ORIGINAL RESEARCH

Utility of quantitative Computed Tomography (CT) parameters in evaluation of Chronic Obstructive Pulmonary Disease (COPD) patients

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ABSTRACT
Background: Airway blockage that is either irreversible or somewhat reversible is a hallmark of chronic obstructive pulmonary disease (COPD), a condition that develops progressively. The present study evaluated utility of quantitative CT parameters in assessment of COPD patients.**Materials & Methods:**85 confirmed cases of COPD of both genders were selected. Following the American Thoracic Society's (ATS) recommendations, a pulmonary function test was conducted. All underwent a 64-slice CT scan in a craniocaudal orientation while being breath-held from the lateral costophrenic sulci to the lung apices.**Results:**There were 25 non- smokers, 47 mild smokers and 13 moderately heavy smokers. The difference was significant (P< 0.05). There was significant difference in the means of all the three parameters between the individual groups with different smoking exposure (P< 0.05). All the parameters showed an inverse relationship with the FEV1. LAA% showed the best correlation with FEV1 (r- -0.56). WA% and pi10 also showed statistically significant correlation with r values of −0.42 and −0.72, respectively. Among individual groups, statistically significant correlation was obtained between FEV1 with LAA% and pi10 in the never-smokers. Correlation with WA% wasnot significant in this group.LAA% showed higher specificity and sensitivity than WA% and Pi10.**Conclusion:**FEV1 and dyspnea in patients with chronic obstructive lung disease are influenced by QCT markers of airway illness.
Keywords: Chronic obstructive pulmonary disease, CT scan, Dyspnea

INTRODUCTION

Airway blockage that is either irreversible or somewhat reversible is a hallmark of chronic obstructive pulmonary disease (COPD), a condition that develops progressively. By 2022, it is expected to rank as the sixth most common cause of disability worldwide.[1] Smoking, air pollution, and occupational exposure are some of the causes of this. However, the condition is heterogeneous, and the heterogeneity of the disease cannot be explained just by pulmonary function tests.[2] Significant differences exist in the clinical presentation and rate of disease development of patients with chronic obstructive pulmonary disease (COPD).The American Thoracic Society defines emphysema as the permanent, aberrant expansion of the airspaces distal to the terminal bronchioles along with the breakdown of the alveolar walls.[3] Airway collapse on expiration, air trapping, and a reduction in elastic recoil are the causes of airflow limitation in emphysema patients. However, some studies claim that the degree of airway restriction does not always correspond with the level of emphysema because of other contributing variables.[4]

High-resolution computed tomography (HRCT) is currently commonly employed for the diagnosis and characterisation of COPD because it provides a precise anatomical investigation of lung anatomy.[5] On computed tomography (CT), morphologic alterations such emphysema, thickening of the bronchial wall, lung hyperinflation, expiratory air trapping, and vascular pruning can be observed and quantitatively described.[6] These individuals have been defined and categorized using HRCT into two main groups: those with airway-predominant disease and those with emphysema-predominant disease. Based on the kind of emphysematous disease, the former group can be further divided into bullous, paraseptal, panlobular, and centrilobular emphysema.[7]

AIM AND OBJECTIVES

The present study assessed utility of quantitative CT parameters in assessment of COPD patients.

MATERIALS & METHODS

The present cohort study consisted of 85 cases of both genders who were hospitalized with an initial diagnosis of a COPD exacerbation at the Department of Radiology, Gouri Devi Institute of Medical Science and Hospital, Rajbandh, Durgapur, West Bengalin collaboration with Department of Psychiatry, Major SD Singh Medical college, farukkhabad Uttar Pradesh, India, from April 2018 to March 2019 after obtaining ethical clearance from the Institutional Ethical Clearance Committee. All were well informed the study and their written consent was obtained. The diagnosis was made based on post-bronchodilator forced expiratory volume in 1 second to forced expiratory vital capacity ratio (FEV1/FVC) <0.7.

Inclusion Criteria

- Patients who provided informed consent and were willing to participate in follow-up assessments.
- Patients whose stable-state spirometry showed a ratio of the forced expiratory volume in 1 second (FEV1) to forced vital capacity of less than 0.70 were included, regardless of their history of cigarette smoking.

Exclusion Criteria

- We excluded definite asthma patients
- Patients with incomplete medical records for the assessment of clinical outcomes, length of hospital stay, hospital death, and intensive care unit care were also excluded. Furthermore, we did not include individuals who had a chest CT scan 72 hours after being admitted to the hospital or who had a chest CT scan prior to the initial chest X-ray. Patients who had a chest CT scan in a clinic or hospital other than our medical centre were also not included.

Data such as name, age, gender etc. was recorded. Following a thorough case study, a clinical evaluation of the disease pattern and severity was noted. Following the American Thoracic Society's (ATS) recommendations, a pulmonary function test was conducted. All underwent a 64-slice CT scan in a craniocaudal orientation while being breath-held from the lateral costophrenic sulci to the lung apices. The CT settings were 0.3 mm slice thickness, kVp of 120, and mA of 90. Two radiologists evaluated the CT parameters—low attenuation area percentage (LAA%), wall area percentage (WA%), and pi10—after analyzing the pictures. The MDCT workstation was used to apply a density mask (−950 to −1024 HU) in order to calculate the LAA%.

Statistical Analysis

The data obtained was subjected to statistical analysis using a Microsoft Excel spreadsheet and analysed using software Statistical Package for the Social Sciences (SPSS) 22.0 version. The data were represented in tables and graphs. Categorical variables were summarised in frequency and percent distribution, and a chi-square test was performed by a statistician. P value less than 0.05 was considered significant.

RESULTS

Table I:Distribution of patients based on smoking pattern

Smoking pattern	Number	P value
Absent	25	0.05
Mild	47	
Moderate- heavy	13	

TableI shows that there were 25 non- smokers, 47 mild smokers and 13 moderately heavy smokers. The difference was significant (P< 0.05).

Table II: QCT parameters in patients with different cumulative smoking exposures

Smoking pattern	LAA %	WA%	Pi10
Absent (25)	10.12	60.19	3.41
Mild (47)	10.32	60.21	3.58
Moderate- heavy (13)	14.56	61.07	3.52
Total (85)	11.9	60.5	3.46
P	0.05	0.05	0.05

Table II, graph I shows that there was significant difference in the means of all the three parameters between the individual groups with different smoking exposure (P< 0.05).

Graph I:QCT parameters in patients with different cumulative smoking exposures

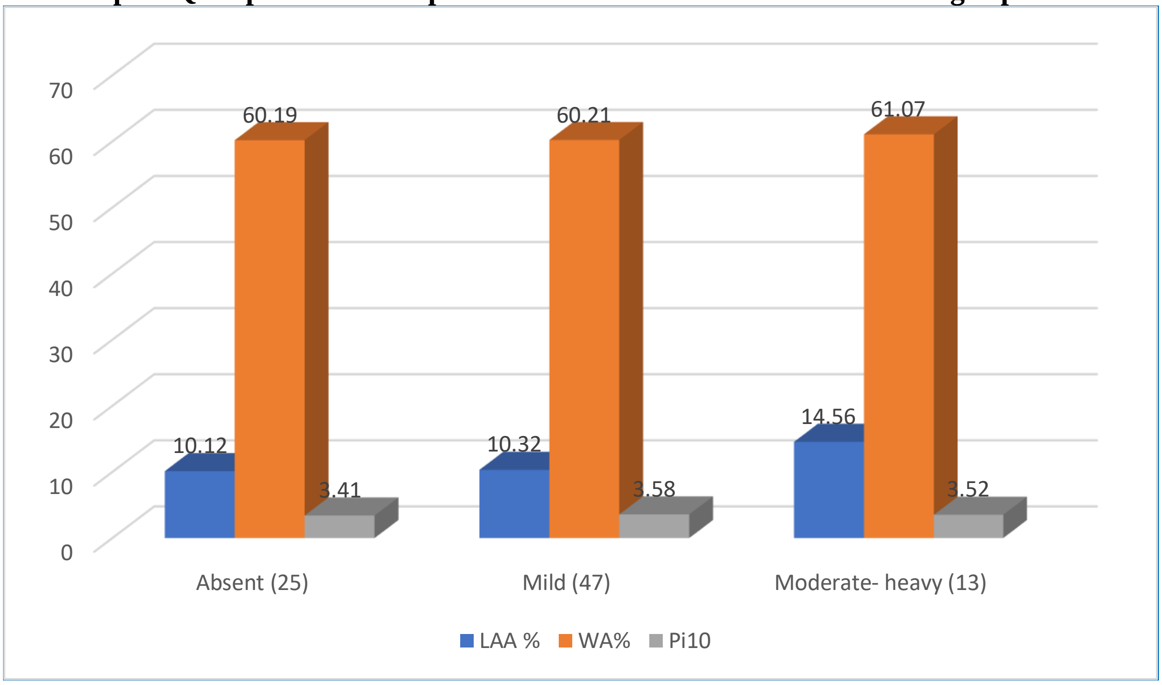

Table III: Correlation of LAA%, WA%, pi10 with FEV1 in patients with different cumulative smoking exposures

Smoking pattern	Pearson LAA%	P value	Pearson WA%	P value	Pearson Pi10	P value
Absent (25)	-0.88	0.07	-0.42	0.21	-0.72	0.04
Mild (47)	-0.29	0.62	-0.038	0.48	0.18	0.17
Moderate- heavy (13)	-0.17	0.85	-0.19	0.59	0.08	0.85
Total (85)	-0.56	0.05	-0.75	0.01	-0.39	0.05

Table III, shows that all the parameters showed an inverse relationship with the FEV1. LAA% showed the best correlation with FEV1 (r- -0.56). WA% and pi10 also showed statistically significant correlation with r values of −0.42 and −0.72, respectively. Among individual groups, statistically significant correlation was obtained between FEV1 with LAA% and pi10 in the never-smokers. Correlation with WA% wasnot significant in this group.

Table IV Sensitivities and specificities of CT parameters

CT parameters	AUC	Cut off value	Sensitivity	Specificity
LAA%	0.71	12.6	77.2	73.2
WA%	0.79	61.2	65.1	64.7
Pi10	0.64	3.8	65.4	58.8

Table IV shows that LAA% showed higher specificity and sensitivity than WA% and Pi10.

DISCUSSION

The Global Initiative for Chronic Obstructive Lung Disease defines chronic obstructive pulmonary disease (COPD) as "a disease state characterized by airflow limitation that is not fully reversible." The combination of small airway remodeling and emphysema, which can vary in severity and distribution, results in airflow limitation in COPD.[8,9] Although it is challenging to assess the relative contributions of these two pathologic processes using the results of routine pulmonary function tests, doing so is clinically significant because it affects how the patient reacts to treatment.[10] Air trapping during expiration, vascular changes, small and big airway abnormalities (bronchiolitis and bronchitis), and variable degrees of parenchymal deterioration (emphysema) seem to be the combined histopathological changes that cause air flow limits.[11]The CT-based classification of COPD cases according to phenotype (emphysema-predominant, airway-predominant, or mixed) is based on the morphologic appearance of pathologic changes related to airflow limitation.Variousstudieshave shown that CT is of considerable value in quantifying the severity of the disease in COPD, either using visual or, more preferably, using quantitative CT techniques (QCT).[12,13]

We found that there were 25 non- smokers, 47 mild smokers and 13 moderately heavy smokers. Twenty-one patients under GOLD stage 3 and forty-four cases under GOLD stage 4 were included in a study by Silvia Maria Doria da Silva et al[14] that examined instances with severe COPD and the relationship between CT results and functional factors. From GOLD stage-I to GOLD stage-IV, the mean values of low attenuation zones in inspiration <-950HU were progressively raised. From GOLD stage I to GOLD stage IV, the mean values of low attenuation zones in expiration <-856HU progressively decreased. From GOLD stage I to GOLD stage IV, the average TLC and FRC values were progressively raised. From GOLD stage I to GOLD stage IV, the mean values of inner area, outer area, and wall area progressively dropped. There was a link between FEV1/FVC (-0.769) and FEV1 (-0.814) (p<-856) and FEV1/FVC (-0.772) (p<0.005) for emphysema in low attenuation zones in inspiration <-950HU.

We observed that there was significant difference in the means of all the three parameters between the individual groups with different smoking exposure (P< 0.05).We found that all the parameters showed an inverse relationship with the FEV1. LAA% showed the best correlation with FEV1 (r- -0.56). WA% and pi10 also showed statistically significant correlation with r values of −0.42 and −0.72, respectively. Among individual groups, statistically significant correlation was obtained between FEV1 with LAA% and pi10 in the never-smokers. Correlation with WA% wasnot significant in this group.Using a threshold value of -910 HU, Muller et al[15] initially explain this method with pathological validation. Although many researchers have advocated different thresholds using this method, the most widely recommended value for quantitative CT evaluation of emphysema is −950. A more sensitive technique for identifying early emphysema, according to some studies, is the D-value (slope of the log-log plot of the representative cumulative frequency of LAA%). It should be noted that in addition to the threshold HU value, a variety of technical elements, including slice thickness, tube current, reconstruction method, contrast medium use, window configuration, and scanner type, significantly affect the quantitative evaluation.

We observed that LAA% showed higher specificity and sensitivity than WA% and Pi10.Kumar et al[16] assessed the relationship between the severity of the disease and the quantitative computed tomography (QCT) parameters of airway disease and emphysema in individuals with COPD. 50 COPD patients, including both nonsmokers and those with varying levels of cumulative smoking exposure. Following the conventional procedure, three QCT parameters—LAA% (low attenuation area percentage), WA% (wall area percentage), and pi10—were computed. The severity of the disease was assessed using the MMRC dyspnea scale, BODE score, and forced expiratory volume in 1 second (FEV1).

LIMITATION OF THE STUDY: The shortcoming of the study is small sample size.

CONCLUSION

Authors found that FEV1 and dyspnea in patients with chronic obstructive lung disease are influenced by QCT markers of airway illness.

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