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Electrocardiographic Changes in Chronic Obstructive Pulmonary Disease – Correlation with Air Flow Limitation

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Abstract:
Background: *Chronic obstructive pulmonary disease is a major cause of morbidity and mortality in India. Present study was undertaken to correlate ECG changes with spirometric parameters in patients with COPD.*
Methodology: *Fifty patients of COPD fulfilling the inclusion criteria coming to OPD/Wards of MGUMST, Jaipur were recruited. They were subjected to detailed history (as per the performa), clinical and diagnostic examination. Data analysis was done using SPSS software.*
Results: *The most common ECG changes were P wave axis > +90°, QRS axis> +90°, P wave height > 2.5 mm in lead II and R wave in V6 < 5 mm. There was significant negative correlation between FEV1, FEV1/FVC ratio and ECG changes.*
Conclusion: *In chronic obstructive pulmonary disease, ECG changes significantly correlated with low values of FEV_1/FVC ratio. It can be inferred that ECG is a useful bedside test to assess the severity of COPD when spirometry is not available.*
Keywords: *chronic obstructive pulmonary disease, electrocardiography*

I. Introduction

Chronic obstructive pulmonary disease is a common and preventable disease, which has great implications on global health. It is a major cause of morbidity and mortality in India, especially in rural areas (1). It is the fourth leading cause of death world over, exceeded only by myocardial infarction, malignancy and stroke (2).

There have been several studies to define the course of events in COPD (3). The major morbidity of COPD is due to the impact on cardiac performance, which is directly due to pulmonary arterial hypertension ultimately leading to cor pulmonale. Chronic cor pulmonale is usually the end result of long standing pulmonary disease, which results from pulmonary hypertension and subsequently right ventricular hypertrophy and failure (4).

The importance of chronic cor pulmonale as a cause of congestive cardiac failure is being recognized in recent years. Therefore, the recognition of chronic cor pulmonale is of great importance to all medical practitioners.

Cor pulmonale is an important cause of mortality in patients with COPD (5). Since the electrocardiogram is a very simple and convenient bedside investigation, it would be of great importance, if it can be established that a high degree of correlation between ECG and spirometric studies is present which indicate the severity of COPD.

In this dissertation an effort is made to establish correlation of various ECG changes with spirometric parameters in patients with COPD (6).

II. Material And Methods

In the present study 50 cases were selected on the basis of simple random sampling method from the Medical Wards/OPD, Mahatma Gandhi Medical College and Hospital, Jaipur.

Inclusion criteria

The patients who were admitted in the medical wards with symptoms suggestive of airway obstruction of more the 2 years duration and in whom clinical diagnosis of chronic obstructive pulmonary disease was made. All these patients were subjected to spirometric test; the patients with forced expiratory volume in first

second (FEV_1) of less than 80% of the expected value, which does not alter significantly after bronchodilator inhalation (<200ml) were included in the study.

Exclusion criteria

- Bronchial asthma,
- Pulmonary tuberculosis,
- Bronchiectasis,
- Known congenital or acquired heart diseases,
- Diabetes mellitus and Hypertension.

After applying above inclusion and exclusion criteria, the 50 patients were selected on the basis of simple random sampling method, and detailed history and thorough clinical examination was done as indicated in the performa. The patients were subjected to radiological examination, spirometry and electrocardiography. ECG was analysed in detail for P wave axis ≥ +90°, QRS axis ≥+90°, P wave height ≥2.5 mm in lead II, R wave in V6 ≤ 5 mm, R/S ratio in V5V6 ≤ 1, RBBB, R wave V1 > 7 mm and ventricular ectopics.

III. Results

Table 1: ECG Changes in COPD patients

ECG changes	Criteria	Number (n=50)	%
P wave axis	**$<90^0$**	**18**	**36**
	$\geq+90^0$	**32**	**64**
QRS axis	**$<90^0$**	**30**	**60**
	$\geq+90^0$	**20**	**40**
P wave height in mm	**< 2.5**	**31**	**62**
	≥2.5	**19**	**38**
R wave height in V_6 in mm	**>5**	**36**	**72**
	≤5.0	**14**	**28**
R/S ratio in V_5/V_6	**>1.0**	**37**	**74**
	<1.0	**13**	**26**
RBBB	**Absent**	**48**	**96**
	Present	**2**	**4**
R V_1 height in mm	**< 7**	**49**	**98**
	> 7	**1**	**2**

In the present study, the most frequent ECG changes observed was P wave axis ≥+90° (64%), QRS axis > +90° (40%), P wave height ≥ 2.5 mm in lead II (38%), R wave in V6 ≤ 5 mm (28%) and R/S ratio in V5V6 ≤ 1 (26%). Few patients had R wave in V1 > 7 mm (2%), RBBB (4%).

Table 2: Comparison of ECG changes with mean values of FEV1

ECG Changes	Criteria	Number (n-50)	FEV_1 (Mean±SD)	P value
P wave axis	$<90^0$	18	1.32±0.35	0.003
	$\geq+90^0$	32	1.04±0.28	
QRS axis	$<90^0$	30	1.28±0.33	<0.001
	$\geq+90^0$	20	0.94±0.24	
P wave height in mm in lead II	<2.5	31	1.32±0.30	<0.001
	≥2.5	19	0.87±0.17	
R V_6 height in mm	>5.0	36	1.25±0.34	0.001
	<5.0	14	0.89±0.17	
R/S ratio in V_5 V_6	>1.0	37	1.22±0.35	0.014
	<1.0	13	0.95±0.20	
RBBB	Absent	48	1.16±0.34	0.228
	Present	2	0.86±0.00	
R V_1 height in mm	<7	49	1.15±0.34	0.777
	>7	1	1.05	

In the present study observed that COPD patients with positive ECG changes such as P wave axis > +90°, QRS axis > +90°, P wave height in lead II > 2.5 mm, and R wave in V6 < 5 mm had significant reduction in mean FEV1 values, which was statistically significant. However R/S ratio in V5/V6 < 1, R wave in V1 > 7 mm and RBBB in whom p value was >0.05, thus statistically not significant.

Table 3: Correlation of ECG changes with Spirometry severity grade.

ECG Changes	Criteria	Number (n=50)	Spirometry –Severity grade			P value
			Grade I	Grade II	Grade III	
P wave axis	$<90^0$	18	12(66.7%)	6(33.3%)	0(0%)	0.001
	$\geq+90^0$	32	3(9.4%)	16(50.0%)	13(40.6%)	
QRS axis	$<90^0$	30	15(50.0%)	12(40.0%)	3(10.0%)	<0.001
	$\geq+90^0$	20	0(0%)	10(50.0%)	10(50.0%)	
P wave height in mm in lead II	<2.5	31	15(48.4%)	15(48.4%)	1(3.2%)	<0.001
	≥2.5	19	0(0%)	7(36.8%)	12(63.2%)	
R V_6 height in mm	>5.0	36	15(41.7%)	17(47.2%)	4(11.1%)	<0.001
	<5.0	14	0(0%)	5(35.7%)	9(64.3%)	
R/S ratio in V_5 V_6	>1.0	37	14(37.8%)	16(43.2%)	7(18.9%)	0.045
	<1.0	13	1(7.7%)	8(61.5%)	6(46.2%	
RBBB	Absent	48	15(31.3%)	21(43.8%)	12(25%)	0.731
	Present	2	0(0%)	1(50.0%)	1(50.0%)	
R V_1 height in mm	<7	49	15(30.6%)	22(44.9%)	12(24.5%)	0.260
	>7	1	0(0%)	0(0%)	1(100.0%)	

In the present study it was observed that the most frequent ECG changes were P wave axis$\geq + 90^0$, QRS axis $\geq + 90^0$, P wave height $\geq$ 2.5 mm in lead II, R wave in V6 <5mm seen in grade II and III severity, which is statistically significant. However R/S ratio V5/V6 $\leq$ 1, RBBB and R wave V1 > 7 mm were seen less commonly and thus were statistically not significant.

Table 4: Correlation of ECG change with FEV1/FVC ratio.

ECG Changes	Criteria	Number (n=50)	FEV1/FVC (%)					P value
			21-30 (n=3)	31-40 (n=6)	41-50 (n=8)	51-60 (n=12)	61-70 (n=21)	
P wave axis	$<90^0$	18	0(0%)	0(0%)	1(12%)	3(25%)	14(67%)	0.001**
	$\geq+90^0$	32	3(100%)	6(100%)	7(88%)	9(75%)	7(33%)	
QRS axis	$<90^0$	30	0(0%)	1(17%)	3(37%)	8(73%)	18(85%)	0.001**
	$\geq+90^0$	20	3(100%)	5(83%)	5(63%)	4(27%)	3(15%)	
P wave height in mm	<2.5	31	0(0%)	0(0%)	3(37%)	11(92%)	17(81%)	<0.001**
	≥2.5	19	3(100%)	6(100%)	5(63%)	1(8%)	4(19%)	
R V_6 height in mm	>5.0	36	1(33%)	2(33%)	6(75%)	10(87%)	17(81%)	0.081+
	<5.0	14	2(67%)	4(67%)	2(25%)	2(13%)	4(19%)	
R/S ratio in V_5 V_6	>1.0	37	2(67%)	2(33%)	6(75%)	9(75%)	18(86%)	0.135
	<1.0	13	1(33%)	4(67%)	2(25%)	3(25%)	3(14%)	
RBBB	Absent	48	3(100%)	6(100%)	6(75%)	12(100%)	21(100%)	0.072+
	Present	2	0(0%)	0(0%)	2(25%)	0(0%)	0(0%)	
R V_1 height in mm	<7	49	3(100%)	5(83%)	8(100%)	12(100%)	21(100%)	0.180
	>7	1	0(0%)	1(17%)	0(0%)	0(0%)	0(0%)	

The more ECG changes were present in COPD patients with low FEV1/ FVC% values. ECG changes were almost not seen among COPD patients with high FEV1/FVC% values. This is because the reduction of FEV1/FVC was probably associated with increased residual volume (air trapping).

IV. Discussion

COPD is a disease of late adulthood. As the age advances the lung function (FEV_1) declines and other risk factors add to the disease process.In the present and V.K. Singh study groups, P wave axis > +90° is a common ECG abnormality, Next common ECG changes were QRS axis > +90°, P wave > 2.5 mm in lead II and R wave in V6 < 5 mm (7). Both the study groups showed equal percentage of R/S ratio in V5/V6 < 1, is the common ECG abnormality. In the present study 4% of patients showed RBBB and 2% of patients showed R wave in V1 > 7 mm, which was not noticed in V.K. Singh study group. This may be because, in the present study, the mean age of patients was high when compared to V.K. Singh group.

Table 5: Comparison of ECG changes in COPD patients.

ECG changes	V.K. Singh[63] et al 1989 (N=130)	Present study (N=50)
P wave axis > +90°	56.9%	64%
QRSaxis >+90°	49.23%	40%
P wave height > 2.5 mm in lead II	21.5%	38%
R wave in V6 < 5 mm	36.9%	28%
R/S ratio in V5V6 < 1	26.16%	26%
R wave in V1 > 7 mm	-	2%
RBBB	-	4%

Table 6: Correlation of FEV1/ FVC ratio with ECG changes. A comparison of study with Dr. VK Singh et al

FEV_1/FVC	10-20	21-30	31-40	41-50	51-60	61-70	71-80
P wave axis > +90°	□ 100%	100%	72.2%	73.1%	40.5%	61.9%	26.7%
	◙ 0%	100%	100%	88%	75%	33%	0%
QRS axis >+90°	□ 100%	100%	66.7%	73.1%	31.0%	42.2%	26.7%
	◙ 0%	100%	83%	63%	27%	15%	0%
P wave height > 2.5 mm	□ 100%	100%	27.8%	26.9%	11.9%	23.8%	6.7%
	◙ 0%	100%	100%	63%	8%	19%	0%
R wave in V6 < 5 mm	□ 100%	83.3%	50%	69.2%	26.9%	9.5%	20%
	◙ 0%	67%	67%	25%	13%	19%	0%
R/S ratio in V5V6 < 1	□ 100%	81.3%	27.8%	42.3%	19%	9.5%	6.7%
	◙ 0%	33%	67%	25%	25%	14%	0%
R wave in V1 > 7 mm	□ 0%	0%	72.2%	0%	0%	0%	0%
	◙ 0%	0%	17%	0%	0%	0%	0%
RBBB	□ 0%	0%	0%	0%	0%	0%	0%
	◙ 0%	0%	0%	25%	0%	0%	0%

□ Dr. VK Singh[63] et al
◙ Present Study

These observations suggest significant negative correlation between the FEV1/FVC values and the incidence of various electrocardiographic features. The present study showed fairly good correlation between the findings of V.K. Singh et al. study group (8).

As the severity of airflow obstruction increases ECG changes were seen in majority of the patients. As already discussed, hypoxia is one of the major factor in bringing about ECG changes in COPD. Hypoxia in COPD is directly proportional to severity of airway obstruction. In the present study there is significant negative correlation between ECG changes and spirometric assay of FEV1/FVC ratio.

V. Conclusion

Computerized spirometry is a very useful investigation in the diagnosis of chronic obstructive pulmonary disease. Forced expiratory volume in the first second (FEV1) is an important parameter to diagnose as well as to assess the severity of the disease.

The most common ECG findings in COPD were P wave axis > +90°, QRS axis> +90° and P wave height > 2.5 mm in lead II. ECG changes significantly correlated with low values of FEV1/FVC ratio. It can be inferred that ECG is a useful bedside test to assess the severity of COPD when spirometry is not available.

In view of the very significant negative correlation of FEV1/FVC% with the increasing incidence of electrocardiographic abnormalities, a more aggressive approach to treat the COPD patients can be taken so that the onset of corpulmonale would be delayed as long as possible.

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