Usefulness of right atrial volume index in predicting outcome in chronic systolic heart failure

Khaled Darahim [a,*]

[a] Department of Cardiovascular Medicine, Faculty of Medicine, Ain Shams University, Cairo
[a] Egypt

Background: Right ventricular (RV) dysfunction is associated with poor prognosis in patients with heart failure (HF). Echocardiographic assessment of RV systolic function is challenging. The ability to visualize the right atrium (RA) allows a quantitative, highly reproducible assessment of RA volume.

Objective: The aim is to study the relationship between the right atrial volume index (RAVI) and prognosis in patients with chronic systolic HF.

Methods: 120 patients with chronic systolic HF and left ventricular ejection fraction (LVEF) <40% were enrolled. The RA volume was calculated by Simpson's method using single-plane RA area and indexed to body surface area (RAVI). RV systolic assessment was done using the RV fractional area change (RVFAC), and peak systolic velocity (Sa_{tri}) using tissue Doppler imaging at the tricuspid annulus. The primary endpoint was death, urgent transplantation, or acute HF episode requiring hospital admission during a follow-up of 1 year.

Results: Follow up was complete for 117 of 120 patients. Fifty-two patients reached the primary endpoint. The mean RAVI was higher in patients with adverse events (45.5 ± 15 ml/m^2 versus 25.2 ± 11 ml/m^2, $p < 0.001$), and increased with worsening LVEF, RVFAC, Sa_{tri} (Spearman's $r = -0.46$, $r = -0.45$, $r = -0.59$, $p < 0.001$ for all). RAVI was not correlated with estimates of RV diastolic dysfunction. The cut-off threshold for RAVI to predict the primary endpoint using receiver-operating characteristic curve was 29 ml/m^2 (area under the curve was 0.89%, 95% confidence interval: 0.82–0.95) with a sensitivity of 92%, and a specificity of 75%. NYHA > 2 (OR = 2.1, $p < 0.01$), and RAVI (OR = 1.6, $p < 0.05$) were found to be independent predictors of adverse outcome.

Conclusion: In patients with chronic systolic HF, RAVI is an independent predictor of adverse outcome with a threshold value of 29 ml/m^2.

Keywords: Heart failure, Right atrium, Prognosis, Echocardiography

---

Disclosure: Author has nothing to disclose with regard to commercial support.

Received 29 June 2013; revised 5 September 2013; accepted 21 September 2013.
Available online 17 October 2013

* Address: Department of Cardiovascular Medicine, Ain Shams University Hospital, Abbassia Street, ZIP 11381 Cairo, Egypt. Tel.: +20 1061777957; fax: +20 24820416.
E-mail address: kdarahim@yahoo.com

P.O. Box 2925 Riyadh – 11461KSA
Tel: +966 1 2520088 ext 40151
Fax: +966 1 2520718
Email: sha@sha.org.sa
URL: www.sha.org.sa

Peer review under responsibility of King Saud University.
URL: www.ksu.edu.sa
http://dx.doi.org/10.1016/j.jsha.2013.09.002

Production and hosting by Elsevier

Introduction

Patients with congestive heart failure (HF) still have a poor prognosis, even after recent advances in therapy [1,2]. It is, therefore, important to establish a reliable means of identifying those patients at higher risk. Right ventricular (RV) systolic dysfunction is associated with poor long-term prognosis [3,4]. However, precise echocardiographic assessment of RV systolic function is challenging, primarily because the morphology of RV is complicated.

The ability to visualize the right atrium (RA) allows a quantitative, highly reproducible assessment of the RA volume that can be indexed to the body surface area [5,6]. However, there have been no many studies correlating RA volume and prognosis in patients with chronic HF [6].

Objective

Is to determine the relationship between the right atrial volume index and prognosis in patients with chronic systolic heart failure.

Abbreviations

Aa	peak late diastolic TDI velocity
ACE	angiotensin converting enzyme
A-wave	peak late diastolic filling velocity
CABG	coronary artery bypass grafting
CI	95% confidence interval
DT	early diastolic deceleration time
Ea	peak early diastolic TDI velocity
E-wave	peak early diastolic filling velocity
HF	heart failure
IVC	inferior vena cava
LVEF	left ventricular ejection fraction
NYHA	New York Heart Association
PCI	percutaneous coronary intervention
RA	right atrium
RAVI	right atrial volume index
ROC	receiver operator characteristic
RV	right ventricular
RVFAC	right ventricular fractional area change
Sa	peak systolic TDI velocity
Sa_{tri}	peak tissue Doppler systolic velocity at the tricuspid annulus
sPAP	systolic pulmonary artery systolic pressure
TDI	tissue Doppler imaging
V_{max}	peak velocity

Methodology

Patient population

We enrolled consecutive patients with chronic heart failure evaluated at a tertiary cardiac center from 2009 to 2011. Inclusion criteria were age >18 years, symptomatic heart failure (New York Heart Association class II-IV), and left ventricular ejection fraction (LVEF) <40%. Exclusion criteria were mitral stenosis, mitral valve surgery, severe mitral regurgitation (>grade 3), severe aortic stenosis (peak velocity >4 m/s), malignancy, and severe renal failure requiring dialysis.

The study was approved by the medical ethics committee of our institution. The study protocol was designed in accordance with The Code of Ethics of the World Medical Association (Declaration of Helsinki) for experiments involving humans. All patients gave informed consent before the procedure.

Echocardiographic examination

Comprehensive transthoracic echocardiography was performed using an Aloka alpha 5 echocardiography machine (Hitachi Aloka Medical, Ltd., manufactured in Tokyo, Japan) equipped with tissue Doppler imaging (TDI) technology. Two-dimensional, M-mode, Doppler echocardiography measurements and quantification were performed according to recommendations of the American Society of Echocardiography [7,8]. Right atrial volume was calculated using the Simpson's method from the apical four-chamber view at end systole [5,6]. The right atrial volume index (RAVI) was derived by dividing the volume by body surface area, which was calculated using the Du Bois and Du Bois formula [9]. Continuous Doppler echocardiography was used to measure pulmonary artery and aortic velocities, tricuspid regurgitation velocity, and mitral regurgitation velocity. Pulsed Doppler echocardiography for the assessment of the standard diastolic filling velocities of both ventricles was performed using the apical four-chamber view. Thus, the peak early diastolic filling velocity (E-wave), early diastolic deceleration time (DT), and peak late diastolic filling velocity (A-wave) were recorded. For the right ventricle 2D and TDI measurements, care was taken to obtain an ultrasound beam parallel to the tricuspid annulus motion. The RV endocardium was traced manually in systole and diastole. The RV fractional area change (RVFAC) was calculated using the formula: (end-diastolic area – end-systolic area)/end-diastolic area. Tricuspid annular TDI was acquired in the apical 4-chamber view. Peak systolic (Sa), early diastolic (Ea), and late diastolic (Aa) velocities of the tricuspid annulus were measured as recommended previously (sample TDI volume less than 5 mL and an angle between the TDI sample volume and the longitudinal myocardial wall vector less than 20°) [10]. The systolic pulmonary artery systolic pressure (sPAP) was