The Egyptian Journal of Critical Care Medicine (2016) xxx, xxx–xxx

The Egyptian College of Critical Care Physicians

The Egyptian Journal of Critical Care Medicine

http://ees.elsevier.com/ejccm
www.sciencedirect.com

ORIGINAL ARTICLE

2-D Speckle tracking in the assessment of left and right ventricular functions in hemodialysis versus recently diagnosed uremic patients with preserved systolic function

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Received 10 March 2016; revised 9 August 2016; accepted 26 August 2016

KEYWORDS

2D strain;
Tissue Doppler;
RV functions;
Uremia

Abstract Several studies have demonstrated that uremic patients who have preserved left ventricular (LV) systolic function could still have subtle systolic dysfunction. In our study, we assessed the right ventricular (RV) and LV myocardial functions measured by conventional echocardiography and two-dimensional (2D) longitudinal speckle-tracking in hemodialysis and non-dialysis recently diagnosed uremic patients. The study population consisted of 24 newly diagnosed uremic patients, 25 hemodialysis patients, and 20 healthy controls. The RV and LV longitudinal strains were significantly lower in patients than in controls (−9.6 vs. −15.3, $P < 0.001$ for RV and −11.3 vs. −14.8, $p < 0.001$ for LV). In the hemodialysis group, the RV longitudinal strain was significantly lower than in the non-dialysis group ($p = 0.018$). The RV longitudinal strain was correlated with hypertension and LV strain. The 2-D longitudinal speckle tracking can detect early ventricular (left and right) systolic dysfunction in patients with uremia in the presence of normal systolic function by conventional methods.

1. Introduction

In dialysis patients, both cardiovascular and non-cardiovascular mortality are significantly increased when compared to the general population [9]. In particular, cardiovascular mortality contributes to about 40% of all-cause mortality in these patients, mainly due to sudden cardiac death [11]. Several parameters, such as left ventricular hypertrophy (LVH) and left ventricular (LV) systolic dysfunction, have been iden-

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Peer review under responsibility of The Egyptian College of Critical Care Physicians.

Production and hosting by Elsevier

http://dx.doi.org/10.1016/j.ejccm.2016.08.001
2090-7303

tified as independent predictors of cardiovascular outcome in dialysis patients. Diastolic heart dysfunction, as assessed by tissue Doppler imaging (TDI), has also demonstrated significant incremental prognostic value for all-cause mortality and cardiovascular death [26].

Most studies have used the conventional echocardiographic parameters, such as ejection fraction and fraction shortening, of cardiac function that are usually normal in uremic patients [11,26]. However, a previous study showed that these conventional echocardiographic parameters do not sufficiently describe the regional systolic function and the loading conditions that affect these parameters [22]. Recently, studies have mainly focused on the use of Doppler tissue imaging in assessing LV regional systolic function by measuring tissue velocities, displacement, strain, and strain rate. Myocardial systolic excursion velocity (S′) is a well-established, easy and reproducible method for the assessment of right ventricular (RV) systolic global function [21]. It is considered as one of the most reliable and reproducible methods for RV systolic function assessment, and it correlates well with RV ejection fraction (RVEF) as calculated by cardiac magnetic resonance [13].

Two-dimensional (2D) speckle-tracking echocardiography (STE) imaging is a relatively novel echocardiographic approach for assessing regional LV function [2,14]. The analysis of STE imaging can determine deformation and subtract the effect of tethering and translational motion of the whole heart. It is, therefore, considered to be superior to other echocardiographic measures as it can detect the early changes in myocardial function. Moreover, it enables the assessment and analyses of strain and strain rate in different myocardial axes (*i.e.*, longitudinal, circumferential, and radial) due to its non-dependency on the Doppler angle, as in the case of tissue Doppler imaging [3,5,8,23].

Therefore, a 2D STE was adopted to detect the subtle impairment of the LV systolic function in uremic patients who have a normal LV ejection fraction (LVEF) [12,16].

In our study, we assessed the difference between the RV and LV myocardial function measured by conventional echocardiography in hemodialysis and non-dialysis recently diagnosed uremic patients using 2D longitudinal STE.

2. Methodology

2.1. Study patients

Forty-nine uremic patients with an LVEF of 55% or greater from the nephrology clinic between December 2014 and June 2015 were consecutively enrolled in our study. The exclusion criteria were patients with arrhythmias, severe valvular heart disease, uncontrolled hypertension (blood pressure >140 mmHg and/or diastolic blood pressure >90 mmHg at the time of examination), a history of acute coronary syndrome, liver disease, and those with inadequate 2D STE image quality. The patients were divided into two groups: group I included 24 patients who were hospitalized for investigation of their symptoms of uremia, and group II included 25 patients on maintenance hemodialysis (the hemodialysis group; 4-h sessions, 3 times weekly for 6 months or more). We recruited 20 age and sex-matched control volunteers who had normal blood pressure and were non-diabetic with normal results on electrocardiography and transthoracic echocardiography. The biochemical indexes of all the study participants were evaluated at the hospital laboratory. Written and informed consent was obtained from all the study participants. The study was approved by the local ethics committee of the Assiut University Hospital.

2.2. Echocardiography

All the echocardiographic studies were done using a commercial scanner (iE33; Philips Medical System, USA). Real-time 2D echocardiographic imaging was performed from the cardiac apex by an S4 transducer. The full-volume acquisition was recorded with five consecutive cardiac cycles during a single breath-hold. Then, off-line analysis of recorded images was done using CMQ Q-Lab 9 (Philips Medical System, USA). An experienced echocardiographer obtained all the images using the standard protocol, and another researcher who was blinded to the clinical data of the study subjects analyzed the data. The LV diameters were measured at the end-systole and end-diastole phases. The peak systolic S′ wave, the early (E′) and late (A′) diastolic peak velocities of the septal and lateral mitral annuli, as well as lateral tricuspid annulus, were measured by pulse wave Doppler and Doppler tissue imaging. S′ was obtained using the A4C view, and the measurement was performed at the lateral tricuspid annulus using color Doppler Tissue Imaging (DTI). Subsequently, the E′/A′ ratio was calculated to evaluate the LV and RV diastolic function. The RV systolic function was assessed using Fractional Area Change (FAC) by measuring the difference between RV volume in diastole and systole in A4C view. The pulmonary artery systolic pressure was measured using tricuspid regurge velocity gradient, and the RA pressure was estimated using inferior vena cava (IVC) diameter and distensibility [10].

2.2.1. Assessment of global ventricular longitudinal strain

The global longitudinal systolic strain was assessed via the automated functional imaging method. Three apical views were recorded in each patient (apical long-axis and four- and two-chamber views) in grayscale with a frame rate of at least 50 per second. The mitral annulus and the LV apex were defined in each view. Using modified apical 4-chamber view, RV was traced to obtain RV global longitudinal systolic strain. The strain analyses were done on an offline basis (Fig. 1). The echocardiographic data were gathered and interpreted blindly to the subjects' clinical status.

2.3. Statistical analysis

SPSS version 21 was used for statistical analysis. Continuous variables were expressed as mean ± SD. Unpaired *t*-test was used to compare between patients and controls and between the two renal groups. Chi-square test was used when appropriate. Pearson's bivariate correlation test was used to correlate between the different Doppler parameters and both RVS and LVS.

Please cite this article in press as: Rahman Helmy Ali HA et al. 2-D Speckle tracking in the assessment of left and right ventricular functions in hemodialysis versus recently diagnosed uremic patients with preserved systolic function, Egypt J Crit Care Med (2016), http://dx.doi.org/10.1016/j.ejccm.2016.08.001