Research Paper Medical Science

Correlation of Q T and P Wave Dispersion to Ventilatory Functions in COPD Patients

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ABSTRACT

Introduction: Chronic obstructive pulmonary disease (COPD) is the fourth leading cause of death, affects more than 2.7 million people in India. Patients with COPD also carry an increased risk of mortality due to tachyarrhythmia and sudden cardiac death due to prolonged QT and P wave dispersion.

Method: 50 diagnosed COPD patients of chronic bronchitis and emphysema was compared with 50 healthy control. ECG was recorded using Clarity Med ECG 50-1 CH. and pulmonary function tests were performed with 702 Helios Spirometer (RMS, India). ECG parameters and pulmonary function tests were compared by using unpaired 't' test. Correlation was done by Pearson's co-relation coefficient and p value was calculated.

Observations and Results: QT & P wave dispersion is found to be prolonged in COPD patients compared to healthy control group and there was negative correlation of QT and P wave dispersion with various spirometric parameters.

Conclusion: Prolonged QT dispersion in COPD patients is associated with generation of life threatening rhythm disturbances and sudden cardiac death. There is Intriguing relationship between the QT dispersion and functional respiratory parameters.

KEYWORDS | QT dispersion, P wave dispersion, chronic obstructive pulmonary disease.

INTRODUCTION

Chronic Obstructive Pulmonary Disease (COPD) is highly prevalent disease affecting lungs as well as cardiovascular system. COPD refers to a spectrum of disease characterized by cough, sputum production, dyspnoea, air flow limitation and impaired gas exchange. Smoking, exposure to biomass smoke, indoor & outdoor pollution, occupational exposure to dust & gases are the common causes of COPD. (1)

The lung health study showed that substantial proportion of deaths in patients with mild COPD was the result of the cardiovascular complications.(2) The spectrum of cardiovascular diseases in COPD includes pulmonary hypertension and cor pulmonalae i.e. Right ventricular hypertrophy, P pulmonalae, Right axis deviation and Right bundle branch block.(3) Patients with COPD also carry an increased risk of mortality due to tachyarrhythmia & sudden cardiac death compare with those who do not.(4) However COPD patients are not usually assessed by ECG in routine medical practice particularly in developing countries like India. Various electrocardiographic changes have been described in patients with COPD.

QT dispersion (QTd) & P wave dispersion (Pd) calculated from 12 lead ECG have been proposed as non invasive predictors of cardiac arrhythmias & atria fibrillation that occurs in patients with COPD respectively.(5)

Pathogenesis of tachyarrhythmia in COPD patients is multifactorial and includes a number of risk factors such as hypoxemia, acidosis & reduced FEV1.(5)

Present study was conducted to evaluate ECG derived indices like QT interval, QT dispersion, P wave dispersion in COPD patients and also to correlate these ECG parameters with spirometric parameters like FEV1, FEV1/FVC, FEF(25-75).

MATERIAL AND METHOD

Present study was conducted in outpatient department of Sasoon general Hospital, Pune. Written informed consent of subjects and Ethical committee approval was taken.

Study design: cross sectional comparative study.

Study type: comparative and correlative.

Study group : Fifty diagnosed COPD patients (both male and female) 35-70 yrs, of chronic bronchitis and emphysema were selected. Diagnosis is done according to GOLD criteria (FEV_1 < 80% & FEV_1/FVC< 70%) after taking bronchodilator therapy.

Control group: 50 healthy control of same age and sex.

Exclusion criteria : Diabetes,Hypertension, LVH, IHD, Obesity (BMI < 24.9 kg/m²).

Data collection : Vital parameters like Pulse rate , Blood Pressure was recorded in supine position. BMI was calculated by using formula.

BMI = Weight in Kg / (Height in meters).

ECG was recorded using **Clarity Med ECG 50-1 CH**. Participants were instructed not to smoke or consume alcohol, tea, coffee or to engage in strenuous physical activity 12 hours prior to ECG recording. 12 lead ECG was taken after 10 minutes of rest in supine position at the same time of the day (10 a.m.-1p.m.)

Following ECG derived indices were measured.

(1) **QT interval (QT)** :- Time interval between beginning of Q wave to the end of T wave i.e reaching to baseline in all 12 leads, measured manually and average of 3 readings was taken.(6)

(2) **Corrected QT interval (QTc)** (7): calculated manually by **Bazett's Formula : QTc =QT/ $\sqrt{}$ RR**. QTc represents the QT interval corrected for heart rate.

RR is calculated from the onset of one QRS complex to the onset of next QRS complex.

(3) **QT dispersion (QTd)** (8) QT dispersion was calculated from the difference between maximum & minimum QT interval.

(4) **P wave duration** : The beginning of the P wave was defined as the point where the initial deflection of the P wave crossed the isoelectric line and the end of the P wave was defined as the point where the final deflection of the P wave crossed the isoelectric line. [9]
(5) **P wave dispersion** : P wave dispersion was defined as the difference between maximum and minimum P wave duration.[9]

SPIROMETRY: The pulmonary function parameters were measured using a computerized portable **RMS Helios 702 (Chandigarh) spirometer.** This spirometer is automated and has a flow sensor which converts the airflow signals to digital signals. Values obtained were in litres and they were compared with the existing data base for the normal healthy Indian population depending on age, sex, height and weight. The tests were conducted according to the American Thoracic Society[10] European Respiratory Society (ATS/ERS) task force guidelines.

Procedure-- The pulmonary functions were recorded in the sitting position Name, age, sex, height and weight were entered in the spirometer.

Forced Vital Capacity (FVC) manoeuvre was conducted in the following order:

1) Subjects were instructed to hold the mouthpiece in the mouth with lips pursed around it.
2) They were instructed to breathe normally through the mouthpiece.
3) After the three normal breaths, they were asked to take deep inspiration and asked to blow forcefully into the mouthpiece as long as possible without hesitation and coughing. Then without removing the mouthpiece from the mouth, they were instructed to inspire maximally through the mouthpiece following Parameters recorded and expressed as predicted value and test value .

a.Force expiratory volume in one second (FEV_1) in litres.
b.FEV_1/FVC in %.
c. FEF(25-75)

STATISTICAL ANALYSIS
All variables are expressed as mean + SD. ECG parameters and pulmonary function tests were compared by using unpaired 't' test in COPD patients and control. Correlation of QTd and Pd with pulmonary function parameters was done by Pearson's correlation coefficient and P value was calculated. The level of statistical significance in each case was taken as P<0.0

RESULTS
Table 1 Shows comparison of age (59.16 ± 4.26 vs. 59.24 ± 4.78, p>0.05) and BMI (19.68 ± 4.76 vs. 20.41 ± 3.84, p>0.05) in COPD and control group respectively. BMI is within normal range (18.5 - 24.9 kg/m^2).which rule out obesity. Both groups were comparable with respect to age and BMI. Systolic blood pressure (143.2 ± 4.9 vs 119.72 ± 8.01, p<0.0001), Diastolic blood Pressure (92.84 ± 2.9 vs 75.68 ± 4.68, p<0.0001), and Heart Rate (126.62 ± 5.02 vs 81.26 ± 5.31, p<0.0001) is more in COPD patients compared to control group.

Table 2 Shows decreased QT interval in COPD patients (302.8 ± 8.18 vs 322.72 ± 25.99, p<0.001) as compared to control group. Increased resting heart rate which affect QT interval but after correction with heart rate by **Bazett's formula** [17] corrected QT interval (QTc) is more in COPD patients (431.7 ± 26.6 vs 384.24 ± 33, p<0.0001) as compared to control group . **QT dispersion (QTd) is found to be significantly increased in COPD patients (65.2 ± 4.5 vs 37.34 ± 5.33, P value <0.0001) as compared to control group**. Table No. 2 also shows prolonged P wave duration (115.2 ± 8.62 vs. 90.2 ± 12.53, P <0.0001) and prolonged P wave dispersion (43 ± 12.16 vs. 37.2 ± 8.09, p<0.05) in COPD patients compared to control group

Table No 3 Shows significantly reduced spirometric parameters i.e.FEV_1 (1.80 ± 0.69 vs 2.63 ± 0.46, p<0.0001), FEV_1/FVC (77.06 ± 6.97 vs 88.18 ± 5.73, p<0.01) and FEF_{25-75} (2.78 ± 0.59 vs 3.33 ± 0.90, p<0.05) in COPD patients compared to Control group respectively.

Table No.4 Shows positive correlation of QT dispersion with Heart Rate (r =0.888, p<0.0001), Systolic Blood Pressure (r = 0.670, p<0.0001) and Diastolic Blood Pressure(r = 0.969, p<0.0001) in COPD patients as compared to control.

Table No.5 Shows positive correlation of QT dispersion with various spirometric parameters like FEV_1 (r = -0.874, p<0.0001), FEV_1/FVC (r = -0.903, p<0.0001) and $FEF_{(25-75)}$ (r = -0.715, p<0.0001) in COPD patients and there was no correlation of

QT dispersion with FEV_1 (r = -0.058, p>0.05), FEV_1/FVC (r = -0.178, p>0.05) and $FEF_{(25-75)}$ (r = -0.066, p >0.05) in control group.

Table No 6 Shows there is no correlation of P wave dispersion with any cardiac parameters like Heart Rate (r = 0.163, p>0.05), Systolic blood pressure (r = 0.095, p>0.05) and Diastolic blood pressure (r = 0.227, p>0.05) in COPD patients compared to control group.

Table No.7 P wave dispersion is not correlated with spirometric parameters like FEV_1 (r = - 0.202, p>0.05), FEV_1/FVC (r = - 0.156, P>0.05) in COPD patients. but there is positive correlation of P wave dispersion with $FEF_{(25-75)}$ (r = - 0.455 P<0.005) in COPD patients compared to control group (r = 0.145, p>0.05).

DISCUSSION
In the present study, we evaluated ECG derived indices like QT interval, corrected QT interval, QT dispersion, P wave duration and P wave dispersion in 50 COPD patients and 50 age and sex matched Control. QT dispersion and P wave dispersion was correlated with following parameters between COPD and control group.

1. Age, BMI, Heart Rate, Systolic and Diastolic blood pressure.
2. Spirometric parameters like FEV_1, FEV_1/FVC, $FEF_{(25-75)}$.

The present study shows following statistically significant findings which need to be addressed

1. QT dispersion (QTd) is found to be significantly increase in COPD patients (65.2 ± 4.5 vs 37.34 ± 5.33, P value <0.0001) as compared to control group.
2. Prolonged P wave duration (115.2 ± 8.62 vs. 90.2 ± 12.53, P <0.0001) and prolonged P wave dispersion (43 ± 12.16 vs. 37.2 ± 8.09, p<0.05) in COPD patients compared to control group.
3. Positive correlation of QTd with various spirometric parameters FEV_1, FEV_1/FVC and $FEF_{(25-75)}$.
4. Positive correlation of P wave dispersion with $FEF_{(25-75)}$ (r = - 0.455 P<0.005) in COPD patients compared to control group (r = 0.145, p>0.05).

Increased QTd in COPD patients.
Previous study by **Pinar Yildiz** [5] et al have shown that development of ventricular arrhythmia in COPD patients is associated with QT dispersion. Our results are comparable with their study. **Niranjan Mambally Rachaiah** [11] et al studied 108 patients of COPD and showed positive correlation between ECG changes and pulmonary function parameter.

Several explanations have been put forward to explain increased QTd in COPD patients.

1) Hypoxia in COPD patients increase myocardial O_2 demand

and Adversely affects left ventricular performance, which may alter QT dispersion.[12]

2). Hypoxia increases phase 4 depolarization of myocardial muscles and also increases rate of spontaneous depolarization in conducting tissues of heart leads to vulnerable development of tachyarrhythmias. [13]

3). Flick & Block found that cardiac arrhythmias were at their maximum when arterial oxygen saturation is at its lowest and oxygen therapy ameliorate these arrhythmias. [14]

4). Autonomic Nervous System directly affects QT interval. Autonomic tone may affect corrected QT interval and QT dispersion through depolarization and repolarization kinetics of myocardial cells. [15]

5). QT dispersion has been reported to be prolonged in patients with primary autonomic failure. [15].

Prolonged P wave duration and prolonged P wave dispersion in COPD patients

Previous study done by **Hekim karapinar** [16] shown that prolonged P wave dispersion is an ECG marker that reflects discontinuous and inhomogeneous conduction of sinus impulses. [16] Therefore such patients are more prone to carry an increased risk for atrial fibrillation. [16] They also proposed that P wave duration and P wave dispersion is influenced by the autonomic tone, which induce changes in the velocity of impulse propagation. [16] Our results are also comparable with previous study.

Cardiac arrhythmia and sudden death are common and important causes of mortality in COPD patients. [5] Prolonged QT dispersion is an indication of inhomogeneous ventricular repolarization phase responsible for developing tachyarrhythmias & sudden cardiac death.[5] So, the present study shows that COPD patients are prone to develop tachyarrhythmias & sudden cardiac death due to prolonged QT dispersion and also prone to develop atrial fibrillation due to prolonged P wave duration & P wave dispersion compared to control group**.**

Positive correlation of QTd with various spirometric parameters FEV_1, FEV_1/FVC and $FEF_{(25-75)}$.

In COPD patients decreased FEV_1, FEV_1/FVC and $FEF_{(25-75)}$ is responsible for prolongation of QT dispersion suggesting that hypoxia, hypercapnia due to airway obstruction may influence ventricular repolarization which is responsible for prolongation of QT dispersion.[13,14]

Positive correlation of P wave dispersion with FEF in COPD patients.

$FEF_{(25-75)}$ is a sensitive index of obstructive pathology.[17] Chronic airway obstruction may affect conduction of sinus node responsible for arrhythmias like atrial fibrillation .

From above discussion, it appears that in COPD patients, chronic airway obstruction affect cardiovascular system leading to increased Heart Rate, Systolic Blood pressure, Diastolic Blood pressure. It is due to increased myocardial oxygen demand and workload.[18] In due course it affects electrophysiological parameters like QT Interval, QT dispersion, P wave duration, P wave dispersion leading to prolonged QT dispersion and ventricular arrhythmia. Chronic airway obstruction may affect conduction of sinus node responsible for arrhythmias like atrial fibrillation .

CONCLUSION

1) Prolonged QT dispersion in COPD is associated with generation of life threatening rhythm disturbances and sudden cardiac death.

2). QT dispersion, is a non invasive marker of arrhythmogenicity so,analysis of routine ECG is an important, non invasive, inexpensive, bedside, diagnostic tool to detect early arrhythmias in COPD patients.

3). There is Intriguing relationships between the QT dispersion and functional respiratory parameters.

4). Greater the severity of COPD, greater will be the prolongation of QT dispersion.

5) We recommend that, all COPD patients should undergo routine ECG recordings for early diagnosis as well as prevention of cardiac arrhythmia.

These findings suggest the need for a global and multidisciplinary risk assessment in COPD patients. Therefore, special attention in the diagnostic work-up of these patients is needed, coming to a more integrated pulmonary and cardiovascular care.

Acknowledgements: Authors acknowledge the immense help received from the scholars whose articles are cited & included in references of this manuscript. The authors are grateful to all the staff that have contributed & cooperated in the study. And are also thankful to the Department of Physiology, Department of Chest & TB, B J M C Pune for providing the requisite infrastructure for the study.

Table 1: Shows mean values of Age, BMI, Heart Rate , Systolic & Diasolic Blood Pressure.

Parameters	COPD (n=50)	control (n=50)	t value	p value
	Mean ± SD	**Mean ± SD**		
Age (yrs)	59.16 ± 4.26	59.24 ± 4.78	0.06	>0.05
BMI (kg/m^2)	19.68 ± 4.76	20.41 ± 3.84	0.6	>0.05
Systolic BP (mm of Hg)	143.2 ± 4.9	119.72 ± 8.01	12.46	0.0001**
Diastolic BP (mm of Hg)	92.84 ± 2.9	75.68 ± 4.68	15.15	<0.0001**
Heart Rate (bpm)	126.62 ± 5.02	81.26 ± 5.31	31	0.0001**

Table 2: Shows mean values of QT Interval, corrected QT Interval, QT dispersion P wave duration and P wave dispersion in COPD patients and control group.

Parameters.	COPD	control	t value	p value
QT Interval (ms)	302.8 ± 8.18	322.72 ± 25.99	3.65	<0.001**
QTc Interval (ms)	431.7 ± 26.6	384.24 ± 33.00	5.59	<0.0001**
QT dispersion (ms)	65.2 ± 4.5	37.34 ± 5.33	19.84	<0.0001**
P wave duratio(ms)	115.2 ± 8.62	90.2 ± 12.53	8.21	<0.0001**
P wave dispersion.	43 ±12.16	37.2 ± 8.09	1.99	<0.05*

Table 3 : Shows mean values of FEV_1, FEV_1/FVC & $FEF_{(25-75)}$, in COPD Pt. & control group.

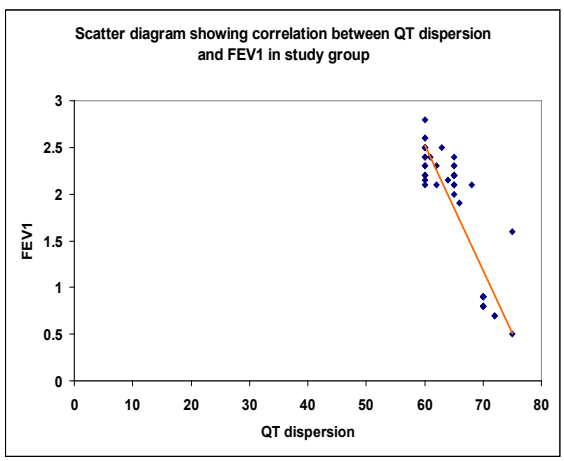
Parameters	COPD	control	t value	p value
FEV_1 (Litres)	1.80 ± 0.69	2.63 ± 0.46	4.82	<0.0001**
FEV_1/FVC (%)	77.06 ± 6.97	88.18 ± 5.73	6.16	<0.0001**
FEF_{25-75} (L/sec)	2.78 ± 0.59	3.33 ± 0.90	2.53	<0.05*

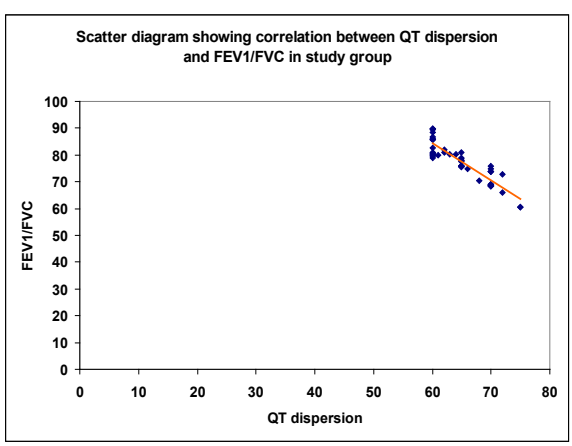
Table 4: Shows correlation of QT dispersion with age, BMI, Heart Rate, Systolic and Diastolic Blood pressure in COPD patients and control group.

Parameters	COPD		control	
	r value	p value	r value	p value
A Age (Yrs)	-0.240	>0.05	-0.268	>0.05
B BMI (Kg/m^2)	0.201	>0.05	0.139	>0.05
H Heart Rate (bpm)	0.888	<0.0001**	-0.169	>0.05
S Systolic BP (mmHg)	0.670	<0.0001**	-0.264	>0.05
D Diastolic BP (mmHg)	0.969	<0.0001**	-0.115	>0.05

Table 5: Shows correlation between QT dispersion and spirometric parameters in COPD patients and control group.

Parameters	COPD		control	
	r Value	p Value	r value	p value
FEV_1 (Litres)	-0.874	<0.0001**	-0.058	>0.05
FEV_1/FVC (%)	-0.903	<0.0001**	-0.178	>0.05
$FEF_{(25-75)}$ (L/sec)	-0.715	<0.0001**	-0.066	>0.05





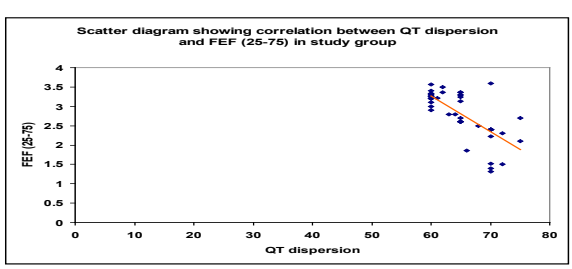


Table 6: Shows correlation between P wave dispersion and age, BMI, Heart Rate,Systolic and Diastolic Blood pressure in COPD patients and control group.

Parameters	COPD		control	
	r Value	p Value	r value	p value
Age (Yrs)	0.010	>0.05	0.039	>0.05
BMI (Kg/m^2)	0.099	>0.05	0.128	>0.05
Heart Rate (bpm)	0.163	>0.05	0.027	>0.05
S Systolic BP (mmHg)	0.095	>0.05	0.114	>0.05
D Diastolic BP (mmHg)	0.227	>0.05	-0.089	>0.05

Table 7: Shows correlation between P wave dispersion and spirometric parameters in COPD and control group.

Parameters	COPD		control	
	r value	p value	r value	p value
FEV_1 (Litres)	-0.202	>0.05	0.112	>0.05
FEV_1/FVC (%)	-0.156	>0.05	0.085	>0.05
$FEF_{(25-75)}$ (L/sec)	-0.455	<0.005*	0.145	>0.05

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