International Journal of Science and Research (IJSR)
ISSN: 2319-7064
SJIF (2020): 7.803

Right Atrial Volume Index in Patients with Chronic Obstructive Pulmonary Disease

S. M. Shankar Rajan[1], M. Chokkalingam[2], G. Ashok[3], Durga Devi[4]

Department of Cardiology, Chettinad Hospital and Research Institute, Chennai, India

[1]DM Postgraduate Student, Department of Cardiology, Chettinad Hospital and Research Institute, Chennai, India

[2]Professor and Head of the Department, Department of Cardiology, Chettinad Hospital and Research Institute, Chennai, India

[3]Associate Professor, Department of Cardiology, Chettinad Hospital and Research Institute, Chennai, India

[4]Assistant Professor, Department of Cardiology, Chettinad Hospital and Research Institute, Chennai, India

Abstract:* "Right Atrial Volume Index in patients of Chronic Obstructive Pulmonary Disease-(COPD) " Objectives: To correlate right atrial volume index (RAVI) with right ventricular systolic & diastolic dysfunction in patients of COPD. Background & Review of Literature: RAVI is the echocardiographic parameter associated with right ventricular diastolic & systolic dysfunction in patients with COPD, PHT of Other Causes including Heart Failure. Methodology: Cross Sectional Observational Study. Prospective Study. Study Period: MARCH 2019 TO JAN.2021. Sample Size: 100 patients with Chronic Obstructive Pulmonary Disease (COPD) Inclusion Criteria: Proven case of COPD as per Gold Criteria. Exclusion Criteria: Very severe COPD. (GOLD 4), Acute exacerbation of COPD, artery disease Other causes of PHT, & Not willing for the study. Statistical Method: Statistical analysis done using software version 21.0.

Keywords: Right Atrial, Volume Index, Chronic Obstructive Pulmonary Disease, Right Ventricular Systolic, Diastolic Function, Pulmonary Hypertension

1. Introduction

Remodeling in the pulmonary vascular bed leads to pulmonary arterial hypertension and RV dysfunction in COPD. RA provides RV filling with its reservoir, conduit and booster pump functions. In chronic RV pressure overload as in COPD with PHT, initially the RV diastolic function is impaired with preserved systolic function. This is due to compensatory increase in RA contractility and expandability. Later, RA enlargement and hypertrophy with reduced contractility occur. Thus Right atrium is of clinical importance in COPD. Echocardiography is the relevant noninvasive technique for screening, diagnosis, and follow-up assessments in COPD. RA can be visualized by 2D Echocardiography for a quantitative assessment of the RA volume. RA volume correlates with RV dysfunctional severity.

Aim

We aimed at correlation between right atrial volume index (RAVI) and severity of COPD, PHT and RV dysfunction in patients with COPD.

2. Materials & Methods

This is a prospective study from April 2019 to January 2021.

100 cases of proven COPD were studied.

Inclusion Criteria

Proven case of COPD as per GOLD criteria

Exclusion Criteria

Very severe COPD-GOLD 4.
Acute exacerbation of COPD
Arrhythmias
Other causes of PHT
Patients not willing for the present study
Patient's consent was obtained
Gold criteria were applied to label the severity of COPD.

Detailed history & clinical examination was done. Relevant blood tests, X ray chest, 12-lead ECG & ECHO were done.

Standard transthoracic echocardiographic studies were performed.

Apical 4-chamber view and 2 chamber view were used. All data were stored and analysed.

Apical 4-chamber view was used for RA measurements. Planimetry was used to calculate RA area. Simpson's modified rule was applied. . RA volume index was deducted by the echo machine according to height and weight of the person thereby the body surface area.3 consecutive cardiac cycles were studied for averaging all measures.

More than 36 mm was considered as RA dilatation. Normal cut off value for RAVI was taken as 28mL/m², in comparison with 10 normal individuals. More than 6 mm thickness of anterior wall of RV in end-diastole was considered as RVH. Tricuspid regurgitation, dilatation of inferior vena cava and hepatic veins were studied to diagnose RV failure. Tricuspid regurgitation velocity plus estimated RA pressure was used to calculate

Pulmonary artery systolic pressure. More than 25 mm of Hg was considered as pulmonary arterial hypertension (PHT). PHT were divided into two groups with 35 mm of Hg as mid value.

Apical four chamber view was used to measure TAPSE and RVEF.

RV systolic dysfunction was diagnosed if TAPSE < 16 mm and RVEF < 50%. Apical 4-chamber view was used for tricuspid diastolic flow measurement. E/A ratio was used to assess RV diastolic function.

Only 40 patients were co-operative for 6 Minute Walk Test (MWT).

Their walking distance was compared for the RAVI. Normal cut off value of 500MTS was arrived through 10 healthy volunteers.

Mean value± standard deviation (SD) was derived.

The correlation between RAVI and the severity of RV systolic and diastolic dysfunctions were analysed using the ANOVA TEST. Relationships between other echocardiographic variables and RAVI were evaluated.

Statistical Methods:
1) Descriptive statistics
2) Univariate & Multivariate analysis

Software used-IBM SPSS version-21

3. Observations & Analysis

Among 100 cases studied, 90 were males and 10 were females.

Age group ranged from 40 yrs to 82 yrs.

Majority belonged to the age group of 51-60yrs.

Among males, 54 pts were smokers and none females were smokers.

COPD Severity Gold (Criteria)
MILD – 38 cases
MODERATE – 47 cases.
SEVERE-15 cases.

RA Measurements: cm/m2

RA AREA index cm/m2: Ranging from 8.5+/-2.4 cm/m2 for mild cases, 10.7+/-1.5 cm/m2 for moderate COPD and 12.0+/-2.1 cm/m2 for severe COPD CASES. (P VALUE <0.01)

LONG AXIS index cm/m2: Ranging from 3.0 to 4.3 cm/m2 (3.2+/-0.2 cm/m2for mild COPD, 3.4+/-0.5 cm/m2 FOR MODERATE COPD and 3.7+ /-0.6 cm/m2for severe COPD.) (P VALUE 0.23)

SHORT AXIS index cm/m2: Ranging from 1.5 to 2.9 cm/m2 according to COPD SEVERITY. (P VALUE 0.14)

RVH mm: 5.1 to 9.2 mm (6.5+/-1.4 mm for mild, 7.0+/-1.2 mm for moderate and 7.8+/-1.4mm for severe COPD.

RV Dilatation mm: 25.2 mm to 33 mm (26.4+/-1.2 mm for mild, 29.5+/-1.5 mm for moderate and 31.5+/-1.5mm for severe COPD RVEF %: 28 to 36 % (34+/-2.0 % for mild, 31. .5+/-1.5 % for moderate and 29.5+/-1.5 % for severe COPD.

RAVI of 25.2+/-2.2 ML/ M^2 FOR MILD COPD, 28 +/-1.5 ML/M^2 FOR MODERATE COPD AND 33.4+/-1.2 ML/M^2 FOR SEVERE COPD (P VALUE <0.001).

RAVI of 26.5+/-1.4 ML/M^2 FOR MILD PHT AND 30+/-1.2 ML /M^2 FOR SEVERE PHT (P VALUE<0.001).

RAVI of 30.5+/-4.1 ML/M^2 FOR RV DIASTOLIC DYSFUNCTION VS 24.2+/-3.2 ML/M^2 FOR NORMAL RV DIASTOLIC FUNCTION. (P VALUE < 0.001)

RAVI VS RV DILATATION: 30.0+/-1.4 ml for dilated RV vs 24.2+/-2.2 ml for normal RV. (P VALUE<0.001)

RAVI OF 30+/-1.5 ML/M^2 FOR DECREASED TAPSE VS 25.2+/-2.2 ML/M^2 FOR NORMAL TAPSE (P Value <0.001).

RAVI OF 31.7+/-MML/M^2 FOR 6MWT OF 251 MTS VS 25.2+/-2.2 ML/M^2 FOR 478MTS. (P Value <0.001)

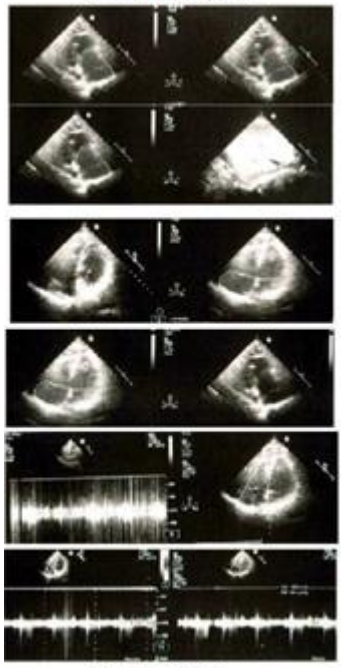
RAVI was increased in 68% of cases.

RIGHT ATRIAL PARAMETERS RELATED TO COPD SEVERITY:

COPD SEVERITY	MILD	MODERATE	SEVERE
	M: F = 33: 5	M: F = 42: 5	M:F = 15:0
RA AREA index cm/m²	8.5+/- 2.4	10.7+/- 1.5	12.0+/- 2.1
LONG AXIS index ,,	3.2+/-0.2	3.4+/- 0.5	3.7+ /- 0.6
SHORT AXIS index ,,	2.0+/- 0.5	2.2+/- 0.6	2.4+/_0.5
RAVI ml/m²	25.2+/-2.2	28.0+/- 1.5	33.4+/-1.2
RVH mm	6.5+/-1.4	7.0+/-1.2	7.8+/-1.4
RV DILATATION mm	26.4+/-1.2	29.5+/-1.5	31.5+/-1.5
RVEF %	46+/-2.0	39.5+/-1.5	34.5+/- 1.0

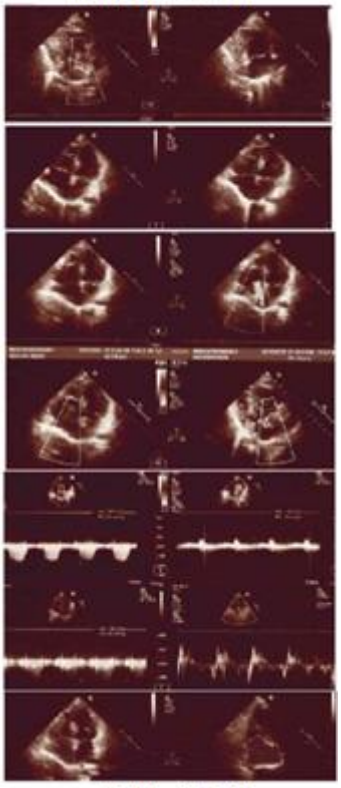
MILD = GOLD 1; MODERATE = GOLD 2 ; SEVERE = GOLD 3

SAMPLE CASE 1



RAVI – 34.6ML

SAMPLE CASE 2



RAVI – 35.5ML

SAMPLE CASE 3

RAVI – 32.6ML

4. Discussion

Echocardiographic study for RA size in COPD was done by many authors (1-9). In this study, RA area indices, long axis and short axis indices were directly proportional to the severity of COPD. However, only RA area index increment in relation to severity of COPD is statistically significant. (p value <0.001).

In the present study, RAVI increment in relation to severity of COPD is also statistically significant (p value <0.001).

Linear measurements were studied by Oben Baysan and others (10, 3, 4, 11-21) and compared with volumetric quantification of right atrium in COPD. Volumetric quantification of the right atrium is very useful than linear measurements (10, 3, 4, 11-21).

In our study, right atrial area and volume reflect the RV function and is correlated with pulmonary hypertension due to COPD. Similar observations were noted by others also. (22-26),

In our study RAVI is not significantly affected by gender.

Lang RM et al (19) observed that RA volumes are affected by gender but RA volume index is more or less same for both genders.

RA size correlates with RV diastolic and systolic dysfunctions (27-30). In our study, Right Atrial Volume Index is associated with Right Ventricular dysfunction. (p value <0.001)

In our study, RAVI increases significantly with severity of PHT. (P value <0.001) Giovanni Cioffi et al (31) found that increased RA size is an early sign and has negative impact in PH.

Similar findings were observed by Agoston Coldea, et al (7).

In the present study, RAVI increases in relation to RVDD, as observed by Nagueh SF (29)

In the present study, RAVI increases with increase of RV wall thickness (RVH).

RAVI is correlated to indices of RV systolic dysfunction (RV dilatation TAPSE and RVEF).

Sallach et al concluded that RAVI reflects RV dysfunction severity (9).

In our study, RV systolic dysfunction and elevated pulmonary systolic pressure are independently related to RAVI. Agoston-Coldea et al (7) concluded that in COPD, RAVI correlates with PHT and RV Systolic dysfunction.

We observed the inverse correlation between RAVI and six minute walk distance.

Zh. Cherneva et al (32) noted that higher RAVI is directly proportional to increased pulmonary artery pressure and increased E/e ratio and decreased six minute walking distance.

Cuttica MJ et al observed the relation between right heart changes and exercise capacity in COPD (24). Increased RAVI is related to low functional capacity and higher mortality (33).

Vikram B Vikhe et al studied the 2D echocardiographic findings as cardiovascular complications in COPD. (34). They noticed increased RAVI in 34% of COPD. They compared their echo findings with Himelman's observations. (35). They observed elevated RAVI in 89% of COPD.

We noticed that increased RAVI in 68% of COPD according to severity of COPD.

5. Conclusion

Our study reveals that increased RAVI is correlative with severity of COPD, severity of pulmonary arterial hypertension, RV diastolic dysfunction and RV systolic dysfunction. Increased RAVI in COPD is associated with decreased work capacity.

References:

[1] Grünig E, Barner A, et al:. Non-invasive diagnosis of pulmonary hypertension: ESC/ERS guidelines with updated commentary of the Cologne Consensus Conference 2011. Int J Cardiol.2011; 154 (suppl 1): S3–12
[2] Galie N, Hoeper MM et al: Guidelines for the diagnosis and treatment of pulmonary hypertension. Eur Respir J.2009; 34: 1219–1263.
[3] Rudski LG, Lai WW 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: 685–713; quiz 786.
[4] Triulzi MMD, Gillam LD, et al:. Normal adult cross-sectional echocardiographic values: linear dimensions and chamber areas. Echocardiogr Rev Cardiovasc Ultrasound.1984; 1: 403–426.
[5] Fukuda S, Gillinov AM, Song JM, et al. Echocardiographic insights into atrial and ventricular mecha-nisms of functional tricuspid regur-gitation. Am Heart J 2006; 152: 1208 –14
[6] Badesch DB, Champion HC, Sanchez MA, et al. Diagnosis and assessment of pulmonary arterial hypertension. J Am Coll Cardiol.2009; 54: S55-66
[7] Agoston-Coldea L, Petrovai D et al: Right atrium volume index in patients with secondary pulmonary hypertension due to chronic obstructive pulmonarydisease. Acta Cardiol Sin, 2015.31 (4): 325–336
[8] Cioffi G, de Simone G, Mureddu G, Tarantini L, Stefenelli C. Right atrialsize and function in patients with pulmonary hypertension associated with disorders of respiratory system or hypoxemia. Eur J Echocardiogr 2007; 8: 322–31
[9] John A. Sallach, MD* W. H. Wilson Tang, MD, et al: Right Atrial Volume Index in Chronic Systolic Heart Failure and Prognosis. JACC: CARDIOVASCULAR IMAGINGVOL.2, NO.5, 2009
[10] Oben Baysan, Ezgi Polat Ocaklı et al:. Atria: A comprehensive evaluation with echocardiography, Heart Vessels and Transplantation 2017; 1: doi: 10.24969/2017.8
[11] Lang RM, Bierig M, et al: Chamber Quantification Writing Group; American Society of Echocardiography's Guidelines and Standards Com-mittee; European Association of Echocardiography. Recommendations for chamber quantification: a report from the American Society of Echo-cardiography's Guidelines and Standards Committee and the Chamber Quantification Writing Group, developed in conjunction with the European Association of Echocardiography, a branch of the European Society of Cardiology. J Am Soc Echocardiogr.2005; 18: 1440–1463.
[12] D'Andrea A, Riegler L, Golia E, et al:. Range of right heart measurements inop-level athletes: the training impact [published online ahead of print J
[13] Yock PG, Popp RL. Et al: Noninvasive estimation of right ventricular systolic pressure by Doppler ultrasound in patients with tricuspid regurgitation. Circulation.1984; 70: 657–662.
[14] Ommen SR, Nishimura RA, et al: Assessment of right atrial pressure with 2-dimensional and Doppler echocardiography: a simultaneous catheterization and echocardiographic study. Mayo Clin Proc.2000; 75: 24–29
[15] Du Bois D, Du Bois EF. A formula to estimate the approximate surface area if height and weight be known; 1916. Nutrition.1989; 5: 303–311.
[16] Lambertz H, Heiliger Ret al: C. A new echocardiographic procedure for calculation of the accurate volume of the right atrium. Z Kardiol.1986; 75: 342–354.
[17] Lambertz H, Krebs W, et al: Determination of the size of the right atrium in patients with pulmonary hypertension using 2-dimensional echocardiography. Z Kardiol.1984; 73: 646–653.

[18] Wang Y, Gutman JM, Heilbron D, et al:. Atrial volume in a normal adult population by two-dimensional echocardiography. Chest.1984; 86: 595–60
[19] Lang RM, Badano LP et al. Recommendations for cardiac chamber quantification by echocardiography in adults: An update from the American Society of Echocardiography and the European Association of Cardiovascular Imaging. Eur Heart J Cardiovasc Imaging 2015; 16: 233-71
[20] Kou S, Caballero L, Dulgheru R, et al. Echocardiographic reference ranges for normal cardiac chamber size: results from the NORRE study. Eur Heart J Cardiovasc Imaging 2014; 15: 680-90.
[21] Moreno J, Perez de Isla L,, et al. Right atrial indexed volume in healthy adult population: reference values for two-dimensional and three-dimensional echocardiographic measurements. Echocardiography 2013; 30: 667-71.
[22] Iyer AS, Wells JM, Vishin S, et al. CT scan-measuredpul-monary artery to aorta ratio and echocardiography for detecting pulmonary hypertension insevere COPD. Chest.2014; 145 (4): 824-832
[23] Peacock AJ, Crawley S. et al: Changes in right ventricu-lar function measured bycardiac magnetic resonace imag-ing in patients receiving pulmonary arterial hypertensiontar-geted therapy the Euro MR study. Circ Cardiovasc Imaging.2014: 7; 107-14
[24] Cuttica MJ, Shah SJ, Rosenberg SR, et al. Right heart structural changes are independently associated with exercise capacity in non-severe COPD. PLoS One.2011; 6: e29069.
[25] Lancellotti P, Moura L, Pierard LA, et al. European Associa-tion of Echocardiography European Association of Echocardiography recommendations for the assessment of valvular regurgitation. Part 2: mitral and tricuspidregurgitation (native valve disease). Eur J Echocardiogr.2010; 11 (4): 307-32
[26] Barnes PJ. Chronic obstructive pulmonary disease. N Engl J Med.2000; 343: 269-80.
[27] Gaynor SL, Maniar HS, Prasad SM, et al:. Reservoir and conduit function of right atrium: impact on right ventricular filling and cardiac output. Am J Physiol Heart Circ Physiol 2005; 288: H2140-5.
[28] Gaynor SL, Maniar HS, Bloch JB, Steendijk P, Moon MR. Right atrial and ventricular adaptation to chronic right ventricular pressure overload. Circulation.2005; 112 (9 Suppl): I212-8.
[29] Nagueh SF, Zoghbi WA. Evaluation of right ventricular diastolicfunction. In: Klein AL, Garcia MJ. Diastology. Clinical approach todiastolic heart failure. Philadelphia: Saunders, 2008: 171-80.
[30] Nageh MF, Kopelen HA, Zoghbi WA, et al. Estimation of mean right atrial pressure using tissue Doppler imaging. Am J Cardiol1999; 84: 1448-51.
[31] Cioffi G, de Simone G, et al:. Right atrial size and function in patients with pulmonary hypertension associated with disorders of respiratory system or hypoxemia. Eur J Echocardiogr.2007; 8: 322–331.
[32] Cherneva, S. Denchev et al,. RIGHT ATRIUM VOLUME INDEX IN NONSEVERE CHRONIC OBSTRUCTIVE PULMONARY DISEASE. Acta Medica Bulgarica, Vol. XLVII, 2020, No 1 // Original article
[33] Mantziari L, Kamperidis V, Ventoulis I, et al. Increased right atrial volume index predicts low Duke activity status index in patientswith chronic heart failure. Hellenic J Cardiol2013; 54 (1): 32–8.
[34] Vikram B Vikhe et al: 2D echocardiographic findings as cardiovascular complications in COPD. NATIONAL JOURNAL OF MEDICAL RESEARCH: Volume 3 | Issue 4 | Oct – Dec 2013 Page 385
[35] Himelman RB, Struve SN, Brown JK, Namnum P, Schiller NB. Improved recognition of corpulmonale in patients with severe chronic obstructive pulmonary disease. Am J Med 1988; 84: 891-8.