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Electrocardiographic & Pulmonary Function tests with Special Reference to Spirometry and DL_{co} in Obstructive & Restrictive Lung Disease

Authors
Dr Maaz Farooqui[1], Dr Anjana Pandey[2], Dr Mahendra Pratap Singh[3]
[1,3]Junior Resident, P.G. Dept. of Medicine, S.N. Medical College, Agra (INDIA)
[2]Associate Professor, P.G. Dept. of Medicine, S.N. Medical College, Agra (INDIA)
Corresponding Author
Dr Anjana Pandey
Associate Professor, P.G. Dept. of Medicine, S.N. Medical College, Agra (INDIA)
Email: *docapg@gmail.com*, +91-9410290537, (0562)2522188

Abstract
Objectives: *To study the electrographic changes & pulmonary function test changes with special reference to spirometry & DL_{co} in obstructive & restrictive lung disease.*
Material & Methods: *The present study was carried out in Post Graduate Department of Medicine, S.N. Medical College & Hospital, and Agra. The material of the study included 50 cases admitted in indoor medicine wards and those attending allergy and respiratory clinic and medicine OPD.*
In the present study we had 30 cases of Chronic Obstructive Pulmonary Diseases (COPD) and 20 cases of Restrictive Lung Disease (IPF). Informed consent was obtained at enrolment. All were subjected to Spirometry, Peak Flow Metry, DL_{co} and ECG.
Result: *The most common ECG change in COPD is rightward shift of P-axis preceded by P-pulmonale and the most common ECG finding in restrictive group is ECG changes showing P-pulmonale and right ventricular hypertrophy without change in P-axis including a positive P-wave deflection in aVL.*
All of the cases of restrictive lung disease were found to have DL_{CO} values markedly reduced while amongst COPD cases; patients having emphysema DLCO values were either normal or reduced. Rest of the COPD patients predominantly having chronic bronchitis, DL_{CO} values remains unaltered.
FEV_1/FVC % in COPD patient was ranging from less than 40 to 79 per cent whereas it was unaltered in restrictive group, FVC is markedly reduced in restrictive group had a range.
Conclusion: *obstructive & restrictive lung disease can be differentiated on the basis of ECG changes, PFT (spirometry, DL_{co}).*
Keywords: *COPD, morbidity, GOLD, PFT, corpulmonale, spirometry, vital capacity, flow-volume curves, DL_{co} test.*

Introduction

Chronic obstructive pulmonary disease (COPD) is defined as a disease state characterized by airway limitation that is not fully reversible. COPD includes *EMPHYSEMA*, an anatomically defined condition characterized by destruction and enlargement of lung alveoli; *CHRONIC BRONCHITIS*, a clinically defined condition with

chronic cough and phlegm; and *SMALL AIRWAY DISEASE*, a condition in which small bronchioles are narrowed. COPD is present only if chronic airway obstruction occurs; chronic bronchitis *without* chronic airway obstruction is not included within COPD. COPD is the *fourth* leading cause of death. Estimates suggest that COPD will rise from sixth to third most common cause of death worldwide by 2020 [1]. Obstructive and restrictive lung disease are difficult to differentiate merely on the basis of clinical observations, ECGs, spirometry along with DL_{co} has been used for the diagnosis of these two types of COPD as well as for follow up. Yet, COPD remains relatively unknown or ignored by the public as well as public health and government officials. In 1998, in an effort to bring more attention to COPD, its management, and its prevention, a committed group of scientists encouraged the U.S. National Heart, Lung, and Blood Institute and the World Health Organization to form the Global Initiative for Chronic Obstructive Lung Disease (GOLD). Among the important objectives of GOLD are to increase awareness of COPD and to help the millions of people who suffer from this disease and die prematurely of it or its complications. The first step in the GOLD program was to prepare a consensus report, Global Strategy for the Diagnosis, Management, and Prevention of COPD, published in 2018.

Guidelines from the global initiative for COLD (GOLD) states that the airway limitation in COPD is characterized by a FEV_1 value that less than 80% of the predicted normal value & a FEV_1:FVC ratio of less than 0.70

In GOLD, COPD classifications are then used to describe the severity of the obstruction or airflow limitation. *The worse a person's airflow limitation is, the lower their FEV_1. As COPD progresses, FEV_1 tends to decline*.

Pulmonary function tests (PFT) provide objective & quantifiable measures of lung function. They are used to evaluate & monitor disease that affects lung function. Spirometric examination is the most widely used such test. It should be more widely used in routine examinations. Chronic obstructive pulmonary disease is easily detected in its preclinical phase, using spirometry. Spirometry measures the ratio of the forced expiratory volume in the first second to the forced vital capacity (FEV_1/FVC), which is the most sensitive and specific test for detecting airflow limitation.

The primary physiological abnormality in COPD is an accelerated decline in *forced expiratory volume in one second (FEV1).* Predicted normal standards must apply to the particular spirometer. Recommended tests are those of vital capacity (VC), forced vital capacity (FVC), one-second forced expiratory volume (FEV_1), the ratio of one-second forced expiratory flow (FEF200-1200) and forced mid expiratory flow ($FEF_{25-75\%}$). The maximum voluntary ventilation (MVV) test may be useful for evaluation of work disability and detection of extrathoracic obstruction. Additional consideration may be given to measurements of total lung capacity (TLC) to discriminate between restrictive and obstructive impairment. At this time, flow-volume curves measurement cannot be justified for routine clinical use.[2]

The DL_{co} test is convenient and easy for the patient to perform. The ten seconds of breath holding required for the DL_{co} maneuver is easier for most patients to perform than is the forced exhalation required for spirometry.

Material & Methods

The present study was carried out in Post Graduate Department of Medicine, S.N. Medical College & Hospital, and Agra. The material of the study included 50 cases admitted in indoor medicine wards and those attending allergy and respiratory clinic and medicine OPD.

In the present study we had 30 cases of Chronic Obstructive Pulmonary Diseases (COPD) and 20 cases of Restrictive Lung Disease (IPF). Informed consent was obtained at enrolment. All were subjected to Spirometry, Peak Flow Metry, DL_{co} and ECG

Result

Pulmonary function test was done in all the cases and forced expiratory volume in one second (FEV_1), forced expiratory volume (FVC) was measured and FEV_1/FVC was calculated. It was noted in all the COPD patients FEV_1/FVC ratio was less than 80 %. The maximum number of patients (43.33 %) had FEV_1/FVC in the range of 51 to 60 % followed by 30 % patients who had the value in the range of 41.50 %.

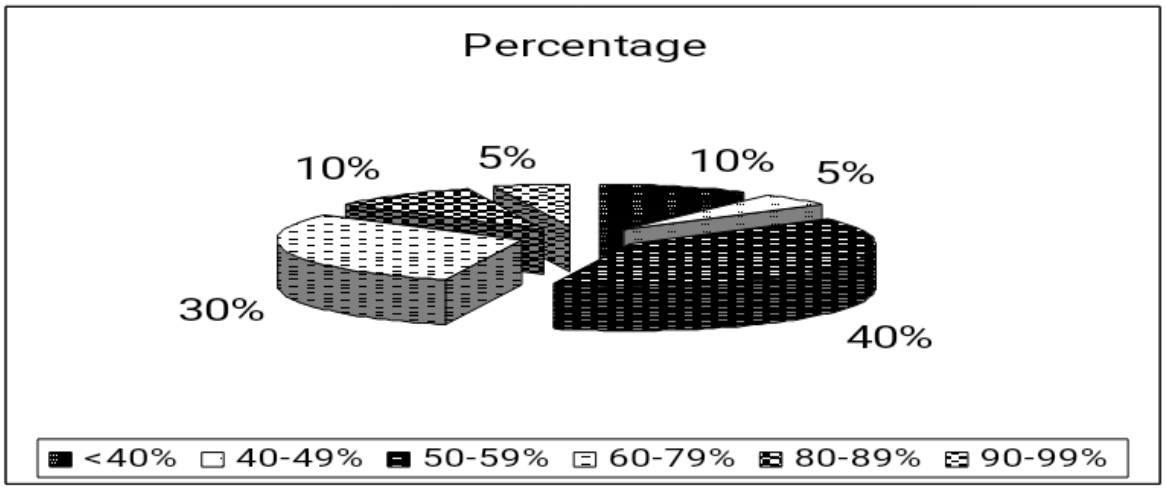

Fig 1 Degree of reduction of FVC in restrictive lung disease

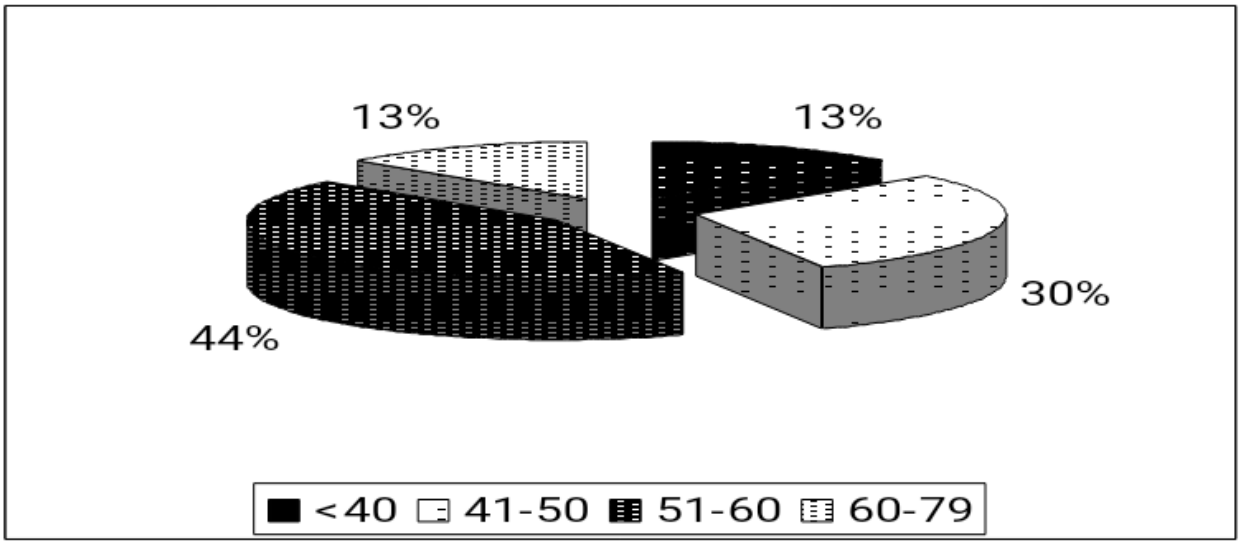

Fig 2 Degree of FEV_1/FVC in COPD patient

Electrocardiographic abnormalities: A-12 lead electrocardiogram was performed in all the COPD patients and was recorded in proforma.

Rate: The mean heart rate of 30 patients of COPD was 81 per minute.

P-wave axis: In the present study group of COPD patients, 86.66 % had P-axis of 60° or more. In this study only one patient had P-wave axis more than 90° indicating that in patients of COPD, right axis deviation of mean P-axis is rarely found.

In this study 40.42 % of COPD had P-wave amplitude 2.5 or more (normal being less than 2.5 mm). Gothic P-wave (P-peaked but less than 2.5 mm) was found in 20 % cases which has got no relation with the lung functions.

Inversion of P-wave in aVL was present in 80 % of COPD patients which is comparable to report by Caird and Wilcken. Inversion of P-wave in aVL is due to hyperinflation of lungs.

Amplitude: QRS amplitude in frontal plane (RV_1) shows downward trend in patients having

FEV_1/FVC less than 40 %. R/S V_6 was significantly lowered when lung function was worse. Also $SV_1 + RV_6$ were decreased to -10 mm in 20 % cases of COPD in whom lung function was severely impaired.

This study confirms the importance of P-wave amplitude and axis in COPD and shows that rightward shift of P-axis more than 60° is the most common P-wave changes in COPD, The more severe the lung disease (FEV_1/FVC less than 45 %) higher the incidence of rightward shift of P-axis (100 %).

The P-pulmonale (amplitude 2.5 or more) was found in 40.42 % of patients). Peaked P-wave was seen in 20 % cases. Thus abnormal contour was found in 60.42 % as compared to P-axis in 86.66 % of patients.

Thus it is apparent that rightward P-axis is the most important finding.

Restrictive Group

Idiopathic pulmonary fibrosis is commonly occurring interstitial disease of unknown etiology affecting male and female equally between age group of 40-70 years.

P-wave - The distribution of the P-wave axisand the direction of P-wave in aVL is entirely in agreement with the findings in normal subject[3]. In this study majority of the patients (85 %) have P-axis 60° or less (within normal limit). 15% patients have exceeded this value to 70°. No patient has P-axis more than 70°. This is in striking contrast to the findings, as it is the chronic obstructive lung disease where a P-wave axis of 60° or more is found in 86.66

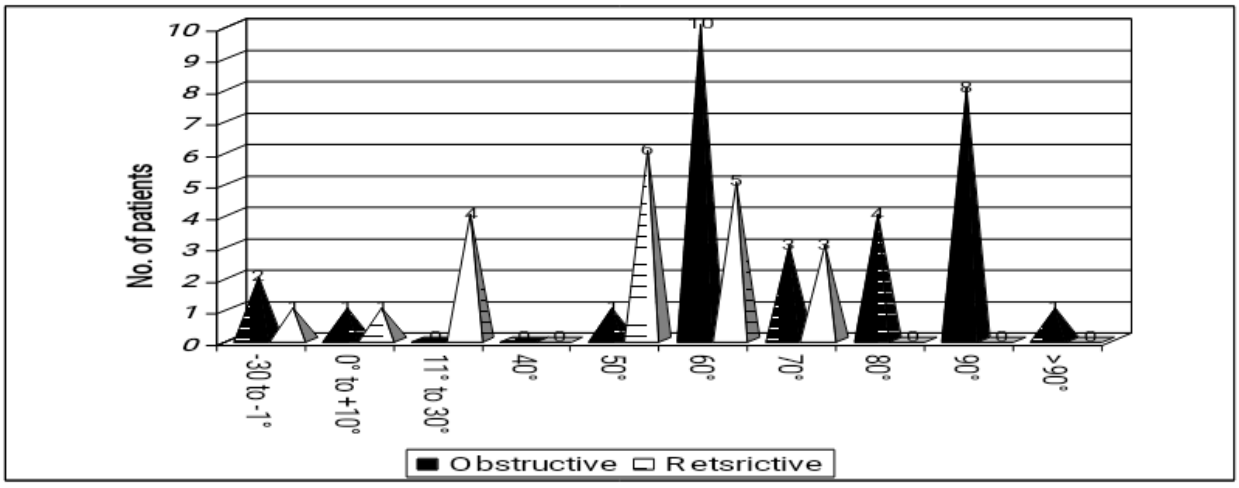

Fig 3 P-wave axis in frontal plane

There are two types of P-wave pattern chronic lung diseases. In generalized lung disease P-wave axis shifted to right. In diffuse interstitial lung diseases it does not. A negative P-wave in aVL is found in 10 % of the cases of IPF, 70 % has positive P-wave deflection and 20 % has isoelectric P-wave whereas in COPD majority (80 %) of the patients have negative P-wave in aVL, only 10 % have positive and 10 % have isoelectric P-wave. This inversion of P-wave in aVL in COPD patient is a sign of hyperinflation.[4,5,6]

There is no significant correlation between P-axis and pulmonary function test as P-wave axis remains normal in majority of the patients of chronic diffuse interstitial lung diseases.

P-wave amplitude: Only 5 patients showed P-pulmonale (P-wave amplitude 2.5mm or more). Majority of patient 15 out of 20 has P-wave amplitude less than 2.5 mm. All the cases P-pulmonale had P-wave axis less than 70°.

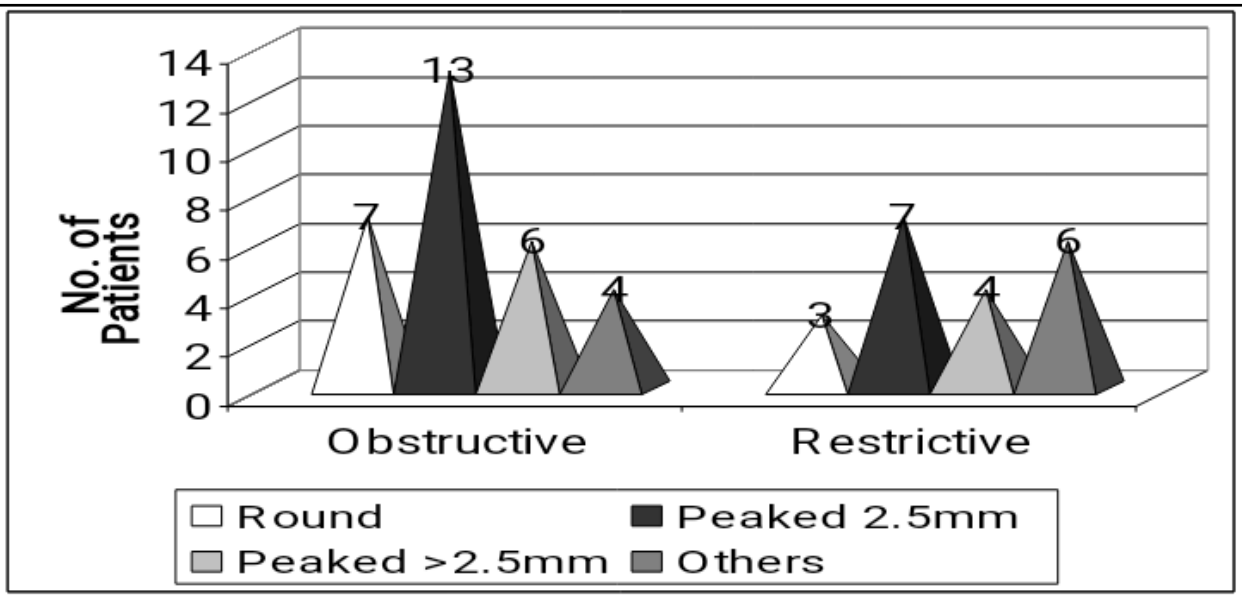

Fig 4 P-wave contour in frontal plane

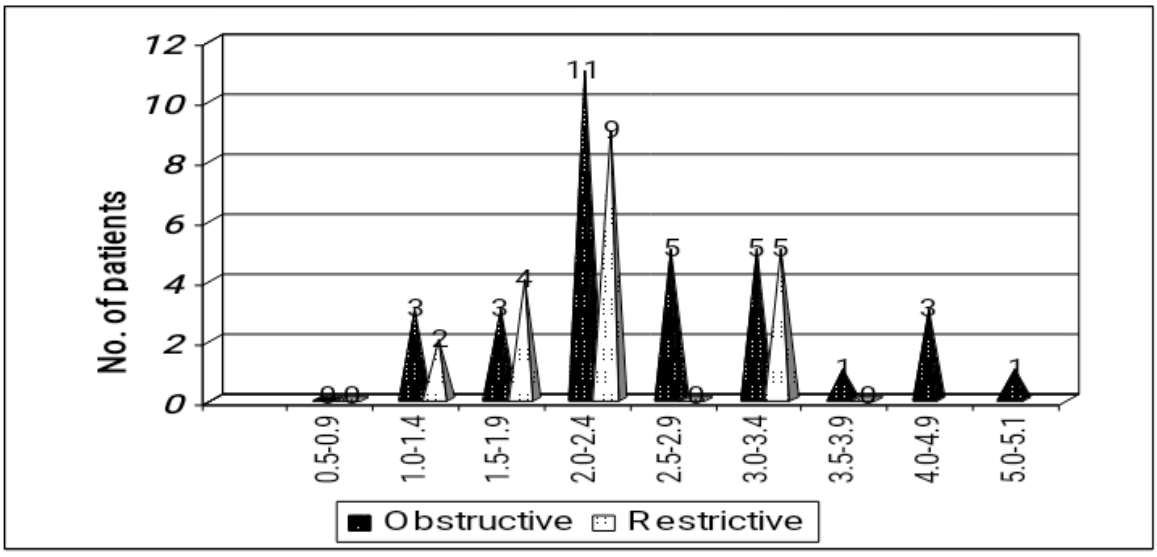

Fig 5 P-wave amplitude in mm

Right ventricular hypertrophy - Electrocardiographic evidence of RVH was found in 3 cases (two Grades I + one Grade IV RVH). All three cases of RVH also had P-pulmonale. 3 cases had incomplete RBBB. Relation to Pulmonary Function: In this study incidence of P-pulmonale and electrocardiographic evidence of right ventricular hypertrophy is more closely related to the vital capacity than reduction in $FEV_{1.}$

Thus important electrocardiographic changes in the restrictive lung disease in this study is development of P-pulmonale and RVH without deviation of mean P-wave axis which is in contrast to the findings in COPD patients who often have P-wave axis + 80° or more.

A positive deflection of P-wave in aVL in majority of the patient, negative deflection found in COPD, which indicate hyperinflation.

DL_{CO}: In the present study all of the cases of restrictive lung disease (20) were found to have reduced DL_{CO} ranging between 10-20 ml/min/mm of Hg as compared to obstructive group, but in obstructive group of patients 53.33% were found to have reduced $DL_{CO.}$ Most of these were suffering from emphysema.

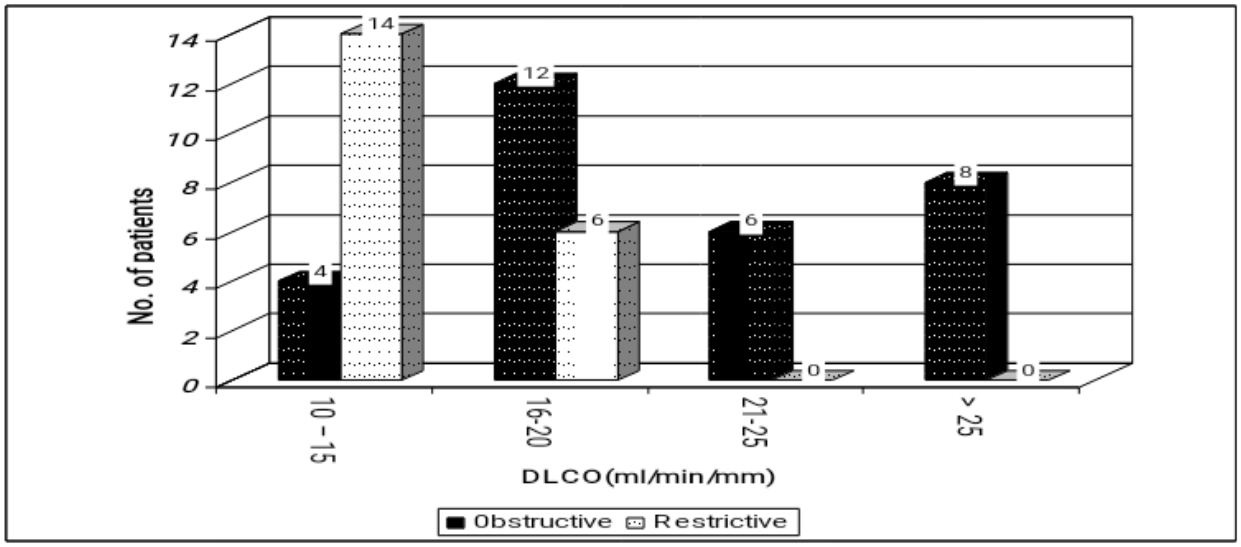

Fig 6 Comparison of DL_{co} of obstructive & restrictive lung disease

Discussion

Chronic Obstructive Pulmonary Disease (COPD) ranks second to Coronary Heart Disease (CHD) among people over 40 years of age specially those who have been chronic and heavy smoker. The incidence of this disease was highest in the age group of 40-60 years. The incidence was higher in males (80 %) as compared to females (20 %) and the male: female ratio was 4:1. The patients of the COPD have permanent disability in the form of breathlessness or cough with expectoration. With exacerbation of symptoms, most commonly in winter, COPD lose their respiratory reserve and later go into decompensation of heart (Corpulmonale). [7]

The two major patterns of abnormal ventilator function, as measured by static lung volumes &spirometry, are restrictive & obstructive pattern. In obstructive pattern, the hallmark is a decrease in expiratory flow rates. With fully established disease, the ratio FEV_1/VC is decreased, as is the $FEF_{25-75\%}$. With early obstructive disease, which originates in small airways, FEV_1/VC may be normal; the only abnormalities noted on routine testing of pulmonary function may be a depression in $FEF_{25-75\%}$ & an abnormal, i.e, covered, configuration in the terminal portion of the forced expiratory flow-volume curve.

In obstructive disease, the TLC is normal or increased. Residual volume is elevated as a result of airway closure during expiration & the ratio RV/TLC is increased. VC is frequently decreased in obstructive disease because of striking elevation in RV with only minor changes in TLC.

The hallmark of restrictive pattern is a disease in lung volumes, primarily TLC & VC. Disorders resulting in a restrictive pattern can be broadly divided into two subgroups, depending on the location of the pathology: pulmonary parenchymal & Extraparenchymal. In pulmonary parenchymal disease, RV is also generally decreased & FEF rates are preserved. In fact, when FEV_1 is considered as a percentage of FVC, the flow rates are often supranormal. i.e, disproportionately high relative to the size of lungs.

With Extraparenchymal disease, dysfunction can be due to neuromuscular disease with associated respiratory muscle weakness or to disorders of chest wall or pleura. In Extraparenchymal disease, TLC is decreased due to inspiratory muscle weakness, a stiff chest wall, or a space occupying process within the pleura. If the inspiratory muscle weakness is the cause of this pattern, then RV is often not significantly affected, expiratory flow rates are preserved & MIP is decreased. Alternatively if restrictive pattern is due to deformed chest wall that is abnormally rigid at volumes below FRC, the ability to expire to a normal is also limited. Consequently, RV is often

elevated, unlike the pattern observed in the other restrictive subcategories.

Diffusion capacity

Measurement of DL_{co} may be useful for assessing disease affecting the alveolar-capillary bed or the pulmonary vasculature. In practice three main categories of disease are associated with lowered DL_{co}: interstitial lung disease, emphysema & pulmonary vascular disease. With interstitial lung disease, scarring of alveolar-capillary units diminish the area of alveolar-capillary bed as well as pulmonary blood volume. With emphysema, alveolar walls are destroyed, so the surface area of the alveolar-capillary bed is again diminished.[8]

The ECG in Chronic Obstructive Pulmonary Disease: A 12-lead electrocardiogram was performed in all the COPD patients.

The most typical ECG findings in emphysema are:

- Rightward shift of the P wave axis with prominent P waves in the inferior leads and flattened or inverted P waves in leads I and Avl[10].
- Rightward shift of the QRS axis towards +90 degrees(vertical axis) or beyond (right axis deviation)[11].
- Exaggerated atrial depolarization causing PR and ST segments that "sag" below the TP baseline.
- Low voltage QRS complexes, especially in the left precordial leads (V4-6)[11].
- Clockwise rotation of the heart with delayed R/S transition point in the precordial leads +/- persistent S wave in V6. There may be complete absence of R waves in leads V1-3 (the "SV1-SV2-SV3″ pattern).

With development of corpulmonale, the following additional changes are seen:

- Right atrial enlargement (P pulmonale)[11]
- Right ventricular hypertrophy

Other ECG changes that may be seen include:

- Right bundle branch block (usually due to RVH)
- Multifocal atrial tachycardia – a rapid, irregular atrial tachycardia with at least 3 distinct P wave morphologies (associated with increased mortality in patients with COPD).(9)

Conclusion

This study has demonstrated that Obstructive & restrictive lung diseases can be differentiated on the basis of ECGs, Spirometry & DL_{co}.

References

1. John J. Reilly, Jr., Edwin K. Silverman, Steven D. Shapiro Chronic Obstructive Pulmonary Disease Harrison principle of internal medicine 19th edition chapter 314 page 1700
2. Gentry SE, Hodge RH, Kaiser D, Walker FB IV, Suratt PM. Pulmonary function testing in a general medical practice. J Community Health 1983; 8:263-268
3. Caird FT, Wilcken DEL: The electrocardiogram in chronic bronchitis with generalized obstructive lung disease. Am. J. Cardiol. 1962; 10,
4. Burch, GE, and DepasqualeNPj The electrocardiographic diagnosis of pulmonary heart disease. Am. Jr. Cardiol, 1963 11:622-628
5. Calatayud JB, Abad JM, Khoi NB et. al. P-wave changes in chronic obstructive pulmonary disease. Am .Heart J. 1970; 444.
6. Chappell AG: The electrocardiogram in chronic bronchitis emphysema. Brit Heart J, 1966; 28, 517
7. Gularia JS, Pande IN and Gupta RG, COPD in Northern India. Aa. Rev. Respir. Dis., 1969; 100,490.
8. Krogh and Krogh, Skand. Arch. Physiol. 23, 236–247, 1909.
9. Gross D; The correlations between vital capacity and the P-waves of electrocardiogram. Acta. Med. Acand, 1956, 156, 97

10. C.Narasimhan, Johnson Francis, Colin Schamroth, eight adapted edition Leo Schamroth An introduction to electrocardiography chapter 20 page 156
11. C.Narasimhan, Johnson Francis, Colin Schamroth, eight adapted edition Leo Schamroth An introduction to electrocardiography chapter 20 page 157