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Review Article

Assesment of Right Ventricular Function by Echocardiography in Patients with Ischemic Cardiomyopathy and Non-ischemic Cardiomyopathy

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Heart failure (HF) is the fact that the heart can not pump enough blood that tissue need or deliver it in the case of a high ventricular pressure despite adequate venous return.[1] The most common cause is ischemic heart disease (IHD) due to coronary artery disease (CAD). Decrease in ventricular systolic function and ventricular remodeling are observed with fibrous tissue in the place of loss of myocardial cell that is formed as a result of ischemia.[2] The pressure load is reflected in the pulmonary system over time and increased pulmonary pressure starts to counteract the right ventricular remodeling. As a result, diminished systolic function and dilatation in all cardiac chambers are observed in advanced HF. Other important causes besides IHD are nonischemic cardiomyopathies (NICMP).[3] Idiopathic dilate cardiomyopathy (IDCMP) is the major part of this group that does not have severe CAD that can disturb the blood supply of the myocardial tissue. Right ventricular (RV) failure develops due to hemodynamic changes caused by left ventricular (LV) systolic dysfunction and even after cardiomyopathy that including also RV myocardium.[4]

Despite improvements in diagnosis and treatment in cardiovascular diseases, there is no significant improvement in heart failure prognosis at the desired level.[5] Recently, prognostic factors such as the left ventricular ejection fraction (LVEF), LV filling

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pressure, S3 gallop, New York Heart Association (NYHA) functional class (FC), hyponatremia, natriuretic peptides (Atrial natriuretic peptide (ANP), N-terminal ANP, brain natriuretic peptide (BNP)), plasma renin activity, norepinephrine, peak exercise oxygen consumption, ventricular arrhythmias, atrial fibrillation (AF) and intraventricular conduction delay, as well as the importance of RV function in the prognosis of heart failure revelead.[6,7] Two dimensional (2D) transthoracic echocardiography (TTE) and tissue Doppler echocardiography (tDE) have an important role in assessing RV function. It has been shown that RV functions are more affected in ischemic cardiomyopathy (ICMP) than in NICMP according to some of the echocardiographic methods used in different studies.[8] However, in these studies, only some of the echocardiographic parameters that provide information about right ventricular functions have been used. Our aim in this study is to evaluate the right ventricular functions in more detail with 2D, Doppler and tDE in NICMP groups with ICMP.

1. Method

A total of 50 patient was enrolled in study. But two of them excluded because of severe valve insufficiency, four of them excluded because they want to stay out study. Patients with clinical sign of HF and echocardiographic parameters as LVEF $\leq$ 35% and LV end diastolic diameter (LVEDD) $\geq$ 55 mm,sinus rhythm (SR), clear image quality, absence or mild valve insufficiency were included in the study. The ethical committee approval of the study was taken by the ethical committee of our hospital. Every patient was given written inform consent.

Exclusion criteria are myocardial infarction (MI) and unstable angina (UA) in the last 3 months, moderate-severe valve disease, systolic pulmonary artery pressure (sPAP) > 35 mmHg, patient with cardiac pacemaker, adult congenital heart disease, presence of intracardiac thrombus or vegetation, presence of rhythm disturbances (atrial fibrillation (AF), ventricular tachycardia (VT), atrial tachycardia, 2nd or 3rd atrioventricular block, etc.), significant multiple organ dysfunction (such as severe chronic obstructive pulmonary disease (COPD), liver failure and renal failure).

Patients with decreased LV systolic function due to > 50% stenosis in one or more coronary arteries were considered to be ischemic origin, and with normal coronary arteries or plaque were considered to be nonischemic origin. RV systolic dysfunction was not observed in none of patient with previous inferior MI. Complete blood count, creatinine, aspartate aminotransferase (AST), alanine aminotransferase (ALT) levels were studied to assess compliance with the exclusion criteria.

1.1. Echocardiographic measurements

TTE studies of the cases were performed using a GE Vivid 7 Dimension instrument (Vingmend Ultrasound, GE, Horten, Norway) and a 2.5 MHz frequency transducer. Each patient was evaluated with standard 2D, color flow Doppler echocardiography and tDE methods in the parasternal long axis, parasternal short axis, apical 4 space and subcostal images. For measurements, the recordings were taken to include 3 cycles with a speed of 100 mm/s. Measurements were made in the left lateral position in the presence of electrocardiographic (ECG) monitoring. RV diameter measurements and valvular insufficiency grading were done according to the American Society of Echocardiography (ESCA) recommendations. LV and RV ejection volumes were calculated using the 2D Modified Simpson method. sPAP was obtained in patients with tricuspid regurgitation (TR) by adding the right atrium (RA) pressure calculated from the maximal velocity to the RA/RV gradient found with the Bernoulli equation, taking into account the vena cava inferior (VCI) respiratory change and diameter. Evaluation of the right ventricular outflow tract (RVOT) was made by measuring the parasternal long axis and the distal and proximal diameter of the parasternal short axis. RV systolic and diastolic volumes, RA diameters, RA area (RAA), and tricuspid annular plane systolic excursion (TAPSE), RV end diastolic diameter (RVEDD), RV end-systolic diameter (RVESD), RV area change (RVAC) were measured to evaluate RV functions in apical 4-cavity images in which the RV cavity is best viewed. Transtricuspid and transmitral flow early filling (E) and late filling (A) velocities and ratio of (E/A) were used to evaluate the RV and LV diastolic function, respectively. Records for tDE were taken from junction of mitral annulus-interventricular septum and RV free wall via apical four-chamber approach. Early diastolic velocity (Em), late diastolic velocity (Am) were measured on the mitral annulus tDE images. RV lateral wall systolic velocities (RV Sm vel), ejection time (ET), isovolumic contraction time (IVCT) and isovolumic relaxation time (IVRT) were measured from the basal-to-mid level of RV free wall by tDE. Subcostal approach images were used to evaluate VCI diameters and the ability to be compressible.

1.2. Calculation of parameters used in assessing RV function

Myocardial performance index (MPI), RVAC and TAPSE were calculated in assessing RV systolic functions using the above data. RVAC, is calculated via the formula [(RVEDA – RVESA/RVESA) $\times$ 100] and MPI is calculated via the formula (IVCT + IVRT)/ET.

2. Statistical analysis

Categorical variables as mean $\pm$ standard deviation of numerical variables were expressed as percentage. The distribution of numerical variables was evaluated by the Kolmogorov Smirnov test. The Student- *t* test was used for normal numerical variables, the Mann–Whitney *U* test for normal numerical variables and the Chi-square test or Fisher-exact test for categorical variables were used to determine the difference between NICMP and ICP groups. Statistical significance was accepted if $p < 0.05$ for analysis results. All statistical analyzes were performed using SPSS 15.0 (Chicago, IL) program.

3. Results

The average age of the patients included in the study was 63 in the NICMP group and 66 in the ICPM group. 53.3% of the patients were male and 46.7% were female. The rate of smoking was 5% in the ICMP group and 8.3% in the NICMP group. The average body mass index (BMI) of the patients was 28. Numerical and mean values of other demographic data of the patients are shown in Table 1.

There were no differences in LV systolic and diastolic diameters, LA diameters and LVEF in both groups of patients (Table 2). Transmitral flow Doppler velocities, deceleration time (DT), IVRT and left ventricular septal tDE values did not differ between the two groups in terms of RV diastolic function parameters.

In both NICMP and ICMP groups, RVOT was found to be similar to the RV basal and mid diameters but the longitudinal diameter was found to be higher in the NICMP group than in the ICMP group (7.4 $\pm$ 1.03 cm, 6.80 $\pm$ 0.83 cm, $p = 0.03$). RV volume and area were similar in all patients. RVAC is 39.0 $\pm$ 12.0% in the NICMP group, 45.1 $\pm$ 8.15% in the ICMP group. However, there was no statistical significance between the two groups ($p = 0.07$). The mean right ventricular ejection fraction (RVEF) was similar and was found to be 59% in NICMP and 62% in ICMP. RV 2D TTE values of all patients included in the study are shown in Table 3.

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