International Journal of Current Advanced Research
ISSN: O: 2319-6475, ISSN: P: 2319-6505, Impact Factor: SJIF: 5.995
Available Online at www.journalijcar.org
Volume 7; Issue 1(K); January 2018; Page No. 9503-9506
DOI: http://dx.doi.org/10.24327/ijcar.2018.9506.1573

Research Article

EVALUATION OF RIGHT VENTRICLE FUNCTIONS IN PATIENTS WITH PULMONARY HYPERTENSION

BaturGönenç Kanar*

Department of Cardiology, Faculty of Medicine, Marmara University, Istanbul, Turkey

A R T I C L E I N F O

Article History:
Received 16th October, 2017
Received in revised form 10th November, 2017
Accepted 26th December, 2017
Published online 28th January, 2018

Key words:

Echocardiography, Pulmonary Arterial Hypertension, Right Ventricle

A B S T R A C T

Pulmonary hypertension is a progressive disease marked by increased pulmonary artery resistance leading to right heart failure with high mortality. Better survival rates have been obtained by new drugs and early detection of the disease., Two-dimensional echocardiography is commonly used owing to its accuracy, feasibility, and reliability, although imaging of the right ventricle is difficult owing to its complex crescent-shaped structure, heavy trabeculations, and retrosternal location. This review summarizes the diagnostic approach to patients with pulmonary hypertension using two-dimensional echocardiography in the light of the current guidelines.

INTRODUCTION

Definition and classification of pulmonary hypertension was updated in 2015 in pulmonary hypertension (PH) guideline of European Society of Cardiology. PH was classified under five subgroups. Definition was updated: PAH is diagnosed when the mean pulmonary artery pressure measured by right heart catheterization is ≥25 mmHg and capillary wedge pressure is <15 mmHg. Pulmonary vascular resistance ≥3 Woods unite was added to the definition of PH. Right heart catheterization is mandatory for the diagnosis. Registries of patients with PH have been very helpful in characterizing the natural history, presentation and prognosis of the disease.

Pulmonary hypertension can be a result of with different etiologies. Therefore, a multidisciplinary approach is required to reach the correct diagnosis, with the help of imaging techniques. Our purpose in this review is to inform about echocardiography.

Echocardiography is the most commonly used and cheapest imaging technique in patients with pulmonary hypertension [1]. A basic echocardiographic approach is essential to suspect the disease. Echocardiography not only helps with the diagnosis, it also guides the physician to the underlying or contributing pathology. It particularly has a crucial role in identifying left-sided and congenital heart diseases. Also, detailed right ventricular dysfunction assessment, prognostic factors of the disease, response to treatment can be provided by the echocardiography. Because the right heart plays an important role in the morbidity and mortality of a patient presenting with signs and symptoms of pulmonary disease [2] and its assessment has been mostly based on qualitative measures, interest in the evaluation of the right heart has increased recently.

Right heart assessment should not be done with one parameter. Screening should examine the right heart using multiple acoustic windows, and the report should perform an assessment based on parameters. The parameters to be represented and stated should contain measurements of right ventricular (RV) size, right atrial (RA) size, RV systolic function (at least one of the following: fractional area change (FAC), tricuspid annular plane systolic excursion (TAPSE), S', and myocardial performance (IMP), and pulmonary artery (PA) pressure (sPAP) with an estimate of RA pressure on the root of inferior vena cava (IVC) size and collapse.) The reference values for these advised measurements are displayed in **Table 1.** These reference values are grounded on values derived from healthy individuals. Main imaging windows are apical 4-chamber, modified apical 4-chamber, left parasternal long axis (PLAX) and parasternal short axis (PSAX), left parasternal RV inflow, and subcostal views. Those windows ensure images for the overall assessment of RV systolic pressure (RVSP) and RV systolic and diastolic function [3-5].

Corresponding author:* **BaturGönenç Kanar
Department of Cardiology, Faculty of Medicine, Marmara University, Istanbul, Turkey

Right Heart Dimensions

Table 1 Normal Value for Right Ventricle and Pulmonary Circulation

	Normal Value
Right Ventricular Systolic Pressure(mmHg)	<37
Tricuspid Regurgitation Velocity(m/sec)	<2.6
Right Atrium Volume Index(ml/m²)	<34(Men) <27(Women)
Right Ventricular Area Change	32-60%
Right Ventricular MPI	<0.28
TAPSE(mm)	≥20
TDI S´(cm/sec)	>12
LV eccentricity index	1
Pulmonary Vascular Resistance(Wood Unit)	<1

Right Ventricle: RV dimension is best forecasted at end-diastole from a right ventricle–focused apical 4-chamber view. Care should be taken to get the image demonstrating the maximum diameter of the right ventricle without foreshortening. It can be accomplished by making sure that the crux and apex of the heart are in view (Figure 1). RV diameter> 35 mm at themid-level and > 42 mm at the base and states RV dilatation. Likewise, longitudinal dimension > 86 mm indicates RV enlargement [1].

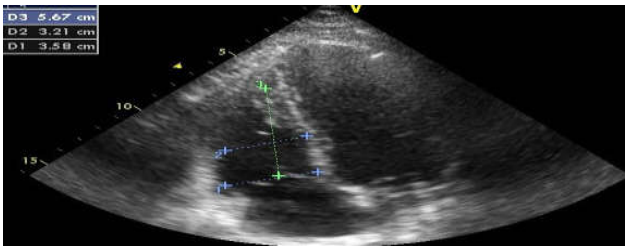


Figure 1 Measure of RV Dimension(Basal-D1, mid-D2 and longitudinal-D3 diameters)

Right Atrium: The apical 4-chamber view allows estimation of the RA dimensions (Figure 2). RA length (indicated as the major dimension) > 53 mm, RA area > 18 cm2, RA diameter (or else known as the minor dimension) > 44 mm indicate at end-diastole RA enlargement.

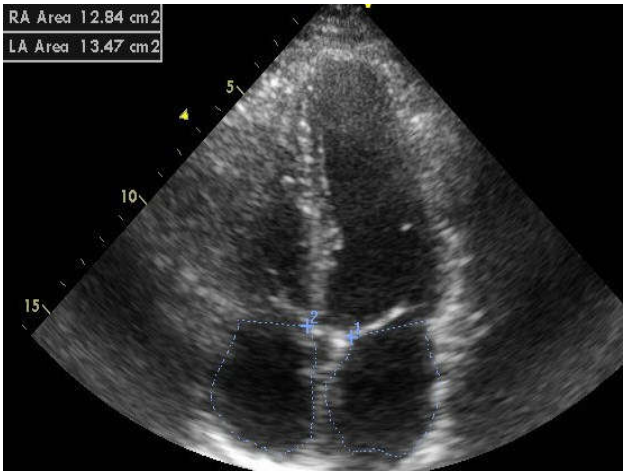
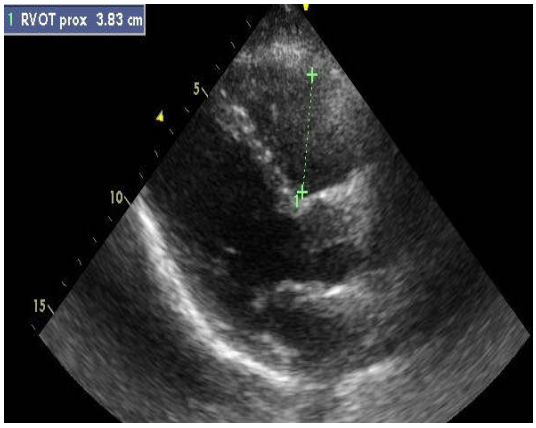


Figure 2 Measure of Right Atrium(Apical 4 chamber view)

Right Ventricle Outflow Tract Dimension: The left PSAX view demonstrating RVOT at the level of the pulmonic valve yields the ‘‘distal diameter’’, while the left PLAX view provides for the measurement of the proximal portion of the RVOT, also attributed to as ‘‘proximal diameter’’(Figure 3). Diameter > 27mm at end-diastole at the level of pulmonary valve insertion (‘‘distal diameter’’) indicates RVOT dilatation [2].

Right Wall Thickness: RV wall thickness is measured in diastole, ideally from the subcostal view, using either M-mode or two-dimensional (2D) imaging. Interchangeably, the left parasternal view is also used for measuring RV wall thickness. Thickness > 5 mm indicates RV hypertrophy (RVH) and may suggest RV pressure overload in the absence of other pathologies [7].

Inferior Vena Cava Dimension: The subcostal view allows imaging and measurement of the IVC and assesses inspiratory collapsibility too. IVC diameter should be evaluated just proximal to the proximal of hepatic veins (Figure 4). For simplicity and kinship of reporting, values of RA pressure, instead of ranges, should be used in the stabilization of pulmonary artery pressure. IVC diameter 2.1 cm that collapses >50% with a sniff suggests normal RA pressure of 3 mm Hg (range, 0-5 mm Hg), while IVC diameter > 2.1 cm that collapses < 50% with a sniff suggests high RA pressure of 15 mm Hg (range, 10-20 mm Hg) [3]. IVC diameter and collapse do not fit this paradigm, an intermediate value of 8 mm Hg (range, 5-10 mm Hg) may be used or, favourably, other indices of RA pressure should be compounded to downgrade or upgrade to the normal or high values of RA pressure.



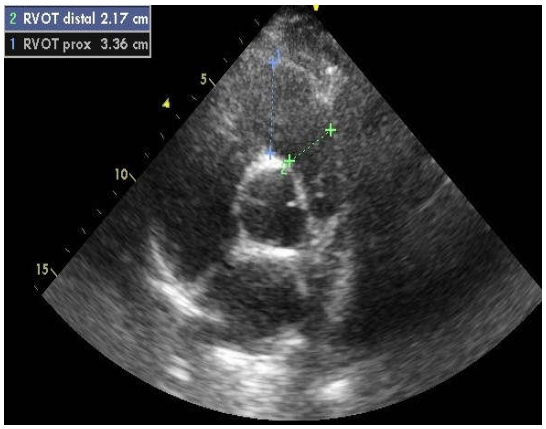
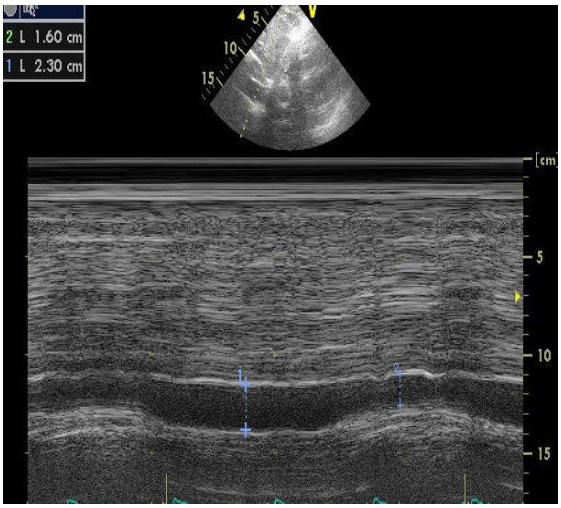


Figure 3 Measure of RVOT(Parasternal long axis and Parasternal short axis)

Left Ventricular Eccentricity Index: It is evaluated by the parasternal short-axis at the level of left ventricular muscles. It is evaluated as the ratio of the minor axis of the left ventricle parallel to the septum (D2), divided by the minor axis perpendicular to the septum (D1). (Figure 5)



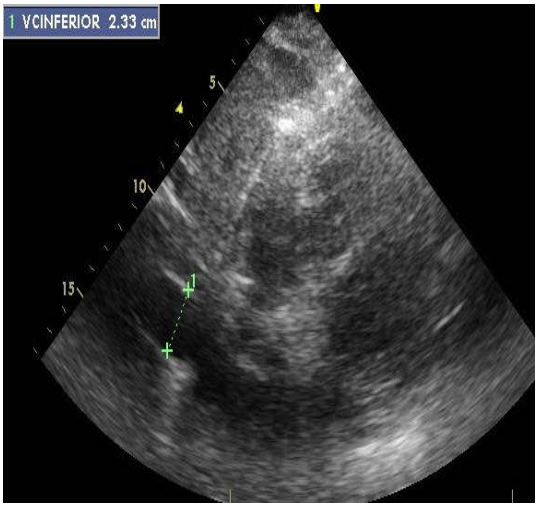


Figure 4 Measure of IVC(Subcostal view)

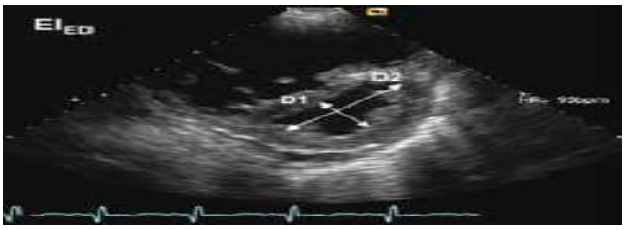


Figure 5 Measurement of Left Ventricle Eccentiricityindex(Parasternal Short Axis)

Right Ventricle Systolic Function: RV systolic function has been evaluated using several parameters, namely, RVIMP, TAPSE,S', 2D RV FAC, 2D RV ejection fraction (EF), three-dimensional (3D) RV EF, and longitudinal strain and strain rate. Among these, more studies have demonstrated the clinical utility and value of RV IMP, TAPSE, 2D FAC, and S'. Though 3D RV EF seems to be more reliable with fewer reproducibility errors, there are insufficient data demonstrating its clinical value at present [2, 4].

RIMP: It ensures an index of global RV function. IMP > 0.40 by pulsed doppler and > 0.55 by tissue doppler states RV dysfunction. By measuring the isovolumic contraction time (IVCT), isovolumic relaxation time (IVRT), and ejection time (ET) indices from the pulsed tissue doppler velocity of the lateral tricuspid annulus, one avoids errors pertain to variability in the heart rate.(Figure 6) RIMP can be falsely low in conditions be connected with elevated RA pressures, which will decrease the IVRT.

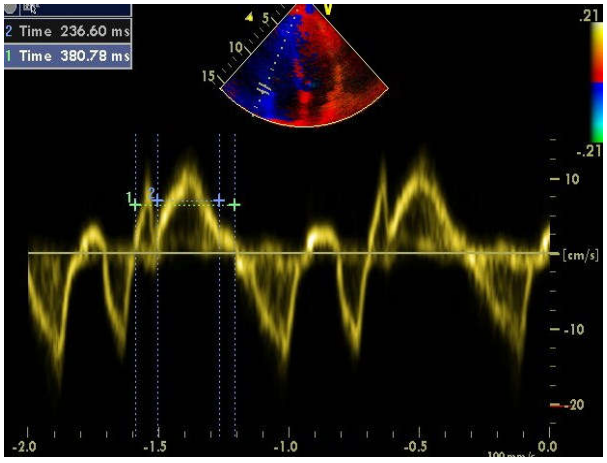


Figure 6 Measure of RV MPI (380-236/236)

Tapse: Itis easily available and is a measure of RV longitudinal function. TAPSE < 16 mm indicates RV systolic dysfunction. It is evaluated from the tricuspid lateral annulus (**Figure 7**). Though it evaluates longitudinal function, it has shown good correlation with techniques estimating RV global systolic function, e.g. radionuclide-derived RV EF, 2D RV FAC, and 2D RV EF [5].

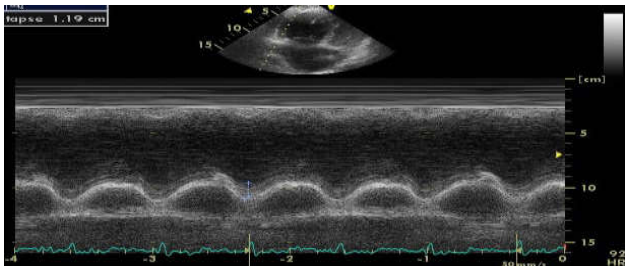


Figure 7 Measure of Tricuspidannuler plane systolic excursion(TAPSE)

Two-dimensional FAC (as a percentage): Itensures an estimate of RV systolic function. Two-dimensional FAC < 35% indicates RV systolic dysfunction. It is important to assure that the all right ventricle in the view, comprise the apex and the lateral wall in both systole and diastole [6]. Care must be taken to omit trabeculations while tracing the RV area.

S': It is easy to measure, confidential and repeatable. S' velocity < 10 cm/s indicates RV systolic dysfunction. S' velocity has been shown to associate well with other measures of global RV systolic function(**Figure 8**)

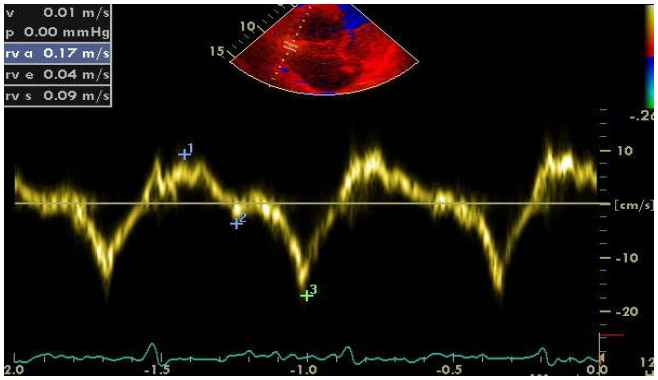


Figure 8 Measure of RV tissue doppler(RVs, RVa´. RVe´)

RV Diastolic Dysfunction. Assessment of RV diastolic function is performed by pulsed doppler of the tricuspid inflow, tissue doppler of the lateral tricuspid annulus, pulsed Doppler of the hepatic vein, and measurements of IVC size

and collapsibility. Several parameters with their upper and lower reference ranges are shown in Table 1. Among these, the E/A ratio, deceleration time, the E/e' ratio, and RA size are recommended [7, 8].

Grading of Right Ventricle Dysfunction: A tricuspid E/A ratio < 0.8 suggests impaired relaxation, a tricuspid E/A ratio of 0.8 to 2.1 with an E/e' ratio > 6 or diastolic flow predominance in the hepatic veins suggests pseudonormal filling, and a tricuspid E/A ratio > 2.1 with deceleration time < 120 ms suggests restrictive filling.

Pulmonary Systolic Pressure/RVSP. TR velocity infallibly permits estimation of RVSP with the addition of RA pressure, assuming no significant RVOT obstruction. It is advised to use the RA pressure estimated from IVC and its collapsibility, rather than arbitrarily assigning a fixed RA pressure. Tr velocity > 2.8 to 2.9 m/s, corresponding to SPAP of approximately 36 mmHg, assuming an RA pressure of 3 to 5mmHg, indicates elevated RV systolic and PA pressure (**Figure 9**). SPAP may increase, after all, with age and in obesity. SPAP is also related to stroke volume and systemic blood pressure. Elevated SPAP may not always state increased pulmonary vascular resistance (PVR). In general, those who have elevated SPAP should be carefully evaluated. It is important to consider that the RV diastolic function parameters and SPAP are influencedby the systolic and diastolic function of the left heart. PA pressure should be reported along with systemic blood pressure or mean arterial pressure [9, 10]**.**

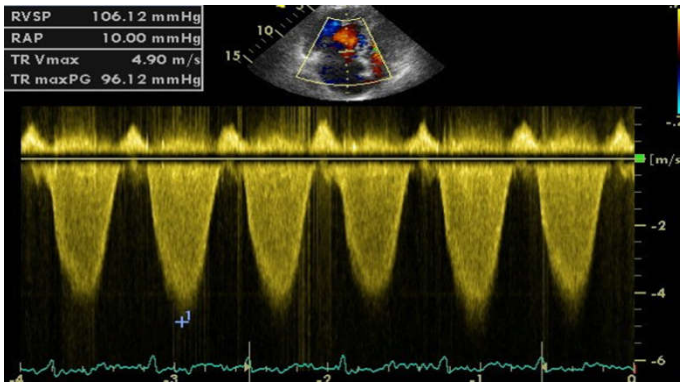


Figure 9 Measure of systolic pulmonary artery pressure

Other parameters recommended for RV quantification

In addition to the indices of RV systolic function described previously, it is mandatory to evaluate other standard parameters such as: RA and RV dimensions, inferior vena cava size and collapse, pulmonary artery systolic pressure, and, in some cases, RV diastolic function as well as RV outflow tract dimension and RV wall thickness, when indicated.

References

1. Rudski LG, Lai WW, Afilalo J *et al*. Guidelines for the Echocardiographic Assessment of the Right Heart in Adults: A Report from the American Society of Echocardiography: Endorsed by the European Association of Echocardiography, a registered branch of the European Society of Cardiology, and the Canadian Society of Echocardiography. *Journal of the American Society of Echocardiography* 2010; 23: 685-713.
2. Sugishita Y, Watanabe M, Fisher SA. The Development of the Embryonic Outflow Tract Provides Novel Insights into Cardiac Differentiation and Remodeling. *Trends in Cardiovascular Medicine* 2004; 14: 235-41.
3. FeigenbaumH A, RyanT. Feigenbaum'sechocardiography 2005. *Lippincott Williams & Wilkins* 2005; 6th ed. Philadelphia.
4. Lindqvist P WA, Henein M, Morner S, Kazzam E. Regional and global right ventricular function in healthy individuals aged 20-90 years: a pulsed Doppler tissue imaging study: Umea General Population Heart Study. . *Echocardiography* 2005; 39: 110-9.
5. Miller D, Farah MG, Liner A *et al*. The relation between quantitative right ventricular ejection fraction and indices of tricuspid annular motion and myocardial performance. *Journal of the American Society of Echocardiography* 2004; 17: 443-7.
6. Levy PT, Diodena B, Holland MR *et al*. Right Ventricular Function in Preterm and Term Neonates: Reference Values for Right Ventricle Areas and Fractional Area of Change. *Journal of the American Society of Echocardiography : official publication of the American Society of Echocardiography* 2015; 28: 559-69.
7. Nagueh SF, Kopelen HA, Zoghbi WA. Relation of Mean Right Atrial Pressure to Echocardiographic and Doppler Parameters of Right Atrial and Right Ventricular Function. *Circulation* 1996; 93: 1160-9.
8. Ommen SR, Nishimura RA, Hurrell DG, Klarich KW. Assessment of Right Atrial Pressure With 2-Dimensional and Doppler Echocardiography: A Simultaneous Catheterization and Echocardiographic Study. *Mayo Clinic Proceedings* 2000; 75: 24-9.
9. Badesch DB, Champion HC, Gomez Sanchez MA *et al*. Diagnosis and Assessment of Pulmonary Arterial Hypertension. *Journal of the American College of Cardiology* 2009; 54: S55-S66.
10. Lam CSP, Borlaug BA, Kane GC *et al*. Age-Associated Increases in Pulmonary Artery Systolic Pressure in the General Population. *Circulation* 2009; 119: 2663-70.

How to cite this article:

BaturGönenç Kanar (2018) 'Evaluation of Right Ventricle Functions in patients with Pulmonary Hypertension ', *International Journal of Current Advanced Research,* 07(1), pp. 9503-9506. DOI: http://dx.doi.org/10.24327/ijcar.2018.9506.1573

****