An Analytical Cross-Sectional Study Comparing Thoracic Dimensions between Chronic Obstructive Pulmonary Disease (COPD) Patients and Healthy Controls

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ABSTRACT

Introduction: Thoracic dimensions play a vital role in the pathogenesis and management of dyspnea among Chronic obstructive pulmonary disease [COPD] patients. COPD may cause changes in the shape of thoracic cage by increasing lung volume and hyperinflation. Hence it is essential to know the variations in thoracic dimensions among normal and COPD patients. Study aimed to compare the thoracic dimensions Antero posterior [AP] diameter, Transverse diameter and Height of diaphragm [HDI] between COPD patients and healthy controls.
Material and Methods: The present study was a cross-sectional study. The study included 80 subjects diagnosed with COPD as per GOLD guidelines and 80 healthy controls. Both the groups underwent chest radiographic evaluation with PA and Lateral views.
Results: The average AP diameter was significantly greater in subjects with COPD [10.64cms ± 2.16cms] compared to healthy controls [9.29cms ± 1.47cms]. The difference was statistically significant [p <0.001]. The Mean transverse diameter was 22.5cms ± 2.1cms in COPD subjects and among the healthy controls [21.83cms ± 2.02cms]. The difference was statistically significant (P value 0.041). Also, among COPD mean HDI was 23.35cms ± 2.6cms and among the healthy controls was 20.57cms ± 0.91cms which was statistically significant [p<0.001].
Conclusion: The present study demonstrated that AP, Transverse diameters of thoracic cage, and HDI evaluated using Chest X-ray, were increased in COPD subjects compared to healthy controls.

Keywords: COPD, Chest Radiographic, AP Diameter, PFT, HDI

INTRODUCTION

Chronic obstructive pulmonary disease (COPD), a heterogeneous collection of diseases with differing causes, pathogenic mechanisms, and physiological effects is one of the leading causes of death worldwide.[1] This marked heterogeneity impedes identification of subpopulations at risk for accelerated progression, thwarting therapeutic advances. Most COPD studies have included populations with mean ages older than 60 years.[1] Chronic obstructive pulmonary disease (COPD) is characterized by airflow obstruction with chronic cough with expectoration, exertional dyspnea, and wheeze.[2] The mortality due to COPD is rising, and it is expected to become the third leading cause of death globally by 2030.[3]

COPD is a progressive disease and can be attributed to initial complex biochemical and cellular events in the small airways and surrounding alveoli.[4] Alveolar destruction with emphysema is one of the features of COPD. Scanning electron microscopic examination of emphysematous lung sections demonstrate characteristic destruction of tissue, loss and collapse of regularly shaped alveoli, and enlarged alveolar ducts. In a significant proportion of patients with COPD, reduced lung elastic recoil combined with expiratory flow limitation eventually leads to lung hyperinflation with progression of disease.[5] In COPD lung hyperinflation alters chest wall geometry and, as a consequence, chest wall function. Several western studies have reported alterations in thoracic geometry and dimensions in COPD patients[6,7], but very few Indian studies were done in alterations in thoracic dimensions among COPD.

Among COPD due to hyperinflation, the diaphragm is flatter and lower than in normal subjects and the size of the zone of apposition is reduced. Consequently, the expansion of

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How to cite this article: Viswambhar Vallabhaneni, Bandlamudi Sowjanya, Aruna Shanmuganathan, Meenakshi Nara Simhan, Ashwin Kailash Jaya Kumaran, Navaneetham Karuna Karan. An analytical cross-sectional study comparing thoracic dimensions between chronic obstructive pulmonary disease (COPD) patients and healthy controls. International Journal of Contemporary Medical Research 2020;7(2):B5-B8.

DOI: http://dx.doi.org/10.21276/ijcmr.2020.7.2.8

the lower rib cage caused by diaphragmatic contraction is lesser than in normal subjects. In the most severe cases of hyperinflation, the diaphragm fibres at their origin on the ribs run transversally inward rather than cranially. In this condition, the contraction of the diaphragm produces an inspiratory decrease (paradoxical motion) in the transverse diameter of the lower rib cage or in the volume of the lower rib cage.[8-10] Clinical heterogeneity in COPD is likely to be the consequence of several morphological changes within the lung, which include emphysema, airway remodelling, mucoid impaction, and vascular remodelling.[11-13]

As the thoracic dimensions play a vital role in the pathogenesis and management of dyspnea among COPD subjects it is important to know the variations of thoracic dimensions among normal and COPD patients based on which a better management of COPD patients may be possible in the absence of Pulmonary function testing so that COPD patients may have a better quality of life. Hence this study was conducted with an aim to compare the thoracic dimensions between normal and COPD subjects.

MATERIAL AND METHODS

The study was an analytical cross-sectional study conducted in the Department of Pulmonary Medicine of a tertiary care teaching hospital. The study was conducted between January 2018 to June 2019. After the approval by the Institutional Human ethics committee, 80 subjects diagnosed with stable COPD as per GOLD guidelines and 80 healthy controls were included in the study. Both the groups in the ages between 55 to 65 underwent chest radiographic evaluation with PA and LATERAL views. Informed written consent was obtained from all the participants. The healthy control group comprised individuals who visited general health clinics. Subjects who were unable to perform PFT or who were contraindicated for PFT were excluded from the study. We measured thoracic dimensions including Average anteroposterior rib cage diameter taken from bases of 5th 7th 9th thoracic vertebrae. Average transverse rib cage diameter obtained from average of the maximal internal diameter of chest well at the level of 3rd, 6th, 9th pair of ribs, and average vertical height of the diaphragm from the base of T1 to the silhouette of the left and right diaphragmatic domes midway between the internal aspect of chest wall at the level of the 9th rib and the centre of the thoracic spine.

From patient's case sheet we obtained name, age, sex, height/weight, BMI, chest X-ray PA and lateral view, PFT. All these parameters were recorded and correlated to obtain the results.

The study was approved by Institutional human ethical committee.

AP diameter, Transverse diameter and HDI values were considered as primary outcome variables. COPD Vs Healthy controls was considered as Primary explanatory variable. For normally distributed Quantitative parameters the mean values were compared between study groups using Independent sample t-test (2 groups). IBM SPSS version 22 was used for statistical analysis.

RESULTS

A total of 160 subjects were included in the final analysis.

Among COPD mean age was 60.04 ± 3.58 and among the healthy controls, the mean age was 59.41 ± 3.18 (P value 0.244). Among COPD, 62 (51.67%) subjects were male and remaining 18 (45%) were female. Among the healthy controls, 58 (48.33%) were male and remaining 22 (55%) were female (P value >0.465). Among COPD mean BMI was 25.49 ± 5.05 and among the healthy controls, the mean BMI was 26.11 ± 5.66. The difference was statistically not significant (P value 0.464). (Table 1)

Among COPD patients, mean AP diameter was 10.64 ± 2.16cm and among the healthy controls, the mean AP diameter was 9.29 ± 1.47cm. The difference was statistically significant (P value <0.001). Among COPD mean Transverse diameter was 22.5 ± 2.1cm and among the healthy controls, the mean Transverse diameter was 21.83 ± 2.02cm. The difference was statistically significant (P value 0.041).

Parameter	COPD	Heathy Controls	P value
AGE (Mean± SD)	60.04 ± 3.58	59.41 ± 3.18	0.244
Gender			
Male	62 (51.67%)	58 (48.33%)	0.465
Female	18 (45%)	22 (55%)	
BMI (Mean± SD)	25.49 ± 5.05	26.11 ± 5.66	0.464

Table-1: Comparison of baseline parameters between Study group (N=160)

Parameter	COPD (Mean± SD)	Heathy Controls (Mean± SD)	Mean difference	95% CI		P value
				Lower	Upper	
AP diameter	10.64 ± 2.16	9.29 ± 1.47	1.36	0.78	1.93	<0.001
Transverse diameter	22.5 ± 2.1	21.83 ±2.02	0.67	0.03	1.31	0.041
HDI	23.35 ± 2.6	20.57 ±0.91	2.78	2.17	3.39	<0.001

Table-2: Comparison of thoracic dimensions between the study group (N=160)

Parameter	COPD (Mean± SD)	Heathy Controls (Mean± SD)	Mean difference	95% CI		P value
				Lower	Upper	
FEV1	54.56 ± 10.2	89.96 ± 8.03	35.40	32.53	38.27	<0.001
FVC	46.39 ± 10.14	91.23 ± 6.61	44.84	42.16	47.51	<0.001
FEV1/FVC	42.45 ± 12.23	97.19 ± 9.2	54.74	51.36	58.12	<0.001

Table-3: Comparison of PFT between the study group (N=160)

Among COPD mean HDI was 23.35 ± 2.6cm and among the healthy controls, the mean HDI was 20.57 ± 0.91cm. The difference was statistically significant (P value <0.001). (Table 2)

Among COPD subjects, mean FEV1 was 54.56 ± 10.2 and among the healthy controls, the mean FEV1 was 89.96 ± 8.03. The difference was statistically significant (P value <0.001). Among COPD mean FVC was 46.39 ± 10.14 and among the healthy controls, the mean FVC was 91.23 ± 6.61. The difference was statistically significant (P value <0.001). Among COPD mean FEV1/FVC was 42.45 ± 12.23 and among the healthy controls, the mean FEV1/FVC was 97.19 ± 9.2. The difference was statistically significant (P value <0.001). (Table 3)

DISCUSSION

COPD patients often develop hyperinflation. Hyperinflation occurs due to expiratory flow limitation caused by reduced lungs' elastic recoil and increased airway resistance. Hyperinflation increases during exercise and acute exacerbation. Hyperinflation has a significant negative impact on respiratory muscles, particularly the diaphragm. Studies done in healthy humans, and COPD patients have shown that hyperinflation increases the contribution of rib cage and neck muscles and decreases relative contribution of the diaphragm. The effect of hyperinflation on diaphragmatic length is the main mechanism by which it affects the force-generating capacity of the diaphragm.[14,15]

Our aim was to compare the thoracic dimensions between normal and chronic obstructive pulmonary disease patients**.** Previous studies reported increase in prevalence with age, from 0.8% in the youngest age group (15-29 years) to 7.5% in the eldest age group (60-69 years).[16] There was no significant association of gender and BMI. We observed comparatively a greater number of male COPD patients than females. Study done by Dransfield MT et al. revealed that at all stages of COPD severity, men had more CT emphysema than women.[17] COPD in women is distinct from that in men with respect to phenotype, symptom burden, and comorbidities. Women are more predisposed to develop chronic bronchitis, have more dyspnea, and suffer more frequently from coexistent anxiety or depression.[18]

Increased anteroposterior diameter, increased retrosternal airspace, reduced cardiac silhouette with a vertical heart, flattening of the diaphragms, (better demonstrated on lateral chest x-ray), enlarged central pulmonary arteries and reduced peripheral vascular markings are considered as radiographic signs of hyperventilation.[19] Our study showed statistically significant difference of AP diameter and HDI and transverse diameter in both the groups. Increased lung volume and hyperinflation may cause changes in the shape of the thoracic cage in COPD patients. Therefore, it has been traditionally accepted that COPD patients exhibit increased thoracic cage dimensions, especially anteroposterior (AP) diameter, leading to a circular, "barrel-chest" appearance due to increased lung volume and hyperinflation.[20-25]

CONCLUSION

Present study demonstrated that AP diameter, transverse diameter and HDI of thoracic cage, evaluated using chest X-ray PA and lateral view, were increased in COPD patients compared to normal healthy individuals. In resource limited hospitals where PFT may not be available chest x ray PA and Lateral views along with clinical history may be helpful to diagnose COPD.

We recommend patients with clinical suspicion of COPD may be screened and assessed for AP, Transverse diameters and HDI for better understanding of changes in thoracic dimensions.

ACKNOWLEDGMENTS

We acknowledge the technical support in data entry, analysis and manuscript editing by "Evidencian Research Associates."

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Source of Support: Nil; **Conflict of Interest:** None

Submitted: 05-01-2020; **Accepted:** 06-02-2020; **Published:** 13-02-2020