

ORIGINAL RESEARCH

Radiological Phenotyping of COPD and its correlation to disease severity.

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ABSTRACT

Background: Chronic obstructive pulmonary disease (COPD) is characterized by the presence of airflow obstruction caused by emphysema or airway narrowing, or both. Cigarette smoking, which is the major risk factor of COPD, causes the abnormalities by inducing inflammation in the lung parenchyma and peripheral airways. A large number of studies have been done to detect and Quantify pulmonary emphysema using computed tomography (CT). Low attenuation areas (LAA) on CT scans *in vivo* have been shown to represent macroscopic or microscopic emphysematous changes in the lungs of patients. Although the CT measurement of LAA correlates well with diffusing capacity, the relationship to measurements of airflow obstruction is less significant presumably because airflow obstruction is related to both loss of recoil and inflammatory narrowing of the airways. We hypothesized that the diversity of morphological Changes on HRCT may be associated with the differences in severity of disease and prognosis. To clarify the hypothesis, COPD was classified morphologically using HRCT into the three morphological phenotypes in accordance with the presence or absence of apparent emphysema and bronchial wall thickening, and examined the association of the morphological characteristics on HRCT with severity of disease and prognosis using BODE index.

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INTRODUCTION

Aims and objectives: To classify copd patients based on HRCT features. To study if these morphological features of HRCT determine severity of COPD. To study the correlation of these morphological features with prognosis of COPD.

MATERIAL AND METHODS

This is a cross sectional study of 50 COPD patients attending the pulmonary medicine department, konaseema institute of medical sciences during the period of march 2019- Feb 2020.

Inclusion Criteria: All stable copd patients

Exclusion Criteria: History of Chronic lung disease other than COPD, Pulmonary TB, Interstitial lung disease, Bronchial asthma. Any primary cardiac disease and patients with Acute Exacerbation of COPD in last 3 months, Myocardial Infarction in previously 3 months

and who are unable to perform Spirometry (Pulmonary Function Test), bed ridden patients Patients not willing for investigations. Thorough history and clinical examination of the patients, smoking status, previous hospitalization status and treatment history were collected. Height and weight were assessed. BMI calculated using formula

$$\text{BMI} = \frac{\text{WEIGHT (KG)}}{\text{HEIGHT (Mt)}^2}$$

chest xray PA and complete blood picture was done to rule out active pulmonary infection Pulmonary function testing done after stopping inhaled bronchodilators for more than 12 hrs using **RMS turbine based spirometer**.

Air flow obstruction was considered if the FEV1/FVC ratio is less than 0.7, post bronchodilator

Reversibility of air flow obstruction was tested after post bronchodilator testing.

COPD is considered in those who showed no reversibility in FEV1/FVC post bronchodilators.

FEV1, FVC, FEV1/FVC Values were recorded.

From their history, grading of dyspnea done according to MMRC scale

Six minute walk test was done according to ATS guidelines.

BODE index was calculated.

High resolution computerized tomography was done using XXXXX Machine and images obtained with 1 mm collimation.

Based on their HRCT findings, patients were classified into FOUR groups:

- A) NORMAL
- B) predominant bronchial wall thickening
- C) emphysema
- D) mixed.

These HRCT findings were correlated with BODE index.

RESULTS

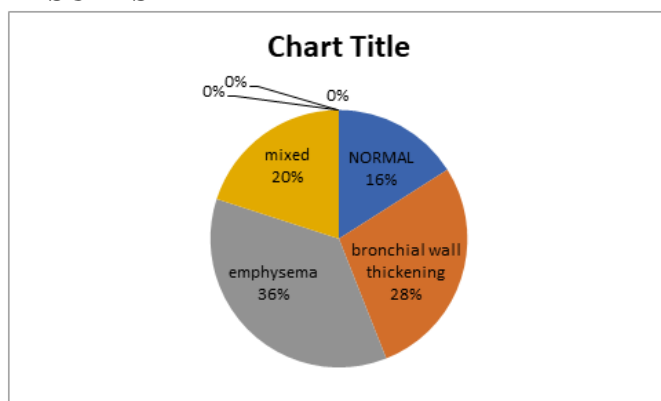


Figure 1: No. of cases in each phenotype

Of the 50 cases, 8 cases have normal HRCT, 14 patients showed predominant bronchial wall thickening, 18 patients showed predominant emphysema and 10 patients have both these.

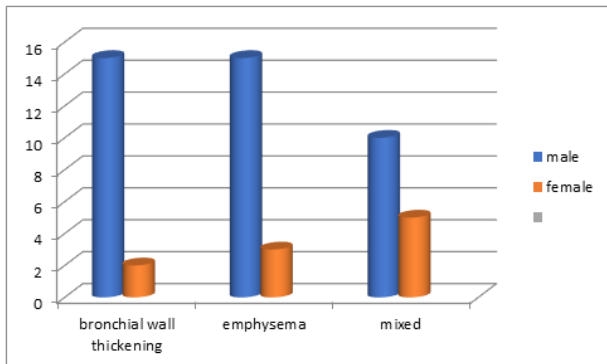


Figure 2: Comparison of gender distribution

Clinical characteristics:

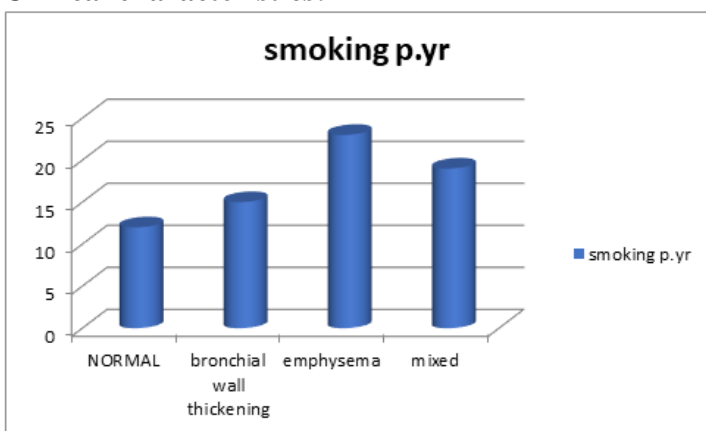


Figure 3: Comparison of smoking index

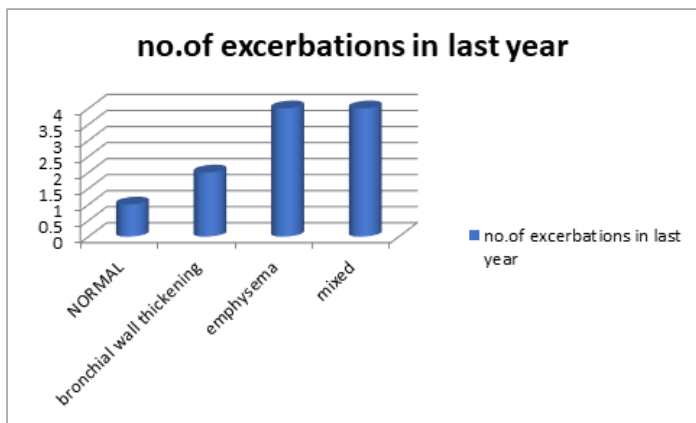


Figure 4: Comparison of no. exacerbations in last year

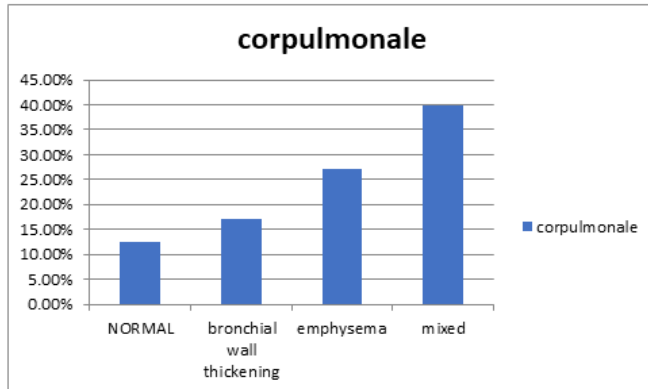


Figure 5: Comparison of no. of cases of corpulmonale

Table 1: Clinical features vs HRCT features

	NORMAL	bronchial wall thickening	emphysema	mixed
age	54	54+_4	61+_6	61+_7
smoking p.yr	12	15	23	19
duration of illness	4	4+_1	8+_2	6+_2
no.of exacerbations in last year	1	2	4	4
corpulmonale	12.50%	17%	27%	40%

The mean age of presentation in those with bronchial wall thickening is less (54+_4) and that in emphysema and mixed phenotypes is similar as (61+_6).

Mean smoking index in bronchial wall thickening patients is 10+_7, in emphysema 23+_12, in mixed 19+_14.

It is evident from above figures that mean smoking is much higher in emphysema and mixed types.

Mean duration of illness in BWT type is 4+_1, in emphysema type is 8+_1, in mixed type is 6+_1.

No. of exacerbations in last year in BWT is 2+_2, in emphysema is 4+_2, in mixed type is 4+_2.

Percentage of patients with corpulmonale in BWT is 17%, in emphysema is 27%, in mixed type is 40%.

Objective Variables

Table 2: Objective variables vs HRCT features

Column1	NORMAL	bronchial wall thickening	emphysema	mixed		
BMI	24	23	22	24		
FEV1%	68+_10	61+_14	47+_10	53+_15		
MMRC GRADE	1	2+_1	2+_2	2+_1		
6MWT	410+_80	387+_100	320+_100	340+_110		

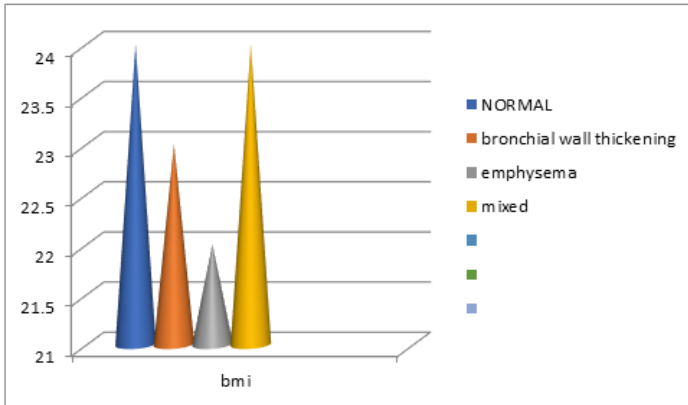


Figure 6: Comparison of BMI

The mean BMI is almost same in all the four groups with 24,22,23,24 respectively.

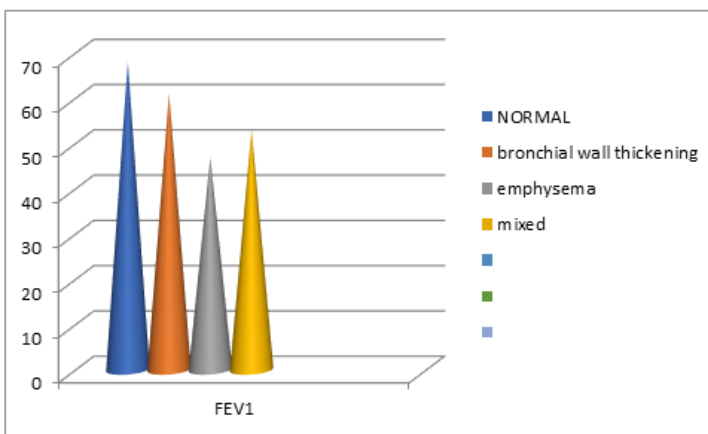


Figure 7: Comparison of FEV1%

The mean forced expiratory volume in 1 sec(fev1) % is 68+_10 in normal, 61+_14 in BWT, 47+_10 in emphysema, 53+_15 in mixed type.

The MMRC dyspnea score in all the three types is same with 2+_2, normal group is 1.

The mean six minute walk distance in normal group is 410+_80, BWT is 387+_100, in emphysema 320+_110, in mixed type it is 340+_120.

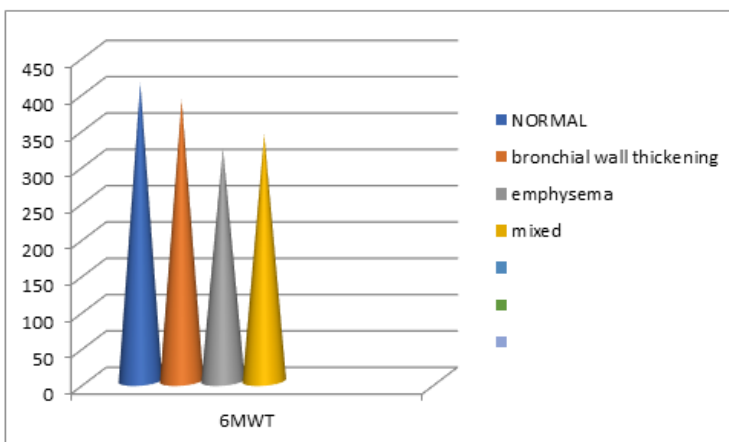


Figure 8: Comparison of 6MWD

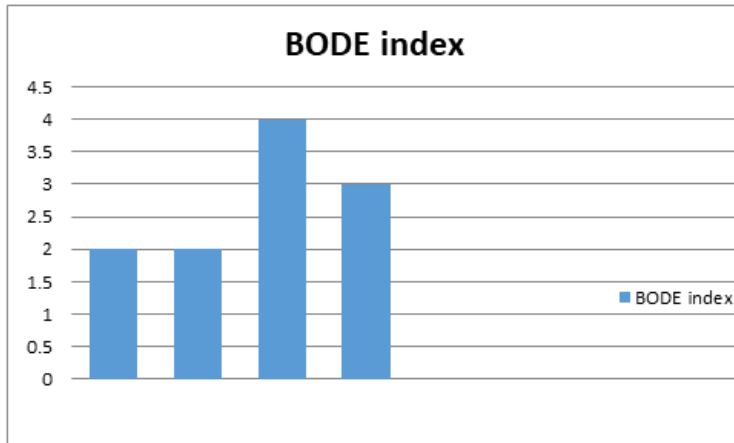


Figure 9: Comparison of BODE index

Table 3: BODE index vs HRCT features

	normal	BWT	emphysema	mixed
BODE index	2	2	4	3

The mean BODE index of Normal and BWT is 2, of emphysema is 4 while that of mixed group is 3.

DISCUSSION

The morphologic classification of COPD can be achieved in accordance with the presence or absence of apparent emphysema, bronchiectasis and bronchial wall thickening. However, as mentioned earlier, the relationship between the morphologic phenotypes and airflow limitation is complicated because airflow limitation in COPD results from a combination of small airway remodeling and a loss of lung elastic recoil. The relative contributions of these pathologic abnormalities may vary among patients with the same degree of airflow limitation.

Identifying the causes of airflow limitation in patients with COPD is crucial for determining the appropriate therapeutic strategy. In the present study, we classified the copd patients into four gropus based on HRCT features as

- a. Normal
- b. with bronchial wall thickening
- c. emphysema
- d. mixed

we tried to correlate the clinical features and severity indices of COPD with HRCT features.

As evident from the results, group A showed lesser risk exposure with low mean smoking index, while group c, d showed higher smoking indices.

A similar study by Bosken and coworkers found that smoking history was unrelated to the morphometric measures of peripheral airway dimensions.

In study by YASUTAKA NAKANO, SHIGEO MURO, there were not significant relationships between smoking index and airway dimensions.

Further quantitative analysis need to be done in our study to estabilish the correlation between smoking and airway dimension.

In our study, all the four groups showed similar BMI , with slightly lower in group c .

Fujimoto et al used a visual estimate of airway wall thickness and found that patients with COPD who had an airway dominant phenotype had a higher BMI than those with an emphysema dominant or mixed phenotype.

Our finding of an association of an emphysema predominant phenotype in patients with COPD and a lower BMI is in keeping with the longstanding observation that a subset of patients with COPD are “pink puffers”. This traditional clinical designation was used to characterise patients with COPD who had predominant emphysema, relatively preserved ventilatory drive and a low BMI. As in any previous studies of these COPD sub-phenotypes, this study does not allow us to determine whether the decreased BMI is secondary to the emphysematous process which results in increased LAA or whether the decreased BMI contributes to the emphysema predominant phenotype.

The Forced expiratory volume in 1st second (FEV1) % is higher in normal group and is much lower in emphysema group.

Study by *Umang Shah1, Jayalakshmi T.K1 no. of cases with severe COPD are more in emphysema group while in bronchial wall thickness group, moderate severity are more.

Yoshiaki Kitaguchia study also showed that FEV1 values are higher in bronchial wall thickness group when compared to mixed and emphysematous groups.

So it is evident that the severity of disease is more in emphysema group. The loss of elastic and lung recoil adds to airway obstruction along with airway thickness.

The symptom score as assessed by MMRC scale is same in all the three groups with the normal group showing less score of 1.

Yoshiaki Kitaguchia study showed that Dyspnea score by (F-H-J classification) is much lower (2.3) in A phenotype while it is (3.2) in M phenotype.

The ventilation perfusion mismatch, along with change in chest wall mechanics result in more dyspnea score in emphysema group.

Six minute walk distance covered is more in Normal group(410) when compared with rest and lower in emphysema group.(320).

*Umang Shah1, Jayalakshmi T.K, study also showed similar results to our study with lower 6MWD in emphysema group.

The BODE index, that is a cumulative score of above variables is less in Normal group, more in emphysema group.

The mixed group has slightly higher index when compared to BWT and Normal group.

So, presence of emphysema changes on HRCT is an indicator for worsening of COPD.

Though we cannot consider these changes to be occurring in a sequence, identification of emphysema changes may be considered as bad prognostic sign when compared to other phenotypes on HRCT.

LIMITATIONS OF STUDY

1. small sample of the study group.
2. further grading of emphysema or bronchial wall thickening would add more data to our study
3. only qualitative analysis of HRCT findings are considered. Quantitative assessment adds much information for prognostification
4. severe COPD cases who cannot perform the PFT and 6MWT were excluded .

SUMMARY AND CONCLUSION

The severity of COPD is mainly now determined by severity of airflow obstruction on spirometry. But airway remodeling and loss of elastic recoil along with chest wall mechanics play a role in determining the result of pulmonary function test. So addition of HRCT characteristics to these other prognostic variables can further aid us in better grading of severity.

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