Journal of the American Society of Hypertension 10(4) (2016) 318–324

Research Article

The influence of masked hypertension on the right ventricle: is everything really masked?

Marijana Tadic, MD, PhD[a,b,*], Cesare Cuspidi, MD[c], Vladan Vukomanovic, MD[a], Vera Celic, MD, PhD[a,b], Tatjana Pavlovic, MD[a], and Vesna Kocijancic, RN[a]

[a]*Cardiology Department, University Clinical Hospital Center ''Dr. Dragisa Misovic—Dedinje'', Belgrade, Serbia;* [b]*School of Medicine, Belgrade University, Belgrade, Serbia; and* [c]*Clinical Research Unit, University of Milan-Bicocca and Istituto Auxologico Italiano, Meda, Italy*

Manuscript received January 5, 2016 and accepted February 1, 2016

Abstract

We sought to investigate right ventricular (RV) structure, function, and mechanics in subjects with masked hypertension (MH), normotensive, and sustained hypertensive patients. This cross-sectional study included 186 untreated subjects who underwent 24-hour ambulatory blood pressure (BP) monitoring and complete two-dimensional echocardiographic (2DE) examination including multilayer strain analysis. MH was diagnosed if clinic BP was normal (<140/90 mm Hg) and 24-hour BP was increased (≥130/80 mm Hg). Global and free-wall RV longitudinal strains were significantly lower in MH and sustained hypertensive patients comparing with controls. Systolic and early diastolic RV strain rates were lower, whereas late diastolic strain rate was higher, among patients with MH and sustained hypertension than in control group. Endocardial and midmyocardial RV strains were also significantly lower in MH and hypertensive patients. There was no difference between MH and subjects with sustained hypertension. RV structure, function, and deformation are significantly changed in subjects with MH and sustained hypertension. J Am Soc Hypertens 2016;10(4):318–324. © 2016 American Society of Hypertension. All rights reserved.

Keywords: Masked hypertension; right ventricle; two-dimensional speckle tracking.

Introduction

Masked hypertension (MH) is defined as normal office blood pressure (BP) with elevated ambulatory or home BP. A growing body of evidence suggests that MH has been associated with target organ damage (left ventricular hypertrophy, aortic and carotid atherosclerosis, microalbuminuria),[1–5] as well as cardiovascular morbidity and cerebrovascular events.[5,6] Our recent meta-analysis that included 4884 untreated subjects (2467 normotensive, 776 MH, and 1641 sustained hypertensive subjects) of both genders showed that left ventricular mass index gradually increased from normotensive to MH and to sustained hypertensive patients.[7]

Most studies that investigated target organ damage have revealed remodeling of the left ventricle, primarily left ventricular hypertrophy.[1–3,5–9] However, the potential role of MH in right ventricular (RV) remodeling has not been investigated so far. On the other side, researchers have demonstrated that arterial hypertension has important impact on RV structure, function, and mechanics.[10–13] Considering the importance of RV structural and functional remodeling on the outcome in general population and some specific patient groups,[14–16] it would be of potential interest to investigate RV changings in MH.

The purpose of the present study was to determine and compare RV structure, function, and mechanics in patients with untreated MH, normal BP, and sustained hypertension using modern two-dimensional speckle tracking imaging tools.

Methods

This cross-sectional study included 186 untreated subjects referred to our outpatient clinic due to ambulatory

Conflict of interest: None.

*Corresponding author: Marijana Tadic, MD, PhD, Cardiology Department, University Clinical Hospital Center ''Dr. Dragisa Misovic—Dedinje'', Heroja Milana Tepica 1, 11000 Belgrade, Serbia. Tel: +381658107085; Fax: +381112411464.

E-mail: marijana_tadic@hotmail.com

http://dx.doi.org/10.1016/j.jash.2016.02.001

BP monitoring from November 2013 to October 2015. Subjects with heart failure, coronary artery disease, previous cerebrovascular insult, atrial fibrillation, congenital heart disease, valve heart disease, obstructive pulmonary disease, asthma, neoplastic disease, cirrhosis of the liver, kidney failure or endocrine diseases including type II diabetes mellitus, and unsatisfactory echocardiographic images were excluded from the study.

Anthropometric measures and laboratory analyses were taken from all the subjects included in the study. Body mass index and body surface area (BSA) were calculated for each patient. The study was approved by the local Ethics Committee, and informed consent was obtained from all the participants.

Clinic BP Measurement and 24-Hour Ambulatory BP Monitoring

Clinic arterial BP values were obtained by E-mega aneroid manometer (Riester, Jungingen, Germany) in the morning hours by measuring the average value of the two consecutive measurements in the sitting position. BP was obtained in at least two separate occasions.

All the participants underwent a 24-hour BP monitoring. The noninvasive 24-hour ambulatory BP monitoring was performed by Schiller BR-102 plus system (Schiller AG, Baar, Switzerland) according to the current guidelines.[17] The device was programmed to obtain BP readings at 20-minute intervals during the day (07:00–23:00 hours) and at 30-minute intervals during the night (23:00–07:00 hours). The recording was then analyzed to obtain a 24-hour average systolic and diastolic BP (SBP and DBP), and heart rates.

MH was defined as an normal clinic BP (SBP $<$140 mm Hg and DBP $<$90 mm Hg) measured in at least two separate occasions associated with a 24-hour ambulatory SBP $>$ 130 mm Hg and/or DBP $>$ 80 mm Hg, whereas those with sustained hypertension had an elevated clinic SBP of 140 mm Hg together with a 24-hour ambulatory SBP $\geq$ 130 mm Hg or DBP $\geq$ 80 mm Hg.

Echocardiography

Echocardiographic examination was performed by a Vivid 7 ultrasound machine (GE Healthcare, Horten, Norway). The values of all two-dimensional echocardiographic (2DE) parameters were obtained as the average value of three consecutive cardiac cycles. Left ventricular diameters, interventricular septum, and relative wall thickness were determined according to the recommendations.[18] Left ventricular ejection fraction (EF) was assessed by the biplane method. Left ventricular mass was calculated by using the formula of the American Society of Echocardiography,[18] and indexed for BSA. Left atrial volume (LAV) was measured by the biplane method in 4- and 2-chamber views and indexed for BSA. Transmitral Doppler inflow and tissue Doppler velocities were obtained according to the guidelines.[19]

The RV internal diameter was measured in the parasternal long-axis view.[20] RV thickness was measured in the subcostal view.[20] Right atrial maximal volume was obtained in the 4-chamber view during ventricular end-systole and indexed for BSA. Tricuspid inflow (E) and tissue Doppler velocities (e'_t, s_t) were evaluated in the apical 4-chamber view,[20] and E/e'_t ratio was calculated. RV SBP (pulmonary artery systolic pressure) was assessed in the patients with minimal or mild tricuspid regurgitation.

Two-Dimensional Right Ventricular Strain and Strain Rate

2DE strain imaging was performed by using 3 consecutive cardiac cycles of 2DE images in the apical 4-chamber view. EchoPAC 113 (GE-Healthcare, Horten, Norway), as a commercially available software, was used for the 2DE strain analysis.

The variables that were used for the evaluation of systolic function and contractility were the longitudinal peak and systolic strain rate, respectively. The parameters of early myocardial relaxation and late ventricular filling were estimated by early and late diastolic strain rate. The peak longitudinal strain, systolic, and diastolic strain rates for the RV lateral wall and global RV were determined separately.

Multilayer longitudinal strain was determined by modified 2DE strain software. The modified 2DE strain speckle tracking includes the delineation of the endocardial border, similarly to traditional 2DE strain, but instead of a single chain of nodes, the myocardial wall is automatically defined with multiple chains of nodes, allowing investigation of 3 myocardial layers: endocardial, midmyocardial, and epicardial.

Statistical Analysis

Continuous variables were presented as mean $\pm$ standard deviation and were compared by the analysis of equal variance, as they showed normal distribution. Bonferroni post hoc analysis was used for the comparison between different groups. Differences in proportions were compared by the χ^2 test. The correlation analysis was used to determine the association between E/e'_t and RV mechanics parameters. The *P*-value $<$.05 was considered statistically significant.

Results

According to criteria provided in the Methods, the study sample included 56 normotensive subjects (30.1%), 60 MH (32.3%), and 70 sustained hypertensives (37.6%).