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RESEARCH ARTICLE

EFFICACY OF MANUAL HYPERINFLATION FROM SUPINE POSITION ON ARTERIAL OXYGENATION IN PATIENTS WITH UNILATERAL LUNG DISEASES

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ABSTRACT

Background/aim: One of the more difficult ventilator problems confronting physicians in the critical care unit is the management of patients who have unilateral lung disease (ULD) . This study was conducted to investigate the efficacy of manual hyperinflation (MHI) in supine position on arterial partial pressure of oxygen (PaO2) and arterial oxygen saturation (SaO2) in those patients.
Materials and methods: Totally, 20 patients (men) with unilateral lung diseases and their ages ranged from 40 to 50 years were recruited .The patients were selected from Kasr El-Aini Hospitals (intensive care unit) and all patients received manual hyperinflation (MHI) from supine position in addition to routine chest physiotherapy for 15 min for each session two sessions per day for three consecutive days.
Outcomes: PaO2 and SaO2 were assessed before the 1st morning session (Pre 1) and after the 5TH morning session (Post) of manual hyperinflation (MHI) and chest physiotherapy to subside any drug interactions on ABG results at night session.
Results: After sessions, significant improvements of PaO2 and SaO2 were obtained in the post measurement compared with that at the beginning of the sessions.
Conclusion: It was concluded that the physiological effect of the manual hyperinflation from supine lying position showed significant improvement on PaO2 and SaO2 in mechanically ventilated patients with unilateral lung disease (ULD).

INTRODUCTION

One of the primary goals of mechanical ventilation is to improve arterial oxygenation. Improvement is achieved partly through the use of endotracheal intubation to ensure the delivery of oxygen to the airway and partly through an increase in airwaypressure. Satisfactory oxygenation is easily achieved in most patients with airway obstruction. The main challenge arises in patients with alveolar-filling disorders (Martin, 2001). Ventilator use is associated with a number of complications, which increase morbidity and mortality of such patients that include atelectasis, occlusion of the endotracheal tube,ventilation-associated pneumonia (VAP) and nosocomial infection, barotrauma, and hypotension (Suzanne, 2012). Physiotherapists are primary contact practitioners and use a comprehensive multisystem assessment that includes the respiratory, cardiovascular, neurological, and musculoskeletal systems to formulate individualized treatment plans (Volsko, 2013). Physiotherapy in mechanical ventilated patients facilitate removal of retained or profuse airway secretions aiming to reduce airway resistance, optimize lung compliance, and decrease the work of breathing ,for this purpose, the ICU physiotherapist disposes of a diversified armamentarium of breathing methods, manual techniques, and mechanical devices, used alone or in combination (Spapen, 2017). Several respiratory physiotherapy techniques, such as mobilization, manual hyperinflation (MHI), percussion and vibrations, are used in patients under MV. It has been shown that the use of respiratory physiotherapy techniques can reduce the retention of pulmonary secretion, besides improving dynamic compliance and static compliance (Hodgson, 2000; Patman, 2000 and Berti, 2012). Manual hyperinflation (MHI) is one of a number of techniques which provides a greater than baseline tidal volume to the lungs. It is frequently used by physiotherapists in the treatment of intubated mechanically ventilated patients. It aims at increasing alveolar oxygenation, recruiting atelectasis or mobilizing pulmonary secretions (Abd, 2015 and Denehy, 2006). Assessment of ABGs is an essential part in the management of the high risk patients as well as in the care of critically ill patients in the ICU. Since both areas manifest sudden and life threatening changes in all systems concerned, a thorough understanding of oxygenation and acid base balance is mandatory for any physician (Babb, 2003).

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MATERIALS AND METHODS

Totally, 20 mechanically ventilated patients (men) who suffered from unilateral lung diseases were received manual hyperinflation from supine lying in addition to routine chest physiotherapy. Patients in this study group received manual hyperinflation in addition to routine chest physiotherapy for 15 min, two times per day for a period of three days. Evaluative procedures were conducted before the 1st morning session (Pre 1) and after the 5TH morning session (Post).

Participants: This study was conducted at the Kasr El-Aini Hospitals (intensive care unit), Cairo University, where the mechanically ventilated patients were recruited. Totally, twenty mechanically ventilated patients (men) with unilateral lung diseases, with ages ranging from 40 to 50 years participated in this study. The inclusion criteria were male genders mechanically ventilated patients with unilateral lung diseases according to chest x-ray, ages ranged from 40-50 years,BMI range from 18.5 to 29.9 and hemodynamic stability. The exclusion criteria were bilateral lung dysfunction, unstable cardiovascular condition e.g arrhythmia, history of pulmonary tuberculosis and intercostal catheter with a visible air leak. After completion of the initial assessments, the patients who matched the inclusion criteria were assigned to the study group. The aim and nature of the study were explained for each patient's family before starting the study. An informed written assent was obtained from patient's family before enrolment.

Evaluative procedures

Chest x-ray: Chest X-ray is used to evaluate lung fields.

Stethoscope: Stethoscope (2203, Classic II S.E, grey 3M Littmann stethoscope, 28 inch, USA) is used to detect which lung was affected and to detect the site of secretions in which lobes or segments.

Arterial blood gases analyzer: Arterial blood gases analyzer (Abbott Laboratories Pharmaceutical Company, Singapore) was used to measure PaO2 and SaO2 before the 1st morning session (Pre 1) and after the 5TH morning session (Post)

Arterial Blood Gases and it's normal vlues includes: Partial pressure of oxygen (PaO2) 75-100mmHg and Oxygen saturation (SaO2) 94-100% (Dennis, 2010).

Therapeutic procedures

Manual resuscitation bag: Manual resuscitation bag (fortune medical instrument CORP, Taiwan, size: adult and REF No: 1610-0003). A bag valve mask, abbreviated to BVM and sometimes known by the proprietary name Ambu bag or generically as a manual resuscitator or "self-inflating bag", is a hand-held device commonly used to provide positive pressure ventilation to patients who were not breathing or not breathing adequately. Manual hyperinflation is defined as inflating the lungs using oxygen and manual compression to provide a tidal volume (Vt) exceeding baseline Vt, and using a Vt that is 50% greater than that delivered by the ventilator, requiring a peak inspiratory pressure of ranged from 20 to 40 cm H_2O (Maxwell, 2003).

Oxygen supply: Oxygen flow meter 15 L/min attached to the bag valve resuscitation circuit.

Traditional chest physiotherapy: The extent and use of manual techniques by physiotherapists in ICU in Australia was last reported 10 years ago.At this time both chest wall percussion and vibration were used by up to 80% of physiotherapists, often in combination with MHI (Chaboyer, 2004).

Intervention

Manual resuscitation bag

- The patients of unilateral lung disease were chosen according to chest X-ray (CXR).
- Before starting the procedure, arterial sample was taken by the physician for assessment of blood gases.
- The resuscitation circuit was attached to oxygen flow meter (100% O2) and set the oxygen to 15 L/min, and the bag valve resuscitation circuit was locked at pressure = 40 cmH2O.
- The patients were disconnected from the ventilator, the resuscitation circuit was attached to the filter and to the patient airway (endotracheal or tracheostomy).
- The hyperinflation breath would be :
- Inspiration for three seconds duration.
- Three seconds end inspiratory pause (hold), during which the bag was held compressed.
- Slow deep breath and hold maximizes collateral ventilation followed by an uninterrupted expiration.
- Quick release of the bag would increase the expiratory phase to mobilize secretions up to the bronchial tree and to stimulate cough (Maa, 2005).
- The rate of inflation was 10 breaths per minute and The patients had received 15 minutes of manual hyperinflation using bag valve resuscitation circuit, connected to a flow of 15 L/min with inspiratory pressure at 40 cmH2O (Ibrahiem, 2009 and Raafat, 2011).
- Airways suctioning was carried out during treatment if indicated or immediately after treatment.
- The patients were reconnected to the ventilator and immediately check the following: the patient's tidal volumes and respiratory rate on ventilator. Observe the patient's respiratory pattern, sign of distress (tachypnea, cyanosis, tachycardia) and position of the endotracheal tube or tracheostomy. The monitor indicated that the cardiovascular system was stable and oxygen saturation was within normal limits for the patients.
- Termination of manual hyperinflation occurred, if the patient became cardiovascular un stable or if oxygen saturation dropped.

Traditional chest physiotherapy

Percussions, are performed using cupped hands to clap over the affected part of the lung and can be added to postural drainage. The theory is that percussion generates flow transients in airways beneath a percussed segment (Pathmanathan, 2017).

Vibrations, can be performed manually or using mechanical devices to compress the chest wall during the expiratory phase. McCarren and colleagues found that vibrations increased peak expiratory flow rates by more than 50% over relaxed expiration (Pathmanathan, 2015).

Suctioning: The application of the aforementioned techniques mobilize secretions in the more peripheral airways centrally, so they can be removed via suction. Secretions in the more peripheral airways should not be removed by airway suction.The catheter diameter should be no greater than half the internal diameter of the tracheal tube (TT) or the tracheostomy The length of time for suction should be no greater than 15s. The correct sizing, timing, and suction pressure are essential to reduce the risk of trauma, atelectasis, and hypoxia (Pathmanathan, 2015).

Postural drainage

Data analysis: In this study, the Descriptive statistics and t-test was conducted for comparison of the subject

Table 1. Mean PaO2 and SaO2 of study group at pre and post treatment

	Study Group (n=20)					
	Pre	Post 1	MD	% of change	P-value	Sig
PaO2 (mmHg)	79.3 ±5.01	93.16 ± 10.26	-13.86	17.47	0.0001*	S
SaO2 (%)	94.15 ±1.03	95.45 ± 0.99	-1.3	1.38	0.0001*	S

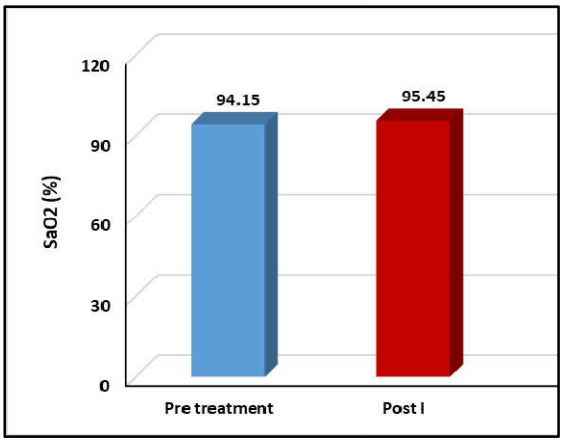

Fig. 1. Mean PaO2 of study group at pre and post treatment

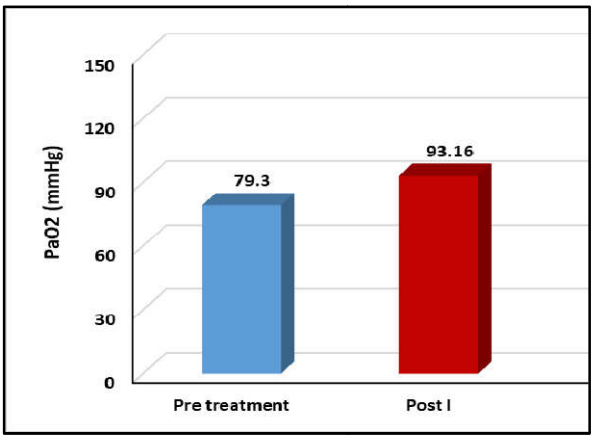

Fig. 2. SaO2 of study group at pre and post treatment

characteristics between pre1 and post of the same 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 19 for windows. The demographic data were expressed as the mean± SD [i.e. age, weight, height and body mass index (BMI)]. Dependent variables (i.e. PaO2 and SaO2) were expressed as mean ± SD.

RESULTS

Overall, Twenty male patients with unilateral lung disease participated in this study. Patients were received manual hyperinflation from supine lying.

Partial pressure of oxygen (PaO2): Within group comparison between the pre treatment (pre 1) and (post) treatment values revealed a significant improvement.

Oxygen saturation (SaO2): Within-study group comparison between the pre treatment (pre 1) and (post) treatment values revealed a significant improvement.

DISCUSSION

The main purpose of this study was to investigate the efficacy of manual hyperinflation (MHI) on arterial oxygenation of mechanically ventilated patients with unilateral lung diseases. According to the current results, there were improvements of measured variables. The significant improvement in these variables in the study group could be attributed to improvement of lung expansion and improvement of gas exchange. It maintain respiratory muscle strength and lung expansion and raises production of surfactant, which results in decreasing surface tension, enhancing lung compliance, better aeration of the alveoli, and decreasing the work of breathing (Dennis, 2010). MHI increase oxygenation and ventilation and improve lung function in the mechanically ventilated patients and re-inflate areas of atelectasis and Mobilise secretions (Maddison, 2006 and Malekzadeh, 2016).

Partial pressure of oxygen (PaO2): In a randomized controlled trials by Ibrahiemi (Hariedy, 2015), Hariedy *et al.* (2015) and Soundararaian and Thankappan, (Soundararajan, 20185), which examined the effect of manual hyper inflation on selected arterial blood gases in mechanically ventilated patients resulted in significant improvements in PaO2 in the experimental group, but not in the control group, which received traditional chest physiotherapy only. In contrast some authors like Dennis *et al*. (Maa, 2005), found that when MHI was compared to ventilator hyperinflation (VHI) on PaO2 in 46 ventilated intensive care unit patients, there was decrease in PaO2 ratio over time following MHI.

Oxygen saturation (SaO2): Hodgson *et al* (Hodgson, 2000), stated that when we used suctioning and, manual lung hyperinflation versus patient positioning and suctioning alone,18 Patients received both treatments on the day of data collection. Results demonstrated significant improvement for O2 saturation in 90% of the cases.In contrast some authors like Patman *et al*. (Patman, 2000), found that there was no change in SaO2 because the patients was maintained in a supine position and the time of session was 4 minutes but in the present study the time of the session was longer than this study, Paulus *et al*. (2010) found no change in SaO2 because most of the subjects needed to the suction during and after technique, which in turn causes a drop in oxygen saturation as transient under normal circumstances,but in our study we did suction for every patient needed to be suction during and after the technique.

Conclusion

It was concluded that the physiological effect of the manual hyperinflation showed significant improvement on PaO2 and SaO2 in mechanically ventilated patients with unilateral lung disease (ULD).

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