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Right ventricular systolic function assessment methods and its correlation for determining the RV function in patients with structurally normal heart and normal pulmonary artery pressure

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Abstract

Background: In clinical practice, RV assessment is often based on qualitative estimation, and it is regarded as a neglected chamber. The right ventricle (RV) has a critical function in cardiovascular physiology and pathology. It is currently receiving increasing attention for its recognition as a critical component of many cardiovascular conditions.

Objectives: To determine the most appropriate method for RV Function assessment in patients with Structurally Normal heart and normal pulmonary artery pressure by echocardiography.

Methods : Echocardiographic imaging was performed using VIVID E7 echocardiographic system (GE) with a standard transducer, electrocardiogram gated images with a minimum of 5 cardiac loop images were acquired. Echocardiographic data will be stored on a personal computer with dedicated software for offline analysis.

Results: In this study, the Right ventricular parameters were measured using M-mode and doppler

echocardiography.The right ventricular Systolic parameters like S' had no significant difference from those of RVMPI (P value = > 0.05). Moreover, there was a significant difference between the right ventricular Systolic parameters like S' with those of TAPSE, FAC (P value = < 0.05) .

Conclusion : In our study, we assessed the right ventricular function by comparing the RV systolic velocity with RVMPI, TAPSE and FAC. We found good correlation between TAPSE, FAC and RV systolic velocity. But RVMPI did not correlated with RV Systolic velocity.

Keywords: RV function, Echocardiography, Right Ventricular Systolic Function.

Introduction

A right ventricle (RV) was formerly considered less relevant to cardiac diseases than its left counterpart, and it was considered to be the forgotten chamber of the heart for many years. Despite this, the RV is increasingly recognized as being important in many cardiac conditions, including congestive heart failure, arrhythmia, and sudden cardiac death. As an additional benefit, RV dimensions (RVD) and RV function (RVF) are strongly correlated with symptom occurrence and exercise capacity in many clinical conditions. Hence, it is important that the RV is evaluated in a comprehensive and accurate way.

The most classic means of exploring the RV are right cardiac catheterization, X-ray computed tomography, cardiac magnetic resonance imaging, and echocardiography. As a noninvasive procedure, echocardiography is widely available, less expensive than other methods, and does not require radiation or contrast material. Additionally, echocardiography is a robust tool for the comprehensive evaluation of RVD and RVF [1].

A measure of RV function can help predict PH outcome. It is difficult to assess RV function due to its complex geometry, so most RV function measurements are based on visual evaluation.

In the RV, there are three main regions: smooth muscular inflow, outflow region, and trabecular apical region. There are inner longitudinal fibers that cause contractions from base to apex in the RV, and superficial circumferential fibers that cause contractions from inward to outward. Global and regional systolic functions of the RV can be evaluated.

Global Assessment of Right Ventricular Function:

RV fractional area change:

Using the equation below, RV fractional area change (FAC) is a measure of RV systolic function:

RVFAC= (end-diastolic area - end-systolic area) ⁄ end-diastolic area ×100.

RV FAC can be determined by tracing the RV endocardium from the tricuspid valve annulus, along the right free wall, along the IVS, and then back to the tricuspid valve annulus. A percentage of fractional area change >35% is considered normal in adults.

Myocardial Performance Index

Myocardial performance index (MPI) measures global ventricular function (systolic and diastolic) without assumptions about geometry. It is defined as the ratio of isovolumic time to ET.

MPI= (isovolumic contraction time (IVCT) + IVRT) ⁄ ET

Spectral Doppler imaging (SDI) as well as tissue Doppler imaging (TDI) are the two easiest ways to obtain MPI. It is difficult to obtain RV MPI in one heartbeat or in a similar heartbeat because it is difficult to simultaneously image the tricuspid valve and the pulmonary valve with the same spectral Doppler signal. As a result, the RV MPI is erroneously calculated. [2]

Regional Assessment of Right Ventricular Function:

Tricuspid Annular Plane Systolic Excursion (TAPSE)

Tricuspid annular plane systolic excursion is another two- dimensional measure with which one can assess systolic right ventricular function. It is obtained by placing the M – mode cursor through the lateral portion of the tricuspid valve annulus in the apical four – chamber view. The excursion of the tricuspid valve from the base of the heart towards the apex is measured as the distance from the annulus to the apex at end - diastolic at end - systole.

Tissue Doppler - Derived Right Ventricular Systolic Excursion Velocity's

Tissue Doppler systolic velocity of the tricuspid annulus is another measure of longitudinal right ventricular systolic performance, similar to tricuspid annular plane systolic excursion. This is a reproducible and easily obtainable measure of right ventricular systolic function with normal reference values. A value < 9.5 cm per second is associated with global right ventricular dysfunction with ejection fraction <45%. Limitations of this technique are similar to tricuspid annular plane systolic excursion and include angle and load dependency. An additional intrinsic limitation to tissue velocity imaging is a phenomenon called tethering by which the passive motion of the normal myocardium surrounding the diseased myocardium can result in falsely normal tissue velocities of the diseased segment .[3]

Methods

In this prospective, single-center trial, 101 patients aged >18 years old who underwent routine echocardiographic study for Cardiac evaluation between Nov 2017 to Dec 2018, among which 73 (68%) were males and 34 (32%) were females. Patients with Mechanical valvular prosthesis, Hypertrophic cardiomyopathy, Pulmonary artery hypertension, Myocardial Infarction, Chronic obstructive pulmonary disease and patients with poor echo acoustic windows were excluded. Subjects aged 18 years old or older with Structurally Normal heart, normal pulmonary artery pressure and subjects with sinus rhythm were eligible. The study protocol was approved by the Institutional Review Board, Ramachandra hospital, Porur, Tamilnadu and all patients provided informed consent.

Sample size estimation and Statistical analysis

The sample size was formulated based on observational data of RV Systolic Function parameters during routine echocardiography study performed over a 2 months in our Echocardiography Laboratory. The number of patients needed in each group to achieve an 95% power at the level of significance 0.05 was estimated at 50 (total n = 100).

Baseline Characteristics and Procedural Characteristics were represented using descriptive statistics for continuous variables in form of frequency tables or Percentage (%) for discrete variables. All statistical analysis was performed with SPSS software.

Comparisons among the groups with regard for normally distributed numeric variables were performed using ANOVA followed by Post hoc analysis. A p value of less than 0.05 is considered as statistically significant.

Results

Procedural characteristics of patients

A total of 107 patients participated in this study of whom 73 (68%) were males and 34 (32%) were females. The mean age of the participants was 37.71 ± 1.33 years, age ranging between 20 to 80 years.

Comparison of Right Ventricular Systolic Function (s') Versus TAPSE, FAC, RVMPI in Patients with Structurally Normal heart, normal pulmonary artery pressure and patients with sinus rhythm

In this study, the Right ventricular parameters were measured using M-mode and Doppler echocardiography. The right ventricular Systolic parameters like S' had no significant difference from those of RVMPI (P value = > 0.05). Moreover, there was a significant difference between the right ventricular Systolic parameters like S' with those of TAPSE, FAC (P value = < 0.05) as illustrated in table1.

	RV Function Assessment	Parameters	Mean Difference	P-Value (Post Hoc)
Normal Pulmonary Artery Pressure	S'	RVMPI	0.68	> 0.05
		TAPSE	4.56	< 0.05
		FAC	88.16	< 0.05

Table 1: Table summarising Right Ventricular Systolic Function Assessment Methods And Its Correlation For Determining The RV Function In Patients with Structurally Normal heart and normal pulmonary artery pressure.

Discussion

In the study of OA Oketona, MO Balogun et al.2017. Right ventricular (RV) dysfunction is being increasingly recognized in HF and found to be an independent predictor of adverse outcomes in HF. This study aimed to determine the prevalence of RV systolic dysfunction in HHF by several echocardiographic parameters. . RV systolic function was assessed in all subjects using different methods based on the American Society of Echocardiography guidelines for echocardiographic assessment of the right heart in adults. This included tricuspid annular plane systolic excursion (TAPSE), RV myocardial performance index (MPI), and RV systolic excursion velocity by tissue Doppler (S′). RV systolic dysfunction was found in 53% of subjects with HHF by TAPSE, 56% by RV MPI, and 48% by tissue Doppler systolic excursion S′. RV systolic dysfunction increased with reducing left ventricular ejection fraction (LVEF) in subjects with HHF. A high proportion of subjects with HHF were found to have RV systolic functional abnormalities using TAPSE, RV MPI, and RV S′. Prevalence of RV systolic dysfunction increased with reducing LVEF. [4]

Similarly, in our study carried out on 107 patients with Structurally Normal heart, normal pulmonary artery pressure and subjects with sinus rhythm, the right ventricular Systolic parameters like S' had no significant difference from those of RVMPI (P value = > 0.05) . In the literature, the impact of RV function on patients with Structurally Normal heart, normal pulmonary artery pressure and with sinus rhythm is less defined Only few recent studies have been conducted by industries to look for the patients with RV dysfunction who sustained Pulmonary artery hypertension, Chronic obstructive pulmonary disease and Myocardial Infarction.

Conclusion

In this study, We found good correlation between TAPSE, FAC and RV systolic velocity. But RVMPI did not correlated with RV Systolic velocity. This might be due to some reasons as follows : it is difficult to simultaneously image the tricuspid valve and the pulmonary valve with the same spectral Doppler signal. As a result, the RV MPI is erroneously calculated.

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