Journal of Cardiovascular Magnetic Resonance

BioMed Central

Poster presentation

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Percutaneous pulmonary valve implantation in right ventricular outflow tract dysfunction enhances cardiac response to exercise by improved bi-ventricular stroke volume-a exercise stress real-time magnetic resonance study

Philipp Lurz*[1], Pia K Schuler[2], Vivek Muthurangu[2], Silvia Schievano[2], Sachin Khambadkone[2], Philipp Bonhoeffer[2] and Andrew M Taylor[2]

Address: [1]UCL Institute of Child Health, London, UK & Heart Centre Leipzig, Leipzig, Germany and [2]UCL Institute of Child Health, London, UK

* Corresponding author

from 13th Annual SCMR Scientific Sessions
Phoenix, AZ, USA. 21-24 January 2010

Published: 21 January 2010

Journal of Cardiovascular Magnetic Resonance 2010, **12**(Suppl 1):P8 doi:10.1186/1532-429X-12-S1-P8

This abstract is available from: http://jcmr-online.com/content/12/S1/P8

Introduction

Magnetic resonance imaging (MRI) often guides the management of patients with congenital heart disease involving right ventricular outflow tract (RVOT) dysfunction. However, the impact of RVOT dysfunction and its relief on cardiac response to exercise stress is unknown.

Purpose

To assess the impact of PPVI on bi-ventricular adaptation to exercise

Methods

12 patients, who underwent percutaneous pulmonary valve implantation (PPVI) for significant RVOT obstruction (echo gradient > 50 mmHg), were included. MRI was performed at rest and during supine exercise stress at the same intensity pre- and within 1 month post-PPVI. Bi-ventricular volumes and function were assessed under free breathing and continuation of exercise using a radial k-t SENSE real-time sequence. Pulmonary regurgitation fraction was calculated as follows: RV stroke volume (SV) - LV SV.

Results

Prior to PPVI, augmentation of cardiac output during exercise was mainly achieved by increased heart rate, RV and LV effective SV improved only slightly. After relief of RVOTO by PPVI, augmentation of RV and LV SV during exercise improved significantly compared to the assessment during exercise pre-PPVI. This was achieved by increased RV ejection fraction and LV end-diastolic volume. This improved RV and LV SV augmentation during exercise resulted in heart rate reduction at maintained cardiac output compared to the response to exercise seen prior to PPVI (see figure 1).

Conclusion

PPVI for RVOT dysfunction improves bi-ventricular response to exercise. Utilisation of such real-time MR imaging techniques during exercise stress may refine the assessment of procedural success post RVOT interventions in patients with congenital heart disease.

	REST		EXERCISE	
	pre-PPVI	post-PPVI	pre-PPVI	post-PPVI
RV EDV, ml/m^2	111.0 ± 46.7	101.1 ± 36.2	113.4 ± 40.8	104.5 ± 33.9 *
RV ESV, ml/m^2	61.2 ± 39.4	53.2 ± 35.1 *	62.2 ± 39.5	49.2 ± 34.3 *
RV SV, ml/m^2	50.3 ± 13.9	47.9 ± 6.8	51.1 ± 10.9	55.3 ± 7.3 *
RV EF, %	47.4 ± 13.3	51.5 ± 14.5	48.2 ± 13.4	57.3 ± 16.7 *
PRF, %	11.2 ± 12.8	1.1 ± 2.4 *	5.7 ± 5.0	1.3 ± 3.5 *
LV EDV, ml/m^2	74.2 ± 22.1	80.1 ± 20.6 *	75.4 ± 25.2	84.7 ± 24.6 *
LV ESV, ml/m^2	30.3 ± 16.5	32.6 ± 15.6	27.3 ± 21.5	29.1 ± 20.7
LV SV, ml/m^2	43.9 ± 8.9	47.6 ± 704 *	48.1 ± 9.6	55.6 ± 7.7 *
LV EF, %	61.0 ± 10.5	61.0 ± 8.7	67.4 ± 14.9	68.3 ± 12.1
Heart rate, bpm	74.0 ± 9.6	74.7 ± 9.8	135.4 ± 16.2	121.8 ± 14.4 *
CO LV, ml/min * m^2	3.2 ± 0.55	3.5 ± 0.45 *	6.5 ± 1.3	6.8 ± 1.5

EDV, end-diastolic; ESV, end-systolic; EF, ejection fraction; CO, cardiac output
* indicates a significant difference ($p<0.05$) between parameters assessed pre-PPVI and post-PPVI

Figure 1