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Relationship between echocardiographic and cardiac magnetic resonance imaging-derived measures of right ventricular function in patients with chronic thromboembolic pulmonary hypertension

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ABSTRACT

Background: Echocardiography is widely used to evaluate right ventricular (RV) function. However, the value of echocardiographic parameters to assess RV function in patients with chronic thromboembolic pulmonary hypertension (CTEPH) is unknown. In this study, we analyzed the correlations between echocardiographic parameters and the RV ejection fraction (RVEF) as measured by cardiac magnetic resonance (CMR) imaging to systematically elucidate the role of echocardiographic parameters in the assessment of RV function in patients with CTEPH.
Methods: Echocardiography was used to measure the tissue Doppler-derived tricuspid lateral annular systolic velocity (S′), fractional area change (FAC), myocardial performance index (MPI), and tricuspid annular plane systolic excursion (TAPSE). CMR was used to measure the RV end-diastolic volume (RVEDV) and end-systolic volume (RVESV), and the RVEF was calculated.
Results: A significant positive correlation was found between S′ and RVEF ($r = 0.689$, $P < 0.0001$) and between FAC and RVEF ($r = 0.423$, $P = 0.022$), a significant negative correlation was found between MPI and RVEF ($r = -0.387$, $P = 0.048$), and no correlation was found between TAPSE and RVEF ($r = 0.451$, $P = 0.22$).
Conclusion: Echocardiography can be routinely used in the clinical setting to measure S′, FAC, and MPI for the evaluation of right heart function in patients with CTEPH.

Introduction

Chronic thromboembolic pulmonary hypertension (CTEPH) is a life-threatening complication that results from single or recurrent pulmonary thromboemboli arising from sites of venous thrombosis. Patients with CTEPH have high pulmonary vascular resistance (PVR) due to fibrotic organization of unresolved thromboemboli and remodeling of pulmonary blood vessels. A substantial change in PVR may lead to pulmonary hypertension, right ventricular (RV) overload, and progressive right heart failure [1].

Most patients with CTEPH show marked RV dysfunction and pulmonary hypertension. In many pathological conditions, RV function is strongly associated with clinical outcomes, disease severity, and patient health-related quality of life, and is an important predictor of prognosis. Thus, assessment of RV size and function plays a crucial role in the management of patients with CTEPH. Cardiac magnetic resonance (CMR) imaging can accurately assess the RV end-diastolic volume (RVEDV) and RV end-systolic volume (RVESV) to calculate the RV ejection fraction (RVEF) [2]. CMR has become the standard reference technique for assessment of RV structure and function. However, CMR may be contraindicated in some patients, including those who are unduly stressed by breath holding, those with a limited ability to lie down for the duration of the scan, and those with an irregular heartbeat and serious tachycardia; and it is time consuming, requires dedicated software and expert radiologists and cardiologists. All of these conditions can affect the image quality and the accuracy of volume measurement [3,4].

Echocardiography is a common and convenient method used to evaluate RV function and the hemodynamics of the pulmonary circulation. On two-dimensional transthoracic echocardiography imaging, RV

Abbreviations: CMR, cardiac magnetic resonance; CTEPH, chronic thromboembolic pulmonary hypertension; FAC, RV fractional area change; mPAP, mean pulmonary artery pressure; MPI, myocardial performance index; PVR, pulmonary vascular resistance; RV, right ventricle; RVEDV, RV end-diastolic volume; RVEF, RV ejection fraction; RVESV, RV end-systolic volume; S′, tricuspid lateral annular systolic velocity; TAPSE, tricuspid annular plane systolic excursion; TDI, tissue Doppler imaging.

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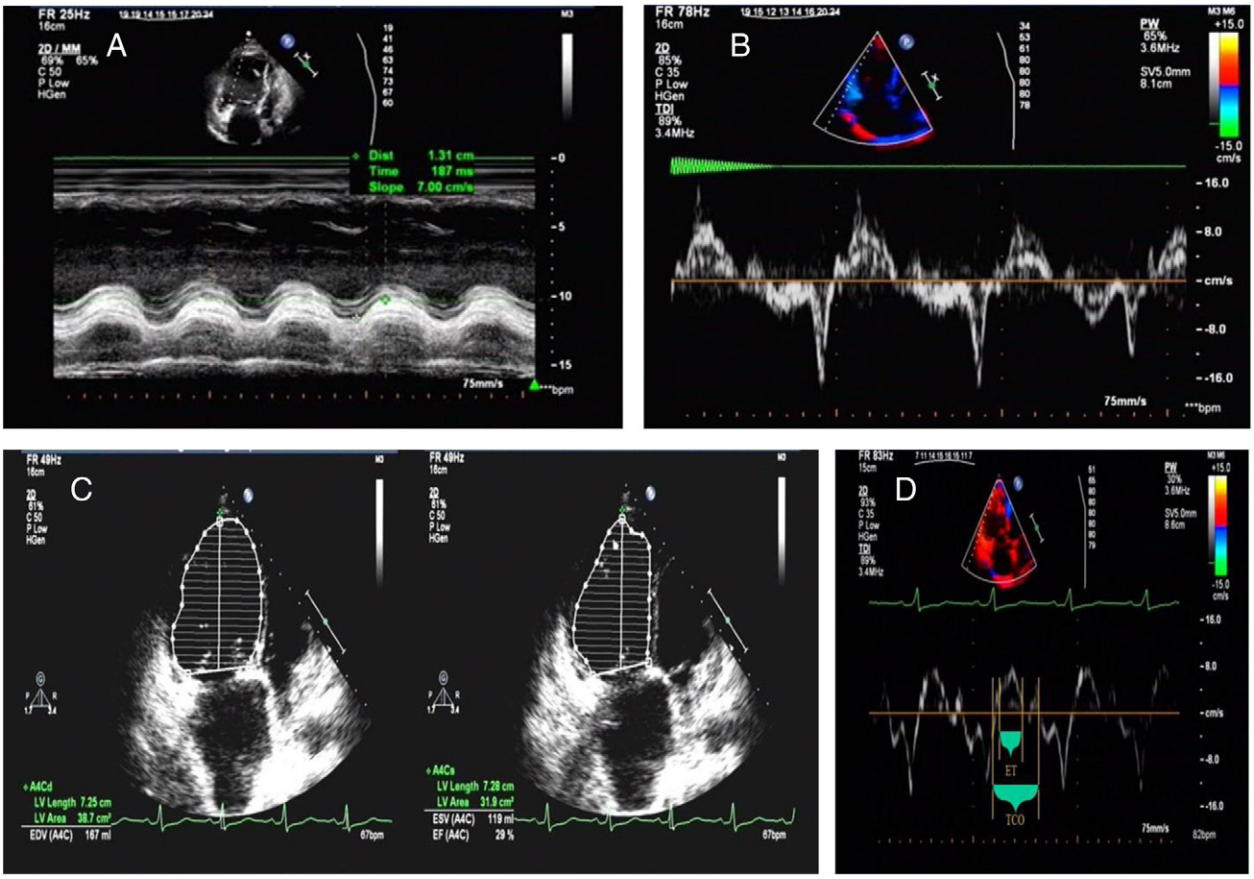

Fig. 1. Measurement of right ventricular parameters of echocardiography. 1A. Measurement of tricuspid annular plane systolic excursion (TAPSE); 1B. Measurement of tricuspid annular systolic excursion velocity (S′); 1C. Measurement of right ventricular fractional area change (RVFAC); 1D. Calculation of right ventricular myocardial performance index (MPI) by pulsed tissue Doppler.

volume is often estimated using linear dimensions or RV area in the apical four-chamber view [5]. Previous studies have investigated the use of several echocardiographic parameters in the assessment of RV function, including the tricuspid annular plane systolic velocity (S′) [6], RV fractional area change (RVFAC), RV myocardial performance index (RVMPI) [7,8], and tricuspid annular plane systolic excursion (TAPSE). However, the clinical value of these parameters for the assessment of RV function in patients with CTEPH is not well defined.

In this study, we analyzed the correlations between echocardiographic parameters and the RVEF as measured by CMR to systematically elucidate the role of echocardiographic parameters in the assessment of RV function in patients with CTEPH.

Materials and Methods

Study Patients

Thirty-two patients with CTEPH who underwent echocardiography and CMR between August 2012 and January 2014 were considered for inclusion in this retrospective study. The diagnosis of CTEPH was

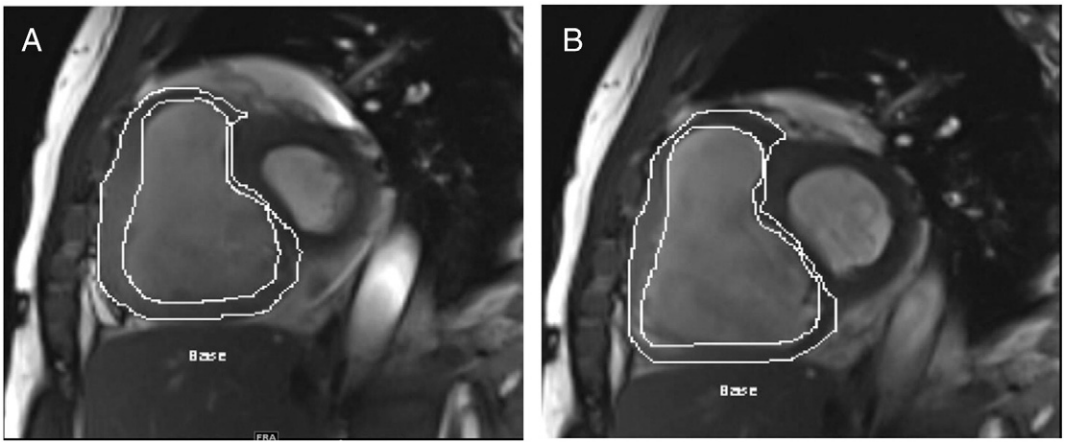

Fig. 2. Measurement of right ventricular volume by cardiac magnetic resonance (CMR). 2A. Measurement of right ventricular end-diastolic volume (RVEDV) by CMR imaging; 2B. Measurement of right ventricular end-systolic volume (RVESV) by CMR imaging.