Journal of Physical Education and Sport ® (JPES), Vol 19 (Supplement issue 1), Art 6, pp.35 - 39, 2019
online ISSN: 2247 - 806X; p-ISSN: 2247 – 8051; ISSN - L = 2247 - 8051 © JPES

Original Article

Comparison of respiratory training methods for chest wall expansion in patients with chronic obstructive pulmonary disease

AGUNG WAHYU PERMADI[1], I MADE WISNU ADHI PUTRA[2]
[1]Departement of Physiotherapy, Faculty of Health, Science and Technology, University of Dhyana Pura, Badung, Bali, INDONESIA
[2]Departement of Nutrition Science, Faculty of Health, Science and Technology, University of Dhyana Pura, Badung, Bali, INDONESIA

Published online: January 31, 2019
(Accepted for publication November 28, 2018)
DOI:10.7752/jpes.2019.s1006

Abstract
Impact of COPD is the presence of chest wall disorders and thoracic mobility disorders, it is necessary for physiotherapists to provide breathing exercises to patients with COPD. Respiratory training methods used in this study are maximal inspiratory exercise (MIE) and pursed-lip breathing (PLB) for chest wall expansion in patients with chronic obstructive pulmonary disease (COPD). This study aims to identify the difference between MIE and PLB in 30 patients with COPD. From the current observations performed in 12 weeks with 3 times per week dosing, it was found that each MIE and PLB group an increased chest wall expansion after treatment. The main results showed that the values of MIE (3.1 ± 0.57) and PLB (2.1 ± 0.72) differed significantly after treatment. The value of MIE was higher than PLB's. This value is value of inspiration and expiration during the breathing process taken before and after treatment. This proves that MIE is better for increasing chest wall expansion in patients with COPD.
Keywords: maximal inspiratory exercise, pursed-lip breathing, chest wall expansion, COPD

Introduction

Chronic obstructive pulmonary disease (COPD) is currently the cause of death in the world (Broderick et al., 2018). COPD can be defined as a treatable disease characterized by a progressive flow of air constraints. It contributes to the severity of the patient, making it the leading cause of morbidity and mortality worldwide and has a major impact on the economic sector (Cortopassi & Gurung, 2017). The number of COPD patients worldwide increased from about 227 million cases in 1990 to 384 million cases with 11.7% prevalence, where the highest prevalence occurred in the United States and Southeast Asia (Bafadhel, 2016). The main problem in the treatment of this disease is to handle problematic psychological functions, both physical and psychological function, of the patients thoroughly. Thus, lung rehabilitation is considered a foundation in the management of patients with COPD (Jarosch et al., 2017). British National Institute of Health and Care Excellence (NICE) on COPD guidelines and the Global Initiative for Chronic Obstructive Lung Disease (GOLD) recommends that COPD treatment is very effective and can be achieved through a broad multidisciplinary combination of pharmacological and multidisciplinary non-pharmaceutical therapies, such as a team of doctors, specialist nurses, physiotherapists, pharmacists, nutritionists, psychologists, and palliative care (Bafadhel, 2016).

Impact of COPD is the presence of chest wall disorders (Elbouhy, AbdelHalim, & Hashem, 2014). This chest wall disorder can lead to deformities of the body and the respiratory process, affecting the thorax, the respiratory, and abdominal muscles, hence the disease requires treatment of pulmonary rehabilitation (Al-Qadi, 2018). The pulmonary rehabilitation program aims to address the systemic consequences of COPD (Rochester, Fairburn, & Crouch, 2014), (Daabis, Hassan, & Zidan, 2017). Breathing exercises are now considered an essential component of pulmonary rehabilitation in patients with COPD. However, there is no training with optimal benefits for pulmonary rehabilitation in patients with COPD. Whether training should be with strength, or endurance, or even both, are still awaiting further research (Daabis et al., 2017).

In pulmonary rehabilitation, it is necessary for physiotherapists to provide breathing exercises to increase chest wall expansion of patients with COPD (Leelarungrayub, Pothongsunun, Yankai, & Pratanaphon, 2009). There is evidence that maximal inspiratory exercise (MIE) can improve chest wall expansion by showing the mechanical changes that occur in COPD in dyspnea reduction after the provision of forced inspiratory exercise (Taube et al., 2011). Another breathing exercise routinely done by lung rehabilitation is a pursed-lip breathing (PLB) exercise because it is considered capable of relieving dyspnea (Spahija, Marchie, & Grassino, 2005), (Mayer et al., 2018). Previous studies of MIE and PLB still have not shown results from measurements

Corresponding Author: AGUNG WAHYU PERMADI, Email: agungwahyu@undhirabali.ac.id

of chest wall expansion in COPD patients, thus this research wanted to compare MIE and PLB and find out which exercise is on increasing the expansion of the chest wall in COPD patients. Surely this is basically the focus on this research.

Material and Methods

Participants

For this preliminary study, 30 patients were recruited from among the staff of the Pulmonology unit of the hospital. The inclusion criteria were as follows: exacerbations in patients with COPD are thought to be caused by bacteria. Patients are suffering from mild to moderate COPD, according to GOLD criteria. They are not suffering from pathological diseases, such as stroke and heart disease, and blood pressure is on normal scale (100/60-140/90mmHg). Exclusion criteria include subjects with asthma or pulmonary function tests showing result 12%, subjects with steroid dependence or requiring long-term steroids, and subjects with other complications (bronchiectasis, tuberculosis, cystic fibrosis and malignancy). The experiment was approved by the Research Ethics Committee of Medical Faculty of Udayana University/ Sanglah Hospital.

Chest Wall Measurement

Chest expansion was measured with a cloth tape at 2 different levels of the rib cage. Anatomic landmarks of upper thoracic expansion are the third intercostal space, the middle of the clavicular line, and spinous process of the fifth thoracic vertebrae on the lower. The land marks of lower thoracic expansion are the xiphoid process and spinous process of the tenth thoracic vertebrae. A measurement was performed on the subjects by 2 different physiotherapists on 2 separate days. While performing the measurements, physiotherapist was blinded. The assessor was blinded when analyzing the results (Debouche, Pitance, Robert, Liistro, & Reychler, 2016).

The breathing instructions given to the subjects were standardized (Bockenhauer, Chen, Julliard, & Weedon, 2007). Before the thoracic measurement, subjects were asked “to inhale slowly through the nose and push against the tape measure to expand the lungs as much as you can.” Then the participants were asked “to breathe out completely through the mouth.” Measurements were taken at the end of a complete inspiration and expiration cycle. Measurements were taken with the participants in standing position (Costa, Almeida, & Ribeiro, 2015). The physiotherapists placed the “0” of the cloth tape measure on the appropriate vertebrae. The cloth tape was held with an index finger between the participant’s body and the cloth tape, without generating any deformation or cutaneous folds. The inspiratory diameter was subtracted from the expiratory diameter to calculate the chest expansion value. Reliabilities were evaluated by repeated measurement by 1 physiotherapist in 2 separate days and by 2 physiotherapists on the same day. Reproducibility was evaluated for lower and upper chest expansion separately: chest expansion measurement was compared between 2 physiotherapists on the same day and 1 physiotherapist on the same day.

Statistical Analyses

Group 1 was given the maximal inspiratory exercise. Treatment was given by stressing on maximal inspiration and holding their breath at the end of the maximal inspiration pressure of 1-3 counts (seconds) (Taube et al., 2011), (Andrews, Woo, & Keens, 1997). Group 2 was given pursed-lip breathing exercise. Treatment given stressed in expiration process that was performed calmly, aiming to ease the process of exhaling the air that was trapped in the respiratory (Fregonezi, Resqueti, & Rous, 2004), (Mayer et al., 2018). All groups were given 12 weeks’ time and the exercises were done as much as 3 times a week.

Data in the study is analyzed using SPSS. This analysis is used to describe the results of research in the field without having to manipulate the real facts. Data from the group will be tested for normality Shapiro Wilk-Test with a significance level of 0.05. It is to test the difference of an average increase of chest expansion before and after treatment in each group. Then the last, the difference of an average increase of chest wall before and after treatment in both groups will be tested.

Results

In Table 1, results of normality and homogeneity tests on the chest expansion before and after treatment showed $p>0.05$. Therefore, the data collected were classified as normally distributed and homogeneous.

Table 1

Normality and homogeneity tests on data of development chest expansion before and after treatment in group MIE and PLB.

The development value of the chest expansion (Cm)	***p*. Normality test (Shapiro Wilk-Tet)**		***p*. Homogeity**
	MIE	**PLB**	
Before the inspiratory treatment	0.762	0.980	**0.258**
Before expiratory treatment	0.795	0.998	
After inspiratory treatment	0.758	0.999	
After expiratory treatment	0.735	0.983	

In Table 2, it can be seen that in MIE, there was a difference in chest expansion during twelve weeks of study, with the values of pre-treatment and post-treatment were 3.23±0.41 and 6.40±0.47. Mean while in PLB, the values were 3,36±0,50 and 5.60±0.71. This shows that after treatment, the value is doubled. The results show that there was a significant difference in terms of chest expansion development before and after treatment in both groups with a $p<0.05$.

Table 2
Significance test for improvement of development chest expansion before and after treatment in every treatment.

Subject groups	Average ± Standard deviation of thoracic cage development value		*p*
	Pre-test	**Post-test**	
Group treatment 1	3.23 ± 0.41	6.40 ± 0.47	**0.000**
Group treatment 2	3.23 ± 0.50	5.60 ± 0.71	**0.000**

In Table 3, the significant difference in chest expansion, during pre- and post-treatment, was smaller than 0.05, with *p*-values of 0.001. Larger development was shown by MIE rather than PLB. Therefore, the hypothesis was proven that MIE was better than PLB exercise in treating patients with COPD.

Table 3
Analysis of variance in development of chest expansion capacity before and after treatment

Subject group	Average ± development value of the thoracic cage		*p*
	MIE	**PLB**	
Different before and after treatment	3.1 ± 0.57	2.1 ± 0.72	**0.001**

Discussion

This study shows that MIE and PLB have an impact on increasing thoracic progression of patients with COPD. However, our results show that MIE is better than PLB exercise in improving chest wall mobilization. In the literature, it is explained that MIE can provide increased chest wall mobilization of patients with COPD (Stănescu et al., 2000). Case reports show that drug use can improve the quality of life of patients with COPD, but this report cannot prove whether the drug can be consumed in the short or long term (Storms & Miller, 2018). Thus, MIE and PLB exercises are highly recommended as a basis for treatment in patients with COPD. This is consistent with the research of Hambelton (2016) which shows that an effective way other than the use of drugs in COPD is the use of pulmonary rehabilitation (Bafadhel, 2016). This study was supported by Sophie and Elvia on patients with mild to severe COPD that could consider the advantages of the use of inspiratory and expiratory exercise to improve respiratory function in chest wall (Battaglia, Fulgenzi, & Ferrero, 2009),(Debouche et al., 2016).

The study found that MIE is very important to increase inspiratory muscle strength in respiratory function (Ohya, Hagiwara, Chino, & Suzuki, 2016), (Ohya, Hagiwara, Chino, & Suzuki, 2017), (Rodrigues et al., 2017). In the study, there was agreement between pre-test probability of MIE, defined as significant as subjects, and "higher" pre-test probability of other breathing exercise ($p<0.05$) (Rodrigues et al., 2017). The mean of MIE relative value to male was 1.85±0.21 $cmH_2O.Kg^{-1}$. However, when this value was expressed relatively to body mass, this difference disappeared ($p>0.05$). A strong correlation ($r=0.59$, $p<0.001$) was found between mean of maximal inspiration exercise values, but no correlation was found between mean of MIE values and mean of height ($r=0.11$, $p>0.05$) (Ohya et al., 2016), (Ohya et al., 2017). MIE used to be capable of reproducibly detecting the functional response to bronchodilator inhalation in patients with moderate to severe COPD (Taube et al., 2011). This suggests that our study could provide an objective correlated to chest wall expansion in patients with COPD.

Review articles on the Effect of PLB on Lung Function and Arterial Gases, Effects of PLB on Respiratory Patterns, Effect of PLB on Respiratory Muscle, Clinical Effect of PLB indicate that PLB can improve breathing function in patients with COPD. They studied the work of breathing and ventilatory muscle recruitment during PLB in COPD patients and observed a significant decrease in gastric and pleural pressures during inspiration and an increase in respiratory work (Fregonezi et al., 2004). This increase was attributed to an increase in the work of the chest wall (intercostal) muscles as a result of decreased work of the diaphragm. We can conclude that abdominal muscle recruitment and chest wall expansion at rest and during exercise are greater with PLB. The expiratory resistance from PLB provides significant changes in the breathing pattern and in respiratory muscle recruitment. As a result, tidal volume increases, gas exchange improves, and oxygen consumption decreases (Roberts, Schreuder, Watson, & Stern, 2016).

In some previous works, it is also explained that PLB is widely taught in respiratory physical therapy and pulmonary rehabilitation programs to improve the quality of life associated with COPD (Mayer et al., 2018). These results do not support the effectiveness of PLB in improving exercise performance, dyspnea, and oxygen saturation. On the other hand, it was shown that a PLB is effective in reducing respiratory rate during exercise.

However, the effect sizes for respiratory rate were medium and low, respectively. Thus, probably the effectiveness of PLB in improving chest wall expansion is not large enough to be clinically relevant. In summary, it is still unclear, however, who the "responders" are and how patients with COPD benefit from PLB. So in connection with our study, PLB can increase chest wall expansion, but the result is not maximal. Despite the discrepancies among the limited number of studies on the effects of PLB, we believe that the maneuver should be included in respiratory physiotherapy programs to improve breathing efficiency in patients with COPD.

We found research on Andrew's most inspiring exercise that more accurately explains assessment of the real maximal inspiratory pressure (MIP) from 367 test data review. One hundred and seventy-eight were pediatric and adult subjects (age, 14±3 [SD] years, 53% of men) with suspected muscle weakness of inspiration. MIP length (91±39 cm H2 0) was significantly greater than short MIP (82±39 cm H20) (p<0.000005). In 177 of 367 tests, short MIP underestimated peak performance. The study concluded that long MIPs were significantly larger than short MIP. In 48% of the tests, the short MIP method underestimated peak performance determined by the long MIP method. We speculate that the difference between short MIP and short MIP can be used on the basis of doing maximum inspiratory exercise in patients with COPD (Andrews et al., 1997).

We also found evidence of the benefits of PLB in chest wall kinematics during breathing exercises in patients with COPD (Bianchi, Gigliotti, & Romagnoli, 2004). The results showed that PLB contributed to twenty-two patients with mild to severe COPD and PLB values showed a significant reduction compared to spontaneous breathing, (mean SD) in final expiratory volume (p<0.000004), and a significant increase in final inspiration (p<0.003). Nonetheless, it is not for initial functional residual capacity (FRC) and volume tidal (VT) of the chest wall (p<0.000004). We speculate that PLB is able to increase chest wall expansion and result in a decrease of shortness of breath in patients with COPD.

The main limitation of our study is that we have not found a comparative study of these two training methods, so we need the literature related to COPD treatment. This research can be hypothesized that MIE and PLB contribute to chest wall of patients with COPD (Andrews et al., 1997), (Fregonezi et al., 2004). Thus, rather than PLB exercise, we recommend MIE for overcoming the effects of COPD, such as decreased mobilization of the thoracic wall and shortness of breath. This is also interesting that one of the proposed training methods is still new and further research regarding the comparison between MIE and PLB is still needed to warrant further study.

Conclusions

From the present observation conducted in 12 weeks with 3 times per week dosing, according to chest expansion measurements using cloth tape, chest wall expansion through MIE is better than it is through PLB in improving thoracic progression in patient with COPD. However, in order to know more about the improvement of chest wall expansion in long-term COPD patients, larger sample size is needed because the prevalence and mortality might continue to increase in the coming decades.

Conflict of interest

The authors declare that there is no conflict of interest related to this study.

References

Al-Qadi, M. O. (2018). Disorders of the Chest Wall: Clinical Manifestations. *Clin Chest Med, 39*(2), 361–375.

Andrews, W., Woo, M. S., & Keens, T. G. (1997). Pulmonary Physiologic Test of the Month How Many Maneuvers Are Required to Measure Maximal Inspiratory Pressure Accurately□?*, *CHEST, 111*(3), 2–7.

Bafadhel, M. (2016). Chronic obstructive pulmonary disease□: management of chronic disease Key points. *Medicine, 44*(5), 310–313.

Battaglia, E., Fulgenzi, A., & Ferrero, M. E. (2009). Rationale of the Combined Use of Inspiratory and Expiratory Devices in Improving Maximal Inspiratory Pressure and Maximal Expiratory Pressure of Patients With Chronic Obstructive Pulmonary Disease. *Arch Phys Med Rehabil, 90*(6), 913–918.

Bianchi, R., Gigliotti, F., & Romagnoli, I. (2004). Chest Wall Kinematics and Breathlessness During Pursed-Lip Breathing in Patients With COPD *. *CHEST, 125*(2), 459–465.

Bockenhauer, S. E., Chen, H., Julliard, K. N., & Weedon, J. (2007). Measuring thoracic excursion: reliability of the cloth tape measure technique. *J Am Osteopath Assoc, 107*(5), 191–196.

Broderick, J., Grath, C. M., Cullen, K., Talbot, D., Gilmor, J., Baily-scanlan, M., & Dwyer, T. O. (2018). Effects of pulmonary rehabilitation on exercise capacity and disease impact in patients with chronic obstructive pulmonary disease and obesity. *Physiotherapy, 104*(2), 248–250.

Cortopassi, F., & Gurung, P. (2017). Chronic Obstructive Pulmonary Disease in Elderly Patients. *Clin Geriatr Med, 33*(7), 539–552.

Costa, R., Almeida, N., & Ribeiro, F. (2015). Body position influences the maximum inspiratory and expiratory mouth pressures of young healthy subjects. *Physiother U K, 101*(2), 239–241.

Daabis, R., Hassan, M., & Zidan, M. (2017). Endurance and strength training in pulmonary rehabilitation for COPD patients. *Egypt J Chest Dis Tuberc, 66*(2), 231–236.

Debouche, S., Pitance, L., Robert, A., Liistro, G., & Reychler, G. (2016). Reliability and Reproducibility of Chest Wall Expansion Measurement in Young Healthy Adults. *J Manipulative Physiol Ther, 39*(6), 443–449.

Elbouhy, M. S., AbdelHalim, H. A., & Hashem, A. M. A. (2014). Effect of respiratory muscles training in weaning of mechanically ventilated COPD patients. *Egypt J Chest Dis Tuberc, 63*(3), 679–687.

Fregonezi, G. A. D. F., Resqueti, V. R., & Rous, R. G. (2004). Pursed Lips Breathing. *Arch Bronconeumol, 40*(6), 279–282.

Jarosch, I., Hitzl, W., Rembert, A., Wencker, M., Welte, T., Gloeckl, R., Kenn, K. (2017). Comparison of exercise training responses in COPD patients with and without Alpha-1 antitrypsin de fi ciency. *Respir Med, 130*, 98–101.

Leelarungrayub, D., Pothongsunun, P., Yankai, A., & Pratanaphon, S. (2009). Acute clinical benefits of chest wall-stretching exercise on expired tidal volume, dyspnea and chest expansion in a patient with chronic obstructive pulmonary disease: A single case study. *J Bodyw Mov Ther, 13*(4), 338–343.

Mayer, A. F., Karloh, M., Santos, K., Laura, C., Araujo, P. De, & Gulart, A. A. (2018). Effects of acute use of pursed-lips breathing during exercise in patients with COPD: a systematic review and meta-analysis. *Physiotherapy, 104*(1), 9–17.

Ohya, T., Hagiwara, M., Chino, K., & Suzuki, Y. (2016). Respiratory Physiology & Neurobiology Maximal inspiratory mouth pressure in Japanese elite male athletes, *Respir Physiol Neurobiol, 230*, 68–72.

Ohya, T., Hagiwara, M., Chino, K., & Suzuki, Y. (2017). Maximal inspiratory mouth pressure in Japanese elite female athletes. *Respir Physiol Neurobiol, 238*, 55–58.

Roberts, S. E., Schreuder, F. M., Watson, T., & Stern, M. (2016). Do COPD patients taught pursed lips breathing (PLB) for dyspnoea management continue to use the technique long-term? A mixed methodological study. *Physiotherapy, 103*(4), 465–470.

Rochester, C. L., Fairburn, C., & Crouch, R. H. (2014). Pulmonary Rehabilitation for Respiratory Disorders Other than Chronic Obstructive Pulmonary Disease. *Clin Chest Med, 35*(2), 369–389.

Rodrigues, A., Silva, M. L. Da, Berton, D. C., Pitta, F., Donnell, D. E. O., & Neder, J. A. (2017). Maximal Inspiratory Pressure: Does the Choice of Reference Values Actually Matter? *CHEST, 152*(1), 32–59.

Spahija, J., Marchie, M. De, & Grassino, A. (2005). Effects of Imposed Pursed-Lips Breathing on Respiratory Mechanics and Dyspnea at Rest and During Exercise in COPD*. *CHEST, 128*(2), 640–650.

StănescuDanMD, PhDaVeriterClaudeMAaVan de WoestijneKarel P.MD, P. (2000). Maximal Inspiratory Flow Rates in Patients With COPD*. *Chest, 118*(4), 976–980.

Storms, W. W., & Miller, J. E. (2018). Improved lung function and quality of life following guaifenesin treatment in a patient with chronic obstructive pulmonary disease (COPD): A case report. *Respir Med Case Rep, 24*, 84–85.

Taube, C., Rydzy, L., Eich, A., Korn, S., Buhl, R., Kornmann, O., Jo, R. A. (2011). Use of a portable device to record maximum inspiratory flow in relation to dyspnoea in patients with COPD*. *Respir Med, 105*(2), 316–321.