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ORIGINAL ARTICLE

Echocardiographic assessment of right ventricular contractile reserve in patients with pulmonary hypertension

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KEYWORDS
Right ventricle;
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Abstract
Introduction and Aim: Right ventricular function is a major determinant of prognosis in pulmonary hypertension. The aim of this study was to assess and compare right ventricular contractile reserve in healthy subjects (controls) and in subjects with pulmonary hypertension (cases).
Methods: In this prospective study of seven cases and seven controls undergoing treadmill stress echocardiography, right ventricular S-wave velocity, tricuspid annular plane systolic excursion (TAPSE), right ventricular fractional area change (RVFAC) and stroke volume index were assessed at rest and with exercise. The increase in each parameter between rest and exercise for cases and controls was analyzed and the magnitude of change in each parameter with exercise between cases and controls was compared.
Results: A significant increase in S-wave velocity was observed in cases (rest: 9.4±3.1; exercise: 13.7±4.8 cm/s [p<0.05]). In controls there was a statistically significant increase in S-wave velocity (12.9±2.3 to 23.0±7.2 cm/s [p<0.005]), TAPSE (25.7±2.4 to 31.0±3.5 mm [p<0.05]) and RVFAC (53.8±14.7% to 64.4±9.9% [p<0.005]). The magnitude of change in S-wave velocity (cases: 4.3±3.3; controls: 10.1±5.5 cm/s [p<0.05]), TAPSE (cases: 0.6±2.5; controls: 5.3±3.8 mm [p<0.05]) and RVFAC (cases: −0.4±11.8; controls: 10.6±5.9% [p<0.05]) was significantly different between cases and controls.
Conclusions: S-wave velocity, TAPSE and RVFAC increased significantly with exercise in controls. S-wave velocity was the only parameter that showed a significant increase in cases, although the magnitude of this increase was significantly less than in controls.

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PALAVRAS-CHAVE
Ventrículo direito;
Reserva contrátil;
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Ecocardiografia de esforço

Avaliação ecocardiográfica da reserva contrátil ventricular direita em doentes com hipertensão pulmonar

Resumo
Introdução e objetivo: A função ventricular direita é um determinante *major* do prognóstico na hipertensão pulmonar. Caracterização e comparação da reserva contrátil do ventrículo direito em indivíduos saudáveis (controlos) e doentes com hipertensão pulmonar (casos).
Métodos: Estudo prospetivo de sete casos e sete controlos submetidos a ecocardiograma de esforço. Avaliámos, em repouso e no esforço, a velocidade da onda S ventricular direita, a excursão sistólica do plano anular tricúspide, a área de encurtamento fracional do ventrículo direito e o volume sistólico indexado. Analisámos o aumento de cada parâmetro entre repouso e esforço para casos e controlos e comparámos a magnitude de variação com o exercício de cada parâmetro entre casos e controlos.
Resultados: Nos casos observámos aumento significativo da onda S (repouso 9,4 ± 3,1; esforço 13,7 ± 4,8 cm/seg [p < 0,05]). Nos controlos ocorreu aumento significativo da onda S (repouso 12,9 ± 2,3; esforço 23,0 ± 7,2 cm/seg [p < 0,005]), da excursão sistólica do plano anular tricúspide (repouso 25,7 ± 2,4; esforço 31,0 ± 3,5 mm [p < 0,05]) e da área de encurtamento fracional (repouso 53,8 ± 14,7%; esforço 64,4 ± 9,9% [p < 0,005]). A magnitude de variação da onda S (casos 4,3 ± 3,3; controlos 10,1 ± 5,5 cm/seg [p < 0,05]), da excursão sistólica do plano anular tricúspide (casos 0,6 ± 2,5; controlos 5,3 ± 3,8 mm [p < 0,05]) e da área de encurtamento fraccional (casos 0,4 ± 11,8; controlos 10,6 ± 5,9% [p < 0,05]) foi significativamente diferente entre casos e controlos.
Conclusões: A onda S, a excursão sistólica do plano anular tricúspide e a área de encurtamento fracional aumentaram significativamente com o esforço nos controlos. A onda S foi o único parâmetro que aumentou significativamente nos casos, embora a magnitude desse aumento seja significativamente menor do que nos controlos.

List of abbreviations

Δ	magnitude of change
BP	blood pressure
BSA	body surface area
HR	heart rate
LV	left ventricular
LVEI	left ventricular eccentricity index
LVOT	left ventricular outflow tract
PAP	pulmonary artery pressure
PH	pulmonary hypertension
RV	right ventricular
RVFAC	right ventricular fractional area change
RV/RA	right ventricular/right atrial
SBP	systolic blood pressure
SO_2	arterial oxygen saturation
SVI	stroke volume index
TAPSE	tricuspid annular plane systolic excursion
VTI	velocity-time integral

Introduction

Pulmonary arterial hypertension and chronic thromboembolic pulmonary hypertension are relatively rare diseases, with estimated prevalences of 15 cases/million adults and 3.8 cases/100 survivors of acute pulmonary embolism, respectively.[1] Pulmonary hypertension (PH) is characterized by a progressive increase in pulmonary vascular resistance leading to right ventricular (RV) failure and death.[2]

RV function is the main determinant of evolution and prognosis in PH patients.[3] Various clinical, functional, echocardiographic and hemodynamic parameters are used to assess severity, prognosis and response to therapy in PH patients, most of which reflect RV function.

RV contractile (or inotropic) reserve is defined as the response of the right ventricle to stress and may be an important prognostic factor, but the best parameters for its assessment remain to be determined.[4]

Treadmill stress echocardiography enables physiological assessment of different echocardiographic parameters throughout exercise.

Aim

The aim of this study was to characterize and compare the RV contractile reserve of PH patients (cases) and healthy individuals (controls) using echocardiographic parameters of RV contractile reserve[4,5] assessed through treadmill stress echocardiography.