ECHOCARDIOGRAPHIC PREDICTORS OF RIGHT VENTRICULAR DYSFUNCTION IN COPD PATIENTS

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ABSTRACT

BACKGROUND

Normal Echocardiography assessment is primarily focused on left ventricle. Owing to the technical difficulty in imaging, right ventricle is neglected often. Since Right ventricle is invariably affected in COPD patients, it is imperative to find out the presence of RV dysfunction in these patients to prevent RV impairment in future.

MATERIALS AND METHODS

This study was done at Department of Cardiology, Govt. Vellore Medical College and Hospital, Adukkamparai, Vellore, Tamil Nadu during the period of October 2016 to March 2017 (Aloka Prosound Alpha 6 Echo machine was used). Seventy six male patients with COPD were taken up for the study. Group A (COPD alone): 36 patients without pulmonary hypertension were included in this group. Group B (COPD with PHT): 36 patients with pulmonary hypertension (TR Velocity < 3.0 m/s; mean pressure gradient < 45 mmHg) were included in this group. The following Echocardiographic measurements were made to all the seventy two patients. (1). FAC (Fractional Area Change), (2). TAPSE (Tricuspid annular plane systolic excursion), (3). RVs' (RV systolic excursion by Tissue Doppler) and (4). RV MPI (RV Myocardial Performance Index).

RESULTS

COPD patients with pulmonary hypertension showed marked deviation from reference values, while COPD patients without pulmonary hypertension showed values above the physiological limits.

CONCLUSION

In this present study, we have found that 2D echocardiography markers like FAC, TAPSE, RVs' and RV MPI were simple and very good predictors of RV function. It was useful in assessing the RV function in COPD patients with mild-to-moderate pulmonary hypertension.

KEYWORDS

RV, ECHO, COPD, PHT, FAC, TAPSE, RVMPI.

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BACKGROUND

Assessment of Right ventricular function has been never included in routine echocardiographic examination of any patient, because it is considered to be only a conduit and its performance was thought to be unimportant.[1] We observe many patients with COPD with or without significant pulmonary hypertension soon develops RV failure and end up with end stage heart disease. Many of these patients are refractory to treatment. Hence, it is necessary to assess RV function, especially in patients with primary or secondary RV disease. This will help us to plan our treatment strategy as well as to prevent complications. Chronic Obstructive Pulmonary Disease (COPD) is a common illness in our country, which results in RV dysfunction and irreversible RV failure. We thought it is mandatory to assess the RV function in COPD patients, whether they have pulmonary hypertension or not. The very purpose of this observational study is to find out echocardiographic parameters to evaluate RV function in these patients. This will certainly enable us to prevent the worsening of RV function and treat the same.

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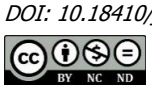


Aim

COPD leads to reduced RV compliance and changes in RV function before severe pulmonary hypertension develops. Based on this we tried to find out simple, effective, non-invasive echocardiographic methods to assess the RV function and the utility of these markers in finding out the RV dysfunction in COPD patients with or without mild-to-moderate pulmonary hypertension.

This study was done at Department of Cardiology, Govt. Vellore Medical College and Hospital, Adukkamparai, Vellore, Tamil Nadu during the period of October 2016 to March 2017 (Aloka Prosound Alpha 6 Echo machine was used). Seventy

six male patients with COPD were taken up for the study. All the patients underwent pulmonary function test followed by post salbutamol nebulisation to confirm the diagnosis of COPD (FEV1/FVC= < 0.7). Routine clinical examination, ECG and Echocardiogram was done. The diagnosis of pulmonary hypertension was made by measuring TR velocity by Echo.

These patients were divided into two groups.

Group A (COPD Alone)- 36 patients without pulmonary hypertension were included in this group.

Group B (COPD with PHT)- 36 patients with pulmonary hypertension (TR Velocity < 3.0 m/s; mean pressure gradient < 45 mmHg)[2,3] were included in this group.

Exclusion Criteria

1. Patients with severe LV dysfunction.
2. Severe pulmonary hypertension (TR velocity > 3.5 m/s; mean pressure gradient > 50 mmHg).
3. LV disease of any form.
4. Uncontrolled hypertension.
5. Arrhythmias.
6. Malignancies.
7. Cor pulmonale with overt RV failure.

The following Echocardiographic measurements were made to all the seventy two patients.

1. FAC (Fractional Area Change).
2. TAPSE (Tricuspid Annular Plane Systolic Excursion).
3. RVS' (RV Systolic Excursion by Tissue Doppler).
4. RVMPI (RV Myocardial Performance Index).

FAC (Fractional Area Change)- Figure 2, 3

FAC is obtained by tracing RV endocardial border in both systole and diastole from annulus along free wall to the apex and then back to the annulus along the IVS. Care must be taken to trace the free wall behind the trabeculae. The percentage is calculated by (End diastolic area- End systolic area)/ End diastolic area X 100.

TAPSE (Tricuspid Annular Plane Systolic Excursion)

TAPSE is done by placing the cursor over the RV free wall near tricuspid annulus along the longitudinal plane. Pulsed wave Doppler, the systolic excursion distance of the tricuspid annulus was measured.

RVS' (RV Systolic Excursion by Tissue Doppler)

This is almost a counterpart to TAPSE. Here, the same measurement of tricuspid annular excursion during systole was done under Tissue Doppler mode.

RV MPI (RV Myocardial Performance Index)- Figure 4, 5

In 2-D echo under tissue Doppler mode, cursor was placed on the base of RV at the tricuspid annulus; single image with S', E' and A' was saved. The following measurements were made to derive RV MPI (Tei Index).

IVCT- End of A' to the beginning of S'

IVRT- End of S' to the beginning of E'

ET- Ejection Time- beginning of S' to end of S'

IVCT + IVRT= TCO (End of A' to Beginning of E')

MPI= (IVCT + IVRT)/ ET

= TCO - ET

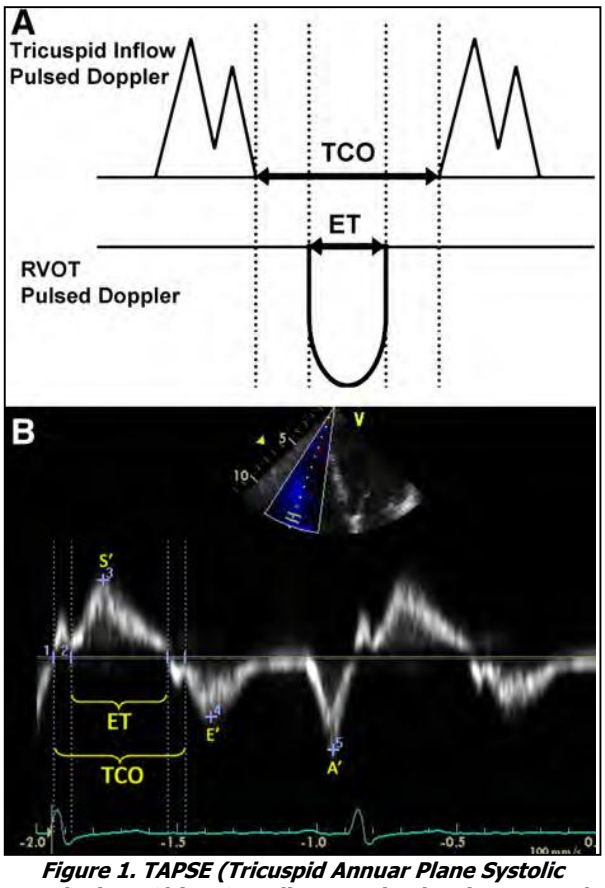


Figure 1. TAPSE (Tricuspid Annuar Plane Systolic Excursion), RVS' (RV Systolic Excursion by Tissue Doppler) and RV MPI (RV Myocardial Performance Index)

Figure 2. FAC (Fractional Area Change) in Systole

Figure 3. FAC (Fractional Area Change) in Diastole

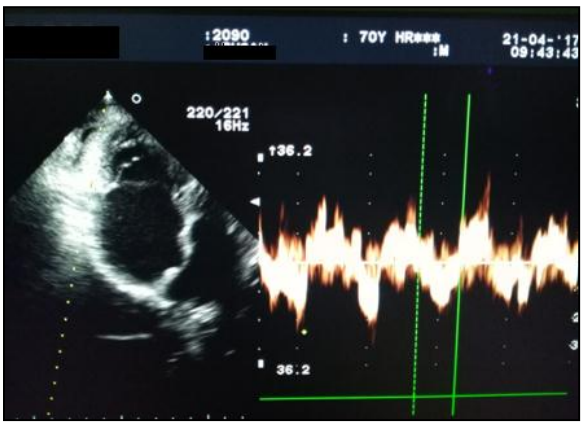


Figure 4. RV MPI (RV Myocardial Performance Index)- TCO

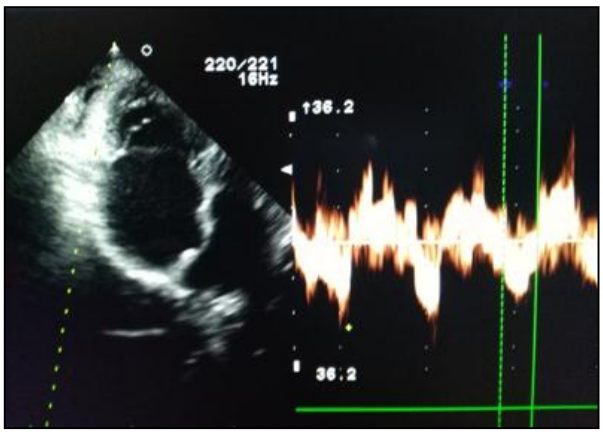


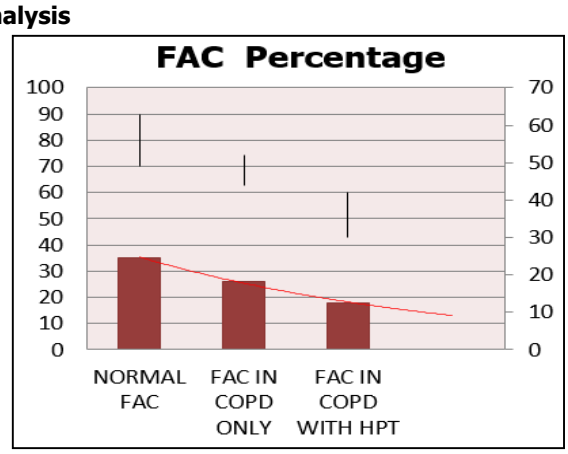
Figure 5. RV MPI (RV Myocardial Performance Index)- ET

RESULTS

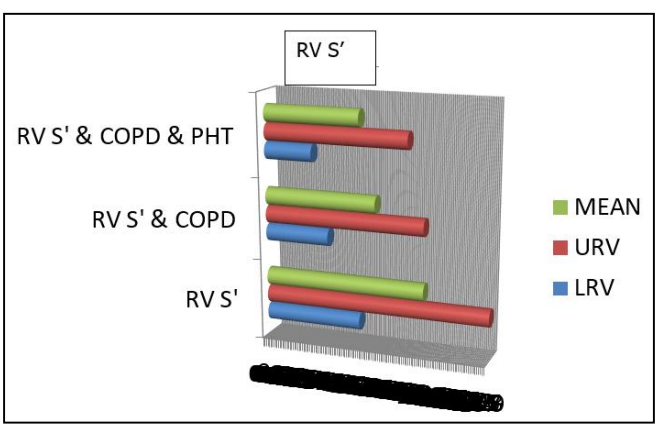
The following observations were made at the end of our study.

ECHO Parameter	Reference Value[4]			COPD			COPD with PHT		
Values	**URV**	**LRV**	**Mean**	**URV**	**LRV**	**Mean**	**URV**	**LRV**	**Mean**
FAC (%)	35	63	49	26	52	44	18	42	30
TAPSE (mm)	16	30	23	10	28	18	8	14	11
RVS' (cm/s)	6	14	10	3	11	7	3	9	6
RV MPI	0.24	0.55	0.38	0.32	0.54	0.44	0.44	0.78	0.61

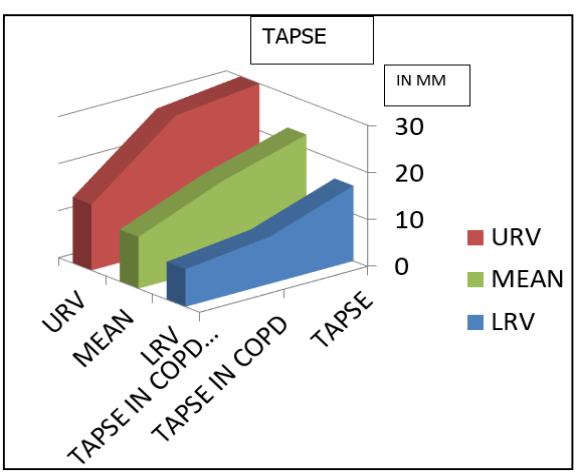
Analysis



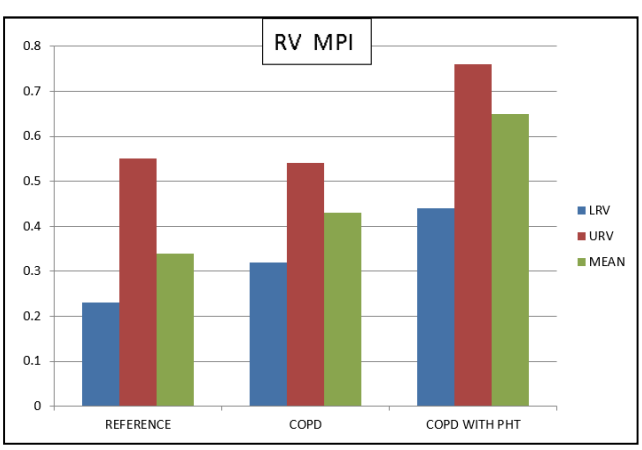
Graph 1. FAC Percentage



Graph 3. RVS'



Graph 2. TAPSE



Graph 4. RV MPI

DISCUSSION

The assessment of Right Ventricular function is less familiar and is usually not included in routine Echocardiographic examinations.[5] In this present study, we tried to find out some reliable and convenient echocardiographic markers to measure Right Ventricular function and to identify Right Ventricular dysfunction, especially in patients with Chronic Obstructive Pulmonary Disease.[6]

COPD is well known to cause systemic effects. The assessment of severity of COPD often uses a combination of assessment tools such as BODE index, St. George's Respiratory Questionnaire, etc. None of these indices include an assessment of pulmonary artery pressure or right ventricular load.[7] Some studies have reported that pulmonary hypertension is an independent risk factor for death in patients with COPD. Early changes in RV function have been reported in clinically stable COPD patients with no evidence of pulmonary hypertension. If a non-invasive and easily available marker of RV function is included in prognostic models of COPD, RV overload may be detected even in patients with mild or absent elevation of pulmonary artery pressure.[8]

The literature for RV function assessment is comparatively very less to LV function assessment.

We have taken four Echocardiographic parameters for this purpose. The reference cut-off values were taken from guidelines for the echocardiographic assessment of the right heart in adults, a report from the American Society of Echocardiography.[4]

1. FAC (Fractional Area Change).
2. TAPSE (Tricuspid Annular Plane Systolic Excursion).
3. RVS' (RV Systolic Excursion by Tissue Doppler).
4. RV MPI (RV Myocardial Performance Index).

FAC is a measurement of RV systolic function that has been shown to correlate with RV EF by MRI. FAC was found to be an independent predictor of heart failure, sudden death and/or mortality in studies of patients after pulmonary embolism and RV infarction. The American Society of Echocardiography recommends low reference value of 35% for normal RV function.[9]

TAPSE is a simple less dependent on optimal image quality and reproducible. It does not require sophisticated equipments or prolonged image analysis. In a study by Karl et al at TAPSE correlates strongly with radionuclide angiography. It has been validated against biplane Simpson RV EF and RV FAC.[10] There have been more than 40 studies with more than 2000 normal subjects evaluated.

Utility of TAPSE, a TAPSE cut-off value of < 17 mm yields high specificity, though low sensitivity to distinguish abnormal from normal subjects.[11]

RVS' is similar to TAPSE, which is a simple reproducible technique with good discriminative ability to detect normal versus abnormal RV function. The disadvantage of this method is that it is angle dependant and we assume that the function of single segment represent the function of whole RV.

MPI is also known as RIMP or Tei index is a global estimate of both systolic and diastolic function of RV. It is based on the relationship between ejection and non-ejection work of the heart, as it is defined as the ratio of isovolumetric time to ejection time. The measure remains accurate within broad range of heart rate, but it is advisable to measure at constant RR intervals. MPI is unreliable when RA pressure is elevated (e.g. Infarction). Hence, we have not included patients with Rhythm disturbances, severe PHT and RV failure in this study.[11,12]

The interesting aspect of this study was the hidden changes in RV performance even in COPD patients without Pulmonary Hypertension, which correlates with a detailed study by Janne Mykland Hilde et al.[13]

The chronic obstructive pulmonary disease patients who ends up with right ventricular dysfunction will result in increased risk of hospital readmissions and generally carries a poor prognosis. There are many studies in literature regarding the evaluation of right ventricular function in chronic obstructive pulmonary disease with pulmonary hypertension, but only few studies are available for patients without pulmonary hypertension for reference. Chronic obstructive pulmonary disease causes physiological and pathological changes in pulmonary vasculature, which results in pulmonary hypertension. This subsequently increases right ventricular afterload. Right ventricular compliance will be worsened if this increase in RV afterload persists for a long time. Hence, echocardiography evaluation provides almost accurate measurement of RV function which is very essential in this clinical scenario.

Haemodynamic measurements of right ventricle by right heart catheterisation is the standard definitive diagnostic method to assess right ventricular function precisely, but it is invasive and needs technical expertise as well as sophisticated equipments. The complex anatomy of right ventricle makes the non-invasive echocardiographic evaluation difficult many times.

During the evaluation of right ventricular function, it is important that both right ventricular and left ventricular sizes are compared. On an average, the right ventricular size appears two-thirds of the size of left ventricle, mainly in apical four chamber views in normal patients. Right ventricular dilatation is said to be present if the RV appears equal to or larger than left ventricle.

In many modified conventional and unconventional echocardiographic views are needed to eliminate false positive findings. Subcostal projection should be tried in all patients, especially in patients with chronic obstructive pulmonary disease. In this view, right ventricle appears clear and larger in length and dimension when compared to other views.

The right ventricular endocardial tracing is done by starting from RV apex, RV free wall, Tricuspid annulus, Interventricular septum and again back to apex. At times it is difficult and needs familiarity with the technique. This endocardial tracing should be done in end systole and end diastole to quantitatively assess the RV dimensions and RV function. The validity of endocardial border tracing to assess

the RV dimension and function is established by comparative studies with radionuclide angiography and MRI studies. RV tracing can be improved by injecting intravenous contrast agents. The only disadvantage of this method is wide interobserver variations.

Tissue Doppler Imaging is a novel method, which will allow us to quantitatively assess RV systolic and diastolic function. In this method, we measure the myocardial velocities rather than blood flow velocities. In patients with inferior wall myocardial infarction with right ventricular involvement, the myocardial velocity of tricuspid lateral annulus is significantly reduced when compared to normal individuals. The reduction in tricuspid lateral annulus systolic velocity is alone associated with severe RV dysfunction in cardiac failure patients. Tissue Doppler Imaging is also useful in measuring right atrial pressure by combining tricuspid pulse wave Doppler with tricuspid tissue Doppler (E/E').

Tissue Doppler imaging is also useful in assessing the ventricular dyssynchrony. This is extensively used to assess left ventricular dyssynchrony than right ventricular dyssynchrony. Hence, the prevalence of RV dyssynchrony is yet to be defined.

Newer techniques like tissue Doppler velocity measurements, strain rate imaging, 3-dimensional and 4-dimensional will enable us to measure right ventricular function more accurately in near future.

CONCLUSION

Two dimensional and Tissue Doppler Echocardiographic parameters are useful in assessing the function of right ventricle. In this observational study, we found that chronic obstructive pulmonary disease patients with or without pulmonary hypertension showed deviations from normal RV functions. Implementation of newer techniques and large scale studies will prompt us to find out more methods to diagnose RV function in future.

REFERENCES

[1] Haddad F, Hunt SA, Rosenthal DN, et al. Right ventricular function in cardiovascular disease, part I: anatomy, physiology, aging, and functional assessment of the right ventricle. Circulation 2008;117(11):1436-1448.

[2] Naeije R, Torbicki A. More on the noninvasive diagnosis of pulmonary hypertension: doppler echocardiography revisited. Eur Respir J 1995;8(9):1445-1449.

[3] Badesch DB, Champion HC, Sanchez MA, et al. Diagnosis and assessment of pulmonary arterial hypertension. J Am Coll Cardiol 2009;54(1 Suppl):S55-S66.

[4] 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. J Am Soc Echocardiogr 2010;23(7):685-713.

[5] Otto C. The practice of clinical echocardiography. 3rd edn. Philadelphia: Saunders Elsevier 2007.

[6] Burgess MI, Mogulkoc N, Bright-Thomas RJ, et al. Comparison of echocardiographic markers of right ventricular function in determining prognosis in chronic pulmonary disease. J Am Soc Echocardiogr 2002;15(6):633-639.

[7] Tanaka Y, Hino M, Mizuno K, et al. Evaluation of right ventricular function in patients with COPD. Respir Care 2013;58(5):816-823.

[8] Bagnato GF, Mileto A, Gulli S, et al. Non invasive assessment of cardiac function in patients with bronchial asthma (BA) or chronic obstructive pulmonary disease (COPD). Allergol Immunopathol (Madr) 1999;27(1):5-10.

[9] Anavekar NS, Gerson D, Skali H, et al. Two-dimensional assessment of right ventricular function: an echocardiographic-MRI correlative study. Echocardiography 2007;24(5):452-456.

[10] Tamborini G, Pepi M, Galli CA, et al. Feasibility and accuracy of a routine echocardiographic assessment of right ventricular function. Int J Cardiol 2007;115(1):86-89.

[11] Tei C, Dujardin KS, Hodge DO, et al. Doppler echocardiographic index for assessment of global right ventricular function. J Am Soc Echocardiogr 1996;9(6):838-847.

[12] Chockalingam A, Gnanavelu G, Alagesan R, et al. Myocardial performance index in evaluation of acute right ventricular myocardial infarction. Echocardiography 2004;21(6):487-494.

[13] Hilde JM, Skjørten I, Grøtta OJ, et al. Right ventricular dysfunction and remodeling in chronic obstructive pulmonary disease without pulmonary hypertension. J Am Coll Cardiol 2013;62(12):1103-1111.