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Lung Compliance and Arterial Blood Gases Response to Diaphragm Stretch in Intubated Patients

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Abstract: This study evaluated the lung compliance and arterial blood gases response to diaphragm stretch in intubated patients. Thirty patients participated in this study were divided randomly into two groups, study group (fifteen patients) received both diaphragm stretch and traditional chest physiotherapy and control group (fifteen patients) received traditional chest physiotherapy only. Mechanical ventilator was used to assess static lung compliance and blood gases analyzer was used to assess blood gases. Results showed that the two groups were similar in terms of the baseline characteristics. There were no significant differences between the control and study groups regarding the lung compliance and arterial blood gases. Conclusion: The results showed that the use of diaphragm stretch had no effect on improving lung compliance, pao2 and paco2.

Key words: Diaphragm Stretch · Lung Compliance · Arterial Blood Gases

INTRODUCTION

Lung compliance is a measure of the lung's ability to stretch and expand. Low compliance indicates a stiff lung and means extra work is required to bring in a normal volume of air. This occurs as the lungs become fibrotic, lose their distensibility and become stiffer [1].

Arterial blood gases analysis is an essential part of diagnosing and managing a patient's oxygenation status and acid-base balance [2].

Chest physiotherapy is reported to be an integral part of patient management in the intensive care unit (ICU) of hospitals in industrialized countries [3]. Various respiratory physiotherapy techniques, such as mobilization, manual hyperinflation, diaphragm stretch, percussion and vibration can reduce pulmonary secretion retention, as well as improving dynamic compliance and static compliance [4].

Given the interdependent relationship between the respiratory and musculoskeletal systems, various manual techniques have been proposed for the treatment of COPD symptoms. A common goal is increasing the mobility of the thoracic structures involved in the respiratory mechanics [5].

The manual diaphragm release technique is an intervention intended to directly stretch the diaphragmatic muscle fibers [6, 7]. Although this technique is widely used in clinical practice in some regions, it is believed that, to date, there are no quantitative studies or clinical trials evaluating the effects of this technique [8].

Mechanical ventilation is indicated in acute reversible respiratory failure. However, patients receiving mechanical ventilation may have an increased risk of sputum retention, atelectasis and pneumonia, making weaning from ventilation more difficult and resulting in excess morbidity and mortality. The cost of maintaining patients on ventilation for long time in the intensive care unit (ICU) of acute care hospitals is high. Thus, every effort should be made to determine which patients can be rapidly weaned so as to keep the weaning period to a minimum [9].

This study aimed to investigate the effect of diaphragm stretch on the lung compliance, pao2 and paco2 in intubated patients.

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MATERIALS AND METHODS

Subjects Characteristics and General Experimental Design

Study Subjects: Thirty patients were selected from Beni-suef University Hospital (critical care department) with body mass index (BMI) ranged from 22 to 38.1 kg/m2, their age ranged from 53 - 73years.

Evaluated Parameters

Mechanical Ventilator: to assess the static lung compliance.

Blood Gases Analyzer: to assess blood gases.

Patients Were Divided Randomly into Two Groups: Study group received diaphragmatic stretch and traditional chest physiotherapy; control group received traditional chest physiotherapy only. The program was applied once daily for five days for both groups. All sessions were supervised and applied by same physiotherapist. All patients were mechanically ventilated, their positive end expiratory pressure (PEEP) did not exceed 10 cmH2O and the patients were hemodynamically stable (vital signs). Patients were excluded from the study if they had one of the following: Fraction of inspired oxygen (FiO2) > 0.6, positive end expiratory pressure (PEEP) > 10 cmH2O to avoid barotraumas, unstable cardiovascular condition as defined by a mean arterial pressure (MAP) < 75 mmHg, arterial oxygen saturation (SaO2) < 90% and any surgery in the abdomen, undrained pneumothorax, high peak airway pressures, low blood pressure (systolic < 80 mm Hg) and severe bronchospasm. Patients would be withdrawn from the study if they suffered cardiovascular compromise during the treatment as defined by the above variables. The detailed training regimen was as follows:

Diaphragm stretch procedure was applied to patients in the study group. The Patient was supine on the bed with the operator standing at the side. Operator's fingertips contact the inferior surface of the diaphragm below the costal arch on the opposite side. Operator's other hand stabilizes the lower anterior rib cage of the opposite side. Operator maintained cephalic pressure on the inferior aspect of the diaphragm. Inhalation was resisted and exhalation encouraged. Fingertips compression was maintained until diaphragm was released. The treatment session was maintained 5 minutes for each side.

Traditional chest physiotherapy including percussion, vibration, positioning, suction and postural drainage were applied for all patients in both groups for 30 minutes once daily for five days.

Statistical Analysis: The mean values of lung compliance, pao2 and paco2obtained for five days in both groups was compared using the factorial ANOVA test

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RESULTS

The Study Involved Thirty Patients: Their age ranged from 53 - 73years. The subjects were divided into two equal groups: the study group (9 males & 6 females) received diaphragm stretch procedure and traditional chest physiotherapy. The control group (6 males & 9 females) received traditional chest physiotherapy only once daily for five days. Table 1 represented non significant difference between both groups. Table 2 represented the mean values of lung compliance were non significant from 31.5 to 28.1 in control group and from 32.4 to 33.4 in study group, the mean values of pao2 were non significant from 107.2 to 120.4 in control group and from 126.7 to 138in study group, the mean values of paco2 were non significant from 35 to 34.5 in control group and from 38.9 to 34.6 in study group.

DISCUSSION

The aim of this study was to evaluate the effect of diaphragmatic stretch on lung compliance, pao2 and paco2 in intubated patients. The mean values of lung compliance were non significant in both groups. Also, there was a non-significant difference between the groups after treatment.

Mechanical ventilation can decrease the patient's work of breathing by unloading respiratory muscles in a synchronous manner. Patients receiving mechanical ventilation may have an increased risk of sputum retention, atelectasis and pneumonia, making ventilation weaning more difficult and resulting in excess morbidity and mortality. The sputum retention affects the lung compliance and extra work is required to bring in a normal volume of air [10].

Mechanical ventilation which is a supportive therapy used to assist patients who are unable to maintain adequate oxygenation or carbon dioxide elimination.

Table 1: Anthropometric characteristics of patients in both groups (T-Test)

	Control/ study	N	Mean	Range	Sig. (2-tailed)
Age	Control	15	63.27	53 - 73	.348
	study	15	65.53	53 - 73	
BMI	Control	15	28.173	24.5 - 38.1	.458
	study	15	27.180	22.0 - 34.6	
ICU stay at 15 days from beginning P T	Control	15	7.13	1 - 12	.551
	study	15	7.87	2 - 15	

Table 2: Analysis of compliance and arterial blood gases between patients of both groups before and after treatment

		Groups				
		Control	Study	P1	P2	P3
		Mean	Mean	Time	Group	Interaction
Compliance	1st day	31.5	32.4	0.496	0.402	0.152
	5th day	28.1	33.4			
PaO_2	1st day	107.2	126.7	0.651	0.199	0.820
	5th day	120.4	138			
$PaCo_2$	1st day	35	38.9	0.527	0.732	0.583
	5th day	34.5	34.6			

The goal of mechanical ventilation is to improve ventilation, oxygenation, maintaining an optimal dynamic lung compliance by using ventilator management and respiratory care is considered to be most important when caring for these patients comfort while preventing complications [11]

Stretching of respiratory muscles, myofascial release and soft tissue massage are included in what is known as thoracic manual therapy [12].The aim of most of these techniques is to increase movement in the rib cage and the spine in order to improve lung function and circulation [13, 14]. However, two different systematic reviews [12, 15 &16] have examined the role of manual therapy in pulmonary pathologies, concluding that there is a lack of high quality research in this area and showing no evidence for the application in patients with chronic obstructive pulmonary disease or asthma.

The current study was early supported by Engel and Vemulpad [17] who did not find substantial improvements in spirometry measures after manual therapy in normal asymptomatic individuals.

Another mechanism, Ntoumenopoulos *et al*. [18] conducted a study using postural drainage, manual hyperinflation (without expiratory rib cage compression) and suctioning twice a day throughout the ICU stay of the patients. Non-significant differences were found between the control and study groups regarding the length of ICU stay (6.8 days vs. 7.4 days), duration of MV (5.2 days vs. 6.1 days), or ICU mortality (0% for both) in trauma patients. The replacement of manual hyperinflation by a vibration step did not improve those variables in a nonrandomized study involving patients with ventilator-associated pneumonia [19]. Although those studies [18, 19] did not compare the techniques in the same population, their results indicated that neither manual hyperinflation nor vibration was effective in patients on mechanical ventilation when individually applied.

The present study is in opposite direction to Hosking *et al.* [20], osteopathic manipulative techniques applied to anatomical attachment areas of the diaphragm had a beneficial effect on diaphragm movement and spirometric measurements.

Another contradict is with Berti *et al.* [21] who found an improvement in secretion clearance and static compliance of the respiratory system in patients on pressure support ventilation.

In another contradict, Jones *et al.* [22] examined the effects of bagging and percussion on total static compliance of the respiratory system and they found improvement. As well as Lemes *et al.* [23] using a different hyperinflation technique (i.e., ventilator-induced hyperinflation), the study showed an improvement in secretion clearance and static compliance of the respiratory system in patients on pressure support ventilation.

Effects of chest physiotherapy on various respiratory parameters of the patients under intubation and mechanical ventilation have been well documented by Paratz *et al*. [24], which have shown to significantly increase lung compliance (CL) and PaO 2: fio2 and decrease PCO 2 of treatment group in a study to determine the effect of manual hyperinflation on hemodynamics, gas exchange and respiratory mechanics in ventilated patients

Limitations: Our study has some limitations, such as the small sample size. Another limitation is the weaning of some patients (9 patients) from mechanical ventilation during the application of the study from 30 patients.

CONCLUSIONS

In summary the present study showed that there was non-significant difference between study group and control group regarding to lung compliance, pao2 and paco2. Further studies evaluating the effectiveness of chest physiotherapy in ICU patients on mechanical ventilation can provide additional evidence.

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