

## Evaluation of diaphragm in chronic obstructive pulmonary disease patients using ultrasonography in relation to disease severity.

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### Abstract

**Back Ground:** The diaphragm is considered a major respiratory muscle in which any alterations in either structure or function in stable COPD patients may cause a significant adverse clinical consequence. (1) Evaluation of the diaphragm using ultrasonography is considered a simple, non-invasive, available bedside technique that has been used increasingly both in clinical and research settings. (2)

**Aim of Work:** ultrasonographic evaluation of the diaphragm in COPD patients and its relation to disease severity.

#### **Patients and methods:**

The study was carried out during the period from December 2019- December 2020 on forty patients with clinically stable COPD during their follow up in the outpatient clinic of

the chest department, Fayoum University hospital.

#### **Results:**

The diaphragmatic excursion assessed by ultrasonography was found to decrease progressively with increasing COPD severity.

#### **Conclusion:**

Ultrasonography is a reliable, non-invasive, and simple method that can be used for the evaluation of diaphragmatic excursion and a negative correlation was found between diaphragmatic excursion assessed by ultrasonography and COPD severity.

#### **Keywords**

**ultrasonography, diaphragmatic Excursion, chronic obstructive pulmonary disease severity.**

## **Introduction:**

Chronic obstructive pulmonary disease is a widespread disease that can be both prevented and treated, it's characterized by permanent respiratory symptoms and airflow limitation caused by airway and /or alveolar disorders typically due to significant exposure to harmful gases or particles, and it's also affected by factors related to the host such as lung development abnormality [3].

COPD is considered a systemic inflammatory disease so it can cause impacts on several systems such as skeletal muscle dysfunction and weight loss [4].

In addition to affecting the peripheral musculature, muscle fatigue caused by the harmful effect of COPD may impair respiratory muscle function [5].

The diaphragm is the major respiratory muscle used for quiet breathing. Different structural and functional techniques are available for evaluating the diaphragm [6]. Recently diaphragmatic ultrasound evaluation has gained importance as a safe, radiation-free, bedside tool to study diaphragm function [7]. Ultrasound can provide both morphological and functional information, then allowing to repeat measurement over time by both B.mode, M.mode [8].

## **Patients and methods:**

A cross sectional study was conducted in the chest department, Fayoum University hospital from December 2019 to December 2020 for

ultrasonographic assessment of diaphragmatic excursion and its relation COPD severity.

### **Patients' selection:**

The study included forty patients with COPD who were diagnosed and classified into four groups according to GOLD 2020 as following: The first group: included 10 patients with a mild stage. The second group: included 10 patients with a moderate stage. The third group: included 10 patients with a severe stage. The fourth group: included 10 patients with a very severe stage. The study also included forty healthy individuals of the same age and sex as COPD patients.

### **Inclusion criteria:**

1-stable COPD patients aged more than 40 years who were diagnosed and classified into four groups of severity according to GOLD 2020.

2- controls will be healthy individuals who never smoked.

### **Exclusion criteria:**

Subjects who had any of the following conditions were excluded from the study:

1-patient with a known neuromuscular disorder.

2- patient with known anatomical malformation of the diaphragm.

3-post abdominal or thoracic surgery

## Methods:

All participants gave their informed consent for inclusion before sharing in the study. Every person was submitted to:

1. **full medical history**
2. **clinical examination**
3. **chest x-ray**
4. **Spirometry**

5. **6MWT** (six-minute walk test)
6. **chest ultrasonography:** An ultrasound machine (Philips Clear Vue 350) was used to assess the diaphragmatic excursion at TLC through the low-frequency curvilinear probe (4 MHz).

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## Techniques:

Patients were examined in the semi-sitting position. The examination was performed to the right hemidiaphragm through the liver window due to difficult visualization of the left hemidiaphragm caused by the presence of the smaller splenic window.

### Assessment of diaphragmatic excursion (DE):

- The lower frequency curvilinear probe was placed subcostally parallel to the intercostal space between the midclavicular and anterior axillary lines, “anterior subcostal view”.
- In B-mode ultrasonography the diaphragm was seen as a hyperechogenic line surrounding the liver. At this point, the probe was directed medially, cranially, and

dorsally to visualize the posterior third of the right diaphragm.

- Then Imaging was changed to M-mode with the line of sight positioned to obtain maximum excursion.
- in M-mode, the diaphragm was visualized as a hyperechogenic line that assumed in time a sinusoidal form with the peak corresponding to maximum inspiration and the trough corresponding to expiration.
- the diaphragmatic excursion on this M-mode trace was measured as it represented the height of the curve [9].
- **Ethical consideration:**
- This study was reviewed by the Faculty of Medicine Research Ethical Committee. The participants were informed about the objectives of the study, the examination, the

investigation that will be done, and the confidentiality of their information, and their right not to participate in the study.

- **Statistical methods:**
- Data were coded and entered using the statistical package for the Social Sciences (SPSS) version 26 (IBM Corp., Armonk, NY, USA). Data were summarized using mean and standard deviation for quantitative variables and frequencies (number of cases) and relative frequencies (percentages) for categorical variables. Comparisons between groups were done

using unpaired t-test when comparing 2 groups and analysis of variance (ANOVA) with multiple comparisons post hoc test when comparing more than 2 groups [10]. For comparing categorical data, Chi-square ( $\chi^2$ ) test was performed. An exact test was used instead when the expected frequency is less than 5 [11]. Correlations between quantitative variables were done using the Pearson correlation coefficient [12]. P-values less than 0.05 were considered as statistically significant.

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## Results:

In this study, 80 male patients were included in the form of 40 COPD patients diagnosed and classified according to GOLD 2020 as follows: 10(25%) as mild, 10(25%) as moderate, 10(25%) as severe, 10(25%) as very severe and another 40 individuals served as the control group with no significant statistical difference between the patients and the control group (**P<0.009**) with a mean age of the cases (59.18 ±4.93), while that of the control group was (56.38±4.48).

**Table (1): statistical comparison between cases and control excursion.**

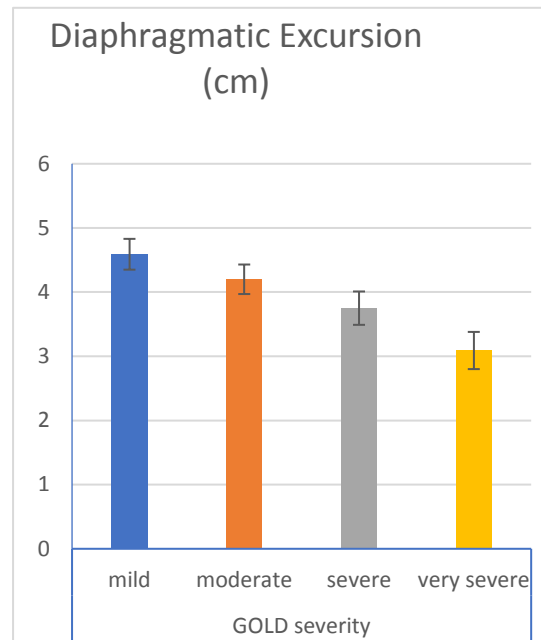
	cases				control				P-value
	Mean	SD	Minimum	Maximum	Mean	SD	Minimum	Maximum	
Diaphragmatic Excursion (cm)	3.91	0.62	2.50	5.05	6.30	0.42	5.25	6.90	< 0.001

The table illustrates a statistical comparison between the study group and control showing that there was a highly significant statistical difference between cases and control as regard diaphragmatic excursion) (**P<0.001**) with lower values in the cases, with mean value in the COPD patients being (3.91±0.62) While the mean value in the control group of diaphragmatic excursion was (6.3±0.42).

**Table (2): statistical comparison among COPD patients with different grades of severity as regard Diaphragmatic excursion.**

	GOLD severity								P-value
	mild		moderate		severe		very severe		
	Mean	SD	Mean	SD	Mean	SD	Mean	SD	
Diaphragmatic Excursion (cm)	4.59	0.24	4.20	0.23	3.75	0.26	3.09	0.29	< 0.001

Table showing highly significant statistical difference(**P<0.001**) between COPD patients with different grades of severity as regard diaphragmatic excursion with the lowest values in the very severe group.



**Figure (1): statistical comparison between COPD patients with different grades of severity regarding diaphragmatic excursion.**

### Discussion:

Ultrasonography provides a simple, safe, and non-invasive method for assessment and visualization of diaphragmatic function and mobility. The primary goal of our study was to determine the diaphragmatic mobility in patients with COPD compared with normal controls and comparing them between different grades of severity in COPD patients.[13]. in the present study, 80 patients have been included 40 COPD patients and 40 controls all of them were males. with a mean age of the cases (59.18

$\pm 4.93$ ), while that of the control group was ( $56.38 \pm 4.48$ ).

In our study, there was a highly significant difference ( $p < 0.001$ ) between the cases and control as regards diaphragmatic excursion, With lower values in the COPD patients.

This agreed with the study by **Abd El-hay Ibrahim Abd El-hay, et al;2019** [13] who found that the control showed a higher diaphragmatic excursion than the COPD group.

It also agreed with **Camilo Corbellini, et al;2018**[14] who found that the diaphragmatic mobility showed significant differences between the COPD patients and the healthy controls and that Diaphragmatic mobility during deep inspiration lower than in the healthy controls.

**Davachi, et al;2014**[15], **Paulin, et al;2007**[16], **Dos Santos Yamaguti, et al;2008**[17]. agreed with our study as they reported statistically significant differences regarding diaphragmatic motility measured by the US, between

the patients and control.

In our study, there was a highly significant statistical difference in diaphragmatic excursion between different grades of COPD severity with decreasing values with the disease progression

This study agreed with **Ayman Amin and Moustafa Zedan,2018**[18]and **Dos Santos Yamaguti, et al; 2008** [17]who reported that Diaphragmatic excursion during deep breathing correlated significantly with disease severity.

## Conclusion:

Ultrasonography is a reliable, non-invasive, and a simple method that can be used for assessment of diaphragmatic excursion.

A negative correlation was found between diaphragmatic excursion assessed by ultrasonography and COPD severity

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