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Original Article

Diaphragmatic breathing exercise in adult asthmatic patients

Pulmonology

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ABSTRACT

Background: Short period exercise used for strengthening the diaphragm has been observed to improve exercise capacity and asthma symptoms and decreasing frequency of asthma exacerbation and hospital admission.

Objective: To evaluate the impact of diaphragmatic breathing exercise on asthmatic patients.
Methodology: An interventional study was conducted on 60 asthmatics patients. Measurements of ventilatory-function tests (VC%, FVC%, FEV_1%, FEV_1/FVC ratio, FEF25-57% and MVV%) and ultrasound assessment of diaphragmatic excursion and thickness were done before and after 12 weeks of diaphragmatic breathing exercise. Recording of diaphragm surface electromyography was done after maximum voluntary ventilation(MVV) maneuver.
Result: In total asthma group, the ventilatory-function indices values were significantly increased after diaphragmatic breathing exercise compared to baseline values ($p<0.05$), the uncontrolled asthmatics showed the highest increase followed by partially controlled and lastly controlled asthmatics (p $p<0.05$). The ultrasound diaphragmatic excursion during (normal, deep and sniffing) breathing and the diaphragmatic thickness at end inspiration and end expiration values were significantly increased after diaphragmatic breathing exercise in total asthma group compared to baseline values ($p<0.05$), the uncontrolled asthmatics showed the highest significant increase of diaphragmatic excursion during either normal or deep breathing and the diaphragmatic thickness at end expiration followed by partially controlled and lastly controlled asthmatics ($p<0.05$). After MVV maneuver, there was a significant decrease of diaphragm surface electromyography value in total asthma group compared to baseline values ($p<0.05$), the uncontrolled asthmatics showed the greatest significant decrease followed by partially controlled subgroup and lastly controlled subgroup (p-$p<0.05$). The delta changes of FEV_1%, FEV_1/FVC ratio, FEF 25-57%, and MVV% were positively correlated with delta changes of diaphragmatic excursion during either normal or deep breathing and diaphragmatic thickness at end expiration ($p<0.05$).
Conclusion: Diaphragm breathing exercise has favorable impacts in asthmatic patients at any asthma control level, improving ventilatory-function indices and diaphragmatic functions.

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Keywords: Bronchial asthma; diaphragmatic function; diaphragmatic breathing exercise, breathing exercises, pulmonary rehabilitation.

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INTRODUCTION

Asthma is a heterogonous disease characterized by chronic airway inflammation [1]. The reduction of symptoms, especially breathlessness, is an important goal in managing asthmatic patients. Respiratory muscle function contributes to sensation of dyspnea; evaluation of respiratory muscle functions is important in clinical practice [2].

In quiet resting breathing, diaphragm is the main inspiratory muscle [3]. Decreasing ability of the diaphragm to generate force after muscle action under load that return to normal function after rest is described as diaphragmatic fatigue [4]. Differentiating the form of inspiratory muscle exhaustion by using a non-invasive technique is clinically important helping clinicians to choose effective treatment for the patients [5]. The surface electromyography (sEMG) of the diaphragm resulting from phrenic nerve stimulation is used in clinical practice as it was safe and applicable [6].

Ultrasound (US) evaluation of the diaphragmatic functions has been used in chronic respiratory diseases, such as COPD, asthma, diaphragmatic paralysis, as well as during weaning from mechanical ventilation.

Diaphragmatic US assessment has many advantages, as it is noninvasive, absence of radiation, portable, repeatable and low price. It is utilized for the assessment of diaphragm function and structure [7].

Diaphragm strengthening exercise is a type of breathing exercise that helps strengthen diaphragm. Short period exercise used for strengthening diaphragm has been observed to improve exercise capacity and decrease severity of asthma symptoms, number of asthma exacerbation, and hospitalization rate. Also, it leads to major improvement in pulmonary function and asthma control [8]. Therefore, this study was conducted to evaluate the impacts of diaphragmatic breathing exercise on adult's asthmatic patient's.

PATIENTS AND METHODS

Study design

An interventional study was conducted on 60 known asthmatic patients attending chest diseases outpatient clinic or admitted at chest diseases department at Al-Zahraa University Hospital, Cairo, Egypt from November 2019 to February 2022. Diagnosis of asthmatic patients was based on criteria established by Global Initiative for Asthma Guideline (GINA 2019) [9]. Based on this guideline the asthmatic patients were classified into uncontrolled, partially controlled, and well controlled asthma subgroups each subgroup included 20 patients (33.3%).

The research protocol was approved by institutional review board of faculty of medicine for girls, Cairo, Al-Azhar university, Egypt (Reg No: RHDIRB 201910173). All participants were volunteers and can get out from study at any time and the rights of research participants were safeguarded. This was done by making sure the individual gets sufficient knowledge which can be easily known about this study and they were protected from any adverse effect of the study.

Exclusion criteria: Patient with major clinical illness (like liver cell failure, renal failure and heart failure), patients with chest diseases other than bronchial asthma, patients with neurological or muscles disorders, and patients with trauma affecting diaphragm were excluded from the study. Moreover, patients can't perform acceptable spirometric maneuver, patients with missed data, and patients who either not adherent or not completed 12 weeks of diaphragmatic breathing exercise were excluded from the study.

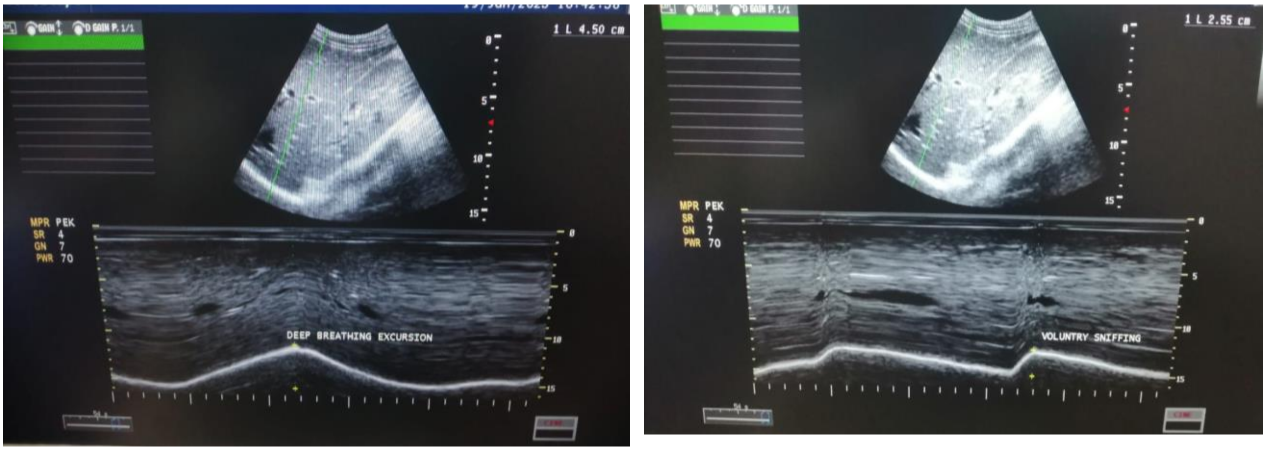
Measurement of ventilatory function test was done using a HypAir compact plus flowmeter pulmonary function testing station (Medisoft, Sorinnes, Belgium). The FEV_1/FVC ratio**,** and the percent predicted value of VC%, FVC%**,** FEV_1%, FEF25-75% and MVV% were recorded. The best of three technically accepted maneuver was used in data analysis.

Ultrasonographic assessment of diaphragmatic excursion and thickness was carried out on Sonoscape SSI6000, equipped with a 3.5 MHz low frequency curvilinear probe and 8 MHz high frequency linear probe, Nanshan, China**.** Semi-recumbent position was preferred as it was comfortable to patient, shows less variability and allows greater excursion of diaphragm. Additionally, as there is no significant difference in excursion and thickness between bright and left hemidiaphragm, as well as right the hemidiaphragm is easier for US assessment due to large acoustic window of the liver, we assess excursion and thickness of right hemidiaphragm.

- **Ultrasonographic assessment of diaphragmatic excursion:** for US assessment of diaphragmatic excursion, the curvilinear probe was used. Diaphragmatic excursion assessed by using both M-mode and B-mode. The curvilinear probe was placed longitudinally halfway between anterior and mid axillary line at the level of 9th-10th ribs. B-mode was applied to find a proper position of the probe to acquire a best image for movement (excursion) of diaphragm. The US beam was passed vertical to the posterior part of the diaphragm. Then M-mode was applied to demonstrate and measure. The craniocaudally movements of the diaphragms at different breathing techniques such as quiet, deep, and sniffing. The amplitude of the diaphragmatic excursion was measured by placing caliper at the top and bottom of diaphragm inspiratory slope [10] (figure 1).

A. Patient position

B. Quiet breathing excursion

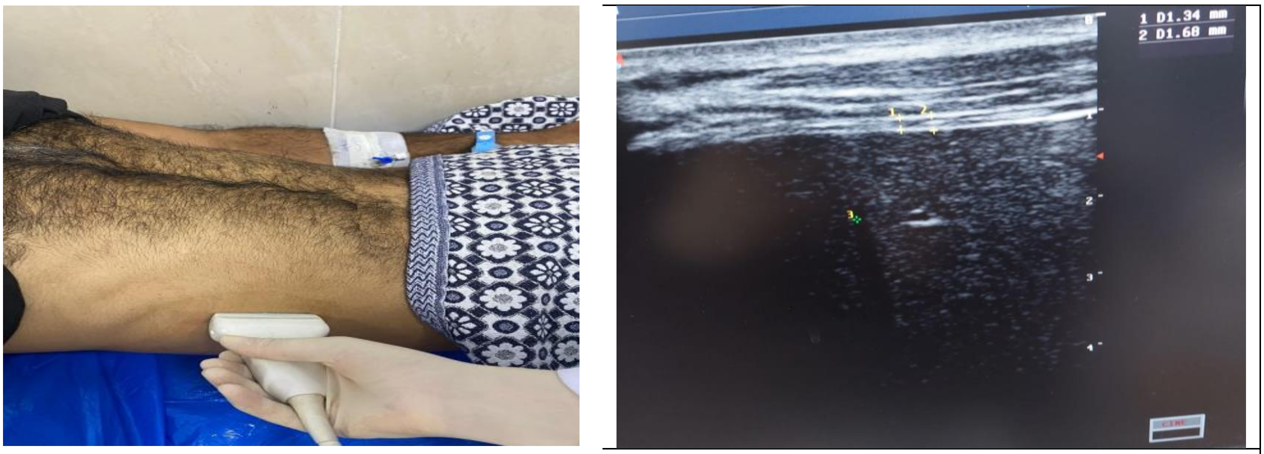


C. Quiet breathing excursion **D. Sniff excursion**

Figure (1): Sonographic assessment of diaphragm excursion

- A: Demonstrate patient in a semi-recumbent position and the convex probe was placed longitudinally midway between anterior and mid axillary line at the level of 9th-10th ribs.
- B, C, D: Demonstrate diaphragm excursion at quiet breathing (1.83 cm), deep breathing (4.50 cm), and sniffing (2.55 cm). The amplitude of the diaphragmatic excursion was measured by placing caliper at the bottom and top of the diaphragmatic inspiratory slope

- **Ultrasonographic assessment of diaphragmatic thickness:** for measurement of diaphragm thickness the high frequency linear probe was placed longitudinally at the zone of apposition halfway between anterior and mid-axillary lines at the level of 9th-10th ribs [11]. Visualization of both pleural and peritoneal layers was achieved by angling US beam close to ninety degrees. By using B-mode diaphragm was seen as a thick echogenic linear structure between highly reflective pleural and peritoneal layers. Diaphragmatic thickness was measured by placing the caliper on reflective lines at end expiration i.e. residual volume and end deep inspiration i.e. total lung capacity [12] (figure 2).



A. Patient position B. US diaphragm thickness

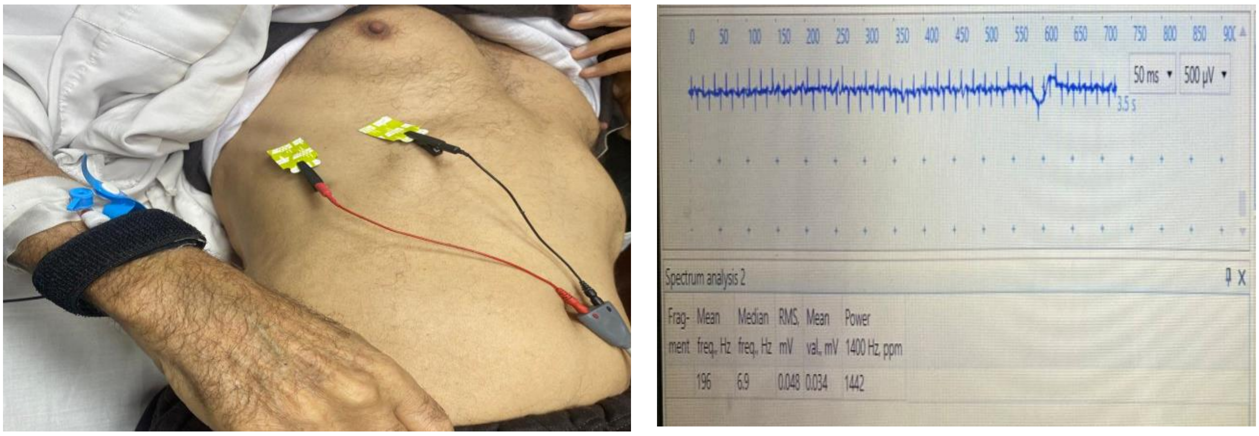
Figure (2): Sonographic assessment of diaphragm thickness

- A: Demonstrates patient in semi-recumbent position and the linear probe was placed midway between anterior and mid axillary line at the level of 9th-10th ribs in longitudinal view.
- B. Demonstrates ultrasound measurements of diaphragm thickness at end inspiration (1.68 mm) and at end expiration (1.34 mm).

Surface sEMG of the diaphragm: it was carried out on Neuro-EMG-Micro (Nihan Kahden-Japan). The participant was connected to the device using three electrodes. Two electrodes of them were placed in the 7th and 8th intercostals space on the right midclavicular line and right anterior axillary line. The electrodes positioned in the same direction of the muscle fibers and the distance between them was no more than two centimeters. The third ground electrode was placed on the right wrist joint (figure 3). The sEMG was measured as two sets of 15 seconds rapid and deep breathing technique with two minutes' rest in-between them [13].

Measurement of ventilatory function test and US assessment of diaphragm excursion and thickness were done before (baseline) and after 12 weeks of practicing diaphragmatic breathing exercise training, while sEMG of the diaphragm was recorded before and after MVV maneuver.

Diaphragm breathing exercise: The exercise was carried on as three sessions per week each session takes five to ten minutes, about three to four times per day for 12 weeks. It was done as the following; 1) Patient was lied supine on a flat surface or in bed, with both knees bent and head supported. A cushion was putted under both knees to support legs. One hand was placed on upper chest and the other hand just below the rib cage. This allowed the patient to sense diaphragmatic movement with respiration. 2) The patient was inhaled slowly through his nose so that the abdomen moved out against the hand and the hand on chest was stayed stationary as possible. 3) The patient tensing his abdominal muscles, and felt it moved inward with expiration through pursed lips, the hand on the upper chest was stayed stationary as possible [14].



A. Electrode position B. Electromyography of diaphragm

Figure (3): Surface electromyography of diaphragm

- **A:** Demonstrates patient in semi-recumbent position and was was connected to the device using three electrodes. Two electrodes of them were placed in the 7th and 8th intercostals space on the right midclavicular line and right anterior axillary line. The electrodes positioned in the same direction of the muscle fibers and the distance between them was no more than two centimeters. The third ground electrode was placed on the right wrist joint.
- B: Demonstrates recorded sEMG of diaphragm (RMS).

Statistical analysis

The studied variables were analyzed using the statistical package for social sciences, version 23.0 (SPSS Inc., Chicago, Illinois, USA). The studied quantitative variables were assessed for normality using Kolmogorov-Smirnov and Shapiro-Wilk Test. As the quantitative variables presented as mean± standard deviation. Also, qualitative variables were presented as number and percentages. Comparison between differences before and after diaphragmatic breathing exercise in total asthma group were done using Wilcoxon Ranked test. Analysis of variance (ANOVA) test was for multiple-group comparisons of parametric data between asthma subgroups. Pearson correlation coefficient (r) test was used to evaluate the correlation between two sets of quantitative variables. The confidence interval was set to 95% and the margin of error accepted was set to 5%. For all statistical test the probability (p) value <0.05 was considered significant. The percentage of change (delta "Δ" change %) to calculate the percent change of spirometric-indices and diaphragmatic US indices after diaphragmatic breathing exercise and diaphragmatic sEMG after MVV maneuver was calculated using this equation:

$$\left(\frac{\text{post diaphragmatic breating exercuse value} - \text{before diaphragmatic breating exercuse value}}{\text{before diaphragmatic breating exercuse value}}\right) X\ 100$$

RESULTS

The age of the studied asthmatic patients ranged from 18 to 75 years, with female predominance (53 females and 7 males) (table 1).

In the total asthma group, the VC%, FVC%, FEV_1%, FEV_1/FVC ratio, FEF 25-57% and MVV% values were significantly increased after diaphragmatic breathing exercise than baseline values ($p<0.05$), The uncontrolled asthma subgroup showed the greatest significant improvement followed by partially controlled asthma subgroup, while the least improvement was found in the controlled asthma subgroup ($p<0.05$) (tables 2 and 3).

In the total asthma group, the ultrasound diaphragmatic excursion measured during (normal, deep and sniffing) breathing values and the diaphragmatic thickness measured at either end inspiration or end expiration values were significantly increased after diaphragmatic breathing exercise compared to baseline values ($p<0.05$). Moreover, the uncontrolled asthma subgroup showed the highest significant increase of diaphragmatic excursion during either normal or deep breathing and the diaphragmatic thickness at end expiration followed by partially controlled asthma subgroup and lastly controlled asthma subgroup ($p<0.05$) (tables 2 and 3).

The delta changes of FEV_1%, FEV_1/FVC ratio, FEF 25-57% and MVV% were positively correlated with delta changes of diaphragmatic excursion measured during either normal or deep breathing and diaphragmatic thickness measured at end expiration ($p<0.05$) (table 4).

There was significant decrease of sEMG of diaphragm after MVV in total asthma group compared to baseline value ($p<0.05$). Additionally, the uncontrolled asthmatics showed the greatest significant decrease followed by partially controlled subgroup and lastly controlled subgroup ($p<0.05$) (table 5).

Table (1): Age, sex and ventilatory function of studied bronchial asthma patients

Item	n = 60
Sex	
Male	7 (11.7%)
Female	53 (88.3%)
Age (years) (Mean± SD)	43.98±13.72
Ventilatory function indices (Mean ± SD)	
VC%	82.20±8.90
FVC%	72.30±9.27
FEV_1%	51.73±9.83
FEV_1/FVC ratio	71.02±6.16
FEF 25-75 %	39.65±15.34
MVV%	33.03±14.99

FEV_1%: Forced expiratory volume in first-second percent predicted, FVC%: Forced vital capacity percent predicted, VC%: Vital capacity percent predicted, FEF25-75%: Forced expiratory flow 25-75% percent predicted.

Table (2): Comparison of ventilatory function tests and diaphragmatic ultrasound indices before and after diaphragmatic breathing exercise with of delta changes% among total asthma patients

Ventilatory function test	Diaphragmatic breathing exercise		Wilcoxon Ranked test		
	Before n = 60	After n = 60	Δ Change%	z-test	p-value
VC%	82.20±8.90	86.02±9.19	4.68	-16.61	<0.001*
FVC%	72.30±9.27	79.28±9.26	9.91	-16.98	<0.001*
FEV_1%	51.73±9.83	70.13±9.55	37.00	-64.02	<0.001*
FEV_1/FVC ratio	71.02±6.16	87.48±3.55	23.82	-26.10	<0.001*
FEF 25-75 %	39.65±15.34	55.65±16.76	46.89	-30.72	<0.001*
MVV%	33.03±14.99	46.78±16.97	48.53	-23.33	<0.001*
Quiet breathing diaphragm excursion (cm)	2.56±0.90	3.70±1.48	42.59	-13.56	<0.001*
Deep breathing diaphragm excursion (cm)	3.35±0.98	4.49±1.40	33.77	-17.01	<0.001*
Sniff breathing diaphragm excursion (cm)	1.95±0.68	2.66±0.93	38.06	-14.44	<0.001*
End inspiration diaphragm thickness (mm)	1.29±0.53	1.69±0.64	32.75	-17.71	<0.001*
End expiration diaphragm thickness-(mm)	0.93±0.38	1.24±0.43	37.57	-20.34	<0.001*

FEV_1%: Forced expiratory volume in first-second percent predicted, FVC%: Forced vital capacity percent predicted, VC%: Vital capacity percent predicted, FEF25-75%: Forced expiratory flow 25-75% percent predicted, MVV: Maximum voluntary ventilation, *: Significant p-value (<0.005)

Table (3): Comparison of delta changes % of ventilatory function tests and diaphragmatic ultrasound indices before and after diaphragmatic breathing exercise among asthma subgroups

Delta changes %	Asthma subgroups			ANOVA	
	Controlled n=20	Partially n=20	Uncontrolled n=20	F	p-value
VC%	4.54±2.02	4.61±1.95	4.90±2.84	0.137	0.872
FVC%	8.63±3.98	10.57±5.52	10.53±4.73	1.069	0.350
FEV_1%	28.56±6.19	37.59±4.58	44.86±4.37	51.067	<0.001*
FEV_1/FVC ratio	18.01±7.27	22.46±6.44	31.00±5.67	20.676	<0.001*
FEF 25-75%	31.66±9.99	41.81±16.47	67.19±18.46	28.234	<0.001*
MVV%	31.65±9.85	58.25±22.18	55.69±19.63	13.263	<0.001*
Quiet breathing diaphragm excursion (cm)	41.70±13.04	47.21±7.29	58.85±18.89	18.532	<0.001*
Diaphragm excursion deep breathing (cm)	30.41±10.73	38.35±11.33	45.56±7.46	12.221	<0.001*
Deep breathing diaphragm excursion (cm)	38.45±10.26	41.04±26.22	34.70±22.72	0.466	0.630
End inspiration diaphragm thickness(mm)	27.21±10.19	35.19±19.14	35.86±12.14	2.250	0.115
End expiration diaphragm thickness	28.55±11.87	32.88±13.66	51.29±24.86	9.255	<0.001*

FEV_1%: Forced expiratory volume in first-second percent predicted, FVC%: Forced vital capacity percent predicted, VC%: Vital capacity percent predicted, FEF25-75%: Forced expiratory flow 25-75% percent predicted, MVV: Maximum voluntary ventilation, ANOVA: Analysis of variance, *: Significant p-value (<0.005)

Table (4): Correlation of delta changes % of ventilatory function indices with delta changes % of diaphragmatic ultrasound indices in total asthma group

Parameters			Delta changes % of ventilatory function indices					
			VC%	FVC%	FEV_1%	FEV_1/ FVC%	FEF25-75%	MVV
Delta changes % of diaphragmatic US indices	Quiet breathing diaphragm excursion (cm)	r	-0.022	0.130	0.304	0.371*	0.446	-0.277
		p	0.870	0.322	0.018*	0.003*	0.001*	0.032*
	Deep breathing diaphragm excursion (cm)	r	0.033	0.152	0.307	0.371	0.341	0.011
		p	0.802	0.245	0.017*	0.004*	0.008*	0.005*
	Sniff breathing diaphragm excursion (cm)	r	0.179	.298	-0.112	-0.235	-0.042	-0.010
		p	0.171	0.221	0.396	0.070	0.750	0.937
	End inspiration diaphragm thickness-(mm)	r	0.171	.303	0.147	-0.027	0.040	0.153
		p	0.190	0.219	0.262	0.837	0.761	0.242
	End expiration diaphragm thickness (mm)	r	.316*	0.193	0.306	0.245	0.256	0.004
		p	0.014	0.140	0.017*	0.019*	0.048*	0.021*

FEV_1%: Forced expiratory volume in first-second percent predicted, FVC%: Forced vital capacity percent predicted, VC%: Vital capacity percent predicted, FEF25-75%: Forced expiratory flow 25-75% percent predicted, MVV: Maximum voluntary ventilation, r: Correlation coefficient, *: Significant p-value (<0.005)

Table (5): Comparison of surface diaphragm electromyography before and after performing maximum voluntary ventilation maneuver in total asthma group and comparison of delta changes % in asthma subgroups

Items	Before MVV n=60	After MVV n=60	-	Wilcoxon Signed-Rank Sum test		
			-	Change%	z-test	p-value
Total asthma group						
sEMG (mV)	0.061±0.043	0.038±0.020	-	-32.59	2.60	0.012*
Asthma subgroups						
sEMG (mV)	**Controlled n=20**	**Partially n=20**	**Uncontrolled n=20**	**ANOVA**		
				F		**p-value**
	-20.98±7.18	-29.74±7.76	-47.05±7.70	25.464		<0.001*

sEMG: Surface electromyography, MVV: Maximum voluntary ventilation, ANOVA: Analysis of variance, *:0Significant p-value (<0.005)

DISCUSSION

In the current study, we found that diaphragmatic breathing exercises improve lung function and diaphragmatic function in total asthma group ($p < 0.05$). The same result was obtained by Fouda et al. [15] who revealed that improving in diaphragmatic thickness and motion in asthmatic patients after diaphragm strengthen training also, there was improvement of spirometric values of FEV_1, FEV_1/FVC, and PEF. Franca-Pinto et al. [16] evaluate the effect of exercise as a non-pharmacological treatment on moderate–severe asthmatic patients followed up over a three-month period. The outcomes proved that bronchial hyperresponsiveness, systemic inflammation, quality of life and asthma flare up were improved after pulmonary rehabilitation. Other research that proved the results of this study is a study done by Widarti [17] who reported that diaphragmatic breathing exercise improve the quality of life of asthmatic patients because it can teach people to breathe in the proper way. The efficiency of diaphragmatic breathing exercises is also confirmed by related research done by Mayuni et al. [18] who revealed that diaphragmatic breathing affects the VC% of the lungs in asthmatic patients.

We found that the highest value of percentage of change of ventilatory function tests, diaphragmatic excursion, and diaphragmatic thickness was found in uncontrolled subgroup, followed by partially controlled subgroup while the lowest value was found in controlled subgroup ($p < 0.05$). This indicates that patients with more symptoms are liable to be more benefit from diaphragmatic breathing. This may be due to air trapping and dynamic hyperinflation that improve with diaphragmatic breathing exercise. The same result was obtained by Sahin and Naz [19] who assessed the impacts of an eight-week outpatient pulmonary rehabilitation schedule on asthma symptoms, in patients with partially controlled asthma and patients with uncontrolled asthma. The outcomes showed that, the asthma symptom control, exercise capacity and quality of life significantly improved in both groups ($p < 0.05$) and that improvement was significantly more in patients with uncontrolled asthma than in those with partially controlled asthma ($p < 0.001$).

We found significant positive association between percent change of ventilatory function tests and percentage of change of diaphragmatic excursion and diaphragmatic thickness. This could be explained by improvement of ventilatory function test leads to decrease in air trapping and dynamic hyperinflation which cause better position of diaphragm from low flat diaphragm to its normal position with subsequent improvement of diaphragmatic function. On the other hand, improvement of diaphragmatic function after diaphragmatic breathing exercise subsequently leads to improvement of ventilatory function test. Similarly, Fouda et al. [15] demonstrated positive relationship between both diaphragmatic excursion and thickness with PEFR and FEV_1 in asthmatic patients ($p < 0.01$).

We found a statistically significant decrease of sEMG of diaphragm after MVV maneuver in comparison to before MVV. This indicated that diaphragmatic fatigue after exercise. The greatest value was found in the uncontrolled group, followed by partially controlled group, while the least value was found in controlled group. Several processes could be implicated in decreasing diaphragmatic sEMG amplitude and frequency in asthmatic patients. It was described that reduced stimulation of the diaphragm affected by exhaustion or reduction of motor unit action potential cause reduction of sEMG amplitude in the diaphragm. Decreased frequency of the diaphragmatic sEMG believed to be a sign of exhaustion by maximum and sub-maximum voluntary contractions. Fatigue-induced accumulation of metabolite, alteration in intracellular power of hydrogen (pH) and decline in muscle fiber conduction velocity believed to be the cause for decreasing in the EMG power spectrum [20].

CONCLUSION

Diaphragm breathing exercise has favorable impacts in asthmatic patients at any asthma control level, improving spirometric-indices and diaphragmatic functions. Therefore, we recommend diaphragmatic breathing exercise to be an integral part of management of asthmatic patients especially those with uncontrolled and partially control asthma.

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Conflict of interest: The authors declared that there is no direct or indirect conflict of interest.

REFERENCES

1. **Global Initiative for Asthma (GINA 2022):** Global Strategy for asthma management and prevention. Ch 1. Page 20. https://ginasthma.org/gina-reports
2. **Westerhof GA, Coumou H, De Nijis, Weersink EJ, and Bel EH.** Clinical predictors of remission and persistence of adult-onset asthma. Journal of Allergy and Clinical Immunology. 2018; 141(1):104-09.
3. **Troyer AD and Wilson TA.** Mechanism of the increased rib cage expansion produced by the diaphragm with abdominal support. Journal of Applied Physiology. 2015; 118(8):989-95.
4. **Romer LM and Polkey MI.** Exercise-induced respiratory muscle fatigue: implications for performance. Journal of Applied Physiology. 2008; 104(3):879-88.
5. **Demoule A., Verin E., Locher C, Derenne JP and Similowski T.** Validation of surface recordings of the diaphragm response to transcranial magnetic stimulation in humans. Journal of Applied Physiology.2003; 94(2):453–61.
6. **Kacmarek M, Berra L, and Villar J.** On the road to surface monitoring of diaphragmatic activity in mechanically ventilated patients. Respiratory care. 2018; 63(11):1457-58.
7. **Turton P, Alaidarous S, and Welters I.** A narrative review of diaphragm ultrasound to predict weaning from mechanical ventilation: where are we and where are we heading? Ultrasound Journal. 2019; 11(2).
8. **Bruton A, Lee A, Yardley L, Raftery J, Arden-Close E, Kirby S, et al.** Physiotherapy breathing retraining for asthma: a randomized controlled trial. Lancet Respiratory Medicine. 2017; 6(1):19-28.
9. **Global Initiative for Asthma (GINA 2019):** Global Strategy for asthma management and prevention. Ch 2. Page 36. https://ginasthma.org/gina-reports.
10. **Boussuges A, Rives S, Finance J, and Brégeon F.** Assessment of diaphragmatic function by ultrasonograghy: Current approach and perspectives. World Journal of Clinical Cases. 2020; 8(12)2408-24.
11. **Sarwal A, Walker FO, and Cartwright MS.** Neuromuscular ultrasound for evaluation of the diaphragm. Muscle & Nerve Journal. 2013; 47(3):319-29.
12. **Ferrari G, De Filippi G, Elia F, Panero F, Volpicelli G , Apra F.** Diaphragm ultrasound as a new index of discontinuation from mechanical ventilation. Critical Ultrasound journal. 2014; 6(1):8.
13. **Chien MY, Ying-Tai Wu and Chang YJ.** Assessment of diaphragm and external intercostals fatigue from surface EMG using cervical magnetic stimulation. Natinal Library of Medicine. 2008; 8(4):2174-87**.**
14. **Tomich GM, Franca DC, Diorio AC, Britto RR, Sampaio RF and Parreira VF.** Breathing pattern, thoracoabdominal motion and muscular activity during three breathing exercises. Brazilian Journal of Medical Biological Research. 2014; 40(10):1409-17.
15. **Fouda EM, Morsy M, Mohamed SK, El-Kahky AM, and Al Azziz MA.** Ultrasonography assessment of diaphragm in asthmatic children and effects of diaphragm strengthening exercise on Angiogenin level and pulmonary functions**.** International journal of pulmonary and respiratory science. 2017; 1(5):130-38.
16. **Franca-Pinto A, Mendes FA, de-Carvalho-Pinto RM, Agondi RC, Cukier A , Stelmach R , et al.** Aerobic training decreases bronchial hyperresponsiveness and systemic inflammation in patients with moderate or severe asthma. A randomized controlled trial. Thorax. 2015; 70(8): 732–39.
17. **Widarti A.** Diaphragmatic Breathing Exercise. Jurnal Pengaruh. 2011;154(3): 431-442.

18. **Mayuni, D, Kamayani A, and Puspita M.** Diaphragmatic breathing exercise. NERS Journal. 2015; 39:801–10.
19. **Sahin H and Naz I.** Comparing the effect of pulmonary rehabilitation in patients with uncontrolled and partially controlled asthma. Journal of Asthma. 2019; 56(1):87–94.
20. **Verges S, Notter D, and Spengler CM.** Influence of diaphragm and rib cage muscle fatigue on breathing during endurance exercise. Respiratory Physiology and Neurobiology. 2006; 154(3): 431-42.

الملخص العربي

التمارين التنفسية علي عضلة الحجاب الحاجز في مرضي الربو الشعبى البالغين

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ملخص البحث:

الخلفية: لوحظ أن ممارسة التمارين الرياضية قصيرة المدى لتقوية الحجاب الحاجز تعمل على تحسين القدرة على ممارسة الرياضة وأعراض الربو وتقليل تكرار نوبات تفاقم الربو والتنويم بالمستشفى

الهدف: تقييم تأثير تمارين التنفس الحجابي على مرضى الربو.

الطرق: أجريت دراسة تداخليه علي ستين مريضا بحساسية الصدرالبالغين وقد خضعوا جميعاً لقياس وظائف التنفس و عمل موجات صوتية علي الحجاب الحاجز لقياس سمكه و حركته قبل و بعد 12 اسبوعا من ممارسة تمارين التنفس الحجابي. تم عمل تخطيط كهربي لعضلة الحجاب الحاجز قبل وبعد ممارسة اقصي تهوية طوعية.

النتائج: في مجموعة الربو الشعبى الكلية تبين وجود ارتفاع احصائى في قيم وظائف التنفس بعد ممارسة تمارين التنفس الحجابي مقارنة بالقيم الأولية، وكانت مجموعة الربو الشعبى الغير متحكم فيه اكثر المجموعات ارتفاعا تليها مجموعة الربو الشعبى المتحكم فيه جزئيا ثم مجموعة الربوالشعبى المتحكم فيه. في مجموعة الربو الشعبى الكلية تبين وجود زيادة احصائية في قيم حركة الحجاب الحاجز اثناء التنفس (الهادئ، التنفس العميق، الشم) وسمك الحجاب الحاجز في نهاية الشهيق و نهاية الزفير بعد ممارسة تمارين التنفس الحجابي مقارنة بالقيم الأولية، وكانت مجموعة الربو الشعبى الغير متحكم فيه اكثر المجموعات ارتفاعا في حركة الحجاب الحاجز اثناء التنفس الهادئ و العميق وسمك الحجاب الحاجز في نهاية الزفير بعد ممارسة تمارين التنفس الحجابي تليها مجموعة الربو الشعبى المتحكم فيه جزئيا ثم مجموعة الربو الشعبى المتحكم فيه. انخفضت قيمة التخطيط الكهربى لعضلة الحجاب الحاجزبعد ممارسة اقصي تهوية طوعية مقارنة بالقيمة الاولية وذلك في مجموعة الربو الشعبى الكلية، وكانت مجموعة الربو الشعبى الغير متحكم فيه اكثر المجموعات انخفاضا تليها مجموعة الربو الشعبى المتحكم فيه جزئيا ثم مجموعة الربو الشعبى المتحكم فيه. و تناسبت نسبة التغير في كلا من اقصى معدل للزفير في الثانية الاولى، النسبة ما بين اقصى معدل للزفير في الثانية الاولى / السعة القسرية الحيوية، و اقصى معدل للزفير في النسبة ما بين 25-75% مع نسبة التغير في حركة الحجاب الحاجز اثناء التنفس الهادئ والعميق وسمك عضلة الحجاب الحاجز في نهاية الزفير.

الاستنتاجات: تمارين التنفس الحجابي لها تاثير ايجابى علي مرضى الربو الشعبي في اي مرحلة من التحكم بالربو، حيث انها تحسن وظائف التنفس و وظائف الحجاب الحاجز.

الكلمات المفتاحية: الربو الشعبى، وظيفة الحجاب الحاجز، تمارين التنفس الحجابي، التمارين التنفسية، التأهيل الرئوي.

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