EVALUATION OF RIGHT VENTRICULAR FUNCTION BY ECHOCARDIOGRAPHY IN PATIENTS WITH CHRONIC OBSTRUCTIVE PULMONARY DISEASE

Thesis
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Dedication

To my Father, It was your encouragement and support that made me what I am.

To my Mother, I found guidance in your footsteps.

To my Sister, Thank you for enduring with me.

To my Fiance, Thank you for your support & patience.

List of Contents

List of Abbreviations

π : Pi - The ratio of a circle's circumference to its diameter, and is approximately equal to 3.14159.
2-D : Two Dimensional.
AC : Alveolar-Capillary.
Am : Myocardial Atrial (late) Diastolic Velocity.
AoV : Aortic Valve.
A[psa] : Left Ventricular Area from the Parasternal Short Axis (PSA) View.
ATS : American Thoracic Society.
AV : AtrioVentricular.
A Velocity : Peak Velocity of Late Filling (Diastole).
A Wave : Late (Diastolic) Filling – Atrial Contraction.
Cm/S : Centimeter per Second.
Cm^2 : Centimeter squared.
COPD : Chronic Obstructive Pulmonary Disease.
CTm : Myocardial Contraction Time.
DP/DT : Rate of Rise of Left Ventricular Pressure.
DTm : Myocardial Deceleration Time.
ECG : Electrocardiography.
Edt : Deceleration Time of Early Filling.
EF : Ejection Fraction.
Em : Myocardial Early Diastolic Velocity.
ET : Ejection time.
ERS : European Respiratory Society.
E Velocity : Peak Velocity of Early Filling (Diastole).
E wave : Rapid (Diastolic) Filling Period.
FAC : Fractional Area Change.
FEV_1 : Forced Expiratory Volume in one second.
FVC : Forced Vital Capacity.
GERD : Gastro Esophageal Reflux Disease.
GOLD : Global Initiative for Chronic Obstructive Lung Diseases.
HF : Heart Failure.

HIV : Human Immunodeficiency Virus.
HS : Highly Significant.
ICT : isovolumic contraction time.
IRT : isovolumic relaxation time.
IVS : Interventricular Septum.
Kpa : Kilopascal.
LA : Left Atrium.
LAD : Left Atrial Diameter.
LPFB : Left Posterior Fascicular Block.
LV : Left Ventricle.
LVEDD : Left Ventricular End Diastolic Diameter.
LVESD : Left Ventricular End Systolic Diameter.
LVID : Left Ventricular Internal Dimensions.
MI : Myocardial Infarction.
Mm : Millimeter.
Mm/S : Millimeter per Second.
MmHg : Millimeter of mercury.
M-Mode : Time-Motion Mode.
MPI : Myocardial Performance Index.
MVG : Myocardial Velocity Gradient.
NHIS : The National Health Interview Survey.
NICE : The National Institute for Clinical Excellence.
NS : Non Significant.
PA : Posteroanterior.
PaO_2 : Partial Pressure of Oxygen.
$PaCO_2$: Partial Pressure of Carbon Dioxide.
PAT : Pulmonary Acceleration Time.
PCTm : Myocardial Pre-Contraction Time.
PH : Pulmonary Hypertension.
PS : ParaSternal.
Pts : Patients
PV : Pulmonary Valve.
PW : Pulsed Wave.
PWT : Posterior Wall Thickness.
Q-Sa : Peak of the systolic Doppler tissue imaging wave.
RA : Right Atrium.

RBBB : Right Bundle Branch Block.
RIVCT : Regional Isovolumic Contraction.
RIVRT : Regional Isovolumic Relaxation.
ROI : Region of Interest.
RTm : Right Ventricular Myocardial Relaxation Time.
RV : Right Ventricle.
RVH : Right Ventricular Hypertrophy.
RVOT : Right Ventricular Outflow Tract.
RVSP : Right Ventricular Systolic Pressure.
Sa : Peak Systolic of Lateral TV annular velocity.
Sm : Myocardial Systolic Velocity.
SPAP : Systolic Pulmonary Arterial Pressure.
SPECT : Single Photon Emission Computed Tomography.
SPSS : Statistical Package for Social Science.
TAPSE : Tricuspid annular plane systolic excursion.
TD : Tissue Doppler.
TDI : Tissue Doppler Imaging.
TR : Tricuspid Regurgitation.
TTF : Transtricuspid flow.
TTPG : Trans-tricuspid Pressure Gradient.
TV : Tricuspid Valve.
TV A' : Late tricuspid annular diastolic velocity.
TV E' : Early tricuspid annular diastolic velocity.
TV S' : Tricuspid annular systolic velocity
USA : United States of America.
YLD_S : Years of Living with Disability.

List of Tables of Review

List of Tables of Results

List of Figures of Review - Patients and Methods

Fig. No.	Title	Page No.

List of Figures of Results

Fig. No.	Title	Page No.

Introduction:

Chronic Obstructive Pulmonary Disease (COPD) is a preventable and treatable disease with some significant extra pulmonary effects that may contribute to the severity in individual patients. Its pulmonary component is characterized by airway obstruction that is not fully reversible. The airway obstruction is usually progressive and associated with an abnormal inflammatory response of the lung to noxious particles or gases ***(Gold, 2011)***.

Right ventricular systolic function can be evaluated in terms of right ventricular fractional area change and right ventricular ejection fraction. Right ventricular dP/dt or rate of rise of right ventricular pressure can be estimated from the tricuspid regurgitation Doppler jet. While the left ventricular dP/dt is over 1200 mm Hg/second, that of the right ventricle is over 400 mm Hg/ second. Tricuspid annular plane systolic excursion (TAPSE) is another measure of right ventricular systolic function.

Fractional area change can be measured from single plane and biplane methods using the area-length or Simpson's methods. Apical four chamber and subcostal four chamber views are useful for biplane evaluation.

Right ventricular diastolic function can be evaluated from the tricuspid inflow pattern by Doppler interrogation. Hepatic venous Doppler and Doppler interrogation of right ventricular outflow tract are other methods of assessing right ventricular diastolic function.

During Doppler evaluation of right ventricle, the 5-10% increase in the measurements with inspiration has to be considered. This is applicable to pulmonary artery systolic velocity, right ventricular gradient, tricuspid regurgitation velocity and tricuspid inflow Doppler. This may lead to inability to detect small changes in status of the right ventricle.

Right ventricular global function can be assessed by myocardial performance index and by three dimensional echocardiography. Myocardial performance index (MPI) is the ratio of the time spent in isovolumetric activity divided by the time spent in ventricular ejection.

MPI = (ICT + IRT)/ET. [*ICT: isovolumic contraction time; IRT: isovolumic relaxation time; ET: ejection time*].

Longitudinal function of the right ventricle can be quantified by tissue Doppler methods. Longitudinal velocities assessed by tissue Doppler techniques are the

lateral mitral annuls velocity, septal annulus velocity and the tricuspid annulus velocity. These tracings have distinct E and A in diastole, a systolic velocity and spikes for isovolumetric contraction and relaxation. Tissue Doppler can quantify both systolic and diastolic myocardial function and is less load dependent. Early identification of right ventricle function and correlation with clinical function is feasible. Tissue Doppler technique can also assess radial function. Limitations of tissue Doppler include the angle dependence and confounding effects of cardiac tethering and translation ***(Francis J, 2011).***

To the practicing clinician this is a common presentation of chronic right ventricular dysfunction. In both chronic obstructive and parenchymal pulmonary disease right ventricular dysfunction is associated with limited peripheral oxygen delivery and exercise capacity ***(Burgess M et al., 2002).*** It has an important bearing on prognosis that is independent of other factors such as severity of airflow obstruction and probably reflects the inter-relationship between it and deranged pulmonary haemodynamics. This group of patients usually have mild to moderate pulmonary hypertension that may increase considerably during exercise or pulmonary exacerbations. The term right ventricular

dysfunction is probably a misnomer here. It is important to understand that the right ventricular hypertrophy and dilation that occurs in these patients is a beneficial adaptation allowing the ventricle to cope with an increased afterload and maintain a normal cardiac output ***(Weitzenblum E, 2002)***.

Studies have shown right ventricular contractility to be preserved or even increased in these patients and 'true' right ventricular failure only occurs during times of worsening hypoxia and hence increased afterload stress ***(Vizza CD et al., 2002).***