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Correlation of the Ratio of Upper Third to Lower Third Circumferences of the Chest with Obstructive Pattern in Spirometry

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Background: Obstructive Lung Diseases (OLDs), could lead to progressive hyperinflation of the lungs that cause increased work of breathing, impaired gas exchanges and functional limitations in patients. In this study, thoracic circumference of patients in upper and lower third were measured directly and the association of the upper to lower third width of chest with spirometric parameters was evaluated.

Materials and Methods: In this cross-sectional study, five hundred twenty nine consecutive patients, with obstructive pattern in spirometry (FEV1/FEVC<70% and FEV1<80%), and 143 controls with normal spirometry were entered. Demographic and clinical data including age, sex, smoking, type, duration and severity of disease and spirometric characteristics were recorded. Upper Third circumference of Chest (UTCC) at axillary level, and Lower Third circumference of Chest (LTCC) at lower rib edge, were measured with an ordinary tape meter.Asthma Control Test (ACT) questionnaire for asthmatic and COPD Assessment Test (CAT) questionnaire in COPD patients were completed.

Results: We found that in patients with UTCC/LTCC ratio > 0.8, UTCC had significant correlation with FEV1 and FEV1/FVC (R: 0.069, 0.055); Moreover significant correlation was found in UTCC, LTCC and UTCC/LTCC ratio with ACT score in this subgroup (R: -0.123, -0.092, -0.124)On the other hand in patients with UTCC/LTCC ratio > 0.9 , UTCC and LTCC had significant correlation with FEV1 (R: 0.07, 0.051).

Conclusion: UTCC/LTCC ratio > 0.8, may be a predictor of obstructive pattern in patients. This is more important in some occations, for example during preoprative evaluation of a patient in an emergency conditions which there is no enough time for performing appropriate diagnostic tests such as spirometry to reveal the type and severity of obstructive pulmonary diseases.

Key words: Spirometry; Lung Diseases, Obstructive

INTRODUCTION

Obstructive lung diseases can lead to progressive hyperinflation of the lungs and subsequently increased work of breathing, impaired gas exchange and functional limitations in patients (1-3).

Asthma, chronic obstructive pulmonary disease (COPD) and bronchiectasis are the main diseases that fall into this category (1,2,4). Hyperinflation of the lungs appears on chest X-rays (CXR) by a flattened diaphragm,

increased retrosternal space and widening of the upper part of the thoracic cage (4-6).

The best practical test for detecting hyperinflation in patients with OLD is pulmonary function test, which shows increased total lung capacity (TLC), functional residual capacity (RFC) and residual volume (RV) with reduction in inspiratory capacity (IC) and vital capacity (VC). In daily clinical practice; however, spirometry is the first step to differentiate obstructive from restrictive ventilatory defects (3,7). In our previous studies, we showed that the upper to lower third width ratio of the chest in patients with hyperinflation could tend toward one and the thoracic cage tends to become cylindrical or barrel-shaped (8).

Therefore, we conducted a new study with a larger sample size than previous ones to assess the relationship between the proposed sizes of the chest and spirometric indicators of obstructive ventilatory defects. In this study, thoracic circumference of patients in upper and lower thirds was measured directly and the association of the upper to lower third width ratio of the chest with spirometric parameters was evaluated.

MATERIALS AND METHODS

We conducted a cross-sectional study in a referral pulmonary clinic in Rasht, Iran during 2011-2013.

Five hundred twenty nine consecutive patients with obstructive pattern in spirometry (FEV1/FEVC<70% and FEV1<80%), and 143 controls with normal spirometry were entered in the study.

Different obstructive lung diseases were diagnosed by a pulmonologist based on standard diagnostic methods. Demographic and clinical data including age, sex, smoking, type, duration and severity of disease and spirometric characteristics were recorded.

Pregnant women and patients with restrictive pattern in spirometry, congenital thoracic deformity (except for the barrel chest), traumatic chest deformity, thoracic surgery with reconstruction, pleural effusion, fibrothorax and history of chest tube insertion were excluded. Upper third circumference of the chest (UTCC) at the axillary level and lower third circumference of the chest (LTCC) at lower rib edge were measured with an ordinary tape measure. Asthma Control Test (ACT) questionnaire for asthmatics and COPD Assessment Test (CAT) questionnaire for COPD patients were completed (9,10). Statistical analysis was performed using chi-square test, t-test, Mann Whitney test, one way ANOVA and Tukey's post hoc test. Correlation of UTCC, LTCC and UTCC/LTCC with demographic, clinical and spirometric findings of patients was evaluated by the Pearson's correlation coefficient or the Kendall's Tau-b correlation coefficient. All statistical analyses were done by SPSS software version 16 for Windows. P values less than 0.05 were considered significant.

RESULTS

Three-hundred seventy eight asthmatic, 100 COPD and 51 bronchiectasis patients and 143 healthy subjects were included. Demographic, clinical and spirometric characteristics of patients and healthy subjects are listed in Table 1. There was a significant difference in the mean age of healthy subjects with that of COPD and bronchiectasis patients (P=0.001 and P=0.004, respectively) .The control group had significant differences with COPD patients for BMI (P=0.001). In normal subjects, FEV1 had significant differences with that in COPD and bronchiectasis patients (P<0.001 and P<0.001, respectively). In addition, FEV1/FVC had a statically significant difference in control subjects with that in asthmatics, COPD and bronchiectasis patients (P=<0.001, P<0.001 and P<0.001, respectively). A significant difference between healthy and bronchiectasis groups was seen for UTCC (P=0.027). Also, we found significant differences in UTCC and LTCC between patients with asthma and bronchiectasis (P<0.00 and P<0.001, respectively). But, UTCC/LTCC ratio was not significantly different among the groups (Table 1). The

correlation coefficient between UTCC, LTCC and their ratio with demographic, clinical and spirometric characteristics of subjects was shown in Table 2. According to these data, there was a significant correlation between UTCC/LTCC and FEV1/FVC in patients with asthma (R:-0.135); also UTCC, LTCC and UTCC/LTCC ratio had a significant correlation with ACT score in this group (R:-0.134, -0.110, -0.138). In patients with COPD, UTCC had a significant correlation with FEV1/FVC (R:0.207). We found that in patients with UTCC/LTCC ratio>0.8, UTCC had a significant correlation with FEV1 and FEV1/FVC (R: 0.069, 0.055). Moreover, a significant correlation was found between UTCC, LTCC and UTCC/LTCC ratio with ACT score in this subgroup (R: -0.123, -0.092, -0.124). On the other hand, in patients with UTCC/LTCC ratio>0.9, UTCC and LTCC had a significant correlation with FEV1 (R: 0.07, 0.051); also there was a significant correlation between UTCC and FEV1/FVC ratio (R: 0.053). In this subgroup, we found a significant correlation between UTCC, LTCC and their ratio with CAT score (-0.061, -0.048, -0.004); in addition, there was a significant correlation between UTCC and LTCC with ACT score (R: -0.120,-0.092).

Table1. Demographic, clinical and spirometric characteristics of subjects

Variables	Control N=143	Asthma N=378	COPD N=100	Bronchiectasis N=51	P1	P2	P3
Age							
Mean±SD (years)	48.69±17.72	52.90±16.44	69.04±11.02	58.11±15.69	0.07	0.001	0.004
BMI							
Mean±SD (kg/m^2)	27.52±5.92	28.47±5.48	24.66±4.91	25.02±5.8	0.48	0.001	0.06
Smoking							
Mean±SD (pack/year)	28.13±25.3	23.46±22.89	45.38±36.72	30.83±9.17	0.99	0.20	1.00
FEV1							
Mean±SD	91.30±27.41	85.42±27.24	52.99±22.24	60.00±18.94	0.20	0.001	0.001
FEV1/FVC							
Mean±SD	80.32±10.64	75.24±10.79	57.65±11.89	66.35±11	0.001	0.001	0.001
UTCC							
Mean±SD(cm)	94.30±8.68	95.66±11.11	93.66±8.61	89.29±7.93	0.74	1.0	0.027
LTCC							
Mean±SD(cm)	90.13±11.69	92.28±12.06	90.49±11.08	85.17±9.67	0.42	1.0	0.09
UTCC/LTCC							
Ratio mean± SD(cm)	1.05±0.07	1.04±0.12	1.04±0.08	1.05±0.06	0.96	0.96	1.0

P1: Normal and Asthma; P2:Normal and COPD; P3:Normal and Bronchiectasis

Table2. Pearson (or Kendall's tau-b) correlation coefficient between UTCC, LTCC and UTCC/LTCC with other variables.

Subject		Age	BMI	Smoking	FEV1	FEV1/FVC	Duration of disease	ACT score	CAT score
Normal N=143	UTCC	-0.044	0.492*	-0.049	0.055	-0.014	-0.042	-	-
	LTCC	0.329*	0.571*	-0.069	-0.004	-0.067	0.091	-	-
	UTCC/LTCC	-0.288*	-0.361*	0.132	0.061	0.059	-0.035	-	-
Asthma N=378	UTCC	-0.016	0.478*	0.528*	0.029	0.034	0.001	-0.089*	-
	LTCC	0.225*	0.696*	-0.30	-0.009	0.022	-0.023	-0.107*	-
	UTCC/LTCC	-0.306*	0.306*	0.658*	0.051	0.008	0.002	-0.122*	-
COPD N=100	UTCC	-0.105	0.590*	-0.056	0.130	0.075	0.061	-	-0.096
	LTCC	-0.016	0.877*	0.077	0.085	0.206*	0.133	-	-0.056
	UTCC/LTCC	-0.114	-0.362*	-0.057	-0.017	-0.125	0.059	-	-0.011
Bronchiectasis N=51	UTCC	-0.113	0.497*	0.446	0.109	-0.011	0.122	-	-
	LTCC	-0.007	0.512*	0.548	0.006	0.106	0.024	-	-
	UTCC/LTCC	-0.312*	-0.163	-0.689	-0.088	-0.169	0.142	-	-

* P values less than 0.05 were considered significant

DISCUSSION

Asymptomatic nature of many chronic and slowly progressive respiratory diseases, especially in early subclinical stage, and also their nonspecific symptoms and signs, which may not be appropriately correlated with their severity make screening attempts useful and valuable for evaluation of these patients. This is more important in some occasions, for example during preoperative evaluation of a patient in an emergency condition, when there is not enough time for performing appropriate diagnostic tests to reveal the type and severity of diseases.

Obstructive lung diseases as a large group of human disorders are frequently associated with hyperinflation of the lungs due to airflow limitation, which could be detected by pulmonary function test, particularly spirometry as the standard method for diagnosis and determining the severity of obstruction and monitoring their progression (8).

Chest radiography is a simply available procedure, which can show hyperinflation of the lungs by flattened diaphragms, increased retrosternal space and widening of the upper part of the thoracic cage (8). There are many studies that have investigated the correlation between many radiographic parameters of pulmonary hyperinflation and obstructive indices of pulmonary function test. Therefore chest films are used in daily clinical practice as a screening tool in predicting obstructive lung diseases.

In a recent study on patients with obstructive pulmonary diseases and in subgroup analysis, we observed the significant correlation of obstructive spirometric indices with the ratio of upper third to lower third width of posteroantrior chest X-ray when this ratio was more than 0.9 (8).

In the current study, we conducted a more comprehensive work on a larger sample size by directly measuring the thoracic circumference in the upper and lower thirds instead of obtaining a chest X ray, and the correlation of UTCC, LTCC and UTCC/LTCC with spirometric parameters of obstructive ventilatory defect was evaluated. To the best of our knowledge, no similar study has been performed. The data of our study generally revealed the negative correlation of UTCC/LTCC and FEV1 / FVC. In addition, UTCC, LTCC and UTCC/ LTCC ratio were correlated with ACT score in asthmatics. These findings propose that measuring the thoracic circumference can be a good indicator of the physiological and clinical state of these patients. In COPD patients, only the UTCC showed a significant correlation with FEV1/FVC, which may be due to more pronounced hyperinflation in this type of irreversible obstructive lung disease. In subgroup analysis by considering patients with UTCC/LTCC ratio >0.8 and especially ratio >0.9, we found significant correlations between UTCC with FEV1/FVC and FEV1 as indicators of obstruction and its severity. Moreover, in this subgroup, UTCC and LTCC were significantly correlated with ACT and CAT scores; which could be considered as predictors of clinical control of asthma and COPD.

A limitation of this measurement may be in evaluation of patients with mild obstructive pulmonary diseases, in whom hyperinflation is negligible. In addition, patients with marked chest wall deformities excluding the barrel chest, those with a history of chest wall trauma or thoracic surgery, chronic pleural effusion or fibrothorax may not be good candidates for this form of screening.

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