

- 139 doentes consecutivos com IC, 77% NYHA III/IV.
- S' tricúspide < 10,8 cm/s mostrou ser um preditor independente de mortalidade e sobrevivência livre de eventos em doentes com IC sintomática.

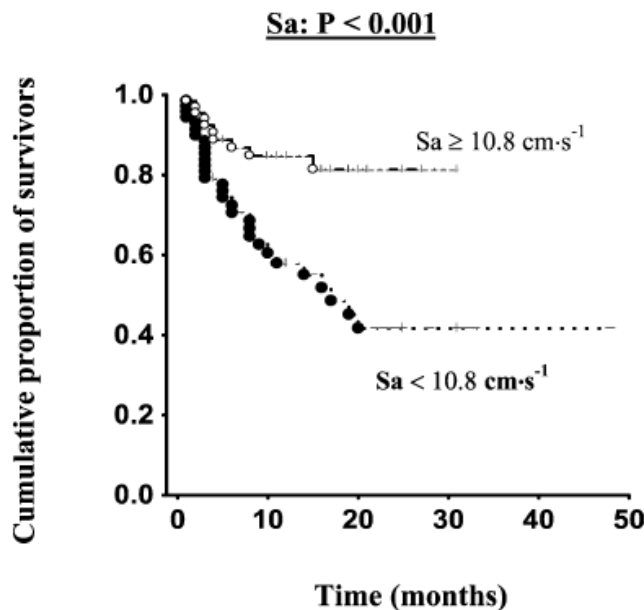


Figure 1. Kaplan–Meier analysis of event-free survival stratified according to the Sa (+: censored points). Sa = peak systolic tricuspid annular velocity.

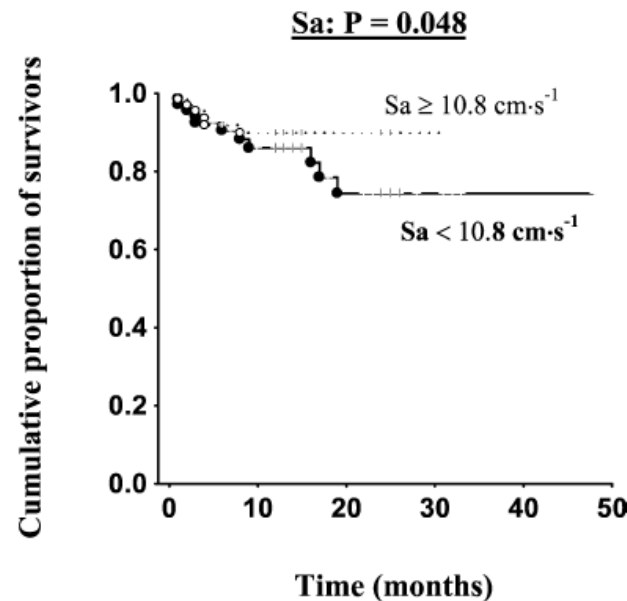


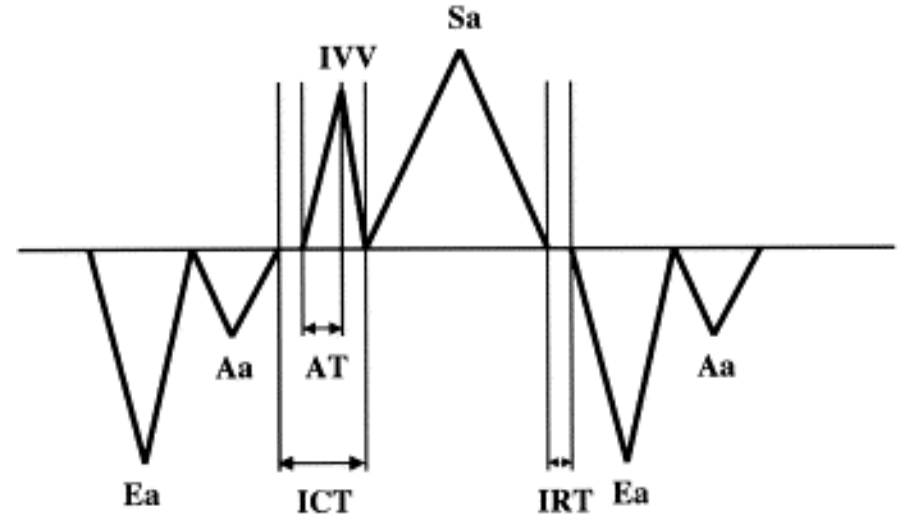
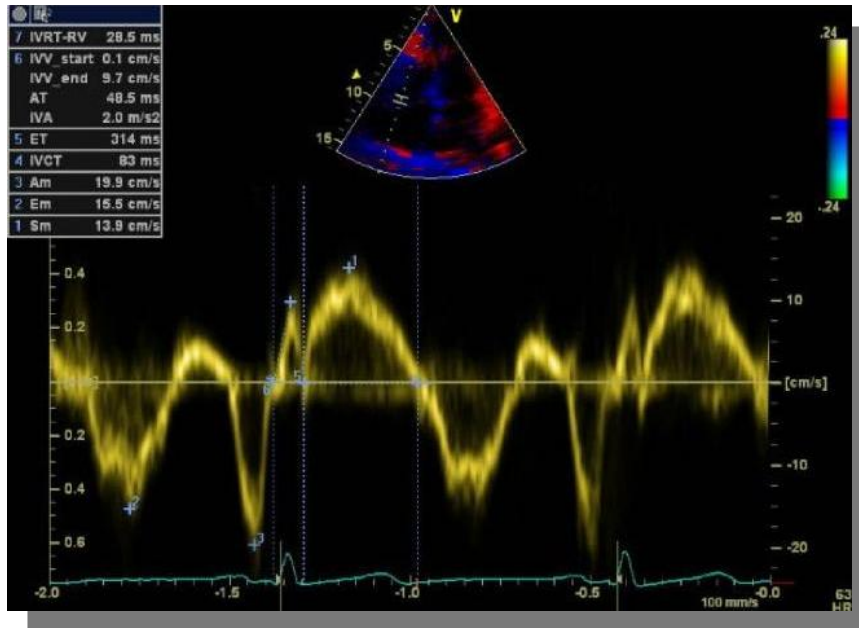
Figure 2. Kaplan–Meier analysis of survival stratified according to the Sa (+: censored points). Sa = peak systolic tricuspid annular velocity.

LIMITAÇÕES de S' tric

- Ajuste para valores de FC <70 e > 100 bpm
- Depende das condições de carga do VD

Ecocardiografia

*Aceleração miocárdica
isovolumétrica*



Velocidade de contracção isovolumétrica

Tempo de aceleração isovolumetrico

Menor dependência das
condições de carga

Circulation

JOURNAL OF THE AMERICAN HEART ASSOCIATION



Validation of Myocardial Acceleration During Isovolumic Contraction as a Novel Noninvasive Index of Right Ventricular Contractility : Comparison With Ventricular Pressure-Volume Relations in an Animal Model

Michael Vogel, Michael R. Schmidt, Steen B. Kristiansen, Michael Cheung, Paul A. White, Keld Sorensen and Andrew N. Redington

Circulation. 2002;105:1693-1699; originally published online March 25, 2002;

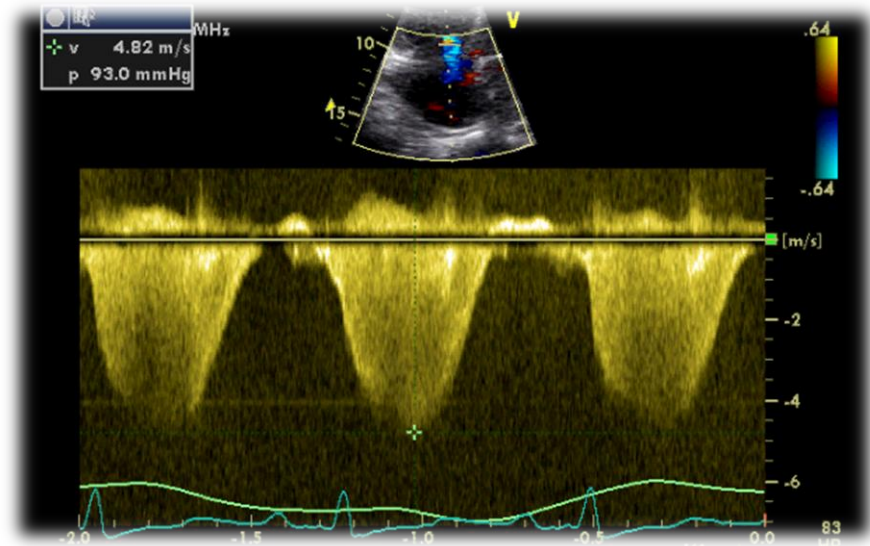
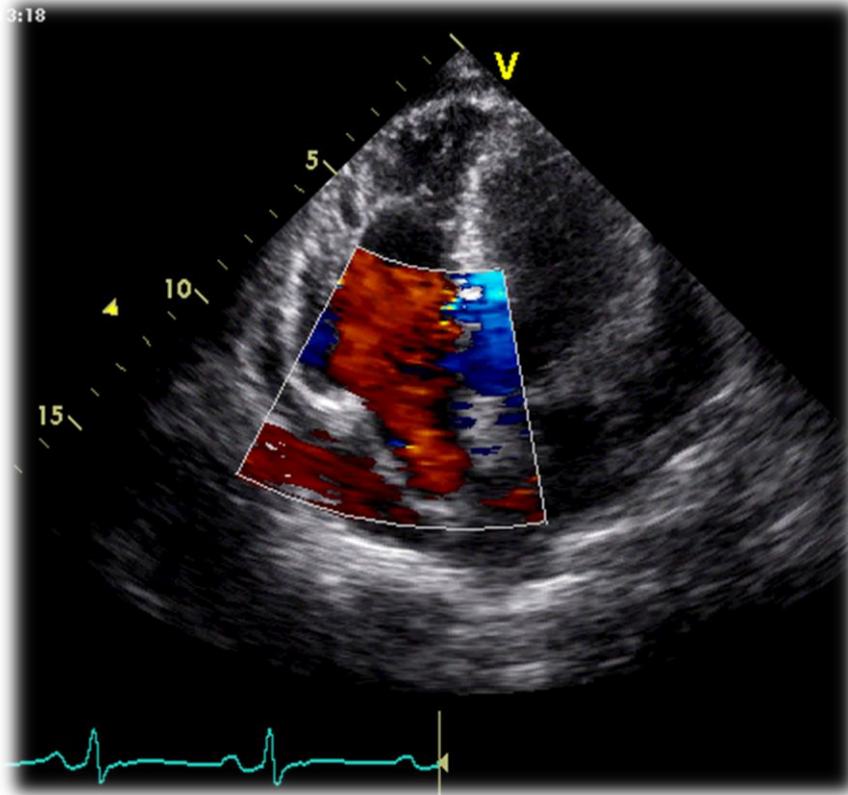
- Estudo em modelo animal (suínos).
- Parâmetro de contractilidade do VD mais robusto.
- Necessárias validações adicionais para o seu uso clínico.

TABLE 1. Data on Preload Reduction With Simultaneous Volume Measurements and Afterload Increase With Simultaneous Pressure Measurements by Conductance Catheterization and TDI-Derived Data During 6 Consecutive Cardiac Cycles

	Cycle Before	Cycle 1 After	Cycle 2 After	Cycle 3 After	Cycle 4 After	Cycle 5 After	P (ANOVA)
A. Preload reduction							
IVA, m/s ²	2.6±1.0	2.5±1.0	2.6±1.0	2.8±1.3	2.8±1.3	2.5±1.3	<0.5
IVV, cm/s	7.3±2.9	7.4±2.6	7.6±2.8	7.8±2.9	8.1±3.3	7.6±4.1	<0.5
S-wave acc, m/s ²	0.8±0.3	0.7±0.2	0.7±0.2	0.7±0.2	0.6±0.2	0.6±0.1	<0.04
S-wave velocity, cm/s	6.1±1.6	5.8±1.6	5.2±1.3	5.0±1.5	4.5±1.8	4.3±1.6	<0.0001
RV end-diastolic volume, m/s	36.7±7.4	33.6±10	31±11	27.2±9	22.9±9.4	19.9±8.2	<0.0001
dP/dt _{max} , mm Hg/s	306±48	295±54	285±51	275±53	264±50	254±50	<0.0001
B. Afterload increase							
IVA, m/s ²	2.3±0.6	2.4±0.7	2.3±0.7	2.2±0.7	2.3±0.6	2.2±0.7	<0.6
IVV, cm/s	5.5±1.5	5.8±1.3	5.5±1.6	5.2±1.7	4.6±1.4	5.0±1.1	<0.0001
S-wave acc, m/s ²	0.8±0.3	0.7±0.3	0.7±0.3	0.6±0.3	0.6±0.2	0.6±0.2	<0.007
S-wave velocity, cm/s	7.1±2.6	6.4±2.9	6.4±2.6	5.7±2.4	5.4±2.0	5.2±1.8	<0.001
RV sys pressure, mm Hg	21.6±4.0	24.8±5.4	29.0±4.6	32.1±5.2	32.9±5.3	32.9±5.2	<0.001
dP/dt _{max} , mm Hg/s	303±44	340±57	348±68	357±73	353±68	353±67	<0.0001

IVV indicates isovolumic velocity; acc, acceleration; RV, right ventricle; and sys, systolic.

Sem valor preditivo na sobrevida dos doentes com HTP



Sem valor preditivo na sobrevida dos doentes com HTP

Journal of the American College of Cardiology
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Echocardiographic Predictors of Adverse Outcomes in Primary Pulmonary Hypertension

Ronald J. Raymond, MD,* Alan L. Hinderliter, MD,* Park W. Willis, IV, MD,* David Ralph, MD,†



- Estudo prospectivo; 81 dts com HAP grave.
- **Objetivo:** Avaliar a relação entre os achados ecocardiográficos e clínicos no outcome (endpoint primário: morte de qualquer causa; endpoint composto: morte ou transplantação pulmonar).

Sem valor preditivo na sobrevida dos doentes com HTP

Journal of the American College of Cardiology
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Echocardiographic Predictors of Adverse Outcomes in Primary Pulmonary Hypertension

Ronald J. Raymond, MD,* Alan L. Hinderliter, MD,* Park W. Willis, IV, MD,* David Ralph, MD,†

Table 3. Results of Univariable Proportional Hazards Modeling: Hazard Ratios, 95% Confidence Intervals and p Values for Echocardiographic Variables

	Death		Composite End Point	
	HR (95% CI)	p Value	HR (95% CI)	p Value
RV end-diastolic area index (5 cm ² /m)	1.34 (0.90–1.98)	0.148	1.26 (0.95–1.66)	0.110
RV % area change (10%)	0.70 (0.39–1.25)	0.225	0.86 (0.57–1.28)	0.454
RA area index (5 cm ² /m)	1.54 (1.13–2.10)	0.005	1.33 (1.06–1.66)	0.012
Systolic eccentricity index (0.5 U)	1.41 (0.94–2.13)	0.096	1.20 (0.86–1.68)	0.286
Diastolic eccentricity index (0.5 U)	1.39 (0.97–2.00)	0.074	1.45 (1.12–1.86)	0.004
Pericardial effusion (Y/N)	3.89 (1.49–10.14)	0.003	2.08 (1.12–3.86)	0.017
TR/RA ratio (0.2 U)	1.24 (0.75–2.06)	0.400	1.37 (0.96–1.97)	0.080
Maximum TR velocity (0.5 m/s)	0.90 (0.62–1.31)	0.591	1.00 (0.77–1.30)	0.981

- ✧ Está demonstrado que a capacidade adaptativa do VD aos aumentos progressivos de pressão na AP é o factor determinante da capacidade funcional e sobrevivência

Annals of Internal Medicine

ESTABLISHED IN 1927 BY THE AMERICAN COLLEGE OF PHYSICIANS

Survival in Patients with Primary Pulmonary Hypertension: Results from a National Prospective Registry

Gilbert E. D'Alonzo, DO; Robyn J. Barst, MD; Stephen M. Ayres, MD; Edward H. Bergofsky, MD; Bruce H. Brundage, MD; Katherine M. Detre, MD; DrPH; Alfred P. Fishman, MD; Roberta M. Goldring, MD; Berton M. Groves, MD; Janet T. Kernis, MPH; Paul S. Levy, ScD; Giuseppe G. Pietra, MD; Lynne M. Reid, MD; John T. Reeves, MD; Stuart Rich, MD; Carol E. Vreim, PhD; George W. Williams, PhD; and Margaret Wu, PhD

Ann Intern Med. 1 September 1991;115(5):343-349

Circulation

JOURNAL OF THE AMERICAN HEART ASSOCIATION



Survival in primary pulmonary hypertension. Validation of a prognostic equation.
J Sandoval, O Bauerle, A Palomar, A Gómez, M L Martínez-Guerra, M Beltrán and M L Guerrero

Circulation. 1994;89:1733-1744



EUROPEAN RESPIRATORY journal

OFFICIAL SCIENTIFIC JOURNAL OF THE ERS

Eur Respir J 2005; 25: 244-249
DOI: 10.1183/09031936.05.00054804
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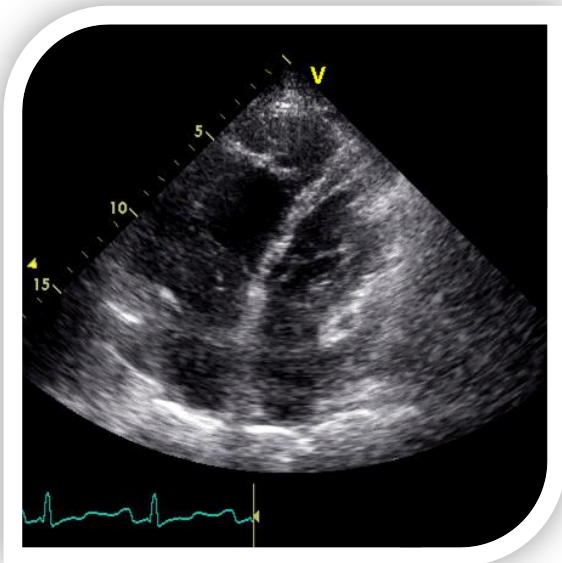
Survival with first-line bosentan in patients with primary pulmonary hypertension

V.V. McLaughlin*, O. Sitbon[#], D.B. Badesch[†], R.J. Barst⁺, C. Black[§], N. Galie[/], M. Rainisio^{**}, G. Simonneau[#] and L.J. Rubin^{##}

- ✧ Está demonstrado que a capacidade adaptativa do VD aos aumentos progressivos de pressão na AP é o factor determinante da capacidade funcional e sobrevivência



A **AVALIAÇÃO MORFOLÓGICA** das cavidades direitas é fundamental, embora limitada do ponto de vista técnico



Geometria, orientação e relação espacial com o VE alteram-se na presença de sobrecarga de pressão e / ou volume

Estrutura
complexa

Interdependência Ventricular

✧ Sob condições de HTP, o movimento anormal do septo afecta a geometria do VE.

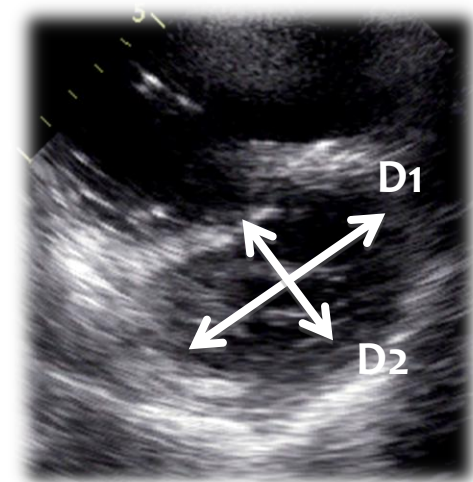
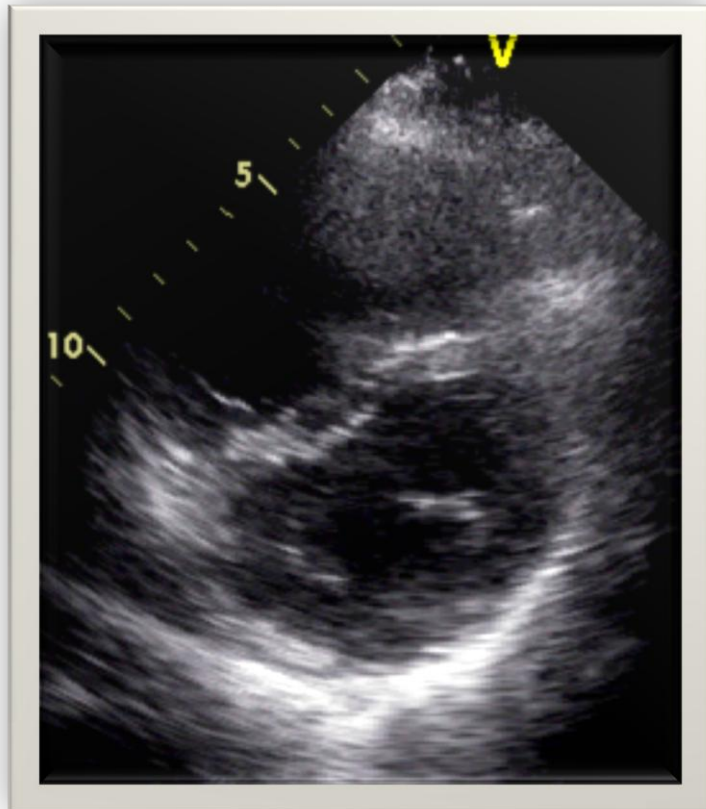


ÍNDICE DE EXCENTRICIDADE DO VE

Método de Ryan et al.

Ø VE paralelo ao SIV (D1)

Ø VE perpendicular ao SIV (D2)



✧ Sob condições de HTP, o movimento anormal do septo afecta a geometria do VE.



ÍNDICE DE EXCENTRICIDADE DO VE

Diástole $\geq 1,7$



International Journal of
CARDIOLOGY

Prognostic relevance of the echocardiographic assessment of right ventricular function in patients with idiopathic pulmonary arterial hypertension

Stefano Ghio^{a,*}, Catherine Klersy^b, Giulia Magrini^a, Andrea Maria D'Armini^c, Laura Scelsi^a,
Claudia Raineri^a, Michele Pasotti^a, Alessandra Serio^a, Carlo Campana^a, Mario Viganò^c

Received 4 September 2008; received in revised form 1 November 2008; accepted 11 November 2008
Available online 12 December 2008

Índice de excentricidade do VE em diástole $\geq 1,7$ teve valor prognóstico no *endpoint* mortalidade em doentes com HAP idiopática e disfunção ventricular direita (TAPSE ≤ 15 mm).

*Hierarchical analysis and mortality rate per 100 person year
Relevant findings*

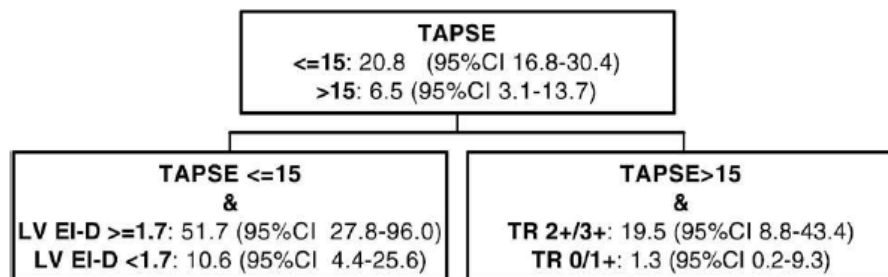


Fig. 2. Event rates (mortality and/or lung transplantation in emergency conditions) in patients subgrouped according to TAPSE (>15 vs ≤ 15 mm), degree of tricuspid regurgitation (TR) (0/1 vs 2+/3+) and left ventricular eccentricity index in diastole (left ventricular EI-D) (≥ 1.7 vs <1.7).

- ✧ Sob condições de HTP, o movimento anormal do septo afecta a geometria do VE.



ÍNDICE DE EXCENTRICIDADE DO VE

Circulation

JOURNAL OF THE AMERICAN HEART ASSOCIATION



Circulation. 1997 Mar 18;95(6):1479-86.

Effects of long-term infusion of prostacyclin (epoprostenol) on echocardiographic measures of right ventricular structure and function in primary pulmonary hypertension. Primary Pulmonary Hypertension Study Group.

- Estudo multicêntrico e randomizado.
- 81 dts com HAP idiopática (classe III / IV OMS).
- Comparar o efeito do epoprostenol ev com a terapêutica convencional
- Associação basal entre o índice de excentricidade do VE em diástole e a PmAP, PmAD, IC e capacidade de exercício.

Table 3.

Spearman's Rank Correlation Coefficients Relating Baseline Echocardiographic Variables to Hemodynamic Parameters

	PAP _m	RAP _m	CI
Right ventricular end-diastolic area	.25	.45 ²	-.16
Right ventricular percent change in area	-.37 ¹	-.01	-.01
Systolic eccentricity index	.50 ²	.17	-.19
Diastolic eccentricity index	.41 ²	.46 ²	-.52 ²
Pericardial effusion size score	.22	.50 ²	-.40 ²
Tricuspid regurgitant jet area	-.04	.46 ²	-.45 ²

• PAP_m indicates mean pulmonary arterial pressure; RAP_m, mean right atrial pressure; and CI, cardiac index.

• 1 $P < .01$;

• 2 $P < .001$

- ✧ Sob condições de HTP, o movimento anormal do septo afecta a geometria do VE.



ÍNDICE DE EXCENTRICIDADE DO VE

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Echocardiographic Predictors of Adverse Outcomes in Primary Pulmonary Hypertension

Ronald J. Raymond, MD,* Alan L. Hinderliter, MD,* Park W. Willis, IV, MD,* David Ralph, MD,†



- Avaliar a associação entre os achados ecocardiográficos e o *outcome* clínico ao final de 1 ano numa população de doentes com HTP idiopática.
- Em análise univariada, o índice de excentricidade do VE em diástole associou-se de forma significativa com o *endpoint* composto morte ou transplantação ($p=0.004$).

Table 3. Results of Univariable Proportional Hazards Modeling: Hazard Ratios, 95% Confidence Intervals and p Values for Echocardiographic Variables

	Death		Composite End Point	
	HR (95% CI)	p Value	HR (95% CI)	p Value
RV end-diastolic area index (5 cm ² /m)	1.34 (0.90–1.98)	0.148	1.26 (0.95–1.66)	0.110
RV % area change (10%)	0.70 (0.39–1.25)	0.225	0.86 (0.57–1.28)	0.454
RA area index (5 cm ² /m)	1.54 (1.13–2.10)	0.005	1.33 (1.06–1.66)	0.012
Systolic eccentricity index (0.5 U)	1.41 (0.94–2.13)	0.096	1.20 (0.86–1.68)	0.286
Diastolic eccentricity index (0.5 U)	1.39 (0.97–2.00)	0.074	1.45 (1.12–1.86)	0.004
Pericardial effusion (Y/N)	3.89 (1.49–10.14)	0.003	2.08 (1.12–3.86)	0.017
TR/RA ratio (0.2 U)	1.24 (0.75–2.06)	0.400	1.37 (0.96–1.97)	0.080
Maximum TR velocity (0.5 m/s)	0.90 (0.62–1.31)	0.591	1.00 (0.77–1.30)	0.981

✧ Sob condições de HTP, o movimento anormal do septo afecta a geometria do VE.



The NEW ENGLAND
JOURNAL of MEDICINE

BREATHE-1

Bosentan Therapy for Pulmonary Arterial Hypertension

Lewis J. Rubin, M.D., David B. Badesch, M.D., Robyn J. Barst, M.D., Nazzareno Galiè, M.D., Carol M. Black, M.D., Anne Keogh, M.D., Tomas Pulido, M.D., Adaani Frost, M.D., Sébastien Roux, M.D., Isabelle Leconte, Ph.D., Michael Landzberg, M.D., and G rald Simonneau, M.D. for the Bosentan Randomized Trial of Endothelin Antagonist Therapy Study Group
N Engl J Med 2002; 346:896-903 | March 21, 2002 | DOI: 10.1056/NEJMoa012212

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Vol. 41, No. 8, 2003
ISSN 0735-1097/03/\$30.00
doi:10.1016/S0735-1097(03)00121-9



Effects of the Oral Endothelin-Receptor Antagonist Bosentan on Echocardiographic and Doppler Measures in Patients With Pulmonary Arterial Hypertension

Nazzareno Gali , MD,* Alan L. Hinderliter, MD,† Adam Torbicki, MD,‡ Thierry Fourme, MD,§ Gerald Simonneau, MD,§ Tomas Pulido, MD,|| Nilda Espinola-Zavaleta, MD,|| Guido Rocchi, MD,* Alessandra Manes, MD,* Robert Frantz, MD,¶ Marcin Kurzy na, MD,‡ Sherif F. Nagueh, MD,# Robyn Barst, MD,** Richard Channick, MD,†† Karl Dujardin, MD,‡‡ Andrew Kronenberg, MD,† Isabelle Leconte, PhD,§§ Maurizio Rainisio, PhD,§§ Lewis Rubin, MD††

- Estudo multic ntrico, randomizado, duplamente cego, controlado por placebo.
- Efic cia do bosentan na capacidade funcional, avaliada pelo T6MM, em doentes com HAP.
- Suban lise do estudo BREATHE-1.
- Avaliar o efeito de 16 semanas de terap utica com bosentan nos par metros ecocardiogr ficos.
- A terap utica com bosentan diminuiu os  ndices de excentricidade do VE.

Table 4. Changes From Baseline in Echocardiographic Variables by Treatment Group and Treatment Effect

Variables	Placebo		Bosentan Groups Combined		Treatment Effect		125 mg of Bosentan		Treatment Effect		250 mg of Bosentan		Treatment Effect	
	N	C � SEM*	n	C � SEM*	Mean	p†	n	C � SEM*	Mean	p†	n	C � SEM*	Mean	p†
LV systolic eccentricity index	27	0.09 � 0.16	52	�0.03 � 0.05	�0.12	0.047	27	0.03 � 0.07	�0.05	0.228	25	�0.10 � 0.05	�0.19	0.027
LV diastolic eccentricity index	28	0.00 � 0.08	52	�0.06 � 0.04	�0.07	0.174	27	�0.09 � 0.06	�0.09	0.142	25	�0.03 � 0.04	�0.04	0.406

- ✧ A alteração da conformação do VE na telessístole e diástole altera o seu relaxamento e compliance.

**Circulation
Research**



Circ Res. 1974;34:498-504

Influence of Right Ventricular Filling Pressure on Left Ventricular Pressure and Dimension

By Charles E. Bemis, Juan R. Serur, David Borkenhagen, Edmund H. Sonnenblick, and Charles W. Urschel

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1298



JACC Vol. 8, No. 6
December 1986:1298-1306

Doppler Echocardiographic Assessment of Impaired Left Ventricular Filling in Patients With Right Ventricular Pressure Overload Due to Primary Pulmonary Hypertension

ERIC K. LOUIE, MD, FACC, STUART RICH, MD, FACC, BRUCE H. BRUNDAGE, MD, FACC
Chicago, Illinois

Circulation



Circulation. 1976;54:179-186

Mechanism of Abnormal Septal Motion in Patients with Right Ventricular Volume Overload

A Cross-sectional Echocardiographic Study

ARTHUR E. WEYMAN, M.D., SAMUEL WANN, M.D.,
HARVEY FEIGENBAUM, M.D., AND JAMES C. DILLON, M.D.

Circulation



Circulation. 1980;62:558-563

Diastolic bulging of the interventricular septum toward the left ventricle. An echocardiographic manifestation of negative interventricular pressure gradient between left and right ventricles during diastole.

H Tanaka, C Tei, S Nakao, M Tahara, S Sakurai, T Kashima and T Kanehisa

Disfunção Diastólica Ventricular Esquerda

✧ A alteração da conformação do VE na telessístole e diástole altera o seu relaxamento e compliance

Disfunção Diastólica Ventricular Esquerda

- A terapêutica com bosentan associou-se a melhoria da função diastólica ventricular esquerda (após 16 semanas de tratamento).
 - ✓ Velocidade de E ($p < 0.003$)
 - ✓ Razão E/A ($p < 0.004$)
 - ✓ VTI fluxo transmitral ($p < 0.001$)

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Effects of the Oral Endothelin-Receptor Antagonist Bosentan on Echocardiographic and Doppler Measures in Patients With Pulmonary Arterial Hypertension



Nazzareno Galiè, MD,* Alan L. Hinderliter, MD,† Adam Torbicki, MD,‡ Thierry Fourme, MD,§ Gerald Simonneau, MD,§ Tomas Pulido, MD,|| Nilda Espinola-Zavaleta, MD,|| Guido Rocchi, MD,* Alessandra Manes, MD,* Robert Frantz, MD,¶ Marcin Kurzyna, MD,‡ Sherif F. Nagueh, MD,# Robyn Barst, MD,** Richard Channick, MD,†† Karl Dujardin, MD,‡‡ Andrew Kronenberg, MD,† Isabelle Leconte, PhD,§§ Maurizio Rainisio, PhD,§§ Lewis Rubin, MD††

Table 5. Changes From Baseline in Doppler Variables by Treatment Group and Treatment Effect

Variables	Placebo		Bosentan Groups Combined		Treatment Effect		125 mg of Bosentan		Treatment Effect		250 mg of Bosentan		Treatment Effect	
	n	C ± SEM*	n	C ± SEM*	Mean	p†	n	C ± SEM*	Mean	p†	n	C ± SEM*	Mean	p†
RV acceleration time, ms	27	-2.41 ± 3.40	50	3.46 ± 2.63	5.87	0.169	25	-0.56 ± 3.21	1.85	0.59	25	7.48 ± 4.08	9.89	0.073
RV ejection time, ms	27	-3.81 ± 5.72	50	18.34 ± 4.03	22.15	0.007	25	14.8 ± 5.48	17.89	0.052	25	22.6 ± 5.90	26.41	0.007
Doppler RV index	26	-0.01 ± 0.03	45	-0.08 ± 0.02	-0.06	0.034	22	-0.06 ± 0.02	-0.05	0.075	23	-0.09 ± 0.03	-0.07	0.070
Maximal TV regurgitant velocity, cm/s	25	6.40 ± 6.45	46	-4.50 ± 5.50	-10.90	0.280	23	-8.48 ± 8.35	-14.88	0.155	23	-0.52 ± 7.27	-6.92	0.681
LV stroke volume, ml	26	0.06 ± 2.04	55	7.43 ± 1.45	7.37	0.007	28	5.94 ± 2.14	5.88	0.071	55	8.97 ± 1.96	8.91	0.005
Heart rate, beats/min	27	-2.11 ± 2.82	55	-4.42 ± 1.45	-2.31	0.118	28	-2.32 ± 1.46	-0.21	0.274	27	-6.59 ± 2.49	-4.48	0.109
Cardiac index, l/min/m ²	26	-0.18 ± 0.11	55	0.19 ± 0.07	0.37	0.007	28	0.18 ± 0.09	0.36	0.020	27	0.20 ± 0.12	0.38	0.021
Doppler MV peak E velocity, cm/s	24	-2.54 ± 2.82	53	7.91 ± 2.40	10.45	0.003	27	3.74 ± 3.49	6.28	0.062	26	12.23 ± 3.13	14.77	0.001
Doppler MV E/A ratio	24	-0.03 ± 0.05	53	0.15 ± 0.04	0.18	0.004	27	0.11 ± 0.06	0.15	0.024	26	0.18 ± 0.05	0.21	0.006
Doppler MV time-velocity integral, cm	24	-0.27 ± 0.48	53	2.07 ± 0.40	2.34	0.001	27	1.15 ± 0.52	1.42	0.054	26	3.02 ± 0.56	3.29	0.000

*C ± SEM denotes mean change ± standard error of the mean. †p values are for the comparison with the placebo group.
MV = mitral valve; LV = left ventricle; RV = right ventricle; TV = tricuspid valve.

ESC Congress 2009



The right ventricular systolic and left ventricular diastolic function as predictors of mortality in pulmonary arterial hypertension

R. Plácido; P. Loureiro; A. G. Almeida; S. Robalo Martins; J. Silva Marques; S. Gonçalves; A. Nunes Diogo. CHLN- Hospital de Santa Maria - Lisbon – Portugal.



- Estudo retrospectivo; 36 doentes com HAP seguidos de forma protocolada em consulta de HTP.
- **Objectivo:** estimar a mortalidade e identificar os preditores de prognóstico desfavorável em doentes com HAP.
- ✧ Mortalidade: 28% no período de seguimento (*follow-up* médio: 23,9 meses).

Características Clínicas da População			
N=36			
	Média±DP	Mínim o	Máximo
Idade (anos)	64±13	33	90
IMC (Kg.m ⁻²)	28,91±6,7 8	22	53
Sexo	Masculino	Feminino	
	12 (33,3%)	24 (66,7%)	
OMS			
I / II	16		
III / IV	20		

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The right ventricular systolic and left ventricular diastolic function as predictors of mortality in pulmonary arterial hypertension

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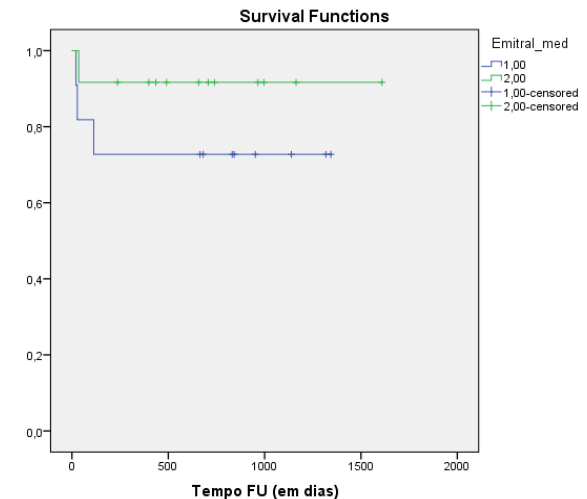
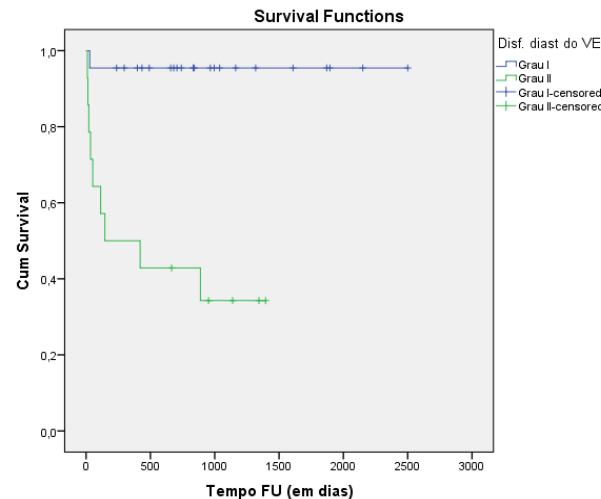
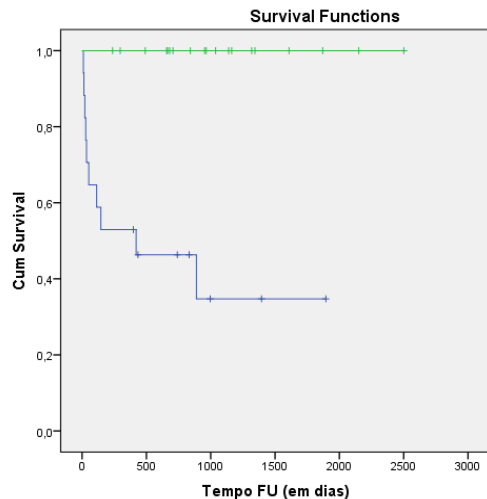


- Por análise bivariada verificou-se associação significativa entre:

- **TAPSE** ($p=0.033$)
- **Disfunção diastólica VE tipo I/II** ($p=0.002$)
- **Velocidade da onda E** ($p=0.022$)



Mortalidade



ESC Congress 2009



The right ventricular systolic and left ventricular diastolic function as predictors of mortality in pulmonary arterial hypertension

R. Plácido; P. Loureiro; A. G. Almeida; S. Robalo Martins; J. Silva Marques. S. Gonçalves. A. Nunes Diogo. CHLN- Hospital de Santa Maria - Lisbon – Portugal

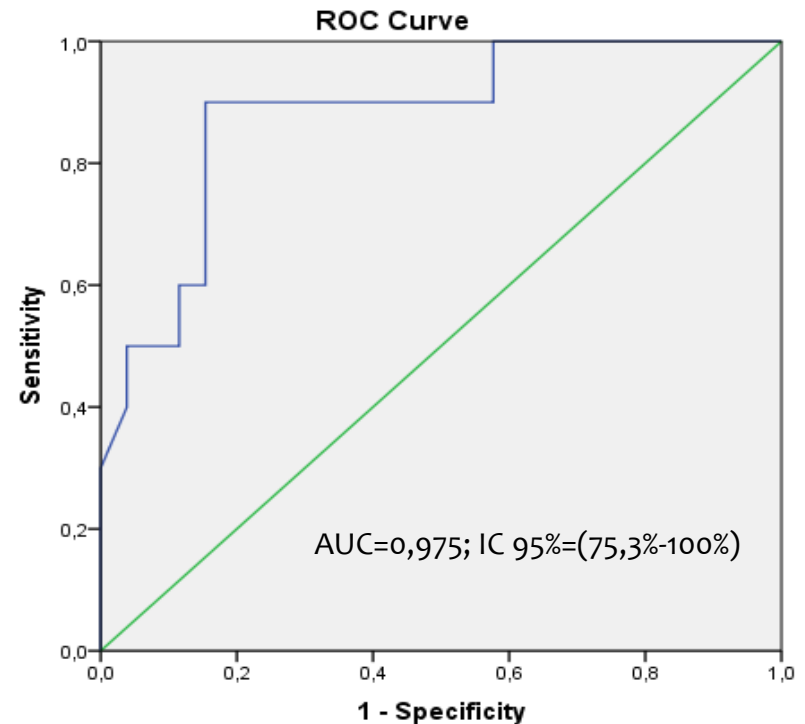


- Por análise multivariada:
 - **TAPSE** ($p=0.005$)
 - **Disfunção diastólica tipo I/II** ($p=0.029$)

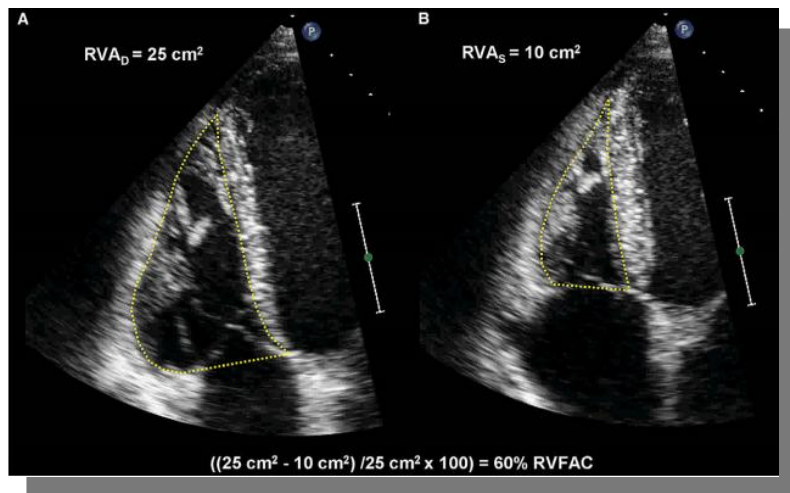


**Preditores independentes
de mortalidade**

- A análise da curva ROC do modelo incluindo estas duas variáveis revelou uma área sob a curva de 0,975.



Diagonal segments are produced by ties.



Fracção de Área do VD

$$\frac{\text{Área telediastólica} - \text{Área telesistólica}}{\text{Área telediastólica}} \times 100$$

LIMITAÇÕES

- Dificuldade na delimitação dos bordos endocárdicos



International Journal of
CARDIOLOGY

Prognostic relevance of the echocardiographic assessment of right ventricular function in patients with idiopathic pulmonary arterial hypertension

Stefano Ghio ^{a,*}, Catherine Klersy ^b, Giulia Magrini ^a, Andrea Maria D'Armini ^c, Laura Scelsi ^a, Claudia Raineri ^a, Michele Pasotti ^a, Alessandra Serio ^a, Carlo Campana ^a, Mario Viganò ^c

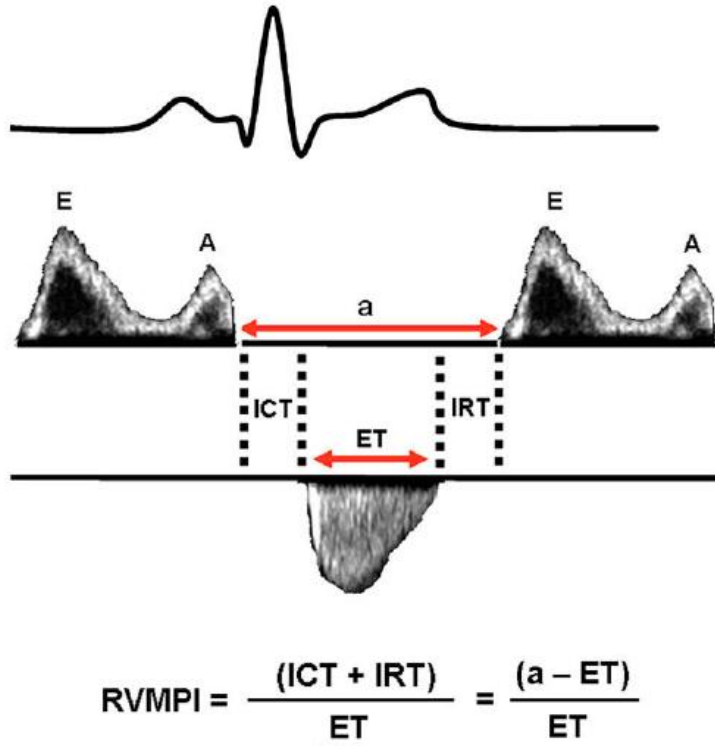
Received 4 September 2008; received in revised form 1 November 2008; accepted 11 November 2008
Available online 12 December 2008

Em análise univariada, a fracção de área do VD associou-se de forma significativa com a mortalidade ($p = 0.025$).

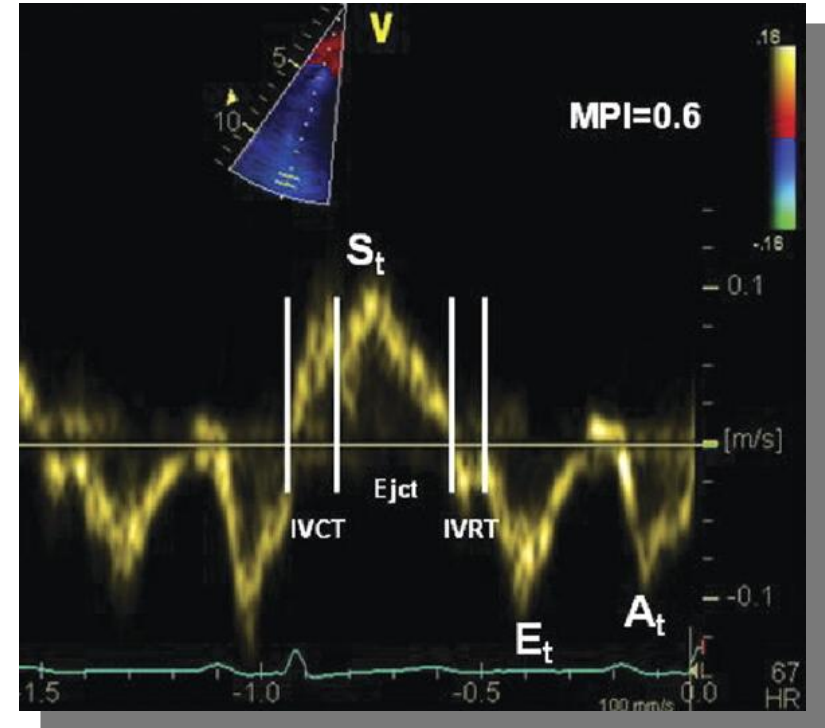
Table 3

Univariate Cox model.

	Hazard ratio	95% confidence intervals	<i>p</i>
TAPSE	0.91	0.83–0.99	0.026
TAPSE ≤ 15	2.74	1.11–6.77	0.022
RV fractional area change	0.004	0.02–0.62	0.025
Moderate to severe tricuspid regurgitation	3.11	1.2–9.48	0.030
Type “Y” flow pattern into the SVC	2.94	1.19–7.26	0.030
IVC collapsibility	0.36	0.15–0.91	0.023
LV eccentricity index in diastole ≥ 1.7	3.68	1.55–8.74	0.040
LV end-diastolic volume	0.98	0.96–0.99	0.019
Tei index	2.61	0.52–13.03	0.26
Transtricuspid gradient	0.99	0.98–1.02	0.92
RV free wall thickness	1.11	0.91–1.35	0.29
Pericardial effusion	0.79	0.18–3.4	0.75



- ✧ Parâmetro importante na avaliação funcional do VD.
- ✧ Resulta da combinação de medidas diastólicas e sistólicas.

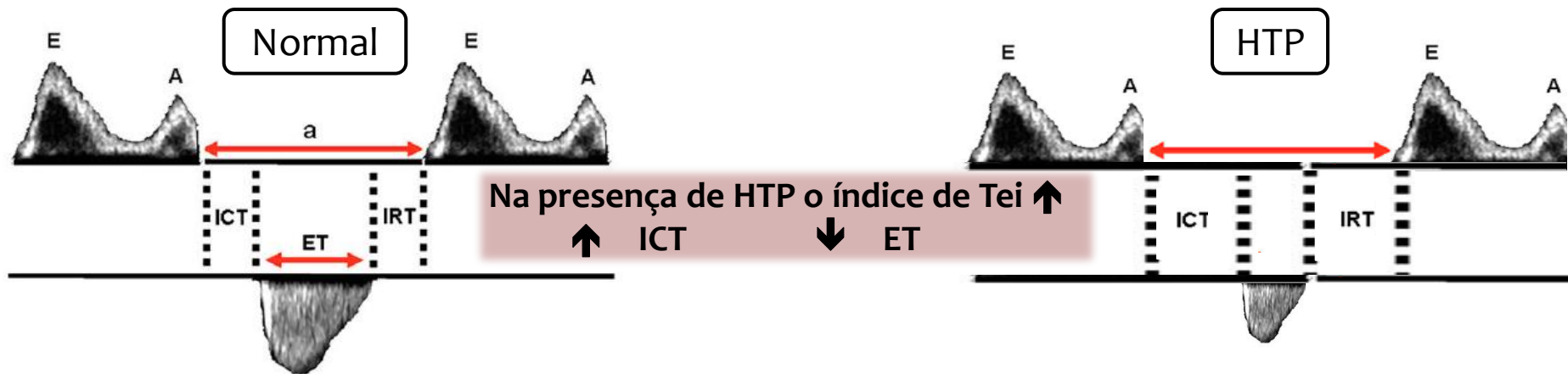


Vantagens

- Relativamente independente das condições de carga ou presença e gravidade da RT.
- Não se baseia no uso de modelos geométricos.
- Reprodutibilidade.
- Cálculo rápido
- Determinação possível na presença de má janela acústica.

Ecocardiografia

Índice de Tei



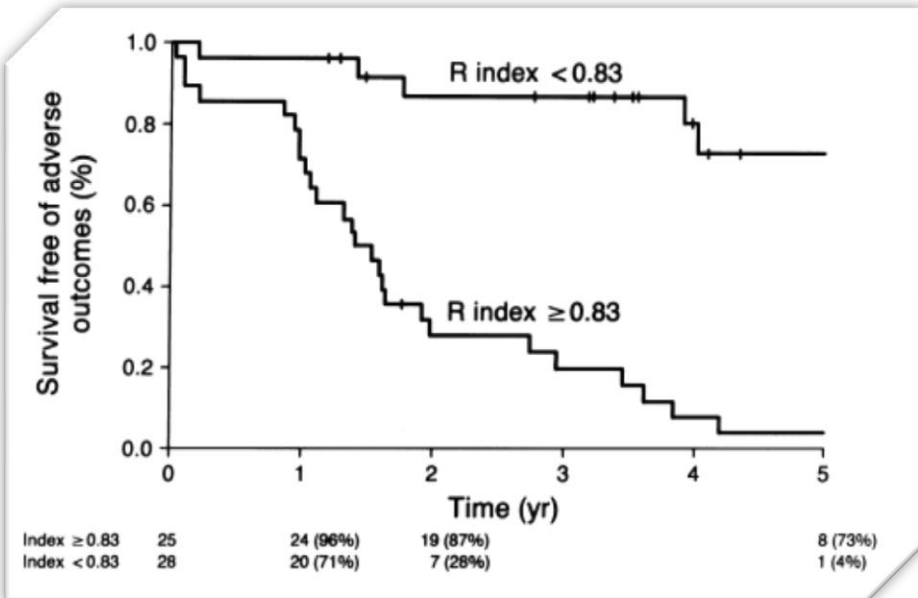
The
American Journal
of
Cardiology

Value of a Doppler-Derived Index Combining Systolic and Diastolic Time Intervals in Predicting Outcome in Primary Pulmonary Hypertension

Tiong Cheng Yeo, MRCP, Karl S. Dujardin, MD, Chuwa Tei, MD, Douglas W. Mahoney, MS, Michael D. McGoon, MD, and James B. Seward, MD

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(Am J Cardiol 1998;81:1157-1161)

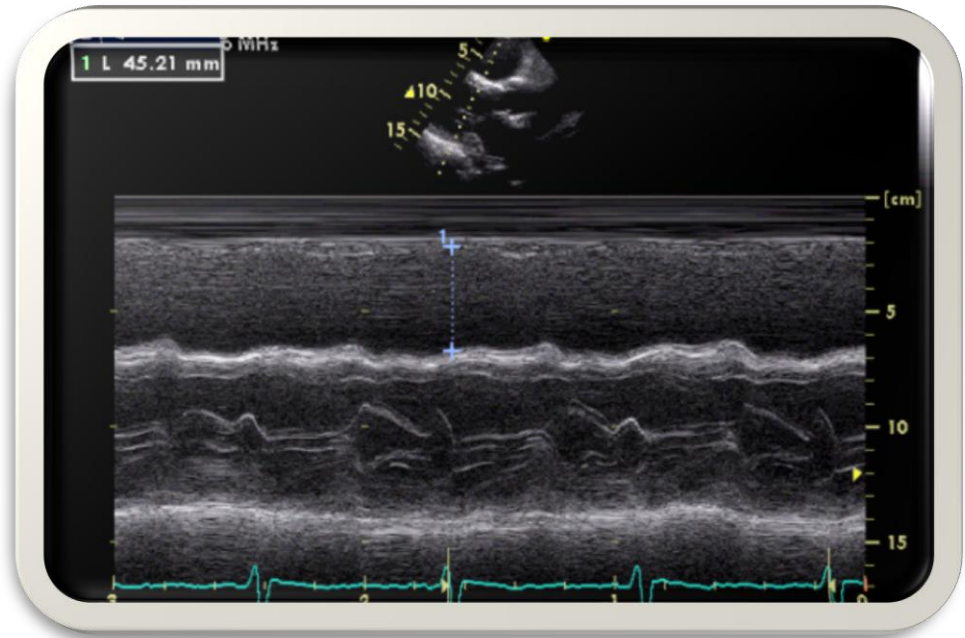
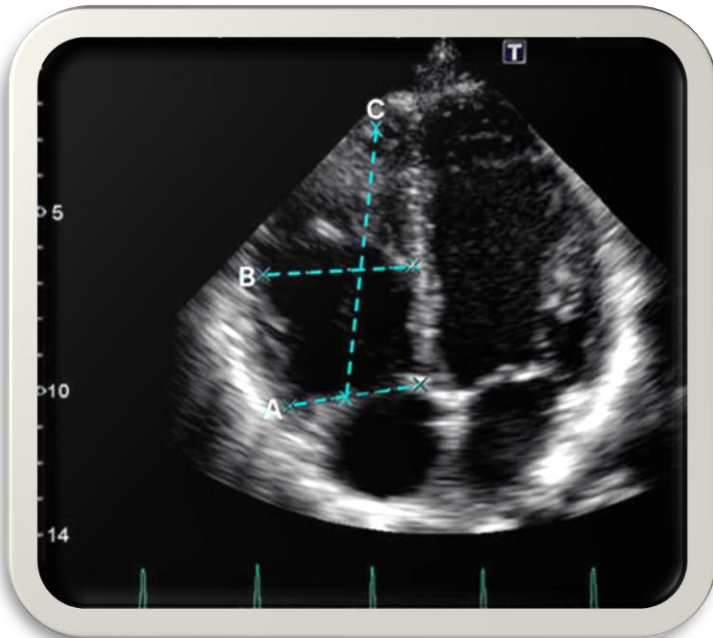
- Estudo retrospectivo de uma coorte de doentes com HTP idiopática
- Follow-up médio: 2,9 anos.
- Em análise multivariada, o índice de Tei mostrou ser o preditor mais importante do endpoint composto (mortalidade ou transplantação).



Avaliação dimensional ventricular simples

- ✧ As avaliações dimensionais lineares simples são limitadas pela geometria e trabeculação do VD.
- ✧ Deverão ser utilizadas como critério de suspeição de dilatação do VD – a confirmar por um método mais robusto.

Sem valor prognóstico



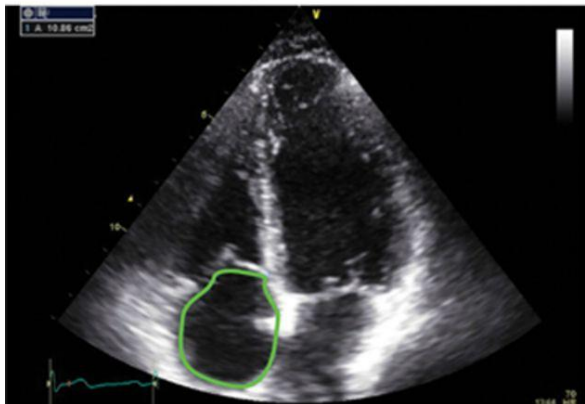
Área indexada da AD

✧ Preditor prognóstico de mortalidade em vários estudos.

normal



RA enlargement



Área indexada da AD

✧ Preditor prognóstico de mortalidade em vários estudos

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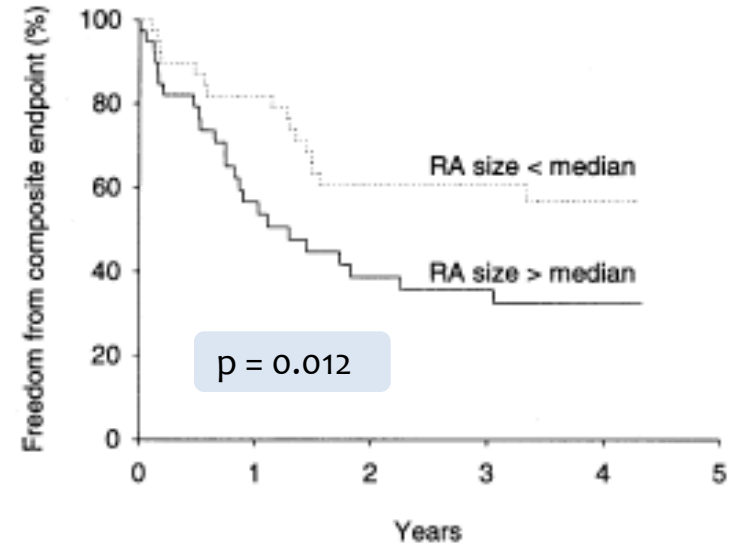
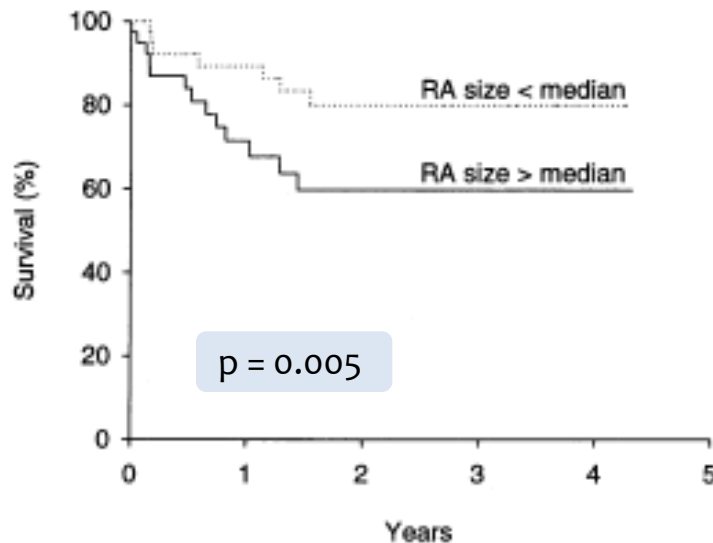
Echocardiographic Predictors of Adverse Outcomes in Primary Pulmonary Hypertension

Ronald J. Raymond, MD,* Alan L. Hinderliter, MD,* Park W. Willis, IV, MD,* David Ralph, MD,†



- PmAD
- Preditor do *endpoint* composto morte ou transplante pulmonar ($p=0.012$) (análise univariada).
- Em análise multivariada (variáveis clínicas, hemodinâmicas e ecocardiográficas), a área da AD continuou a ser preditora de mau prognóstico.

Right atrial size

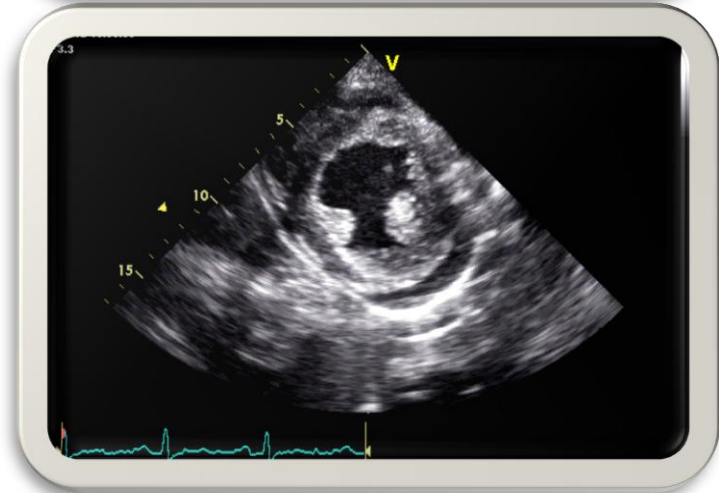
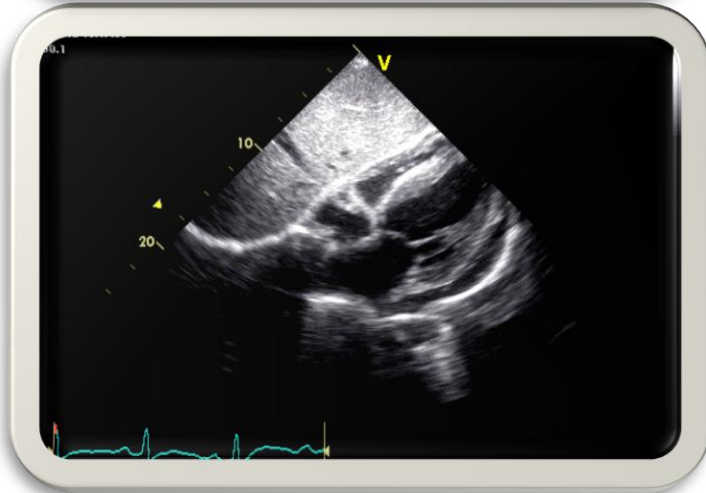
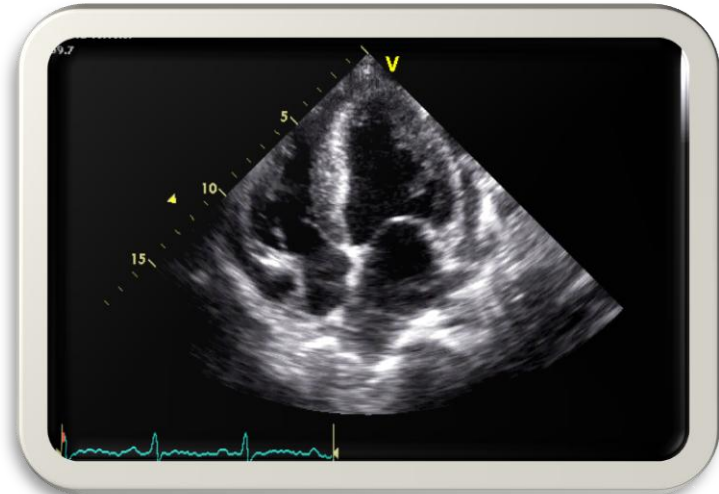
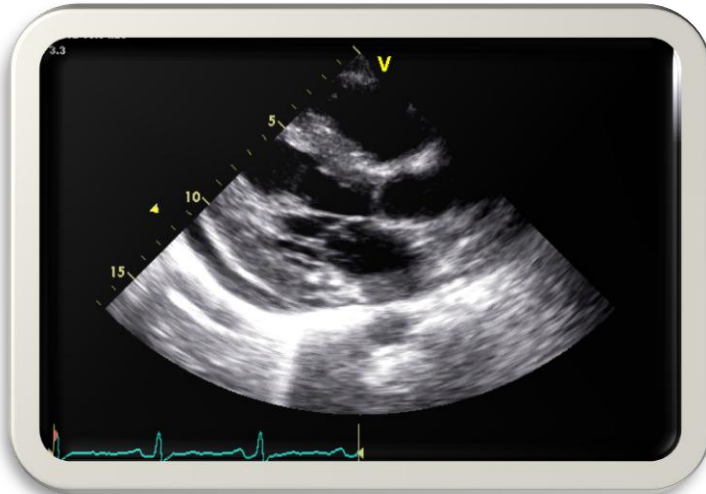


Kaplan-Meier survival curves for echocardiographic predictors of outcomes.

Ecocardiografia

Derrame pericárdico

✧ **Preditor prognóstico *major* na avaliação da HTP, a traduzir aumento da pressão na AD.**



✧ **Preditor prognóstico *major* na avaliação da HTP, a traduzir aumento da pressão na AD.**

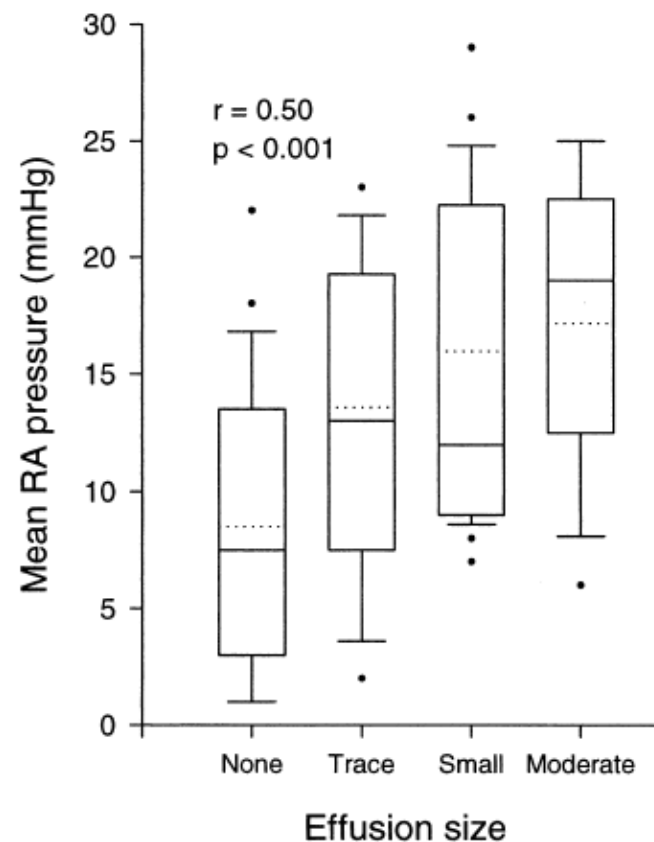
The
American Journal
of
Cardiology

Frequency and Prognostic Significance of Pericardial Effusion in Primary Pulmonary Hypertension

Alan L. Hinderliter, MD, Park W. Willis IV, MD, Walker Long, MD,
William R. Clarke, MD, David Ralph, MD, Edgar J. Caldwell, MD,
William Williams, MD, Neil A. Ettinger, MD, Nicholas S. Hill, MD,
Warren R. Summer, MD, Bennett de Boisblanc, MD, Gary Koch, PhD, Shu Li, MS,
Linda M. Clayton, PharmD, Maria M. Jöbsis, BA, and
James W. Crow, PhD, for the PPH Study Group

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The American Journal of Cardiology Vol. 84 August 15, 1999

- **PmAD** foi o parâmetro hemodinâmico que mais se correlacionou com o tamanho do derrame pericárdico ($r=0.50$, $p<0.001$), suportando assim a sua origem fisiopatológica.



- ✧ Preditor prognóstico *major* na avaliação da HTP, a traduzir aumento da pressão na AD.
- ✧ Ainda estão por definir critérios quantitativos de derrame pericárdico com significado prognóstico.

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Echocardiographic Predictors of Adverse Outcomes in Primary Pulmonary Hypertension

Ronald J. Raymond, MD,* Alan L. Hinderliter, MD,* Park W. Willis, IV, MD,* David Ralph, MD,†



- A presença de derrame pericárdico demonstrou, em análise multivariada (parâmetros clínicos e hemodinâmicos), ser o preditor mais forte de mortalidade ($p = 0.011$).

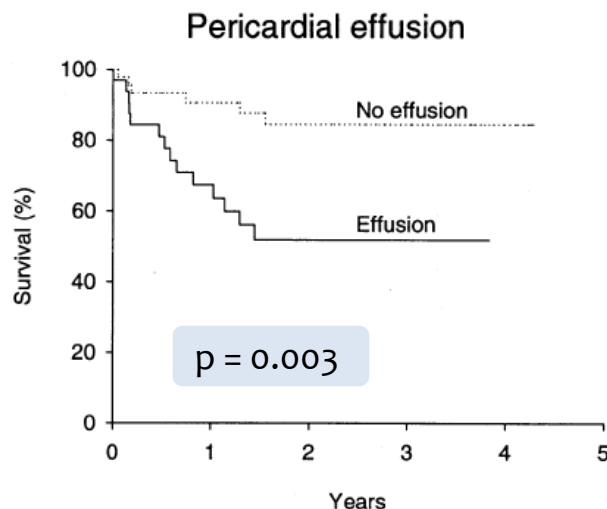
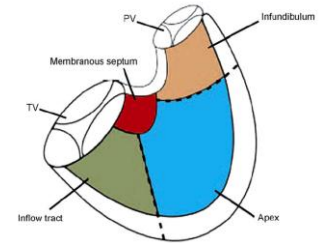


Table 5. Results of Multivariable Modeling: Hazard Ratios, 95% Confidence Intervals and p Values for Significant Multivariable Predictors of Outcome in Models That Incorporate Echocardiographic, Clinical and Hemodynamic Variables

	HR (95% CI)	p Value
Significant multivariable predictors of death		
Pericardial effusion (Y/N)	4.38 (1.41–13.67)	0.011
Randomization to prostacyclin (Y/N)	0.25 (0.08–0.76)	0.014
6-min walk (500 ft)	0.56 (0.29–1.08)	0.082

Kaplan-Meier survival curves for echocardiographic predictors of outcomes.

- ✧ A performance do VD é um importante marcador prognóstico na HTP.
- ✧ A quantificação da função regional e global do VD permanece um desafio devido à sua geometria complexa.



Ecocardiografia 2D Strain

Doppler tecidual

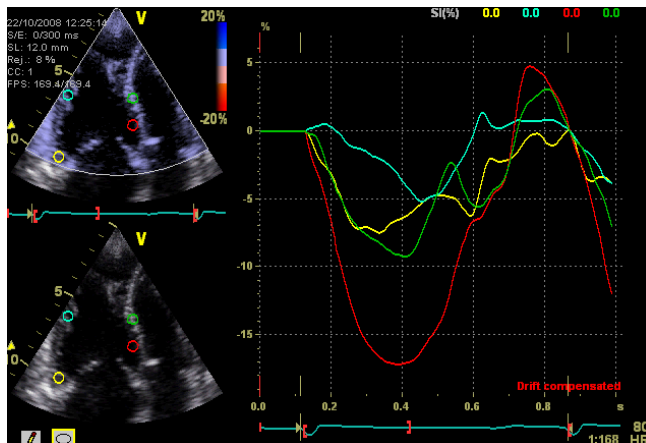
- Processo ângulo-dependente

Speckle-tracking

- Processo ângulo-independente

✓ Permite incluir o ápex

✓ Abordagem subxifoideia comparável à abordagem apical





CHEST

Original Research

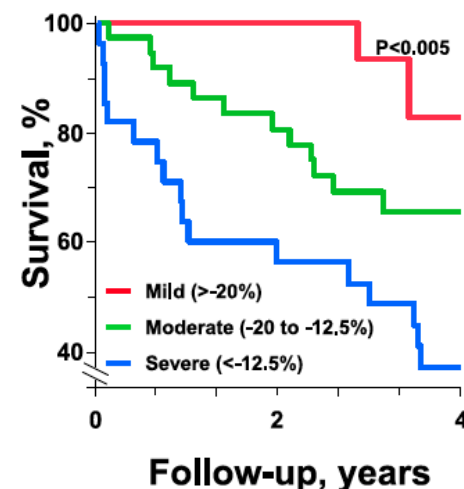
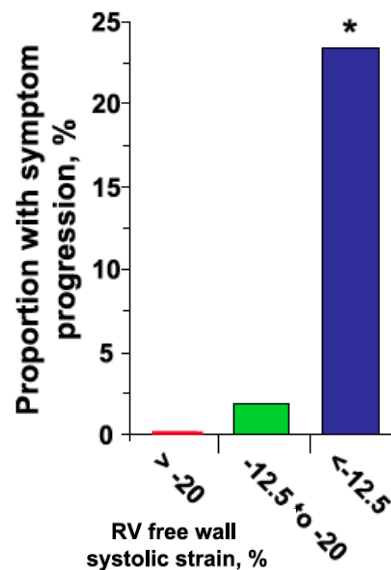
PULMONARY VASCULAR DISEASE

Right Ventricular Strain for Prediction of Survival in Patients With Pulmonary Arterial Hypertension

Arun Sachdev, MD; Hector R. Villarraga, MD; Robert P. Frantz, MD; Michael D. McGoon, MD, FCCP; Ju-Feng Hsiao, MD; Joseph F. Maalouf, MD; Naser M. Ammash, MD; Robert B. McCully, MD; Fletcher A. Miller, MD; Patricia A. Pellikka, MD; Jae K. Oh, MD; and Garvan C. Kane, MD, PhD, FCCP

- Risco 2,9x superior de mortalidade a 1 ano por 5% de declínio no *strain* da parede livre do VD.
(após ajuste para a idade, sexo, etiologia da HP e classe funcional)

- 80 doentes com HAP
- ↓ Pico sistólico de *strain* e *strain-rate* do VD.
- Strain* parede livre do VD > -12,5% associou-se:
 - agravamento clínico aos 6 meses.
 - preditor de mortalidade até aos 4 anos.



Circulation
JOURNAL OF THE AMERICAN HEART ASSOCIATION



Abstract 9491: Prognostic Implications of Right Ventricular Longitudinal Peak Systolic Strain on Long-Term Outcome in Patients with Pulmonary Hypertension

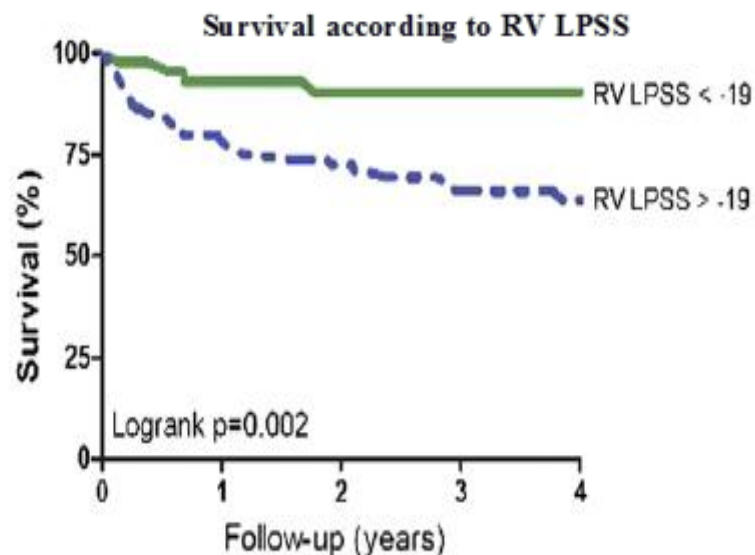
Marlieke L Haeck¹; Roderick W Scherptong¹; Nina Ajmone Marsan²; Eduard Holman²; Hubert W Vliegen¹; Martin J Schalij¹; Jeroen J Bax¹; Victoria Delgado¹

- A mortalidade de qualquer causa associou-se de forma significativa:
 - Pico sistólico de strain longitudinal do VD $\geq -19\%$ (HR 3.36, 95% CI 1.13-9.96, $p=0.029$)

(após ajustamento multivariado)

- Classe funcional NYHA
- TAPSE

- 142 doentes com HP de diferentes etiologias (53% HAP).
- Follow-up médio: 31,2 meses; taxa de mortalidade: 26%.



No. at risk

< -19%	46	39	33	24	18
$\geq -19\%$	96	67	54	40	27

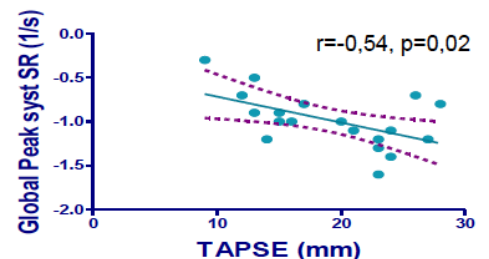
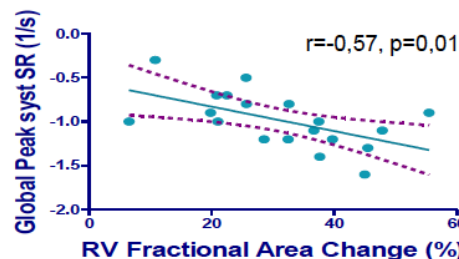
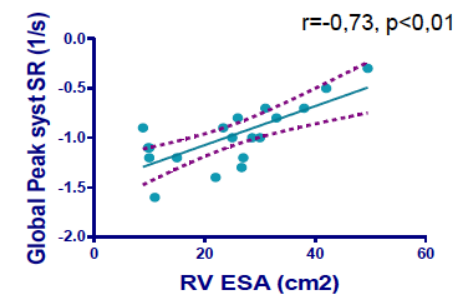
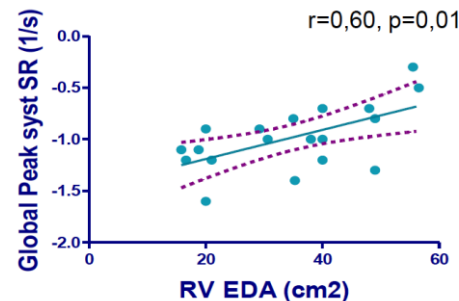


Impact of right ventricular systolic longitudinal strain rate on functional capacity in patients with pulmonary arterial hypertension

J. Silva Marques, S. Robalo Martins, C. Jorge, S. Goncalves, S. Ribeiro, L. Santos, M. Mieiro, A.G. Almeida, A. Nunes Diogo. CHLN- Hospital de Santa Maria - Lisbon – Portugal.

- Estudo transversal; 20 doentes com HP (grupos I e IV, Dana Point - 2008), seguidos de forma protocolada em consulta de HTP.
- **Objectivo:** determinar a acuidade dos parâmetros ecocardiográficos de deformação miocárdica por *speckle-tracking* na avaliação da capacidade funcional e função sistólica do VD.

- O pico sistólico de *strain rate* global longitudinal correlacionou-se:
 - Áreas diastólica e sistólica do VD
 - Fracção de área VD
 - TAPSE



Impact of right ventricular systolic longitudinal strain rate on functional capacity in patients with pulmonary arterial hypertension

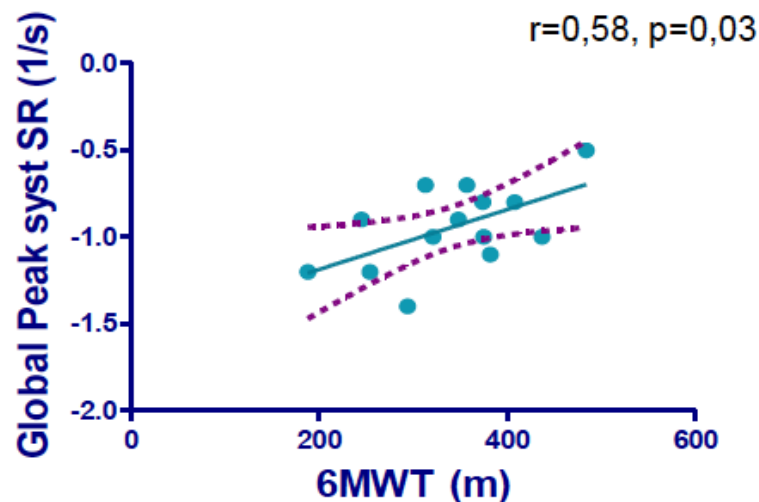
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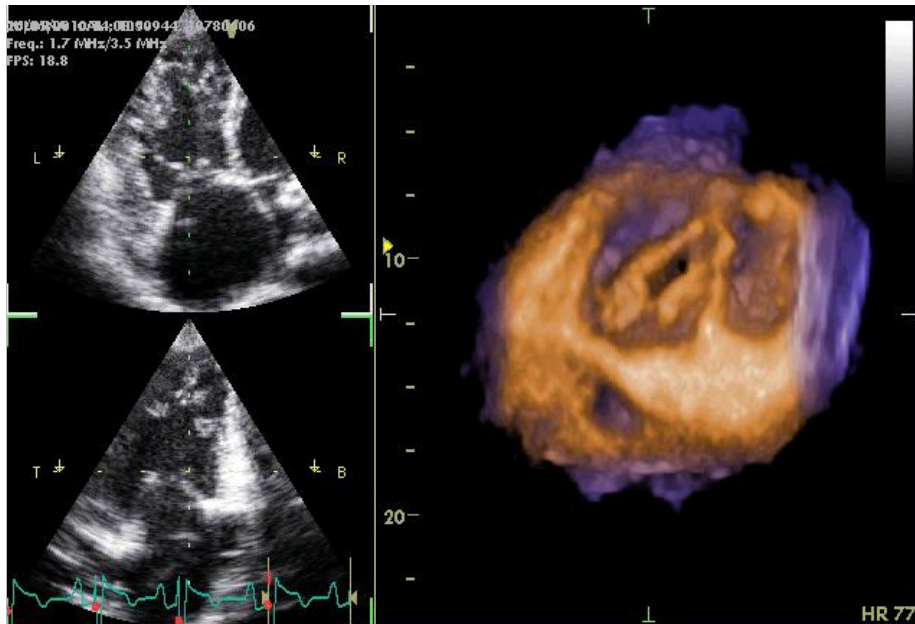
- **Pico sistólico global de *strain rate* longitudinal**
Preditor independente

➤ dT6MM

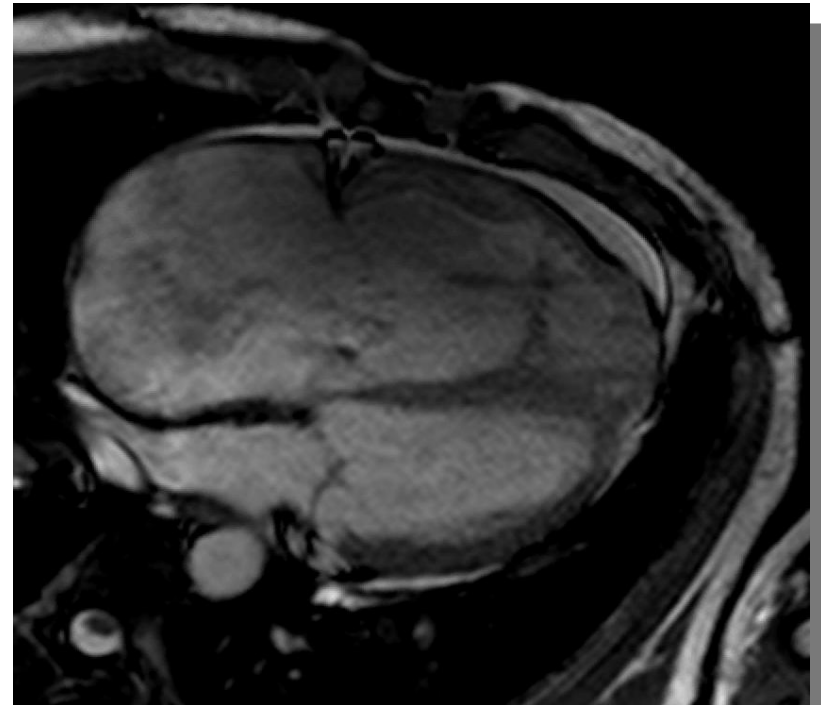


‘A caracterização da estrutura e função do VD é dificultada pela sua anatomia complexa, o que impõe limitações na abordagem bidimensional’

**Ecocardiograma
3D**



**Ressonância
Magnética Cardíaca**



Maior acuidade e reprodutibilidade na avaliação morfológica do VD

- ✧ Aquisição de volumes
- ✧ Avaliação de função ventricular
- ✧ Boa correlação com os dados da RMC

**Anatomically Oriented Right
Ventricular Volume Measurements With
Dynamic Three-Dimensional Echocardiography
Validated by 3-Tesla Magnetic Resonance Imaging**



Petra S. Niemann, MD, PhD,* Luiz Pinho, MD,* Thomas Balbach, MD,† Christian Galuschky, PhD,†
Michael Blankenhagen, PhD,† Michael Silberbach, MD, FACC,* Craig Broberg, MD, FACC,*
Michael Jerosch-Herold, PhD,* David J. Sahn, MD, MACC*

Portland, Oregon; and Unterschleissheim, Germany

*Necessários mais estudos para validação
e standardização dos parâmetros*



European Heart Journal – Cardiovascular Imaging
doi:10.1093/ehjci/ies003

The association of clinical outcome with right atrial and ventricular remodelling in patients with pulmonary arterial hypertension: study with real-time three-dimensional echocardiography

Julia Grapsa¹, J. Simon R. Gibbs², Ines Zimbarra Cabrita², Geoffrey F. Watson^{1,2}, Harry Pavlopoulos¹, David Dawson¹, Wendy Gin-Sing², Luke S.G.E. Howard², and Petros Nihoyannopoulos^{1*}

- Durante um período de *follow-up* de 1 ano verificou-se aumento significativo:
 - AD
 - VD
 - Disfunção sistólica VD
- Agravamento clínico em 37% dos doentes.

- Estudo prospectivo, controlado; 62 doentes consecutivos com HAP.
- **Objectivo:** determinar a relação do *remodelling* longitudinal ventricular e auricular por 3DE com o *outcome* clínico (aumento da classe funcional ou internamento por IC direita).

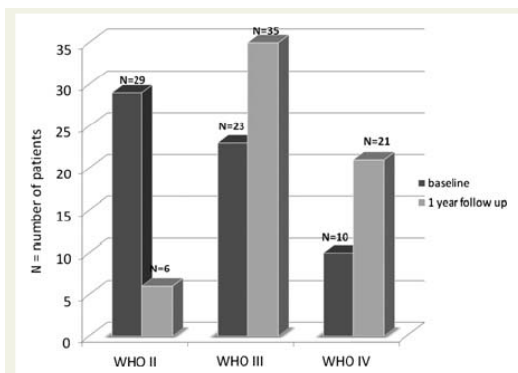


Figure 2 Deterioration of functional class within 1 year of follow-up. At baseline, 29 patients were in WHO class II (48%), 23 patients in WHO class III (37%), and 10 patients in WHO class IV (16.1%). After 1 year, 23 patients (37%) (16 who were previously in WHO II and 7 previously in WHO III) deteriorated clinically.

Table 1 Values of 2D and 3D echocardiography in PAH patients at baseline and after 1 year of follow-up

Values	Baseline mean (SD)	One-year follow-up mean (SD)	P-value
TR velocity (m/s)	4.4 (0.8)	4.52 (0.6)	0.65
RVSP (mmHg)	85 (25)	86.2 (23.6)	0.1
TR	36 mild (58%) 21 moderate (34%) 5 severe (8%)	26 mild (42%) 29 moderate (46%) 7 severe (12%)	<0.001
RVEF (%)	33 (8.2)	28 (7.6)	<0.001
RV sphericity index	0.71 (0.07)	0.98 (0.04)	<0.001
RA sphericity index	0.85 (0.16)	1.2 (0.24)	<0.001
RAVol index (mL/m ²)	70.5 (33.5)	77.2 (34.9)	<0.001
RAVol (mL)	122 (57.9)	133.5 (60.4)	<0.001

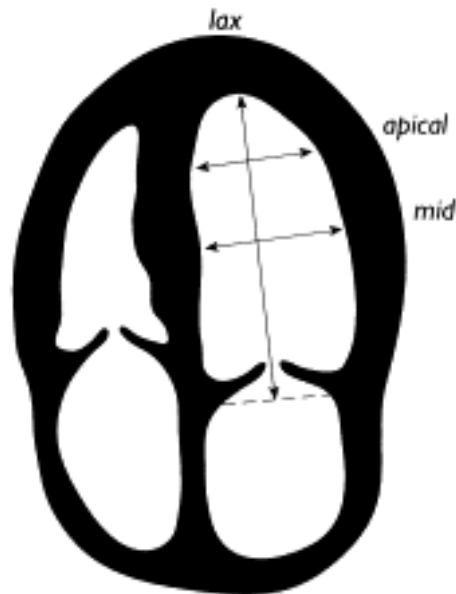
TR, tricuspid regurgitation; RVSP, right ventricular systolic pressure; RV, right ventricle; RA, right atrium; EF, ejection fraction; RAVol, right atrial volume.



European Heart Journal – Cardiovascular Imaging
doi:10.1093/ehjci/ehs003

The association of clinical outcome with right atrial and ventricular remodelling in patients with pulmonary arterial hypertension: study with real-time three-dimensional echocardiography

Julia Grapsa¹, J. Simon R. Gibbs², Ines Zimbarra Cabrita², Geoffrey F. Watson^{1,2}, Harry Pavlopoulos¹, David Dawson¹, Wendy Gin-Sing², Luke S.G.E. Howard², and Petros Nihoyannopoulos^{1*}



INDICES

Apical / mid

Sphericity index = mid / lax

- $\uparrow$ índice esfericidade AD > 0.24 foi preditor d *outcome* primário.
- O índice de esfericidade do VD e a FE(VD) foram menos sensíveis e específicos na previsão do agravamento clínico.

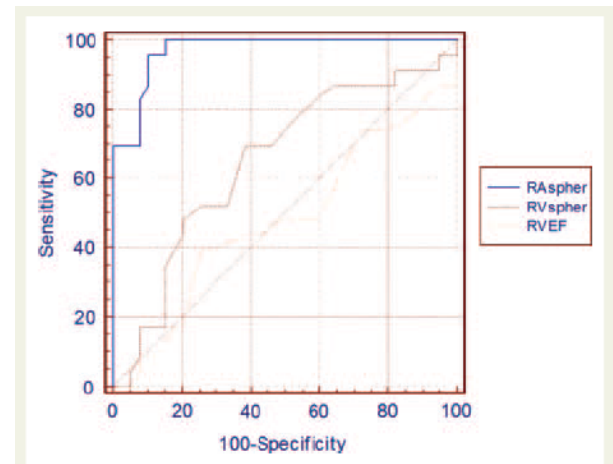


Figure 3 ROC curves for sensitivity and specificity of atrial and ventricular deformation in predicting clinical deterioration (NYHA): an increase of RAspher > 0.24 could predict clinical deterioration with a sensitivity of 96% and a specificity of 90% (AUC 0.97). RVspher was less sensitive (70%) and specific (62%) in predicting clinical deterioration (AUC 0.649). The deterioration in RVEF had an increased sensitivity of 91.1% but a low specificity of 35.3% (AUC 0.479) in predicting clinical deterioration.

Ressonância Magnética Cardíaca

- ✧ **Método de imagem preferencial para a avaliação global da estrutura / função do VD.**
 - Volumes
 - Fracção de ejeção
 - Massa miocárdica
- ✧ **Elevada reprodutibilidade** (ideal para monitorizar as alterações dos parâmetros ventriculares direitos em resposta à terapêutica).

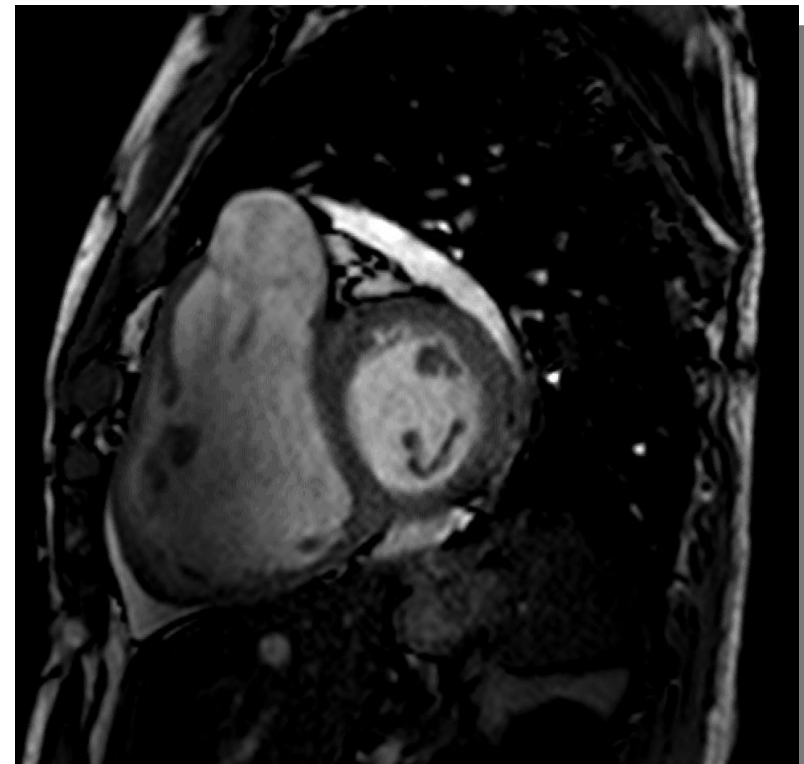
Advantages and Disadvantages of Magnetic Resonance Imaging

Advantages

- Unparalleled resolution
- Three-dimensional imaging capacity
- Noninvasive
- Nontoxic contrast agents*
- Ability to depict soft tissues

Disadvantages

- Long scan times
- Artifacts including motion, respiratory, cardiac motion
- Incompatibility with pacemakers, defibrillators, and aneurysm clips



Ressonância Magnética Cardíaca



EUROPEAN
SOCIETY OF
CARDIOLOGY®

European Heart Journal (2007) 28, 1250–1257
doi:10.1093/eurheartj/ehl477

Clinical research
Hypertension

Prognostic value of right ventricular mass, volume, and function in idiopathic pulmonary arterial hypertension

Serge A. van Wolferen¹, Johannes T. Marcus², Anco Boonstra¹, Koen M.J. Marques³, Jean G.F. Bronzwaer³, Marieke D. Spreeuwenberg⁴, Pieter E. Postmus¹, and Anton Vonk-Noordegraaf^{1*}

- Primeiro estudo de prognóstico na HTP a utilizar a RMC.
- Demonstrou a importância das **dimensões biventriculares indexadas** no *outcome* dos doentes com HAP idiopática.

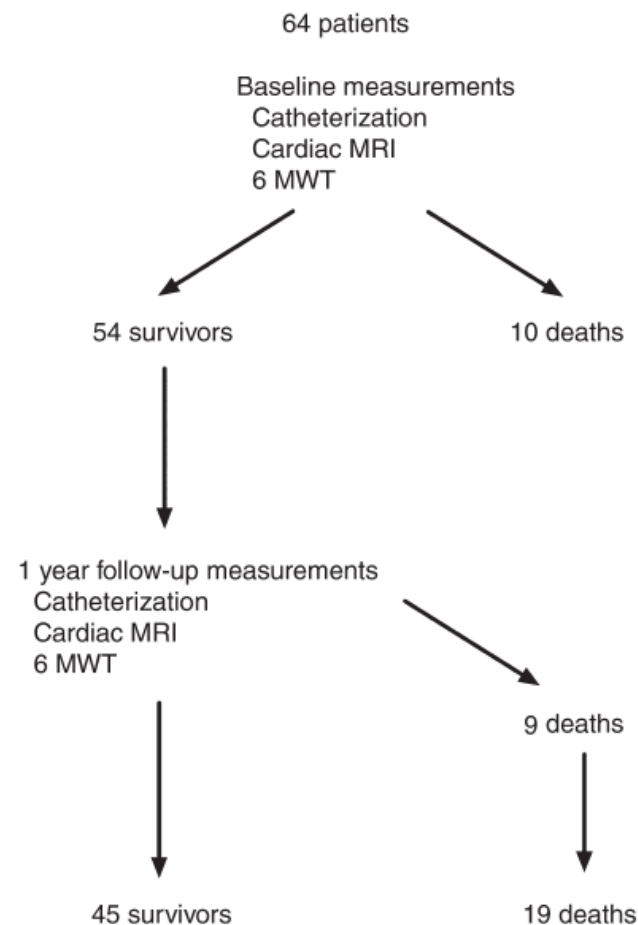


Figure 1 Study profile.

Ressonância Magnética Cardíaca

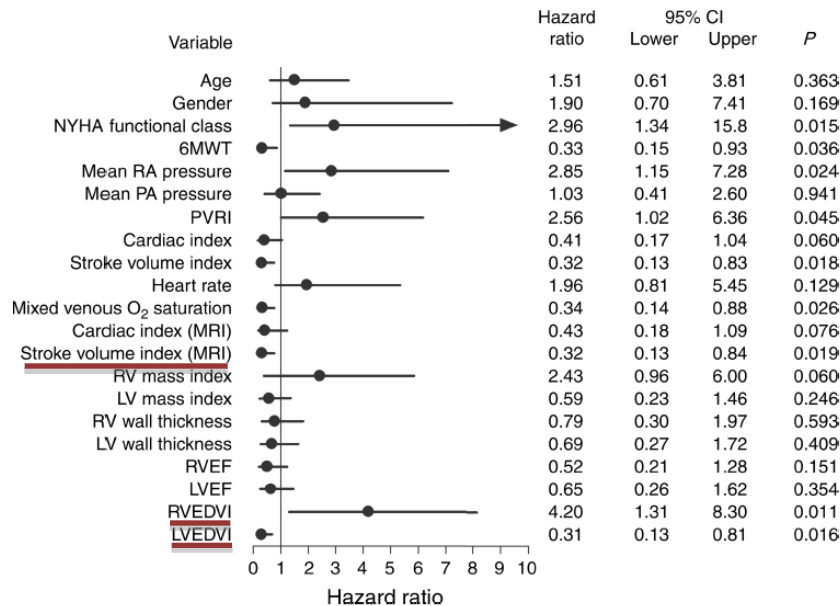


Figure 2 Univariate analysis of potential predictors of mortality in IPAH at baseline.

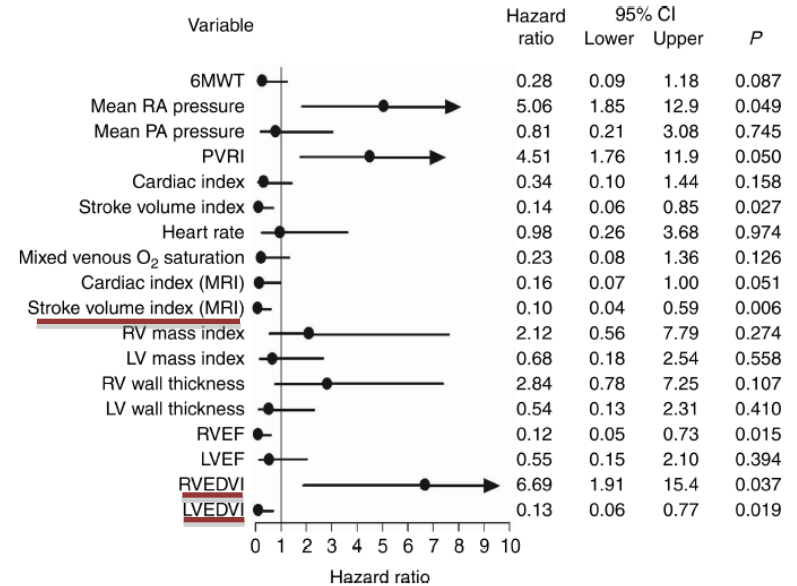


Figure 3 Univariate analysis of the change in variables after 1-year follow-up as potential predictors of mortality in IPAH.

Em análise univariada

- VTD (VD) indexado
- VTD (VE) indexado
- Volume sistólico indexado
(e suas variações após 1 ano de *follow-up*)



Preditores prognósticos de mortalidade

Ressonância Magnética Cardíaca

Variable	Baseline		Follow-up	
	Hazard ratio	P-value	Hazard ratio	P-value
SVI (CMR) (mL/m ²)	0.764	<0.001	0.892	0.012
RVEDVI (mL/m ²)	1.610	<0.001	1.046	0.036
LVEDVI (mL/m ²)	0.705	0.002	0.912	0.023

Em análise multivariada

- VTD (VD) indexado
- VTD (VE) indexado
- Volume sistólico indexado
(e suas variações após 1 ano de *follow-up*)



Predictores independentes de mortalidade

Ressonância Magnética Cardíaca

✧ Novos *Insights* na fisiopatologia da HTP

Table 4 New Insights Provided by CMR

INSIGHT	CMR METHOD
Early Changes	
PA stiffens before pulmonary artery pressure increase at rest	Distensibility of pulmonary arteries
Ventricular Remodeling and Dysfunction	
LV mass is lower in patients with chronic thromboembolic disease but normalizes post-pulmonary endarterectomy	LV mass
Interventricular dyssnchrony and septal bowing in PAH is due to slower contraction for the RV than LV	Tagging
Cardiac Ischemia	
Both ventricles display attenuated vasoreactivity proportional to mPAP	Adenosine Stress Perfusion
RV Metabolism	
Bosentan improves RV energetics	³¹ P-NMR spectroscopy
Ventricular-arterial Decoupling in PH	
Disconnect occurs since increases in arterial load are far greater than those in contractility	Volumes combined with invasively derived pressure loops/pressures

“It is a flexible research tool which has opened new avenues for understanding treatment effects, outcomes and pathogenesis”.

William M Bradlow



Congresso
Novas Fronteiras em Cardiologia
8 a 10 fevereiro.2013
Hotel Vila Galé Ericeira



Hipertensão Pulmonar

Preditores de Mortalidade

Rui Plácido

9 | Fevereiro | 2013