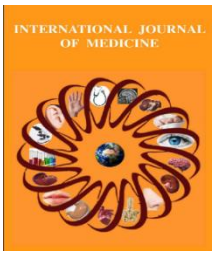
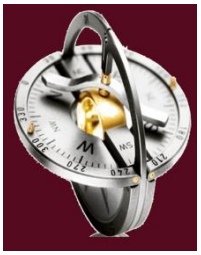


International Journal of Medicine
ISSN (P): 1468-3814; ISSN (e): 2667-7008

https://www.theinternationalmedicine.com



Volume: 7(1) 2025

Original Research

Clinico-Radiological Correlation of Chest X-ray and High-Resolution Computed Tomography Findings in Patients with Chronic Obstructive Pulmonary Disease: An Observational Study

Dr. Anu Priya Jesu Karuniya Thilak[1*], Dr. Suresh Samuel[2], Dr. Praveen Immanuel[3]

1Assistant Professor, Department of Radiodiagnosis, Kanyakumari Medical Mission Research Centre and Hospitals, Muttom, Kanyakumari District, Tamil Nadu, India

2Assistant Professor, Department of General Medicine, Kanyakumari Medical Mission Research Centre and Hospitals, Muttom, Kanyakumari District, Tamil Nadu, India

3Assistant Professor, Department of General Medicine, Kanyakumari Medical Mission Research Centre and Hospitals, Muttom, Kanyakumari District, Tamil Nadu, India

Received: 18 Dec 2024 / Accepted: 05 Jan 2025

Abstract

Background: Chronic obstructive pulmonary disease (COPD) is a heterogeneous respiratory disorder in which symptoms, spirometric impairment and structural lung changes do not always progress in parallel. Chest X-ray is commonly used as an initial imaging tool, whereas high-resolution computed tomography (HRCT) provides detailed assessment of emphysema, airway disease and associated complications. *Objectives:* To evaluate chest X-ray and HRCT findings in clinically diagnosed COPD patients and to assess their correlation with clinical and spirometric severity. *Methods:* This observational study was conducted in the Department of Radiodiagnosis, Kanyakumari Medical Mission Research Centre and Hospitals, Muttom, Kanyakumari District, Tamil Nadu, India, from February 2024 to July 2024. A total of 100 clinically diagnosed COPD patients were evaluated using clinical history, spirometric severity grading, chest X-ray and HRCT chest. Imaging findings were compared, and HRCT severity score was correlated with selected clinical parameters. *Results:* The mean age was 61.8 ± 8.9 years, and 74.0% were males. Smoking history was present in 68.0% of patients. Moderate COPD was observed in 38.0%, severe COPD in 34.0%, and very severe COPD in 18.0%. Chest X-ray showed abnormalities in 83.0%, while HRCT detected abnormalities in 97.0%. HRCT identified emphysema in 78.0%, bronchial wall thickening in 52.0%, air trapping in 47.0%, bullae in 25.0% and bronchiectatic changes in 22.0%. HRCT severity score showed strong negative correlation with FEV1 percentage predicted and positive correlation with mMRC dyspnoea grade. *Conclusion:* HRCT was superior to chest X-ray in detecting COPD-related structural abnormalities and showed stronger clinico-radiological correlation with disease severity.

Keywords: *Chronic obstructive pulmonary disease; Chest X-ray; High-resolution computed tomography; Emphysema; Spirometry; Clinico-radiological correlation.*

Introduction

Chronic obstructive pulmonary disease (COPD) is a common, preventable and treatable respiratory disorder characterized by persistent respiratory symptoms and airflow limitation due to airway and alveolar abnormalities. The disease is usually related to exposure to noxious particles or gases, particularly tobacco smoke, biomass fuel exposure and occupational pollutants. Recent GOLD documents emphasize that COPD is clinically diverse, with variable contributions from chronic bronchitis, emphysema, small airway disease, vascular involvement and systemic consequences [1,2]. This heterogeneity creates a practical challenge in routine care because symptom burden, spirometric impairment and radiological structural damage do not always show identical severity in the same patient.

Spirometry remains the essential test for confirming airflow obstruction and grading disease severity. The forced expiratory volume in one second, especially when expressed as percentage predicted, provides an objective functional measure and is widely used for COPD staging [3]. However, spirometry is a global physiological test and does not localize the anatomical site, pattern or distribution of disease. Patients with similar FEV1 values can show different structural phenotypes on imaging, including emphysema-predominant disease, airway-predominant disease, mixed disease, bullous change, bronchiectatic change and pulmonary vascular enlargement [4,5]. Therefore, imaging has an important complementary role in understanding the morphological expression of COPD.

Address for Correspondence Dr. Anu Priya Jesu Karuniya Thilak, Assistant Professor, Department of Radiodiagnosis, Kanyakumari Medical Mission Research Centre and Hospitals, Muttom, Kanyakumari District, Tamil Nadu, India

DOI: 10.61336/im/25-01-14

This is an Open Access article under the terms of the Creative Commons Attribution-Noncommercial 4.0 International License (https://creativecommons.org/licenses/by-nc/4.0/)

Chest X-ray is often the first imaging investigation performed in COPD because it is inexpensive, available and useful for identifying hyperinflation, flattened diaphragm, vascular pruning, bullae, pulmonary arterial prominence and alternative diagnoses. Nevertheless, the sensitivity of chest radiography is limited, especially in early emphysema, mild airway disease and regional air trapping [6,7]. A normal or near-normal radiograph does not exclude clinically relevant COPD-related structural damage. This limitation is particularly important in symptomatic patients with discordance between clinical findings and radiographic appearance.

High-resolution computed tomography (HRCT) provides superior spatial resolution and better visualization of lung parenchyma, airways and pulmonary vasculature. HRCT can characterize emphysema subtypes such as centrilobular, panlobular and paraseptal emphysema, in addition to detecting bronchial wall thickening, air trapping, mosaic attenuation, bronchiectasis and bullous disease [5,8]. Quantitative and semiquantitative CT parameters have shown meaningful association with airflow obstruction, exacerbation risk and physiological impairment [9,10]. Indian studies have also reported that HRCT findings correlate with clinical characteristics and spirometric indices in COPD patients [11,12].

The present study was conducted to evaluate the clinico-radiological profile of COPD patients attending a tertiary care radiodiagnosis department. The primary objective was to compare chest X-ray and HRCT findings in clinically diagnosed COPD patients. The secondary objectives were to assess the distribution of HRCT abnormalities, determine their relationship with spirometric disease severity and evaluate correlation between HRCT severity score and selected clinical parameters

METHODOLOGY

Study design and setting: This cross-sectional observational study was conducted in the Department of Radiodiagnosis, Kanyakumari Medical Mission Research Centre and Hospitals, Muttom, Kanyakumari District, Tamil Nadu, India, from February 2024 to July 2024. The hospital is a tertiary care referral centre providing outpatient, inpatient, emergency, pulmonary medicine and radiodiagnostic services to patients from Kanyakumari district and adjoining regions.

Study population: The study included 100 adult patients with clinically diagnosed COPD who were referred for chest imaging during the study period. COPD diagnosis was based on compatible clinical symptoms, exposure history and spirometric evidence of airflow limitation as per standard clinical practice. Disease severity was categorized using FEV1 percentage predicted, in accordance with GOLD-based spirometric grading [1,2].

Inclusion criteria: Patients aged 40 years and above with clinical features suggestive of COPD, including chronic dyspnoea, cough, expectoration, wheeze or recurrent exacerbations, and available chest X-ray, HRCT chest and spirometric records were included. Both smokers and non-smokers with relevant exposure history were eligible.

Exclusion criteria: Patients with active pulmonary tuberculosis, lung malignancy, interstitial lung disease, acute pneumonia, previous lung resection, major chest wall deformity, inadequate imaging quality, incomplete clinical records or inability to complete spirometric evaluation were excluded.

Clinical assessment: Demographic variables, exposure history, duration of symptoms, smoking status, biomass fuel exposure, dyspnoea severity, cough, expectoration, wheeze and previous exacerbation history were recorded. Dyspnoea was assessed using the modified Medical Research Council scale. Oxygen saturation and FEV1 percentage predicted were documented from available clinical records. Spirometry was performed according to accepted technical standards, and results were interpreted using standardized quality principles [3].

Imaging protocol and radiological assessment: Posteroanterior chest X-ray was assessed for hyperinflation, flattened diaphragm, tubular or vertical heart, increased bronchovascular markings, prominent hilar shadows, bullous changes and pulmonary arterial prominence. HRCT chest was evaluated for emphysema, emphysema subtype, bronchial wall thickening, air trapping, mosaic attenuation, bullae, bronchiectatic changes and pulmonary arterial dilatation. HRCT findings were interpreted using established morphological concepts for COPD imaging and emphysema classification [5,8].

Statistical analysis: Data were entered into a spreadsheet and analyzed using descriptive and inferential statistical methods. Categorical variables were expressed as frequency and percentage. Continuous variables were expressed as mean and standard deviation. Chest X-ray and HRCT findings were compared using proportions. Correlation between HRCT severity score and clinical variables was assessed using correlation coefficients. A p-value less than 0.05 was considered statistically significant.

Ethical considerations: The study was conducted after approval from the institutional ethics committee. Informed consent was obtained as applicable according to institutional policy. Patient identity was kept confidential, and data were used only for academic and research purposes.

Results

A total of 100 patients with clinically diagnosed chronic obstructive pulmonary disease were included in the study. The mean age of the patients was 61.8 ± 8.9 years. Most patients were males, and smoking was the most common exposure history. Dyspnoea was the leading clinical symptom, followed by chronic cough, expectoration and wheeze. Most patients had moderate to severe COPD on spirometric assessment. The demographic and clinical profile is shown in Table 1.

Table 1. Demographic, exposure, clinical and spirometric profile of the study population

Variable	Frequency / Mean	Percentage
Total patients	100	100.0
Mean age, years	61.8 ± 8.9	-
40-50 years	12	12.0
51-60 years	28	28.0
61-70 years	39	39.0
>70 years	21	21.0
Male	74	74.0
Female	26	26.0
Smoking history	68	68.0
Biomass fuel exposure	18	18.0
Combined smoking and biomass exposure	8	8.0
No definite exposure history	6	6.0
Mean duration of symptoms, years	6.3 ± 3.2	-
Dyspnoea	94	94.0
Chronic cough	82	82.0
Expectoration	76	76.0
Wheeze	64	64.0

Recurrent exacerbations	36	36.0
Mean FEV1 predicted, %	52.6 ± 16.8	-
Mild COPD	10	10.0
Moderate COPD	38	38.0
Severe COPD	34	34.0
Very severe COPD	18	18.0

Chest X-ray showed abnormal findings in 83 patients, while HRCT detected abnormalities in 97 patients. Hyperinflation and flattened diaphragm were the commonest chest X-ray findings. On HRCT, emphysematous changes were most frequent, followed by bronchial wall thickening, air trapping, mosaic attenuation, bullae and bronchiectatic changes. HRCT identified structural abnormalities in several patients with normal or near-normal chest X-ray findings. The comparative radiological findings are presented in Table 2.

Table 2. Comparison of chest X-ray and HRCT findings in COPD patients

Radiological finding	Chest X-ray n (%)	HRCT n (%)
Any radiological abnormality	83 (83.0)	97 (97.0)
Hyperinflation / emphysematous changes	65 (65.0)	78 (78.0)
Flattened diaphragm	58 (58.0)	-
Increased bronchovascular / airway wall changes	42 (42.0)	52 (52.0)
Tubular / vertical heart	35 (35.0)	-
Prominent hilar shadows	24 (24.0)	-
Bullous changes	18 (18.0)	25 (25.0)
Pulmonary arterial prominence / dilatation	16 (16.0)	18 (18.0)
Air trapping	-	47 (47.0)
Mosaic attenuation	-	28 (28.0)
Bronchiectatic changes	-	22 (22.0)
Normal or near-normal imaging	17 (17.0)	3 (3.0)

Among HRCT patterns, centrilobular emphysema was the predominant type, followed by panlobular and paraseptal emphysema. The frequency and severity of HRCT abnormalities increased with worsening COPD severity. Patients with severe and very severe COPD showed higher rates of emphysema and higher mean HRCT severity scores. The distribution of HRCT findings according to clinical severity is shown in Table 3.

Table 3. HRCT findings according to COPD severity

COPD severity	Patients n	Any HRCT abnormality n (%)	Emphysema n (%)	Mean HRCT severity score
Mild	10	8 (80.0)	5 (50.0)	3.1 ± 1.2
Moderate	38	37 (97.4)	27 (71.1)	6.2 ± 2.3
Severe	34	34 (100.0)	29 (85.3)	10.1 ± 2.8
Very severe	18	18 (100.0)	17 (94.4)	13.4 ± 3.1
Total	100	97 (97.0)	78 (78.0)	-

Clinico-radiological correlation showed that HRCT severity score had a strong negative correlation with FEV1 percentage predicted. A positive correlation was observed between HRCT severity score and mMRC dyspnoea grade, symptom duration, number of exacerbations and chest X-ray severity score. The strength of correlation was higher for HRCT than chest X-ray, indicating better radiological characterization of COPD severity by HRCT. The correlation analysis is presented in Table 4.

Table 4. Correlation of clinical parameters with HRCT severity score

Clinical parameter	Correlation coefficient (r)	p-value
Age	0.28	0.005
Duration of symptoms	0.41	<0.001
mMRC dyspnoea grade	0.64	<0.001
Number of exacerbations in previous year	0.49	<0.001
FEV1 percentage predicted	-0.72	<0.001
Oxygen saturation	-0.38	<0.001
Chest X-ray severity score	0.55	<0.001

Overall, HRCT demonstrated better detection of COPD-related structural lung changes than chest X-ray. HRCT was particularly useful for identifying emphysema pattern, air trapping, bronchial wall thickening, bullous changes, bronchiectatic changes and mosaic attenuation. The findings showed that HRCT correlated more strongly with clinical and spirometric severity than chest radiography.

Discussion

The present observational study evaluated the clinico-radiological correlation of chest X-ray and HRCT findings in 100 patients with clinically diagnosed COPD. The study population showed a typical COPD profile, with older age, male predominance and smoking as the dominant exposure. Most patients had moderate to severe airflow limitation, and dyspnoea was the leading symptom. This pattern is consistent with current COPD concepts, where persistent respiratory symptoms and airflow limitation arise from variable involvement of airway and alveolar compartments [1,2].

Chest X-ray detected abnormalities in 83.0% of patients, with hyperinflation and flattened diaphragm being the commonest findings. These features are expected in established COPD because air trapping and lung hyperinflation lower and flatten the diaphragm, increase lung lucency and alter cardiac configuration. However, 17.0% of patients had normal or near-normal chest radiographs despite clinical disease. This reinforces the recognized limitation of chest radiography, especially for early emphysema, subtle airway disease and regional air trapping [4,7]. Miniati et al. also reported that HRCT provides better structural assessment of emphysema than chest radiography in COPD patients [7].

HRCT detected abnormalities in 97.0% of patients and showed a wider spectrum of disease than chest X-ray. Emphysema was the most frequent HRCT finding, followed by bronchial wall thickening, air trapping, mosaic attenuation, bullae and bronchiectatic changes. Centrilobular emphysema was the predominant emphysema subtype, which agrees with the known relationship between smoking and centrilobular destruction [5,6]. HRCT-based characterization is clinically useful because COPD is not a single morphological entity. The Fleischner Society statement highlights emphysema subtypes, airway wall changes, bronchiectasis and pulmonary arterial enlargement as important CT-definable features in COPD [5].

The present study also showed progressive increase in HRCT severity score from mild to very severe COPD. HRCT severity score correlated negatively with FEV1 percentage predicted and positively with mMRC dyspnoea grade, duration of symptoms and exacerbation frequency. Similar associations have been described in previous studies correlating HRCT findings with spirometric indices and clinical characteristics [11,12]. Quantitative CT studies have further demonstrated that emphysema, air trapping and airway wall thickness are independently associated with pulmonary function impairment [9,10]. Koo et al. observed that parenchymal attenuation and airway parameters predicted pulmonary function across COPD severity groups [13].

These findings support the complementary role of HRCT in patients with COPD, particularly when clinical severity is not fully explained by chest radiography or spirometry alone. HRCT provides anatomical detail, identifies phenotypes and detects complications that influence treatment planning, prognosis and follow-up. A recent systematic review also confirmed significant correlations between quantitative CT parameters and lung function in COPD [14]. In routine clinical practice, chest X-ray remains useful as an initial screening tool, while HRCT offers superior phenotypic and structural assessment in selected patients.

Limitations
This study had a single-centre observational design with a sample size of 100 patients, limiting external validity. Quantitative CT software was not used, and HRCT severity scoring was based on radiological assessment. Follow-up imaging was not performed, limiting evaluation of progression. Interobserver agreement between radiologists was not separately analysed. Clinical outcomes after treatment and exacerbation follow-up were outside the study scope

Conclusion
In this observational study of 100 COPD patients, HRCT was superior to chest X-ray in detecting structural lung abnormalities and defining disease morphology. Chest X-ray remained useful for identifying hyperinflation, flattened diaphragm and gross bullous changes, but HRCT detected additional emphysema, airway wall thickening, air trapping, mosaic attenuation and bronchiectatic changes. HRCT severity score showed strong negative correlation with FEV1 percentage predicted and positive correlation with dyspnoea grade, symptom duration and exacerbation history. These findings support the use of HRCT as a valuable adjunct to clinical assessment, chest radiography and spirometry for comprehensive evaluation of COPD severity and phenotype, particularly in symptomatic patients with equivocal radiographic findings in clinical practice.

References
1. Venkatesan P. GOLD COPD report: 2025 update. Lancet Respir Med. 2025 Jan;13(1):e7-e8. doi:10.1016/S2213-2600(24)00413-2. PMID:39647487.
2. Agusti A, Celli BR, Criner GJ, Halpin D, Anzueto A, Barnes P, et al. Global Initiative for Chronic Obstructive Lung Disease 2023 Report: GOLD Executive Summary. Am J Respir Crit Care Med. 2023 Apr 1;207(7):819-837. doi:10.1164/rccm.202301-0106PP. PMID:36856433.
3. Graham BL, Steenbruggen I, Miller MR, Barjaktarevic IZ, Cooper BG, Hall GL, et al. Standardization of Spirometry 2019 Update: An Official American Thoracic Society and European Respiratory Society Technical Statement. Am J Respir Crit Care Med. 2019 Oct 15;200(8):e70-e88. doi:10.1164/rccm.201908-1590ST. PMID:31613151.
4. Raoof S, Shah M, Make B, Allaqaband H, Bowler R, Fernando S, et al. Lung Imaging in COPD Part 1: Clinical Usefulness. Chest. 2023 Jul;164(1):69-84. doi:10.1016/j.chest.2023.03.007. PMID:36907372.
5. Lynch DA, Austin JHM, Hogg JC, Grenier PA, Kauczor HU, Bankier AA, et al. CT-definable subtypes of chronic obstructive pulmonary disease: a statement of the Fleischner Society. Radiology. 2015 Oct;277(1):192-205. doi:10.1148/radiol.2015141579. PMID:25961632.
6. Takahashi M, Fukuoka J, Nitta N, Takazakura R, Nagatani Y, Murakami Y, et al. Imaging of pulmonary emphysema: a pictorial review. Int J Chron Obstruct Pulmon Dis. 2008;3(2):193-204. doi:10.2147/COPD.S2639. PMID:18686729.
7. Miniati M, Filippi E, Falaschi F, Carrozzi L, Milne E, Sostman H, et al. Radiologic evaluation of emphysema in patients with chronic obstructive pulmonary disease: chest radiography versus high resolution computed tomography. Am J Respir Crit Care Med. 1995 May;151(5):1359-1367. doi:10.1164/ajrccm.151.5.7735585. PMID:7735585.
8. Lynch DA, Al-Qaisi MA. Quantitative computed tomography in chronic obstructive pulmonary disease. J Thorac Imaging. 2013 Sep;28(5):284-290. doi:10.1097/RTI.0b013e318298733c. PMID:23748651.
9. Schroeder JD, McKenzie AS, Zach JA, Wilson CG, Curran-Everett D, Stinson DS, et al. Relationships between airflow obstruction and quantitative CT measurements of emphysema, air trapping, and airways in subjects with and without chronic obstructive pulmonary disease. AJR Am J Roentgenol. 2013 Sep;201(3):W460-W470. doi:10.2214/AJR.12.10102. PMID:23971478.
10. Mets OM, Buckens CFM, Zanen P, Isgum I, van Ginneken B, Prokop M, et al. Diagnosis of chronic obstructive pulmonary disease in lung cancer screening computed tomography scans: independent contribution of emphysema, air trapping and bronchial wall thickness. Respir Res. 2013 Jun 4;14(1):59. doi:10.1186/1465-9921-14-59. PMID:23711184.
11. Singh A, Kumar S, Mishra AK, Kumar M, Kant S, Verma SK, et al. Correlation between clinical characteristics, spirometric indices and high resolution computed tomography findings in patients of chronic obstructive pulmonary disease. Lung India. 2016 Jan-Feb;33(1):42-48. doi:10.4103/0970-2113.173064. PMID:26933306.
12. Bhaskar R, Singh S, Singh P. Characteristics of COPD phenotypes classified according to the findings of HRCT and spirometric indices and its correlation to clinical characteristics. Afr Health Sci. 2018 Mar;18(1):90-101. doi:10.4314/ahs.v18i1.13. PMID:29977262.
13. Koo HJ, Lee SM, Seo JB, Lee SM, Kim N, Oh SY, et al. Prediction of pulmonary function in patients with chronic obstructive pulmonary disease: correlation with quantitative CT parameters. Korean J Radiol. 2019 Apr;20(4):683-692. doi:10.3348/kjr.2018.0391. PMID:30887750.
14. Wang Y, Chai L, Chen Y, Liu J, Wang Q, Zhang Q, et al. Quantitative CT parameters correlate with lung function in chronic obstructive pulmonary disease: a systematic review and meta-analysis. Front Surg. 2023 Jan 4;9:1066031. doi:10.3389/fsurg.2022.1066031. PMID:36684267.