Section: General Medicine

Original Research Article

CLINICAL STUDY OF P WAVE AXIS IN DIAGNOSING EMPHYSEMA AND ASSESSMENT OF ITS SEVERITY

R. Shanmugapriya[1], G. Ayyappan[2], M Balamurugan[3]

[1]Junior Resident, Department of General Medicine, Government Medical College & Hospital, Pudukottai, Tamilnadu, India
[2]Senior Resident, Department of General Medicine, Government Medical College & Hospital, Pudukottai, Tamilnadu, India
[3]Assistant Professor, Department of General Medicine, Government Medical College & Hospital, Pudukottai, Tamilnadu, India

Received : 27/11/2024
Received in revised form : 22/01/2025
Accepted : 06/02/2025

Keywords:
Chronic obstructive pulmonary disease, Electrocardiography, Vertical P-wave axis, Emphysema.

Corresponding Author:
Dr. M Balamurugan,
Email: balaanavai@gmail.com

DOI: 10.47009/jamp.2025.7.1.126

Source of Support: Nil,
Conflict of Interest: None declared

Int J Acad Med Pharm
2025; 7 (1); 640-643

Abstract

Background: The vertical P-wave axis observed on electrocardiography (ECG) is a valuable criterion for screening patients with chronic obstructive pulmonary disease (COPD). However, the clinical characteristics of patients with COPD exhibiting a vertical P-wave axis have not been fully elucidated. This study aimed to investigate the clinical features and characteristics of patients with COPD presenting with a vertical P-wave axis on ECG as a potential diagnostic marker for emphysema. **Materials and Methods:** This prospective comparative study included COPD patients aged > 18 years with emphysema severity and P-wave axis deviation. Two groups (individuals with mild to moderate emphysema and individuals with severe emphysema), each consisting of 60 patients, were meticulously formed for the analysis. Patient data, including demographics, medical history, electrocardiograms, and imaging findings, were systematically collected. Emphysema severity was evaluated using pulmonary function testing, specifically FEV1 measurement. **Result:** There was no significant difference in age between groups (p=0.364). The gender distribution between the groups showed an equal representation. A higher prevalence of current and ex-smokers was observed in patients with emphysema (p<0.001). Cardiac assessments revealed a significantly higher mean P-wave axis (72.0±11.1°) and more frequent vertical axis (>60°) in the emphysema group than in the non-emphysema group (47.6±9.6°; p<0.001). Additionally, emphysema was associated with specific P-wave axis categories, particularly with a higher prevalence of a 75–90-degree axis. **Conclusion:** P-axis verticalisation is highly effective for screening emphysema, and the degree of verticalisation provides gross quantification of the disease. Further research should explore the underlying mechanisms and refine diagnostic strategies for integrated cardiopulmonary management in patients with COPD.

INTRODUCTION

Chronic obstructive pulmonary disease (COPD) is a prevalent, largely preventable, and manageable condition characterised by persistent respiratory symptoms and airflow limitation. causes lung over-expansion and elevated pulmonary artery pressure, which can alter the anatomy of the heart. Notably, emphysematous changes and airway wall thickening identified through chest computed tomography (CT) are closely linked to the degree of airflow limitation in COPD patients.[1-3] The degree of airflow restriction in individuals with COPD correlates closely with emphysematous changes and increased airway wall thickness observed on chest CT scans. These alterations can also manifest as abnormalities in electrocardiogram (ECG) readings, particularly in the P-wave axis. Previous studies, including our own, have explored various biomarkers such as serum Clara cell secretory protein-16, eosinophil count, and neutrophil-lymphocyte ratio to predict exacerbations in COPD patients.[1,4-6]

Furthermore, COPD commonly coexists with cardiovascular diseases, which is often evidenced by distinctive ECG abnormalities. These irregularities encompass rhythm, axis, and electrical conduction abnormalities among COPD patients.[1,7] The P-wave and QRS axes, assessed via ECG, offer insights into atrial and ventricular depolarisation patterns, respectively. Specifically, the vertical P-wave axis serves as a valuable screening criterion for COPD and reflects the extent of emphysematous changes observed on chest CT scans. Moreover, both the P-wave and QRS axes are linked to the severity of

ISSN (O): 2687-5365; ISSN (P): 2753-6556

airflow obstruction and lung hyperinflation in COPD.[8]

Surprisingly, prior clinical evidence on the correlation between the clinical characteristics of COPD patients and vertical P-wave axes is lacking. Thus, this study aimed to explore the association between emphysema severity and alterations in the P-wave axis on ECGs, with the aim of enhancing diagnostic and management strategies for cardiovascular complications in patients with COPD. Understanding these cardiopulmonary interactions is crucial for optimising the clinical care of individuals with this prevalent respiratory condition.

MATERIALS AND METHODS

This prospective comparative study was conducted on COPD patients aged > 18 years with emphysema severity and P-wave axis deviation in the Department of General Medicine for one year at Government Medical College & Hospital, Pudukottai. Two groups (individuals with mild to moderate emphysema and individuals with severe emphysema), each consisting of 60 patients, were meticulously formed for the analysis.

Inclusion Criteria

Patients diagnosed with Chronic Obstructive Pulmonary Disease (COPD), aged over 18 years, emphysema severity was confirmed through diagnostic evaluation, and the presence of P-wave axis deviation was included.

Exclusion Criteria

Patients with other significant cardiac or pulmonary conditions that could confound the study outcomes, and pregnant or lactating women were excluded.

Data collection

Complete medical history, smoking history, and information concerning current pharmacologic treatments were obtained from each participant. Patient data, including demographics, medical history, electrocardiograms, and imaging findings, were systematically collected. Emphysema severity was evaluated using pulmonary function testing, specifically FEV1 measurement.

Statistical Analysis

Data analysis was conducted using the SPSS software. Data are presented as mean ± standard deviation (SD) for continuous variables. Comparisons between the two groups were performed using Student's t-test. Categorical variables were represented by frequency (percentages), and a comparison between the two groups was performed using the chi-square test. The p value was set at $p < 0.05$.

RESULTS

This study compared the demographic and cardiac characteristics of individuals with mild to moderate emphysema and those with severe emphysema. No significant differences in age were observed between the groups ($p = 0.364$). The gender distribution between the groups showed an equal representation. A higher prevalence of current and ex-smokers was observed among patients with emphysema ($p < 0.001$) [Table 1].

Table 1: Demographic characteristics of study participants.

Variables	Mild to Moderate emphysema	Severe Emphysema	P value
Age (mean + SD)	66.3±6.8	65.7±7.2	0.364
Gender (M/F) (%)	20/10 (66.7/33.3)	20/10 (66.7/33.3)	
Ex-smoker	15 (50)	5 (16.7)	< 0.001
Non-smoker	0 (0)	20 (66.7)	

Cardiac assessments revealed a significantly higher mean P-wave axis (72.0±11.1°) and more frequent vertical axis (>60°) in the emphysema group than in the non-emphysema group (47.6±9.6°; $p<0.001$). Additionally, emphysema was associated with specific P-wave axis categories, particularly with a higher prevalence of a 75-90-degree axis. These findings suggest a potential relationship between emphysema, smoking, and altered cardiac electrical conduction, underscoring the importance of integrated pulmonary and cardiac care in these individuals [Table 2].

Table 2: Cardiac assessments among the study participants

Variables		Mild to Moderate emphysema	Severe Emphysema	P value
P wave axis	Mean ± SD	72.0+11.1	47.6+9.6	<0.001
P wave axis classification	Vertical (p wave axis >60)	26 (86.7%)	3(10%)	<0.001
	Not vertical (p wave axis >60)	4 (13.3%)	27 (90%)	
P wave axis categories	75-90	14 (46.7%)	0 (0%)	<0.001
	61-74	12 (40%)	3 (10%)	
	Up to 60	4 (13.35)	27 (90%)	

ISSN (O): 2687-5365; ISSN (P): 2753-6556

DISCUSSION

The present study demonstrated a strong correlation between emphysema severity and altered P-wave axis in ECGs, indicating potential cardiac implications. Patients with emphysema showed significantly higher mean P-wave axis values and a higher prevalence of vertical P-wave axis (>60°), suggesting right atrial enlargement. Thus, these findings highlight the importance of ECG assessment in detecting cardiovascular complications early in COPD, especially in emphysema cases with a history of smoking, to optimise patient care and outcomes.

Similar results have been reported by Chhabra et al., who demonstrated that this lone criterion can be used as an effective screen for pulmonary hyperinflation, using a few simple parameters as in our study.[9] Khan et al. observed that significant changes, such as a reduction in P-wave amplitude and a leftward rotation of the P-wave axis, have been observed following effective treatment of acute exacerbations of COPD.[10] The superiority of the P-wave axis over the QRS axis may be attributed to the direct reflection of right atrium displacement by lung hyperinflation.

In our study, we found that the BMI was significantly lower in patients with a P-wave axis >75° than in those with a P-wave axis ≤75°. These findings align with previous reports demonstrating an association between BMI and the P-wave axis.[11] Bardakci et al. identified an early onset of cardiologic pathologies in a notable percentage of COPD patients, with right branch block and diastolic dysfunction observed in 26.3% and 57.9% of patients, respectively. These findings underscore the significance of early intervention for cardiac pathologies to enhance the management outcomes of COPD.[12]

Mohammed et al. reported the prevalence of left ventricular diastolic dysfunction (LVDD) in patients with COPD to be approximately 25%,[13] while Huang et al. reported a higher rate of 65%.[14] These varying rates underscores the significance of assessing and managing LVDD in patients with COPD, particularly in those with severe disease. Additionally, a systematic review and meta-analysis revealed a significant association between COPD and the risk of atrial fibrillation (AF) (RR = 1.99, 95% CI: 1.46–2.70), ventricular arrhythmias (VA) (RR = 2.01, 95% CI: 1.42–2.85), and sudden cardiac death (SCD) (RR = 1.68, 95% CI: 1.28–2.21). These findings suggest that COPD is linked to increased risks of AF, VA, and SCD.[15]

ECG abnormalities are frequent in patients with COPD, particularly in those with moderate to severe disease. These abnormalities primarily stem from factors such as hypoxia, right ventricular hypertrophy or failure due to pulmonary hypertension, changes in the heart position relative to electrode placement, alterations in cardiac conduction, and medications used for COPD treatment. Given these factors, routine ECG analysis can aid in patient management, treatment optimization, and monitoring for potential side effects.[16]

Limitations of the study

We were unable to assess the anatomical axis by using cardiac or magnetic resonance imaging. Therefore, future investigations using advanced cardiac imaging techniques are needed to ascertain whether the observed electrical rotation correlates with the rotation of the anatomical heart axis. We did not evaluate the association with the QRS axis, which warrants further exploration. Additionally, larger sample sizes and inclusion of an adequate number of younger patients are necessary for more comprehensive analyses in future studies.

CONCLUSION

In conclusion, P-axis verticalisation is a highly effective screening tool for emphysema, with the degree of verticalisation offering an approximate quantification of disease severity. Future research should delve into the underlying mechanisms of this phenomenon and refine diagnostic strategies to facilitate integrated cardiopulmonary management in patients with COPD.

REFERENCES

1. Otake S, Chubachi S, Nakayama S, Sakurai K, Irie H, Hashiguchi M, et al. Clinical utility of the electrocardiographic P-wave axis in patients with chronic obstructive pulmonary disease. Respiration 2022;101:345–52. https://doi.org/10.1159/000519668.
2. Vogelmeier CF, Criner GJ, Martinez FJ, Anzueto A, Barnes PJ, Bourbeau J, et al. Global strategy for the diagnosis, management, and prevention of chronic obstructive lung disease 2017 report. GOLD executive summary. Am J Respir Crit Care Med 2017;195:557–82. https://doi.org/10.1164/rccm.201701-0218pp.
3. Hasegawa M, Nasuhara Y, Onodera Y, Makita H, Nagai K, Fuke S, et al. Airflow limitation and airway dimensions in chronic obstructive pulmonary disease. Am J Respir Crit Care Med 2006;173:1309–15. https://doi.org/10.1164/rccm.200601-037oc.
4. Lomas DA, Silverman EK, Edwards LD, Miller BE, Coxson HO, Tal-Singer R, et al. Evaluation of serum CC-16 as a biomarker for COPD in the ECLIPSE cohort. Thorax 2008;63:1058–63. https://doi.org/10.1136/thx.2008.102574.
5. Mochimaru T, Chubachi S, Irie H, Sakurai K, Okuzumi S, Sunata K, et al. Blood eosinophil and neutrophil counts differentially identify frequent exacerbation in patients with COPD with physician-diagnosed asthma and COPD. Allergol Int 2021;70:255–7. https://doi.org/10.1016/j.alit.2020.09.004.
6. Sakurai K, Chubachi S, Irie H, Tsutsumi A, Kameyama N, Kamatani T, et al. Clinical utility of blood neutrophil-lymphocyte ratio in Japanese COPD patients. BMC Pulm Med 2018;18. https://doi.org/10.1186/s12890-018-0639-z.
7. Goudis CA, Konstantinidis AK, Ntalas IV, Korantzopoulos P. Electrocardiographic abnormalities and cardiac arrhythmias in chronic obstructive pulmonary disease. Int J Cardiol 2015;199:264–73. https://doi.org/10.1016/j.ijcard.2015.06.096.
8. Alter P, Watz H, Kahnert K, Rabe KF, Biertz F, Fischer R, et al. Effects of airway obstruction and hyperinflation on electrocardiographic axes in COPD. Respir Res 2019;20. https://doi.org/10.1186/s12931-019-1025-y.
9. Chhabra L, Sareen P, Perli D, Srinivasan I, Spodick DH. Vertical P-wave axis: the electrocardiographic synonym for pulmonary emphysema and its severity. Indian Heart J

ISSN (O): 2687-5365; ISSN (P): 2753-6556

2012;64:40–2. https://doi.org/10.1016/s0019-4832(12)60009-1.
10. Khan A, Zakaria M, Khan S, Iftikhar R. Changes in P-wave amplitude and axis after treatment of chronic obstructive pulmonary disease exacerbation: Changes in P-Wave Amplitude and Axis in COPD. Pak Armed Forces Med J 2015;65:48–52. https://www.pafmj.org/PAFMJ/article/view/662
11. Rangel MO, O'Neal WT, Soliman EZ. Usefulness of the electrocardiographic P-wave axis as a predictor of atrial fibrillation. Am J Cardiol 2016;117:100–4. https://doi.org/10.1016/j.amjcard.2015.10.013.
12. Ozkarafakili MA, Bardakci Mİ, Sumerkan MC. Evaluation of the Cardiac Status of Newly Diagnosed Chronic Obstructive Pulmonary Disease Patients at First Admission. Indian J Respir Care 2024;12:308–14. https://doi.org/10.5005/jp-journals-11010-1074.
13. Mohammed YM, El-Shahid GS, Osman NM, Abd El-Hameed NQ. Cardiac evaluation of patients with chronic obstructive pulmonary disease using echocardiography. Egypt J Bronchol. 2019;13:12–6. https://doi.org/10.4103/ejb.ejb_2_18.
14. Huang YS, Feng YC, Zhang J, Bai L, Huang W, Li M, et al. Impact of chronic obstructive pulmonary diseases on left ventricular diastolic function in hospitalized elderly patients. Clin Interv Aging 2015;10:81–7. https://doi.org/10.2147/cia.s71878.
15. Liu X, Chen Z, Li S, Xu S. Association of chronic obstructive pulmonary disease with arrhythmia risks: A systematic review and meta-analysis. Front Cardiovasc Med 2021;8. https://doi.org/10.3389/fcvm.2021.732349.
16. Valente D, Segreti A, Celeski M, Polito D, Vicchio L, Di Gioia G, et al. Electrocardiographic alterations in chronic obstructive pulmonary disease. J Electrocardiol 2024. https://doi.org/10.1016/j.jelectrocard.2024.05.083.

ISSN (O): 2687-5365; ISSN (P): 2753-6556