

Effect of Prone Position versus Diaphragmatic Release in Patients with COPD in ICU

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Abstract

Background: Chronic Obstructive Pulmonary Disease (COPD) is a major health problem characterized by chronic airflow limitation that is usually progressive and is associated with an abnormal inflammatory response of the lungs to noxious particles or gases, primarily caused by cigarette smoking.

Aim of Study: This study was carried out to compare the therapeutic effect of prone position versus diaphragmatic release in patients with COPD in ICU.

Patients and Methods: Sixty patients with COPD were randomly assigned into two equal groups. The methods of assessment included Acid-base analyzer. Group (A) lied in prone position, for one hour for five consecutive days while Group (B) received diaphragmatic release technique for five consecutive days.

Results: The results showed that there was significant increase in PaO₂ and O₂Sat in second group compared to the first group. In relation to ABG results and O₂Sat. The study revealed that the results obtained in second group were superior to that of first group.

Conclusion: It was concluded that diaphragmatic release technique superior to prone position in treatment of COPD in ICU.

Key Words: COPD, Diaphragmatic release – Prone position – Acid-Base analyzer.

Introduction

COPD is a chronic disease of the airways with high morbidity, mortality and poor quality of patients' life. It is currently the fourth leading cause of death in the world but is projected to be the third leading cause of death by 2020 [1,2].

In patients with COPD there is an acute worsening of respiratory symptoms with significant

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increase in morbidity and mortality. These signs and symptoms are increase dyspnea, productive cough, mucus hyper secretion, reduced expiratory flow, hyperinflation and impaired lung function due to increase airway thickening and increase intraluminal mucus secretion [2].

In COPD, changes in the anatomy of the airways and lung parenchyma occur as the result of bronchial hyper secretion and Broncho alveolar instability. These changes cause expiratory flow limitation and air trapping, known clinically as dynamic hyperinflation. This phenomenon leads to increases in expiratory reserve volume, Residual Volume (RV) and end expiratory lung volume (EEV). The increase in EEV limits tidal and inspiratory reserve volumes resulting in a negative impact on Inspiratory Capacity (IC). These changes alter the position of the ribs causing a state similar to sustained inspiration over time, often referred to as “inspiratory block”. This phenomenon is responsible for the characteristic “barrel chest” commonly seen in patients with COPD. In this state, the position of the diaphragm is flattened and shortened reducing its ability to generate force [3].

The significant physiological effects of the prone position are: Changes of the respiratory mechanics, and ventilation induced lung injury, They may lead to the homogenization of pulmonary gas exchange, a reduction of ventilation-perfusion mismatch, and increase of lung volume involved in gas exchange due to a reduction of marginally or non-ventilated areas (atelectasis) and to a reduction of ventilation-associated lung injury. The assumption is made that an improvement of the drainage of Broncho alveolar secretion is affected [4].

The diaphragmatic release technique is the application of a low load, long duration, optimal length of this stretch into the myofascial complex, with the aim to restore the complex [5].

Release Technique improves diaphragmatic mobility, The Manual Diaphragm exercise capacity and inspiratory capacity in people with chronic obstructive pulmonary disease. This technique could be considered in the management of people with chronic obstructive pulmonary disease [3].

Patients and Methods

Sixty patients had been recruited from Intensive Care Unit (ICU), of Kasr El-Ainy Hospitals during 2019. They were diagnosed as Chronic Obstructive Pulmonary Diseases (COPD), stage III, by specialized physician. They received medical treatment and oxygen therapy.

Sixty patients of both sexes, their age ranged from (50-60 year). They suffered from COPD. They suffered from dyspnea, chronic cough and expectorations, with Forced Expiratory Volume in one second (FEV₁sec) less than 70% of predicted value. All patients suffered from tachypnea where the respiratory rate ranged from (22 to 28) Brpm, severe hypoxemia where PaO₂ ranged from (29 to 73) mmHg and PaCO₂ ranged from (24 to 94) mmHg. The duration of mechanical ventilation ranged from (2-5) days.

Patients were randomly subdivided into two equal groups, each group consisted of 30 patients, group (A) placed in prone lying position. And group (B) received diaphragmatic release.

Exclusion criteria:

Patients with the following criteria will excluded from the study:

- 1- Severe psychiatric or cognitive impairments.
- 2- Progressive neuromuscular disorders.
- 3- Decreased level of consciousness.
- 4- Unstable fracture.
- 5- Pacemaker inserted for fewer than 2 days.
- 6- Deep-venous thrombosis (to minimize risk for pulmonary embolism from being in a prone position.
- 7- Mean arterial blood pressure of less than 65mm Hg with or without vasopressors.
- 8- Tracheal surgery or sternotomy in the last 15 days.
- 9- Massive haemoptysis.

- 10- Intracranial pressure of more than 30mmHg or cerebral perfusion pressure of less than 60mmHg.

Equipment and tools:

All patients were assessed by Blood-Gas analyzer at the beginning of the session and after session for 5 consecutive days.

Treatment procedures:

- *Group A:* Included 30 patients who receive:

- 1- Medical treatment; all patients received their regular prescriptive treatment in the form of bronchodilator and mucolytic.

The first sample was drawn at baseline supine position.

- 2- Prone lying position: In this position the patient's head was turned laterally and the arms parallel to the body. A roll was placed under the upper part of chest wall, and a pillow was placed under the pelvis to minimize the restriction of abdomen movement. Every patient was kept in this position for one hour. Then the blood sample was drawn, and then every patient returned to the supine lying position.

- *Group B:* Included 30 patients who receive:

- 1- Medical treatment: All patients received their regular prescriptive treatment in the form of bronchodilator and mucolytic.

The second sample was drawn before the application of technique.

- 2- Diaphragmatic release: The therapist palpated the fascial restriction and the pressure was applied directly to the skin, into the direction of the restriction, until resistance (the tissue barrier) was manually perceived. Once found, the collagenous barrier was engaged for a few minutes, without sliding over the skin or forcing the tissue, until the band started to yield the complex and a sensation of softening was achieved. Then draw the blood sample.

Statistical analysis:

Descriptive statistics and *t*-test were conducted for comparison of the mean age, weight and height between both groups.

Unpaired *t*-test was conducted for comparison of PaO₂ and SaO₂ between both groups.

Paired *t*-test was conducted for comparison between pre and post-treatment PaO₂ and SaO₂ in each group.

The level of significance for all statistical tests was set at $p < 0.05$.

All statistical measures were performed through the Statistical Package for Social Studies (SPSS) version 25 for windows.

Results

General characteristics of the subjects:

• *Group A:* Thirty patients with COPD were included in this group. Their mean \pm SD age, weight

and height were 56.03 ± 3.04 years, 80.43 ± 10.41 kg and 170.5 ± 7.91 cm respectively (Table 1).

• *Group B:* Thirty patients with COPD were included in this group. Their mean \pm SD age, weight and height were 55.56 ± 3.63 years, 78.4 ± 9.28 kg and 171.13 ± 7.78 cm respectively (Table 1).

Comparing the general characteristics of the subjects of both groups revealed that there was no significance difference between both groups in the mean age weight and height ($p > 0.05$).

Table (1): Comparison of the mean age, weight and height between group A and B.

	Group A X \pm SD	Group B X \pm SD	MD	t- value	p- value	Sig.
Age (years)	56.03 \pm 3.04	55.56 \pm 3.63	0.47	0.53	0.59	NS
Weight (kg)	80.43 \pm 10.41	78.4 \pm 9.28	2.03	0.79	0.42	NS
Height (cm)	170.5 \pm 7.91	171.13 \pm 7.78	-0.63	-0.31	0.75	NS

\bar{x} : Mean. MD : Mean Difference. p-value : Probability value.
SD : Standard Deviation. t-value: Unpaired t-value. NS : Non Significant.

PaO₂:

I- Between groups comparison:

Pre-treatment: The mean \pm SD PaO₂ pre-treatment of the group A was 60.03 ± 3.16 mmHg and that of the group B was 59.3 ± 2.96 mmHg. The mean difference between both groups was 0.73 mmHg. There was no significant difference in PaO₂ between the group A and B pretreatment ($p = 0.35$) (Table 2).

Post-treatment: The mean \pm SD PaO₂ post-treatment of the group A was 64.4 ± 3.11 mmHg and that of the group B was 76.3 ± 3.61 mmHg. The mean difference between both groups was -11.9 mmHg. There was a significant increase in PaO₂ of the group B compared with that of the group A post-treatment ($p = 0.0001$) (Table 2).

Table (2): Comparison of pre and post-treatment mean values of PaO₂ between group A and B.

PaO ₂ (mmHg)	Pre-treatment		Post-treatment	
	Group A	Group B	Group A	Group B
X \pm SD	60.03 \pm 3.16	59.3 \pm 2.96	64.4 \pm 3.11	76.3 \pm 3.61
MD	0.73		-11.9	
t-value	0.92		-13.66	
p-value	0.35		0.0001	
Significance	NS		S	

X : Mean.
MD : Mean Difference.
p-value : Probability value.
SD : Standard Deviation.
t-value : Unpaired t-value.
NS : Non Significant.
S : Significant.

II- Within groups comparison:

Group A: The mean \pm SD PaO₂ pre-treatment of the group A was 60.03 ± 3.16 mmHg and that post-treatment was 64.4 ± 3.11 mmHg. The mean difference between pre and post-treatment was -4.37mmHg and the percent of improvement was 7.28%. There was a significant increase in PaO₂ of the group A post-treatment compared with that pre-treatment ($p = 0.0001$) (Table 3).

Group B: The mean \pm SD PaO₂ pre-treatment of the group B was 59.3 ± 2.96 mmHg and that post-treatment was 76.3 ± 3.61 mmHg. The mean difference between pre and post-treatment was -17mmHg and the percent of improvement was 28.67%. There was a significant increase in PaO₂ of the group B post-treatment compared with that pre-treatment ($p = 0.0001$) (Table 3).

Table (3): Comparison between pre and post-treatment mean values of PaO₂ of the group A and B.

PaO ₂ (mmHg)	Group A		Group B	
	Pre- treatment	Post- treatment	Pre- treatment	Post- treatment
• X \pm SD	60.03 \pm 3.16	64.4 \pm 3.11	59.3 \pm 2.96	76.3 \pm 3.61
• MD	-4.37		-17	
• % of improvement	7.28		28.67	
• t-value	-12.01		-24.12	
• p-value	0.0001		0.0001	
• Significance	S		S	

X : Mean. SD : Standard Deviation.
MD : Mean Difference. t-value : Unpaired t-value.
p-value : Probability value. S : Significant.

SaO₂:

I- *Between groups comparison:*

Pre-treatment: The mean \pm SD SaO₂ pre-treatment of the group A was 89.1 \pm 2.52% and that of the group B was 88.53 \pm 2.71%. The mean difference between both groups was 0.57%. There was no significant difference in SaO₂ between the group A and B pre-treatment ($p=0.4$) (Table 4).

Post-treatment: The mean \pm SD SaO₂ post-treatment of the group A was 92.33 \pm 2.41% and that of the group B was 96.2 \pm 2.6%. The mean difference between both groups was -3.87%. There was a significant increase in SaO₂ of the group B compared with that of the group A post-treatment ($p=0.0001$) (Table 4).

Table (4): Comparison of pre and post-treatment mean values of SaO₂ between group A and B:

SaO ₂ (%)	Pre-treatment		Post-treatment	
	Group A	Group B	Group A	Group B
X \pm SD	89.1 \pm 2.52	88.53 \pm 2.71	92.33 \pm 2.41	96.2 \pm 2.6
MD	0.57		-3.87	
<i>t</i> -value	0.83		-5.96	
<i>p</i> -value	0.4		0.0001	
Significance	NS		S	

X : Mean. *t*-value : Unpaired *t*-value.
 MD : Mean Difference. NS : Non Significant.
p-value : Probability value. S : Significant.
 SD : Standard Deviation.

II- *Within groups comparison:*

Group A: The mean \pm SD SaO₂ pre-treatment of the group A was 89.1 \pm 2.52% and that post-treatment was 92.33 \pm 2.41 %. The mean difference between pre and post-treatment was 3.23% and the percent of improvement was 3.63%. There was a significant increase in SaO₂ of the group A post-treatment compared with that pre-treatment ($p=0.0001$) (Table 5).

Group B: The mean \pm SD SaO₂ pre-treatment of the group B was 88.53 \pm 2.71% and that post-treatment was 96.2 \pm 2.6%. The mean difference between pre and post-treatment was -7.67% and the percent of improvement was 8.66%. There was a significant increase in SaO₂ of the group B post-treatment compared with that pre-treatment ($p=0.0001$) (Table 5).

Table (5): Comparison between pre and post-treatment mean values of SaO₂ of the group A and B.

SaO ₂ (%)	Group A		Group B	
	Pre-treatment	Post-treatment	Pre-treatment	Post-treatment
• X \pm SD	89.1 \pm 2.52	92.33 \pm 2.41	88.53 \pm 2.71	96.2 \pm 2.6
• MD	-3.23		-7.67	
• % of improvement	3.63		8.66	
• <i>t</i> -value	-10.2		-14.63	
• <i>p</i> -value	0.0001		0.0001	
• Significance	S		S	

X : Mean. SD : Standard Deviation.
 MD : Mean Difference. *t*-value : Unpaired *t*-value.
p-value : Probability value. S : Significant.

Discussion

This study was designed to compare the efficacy of diaphragmatic release versus prone position on improving oxygenation and ventilation in patients with COPD.

Sixty patients with Chronic Obstructive Pulmonary Disease (COPD) were included in this study. All patients assigned randomly into two groups of 30 patients in each group. (Group A): Was enrolled in prone position protocol in addition to traditional physical therapy program for COPD. (Group B): Was enrolled in diaphragmatic release protocol in addition to traditional physical therapy protocol. The treatment sessions applied 5 consecutive days.

Blood Gas analyser used to measure arterial blood gases and to evaluate the level of oxygenation and saturation (PaO₂, SaO₂) for all patients participated in this study pre-session and post-session.

There was significant difference between first and second group in ABG results post-treatment sessions in favor of second group.

Results of this study concerning the effect of prone position versus diaphragmatic release in patients with COPD confirmed the observations of studies done by:

Group (A): Prone position:

Pronation of severe chronic bronchitis patients reduces airway resistance and attenuates dynamic hyperinflation. This is probably attributable to improved parenchyma mechanics inducing an increase in airway calibre during the respiratory cycle [6].

Prone position has been shown to result in a short-term gain in oxygenation, and improvement of ventilation and perfusion mismatch and residual

lung capacity, despite their physiological rationale, these easy-to-apply techniques are still not widely used and it is still unclear [7].

On the other hand, in a study on 16 patients with severe degree of COPD concluded that there was no significant change between prone position and supine position regarding respiratory system static compliance. He refers to the fact that limited movement in chest wall secondary to limitation of the sternal movement decreases the lung compliance and concluded that when returning to the supine position oxygenation slightly declined, but no significant differences were observed when compared with baseline or the prone position; but they also commented "because of the small population, we cannot exclude a type II error. Once again, these average values were derived from variable individual responses. Different oxygenation responses when returning to the supine position have been previously described, including both a reversal of oxygenation improvement and a maintenance of improved oxygenation" [8].

In addition, a study on 30 patients with acute on top of chronic respiratory failure due to chronic obstructive pulmonary disease. Patients were subjected to volume controlled, pressure controlled, and pressure support in three different positions: Supine, semi setting and prone, they concluded that there was no significant difference in static compliance between prone and supine position [9].

Group (B): Diaphragmatic release. In agreement with the results of the current study, Carlos, made a study consisted of twelve medically stable patients (n=12) with an existing diagnosis of severe COPD (ten: GOLD Stage III and two: GOLD Stage IV) were included. Residual volume, inspiratory capacity and oxygen saturation (SpO₂) were recorded immediately before and after administration of the STMTTP. Residual volume decreased from 4.5 to 3.9L ($p=0.002$), inspiratory capacity increased from 2.0 to 2.1 L ($p=0.039$) and SpO₂ increased from 93% to 96% ($p=0.001$). So it was concluded that a single application of soft tissue manual therapy intervention appears to have the potential to produce immediate clinically meaningful improvement in the lung function in patients with severe and very severe COPD [10].

Combining manual therapy with exercise appears to increase the respiratory function of normal individuals. The potential for this intervention administered before exercise to permit additional tolerance within the respiratory system that could allow an extended exercise program [12].

In addition, diaphragm release technique generated a significant improvement in posterior chain muscle kinematics measured by schober's test, the finger to floor test, cervical range of motion, and rib cage excursion at xiphoid level immediately after technique.

Against to Donald, who determine that individual manipulation techniques were associated with a modest post-treatment worsening of pulmonary function measures in persons with COPD Overall, the techniques tested worsened pulmonary function at thirty minutes post-treatment in persons with COPD. The longer term effects of these techniques on pulmonary function are still not known. Despite adverse changes in pulmonary function measures, the majority of COPD patients subjectively reported they benefitted from manual techniques and they could breathe better after receiving the manual techniques [12].

Twenty adults aged over 60 years with clinically stable chronic obstructive pulmonary disease. The group received six treatments with the Manual Diaphragm Release Technique on non-consecutive days within a 2-week period. The main outcome was diaphragmatic mobility, which was analysed using ultrasonography. Outcomes were measured before and after the first and sixth treatments. The Manual Diaphragm Release Technique significantly improved diaphragmatic mobility over the course of treatments, The Manual Diaphragm Release Technique improves diaphragmatic mobility, exercise capacity and inspiratory capacity in people with chronic obstructive pulmonary disease. This technique could be considered in the management of people with chronic obstructive pulmonary disease [3].

Muralimohan, applied a study in which the sample size is 15 patients, 45 minutes of each session 4 sessions per week for 6 weeks. The result showed the subjects who received Manual Diaphragmatic Release Technique along with Yogic breathing practice are found to be more effective in improving diaphragm mobility, inspiratory capacity and exercise tolerance in COPD patients. It was concluded that, modern manual diaphragmatic release technique and Yogic breathing technique (yogic breathing practice) gives more effect in improving diaphragm mobility, inspiratory capacity and exercise tolerance in COPD patients [13].

Also Susmitha made a study consists of 30 subjects with chronic obstructive pulmonary disease were selected by random sampling method and were divided into 2 groups namely Group-A and

Group-B respectively. Group-A subjects were involved in Manual Diaphragmatic Release technique and Group-B Subjects performed conventional diaphragmatic strengthening exercises. Study was conducted for a period of three month. The result shows that the subjects in Group A shown a marked improvement in Diaphragmatic Mobility and Exercise capacity when compared with the subjects in Group B. This study concluded that the Manual Diaphragmatic release techniques shows superior improvement in diaphragmatic mobility and exercise capacity in subjects with COPD [14].

As observed in the results of this present study, group (B) diaphragmatic release group, showed a statistical significant improvement in oxygenation and ventilatory functions that was more than the improvement in group (A) prone position group.

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تأثير وضع الإستلقاء على البطن مقابل الإفراج عن الحجاب الحاجز على مرضى الإنسداد الرئوى المزمن فى وحدة الرعاية المركزة

يعد مرض الإنسداد الرئوى المزمن من الأمراض المعقدة والتي تؤثر على الصحة العامة للإنسان وله أسباب كثيرة لحدوثه مثل التدخين والتعرض لإستنشاق مواد كيميائية لفترات زمنية طويلة وله خصائص عدة منها إختناق النفس والكحة المزمنة وإنخفاض مستوى الأكسجين فى الدم ووجود كميات كبيرة من البلغم داخل الرئة مما يؤثر على وظائفها.

صممت هذه الرسالة للمقارنة بين وسيلتين فعاليتين فى علاج هذا المرض لمعرفة ما هو أكثر فاعلية فى علاج الإنسداد الرئوى المزمن اثناء تطوره الحاد فى وحدة الرعاية المركزة.

أجريت هذه الدراسة على ٦٠ ممن يعانون من الإنسداد الرئوى المزمن وقد تراوحت أعمارهم ٥٠-٦٩ سنة وقد تم تقسيمهم عشوائياً إلى مجموعتين متساويتين فى العدد:

(١) المجموعة الأولى (أ): وتضم ٣٠ مريض ممن يخضعون إلى العلاج بإستخدام وضع الإستلقاء على البطن وإستمر العلاج لمدة ٥ أيام متتالية.

(٢) المجموعة الثانية (ب): وتتكون من ٣٠ مريض ممن يتلقون الإفراج عن الحجاب الحاجز وإستمر العلاج لمدة ٥ أيام متتالية.

تم التقييم بإستخدام طريقتين للتقييم قبل بدء الجلسة وبعد نهايتها: قياس نسبة الأكسجين فى الدم وقياس درجة تشبع الدم بالأكسجين.

ويستنتج من هذا البحث أن هناك تحسن ملحوظ فى نسبة الأكسجين ودرجة تشبع الدم منه بعد ٥ أيام متتالية من العلاج لكل المرضى فى المجموعتين.

أن هناك زيادة ذو دلالة إحصائية فى نسبة الأكسجين ودرجة تشبع الدم منه بعد ٥ أيام متتالية فى المجموعة (ب).

أن هناك فروق ذات دلالة إحصائية بين المجموعتين (المجموعة الأولى والمجموعة الثانية). وكانت أفضل النتائج بالنسبة إلى نسبة الأكسجين ودرجة تشبع الدم منه فى المجموعة الثانية.