KLİNİK ÇALIŞMA/RESEARCH ARTICLE Tuberk Toraks 2013; 61(1): 38-42

Geliş Tarihi/Received: 25/05/2012 - Kabul Ediliş Tarihi/Accepted: 19/12/2012

The role of electrocardiography in evaluation of severity of chronic obstructive pulmonary disease in daily clinical practice

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ÖZET

Günlük klinik uygulamada kronik obstrüktif akciğer hastalığının şiddetinin değerlendirilmesinde elektrokardiyografinin rolü

Giriş: *Kronik obstrüktif akciğer hastalığı (KOAH) kronik morbidite ve mortalitenin dördüncü önde gelen nedenidir. Bronşiyal obstrüksiyon ve artmış pulmoner vasküler direnç sağ atriyal fonksiyonları bozmaktadır. Bu çalışmada, KOAH hastalarında bronşiyal obstrüksiyonun p dalga aksı üzerine olan etkisini ve KOAH şiddetini değerlendirmede elektrokardiyografi (EKG)'nin yararlılığını araştırmayı amaçladık.*

Hastalar ve Metod: *Doksan beş hasta (64'ü erkek, 31'i kadın) çalışmaya dahil edildi. Hastalar sinüs ritminde, normal ejeksiyon fraksiyonuna ve normal kalp boşluk boyutlarına sahipti. Hastaların solunum fonksiyon testleri ve 12 derivasyonlu elektrokardiyogramları aynı gün elde edildi. KOAH şiddeti ile p dalga aksı, p dalga süresi, QRS aksı ve QRS süresini içeren EKG bulguları arasındaki ilişkiler araştırıldı.*

Bulgular: *Ortalama yaş 58 ± 12 yıl idi. Ortalama p dalga aksı 62 ± 18 derece idi. Bu çalışmada, p dalga aksı, KOAH evreleri ve QRS aksı ile anlamlı pozitif korelasyonlar, fakat FEV_1, FEF, BMI ve QRS süresi arasında anlamlı negatif korelasyonlar ortaya koydu. KOAH evreleri arttıkça p dalga aksı artmaktadır.*

Sonuç: *Frontal p dalga aksının vertikalizasyonu, p pulmonale gibi sağ kalp boşluklarının genişlemesi ve hipertrofisinin diğer EKG değişikliklerinin oluşmasından önce KOAH'ın kötüleşmesinin erken bir bulgusu olabilir. Sağ atriyal elektriksel aktiviteyi ve sağ kalp yüklenmesini yansıtan frontal p dalga aksının vertikalizasyonu hızlı hasta bakılan poliklinik ortamında KOAH şiddetinin çabuk bir şekilde değerlendirilmesinde yararlı bir parametre olabilir.*

Anahtar Kelimeler: *P dalga aksı, KOAH, spirometri, EKG.*

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SUMMARY

The role of electrocardiography in evaluation of severity of chronic obstructive pulmonary disease in daily clinical practice

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Introduction: *Chronic obstructive pulmonary disease (COPD) is the fourth leading cause of chronic morbidity and mortality. Bronchial obstruction and increased pulmonary vascular resistance impairs right atrial functions. In this study, we aimed to investigate the effect of bronchial obstruction on p wave axis in patients with COPD and usefulness of electrocardiography (ECG) in the evaluation of the severity of COPD.*

Patients and Methods: *Ninety five patients (64 male and 31 female) included to the study. Patients were in sinus rhythm, with normal ejection fraction and heart chamber sizes. Their respiratory function tests and 12 lead electrocardiograms were obtained at same day. Correlations with severity of COPD and ECG findings including p wave axis, p wave duration, QRS axis, QRS duration were studied.*

Results: *The mean age was 58 ± 12 years. Their mean p wave axis was 62 ± 18 degrees. In this study, p wave axis has demonstrated significant positive correlations with stages of COPD and QRS axis but significant negative correlations with FEV_1, FEF, BMI and QRS duration. P wave axis increases with increasing stages of COPD.*

Conclusion: *Verticalization of the frontal p wave axis may be an early finding of worsening of COPD before occurrences of other ECG changes of hypertrophy and enlargement of right heart chambers such as p pulmonale. Verticalization of the frontal p wave axis reflecting right atrial electrical activity and right heart strain may be a useful parameter for quick estimation of the severity of COPD in an out-patient cared.*

Key Words: *P wave axis, COPD, spirometry, ECG.*

Tuberk Toraks 2013; 61(1): 38-42 • doi: 10.5578/tt.4101

INTRODUCTION

Chronic obstructive pulmonary disease (COPD) is a growing major public health problem. In 2020, COPD is projected to rank fifth worldwide in burden of disease, according to a study published by the World Bank/World Health Organization (1). Although COPD has received increasing attention from the medical community in recent years, it is still relatively unknown or ignored by the public as well as public health and government officials (2). In the United States, morbidity caused by COPD is approximately 4%, thus, COPD is ranked as the fourth leading cause of chronic morbidity and mortality after heart attacks, malignancies and strokes (3). COPD, leading reduced lung function, is a strong risk factor for cardiovascular events. COPD and heart diseases often co-exists. Therefore, in daily clinical practice, cardiologists frequently come across patients with COPD. Increased bronchial obstruction and increased pulmonary vascular resistance impairs right atrial functions. In this study, we aimed to investigate the effect of bronchial obstruction on P wave axis in patients with COPD and usefulness of electrocardiography (ECG) findings in the evaluation of severity of COPD classified by spirometry according to the updated new GOLD guidelines (2).

PATIENTS and METHODS

According to Global Initiative for Chronic Obstructive Lung Disease (GOLD) guideline, patients having the diagnosis of COPD were considered for the study (2). Patients who accepted to join in the study were informed about the purpose and methods of study and in-

formed consent was obtained. Patients were in sinus rhythm on ECG and with normal ejection fraction and without significant heart valve disease; chamber dilatation and hypertrophy on echocardiography were included in this study. Patients having known congenital or acquired heart disease, hypertension, coronary artery disease, diabetes mellitus, renal or hepatic disease were excluded from this study. Patients meeting above inclusion and exclusion criteria were selected for the study. Twelve lead ECG and afterwards pulmonary function test according to GOLD spirometry guideline were performed at the same day (4). Classification of severity of air flow limitation in COPD was made according to GOLD classification based on post-bronchodilator FEV_1 (2). Electrocardiographic recordings were performed using General Electric MC 1600 ECG device (Chicago, IL, USA). The values of P wave axis, P wave duration, QRS axis and QRS duration are obtained from the computerized report on electrocardiogram. Correlations between the severity of COPD and ECG findings including P wave axis, P wave duration, QRS axis, QRS duration were studied.

Statistical Analysis

Values were given as mean ± SD. Comparisons of continuous variables between groups were made by Kruskal Wallis variance analysis test. Differences between groups were compared by Mann-Whitney U test. Analyses of categorical variables were made by Chi-square test. Associations between variables were analyzed by Spearman's Rho Correlation test. A p-value < 0.05 was accepted as the level of significance. The level of significance for pairwise comparisons was adjusted when multiple comparisons were performed ($p< 0.05/2 = 0.025$). Statistical analysis were made by SPSS software (Version 17.0, SPSS Inc, Chicago, IL, USA).

RESULTS

Ninety five patients (64 male and 31 female) included to the study. The mean age was 58 ± 12 years. Their mean P wave axis was 62 ± 18 degrees. Demographic characteristics and pulmonary function parameters of patients have been shown in Table 1. In our findings, P wave axis has showed significant positive correlations with grades of COPD. P wave axis increases with increasing stages of COPD. However, the severity of COPD has showed no significant correlation with P wave duration, QRS axis and QRS duration. Comparisons between ECG parameters and severity of COPD have been indicated in Table 2. In this study, P wave axis has demonstrated significant positive correlations with stages of COPD and QRS axis but significant negative correlations with FEV_1, FEF, BMI and QRS duration. Correlations between P wave axis and demographic characteristics, pulmonary function parameters and COPD grade have been displayed in Table 3.

Table 1. Demographic characteristics and pulmonary function parameters of patients.

	Grade 1 (n= 29)	Grade 2 (n= 34)	Grade 3 (n= 17)	Grade 4 (n= 15)	Total (n= 95)	p value
Age (year)	58 ± 13	58 ± 15	57 ± 10	57 ± 10	58 ± 12	NS
Gender (male, %)	69	59	77	73	67	NS
Height (cm)	165 ± 10	164 ± 9	166 ± 7	162 ± 6	165 ± 9	NS
Weight (kg)	79 ± 15	77 ± 11	76 ± 20	65 ± 13	75 ± 16	0.023
BMI	29 ± 6	29 ± 5	28 ± 6	25 ± 4	28 ± 5	NS
FVC predicted	3.4 ± 0.8	3.4 ± 0.8	3.6 ± 0.5	3.3 ± 0.4	3.4 ± 0.7	NS
FVC measured	2.9 ± 0.8	2.4 ± 0.7	2.3 ± 0.5	1.6 ± 0.3	2.4 ± 0.8	0.0001
FVC %	83 ± 13	70 ± 12	64 ± 11	49 ± 8	0.7 ± 0.2	0.0001
FEV_1 predicted	2.8 ± 0.7	2.8 ± 0.7	2.9 ± 0.4	2.7 ± 0.3	2.8 ± 0.6	NS
FEV_1 measured	2.1 ± 0.5	1.6 ± 0.4	1.2 ± 0.2	0.7 ± 0.1	1.5 ± 0.6	0.0001
FEV_1%	71 ± 4	56 ± 5	42 ± 4	26 ± 3	54 ± 16	0.0001
FEV_1/FVC ratio	71 ± 10	67 ± 10	55 ± 10	42 ± 13	62 ± 15	0.0001
FEF_{25-75} predicted	3.2 ± 0.8	3.2 ± 0.8	3.4 ± 0.4	3.3 ± 0.2	3.2 ± 0.7	NS
FEF measured	1.6 ± 0.5	1.1 ± 0.4	0.7 ± 0.2	0.4 ± 0.1	1 ± 0.6	0.0001
FEF %	48 ± 11	35 ± 13	20 ± 5	12 ± 2	33 ± 17	0.0001

BMI: Body mass index, NS: Not significant.

Table 2. Comparisons between electrocardiography parameters and severity of COPD.

	Stage 1 (n= 29)	Stage 2 (n= 34)	Stage 3 (n= 17)	Stage 4 (n= 15)	Total (n= 95)	p value
P wave axis	54 ± 17[a,b]	62 ± 18[c]	68 ± 16	75 ± 9	62 ± 18	0.0001
QRS axis	21 ± 39	27 ± 39	31 ± 51	52 ± 41	30 ± 42	NS
P duration (msn)	87 ± 14	87 ± 20	96 ± 12	90 ± 13	89 ± 16	NS
QRS duration (msn)	85 ± 10	83 ± 13	86 ± 11	82 ± 9	80 ± 12	NS

[a] Grade 1 to 4 p< 0.0001
[b] grade 1 to 3 p= 0.008
[c] grade 2 to 4 p= 0.002
COPD: Chronic obstructive pulmonary disease, NS: Not significant.

Table 3. Correlations between P wave axis and demographic characteristics, pulmonary function parameters, severity of COPD.

	r	p
Age (year)	0.052	0.616
BMI	- 0.206	0.044
QRS axis	0.327	0.001
P duration	0.007	0.946
QRS duration	- 0.239	0.019
FVC predicted	- 0.193	0.059
FVC %	- 0.143	0.167
FEV_1 predicted	- 0.381	0.0001
FEV_1%	- 0.422	0.0001
FEV_1/FVC ratio	- 0.506	0.0001
FEF predicted	- 0.463	0.0001
FEF %	- 0.521	0.0001
COPD stage	0.443	0.0001

COPD: Chronic obstructive pulmonary disease, BMI: Body mass index.

DISCUSSION

In this study, P wave axis has demonstrated statistically significant negative correlations with forced expiratory volume 1, forced expiratory flow, FEV_1/FVC ratio, BMI and QRS duration. P wave axis has also had significant positive correlations with stages of COPD, which means that P wave axis increases with increasing stages of COPD. Higher degrees of P wave axis might point out higher stages of COPD. COPD has long been associated with verticalization of the frontal P axis (5). A vertical P wave axis (> 60°) could be used as a screening tool for obstructive pulmonary disease with 89% sensitivity and 96% specificity (6). Not too long ago, researchers pointed that the increasing verticality of P wave axis had a direct correlation with increasing degrees of airway obstruction (7). Bazuaye et al. reported that there was an inverse relationship between mean P wave axis and the FEV_1 of predicted in Nigerians with COPD (8). Recently, Rachaiah and colleagues study, the P wave axis +90 degrees and above has been found to be associated with advanced airway obstruction (9). Similarly, the Thomas et al. study has reported that the P wave axis at > 60 degrees can be used alone with very high sensitivity (96%) and specificity (87%) to detect emphysema (10). Our results confirm these previous studies in patients with COPD classified by spirometry according to the updated new GOLD guidelines (2). One of the possible mechanisms of P wave axis verticalization in COPD patients is that the right atrium is tightly connected to the diaphragm via a pericardial ligament near the inferior vena cava (11). Thus, the right atrium will be inferiorly displaced by increasing flattening of the diaphragm (10). Our study reveals that increasing verticality of mean P wave axis is associated with increasing degree of disease severity.

In daily clinical practice, the evaluation of COPD patients with echocardiography may have some limitations. The absence of tricuspid regurgitation and right ventricular hypertrophy or dilatation may cause underestimation of severity of COPD by cardiologists. Transthoracic echocardiography, furthermore, may be impeded by poor visualization of acoustic echocardiography windows caused by the pathological changes associated with COPD. The inadequate visualization of echocardiography views may be related to air trapping. In fact, it has been reported that echocardiographic images were unsatisfactory in 10.4% of patients with COPD and this proportion increases to 35% in patients with severe COPD and to 50% in those with very severe airflow obstruction (12,13). In daily clinical practice, the ECG obtained easily in patients with COPD may give valuable clues in management of COPD.

However, our study has some limitations;

1. If healthy controls were included in this study, the changes of p wave axis could have been more clearly revealed.

2. The number of patients for each subgroup is not sufficient to give a cut off value of P wave axis.

3. Not Rated effective COPD treatment is the effect on P wave axis seems to be a limitation. In fact, it has been reported that effective treatment of COPD might alter the electrocardiographic changes in this disease (14). Verticalization of frontal P-wave axis may be an early sign of worsening of COPD, occurring prior to the onset of electrocardiographic findings such as P-pulmonale and right ventricular hypertrophy. Although the overlap of P wave axis values among groups makes it difficult to determine the severity of COPD simply by ECG, verticalization of frontal P-wave axis, which reflects right atrial electrical activity and strain, can be a useful contributor for the fast prediction of the severity of COPD in an out-patient cared to make a rough assessment.

Verticalization of the frontal P wave axis may be an early finding of worsening of COPD before occurrences of other ECG changes of hypertrophy and enlargement of right heart chambers such as p pulmonale. Verticalization of the frontal P wave axis reflecting right atrial electrical activity and right heart strain on ECG may be a useful parameter for quick estimation of the severity of COPD.

CONFLICT of INTEREST

None declared.

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