Cardiovascular Magnetic Resonance Imaging for Risk Assessment and Prediction of Clinical Worsening in Pulmonary Arterial Hypertension

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Background

Dilatation of the right ventricle (RV) and reduction of stroke volume (SV) are associated with increased mortality in pulmonary arterial hypertension (PAH).

Purpose

To determine the clinically detectable changes of right ventricular (RV) volume and SV that predicts clinical worsening in patients with PAH.

Methods

Patients with PAH were followed semi-annually for up to 2.5 years with assessment of RV end-diastolic volume (RVEDV) and SV using cardiovascular magnetic resonance imaging (CMR), and WHO Functional Class (WHO FC). With changes in WHO FC as an anchor, mixed model statistics were used to determine the minimal clinically important difference in RVEDV and SV predicting deterioration in WHO FC.

Results

Twenty-five (25) patients attended a total of 6 (9 patients), 5 (5 patients), 4 (1 patient), 3 (5 patients), 2 (4 patients) visits and 1 (1 patient) visit, totalling 107 scans with concomitant assessments of WHO FC. During the period 2 patients died (after 2 visits respectively) and 1 withdrew (after 3 visits). One step change in WHO FC was associated with a change in RVEDV of 10.6% ($p<0.0001$) and in SV of 9.0% ($p=0.003$).

Population characteristics

	PAH (25)
Sex (F/M)	16/9
Age	46±15
BSA (m^2)	1.87±0.20
WHO FC (I/II/III/IV)	10/9/5/1
6 MWT (m)	523±165

Table 1: ±=Standard deviation; 6MWT=Six-minute walk test; BSA=Body surface area; WHO FC=World Health Organization Functional Class

Right ventricular end-diastolic volume

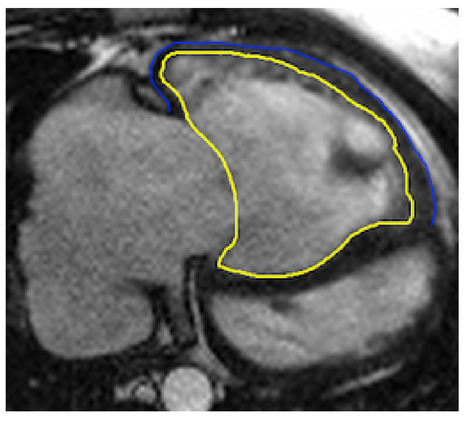

Figure 1: Axial cine images were used for right ventricular assessment as the atrioventricular border is easier to determine. Yellow line is right ventricular endocardial border. Blue line is right ventricular epicardial border.

CMR measurements

RVEDV (mL)	232 ± 60
RVESV (mL)	144 ± 56
RVSV (mL)	89 ± 26
RVEF (%)	40 ± 11
RV mass (g)	72 ± 25
LVEDV (mL)	131 ± 33
LVESV (mL)	51 ± 13
LVSV (mL)	80 ± 23
LVEF (%)	61 ± 7
LV mass (g)	105 ± 25

Table 2: ±=Standard deviation; LV=Left ventricular; EDV=End-diastolic volume; EF=Ejection fraction; ESV=End-systolic volume; SV=Stroke volume; RV=Right ventricular.

The associated changes of right ventricular end-diastolic volume and stroke volume with change in WHO functional class (WHO FC) during follow-up.

	Intercept	**For change in WHO FC**	P
RVEDV	$102.1\%(99.7-104.5)$	$+10.6\%(7.0-14.3)$	<0.0001
SV	$101.9\%(98.5-105.3)$	$-9.0\%(-14.9--3.2)$	0.003

Table 3: RVEDV=Right ventricular end-diastolic volume; SV=Stroke volume. Confidence interval in parentheses.

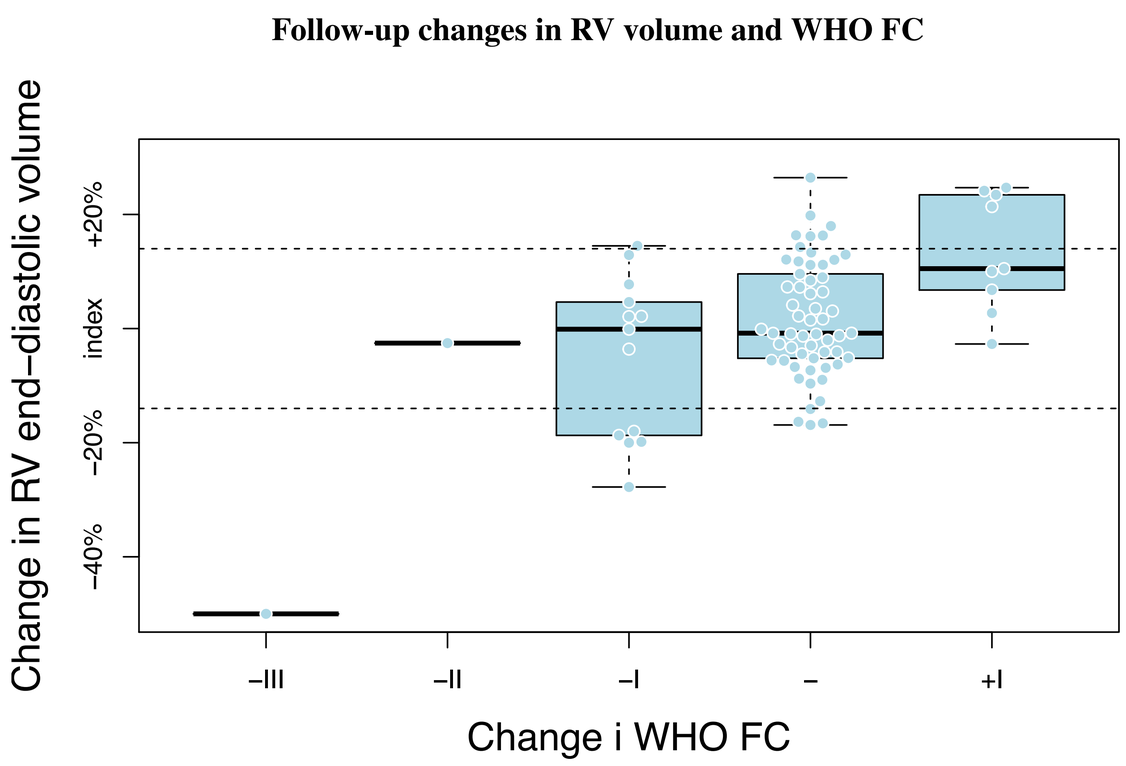

Figure 2: Changes in right ventricular end-diastolic volume in relation to changes in WHO FC. Stippled lines represent limits of normal variation from Göransson et al. [1]

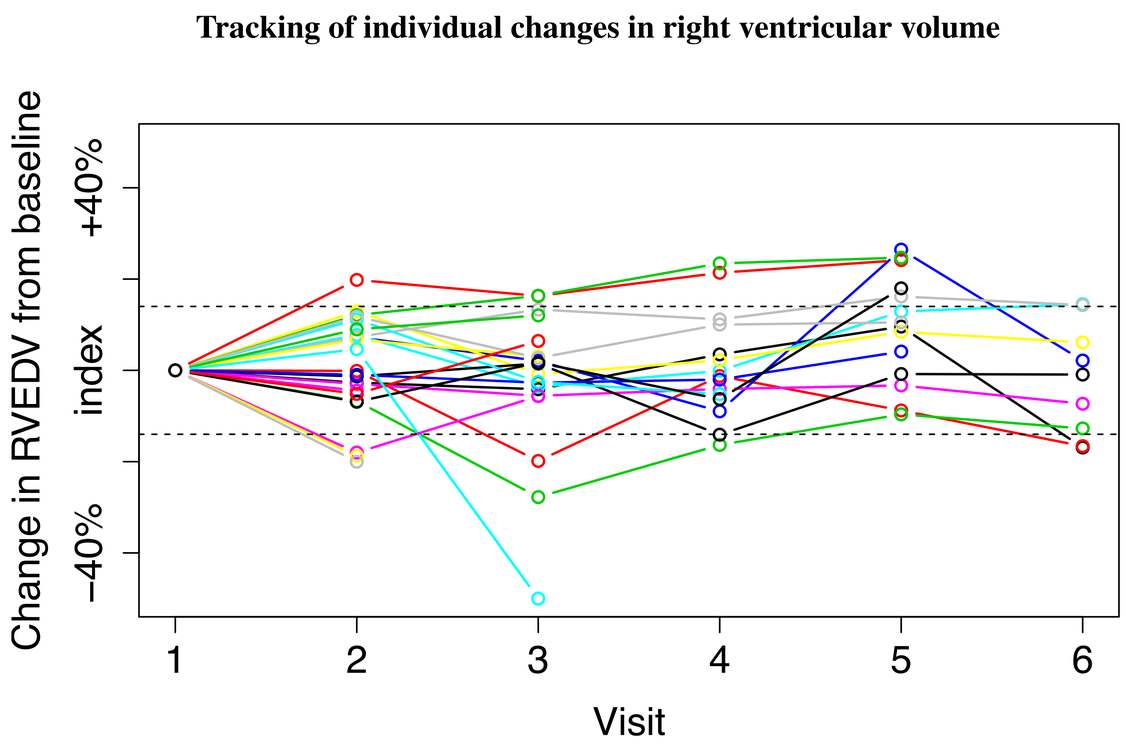

Figure 3: Changes in right ventricular end-diastolic volume during the study period. Stippled lines represent limits of normal variability from Göransson et al [1]. RVEDV = Right ventricular end-diastolic volume. Colours represent individual patients.

Conclusion

In assessment of right ventricular volume, the recognition of dilatation by more than 11% could enable the physician to predict and possibly prevent deterioration of functional class in pulmonary arterial hypertension.

References

[1] Christoffer Göransson, Niels Vejlstrup, Thomas Scheike, and Jorn Carlsen. Implications of cardiac variability with cardiovascular magnetic resonance imaging for calculating trial sample size in pulmonary arterial hypertension. *International Journal of Cardiology*, (257C):343–349, 2018.

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