



The Electrical Axis of the Heart in Nigerian Patients with Chronic Obstructive Lung Disease in Benin City

L'axe électrique du cœur dans les patients nigériens atteints de maladie pulmonaire obstructive chronique à Bénin City

A. O. Obasohan[†], E. E. Egbagbe^{*†}, A. E. Bazuaye[‡]

ABSTRACT

BACKGROUND: Of the electrocardiographic changes in chronic obstructive lung disease (COLD) patients, a shift of the P wave axis greater than 90° which is highly characteristic, is said to be due to hyperinflation and does not occur in interstitial lung disease.

OBJECTIVE: To describe the electrocardiographic changes in chronic obstructive lung disease patients.

METHODS: The electrical axis of the various waves of the ECG using the hexiaxial reference system in 92 Nigerian patients with COLD were examined, 39 of whom had associated cor pulmonale. P wave axis greater than 90° was present in 2(19.1%) of 17 patients with COLD alone and 15(41.7%) out of 36 with development of cor pulmonale ($p < 0.001$). The mean P wave axis was $64.7 \pm 10.6^\circ$ in those without cor pulmonale while it was significantly shifted to the right (83.9°) in those with cor pulmonale. The mean QRS axis was $53.50 \pm 21.2^\circ$ and $89.0 \pm 12.4^\circ$ in those without and with cor pulmonale respectively ($p = 0.7716$). The QRS axis was normal in all but one of those without cor pulmonale while there was a right axis deviation in 51.7% of those with it. ST and T wave changes were mainly present in those with associated cor pulmonale.

CONCLUSION: The study shows that a shift of the electrical axis of the heart occurs in COLD patients mainly with the development of right ventricular hypertrophy (cor pulmonale), rather than the hyperinflation. *WAJM 2011; 30(4): 288–291.*

Keywords: Electrical axis, heart, Nigerians, chronic bronchitis, emphysema, cor pulmonale, chronic obstructive lung disease, ECG.

RÉSUMÉ

CONTEXTE: Des modifications électrocardiographiques dans la maladie pulmonaire obstructive chronique (MPOC) des patients, un décalage de l'axe de l'onde P supérieure à 90° qui est très caractéristique, est dit être en raison de l'hyperinflation et ne se produit pas dans la maladie pulmonaire interstitielle.

OBJECTIF: Décrire les changements électrocardiographiques chez les patients obstructives chroniques du poumon.

MÉTHODES: L'axe électrique des différentes vagues de l'ECG en utilisant le système de référence hexiaxial chez 92 patients nigériens avec COLD ont été examinés, dont 39 avaient associé pulmonaire. Onde P axe supérieur à 90° est présent dans deux (19,1%) des 17 patients atteints de froid seul et 15 (41,7%) sur 36 avec le développement du cœur pulmonaire ($p < 0,001$). L'axe d'onde moyenne P était de $64,7 \pm 10,6^\circ$ chez ceux sans cœur pulmonaire alors qu'il était nettement déplacé vers la droite ($83,9^\circ$) chez les personnes atteintes pulmonaire. La moyenne du QRS axe était $53,50 \pm 21,20 \pm 12,40$ et $89,0$ chez ceux sans et avec cœur pulmonaire, respectivement ($p = 0,7716$). L'axe du QRS était normal dans tous sauf un de ceux sans cœur pulmonaire alors qu'il y avait une déviation de l'axe droit dans 51,7% des personnes avec elle. ST et T changements ondes étaient surtout présents chez les personnes atteintes pulmonaire associée.

CONCLUSION: Cette étude montre qu'un déplacement de l'axe électrique du cœur se produit chez les patients froid principalement avec le développement de l'hypertrophie ventriculaire droite (cœur pulmonaire), plutôt que de l'hyperinflation. *WAJM 2011; 30(4): 288–291.*

Mots-clés: axe électrique, le cœur, les Nigériens, bronchite chronique, emphyseme, pulmonaire, maladie pulmonaire obstructive chronique, de l'ECG.

[†]Department of Medicine, University of Benin Teaching Hospital, PMB 1111, Benin City, Nigeria. [‡]Humanity Clinic, Warri, Nigeria.

Correspondence: Dr. Egbagbe E E, Email: eegbagbe@yahoo.com

Abbreviations: COLD, Chronic obstructive lung disease; ECG, Electrocardiogram; FEV₁, Forced expiratory volume in one second; FVC, Forced vital capacity; PA, Postero-anterior; PEF, Peak expiratory flow; UBTH, University of Benin Teaching Hospital; USA, United States of America; WHO, World Health Organisation.

INTRODUCTION

Chronic obstructive lung disease (COLD) is a common illness among Nigerians.^{1,2} It places a burden on the right heart from pulmonary hypertension, which develops during the course of the illness, eventually leading to right ventricular hypertrophy (cor pulmonale) and to right heart failure.³ Among the electrocardiographic changes that have been described in COLD, it is thought that the axis shift of the various waves especially the P wave is probably most characteristic⁴ and that a P wave axis of $\geq +90^\circ$ is highly suggestive of COLD. This is thought to be due to hyperinflation of the lungs and that it is not seen in interstitial lung fibrosis.⁵ These observations have been made in Caucasians.

The ECG of the Nigerian has been extensively studied and like other black people, it shows some differences from that of the Caucasians.⁶⁻⁹ Although COLD is a common disease in Nigerians, there are no reports of associated electrocardiographic abnormalities especially the axis shift which is said to be characteristic. This study examined the electrical axis of the heart in Nigerian patients with COLD and its relationship to cor pulmonale.

SUBJECTS, MATERIALS, AND METHODS

Study Site

The study was conducted at the University of Benin Teaching Hospital, Benin City in the south-western part of Nigeria.

The electrical axis of the heart was determined from the scalar electrocardiograms. Study subjects were consecutive patients seen at the chest clinic and medical wards of the hospital.

Inclusion and Exclusion Criteria

Inclusion criteria consisted of patients with unequivocal clinical features of chronic bronchitis and/or emphysema and ratio of forced expiratory volume in one second to that of forced vital capacity (FEV_1/FVC) less than 70%.

Patients with other lung diseases like bronchiectasis, pulmonary tuberculosis, pulmonary emboli, lung abscess, pneumonia, pneumoconiosis and kyphoscoliosis were excluded by history,

physical examination and appropriate investigations.

The electrocardiograms were obtained with the patient lying relaxed on a couch or hospital bed using the MAC©1 (Mirocomputer Augmented Cardiograph) machine (Marquette Electronics Inc. Winsconsin U.S.A.) The recommendations of the American Heart Association concerning standardization of leads and specification for instruments were followed.^{10,11} A standard 12-lead electro-cardiogram (ECG) with a rhythm strip of at least 12 seconds was obtained in each patient.

Definitions and Criteria

The diagnosis of chronic bronchitis was based on the criteria set by the Medical Research Council of cough with expectoration of sputum occurring on most days for at least three months for more than two consecutive years, having excluded other localized bronchopulmonary and cardiac disease.

The diagnosis of emphysema was based on the clinical features of dyspnoea associated with reduced chest expansion, reduction or loss of cardiac and hepatic dullness, increased anteroposterior chest diameter or barrel shaped chest. This was in addition to X-ray findings of (i) hyperlucency of the lung fields, (ii) retrosternal space greater than 4.5cm, (iii) low or flat diaphragms below the level of the seventh rib anteriorly, (iv) peripheral pruning of blood vessels, and (v) long tubular heart. Items (iv) and (v) were made optional in those with cor pulmonale as it is known that they disappear with its development^{13,14}. These criteria were entertained only after the exclusion of upper airway obstruction or the presence of isolated asthma.

Cor pulmonale was diagnosed in COLD patients when any of the following were present:^{13,14}

- (i) classical right ventricular failure with the presence of an elevated jugular venous pressure, tender hepatomegaly, peripheral pitting oedema and right ventricular gallop, where there was no other detectable cause for the cardiac failure.
- (ii) right ventricular enlargement or

generalised cardiomegaly on a technically satisfactory posterior anterior chest radiograph in a patient with COLD, where this finding was absent in a previous film taken within the previous six months.

Validity of tests is expressed as sensitivity, specificity and positive predictive value.¹⁵ The sensitivity is defined as the percentage of positive results in patients with the disease, detecting true positives; the specificity as the percentage of negative results among patients who do not have the disease, rejecting true negatives while the positive predictive value defines the percentage of positive results that are true positives detected by the test, which is fundamentally related to the incidence of the disease.¹⁶

Ethical Considerations

The study was conducted in line with the recommendations of the Helsinki Declaration on research in human subjects.

Calculations and Statistical Analysis

The electrical axis of the P, QRS and T waves in the frontal plane were determined using the Baxley's hexiaxial reference chart.¹² The mean axis of the various waves was compared among those COLD patients with and without cor pulmonale. ST segment changes were also analysed among the groups.

Result values are presented as mean \pm SD. Continuous variables were analyzed using two tailed unpaired student's t-test while discrete variables were evaluated using Chi square testing with Yates correction as appropriate.

The level of statistical significance is set at $p \leq 0.05$.

RESULTS

There were 92 patients of which 39 had associated cor pulmonale with COLD. Three patients (two males and one female) had atrial fibrillation and so their P wave axis could not be determined. All three were in the group with cor pulmonale. The mean age of the group was 52.4 ± 4.3 years. Tables 1 and 2 summarise the findings.

The PWave

The mean electrical axis of the P wave was $64.7 \pm 10.6^\circ$ for those without cor pulmonale and $83.9 \pm 12.7^\circ$ for those with cor pulmonale respectively ($p < 0.001$) (Table 1). In the males, it was $65 \pm 11.4^\circ$ and $82.8^\circ \pm 11.8^\circ$ in those without and those with cor pulmonale respectively ($p < 0.001$). The pattern in the females was similar.

Two (3.8%) of the 53 patients with COLD alone had a P wave axis greater than 90° , thus its sensitivity for COLD alone was very low. Table 2 shows that a rightward P wave greater than 90° was significantly associated with the development of cor pulmonale ($\chi^2 = 17.5$; $p < 0.001$). Fifteen (41.7%) out of 36 people with COLD and cor pulmonale had a P wave axis greater than 90° .

The specificity (86.8%) and positive predictive value (78.8%) for the

development of cor pulmonale were high, as only two out of 53 COLD patients without cor pulmonale had a P wave axis greater than 90° .

QRS Axis Deviation

As shown in Table 1, patients who had COLD without cor pulmonale had a mean QRS axis of $53.5 \pm 21.2^\circ$ while the group with cor pulmonale had a significantly shifted QRS axis to the right of $89.0 \pm 12.4^\circ$ ($p < 0.001$). There was also no sex difference. All but one of the patients without cor pulmonale had a normal axis (Table 2), while 51.7% of those with cor pulmonale had an abnormal right axis deviation. Thus the sensitivity of RAD in detecting cor pulmonale in COLD was 51.7% while the specificity was 98% and the positive predictive value was 93.8%.

ST/T Wave Changes

Abnormal ST segment changes and T waves were more prevalent in patients who had cor pulmonale associated with COLD (Table 2). The sensitivity was 35.9% in those who had cor pulmonale as against 9.4% in those who did not have cor pulmonale. (Table 2). The specificity was 90% while the positive predictive value was 73.7%.

DISCUSSION

This study shows that there is no shift of the electrical axis of the P and QRS waves of the ECG in Nigerians with COLD alone, but the axis shifts to the right significantly with the development of cor pulmonale. This is contrary to the impression usually given that a P wave axis of $\geq 90^\circ$ is highly suggestive of COLD.³ The shift of the P wave axis in COLD has been said to be due to over inflation of the lungs and not to be seen in interstitial lung diseases.^{4,5} Our patients here had unequivocal COLD with definite hyperinflation of the lungs but virtually all those who had COLD without cor pulmonale had P wave axis less than 90° . Their mean P wave axis was not higher than that described by Araoye for normal Nigerians above 40 years of age.⁹ In this study, 88.2% of those who had a shift of the P wave greater than 90 degrees were those who had cor pulmonale associated with COLD. The findings therefore suggest that a wave shift in COLD patients is associated with the development of right ventricular hypertrophy (cor pulmonale), rather than hyperinflation as earlier suggested.^{4,5}

Similarly there was no axis shift of the mean QRS complex in the patients without cor pulmonale while there was a significant shift to the right among those with cor pulmonale (Table 3). Virtually all those who had right axis deviation (QRS axis $> 90^\circ$) were those who had cor pulmonale. This tends to indicate that the development of right axis deviation of the QRS complex in our patients with COLD suggests the development of cor pulmonale. Although right axis deviation of the QRS complex is usually one of the criteria suggesting right ventricular hypertrophy,¹⁶ in the presence of COLD, it is said to be non-specific.¹⁷ However the observation in this study shows that it has a high specificity of 93.8% for cor pulmonale in this population of COLD patients.

Abnormalities of ST and T wave were also significantly associated with the development of cor pulmonale. This may be secondary to the right ventricular hypertrophy and consequent delay of ventricular

	Cor Pulmonale Status	
	Present	Absent
PWave Axis (Degrees)* Mean \pm SD		
All (n = 53)	83.9 ± 12.7	64.7 ± 10.6
Male	85.8 ± 11.8	65.0 ± 11.4
Female	85.8 ± 12.7	64.5 ± 9.3
QRS Axis (Degrees) Mean \pm SD (Reange)		
All	89.0 ± 22.4 (30–140)	53.5 ± 21.2 (10–110)
Male	89.7 ± 30.8 (30–140)	56.2 ± 20.1 (15–110)
Female	88.2 ± 17.7 (70–120)	50.8 ± 21.7 (10–80)

Table 2: Distributions of Study Subjects by Presence of Changes in QRS Axis and ST/T Changes

	Number (%)		
	Cor Pulmonale Present	Cor Pulmonare Absent	All
QRS Axis			
$\geq 90^\circ$	14 (48.3)	48 (98.0)	62 (79.5)
$< 90^\circ$	15 (51.7)	1 (2.0)	17 (20.5)
Total	29 (100.0)	49 (100.0)	78 (100.0)
Rightward PWave Axis			
$\geq 90^\circ$	21 (58.3)	51 (96.2)	72 (80.9)
$< 90^\circ$	15 (41.7)	1 (3.8)	17 (19.1)
Total	36 (100.0)	53 (100.0)	89 (100.0)
ST Segment / T Wave Changes			
Present	14 (35.9)	5 (9.3)	19 (20.7)
Absent	25 (64.1)	48 (90.7)	73 (79.3)
Total	39 (100.0)	53 (100.0)	78 (100.0)

activation which leads to earlier recovery of the endocardium, and as repolarisation proceeds from the endocardium to the epicardium, it leads to ST depression and inverted T waves. These may occur in leads V1 and V2, but as a rule significant ST and T wave abnormalities are indicative of moderate or severe right ventricular hypertension.⁴ Only nine percent of those who did not have associated cor pulmonale had ST and T wave changes.

The study shows that a shift of the electrical axis of the heart occurs in COLD patients mainly with the development of right ventricular hypertrophy (cor pulmonale), rather than the hyperinflation. Right axis deviation of the QRS wave appears to be more sensitive and specific in this regard than a shift of the P wave axis.

Duality of interest: Nil.

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