FREQUENCY OF ECG ABNORMALITIES IN PATIENTS OF CHRONIC OBSTRUCTIVE PULMONARY DISEASE ACCORDING TO DISEASE SEVERITY

Asma Shabbir, Syed Badshah Hussain Zaidi*, Shazia Nisar*

Armed Forces Institute of Cardiology (AFIC)/ National University of Medical Sciences (NUMS) Rawalpindi Pakistan, *Military Hospital/ National University of Medical Sciences (NUMS) Rawalpindi Pakistan

ABSTRACT

Objective: The objective of this study was to find out the frequency of ECG abnormalities in patients of COPD in relation to disease severity.

Study Design: Cross Sectional study.

Place and Duration of Study: This study was carried out at the Department of Medicine, Military Hospital Rawalpindi, from Oct 2011 to Jun 2012.

Material and Methods: All patients presenting to the Department of Medicine both inpatient and outpatient, with diagnosis of COPD were included in the study. Patients with cardiac comorbidities were excluded. Also, patients on diuretics and long term oxygen therapy were excluded. A total of three hundred and forty three patients (343) were included in the study. Spirometry of all these patients was done to determine the FEV_1 and FVC in order to classify the grade of severity of COPD. Standard 12 lead ECG of all these patients was done to find out the various ECG abnormalities.

Results: About 77 (22.5%) patients had mild COPD, while moderate COPD was seen in 121 (35.3%). Severe COPD was seen in 100 (29.2%) patients and very severe COPD was seen in 45 (13.1%) patients. The most common ECG abnormalities noted was right atrial enlargement (RAE) in 6 (7.8%) patients of mild COPD, 27 (22.3%) patients of moderate, 48 (48%) patients of severe and 24 (53.3%) patients of very severe COPD. Right ventricular hypertrophy (RVH) in 1 (1.3%) patient of mild, 7 (5.8%) patients of moderate, 19 (19%) patients of severe and 12 (26.7%) patients of very severe COPD. Sinus tachycardia was present in 6 (7.8%) patients of mild, 17 (14%) patients of moderate, 19 (19%) patients of severe and 10 (22.2%) patients of very severe COPD. Right bundle branch block (RBBB) was seen in 5 (6.5%) patients of mild, 9 (7.4%) patients of moderate, 13 (13%) patients of severe and 9 (20%) patients of very severe COPD. SVT was present in 1 (1.3%) patient of mild, 6 (5%) patients of moderate, 10 (10%) patients of severe and 8 (17%) patients of very severe COPD. Low voltage ECG was seen in 3 (3.9%) patients of mild, 7 (5.8%) patients of moderate, 12 (12%) patients of severe and 6 (13.3%) patients of very severe COPD. Atrial premature contractions (APCs) were present in 3 (3.9%) patients of mild, 11 (9.1%) patients of moderate, 14 (14%) patients of severe and 6 (13.3%) patients of very severe COPD. Normal ECG was seen in 54 (70.1%) patients of mild, 52 (43%) patients of moderate, 14 (14%) patients of severe and 3 (6.7%) patients of very severe COPD.

Conclusion: A number of ECG abnormalities were seen in patients with COPD. They were more frequent with increased grade of severity of COPD. Therefore, it is recommended that ECG should be done routinely in patients with COPD.

Keywords: Cor pulmonale, COPD, ECG abnormalities, Spirometry.

INTRODUCTION

The last two decades have seen an increase in the incidence of chronic obstructive pulmonary disease (COPD), making it one of the major health problems faced today[1,2]. International statistics show that COPD causes significant mortality and morbidity globally. Three million people die every year due to this disease and the mortality rate of COPD is expected to increase by 50% in the next 15 years[3].

COPD is linked to arrhythmias in stable cases as well as in acute exacerbations[4]. A

Correspondence: Dr Asma Shabbir, House No. 34 Lane-2 Askari-XI Rawalpindi Pakistan
Email: asma_shabbir@hotmail.co.uk
Received: 15 Jan 2016; revised received: 13 Jun 2016; accepted: 30 Jun 2016

retrospective cohort study was carried out in 2006 to compare prevalence of cardiovascular disease in COPD patients with those without it. Results showed increased risk of hospitalization and mortality due to cardiovascular disease in COPD patients resulting from a higher prevalence of angina, arrhythmias, acute myocardial infarction, congestive heart failure as well as stroke and pulmonary embolism in these patients[5]. COPD leads to various cardiac abnormalities. These include right ventricular dysfunction and pulmonary hypertension thus increasing mortality in this population. Arrhythmias are common in these patients but they are rarely fatal[6].

Cardiovascular complications are frequently observed in patients with chronic obstructive pulmonary disease (COPD) and these complications help to identify a subset of patients with higher mortality. ECG abnormalities (supraventricular ectopic beats, right and/or left ventricular hypertrophy) and digoxin therapy are independent predictors of cardiovascular complications in patient of COPD[7]. The purpose of this study is to determine frequency of various ECG parameters detected in patients of COPD and to grade them according to the severity of disease. As these parameters are predictive of cardiovascular complications and point towards a bad prognosis. Early recognition and treatment of these complications could prove to be beneficial for the patient.

MATERIAL AND METHODS

This is a cross sectional study, conducted at the Department of Medicine, Military Hospital Rawalpindi. Permission was taken from hospital ethical committee prior to conducting the study. Informed consent was taken from all the patients. All patients diagnosed as having COPD but not on long term oxygen therapy were included in this study. This study group had no history of diabetes mellitus, hypertension, coronary artery disease, cardiomyopathy and valvular heart disease (which was ruled out by doing echocardiography). Using WHO sample size calculator, confidence interval (CI) was 95%, anticipated population precision 4%, absolute precision 2.3% taken from literature review. Sample size calculated was 343 patients by Non-probability purposive sampling. Spirometry of all these patients was done in pulmonology department using spirometer of spirolab II to determine FEV_1 and FVC. All patients included in the study had an FEV_1/FVC of less than 0.7. Patients having FEV_1 greater than 80% were included in mild COPD. Patients with FEV_1 between 50% and 80% were labelled as moderate COPD. Patients with FEV_1 between 30% and 50% were included in severe COPD, while patients having FEV_1 less than 30% were classified as very severe COPD. Standard 12 lead ECG of all patients was done to look for various ECG findings.

ECG Findings were as follows:

Right Atrial Enlargement

It was characterized by increased amplitude of *p*-wave >2.5mm or if *p*-wave is upright in lead V_1 with an amplitude greater than 1.5mm.

Right Vevtricular Hypertrophy (RVH)

It was characterized by tall R wave in V_1 and deep S wave in V_6 , where R wave is greater or equal to S.

Supraventricular Tachycardia (SVT)

It was characterized by narrow complex tachycardia with regular RR interval and absence of *p*-waves.

Low Voltage ECG

It was characterized when amplitude of QRS complexes in each of the three standard limb leads (I, II, III) is less than 5 mm.

Premature Atrial Contraction (PAC)

It was characterized by a variable *p*-wave morphology and short RR interval .

Right Bundle Branch Block (RBBB)

It was characterized as broad QRS >120ms rSR pattern in V_1 and qRS inV_6.

Sinus Tachycardia

It was characterized by normal sinus rhythm but heart rate greater than 100 beats per minute.

Normal ECG

It was characterised by normal sinus rhythm and heart rate between 60 and 100 beats per minute[8].

Data analysis was done using SPSS version 17 software. Mean and standard deviations were calculated for quantitative variable that is age for all patients. Analysis and frequencies were carried out for qualitative variables that are gender, ECG findings and spirometry results for all patients. Frequency analysis was carried out between types of ECG abnormalities and grades of COPD using chi square test. A *p*-value <0.05 considered as a significant value.

RESULTS

A total of 343 patients were included in the study. Out of 343 patients, 234 (68.2%) patients were male and 109 (31.8%) patients were females. Mean age was 56.6 years for patients with mild COPD. Patients with moderate COPD had a mean age of 64.03 years. Patients with severe COPD had a mean age of 68.27 years. Patients with very severe COPD had a mean age of 75.56 years. According to grade of severity of COPD 77 (22.4%) patients had mild COPD, 121 (35.3%) had moderate COPD, 100 (29.2%) patients had severe COPD and 45 (13.1%) had very severe COPD (table-I). Various ECG findings analyzed in this study were: RAE, RVH, RBBB, SVT all being more frequent in patients with very severe COPD and normal ECG was more significant in patients with mild COPD (table-II).

Table-I: Demographic characteristics of the population group.

Variables	COPD grade			
	Mild (77)	Moderate (121)	Severe (100)	Very severe (45)
Age (mean) yrs ± S.D	57 ± 11	64 ± 10	68 ± 8	76 ± 10
Males (284)	62 (26.5%)	81 (34.6%)	58 (24.8%)	33 (14.1%)
Females (109)	15 (13.8%)	40 (36.7%)	42 (38.5%)	12 (11%)
Total	77 (22.5%)	121 (35.3%)	100 (29.2%)	45 (13.1%)

DISCUSSION

The spectrum of cardiovascular disease associated with COPD is broad. Patients with COPD tend to develop pulmonary hypertension over time, which increases mortality[9].

In this study, patients with severe and very severe COPD developed pulmonary hypertension as ECG changes favoring corpulmonale were more frequent in such patients. Pulmonary hypertension related with COPD can cause right ventricular hypertrophy. The electrocardiographic sign of corpulmonale are relatively specific[9]. Electrocardiogram features in patients with COPD that suggest pulmonary hypertension are:

- Right atrial enlargement.
- Incomplete or complete right bundle branch block.
- Evidence of RVH, and low voltage QRS[10]. All of these signs werse assessed in our study and the results showed that they were more frequent in very severe COPD. ECG abnormalities that were more frequent in patients with very severe COPD, include RAE, RVH, RBBB, marked clockwise rotation of heart, a QS pattern in leads III and aVF, LAD, PACs, and SVTs[11].

Finding of right ventricular hypertrophy in ECG especially in lead V_1 indicates the presence of right ventricular systolic dysfunction. ECG is therefore a helpful tool for estimation of the presence of right ventricular systolic dysfunction in patients with pulmonary hypertension[12]. In our study right ventricular hypertrophy was present in 39 (11.4%) patients. Right bundle branch

block is associated with hemodynamic consequences in cardiac failure with related asynchrony of the left ventricle and in some cases of right ventricular dilatation[13]. Right bundle branch block was present in 36 (10.5%) patients of COPD in our study.

COPD predisposes patients to cardiac arrhythmias and pulmonary hypertension. Pulmonary hypertension causes right ventricular strain and stretching of the right atrium which predisposes patients to arrhythmias. Metabolic changes such as hypoxia and acidosis are also a cause of arrhythmias in patients of COPD[14].

ECG findings in patients of COPD can assist in decision making regarding disease progression. A hospital based cross sectional study, regarding ECG changes in COPD patients was also carried out in India. ECG changes were present in 35.7% of patients of COPD with peaked *p*-wave in 35.7%. ECG changes were less sensitive (35.7%) but had a high specificity (95.6%)[15]. In our study 123 (35.9%) patients had a normal ECG. Peaked *p*-wave indicating right atrial enlargement was present in 105 (30.6%) patients of COPD.

Table-II: Frequency of ECG findings in patients of copd according to severity of COPD.

ECG findings		COPD grade					
		MILD (77)	Moderate (121)	Severe (100)	Very Severe (45)	Total	Sig
RAE	Count	6	28	48	24	106	<0.001
	% within gp of COPD	7.8%	23.1%	48%	53.3%	30.9%	
	% of total	1.7%	8.2%	14%	7%		
RVH	Count	1	7	19	12	39	<0.001
	% within gp of COPD	1.3%	5.8%	19%	26.7%	11.4%	
	% of total	0.3%	2.0%	5.5%	3.5%		
RBBB	Count	5	9	13	9	36	0.057
	% within gp of COPD	6.5%	7.4%	13.0%	20%	10.5%	
	% of total	1.5%	2.6%	3.8%	2.6%		
APC	Count	3	11	14	6	34	0.129
	% within gp of COPD	3.9%	9.1%	14.0%	13.3%	9.9%	
	% of total	0.9%	3.2%	4.1%	1.7%		
SVT	Count	1	6	10	8	25	0.004
	% within gp of COPD	1.3%	5%	10%	17.8%	7.3%	
	% of total	0.3%	1.7%	2.9%	2.3%		
Low Voltage ECG	Count	3	7	12	6	28	0.096
	% within gp of COPD	3.9%	5.8%	12.0%	13.3%	8.2%	
	% of total	0.9%	2.0%	3.5%	1.7%		
Sinus Tachycardia	Count	6	17	19	10	52	0.100
	% within gp of COPD	7.8%	14.0%	19.0%	22.2%	15.2%	
	% of total	1.7%	5.0%	5.5%	2.9%		
Normal ECG	Count	54	52	14	3	123	<0.001
	% within gp of COPD	70.1%	43.0%	14.0%	6.7%	35.9	
	% of total	15.7%	15.2%	4.1%	0.9%		

According to studies there are about 89,000 new cases per year of supraventricular tachycardia and 570,000 individuals with paroxysmal supraventricular tachycardia in the United States[16]. Supraventricular tachycardia in most of these patients is associated with long term use of oral steroids, long standing

antimuscarinics and temporary use of theophylline[17].

The Takahata study done in Japan showed that the incidence of atrial fibrillation was much higher in patients who had airflow limitations compared to those without airflow limitation. Furthermore, incidence of atrial fibrillation was higher in patients who had severe airflow obstruction with an FEV_1 less than 50%[18]. In our study SVT was present in a total of 25 (7.3%) patients. In patients with very severe COPD 8 (17%) had SVT. The Quebac study done in Canada followed up patients from 1990 to 1999 and included 76,661 patients of COPD out of which 5307 developed arrhythmias with an annual incidence of 10.3 per 1000. Use of beta agonists was held responsible for arrhythmias[19]. Beta agonists tend to increase heart rate by 9.12 beats per minute as compared to placebo. The relative risk calculated for sinus tachycardia was 3.06 and for other event was 1.66[20]. In the present study sinus tachycardia was present in 52 (15.2%) patients. Atrial premature contractions were present in 34 (9.9%) patients.

A study done in Korea in 2009, suggested the association of chronic AF with reduced ventilatory function. It also studied the effects of beta blockers and beta agonists. In medical practice, β-blockers which can unfavorably affect ventilation, are commonly administered to lessen the ventricular rate in AF whereas beta agonists, which can exacerbate the cardiac rhythm are used to manage reduced lung function. Careful use of these drugs is needed as chronic AF co-existing with decreased ventilatory function was significant in this study[21].

The Copenhagen heart study also mentions the association of reduced FEV_1 and AF. Atrial fibrillation, if left untreated, can cause high morbidity from stroke and is related with increased mortality. These point toward the significance of routine electrocardiograms in patients with COPD[22].

Patients with both COPD and heart disease have a more severe disease and a poor quality of life requiring more health care resources as compared to patients of COPD who do not have heart disease[23].

CONCLUSION

COPD is very frequently associated with ECG abnormalities. Frequency of ECG abnormalities increased with increase in grade of severity of COPD. Abnormalities such as RAE, RVH, RBBB, low voltage ECG SVT and APCs were more prevalent in very severe COPD than in mild COPD. Normal ECG was present in 123 (35.9%) patients majority of which had mild COPD. ECG abnormalities in patients of COPD point towards a poor prognosis indicating that these patients are at increase risk of developing cardiovascular complications, also treatment itself i.e. B agonist could be a cause of these findings SVT, APC. ECG is cost effective and can be done very easily. Therefore it is recommended that routine ECG should be done in patients of COPD, especially in patients with very severe COPD. This will help in recognizing the complications and in tailoring treatment for patients of COPD.

CONFLICT OF INTEREST

This study has no conflict of interest to declare by any author.

REFERENCES

1. Younas M, Mehmood A, Rasul S, Khan SA, Khalid M. Role of spirometry in the diagnosis of chronic obstructive pulmonary disease in smokers. J Allama Iqbal Med Coll 2009; 7(4): 11-9.
2. Zardari MK, Mughal SA, Shaikh SA, Mughal MA. Early detection of cardiac failure in chronic obstructive pulmonary disease patients. Pak J Physiol 2008; 4(2): 17-9.
3. Gurgun A, Gurgun C. Chronic obstructive pulmonary disease and cardiovascular system. Tuberk Toraks 2008; 56(4): 464-71.
4. Wood-Baker R, Cochrane B, Naughton MT. Cardiovascular mortality and morbidity in chronic obstructive pulmonary disease; the impact of bronchodilator treatment. Intern Med J 2010; 40(2): 94-101.
5. Curkendall SM, DeLuise C, Jones JK, Lanes S, Stang MR, Goehring E Jr, et al. Cardiovascular disease in patients with chronic obstructive pulmonary disease, Saskatchewan Canada cardiovascular disease in COPD patients, Ann Epidemiol 2006; 16(1): 63-70.
6. Falk JA, Kadiev S, Criner GJ, Scharf SM, Minai OA, Diaz P. Cardiac disease in chronic obstructive pulmonary disease. Proc Am Thorac Soc 2008; 5(4): 543-8.
7. Scarduelli C, Ambrosino N, Confalonieri M, Gorini M, Sturani C, Mollica C, et al. Prevalence and prognostic role of cardiovascular complications in patients with exacerbation of

chronic obstructive pulmonary disease admitted to Italian respiratory intensive care units. Ital Heart J 2004; 5(12): 932-8.
8. Marchlinski F, The tachyarrythmaias. In: Fauci A S, Braunwald E, Kasper D L, Hauser S L, Longo D L, Jameson J L, et al(edi). Harrisons Principles of Internal Medicine 17th ed. New York: Mc Graw-Hill Medical 2008; 1425-32.
9. Salpeter SR, Ormiston TM, Salpeter EE. Cardiovascular effects of beta-agonists in patients with asthma and COPD: a meta-analysis 2004; 125(6): 2309-21.
10. Elwing J, Panos RJ. Pulmonary hypertension associated with COPD. Int J Chron Obstruct Pulmon Dis 2008; 3(1): 55-70.
11. Holtzman D, Aronow WS, Mellana WM, Sharma M, Mehta N, Lim J, et al. Electrocardiographic abnormalities in patients with severe versus mild or moderatechronic obstructive pulmonary disease followed in an academic outpatient pulmonary clinic. Ann Noninvasive Electrocardiol 2011; 16(1): 30-2.
12. Nagai T, Kohsaka S, Murata M, Okuda S, Anzai T, Fukuda K, et al. Significance of electrocardiographic right ventricular hypertrophy in patients with pulmonary hypertension with or without right ventricular systolic dysfunction. Intern Med 2012; 51(17): 2277-83.
13. Lerecouvreux M, Perrier E, Leduc PA, Manen O, Monteil M, Deroche J et al. Right bundle branch block: electrocardiographic and prognostic features. Arch Mal Coeur Vaiss 2005; 98(12): 1232-8.
14. Van der Hooft CS, Heeringa J, Brusselle GG, Hofman A, Witteman JC, Kingma JH, et al. Corticosteroids and the risk of atrial fibrillation. Arch Intern Med 2006; 166: 1016-20.
15. Agarwal RL, Kumar D, Gurpreet, Agarwal DK, Chabra GS. Diagnostic values of electrocardiogram in chronic obstructive pulmonary disease (COPD). Lung India 2008: 25(2): 78-81.
16. Orejarena LA, Vidaillet H Jr, DeStefano F, Nordstrom DL, Vierkant RA, Smith PN, et al. Paroxysmal supraventricular tachycardia in the general population. J Am Coll Cardiol 1998; 31: 150–157.
17. Huerta C, Lanes SF, Garcia Rodriguez LA. Respiratory medications and the risk of cardiac arrhythmias. Epidemiology 2005; 16: 360–366.
18. Shibata Y, Watanabe T, Osaka D, Abe S, Inoue S, Tokairin Y et al. Impairment of pulmonary function is an independent risk factor for atrial fibrillation: the Takahata study. Int J Med Sci 2011; 8(7): 514-22.
19. Wilchesky M, Ernst P, Brophy JM, Platt RW, Suissa S. Bronchodilator use and the risk of arrhythmia in COPD: part 2: reassessment in the larger Quebec cohort. Chest 2012; 142(2): 305-11.
20. Weitzenblum E, Chaouat A. Corpulmonale. Chron Respir Dis 2009: 6(3): 177-85.
21. Kang H, Bae BS, Kim JH, Jang HS, Lee BR, Jung BC. The relationship between chronic a trial fibrillation and reduced pulmonary function in cases of preserved left ventricular systolic function. Korean Circ J 2009; 39(9): 372-7.
22. Buch P, Friberg J, Scharling H, Lange P, Prescott E. Reduced lung function and risk of a trial fibrillation in the Copenhagen City Heart Study. Eur Respir J 2003; 21(6): 1012-6.
23. De Miguel-Diez J, Carrasco Garrido P, Rejas- Gutierrez J, Martin-Centeno A, Gobartt- Vazquez E, Hernandez-Barrera V, et al. The influence of heart disease on characteristics, quality of life, uses of health resources and costs of COPD in primary care settings. BMC Cardiovasc Disord 2010: 10: 8.

.....