Right Ventricular Systolic Dysfunction in Chagas Disease Defined by Speckle-Tracking Echocardiography: A Comparative Study with Cardiac Magnetic Resonance Imaging

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Background: Chagas disease leads to biventricular heart failure, usually with prominent systemic congestion. Although echocardiography is widely used in clinical routine, the utility of echocardiographic parameters to detect right ventricular (RV) systolic dysfunction in patients with Chagas disease is unknown. We sought to study the diagnostic value of echocardiography, including speckle-tracking parameters, to distinguish individuals with RV systolic dysfunction from those with normal RV systolic function in Chagas disease using cardiac magnetic resonance (CMR) as the reference method.

Methods: In this cross-sectional study, 63 individuals with Chagas disease underwent echocardiography and CMR evaluations. Conventional echocardiographic parameters for RV functional evaluation were tricuspid annular plane systolic excursion, RV systolic excursion velocity, fractional area change, and RV index of myocardial performance. Strain and strain rate were obtained by two-dimensional speckle-tracking echocardiography and defined as "RV free wall," when based only in segments from RV free wall, or "RV free wall and septum," when segments from both free RV wall and interventricular septum were included. RV systolic dysfunction was defined as RV ejection fraction (RVEF) < 50% by CMR.

Results: Mean age was 56 ± 14 years, and 58.7% of the patients were men. RV systolic dysfunction was detected by CMR in 18 (28.6%) individuals. RV free wall strain showed the highest correlation with RVEF by CMR ($r = -0.62$, $P < .001$), followed by fractional area change ($r = 0.56$, $P < .001$), RV free wall and septum strain ($r = -0.54$, $P < .001$), RV free wall and septum strain rate ($r = -0.47$, $P < .001$), RV free wall strain rate ($r = -0.45$, $P < .001$), and RV systolic excursion velocity ($r = 0.30$, $P = .016$). The RV index of myocardial performance and tricuspid annular plane systolic excursion showed a small and not significant correlation with RVEF ($r = -0.20$, $P = .320$; $r = 0.14$; $P = .289$, respectively). Using predefined cutoffs for RV systolic dysfunction, RV free wall strain (>−22.5% for men and >−23.3% for women) exhibited the highest area under the receiver operating characteristic curve (area under the curve = 0.829) to differentiate the presence from the absence of RV systolic dysfunction in Chagas disease, with a sensitivity and specificity of 67% and 83%, respectively.

Conclusions: RV free wall strain is an appropriate and superior echocardiographic variable for evaluating RV systolic function in Chagas disease, and it should be the method of choice for this purpose. (J Am Soc Echocardiogr 2017;■:■-■.)

Keywords: Chagas disease, Right ventricular function, Echocardiography, Speckle-tracking imaging

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Abbreviations

AP4-RV = Apical four-chamber view focused on the right ventricle

AUC = Area under the curve

CMR = Cardiac magnetic resonance

ECG = Electrocardiography

ELISA = Enzyme-linked immunosorbent assay

FAC = Fractional area change

IQR = Interquartile range

LGE = Late gadolinium enhancement

LV = Left ventricular

LVEF = Left ventricular ejection fraction

PAAcT = Pulmonary artery acceleration time

PASP = Pulmonary artery systolic pressure

RBBB = Right bundle branch block

RIMP = Right ventricular index of myocardial performance

ROC = Receiver operating characteristic

ROI = Region of interest

RV = Right ventricular

RVEF = Right ventricular ejection fraction

RVS = Right ventricular systolic excursion velocity

TAPSE = Tricuspid annular plane systolic excursion

Chagas disease, a parasitic infection caused by the protozoan *Trypanosoma cruzi,* is a major public health problem, leading to a high global economic burden and social impact.[1] The World Health Organization estimates that around 7 million people are infected worldwide, mostly in the endemic areas of 21 Latin American countries.[2] Population interchange between endemic and nonendemic areas has increased the number of infected individuals living in other countries, such as the United States and European countries.[3,4]

Roughly 30%–40% of individuals infected with *T. cruzi* will develop chronic cardiomyopathy, the most serious and frequent manifestation of Chagas disease.[5] Right ventricular (RV) impairment is a common finding, demonstrated even in the early stages of the disease, as previously reported in seminal studies using radionuclide angiography.[6,7] Heart failure is usually a late manifestation, characterized by the predominance of systemic congestion over signs of pulmonary congestion. The presence of RV dysfunction is associated with poor prognosis at this advanced stage.[8,9] Despite RV function playing a pivotal role in Chagas disease, accuracy of echocardiography to detect RV impairment in this clinical setting has not been assessed.

Assessment of RV structure and function by echocardiography can be challenging, especially because of the complex morpho-functional characteristics of this cardiac chamber. The right ventricle shows a crescent shape in a cross-sectional view, while it appears triangular when viewed from the side.[10] In addition, the RV cavity encompasses three distinct components: the inlet, the main cavity, and the outflow regions, which are usually difficult to visualize all together in a single two-dimensional plane.[11] The moderator band and prominent trabeculae in the midapical region frequently preclude an appropriate visualization of the interface between the endocardium and the cavity of the right ventricle.[12] Furthermore, a deep subendocardial layer of longitudinal fibers leads to a predominantly base-to-apex contraction, in contrast to the left ventricular (LV) contraction, which is directed primarily towards the LV cavity centroid.[13]

Despite those obstacles, echocardiography can provide several parameters to assess RV structure and function in clinical practice. Recently, speckle-tracking echocardiography has allowed the analysis of RV strain, a measurement of myocardial deformation, which has demonstrated higher accuracy for the detection of RV systolic dysfunction in various clinical settings, such as myocardial infarction and idiopathic dilated cardiomyopathy.[14,15]

Cardiac magnetic resonance imaging (CMR) permits a highly accurate assessment of the right ventricle and is considered a reference method for this purpose.[16] However, echocardiography is widely available, can be performed at bedside, and is relative inexpensive, thus it is extensively used in the clinical routine.

The primary purpose of this study was to determine the ability of echocardiographic parameters, including speckle-tracking-derived measures, to distinguish the presence from the absence of RV systolic dysfunction in patients with Chagas disease using CMR as the standard reference method.

METHODS

Study Population

This prospective cross-sectional study included 63 individuals with chronic Chagas disease, defined by the positivity of at least two distinct serological tests (ELISA, indirect immunofluorescence, indirect hemagglutination) and age ≥ 18 years, who were recruited in the outpatient clinics at the Hospital das Clínicas de Ribeirão Preto, University of São Paulo, Brazil, from July 2012 to August 2014. Exclusion criteria were presence of other cardiomyopathies, obstructive coronary disease, severe cardiac valve disease, or systemic disease with potential effect on the RV function. All participants underwent standard 12-lead electrocardiography (ECG), chest x-ray, two-dimensional echocardiography including speckle-tracking analysis, and CMR. The mean time interval between CMR and echocardiography examinations was 24 ± 16 days, with no changes in clinical or medication status in this period of time.

The institutional research ethics committee approved the study protocol (process no. 4913/2010), which was conducted in accordance with the Helsinki Declaration. Written informed consent was obtained from all participants.

Echocardiography

Transthoracic echocardiography was performed in all individuals using the commercially available ultrasound system Vivid E9 (GE Healthcare, Horten, Norway), with a phased-array transducer of 1.5–4.6 MHz. Acquisitions and analyses were performed by a single certified and experienced physician blinded to CMR data. The exams were recorded in vendor-specific format (raw data). Acquisition and reading protocols followed guidelines previously published.[17,18] Briefly, individuals were examined in left lateral and dorsal supine decubitus, utilizing the conventional parasternal, apical, and subcostal views, including the apical four-chamber view focused on the right ventricle (AP4-RV). Images were acquired with simultaneous electrocardiographic signal recording, during quiet respiration. At least three entire cardiac cycles were retrospectively recorded, increasing to five entire cardiac cycles in the presence of cardiac arrhythmia. All right chamber parameters were analyzed in the AP4-RV view, with the exception of RV outflow tract dimension, determined at the parasternal long-axis view. RV linear dimensions were measured at end diastole and were described as longitudinal dimension (from the plane of tricuspid annulus to the RV apex) and basal diameter and midcavity diameter (representing the maximal RV short-axis dimension in the basal one third and in the mid-third, respectively). RV systolic function was assessed by