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Comparison of cardiovascular magnetic resonance with real-time three-dimensional echocardiography and the right ventricular automated systolic index in the assessment of the right ventricular function

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Background

The right ventricular (RV) function has an important diagnostic value in many cardiopulmonary diseases and is a predictor for the long-term outcome. Cardiovascular magnetic resonance (CMR) is the gold-standard for the RV quantification as the complex anatomy of the RV, i.e. its crescentic shape, impedes reliable measurement by two-dimensional echocardiography (EC). Yet, CMR or real-time 3D echocardiography (RT3DE) measurements are time consuming. Recently, a novel EC parameter, the RV automated systolic index (RV-ASI), has been introduced which employs semi-automated whole-cycle endocardial border detection and calculates volume changes based on the sum-of-discs method (modified Simpson's rule). In this study we evaluate the measurement agreements of two novel EC parameters, a) the RV-ASI and b) the RT3DE, with the reference standard CMR.

Methods

We studied 25 patients with different cardiopulmonary diseases (coronary artery disease with preserved left ventricular function (n=4), ischemic cardiomyopathy (n=4), dilated cardiomyopathy (n=10), hypertrophic cardiomyopathy (n=1), cardiac amyloidosis (n=2), pulmonary hypertension (n=4)) and 15 healthy subjects. CMR imaging was performed on a 1.5 T whole-body MRI-scanner applying a cine SSFP sequence with parallel imaging. EC was performed within 30 min with a commercially available ultrasound machine (GE Vivid E9) including RT3DE and the measurement of the RV-ASI. Student's t-test or Mann-Whitney-Wilcoxon-test respectively as well as a regression analysis and a Bland-Altman-plot were performed. Receiver operator characteristics were calculated for RV-ASI compared to CMR RV ejection fraction (RV-EF). A $p<0.05$ was regarded as statistically significant.

Results

The RV measurements could be assessed in 100% of subjects by CMR. RV-ASI was evaluable in 38 of 40 subjects (95 %) by EC. Mean RV-EF measured by CMR was 48±9% compared to 51±10% by RT3DE and a RV-ASI of 52±11%. The correlation between CMR RV-EF and RV-ASI ($r=0.74$, $p<0.0001$) as well as between CMR RV-EF and RT3DE RV-EF ($r=0.55$, $p=0.0003$) were highly significant. The limits of agreement were ±15.1% for RV-ASI and ±17.4% for RT3DE RV-EF compared to CMR RV-EF. An RV-ASI cut-off value of 52% could differentiate between normal and impaired RV function (AUC=0.92, sensitivity=87%, specificity=93%) in this mixed study population.

Conclusions

In this study the time-saving RV-ASI method showed good agreement with CMR regarding the quantification of the RV function. Although it does not provide the measurement of absolute systolic and diastolic RV

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Table 1 Comparison of RT3DE and RV-ASI to CMR

	r	Bias	Limits of agreement	p
RT3DE RV-EF (%)	0.55	+3.1%	±17.4%	0.0003
RV-ASI (%)	0.74	+4.4%	±15.1%	<0.0001

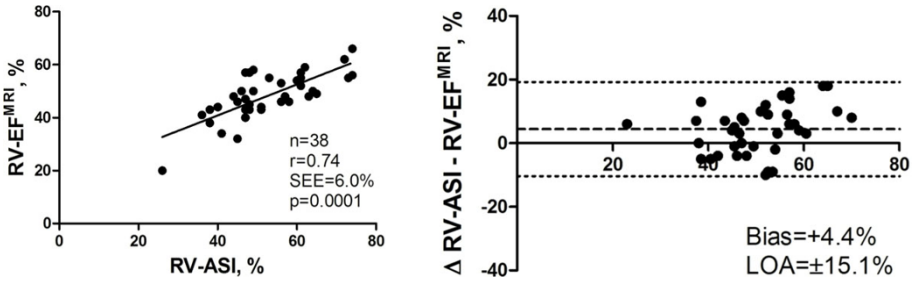

Figure 1 Left: linear regression analysis of RV-ASI and CMR RV-EF. Right: corresponding Bland-Altman-plot of RV-ASI and CMR RV-EF.

volumes, the RV function can be assessed reliably. As it can be obtained easily, it may be utilised for non-invasive follow-up examinations of patients with cardiopulmonary diseases.

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