



## RESEARCH ARTICLE

### MANUAL HYPERINFLATION VERSUS RIB SPRINGING TECHNIQUE IN MECHANICALLY VENTILATED PATIENTS WITH LUNG COLLAPSE

Manar Hussein Dokhan<sup>1\* 2</sup>; Akram A. Said<sup>3</sup>; Ahmed Yassin Elsis<sup>4</sup> and Heba A. Abd El-ghaffar<sup>5</sup>

<sup>1</sup>Master student at Department Cardiovascular / Respiratory Disorder and Geriatrics, Faculty of Physical Therapy, Cairo University

<sup>2</sup>Physical Therapist at National Bank Hospital, Cairo, Egypt

<sup>3</sup>Assistant Professor of Physical Therapy, Department of Cardiovascular /Respiratory Disorder and Geriatrics, Faculty of Physical Therapy, Cairo University

<sup>4</sup>Lecturer of Critical Care Medicine, Faculty of Medicine, Beni suef University

<sup>5</sup>Assistant Professor of Physical Therapy for Cardiovascular /Respiratory Disorders and Geriatrics, Faculty of Physical Therapy, Cairo University

#### ARTICLE INFO

##### Article History:

Received 05<sup>th</sup> February, 2022

Received in revised form

24<sup>th</sup> March, 2022

Accepted 19<sup>th</sup> April, 2022

Published online 28<sup>th</sup> May, 2022

##### Keywords:

MHI, RST, MV and Lung Collapse.

#### ABSTRACT

**Aim:** This study was conducted to compare the effect of manual hyperinflation and rib springing technique in mechanically ventilated patients with lung collapse. **Materials and methods:** forty mechanically ventilated patients with lung collapse who were admitted to the intensive care unit participated in this study. Their ages ranged from 30 to 40 years and randomly distributed into two equal groups: group (A and B). Group (A): twenty patients were received manual hyperinflation in addition to their traditional chest physical therapy program (nebulization / positioning / vibration / percussion / suctioning). Group (B): twenty patients were received rib springing technique in addition to the same traditional treatment as group (A). Each patient in both groups assessed before treatment and reassessed after 4 successive sessions at a rate of one session per day regarding PaO<sub>2</sub> and Respiratory rate. **Results:** In this study there was a statistical increase in PaO<sub>2</sub> of the group A post treatment compared with that of the group B post treatment (p = 0.02). There was no alteration in RR post-chest PT when compared to pre-chest PT in both groups. **Conclusion:** Manual hyperinflation and Rib spring technique both must be added to chest physical therapy management programs in mechanically ventilated patients with lung collapse.

#### INTRODUCTION

Most of the patients in intensive care units are on mechanical ventilation (MV). MV supports breathing and control hypoventilation in patients with chest wall and respiratory problems [1][2]. In ventilated patients, there is a risk of secretions retention that occludes the airways and cause atelectasis. This will lead to decrease oxygenation, as well as increase the morbidity and mortality [3]. One of these common complications of MV is Lung collapse (especially basal atelectasis) [4][5]. Lung collapse (LC) is defined as loss of lung volume. It is classified into two grades: segmental (Lobar and Atelectasis) and total lung collapse (collapse of whole lung) [6]. Chest Physical Therapy CPT is the first line therapy for atelectasis in ICU patients [7]. Traditional chest physiotherapy maneuvers (Nebulizers, positioning, vibration, percussion and suctioning) are commonly applied on critically ill patients with lung collapse to decrease obstruction in airways and re-inflate the lungs [8][9].

Manual hyperinflation (MHI) and Rib Springing Technique (RST) are new common maneuvers done by physiotherapists during the management of mechanically ventilated patients with lung collapse [10]. Hyperinflation in the mechanically ventilated patients aims to increase lung oxygenation, reverse lung collapse, improve lung volume, increase lung compliance and clear lung secretions [11]. RST is a manual chest physiotherapy technique used during the expiratory phase. During expiration, high frequency oscillations of the chest wall of 12 to 20 hertz (HZ) are combined with compression of the ribs in a springing pattern 3 to 4 times. The compression is then removed suddenly; this quick release encourages deep inspiration by utilizing the elasticity of the chest during expansion. This technique mobilizes the secretions especially in smaller airways that have been dislodged during chest percussion [12][13].

#### Inclusion Criteria

- Patients with complete lung collapse or one or more atelectatic lobes who were received mechanical ventilation participated in the study.

\*Corresponding author: Manar Hussein Dokhan,

<sup>1</sup>Master student at Department Cardiovascular / Respiratory Disorder and Geriatrics, Faculty of Physical Therapy, Cairo University

<sup>2</sup>Physical Therapist at National Bank Hospital, Cairo, Egypt.

- Their age ranged between 30-40 years.
- Adult male and female patients participated in the study.
- Hemodynamically stable.

**Exclusion Criteria**

- positive end expiratory pressure (PEEP) >10 cmH2O
- Fraction of inspired oxygen (FiO2) >0.6.
- Undrained and Tension pneumothorax.
- Adult respiratory distress syndrome.

**MATERIALS AND METHODS**

**Trial design:** The presented randomized controlled study was carried out in National Bank Hospital-Specialized Medical Centers (intensive care unit), Cairo, Egypt from August 2019 to December 2020.

**Ethical considerations:** Ethical considerations: Human use analysis has complied with all applicable national regulations and institutional policies, followed the human use study. The tenets of the Helsinki Declaration and the acceptance of the ethical declaration physical therapy faculty of committee, Cairo university, Egypt (No. P.T.REC/001979/012)

**Participants:** Forty adult male and female patients with complete or partial lung collapse who were received mechanical ventilation and who were admitted to the intensive care unit participated in this study. Patients were randomly assigned into two equal groups in number (20 patients for each group) Their ages ranged between 30-40 years. They were hemodynamically stable. Their relatives were fully informed by the physiotherapist and all signed a written informed consent form.

**Outcome measurements**

- Arterial blood gases (ABGs): PaO2
- Respiratory Rate

**Treatment interventions**

- **Manual Hyperinflation for Group A:** This group included twenty patients were received manual hyperinflation in addition to their traditional chest physical therapy program (nebulization / positioning / vibration / percussion / suctioning) and Reassessed after each 4 successive sessions at a rate of one session per day.
- **Rib Spring for Group B:** This group includes twenty patients were received rib springing technique in addition to the same traditional treatment as group (A) and Reassessed after each 4 successive sessions at a rate of one session per day.

**Statistical analysis:** Descriptive statistics and unpaired t-test were conducted for comparison of subject characteristics between both groups. Normal distribution of data was checked using the Shapiro-Wilk test. Levene’s test for homogeneity of variances was conducted to ensure the homogeneity between group. Unpaired t-test was conducted to compare the mean values of PaO2 and RR between group A and B. Paired t-test was conducted for comparison between pre and post treatment in each group The level of significance for all statistical tests was set at  $p < 0.05$ .

All statistical analysis was conducted through the statistical package for social studies (SPSS) version 25 for windows (IBM SPSS, Chicago, IL, USA).

**RESULTS**

**Subject characteristics:** Table (1) showed the subject characteristics of the group A and B. There was no significant difference between both groups in the mean age and sex distribution ( $p > 0.05$ ).

**Table 1. Comparison of subject characteristics between group A and B**

	Mean ± SD		p-value
	Group A	Group B	
Age (years)	33.9 ± 3.56	35.1 ± 3.19	0.26
Sex			
Females	7 (35%)	9 (45%)	0.51
Males	13 (65%)	11 (55%)	

SD, standard deviation; p value, probability value

**Effect of treatment on PaO2 and RR:**

**Within group comparison:** There was a significant increase in PaO2 in the group A and B post treatment compared with that pre treatment ( $p > 0.0001$ ). The percent of change of PaO2 in group A was 9.53% and that in group B was 5.76 %. There was no significant change in RR between pre and post treatment in both groups ( $p > 0.05$ ) (Table 2).

**Table 2. Mean PaO2 pre and post treatment of the group A and B:**

	Pre	Post	MD	% of change	p value
	Mean ± SD	Mean ± SD			
PaO2 (mmHg)					
Group A	85.55 ± 8.37	93.7 ± 5.04	-8.15	9.53	0.0001
Group B	84.25 ± 10.11	89.1 ± 7.09	-4.85	5.76	0.0001
MD	1.3	4.6			
	$p = 0.66$	$p = 0.02$			

SD, Standard deviation; MD, Mean difference; p value, Probability value

**Table 2. Mean RR pre and post treatment of the group A and B:**

	Pre	Post	MD	% of change	p value
	Mean ± SD	Mean ± SD			
RR (breath/min)					
Group A	18.1 ± 1.77	17.4 ± 1.84	0.7	3.87	0.08
Group B	17.95 ± 1.98	17.35 ± 1.81	0.6	3.34	0.16
MD	0.15	0.05			
	$p = 0.8$	$p = 0.93$			

SD, Standard deviation; MD, Mean difference; p value, Probability value

**Between groups comparison:** There was no significant difference in all variables between groups pre-treatment ( $p > 0.05$ ). Comparison between groups post treatment revealed a significant increase in PaO2 of the group A compared with that of the group B ( $p > 0.05$ ) while there was no significant difference in RR between groups post treatment ( $p > 0.05$ ). (Table 2)

## DISCUSSION

The purpose of this study was to compare the effect of manual hyperinflation versus rib springing technique on mechanically ventilated patients with lung collapse through measuring PaO<sub>2</sub> and respiratory rate pre and post treatment for both groups. Forty patients with lung collapse participated in this study and were subdivided into two groups, twenty in each group. The first group was the group A who received the manual hyperinflation and conventional chest physical therapy which include positioning, Nebulized 3-ml of saline solution, positioning, percussion, vibration and suctioning. The second group was the group B who received rib springing and the same conventional chest physical therapy as group A. The present study has revealed no significant change post treatment in compare to pretreatment of both groups for RR. For PaO<sub>2</sub> there was a significant improvement post treatment in compare to pretreatment of both groups. In comparison between groups there was a significant increase in the PaO<sub>2</sub> of group A post treatment compared with that of group B post treatment ( $p = 0.02$ ).

The general aims of any physiotherapy program in the critical areas is to apply advanced and cost-effective therapeutic modalities to decrease the patient's dependency on the ventilator to prevent the need for new hospitalizations, decreasing the risks of bed-rest associated complications and to improve the patient's quality of life. Therefore, weaning process and physiotherapy are two major and related interventions to speed up the patient's recovery [14]. The findings showed that manual hyperinflation is effective in sputum clearance and improving static pulmonary compliance which is consistent with the observation by Berney et al [15]. In agreement with the results of this study Mohamed and Abdalmoniem [16] claimed that manual hyperinflation is a safe intervention that can be applied for mechanically ventilated critical ill patients, and it can help weaning from mechanical ventilator and decrease the time spent in intensive care unit also decrease morbidity. This present study was agreed with the results of study by Maa et al [17] who demonstrated that MH performed on patients with atelectasis from ventilation support significantly improved alveolar recruitment. In contrast to the above, Barker and Adams [18] reported no significance difference in PaO<sub>2</sub>/FiO<sub>2</sub> after MH treatment. Our results of this study supported by by Spapen et al. [19] who did a study to determine the effect of rib spring technique combined with conventional chest physiotherapy interventions on Mechanically ventilated Patients. Rib spring combined with other CPT tends to reduce the occurrence of Gram-negative IVACs, shortens duration of ventilation, length of stay and improves outcome. Another study done by Yamashina et al. [20] aimed to Prove that the rib springing was able to increase the peak inspiratory flow by about 1.6 times in comparison to the manual breathing assist.

## Conclusion

Manual hyperinflation and Rib spring technique both must be added to chest physical therapy management programs in mechanically ventilated patients with lung collapse.

**Disclosure statement:** No author has any financial interest or recieved any financial benefits from this research.

**Conflict of interest:** The authors state no conflict of interest

## REFERENCES

- Chen, Y. C., Wu, L. F., Mu, P. F., Lin, L. H., Chou, S. S., & Shie, H. G. (2009). Using Chest Vibration Nursing Intervention to Improve Expectoration of Airway Secretions and Prevent Lung Collapse in Ventilated ICU Patients: A Randomized Controlled Trial. *Journal of the Chinese Medical Association*, 72(6), 316–322.
- Ambrosino, N., & Clini, E. (2004) Long-term mechanical ventilation and nutrition. *Respiratory Medicine*, 98(5), 413–420.
- Berney, S., Haines, K., & Denehy, L. (2012). Physiotherapy in critical care in australia. *Cardiopulmonary Physical Therapy Journal*, 23(1), 19–25
- Kumar B, U. (2012). Handbook of Mechanical Ventilation. In Handbook of Mechanical Ventilation. The Intensive Care Foundation.
- Pavone, L., Albert, S., DiRocco, J., Gatto, L., & Nieman, G. (2007). Alveolar instability caused by mechanical ventilation initially damages the nondependent normal lung. *Critical Care*, 11(5), 1–10.
- Hall, J. E. (2017). Guyton and Hall: textbook of medical physiology. In *surgical neurology international* (13th ed., Vol. 8). Elsevier, Inc.
- Um, B.-K., Ku, J.-K., & Kim, Y.-S. (2018). Diagnosis and treatment of obstructive atelectasis after general anesthesia in a patient with abscess in the maxillofacial area: A case report. *Journal of Dental Anesthesia and Pain Medicine*, 18(4), 271.
- Paulus, F., Binnekade, J. M., Vroom, M. B., & Schultz, M. J. (2012). Benefits and risks of manual hyperinflation in intubated and mechanically ventilated intensive care unit patients: a systematic review. *Critical Care*, 16(4), R145.
- Schindler, M. B. (2005). Treatment of atelectasis: Where is the evidence? *Critical Care*, 9(4), 341–342.
- Choi, J. S. P., & Jones, A. Y. M. (2005). Effects of manual hyperinflation and suctioning on respiratory mechanics in mechanically ventilated patients with ventilator-associated pneumonia. *Australian Journal of Physiotherapy*, 51(1), 25–30.
- Dennis, D., Jacob, W., & Budgeon, C. (2012). Ventilator versus manual hyperinflation in clearing sputum in ventilated intensive care unit patients. *Anaesthesia and Intensive Care*, 40(1), 142–149.
- Cigna, J. A., & Turner-Cigna, L. M. (2005). Rehabilitation for the Home Care Patient With COPD. *Home Healthcare Nurse: The Journal for the Home Care and Hospice Professional*, 23(9), 578–584.
- Dougherty, P. E., Engel, R. M., Vemulapad, S., & Burke, J. (2011). Spinal manipulative therapy for elderly patients with chronic obstructive pulmonary disease: A case series. *Journal of Manipulative and Physiological Therapeutics*, 34(6), 413–417.
- Clini, E., & Ambrosino, N. (2005). Early physiotherapy in the respiratory intensive care unit. *Respiratory medicine*, 99(9), 1096-1104.
- Berney, S., & Denehy, L. (2002). A comparison of the effects of manual and ventilator hyperinflation on static lung compliance and sputum production in intubated and ventilated intensive care patients. *Physiotherapy Research International: The Journal for Researchers and Clinicians in Physical Therapy*, 7(2), 100–108.
- (Mohamed and Abdalmoniem. 2015) Mohamed, A. R., & Abdalmoniem Ibrahim, A. (2015). Acute Response of Manual Hyperinflation In Addition To Standard Chest

- Physiotherapy on Critically Ill Mechanically Ventilated Patients. *IOSR Journal of Nursing and Health Science (IOSR-JNHS)*, 4(1), 33-38.
- Maa, S. H., Hung, T. J., Hsu, K. H., Hsieh, Y. I., Wang, K. Y., Wang, C. H., & Lin, H. C. (2005). Manual hyperinflation improves alveolar recruitment in difficult-to-wean patients. *Chest*, 128(4), 2714-2721.
- (Barker and Adams 2002) Barker, M., Adams, S., Thomas, S., & Trust, N. H. S. (2002). *An evaluation of a single chest physiotherapy treatment on mechanically ventilated patients with acute lung injury*. 7(3), 157–169.
- Intrapulmonary percussion with autogenic drainage and ventilator-associated Gram-negative infection: A pilot study. *Neth J Crit Care*, 24(2), 6-10
- Yamashina, Y., Hirayama, T., Aoyama, H., Hori, H., & Fukunaga, S. (2019). Differences in the Peak Inspiratory Flow in Manual Breathing Assist and Rib Springing Techniques. *BIOPHILIA*, 1(17), 3–6.

\*\*\*\*\*