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Assessment of the Respiratory Muscles Function in Chronic Obstructive Pulmonary Disease patients

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Abstract

Chronic Obstructive Pulmonary Disease (COPD) is a public health problem worldwide. It is a polygenic disease and a classical example of gene-environment interaction. Of the many inhalational exposures that may be encountered over a lifetime, only tobacco smoke and occupational dusts and chemicals (vapors, irritants, and fumes) are known to cause COPD on their own. Maximal inspiratory pressure (MIP) and maximal expiratory pressure (MEP) may be impaired in patients with COPD.

Aim of the study: to assess respiratory muscle function in male COPD patients by measuring MIP and MEP values and to identify possible correlation between MIP and MEP and the anthropometric parameters as well as degree of airflow obstruction among COPD patients.

Subjects and methods: A case-control study was carried out on 50 COPD male patients and 50 of age and sex matched healthy subjects as a control group. All participants were subjected to assessment of respiratory muscle (RM) strength by MIP and MEP, pulmonary function tests {flow/volume spirometry, and MVV}, as well as the functional exercise capacity (6MWT) and the anthropometric measurements.

Results: the values of MIP and MEP in COPD cases were lower than those of the control group with a statistically significant difference. In COPD cases the MIP and MEP were positively correlated with VC%, FEV_1\FVC, FEV_1%, FVC%, PEF%, MVV%, and 6MWD ($p<0.00$). Furthermore, COPD patients were subdivided according to the presence of respiratory muscle (RM) affection into two subgroups: **Group A (**patients with RM affection) and **Group B (**patients without RM affection). There was a significant difference between the two subgroups concerning smoking index , disease duration, VC% , FVC% ,FEV_1\FVC, FEV_1%, PEF%, MVV%, and 6MWD ($P< 0.05$).

Conclusion: RM is affected in patients with COPD. Measurement of MIP and MEP indicates the state of RM which is related to smoking index, disease duration, and spirometric-indices (VC%, FVC%, FEV_1\FVC, FEV_1%, PEF%, and MVV %).

Recommendation: Health care workers involved in the diagnosis and management of COPD patients especially those with severe airflow obstruction should consider the possibility of RM deterioration and should have an access to RM function assessment.

Key words: COPD, MIP, MEP, respiratory muscle function and pulmonary function test.

Abbreviation: MIP: Maximal inspiratory pressure **- MEP:** Maximal expiratory pressure **- PImax:** Peak inspiratory pressure **- - PEmax:** Peak expiratory pressure **- RM:** Respiratory muscle**- SNIP**: Sniff Nasal Inspiratory Pressure

Introduction

Chronic Obstructive Pulmonary Disease (COPD) is a public health problem and is a major cause of chronic morbidity and mortality throughout the world. The World Health Organization (WHO) estimates that COPD will be the third most common cause of death and the fifth most common cause of disability in the world by 2020 ***(Barnes, 2000).***COPD imposes a high economic burden on the society and health care system and as one of the risk groups of the disease is the working age population, this is leading to losses in wages and salaries for workers and also in the overall productivity ***(Ait-Khaled et al., 2001).***

COPD is a polygenic disease and a classical example of gene-environmental interaction. Individuals may be exposed to a variety of different types of inhaled particles over their lifetime. Of the many inhalational exposures that may be encountered over a lifetime, only tobacco smoke and occupational dusts and chemicals (vapors, irritants, and fumes) are known to cause COPD on their own.***(Ait-Khaled et al., 2001). Pauwels and Rabe (2004)*** reported that almost 90% of COPD deaths occur in low- and middle-income countries, where effective strategies for prevention and control are not always implemented or accessible

Respiratory muscle function is best assessed by measurement of maximal inspiratory pressure (MIP) and maximal expiratory pressure (MEP). MIP and MEP may be impaired in patients with COPD ***(Calverley and Walker, 2003).***

Ventilation plays a key role in the adequacy of the external gas exchange and the ultimate lung function. The appropriateness of the ventilator pump response to a given metabolic load is intrinsically linked to the ability of the force-generator units i.e. RM to provide the required output ***(Neder et al., 1999)***.During normal breathing, most of the respiratory work depends on the diaphragm function and the accessory RM become necessary only during deep inspiration ***(Pollaet al.,2004).***

RM strength can be directly measured using static pressures {MIP and MEP} or inferred from some dynamic maneuvers {such as the Maximal Voluntary Ventilation (MVV)}***(Neder et al., 1999)***.

MIP is the maximum negative pressure that can be generated from one inspiratory effort starting from functional residual capacity (FRC) or residual volume (RV) ***(ATS/ERS, 2002).*** MEP measures the maximum positive pressure that can be generated from one expiratory effort starting from total lung capacity (TLC) or FRC. Unlike inspiratory muscles, expiratory muscles (abdominal and thoracic muscles) reach their optimal force-length relationship at elevate pulmonary volumes ***(Terzano et al., 2008).***When we analyze MIP, we should consider both the difficulty that some subjects have in performing a maximal effort and the normal biological variability of RM strength ***(Neder et al., 1999)***.In several diseases, the evaluation of RM strength can prove to be very useful ***(Terzano et al., 2008).***

MIP and MEP are simple, convenient, and non-invasive indices of RM strength at the mouth ***(Evans and Whitelaw, 2009).***The mouth pressures recorded during these maneuvers are assumed to reflect RM strength ***(ATS/ERS, 2002).***

It is known that a reduction of MIP and MEP has been associated with several neuromuscular diseases, but it is also possible to point up lower values in patients with COPD ***(Iandell et al.,2001).***The factors contributing to RM weakness in many patients with COPD are: **a)** malnutrition related to biochemical, anatomical and physiological changes; **b)** muscular atrophy; **c)** steroid-induced myopathy; **d)** pulmonary hyperinflation with increased residual volume (RV); **e)** reduced blood flow to the RM. The measurement of MIP and MEP is indicated in any of these situations or when dyspnea or hypercapnia are not proportional to FEV_1 reduction ***(Polla et al.,2004).***

Mouth Pressure and Nostril Pressure

Mouth pressure is easy to be measured and may give a reasonable approximation of changes in alveolar pressure providing there is relatively little pressure loss down the airways or across the lungs. This may be realistic with normal lungs, particularly when changes in lung volume are small, but is unlikely to be fulfilled in patients with severe lung or airway disease. When used in combination with voluntary static and dynamic maneuvers at FRC, mouth pressure provides a global index of the action of synergistic RM. When the diaphragm contracts in isolation against a closed airway, as with phrenic nerve stimulation, mouth pressure may be a useful reflection of transdiaphragmatic pressure ***(ATS/ERS, 2002).***

Measurement of the MIP and MEP is a simple way to gauge inspiratory and expiratory muscle strength. The pressure measured during these maneuvers reflects the pressure developed by the RM plus the passive elastic recoil pressure of the respiratory system including the lung and chest wall. At FRC, the passive elastic recoil pressure of the respiratory system including the lung and chest wall is zero so that mouth pressure represents RM pressure. However, at RV, where MIP is usually measured, the passive elastic recoil pressure of the respiratory system including the lung and chest wall may be as much as -30 cmH_2O, and thus makes a significant contribution to MIP of up to 30% (or more if RM pressure is decreased). Similarly, MEP is measured at total lung capacity (TLC), where the passive elastic recoil pressure of the respiratory system including the lung and chest wall can be up to -40 cmH_2O. Clinical measures and normal values of MIP and MEP do not conventionally subtract the respiratory system recoil ***(Polla et al.,2004).***

The main advantages of mouth pressures are that the pressures measured at the mouth during MIP or MEP maneuvers are widely used as specific tests of RM strength, normal values are available for adults, children, and the elderly, and the tests are not complicated to perform and are well tolerated by patients. However, the measurement of mouth pressure does not allow the investigator to discriminate between weaknesses of the different RM ***(ATS/ERS, 2002).***

Evans and Whitelaw (2009) reviewed recent literature, update the 2002 ATS/ERS statement, and propose as the best choice using a flanged mouthpiece for reference values and lower limit of normal (LLN) values as a function of age for adults age up to about 70 years. Because male pressures are higher than female pressures and MEP exceeds MIP, they present 4 linear regression reference equations: Male MIP =120 – (0.41 X age), and male MIP LLN =62 – (0.15 X age). Male MEP =174 – (0.83 X age), and male MEP LLN = 117 - (0.83 x age). Female MIP = 108 - (0.61 x age), and female MIP LLN = 62 - (0.50 x age). Female MEP=131 - (0.86 x age), and female MEP LLN= 95 - (0.57 x age). (Pressure in cm H_2O and age in years). ***Hautmann et al., (2000)*** reported that male exceeds female MIP by 34-66%, and male exceeds female MEP by 41-57%, depending on age.

Aims of the study

- to assess respiratory muscle function in male COPD patients by measuring MIP and MEP values.
- to identify possible correlation between MIP and MEP and the anthropometric parameters as well as degree of airflow obstruction among COPD patients.

Subjects and methods

A case-control study was carried out on 50 COPD male patients and a 50 of age and sex matched healthy subjects as a control group. Cases were selected by purposive sample technique from Chest Department at AlZahraa University hospital in the period from November 2011 till March 2012.While the control group was recruited from patient's relatives within the same hospital.

Inclusion criteria:

- COPD group: The selected 50 COPD patients were had post bronchodilators FEV_1<80%, along with an FEV_1\FVC <70%. They had an increase in FEV_1<200 ml or <12 % of baseline value, 20 minutes after 2 puffs of inhaled salbutamol (100 µg \ puff) that was given via a metered- dose inhaler.

- Control group: The selected 50 age matched male subjects; all of them had no history of any chest disease with normal spirometric pulmonary function test.

Exclusion criteria

The following patients were excluded from the study:

1. Those with FEV_1 improvement, after a bronchodilator test, i.e. ≥ 12% and 200 ml of the baseline value and with a history of asthma.
2. Patients with other clinically significant diseases such as fibrothorax, bronchiectasis, tuberculosis or neuromuscular diseases.
3. Some patients were excluded due to lack of compliance during the forced expiratory test or during the MIP and MEP maneuvers.

Ethical consideration: An informed written consent was taken from every participant before enrollment into the study.

All subjects were subjected to complete history taking (smoking status and disease duration were recorded), clinical examination, MIP and MEP to assess RM strength, pulmonary function tests {flow/volume spirometry, and MVV},as well as the functional exercise capacity (6MWT) and the anthropometric measurements (height and weight and BMI).

Pulmonary function tests were carried out on (MEDISOFT – HYPERAIR compact + flow meter pulmonary function testing-Belgium). Spirometric-indices were calculated using best out of 3 technically - satisfactory performances in accordance to the recommendations of the ***ATS (1987).***The following indices were recorded (% predicted) VC%, FVC%, FEV_1%, and FEV_1\FVC% and peak expiratory flow rate % (PEF).

MIP and MEP were measured using (MEDISOFT – HYPERAIR compact + flow meter pulmonary function testing- Belgium); this had a disposable mouthpiece, and a small leak to prevent glottic closure. MIP was obtained at the level of RV and MEP was measured at the level of TLC. The measurements were made with the subjects seated wearing nose clips and with a rigid, plastic flanged mouthpiece in place.

The ATS authors review studies of flanged versus tube mouthpieces. They make the point that with a flanged mouthpiece the values obtained are less than with a tube mouthpiece, but recommend the flanged mouthpieces as the standard because they are easier for patients to use **(Neder*et al.*, 1999)**.

The subjects were verbally encouraged to achieve maximal strength. The measurements were repeated until three values varying by <20% ***(Pauwels and Rabe, 2004).***The best value achieved was considered in the data analysis. Data were discarded if there was an air leak around the mouthpiece or if the pressure was held for less than one full second.

The initial length of the inspiratory muscles was controlled by initiating each effort from RV. This procedure was adopted because in the clinical situation RV is more reproducible than FRC. Patients were instructed to take their time and slowly empty their lungs to RV and indicate when they were ready to perform each maneuver. In order to avoid problems associated with variability in lung volumes caused by dynamic hyperinflation in conducting these tests. Tests were conducted in a quiet room with no distractions and brief rest periods of slightly less than one minute were taken between repeated MIP and MEP trials.

MVV is the largest volume that can be breathed into and out of the lungs during a 10-15-second interval with maximal voluntary effort. In this study, the subjects wore nose clips and breathed deeply (with a volume greater than the tidal volume but lower than the VC) and rapidly for a 15- second interval.

The subjects were actively encouraged to maintain the same volume and frequency by following a display of the maneuver on a computer screen, i.e., the end-expiratory level remained relatively constant. At least two acceptable maneuvers (with no more than a 10% difference between them) were obtained ***(Barnes,2000).***Also, patients were instructed to take their usual medications as scheduled on day of testing to control for any potential drug effects on RM function. Body mass index (BMI) was calculated as the ratio of weight (kilogram) to squared height (meter squared).

Statistical analysis was done by using SPSS program version 0.17. Quantitative variables were presented as Mean ± SD and qualitative data were presented as frequencies and percentages. Student-t test, ANOVA test were used for comparison between groups. Pearson Correlation test was used for demonstration of association between the variables, it was presented by the correlation coefficient (r) and the P-value .

Results

This study was conducted on male subjects only in order to avoid the intersex differences in MIP and MEP. Also, there was no statistical significant difference between the COPD cases and the control group as regard the age, weight , height and the BMI (P > 0.05) as demonstrated in (table 1).These results indicate that the effect of age and anthropometric measurements (height and weight and BMI) on respiratory functions were neutral.

The mean of the smoking index was significantly high (371.0±165.5) among COPD patients, compared to that of control group (103.5±103.1).While the mean of 6MWD was significantly lower (126.7 ± 12.7) among COPD group than among the control group (240.3 ± 10.0) (P–value <0.05) {table 1}.

As regard the spirometric-indices (% predicted) of COPD group (VC%,FEV$_1$% , FEV$_1$\FVC%, FVC%, PEF%){table 1} showed that all were lower than those of the control group with a statistically significant difference in between (P value < 0.05). Additionally the mean value of MVV% was lower (55.8±13.9) among the COPD patients than among the control group (78.0±7.4), as well as, the mean values of MIP and MEP (both cmH$_2$O and %) of the COPD patients were lower than the mean values of the control group with a statistically significant difference (P-value < 0.05) {table 1}.

Table (1): Comparison between COPD group and the control group concerning all parameters

Group / Items	COPD group No. = 50	Control group No. = 50	P-value
	Mean ± SD	Mean ± SD	
Age /yrs.	60.7 ± 8.1	60.0 ± 5.7	0. 7
Weight / Kg	70.9 ± 13.5	74.8 ± 8.9	0.2
Height /cm	169.6 ± 8.8	173.5 ± 7.3	0.1
BMI kg/m^2	24.5 ± 3.7	25.1 ± 3.1	0.6
Smoking Ind.	371.0 ± 165.5	103.5 ± 103.1	0.000*
6MWD\m	126.7 ± 12.7	240.3 ± 10.0	0.000*
VC %	68.8 ± 17.0	79.4 ± 6.8	0.01*
FEV1\FVC%	51.4 ± 11.4	78.3 ± 4.7	0.000*
FEV1%	47.9 ± 18.8	78.8 ± 7.8	0.000*
FVC%	66.6 ± 16.6	79.6 ±7.5	0.002*
PEF%	44.0 ± 19.2	80.8 ± 9.3	0.000*
MVV%	55.8 ± 13.9	78.0 ± 7.4	0.000*
MIP cmH$_2$O	66.2 ± 22.2	91.4 ± 6.9	0.000*
MIP %	63.0 ± 21.4	91.4 ± 6.9	0.000*
MEP cmH$_2$O	73.2 ± 24.7	93.9 ± 10.5	0.001*
MEP %	52.9 ± 16.0	70.5 ± 7.5	0.000*

*t-test was done for Comparison and P-value ≤ 0.05 is considered significant

Table (2): Correlation between MIP and MEP and all the studied parameters in total COPD group

Items	MIP cmH_2O		MEP cmH_2O	
	r	p	r	p
Age /yrs.	-0.493**	0.006	-0.222	0.238
Weight / Kg	0.114	0.550	0.017	0.929
Height /cm	0.108	0.572	0.121	0.525
BMI kg/m²	0.218	0.246	0.099	0.602
Smoking Index	-0.776**	0.000	-0.548**	0.002
Disease Dur.	-0.607**	0.000	-0.504**	0.005
6MWD\ m	0.616**	0.000	0.665**	0.000
VC %	0.574**	0.001	0.352*	0.050
FEV_1\FVC%	0.669**	0.000	0.587**	0.001
FEV_1 %	0.696**	0.000	0.568**	0.001
FVC %	0.510**	0.004	0.289	0.121
PEF %	0.675**	0.000	0.573**	0.001
MVV %	0.937**	0.000	0.812**	0.000
MEP cmH_2O	0.858**	0.000	-	-

** Correlation is significant at the 0.01 level
* Correlation is significant at the 0.05 level

Pearson correlation was done among COPD cases to identify the relation between different variables with MIP and MEP (cmH_2O). The results revealed a statistically significant positive correlation between both MIP and MEP (cmH_2O) and all of the following variables (6MWD\m, VC%, FEV_1\FVC%, FEV_1 %, FVC%, PEF%, and MVV%).While it was negatively correlated with age (MIP only),smoking index and the disease duration with significant correlation ($P \leq 0.05$).On the other hand there was no correlation between the anthropometric variables (weight, height and BMI) with both MIP and MEP (cmH_2O).Also, in COPD group MIP and MEP (cmH_2O) were positively correlated with each other with significant P-value {table 2}.

Table (3): Classification of COPD patients according to RM affection and airflow obstruction

Degree of airflow obstruction	COPD with RM affection no. = 33	COPD without RM affection no. = 17	Total no.= 50
	no. (%)	no. (%)	no. (%)
Mild ($FEV_1 > 80$)	1 (3.0)	5 (29.4)	6 (12.0)
Moderate ($50 < FEV_1 < 80$)	10 (30.3)	10 (58.8)	20 (40.0)
Severe ($30 < FEV_1 < 50$)	8 (24.24)	2 (11.8)	10 (20.0)
Very severe ($FEV_1 < 30$)	14 (42.42)	-	14 (28.0)

According to the value of FEV_1%, the results revealed that 28% of COPD cases had very severe airflow obstruction (FEV1<30), 20% had severe airflow obstruction ($30 < FEV_1 < 50$), 40% had moderate airflow obstruction ($50 < FEV_1 < 80$), while only 12% of COPD patients had mild airflow obstruction ($FEV_1 > 80$){table 3}.

COPD patients were subdivided according to MIP and MEP values into two subgroup **Group A (**patients with RM affection) includes 33(66%) COPD patients and **Group B (**patients without RM affection) includes 17(34%) COPD patients. Furthermore, the majority of Group B had either mild (29.4%) or moderate (58.8%) airflow obstruction, while nearly all of the Group A had either moderate (30.3%), severe (24.2%) or very severe (42.4%) airflow obstruction {table3}.

Table (4): Comparison between COPD subgroups concerning age, anthropometric measures, spirometric indices and 6MWD

Items \ Group	COPD patients Group(A) No. = 33 Mean ± SD	Group (B) No. = 17 Mean ± SD	P-value
Age /yrs.	62.5 ±8.1	57.1 ±7.4	0.08
Weight / Kg	69.8±15.5	73.1 ±8.7	0.54
Height /cm	168.8±7.8	171.1 ±10.9	0.52
BMI kg/m²	24.0±4.2	25.6 ±2.4	0.3
Smoking Index	446.0± 151.1	221.0 ± 50.6	0.000*
Disease Dur.	24.7 ± 5.2	17.7 ± 3.9	0.001*
6MWD\m	120.2 ± 8.2	139.8 ± 9.6	0.000*
VC%	63.9 ± 18.8	78.6 ± 4.7	0.02*
FEV1\FVC%	45.9 ± 9.3	62.4 ± 6.2	0.000*
FEV1%	39.2 ±1 5.6	65.3 ± 10.9	0.000*
FVC%	62.5 ± 18.9	74.9 ± 4.5	0.05*
PEF%	36.0 ± 14.2	60.0 ± 18.4	0.000*
MVV%	47.4 ± 8.4	72.5 ± 3.8	0.000*

*t-test was done for Comparison and P-value ≤ 0.05 is considered significant

Concerning the comparison between the subgroups of COPD cases, there were no statistical significant differences ($P > 0.05$) as regard the age and the anthropometric measures (weight, height and BMI). However, there were an obvious difference between the subgroups of COPD cases as regard duration of diseases, smoking index with the higher levels were among the group A. On the other hand the lower levels of all spirometric-indices and 6MWD were among the group A with a statistically significant difference ($P< 0.05$) {table 4}.

Table (5): Comparison between COPD subgroups and the control group concerning the MIP and MEP (cmH_2O)

Item	COPD with RM affection	COPD without RM affection	Control group	ANOVA	
	Mean± SD	Mean± SD	Mean± SD	F-test	P-value
MIP	52.4 ± 12.0	93.7 ± 6.0	91.4 ± 6.9	111.1	0.000*
MEP	57.9 ± 9.1	103.9 ± 14.9	93.9 ± 10.5	79.5	0.000*

COPD with RM affection Vs. Control group		COPD with RM Vs. COPD without RM affection		COPD without RM affection Vs. control	
MIP	**MEP**	**MIP**	**MEP**	**MIP**	**MEP**
t-test = 12.5 P=0.000*	t-test = 11.5 P=0.000*	t-test = 10.1 P = 0.000*	t-test = 10.5 P = 0.000*	t-test = 0.86 P = 0.39	t-test = 2.1 P = 0.04*

*P-value ≤ 0.05 is considered significant

This table demonstrates that the lowest values of MIP and MEP were among COPD subgroup with RM affection in comparison to both of the control group and the COPD subgroup without RM affection with a statistical significant difference ($P < 0.05$) by ANOVA test. Also, there were a significant difference between the COPD subgroup with RM affection and each of COPD subgroup without RM affection and the control group by using t-test ($P < 0.05$) for both of MIP and MEP values. However, there was no statistical significant difference between COPD subgroup without RM affection and the control group ($P > 0.05$) of the MIP value only {table 5}.

Table (6): Comparison between the COPD cases according to level of severity concerning the MIP and MEP (cmH_2O)

Item		COPD stage (GOLD Criteria)				ANOVA	
		Mild	Moderate	Severe	V. severe	F-test	P-value
MIP	Range	69.1 - 101.9	49.2 - 101	32- 89.9	30.1 - 68	5.1	0.006*
	Mean ± SD	86 ±16.3	76.7 ± 20.5	55.0 ± 211	50.7 ± 14		
MEP	Range	69.8 - 106	41.3 - 128	44.7-107	41.0 - 71	2.3	0.1
	Mean ± SD	90.7 ± 18.7	81.1 ± 29	68.3 ± 23	58.8 ± 9.2		

*P-value ≤ 0.05 is considered significant

The severity of airflow obstruction is progressively increases as well as the values of MIP and MEP were significantly lowered in patients with severe and very sever airway obstruction with a statistical significant difference between the levels of airway obstruction concerning MIP value only (F-test = 5.1, P = 0.006*), while there was no statistical significant difference concerning MEP value ($P > 0.05$){table 6}.

Discussion

Assessment of COPD severity is based on the Patient's level of symptoms, the severity of the spirometric abnormality, and the presence of complications. Skeletal-muscle (both respiratory and limb) abnormalities are common and may have a profound effects in patients with COPD. RM in COPD patients are overloaded leading to increased fatigue potential, especially during exercise, when hyperinflation worsens. Therefore, the overloaded

RM develops structural changes that help them adapt these conditions ***(MacIntyre, 2006).***

This study conducted on 50 male COPD patient and 50 male subjects (control group) to avoid intersex differences in MIP and MEP. As reported by ***Neder et al., (1999)*** who studied the maximal respiratory pressures and voluntary ventilation in a randomly selected sample of healthy adult Brazilian population {100 non-smoking subjects (50 males and 50 females), aged 20-80 yrs.} and mentioned that age-matched males presented higher values than females for all studied variables ($P<0.05$).

In the current study the mean age of the studied COPD group were 60.7±8.1 yrs. which is matched with age of the control group (60.0 ± 5.7). Also, the weight, height and BMI were matched with control group with no statistical significant difference ($P> 0.5$) (table 1).

These data were coincide with ***Larson et al., (1993)*** and ***Heijdra et al., (1994)*** as they conducted their studies on a COPD sample with similar characteristics as follows: mean age was (65.0±7.0yrs.) and (60.7±6.5yrs.), weight (72.45±16.2kg) and (74.0±10.8kg), height (170 ±10cm) and (174.8±6.9cm), and BMI (25±4kg\m^2) and (24.2±2.8 kg/m^2) respectively. Also, ***Terzano et al., (2008)*** and ***Mesquita et al., (2010)*** reported similar age and anthropometric characteristics of their COPD patients.

In this study all COPD patients were taking their standard pharmacologic therapies, including inhaled and oral β_2-agonists, inhaled corticosteroids, and methylxanthines, 17 patients of them were receiving long term oxygen therapy.

Tobacco smoke and occupational exposures appear to act additively to increase the risk of developing COPD ***(Aıt-Khaled et al., 2001)***.It was found that all COPD patients in the present study were either current or former smokers compared to the control group as 16 subjects were current smokers, 14 were former smokers and 20 subjects were non-smokers.

The spirometric – indices (% predicted) of COPD group in this study (VC, FEV_1, FEV_1\FVC, FVC and PEF) showed lower values than the control group with highly significant difference in all spirometric indices {table 1}.

These results were coincide with those reported by ***Larson et al., (1993)***, ***Maskey-Warzechowska et al., (2006) and Mesquita et al., (2010)*** as they reported that the spirometric parameters of their COPD patients were very similar to the parameters of the current study.

Also,***de Lucas et al., (1998)*** reported that their patients had either moderate or severe airflow obstruction with FEV_1: 37.6±13 which is coincided with this study as most patients had moderate, severe or very severe airflow obstruction {table 3}.

In COPD patients the reduction of RM functions, leads to reduction in compliance of the chest and an increase in resistive and elastic work of breathing. Therefore, MVV and VC were used in this study as an indirect index of RM strength.

This study revealed that MVV% among COPD group was (55.8±13.9) compared to (78.0±7.4) among the control group, these results coincide with ***Larson et al., (1993)*** as they reported that the MVV% in COPD patients was (40.0±22.0). Also, the 6MWD of COPD and control groups were 126.7±12.7m and 240.3±10.0m, respectively with a significant difference ($P < 0.05$){table 1}. This result is not concomitant with that reported by ***Maskey-Warzechowska et al., (2006)*** as the mean distance walked by their COPD patients during the 6MWT was 569.4±101.7m. This variation may be attributed to the different severity of airway obstruction, that most of the COPD patients in the current study had moderate, severe or very severe airflow obstruction.

In the present study the MIP and MEP (cmH_2O) in COPD was 66.2±22.2 (63.0±21.4%) and 73.2±24.7 (52.9±16.0%) respectively, were lower than that for control group as MIP was 91.4±6.9cmH_2O (91.4±6.9) and MEP was 93.9±10.5cmH_2O (70.5±7.5%)] with significant difference ($P< 0.05$){table 1}.

Decramer et al., (1996) agreed with the previous results as they reported that the PImax in COPD was (37±15%) versus (67±24%) in control ($P< 0.001$) and PEmax was (34.0 ± 10%) versus (74.0 ± 23% ,) in the control group with significant P-value <0.05.

Additionally ***Sudo et al., (1997) and de Lucas et al., (1998)*** reported similar results as PImax in COPD was 51.5 ±5.4 cmH_2O and 54±9 cmH_2O at baseline (before inspiratory muscles training in COPD) and it was increased significantly to 80.9±7.0 cmH_2O and 78±16 cmH_2O, respectively at the end of the study in the trained group after rehabilitation with ($P < 0.05$).

The values of MIP among COPD patients in this study is coinciding with that reported by ***Larson et al., (1993)and Maskey-Warzechowska et al., (2006)***as the baseline PImax and PEmax for COPD patients before exercise were 71.4± 23.0 and 124.9±46.5 cmH_2O, respectively. However, it decreased significantly after maximal exercise (63.6±22.2 and 112.3±46.6 cmH_2O, respectively) (P= 0.02).

In the current study the MIP and MEP (cmH_2O) for control group was 91.4±6.9 and 93.9±10.5, respectively with MEP value greater than MIP. This is coincide with PImax value for healthy men volunteers aged 18-82 yrs. with normal lung function reported by ***Hautmann et al., (2000)*** as the mean values of PImax was 9.95 kPa. Moreover, the MIP and MEP values for control group is slightly similar to ***Adamiak-Kardas (2002)***as they reported that the PImax and PEmax(cmH_2O) for men was 73.2 and PEmax was 115.9 with PEmax value was greater than PImax.

In the present study both MIP and MEP in COPD group were negatively correlated with smoking index, and disease duration, but MIP only was negatively correlated with age. This could be interpreted by that aging process is associated with a reduction in the total diaphragmatic and respiratory accessory muscular mass, as well as with a decline in the work output for a same level of neural stimulation. This is concomitant with ***Barnes (2000)*** who reported that COPD is usually a progressive disease and lung function can be expected to worsen over time, even with the best available care.

MIP and MEP in COPD group were not correlated with weight, height, and BMI ($p> 0.05$). Similar results had been reported by ***Adamiak-Kardas (2002)*** who found no correlation between age and PImax or PEmax in both groups {male and female}, and no correlation detected between PImax and PEmax and height in women group and men group treated apart. However, the correlation was found between PImax as well as PEmax and height for whole group ($p< 0.05$). On the other hand, he observed positive correlation between PImax, PEmax and weight in both (male and female) groups. The comparison of results of his study with those obtained in former studies reveals important differences of norms for different populations. So they concluded that the normal values of PImax and PEmax in the mouth should be qualified individually for studied population.

Different results had been reported by ***Neder et al., (1999)*** as they reported that the height, weight, lean body mass and regular level of physical activity showed a significant positive correlation with maximal respiratory muscle pressure. Additionally, in the male group, weight was also a predictor of MIP and height of MVV. However, they coincided with the results of this study as regard age, as they concluded that age was the strongest negative correlate with the MIP.

Also, ***Heijdra et al., (1994)*** reported significant correlations between PImax on one hand, and lung function parameters, BMI in other hand. However, a different results had been reported by ***Uldry and Fitting (1995)*** for both men and women maximal SNIP was negatively correlated with age. This difference may be attributed to that they measure RM function by maximum sniff nasal inspiratory pressure (SNIP) methods in a wide age range (20-80 years) and all subjects had a FVC > 80%, FEV_1/FVC > 85% %, and a BMI of 18-31kg/m^2. So they conclude that normal values of maximal SNIP can be predicted from age and sex. Maximal SNIP is significantly higher than PImax in healthy subjects.

In this study there was positive correlation between MIP and MEP in total COPD group (p = 0.000) {table 2}. This is coinciding with the results reported by ***Heijdra et al., (1994)*** as they reported that PEmax was significantly correlated with PImax ($P < 0.05$).

Additionally, results of this study revealed that MIP and MEP among COPD group were positively correlated with VC%, FEV_1\FVC, FEV_1%, FVC%, PEF%, MVV%, and 6MWD (P = 0.00) {table 2}.

This finding indicate that increased severity of airflow obstruction leads to air trapping which put the RM under mechanical disadvantage. Similar results had been reported by ***Hautmann et al., (2000)*** as they found significant positive correlation between MIP and FEV_1%, FVC%, PEF % in total COPD patients (p< 0.05).

Terzano et al., (2008) conclude that RM in COPD patients are overloaded leading to increased fatigue potential, especially during exercise, when hyperinflation worsens. Therefore, the overloaded RM develops structural changes that help them adapt these conditions. MIP may be reduced by hyperinflation and gas trapping which flattens the diaphragm and places the intercostal muscles at a disadvantage level. Also, MEP may be reduced in severe lung diseases, as MEP < 40cmH_2O leads to an ineffective cough.

In this study both MIP and MEP in COPD group were positively correlated with 6MWD (P = 0.00) {table 2} which is not coincide with the result reported by ***Maskey-Warzechowska et al., (2006)***as they reported that 6MWD is not correlated with PImax or PEmax.

In the present study COPD patients were subdivided according to MIP and MEP values to compare COPD subgroups with each other in order to highlight which anthropometric or functional parameters is responsible for reduction of RM strength (MIP and MEP). There was no difference between both COPD subgroups as regards age, anthropometric parameters {weight, height, and BMI} with (P > 0.05). However, there was significant increase in smoking index and disease duration compared to significant decrease in VC% and FVC%, FEV_1\FVC, FEV_1%, PEF%, MVV% and 6MWD in COPD subgroup with RM affection (P < 0.05) {table 4}.

Conclusions:

We conclude that there is a RM affection in COPD patients that is related to smoking index, disease duration and spirometric indices (VC%, FVC%, FEV_1\FVC, FEV_1%, PEF%, and MVV %).
Measurement of MIP and MEP indicates the state of RM, thus providing clinicians with a further and helpful tool in monitoring the evolution of COPD. The overall approach for managing stable COPD should be individualized to address symptoms and improve quality of life.
This study is considered as a "snapshot" of the maximal respiratory pressures and their correlation with functional parameters at different stages of COPD severity.

Recommendation:

Periodical evaluation of the RM strength could represent a further and helpful tool in monitoring the disease severity of COPD patients especially among occupational workers who are vulnerable to develop COPD.

Health care workers involved in the diagnosis and management of COPD patients, especially those with severe airflow obstruction should consider the possibility of RM deterioration and should have an access to a spirometry.

Early enrollment of COPD patients with severe and very severe airflow obstruction in RM training and rehabilitation programs to prevent development of RM fatigue which further deteriorate their conditions
Many cases of COPD can be reduced or controlled through a variety of strategies aimed at reducing the burden of inhaled particles of tobacco smoke, occupational dusts, chemicals, indoor and outdoor air pollutants.

For patients with COPD, health education plays an important role in smoking cessation and can also play a role in improving skills, ability to cope with illness and health status.

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تقييم وظائف عضلات التنفس بواسطة قياس الضغط الشهيقي و الضغط الزفيري القصوى في مرضى السدة الرئوية المزمنة

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مرض الانسداد الرئوي المزمن هو مشكلة صحية عامة في جميع أنحاء العالم. وهو مرض جينى ويعد المثال الكلاسيكي على تفاعل الجينات والبيئة . ومن المعروف أن التعرض لأستنشاق الكثير من دخان التبغ و غبار المواد الكيميائية المهنية على مدى العمر تسبب مرض انسداد الشعب الهوائية المزمن من تلقاء نفسها. قد ينخفض الضغط الشهيقي والضغط الزفيري القصوى في المرضى الذين يعانون من مرض الانسداد الرئوي المزمن.

الهدف من البحث: تقييم وظائف عضلات التنفس لدى مرضى الانسداد الرئوي المزمن من الذكور بواسطة قياس الضغط الشهيقي والضغط الزفيري القصوى و تحديد علاقة وظائف عضلات التنفس بالعوامل الوظيفية و شدة المرض في هؤلاء المرضى.

الأشخاص و الطريقة: اجري هذا البحث على خمسون رجلا مريضا بمرض السدة الرئوية المزمنة بالإضافة إلى خمسون رجلا سليما متوافقين من حيث السن كمجموعة ضابطة.
و قد تم قياس وظائف عضلات التنفس لهم جميعا بواسطة قياس الضغط الشهيقي والضغط الزفيري القصوى بالإضافة إلى قياس أقصى معدل للزفير وكذلك قياس أقصى قدرة على التنفس متحكم بها و أقصى قدرة على التمارين (أقصى مسافة يستطيع الشخص مشيها في مدة ست دقائق) مع قياس كتلة جسم المريض و طوله و وزنه.

النتائج: أثبت هذا البحث أن الضغط الشهيقي والضغط الزفيري القصوى أقل في مرضى السدة الرئوية المزمنة عن الأشخاص الأصحاء مع وجود فرق ذو دلالة إحصائية بين المجموعتين. الضغط الشهيقي والضغط الزفيري القصوى في مجموعة المرضى يتناسب عكسيا مع السن و مؤشر التدخين و مدة المرض و السعة الحيوية للرئة و النسبة ما بين أقصى معدل للزفير في الثانية الأولى إلى السعة الحيوية للرئة و أقصى معدل للزفير في الثانية الأولى و قمة مرور الهواء أثناء الزفير و أقصى مسافة للمشي في مدة ست دقائق و أقصى قدرة على التنفس متحكم بها.كما أن الضغط الزفيري القصوى يتناسب طرديا مع الضغط الشهيقى القصوى. وقد تم تقسيم مجموعة مرضى السدة الرئوية المزمنة تبعا لقيمة الضغط الشهيقى والضغط الزفيري القصوى (تأثر عضلات التنفس) إلى مجموعتين: **المجموعة الأولى** تشمل المرضى الذين يعانون من تأثر عضلات التنفس. **المجموعة الثانية** وتشمل المرضى الذين لا يعانون من تأثر عضلات التنفس. و اتضح أن المجموعتين بينهم فروق ذات دلالة احصائية بالنسبة لمؤشر التدخين و مدة المرض حيث أنهم كانوا أكثر في المجموعة الأولى بينما السعة الحيوية للرئة و النسبة ما بين أقصى معدل للزفير في الثانية الأولى إلى السعة الحيوية للرئة و أقصى معدل للزفير في الثانية الأولى و قمة مرور الهواء أثناء الزفير و أقصى مسافة للمشي في مدة ست دقائق و أقصى قدرة على التنفس متحكم به كانوا أقل في المجموعة الأولى.

الاستنتاج و التوصية : تقل وظائف عضلات التنفس في مرضى السدة الرئوية المزمنة و لذلك فان قياس الضغط الشهيقي والضغط الزفيري القصوى يعطى دلالة على حالة عضلات التنفس و التي تتناسب مع مؤشر التدخين و مدة المرض و وظائف التنفس و لذلك ينصح الأطباء العاملين في مجال الرعاية الصحية المعنية في تشخيص ومعالجة مرضى السدة الرئوية المزمنة والذين يعانون من انسداد رئوي شديد أن يأخذوا في الاعتبار احتمالية تدهور حالة عضلات التنفس في هؤلاء المرضى مع توفير حق الوصول إلى أجهزة قياس التنفس.