Effectiveness of Chest PNF and breathing Exercises on Pulmonary Function and Chest Expansion in Male Smokers

Apoorva Bhatnagar[1], Sunita Sharma[2]

[1]*Student,* [2]*Associate Professor, Maharishi Markandeshwar Institute of Physiotherapy and Rehabilitation, Maharishi Markandeshwar University, Ambala, India*

Abstract

Background: Cigarettes constitutes various harmful substances like Nicotine which leads to diseases like COPD (Chronic obstructive pulmonary disease), atherosclerosis, and other respiratory and cardiopulmonary disease. This may leads to wheezing, frequent coughing with or without sputum, increased breathlessness and reduced endurance of respiratory muscles. The main objective of the study is to identify more significant effect of Chest proprioceptive neuromuscular facilitation and Breathing Exercises on pulmonary function and chest expansion in male Smokers.

Method: This comparative study was executed on 50 subjects based on the criteria of the study, which were randomly divided into Group A & B. Subjects in Group A received chest proprioceptive neuromuscular facilitation technique but subjects in Group B received breathing exercises for 2 weeks. Pulmonary functions were assessed by Spirometry and chest expansion was measured at axillary level, nipple level and Xiphisternum level by measuring tape. All measurements were taken at the baseline and on the last day of 2nd week. Independent t-test and paired t-test were used to analyse the data.

Conclusion: More significant improvement in terms of pulmonary functions and Chest expansion was observed in group A who received chest proprioceptive neuromuscular facilitation in contrast to group B that received breathing exercises.

Key Words: *Breathing exercises, Chest proprioceptive neuromuscular facilitation, chest expansion, pulmonary function, smokers*

Introduction

Approximately, 4 million deaths occurred in 1999 from tobacco and it is also estimated that the annual number of deaths is likely to increase to 10 million by the 2030s.(1) Generally, people begin smoking during adolescence or early adulthood.(2) Smoking gives feeling of pleasure as the inhaled substances trigger chemical reactions in nerve endings in the brain, which are similar to naturally occurring substances like endorphins and dopamine.

The total number of people who will die from cigarette smoking will exceeds the total number of people dying from AIDS, Cancer, or Traffic accidents, etc.; according to predictions by the WHO (World Health Organization). Cigarettes constitutes various harmful substances like Nicotine which leads to smoking causing various diseases like COPD (Chronic

Corresponding Author:
Dr. Apoorva Bhatnagar
Student, MMIPR,
MMU, Ambala, India
E-mail: dr.apoorvabhatnagar@gmail.com

obstructive pulmonary disease), atherosclerosis, and other respiratory and cardiopulmonary disease.[3] This may leads to wheezing, frequent coughing with or without sputum, increased breathlessness, reduced endurance and strength of respiratory muscles and tightness in the chest.[4] Even the early stage of smoking might affect the respiratory function of young adults due to acute alterations in the lung.[5]

Smoking has negative effect on forced vital capacity (FVC), forced expiratory volume in one second (FEV1) and FEV1 /FVC in pulmonary function along with increased forced residual capacity.[6] Studies have shown reduced pulmonary functions of smokers as compared to non-smokers.[7][8] In a study by Mumtaz et. al., FVC, FEV1 and FVC/FEV1 was found significantly reduced in young adult smokers when compared to non-smokers of same age group.[7]

The expansion and contraction of the lungs are affected by the capacity of the thorax, which is determined by the mobility of the skeletal muscles, the elasticity of surrounding soft tissues, and the intensity of the respiratory muscles.[9] Strength of respiratory muscles depends on the maximal effort made by the muscles used in chest expansion while breathing. Tantisuwat et al., found decreased chest circumference of smoking youths especially at the axillary level which is associated with reduced AP and ML diameter of the upper chest expansion. Reduced chest expansion would affect the performance and work of breathing, hence, may cause dyspnea.[5]

Muscle strength can be enhanced through three-dimensional spiral large scale resistive exercises using proprioceptive neuromuscular facilitation (PNF) indicated by a study which was conducted by Dietz.[10] It provides proprioceptive feedback to the respiratory muscles which creates reflex respiratory movement responses and improves rate and depth of respiration. Stretch reflex is used to facilitate the initiation of inhalation and Repeated Contractions are used to facilitate an increase in inspiratory volume. For breathing control, isotonic contractions are also useful.[11]

Therapeutic interventions are required to improve exercise ability and breathing by augmentation of respiratory muscle function. The aim of breathing exercise interventions is to improve strength, endurance and co-ordination of respiratory muscles.[2] Deep breathing exercise can reduce the work of breathing by decreasing the respiratory rate and relaxing accessory muscles. Strength and endurance of respiratory muscles can be improved by various breathing exercises such as Pursed-lip breathing, Diaphragmatic breathing, Glossopharyngeal breathing and Costal breathing.[4]

The aim of this study was to examine the effects of Chest Proprioceptive Neuromuscular Facilitation and Breathing exercises on pulmonary function and chest expansion in male smokers.

Material and Method

This experimental study was conducted in the outpatient department of Maharishi Markandeshwar institute of physiotherapy and rehabilitation in 2018. Ethical approval was taken from Departmental ethical committee, MMDU. The sample size was calculated by G-Power software, using the power of study 0.95 and probability error 0.05. The calculated sample size was 50.

Inclusion and exclusion criteria:

Male Smokers, aged between 18-30 years who had history of smoking of 2 pack years were recruited for the study. All the subjects had a body mass index (BMI) in the range of 18.5–23 kg/m2. Subjects who had history of any presence of systemic, respiratory, cardiovascular diseases or any orthopaedic disease and subjects with any psychological disorder were excluded from the study.

Assessment parameters:

Subjects underwent assessment for pulmonary function (Spirometry in accordance with American Thoracic Society guidelines) and chest expansion measurement (at axillary, nipple and xiphisternal level).

All the measurements were taken at the baseline and on the last day of 2nd week.

Method

The whole procedure was described to all subjects and written informed consent was taken from them prior to the study. A total of 50 males were randomly allocated into two groups. Group A with 25 subjects in it received chest PNF, and Group B with similar no. of subjects in it i.e. 25 received Breathing exercises. Exercises were performed for 2 weeks in both the groups. Chest expansion exercises were included along with the following protocol in both the groups.

Group A (chest PNF): Subjects received chest PNF in following positions- Supine, side-lying and prone position. Chest PNF technique included oblique downward pressure at the sternum, diagonal pressure at lower rib cage in the supine line, caudal medial pressure at side-lying, Caudal pressure over ribcage in prone lying, dorsal and caudal pressure in prone on the elbow. The duration of the treatment was 30 minutes a day for 3 days per week for 2 weeks.

Group B (Breathing exercises): Subjects received Deep breathing exercises which includes segmental breathing, diaphragmatic breathing and pursed-lip breathing for 30 minutes a day for 3 days per week for 2 weeks.[12]

Results

The data was analyzed by using the software package SPSS 21 for window version. Mean and standard deviation of all the parameters were taken. To compare the difference between the groups for variables (pulmonary function and chest expansion) at baseline and last day of 2nd week independent t-test was used as shown in table 1. Differences within the group A (shown in table 2) and within group B (shown in table 3) for the variables (pulmonary function and chest expansion) at baseline and last day of 2nd week were compared by paired t-test. The level of significance was 95% ($p \leq 0.05$).

At the beginning of the study on pre-exercise comparison, groups were found to be homogenous for Age, height, weight, BMI and outcomes measured FVC, FEV1, FVC/FEV1, chest expansion at axillary level, nipple level and xiphisternal level.

Discussion

Present study was executed to compare the effects of Chest PNF and Breathing exercises on lung function test and chest expansion measurement in male smokers. Findings of this study revealed that both groups yielded significant improvement on pulmonary function test and chest expansion measurement.

Results of this study yielded that subjects in Group A which performed Chest PNF for 2 weeks showed more clinically significant increase in FVC by 10.5 %, in FEV_1 by 18 % and in FVC/FEV_1 by 5 % than the subjects in Group B who performed Breathing exercises showed significant increase in FVC by 9.8 %, in FEV1 by 14 % and FVC/FEV_1 by 1 %. It has been proved that Chest PNF leads to increased strength as well as endurance of the respiratory muscles.

According to Felter et al., sensory muscle spindles are present in intercostal muscles as well as in diaphragm that respond to elongation. Muscle fibers recruited when signal is sent via spinal cord and anterior horn cell and thus increase the strength. Stretch reflex is activated by stretching ribs and diaphragm which helps to take deep breaths.[13]

Breathing exercise also produced a beneficial effect on pulmonary function and chest wall expansion. The possible physiology behind this improvement could be the ability of patients to achieve some breathing control with these exercises and reduce the respiratory muscle tension which can be better utilised during respiration. It also produces a calming effect, which can reduce the breathing effort.(12)

M. Paulraj et al. concluded in his study that the PNF of respiration was more effective and can be a useful therapy in improving exercise capacity in patients with COPD.(4) Similarly, KyoChul Seo et al. conducted a study which concluded that PNF of respiration showed greater improvement in pulmonary function than diaphragmatic breathing.(10)

On contrary, in another study by KyoChul Seo revealed that the diaphragm respiration exercises showed a greater improvement in pulmonary function.(3)

Hyun-ju jun et al. presented a study which investigated the effects of an intervention program to enhance the pulmonary function and muscle activity of elderly smokers show that Feedback Breathing Exercise and Balloon Blowing Exercises improved the pulmonary functions of elderly smokers.(2)

Result of this study showed more significant improvement in Group A who received Chest PNF in chest expansion measurement at axillary level by 6%, at nipple level by 10.1% and at Xiphisternum level by 10.5% as compared to the subjects in Group B who received Breathing exercises at axillary level by 4.4%, at nipple level by 9% and at Xiphisternum level by 10.1%.

Chest PNF provides proprioceptive stimulus to the primary respiratory muscles, which increases chest wall mobility. As mentioned earlier, it also contracts diaphragm and abdominal muscles. The rigid chest wall muscles may be inhibited through autogenic inhibition and promotes mobility to the chest wall. PNF also increases stress relaxation to the chest wall muscles which promotes chest wall mobility.(14) A previous study done by Saha et al demonstrated a positive effect of chest PNF along with breathing exercises on chest expansion measurement in patients with Parkinsonism.(12)

In a study by Kim et al showed effects of breathing exercises on chest expansion in elderly with inspiratory muscle weaknesses.(9) As Muscle tension of the rib cage and mechanical properties caused by movement of the rib cage are important factors in air flow during inspiration and expiration.(14) The expansion and contraction of the lungs are mainly affected by the capacity of the thorax, which is determined by the mobility of the skeletal muscles, the elasticity of surrounding soft tissues, and the intensity of the respiratory muscles.(15)

Limitations of the study are small sample size and short treatment duration. For further future researches, studies can be done on larger sample size and for longer treatment duration and this comparative study can also be done including both males and females.

Table 1: Comparison of variables between the Group A & Group B

Baseline Comparison				
Variables	GROUP A (Mean ± SD)	GROUP B (Mean ± SD)	t-value	p-value
FVC	3.80 ± 0.76	3.06 ± 0.86	-1.732	0.09[NS]

Cont... *Table 1: Comparison of variables between the Group A & Group B*

FEV_1	2.40 ± 0.81	1.96 ± 0.73	-1.998	0.061 NS
FVC/FEV_1	65.56 ± 9.65	59.92 ± 15.78	-1.524	0.134 NS
Axillary level	4.32 ± 1.10	3.18 ± 1.07	-1.295	0.202 NS
Nipple level	3.76 ± 1.09	3.08 ± 1.30	-1.409	0.165 NS
Xiphisternal level	3.04 ± 1.02	2.16 ± 0.71	-1.930	0.060 NS
Comparison at 2nd week				
FVC	4.20 ± 0.86	3.36 ± 0.90	-3.348	0.002*
FEV1	2.84 ± 0.62	2.24 ± 0.87	-2.781	0.008*
FVC/FEV1	68.84 ± 9.81	60.40 ± 15.67	-2.261	0.029*
Axillary level	4.60 ± 1.04	3.32 ± 1.20	-2.265	0.028*
Nipple level	4.14 ± 1.02	3.36 ± 1.28	-2.070	0.044*
Xiphisternal level	3.36 ± 0.96	2.38 ± 0.80	-2.730	0.009*

NS: Non-Significant (p>0.05)

*Significant (p<0.05)

Table 2: Comparison of variables within Group-A

GROUP-A				
Variables	**Baseline (Mean ± SD)**	**2nd week (Mean ± SD)**	**t-value**	**p-value**
FVC	3.80 ± 0.76	4.20 ± 0.86	-3.098	0.005*
FEV1	2.40 ± 0.81	2.84 ± 0.62	-2.400	0.024*
FVC/FEV1	65.56 ± 9.65	68.84 ± 9.81	-4.311	0.000**
Axillary level	4.32 ± 1.10	4.60 ± 1.04	-2.281	0.032*
Nipple level	3.76 ± 1.09	4.14 ± 1.02	-3.055	0.005*
Xiphisternal level	3.04 ± 1.02	3.36 ± 0.95	-3.361	0.003*

*Significant (p<0.05)

**Highly Significant (p<0.000)

Table 3: Comparison of variables within Group-B

GROUP-B				
Variables	**Baseline (Mean ± SD)**	**2nd week (Mean ± SD)**	**t-value**	**p-value**
FVC	3.06 ± 0.86	3.36 ± 0.90	-1.976	0.05*
FEV1	1.96 ± 0.73	2.24 ± 0.87	-2.069	0.045*
FVC/FEV1	59.92 ± 15.78	60.40 ± 15.67	-1.999	0.048*
Axillary level	3.18 ± 1.07	3.32 ± 1.20	-2.041	0.047*
Nipple level	3.08 ± 1.30	3.36 ± 1.28	-2.445	0.030*
Xiphisternal level	2.16 ± 0.71	2.38 ± 0.80	-2.151	0.041*

*Significant ($p<0.05$)

Figure 1: Chest PNF in supine-position

Figure 2: Chest PNF in side-lying position

Figure 3: Chest PNF in prone-lying position

Figure 4: Pursed-lip breathing

Figure 5: Segmental breathing

Figure 6: Diaphragmatic breathing

Conclusion

In conclusion, both training programs i.e. Chest PNF and Breathing exercises yielded a clinically significant improvement on pulmonary function and chest expansion. These findings are clinically relevant thereby supporting the use of Chest PNF and Breathing exercises as adjunct to pulmonary rehabilitation protocol in the management of male smokers.

Conflict of Interest: NIL

Source of Funding: Self

References

1. Jha P, Ranson MK, Nguyen SN, Yach D. Estimates of Global and Regional Smoking Prevalence in 1995 , by Age and Sex. 2002;92(6):1995–9.
2. Hyun-Ju Jun, PT P, Ki-Jong Kim, PT P, Ki-Won Nam, PT P, Chang-Heon Kim, PT P. Effects of breathing exercises on lung capacity and muscle activities of elderly smokers. 2016;1681–5.
3. Seo K, Park SH, Park K. Effects of diaphragm respiration exercise on pulmonary function of male smokers in their twenties. J Phys Ther Sci [Internet]. 2015;27(7):2313–5. Available from: http://www.pubmedcentral.nih.gov/articlerender.fcgi?artid=4540870&tool=pmcentrez&rendertype=abstract

4. Paulraj M, Shristhudhi S, Supriya K, Vinod, Anandbabu K. Effectiveness of PNF of respiration to improve the exercise capacity in patients with COPD: A pilot study. Int J World Res. 2017;1(35):1–6.
5. T A, T P. Effects of Smoking on Chest Expansion , Lung Function , and Respiratory Muscle Strength of Youths. 2014;1–4.
6. Singh VP, Jani H, John V, Singh P, Joseley T. Effects of upper body resistance training on pulmonary functions in sedentary male smokers. 2011;28(3):169–73.
7. Mumtaz MS, Pansota QJ, Majeed MM, Mujeeb M, Rehman UA, Rana M. Original Article Impact of Shisha and Cigarette Smoking on Lung Functions in Young Adults the highest rates of tobacco smoking . 1 Prevalence. 2020;2(1).
8. Camilli AE, Burrows B, Knudson RJ, Lyle SK, Lebowitz MD. Longitudinal Changes in Forced Expiratory Volume in One Second in Adults Effects of Smoking and Smoking Cessation 12. 1986;i:2–7.
9. K C, Y J, C J. The effects of chest expansion resistance exercise on chest expansion and maximal respiratory pressure in elderly with inspiratory muscle weakness. 2015;0–3.
10. Seo K, Cho M. The Effects on the Pulmonary Function of Normal Adults Proprioceptive Neuromuscular Facilitation Respiration Pattern Exercise. J Phys Ther Sci [Internet]. 2014;26(10):1579–82. Available from: http://jlc.jst.go.jp/DN/JST.JSTAGE/jpts/26.1579?lang=en&from= CrossRef&type=abstract
11. Adler SS, Beckers D, Buck M. Vital Functions. PNF in practice. An ilustrated guide. 2008. 272-287 p.
12. Saha M, Verma M, Sharma N, Chatterjee S. Efficacy of chest PNF on pulmonary function in patients with Parkinson ' s diseases : A pilot study. 2020;4(2):79–85.
13. Physiotherapy A, Respiratory C. " EFFECTIVENESS OF PNF TECHNIQUES TO IMPROVE CHEST MOBILITY AND PULMONARY FUNCTION IN COPD " MASTER OF PHYSIOTHERAPY (Advanced Physiotherapy in Cardio Respiratory). 2016;(271430082).
14. Putt MT, Watson M, Seale H, Paratz JD, Mt AP, Watson M, et al. Muscle Stretching Technique Increases Vital Capacity and Range of Motion in Patients With Chronic Obstructive Pulmonary Disease. 2008;89(June):1103–7.
15. Thoracotomy OA. Review article. 1991;5(6):614–26.