How to Cite:
Siva Jyothi, N., Senthil Selvam, P., Ahmedullah, M., Yatheendra, K. G., Subramanian, S. S., & Paul, J. (2022). Effectiveness of PNF stretch of pectoralis major muscle on pulmonary function in COPD patients. *International Journal of Health Sciences*, *6*(S1), 13332–13341.
https://doi.org/10.53730/ijhs.v6nS1.8464

Effectiveness of PNF stretch of pectoralis major muscle on pulmonary function in COPD patients

Siva Jyothi N
Research Scholar, School of Physiotherapy, VELS University, Chennai. & Associate Professor, Department of cardio and pulmonary Physiotherapy, Durgabai Deshmukh College of Physiotherapy, DDMS (AMS), Hyderabad, Telangana, India.
Corresponding author: sivajyothimpt@gmail.com

Senthil Selvam P
Principal/ HOD School of Physiotherapy, VELS University, Chennai.

Md. Ahmedullah
Master of physiotherapy, Durgabai Deshmukh College of Physiotherapy, Hyderabad, Telangana.

Yatheendra Kumar G
Vice Principal, Susruta Institute of Physical Medicine and Rehabilitation, Hyderabad, Telangana, India

Subramanian S S
Principal, Sree Balaji College of Physiotherapy, Chennai- 600100, Tamilnadu, India.

Jibi Paul
Professor/ Research Supervisor, Dr. MGR Educational and Research Institute, Chennai, Tamilnadu, India.

***Abstract*---**COPD is a common and a progressive disorder that is characterised by respiratory symptoms and airflow limitation due to the abnormalities of the airway or alveoli. Proprioceptive neuromuscular facilitation technique can increase the contractive capacity of muscles. The study aimed at assessing the effect of Proprioceptive neuromuscular facilitation stretch of pectoralis major muscle on chest expansion and pulmonary function values in COPD patients. Methods: hold relax PNF of pectoralis major muscle was given for a duration of 6 weeks on the particpants who are met with inclusion and exclusion criteria. Chest expansion was measured at

Manuscript submitted: 27 March 2022, Manuscript revised: 9 April 2022, Accepted for publication: 18 May 2022

axillary level and xiphisternal level, FEV1, FVC and FEV1/FVC were measured pre and the post intervention. Results: statistical analysis was done using paired t test ($p<0.05$). the results of the study shows that there is increase in the chest expansion at axillary level and xiphisternal level and increase in the FEV1/FVC ratio following 6 weeks of hold relax PNF stretch of pectoralis major in COPD patients. Conclusion: the study concludes that with hold relax PNF stretch there is increase in chest expansion and pulmonary function values. The results also provide evidence that hold relax PNF of pectoralis major can be added in the pulmonary rehabilitation of COPD patients.

***Keywords*---**Neurophysiological Facilitation, Pectoralis Major, Hold Relax, Chest Expansion, Pulmonary Function.

Introduction

Chronic obstructive pulmonary disease (COPD) is a progressive condition gaining importance worldwide having high incidence. It is the third most leading cause of death [1]. As per the estimate by WHO, 65 million people are suffering from moderate to severe COPD atleast 90% of COPD related death occur in developing countries [2]. COPD ranks 11th in 2002 and is expected to be in 7th place by the year 2030 and it is leading cause for chronic morbidity [3]. Chronic obstructive pulmonary disease (COPD) is a progressive respiratory disorder having a persistent symptoms and limitation of airflow due to the obstruction of airway or abnormalities in the alveoli which are caused by the exposure to noxious stimuli [4].

In Chronic obstructive pulmonary disease the lung parenchyma gets damaged causing the changes in the structure and results in the collapse of the airways. The limitation to the expiratory airflow results into hyperinflation of lung due to the trapping of air in addition to the changes in the chestwall mechanics, reduction in the zone of opposition of diaphragm muscle fibers [5]. The hyperinflated lung reduces the movement of diaphragm (main inspiratory muscle) by depressing it [6].

The accessory muscles of respiration such as scalene, pectoralis major, sternocleiodomastoid, upper trapezius and serratus anterior will play a major role due to the dysfunction of diaphragm. These muscles elevates the shoulder girdle and motion of the rib cage causes the increase in the vertical diameter in the inspiratory phase. Due to the retraction of soft tissue and muscles of the chest wall causes the limitation of expansion of chest [7].

As the chest is in hyperinflated the pectoralis major muscle will be shortened. This increases the resistance to the expansion of chestwall there by increasing the work of breathing and more demand will be placed on the respiratory muscles inorder to overcome the resistance of the chest wall. The muscles such as pectoralis major and scalene apart from their role as accessory muscles they are also required for the neck and upperlimb movement [8].

Over a period of time as the COPD severity increases, the usage of upperlimb for the activities will become difficult. This disuse can lead to the tightness of the muscles around the quadrant further increasing the resistance to the chest wall motion. Musculoskeletal techniques such as passive stretching, self stretching contraction of the agonist against resistance, passive mobilization of joints and massage helps in increasing the flexibility of muscles are recommended in the management of chronic respiratory conditions [9].

The main diagnostic criteria for COPD is reduction in the ratio of forced expiratory volume in 1 sec (FEV1) and forced vital capacity (FVC) (6). The greater reduction in forced expiratory volume in 1 sec than forced vital capacity affects the ratio of FEV1/FVC. Pulmonary function test is an investigating tool used in the diagnosis of respiratory pathology by measuring the lung volumes and capacities. It shows decrease in the FEV1/FVC ratio. PFT also provides information about the patency of larger and smaller airways, the pulmonary parenchyma and the size and integrity of the pulmonary capillary bed [10].

Neurophysiological facilitation of respiration (proprioceptive neurophysiological facilitation) is also known as controlled breathing technique are the procedures that have been in used in the respiratory physiotherapy for more than 25 years. The application of external proprioceptive and tactile stimulation will produce a reflexive movement that helps in assisting the breathing [11].

In the proprioceptive neurophysiological facilitation various patterns of movements are used which which comprises of multijoint, multiplanar, diagonal pattern and rotational movements of extremities, trunk and neck. Various PNF stretching techniques based on Kabat's concept are: Hold Relax, Contract Relax, and Contract Relax Antagonist Contract etc. Hold Relax is a technique that is used to activate when the agonist is too weak. The restricted muscle should be kept in the stretched position which is followed by an isometric contraction of that restricted muscle. After the allotted time the restricted muscle should be moved in a maximum stretched position. This technique utilizes the autogenic inhibition, which relaxes a muscle after a sustained contraction has been applied to it [12].

Proprioceptive neuromuscular facilitation (PNF) is the most common exercise in the field of muscle rehabilitation, but rare in pulmonary rehabilitation [13,14]. This study aimed at assessing the effectiveness of PNF stretch of pectoralis major muscle on pulmonary function and chest expansion in COPD patients.

Materials and Methods

Thirty subjects who met with inclusion and exclusion criteria were selected using random sampling method and were explained about the procedure. Informed consent was obtained from all the subjects. Male subjects of age 50-60 who were diagnosed with COPD according to GOLD criteria, FEV1/FVC < 70%, individuals who are haemodynamically stable were included in the study. The subjects who have recent exacerbation of disease, condition restricting chest expansion (obesity, severe scoliosis, ankylosing spondylosis), ischemic heart disease, uncontrolled hypertension, and decrease in oxygen saturation to less than 85%, shoulder dysfunction, systemic disease such as rheumatoid arthritis, recent chest or abdominal surgery were excluded from the study. All the 30 subjects were given PNF stretching of pectoralis major muscle. PNF stretch was given in the form of hold relax technique for the pectoralis major muscle.

Hold relax PNF stretch of pectoralis major muscle

The subject was made to sit on a chair with a back support for the neutral positioning of the spine. The subjects was asked to move their arm in the agonist direction (glenohumeral extension, glenohumeral abduction and external rotation with elbow bent). Then the subject was asked to contract the pectoralis major muscle by moving the hand in the antagonistic direction (glenohumeral horizontal flexion in 80^0 to 90^0 of glenohumeral abduction and external glenohumeral rotation with elbow bend) and the therapist applies the pressure. The isometric contraction should be maintained for 6 seconds. The patient then relax and a passive stretch is applied in the opposite direction. Intervention was repeated 6 times on each arm with a rest period of 30 seconds. The treatment was given everyday for a period of 6 weeks. The outcome measures pulmonary function and chest expansion was calculated by using spirometry and inch tape respectively pre intervention and after 6 weeks of intervention.

Pulmonary Function Test

The test procedure was clearly explained and demonstrated to the subject. The subject sitting in a upright position was asked to inhale rapidly through the mouth piece and exhale completely with a maximum force until no more air can be expelled. Throughout the procedure the subject should maintain upright procedure. The test was repeated for three times and the best of three manoeuvres was taken as the final.

Chest expansion measurement

Chest expansion was measured with inch tape at two levels of thorax; axillary and xiphisternal level. For measuring at axillary level the inch tape was placed at 5^{th} thoracic spinous process level and for measuring at xiphisteral level the inch tape was placed at 10^{th} thoracic spinous process. The chest expansion should be measured at maximal Inhalation and the average of 3 trials should be documented.

Statistical analysis

The collected data was tabulated and analysed using descriptive and interferential statistics. Mean and standard deviation was calculated for all the parameters. The statistical analysis was done using paired t test. p-value less than 0.05 is considered as statistical significant.

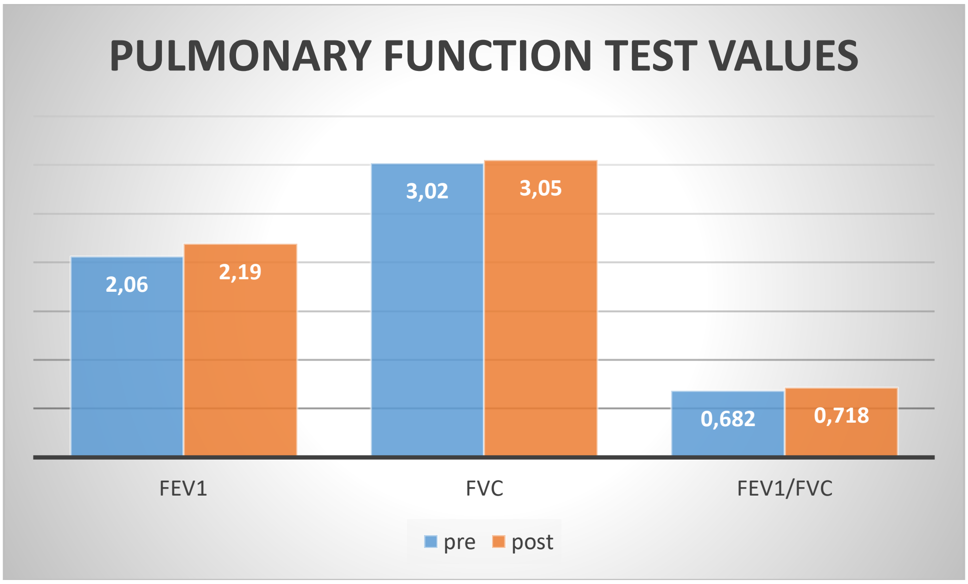
Results

Table1: Demographic data

Group	Sample no	Age		HEIGHT		WEIGHT	
		Mean	SD	Mean	SD	Mean	SD
	30	55.8000	2.46912	168.266	1.92861	71.2000	6.52528

Table 2: Comparison of pre and post-test values of pulmonary function test

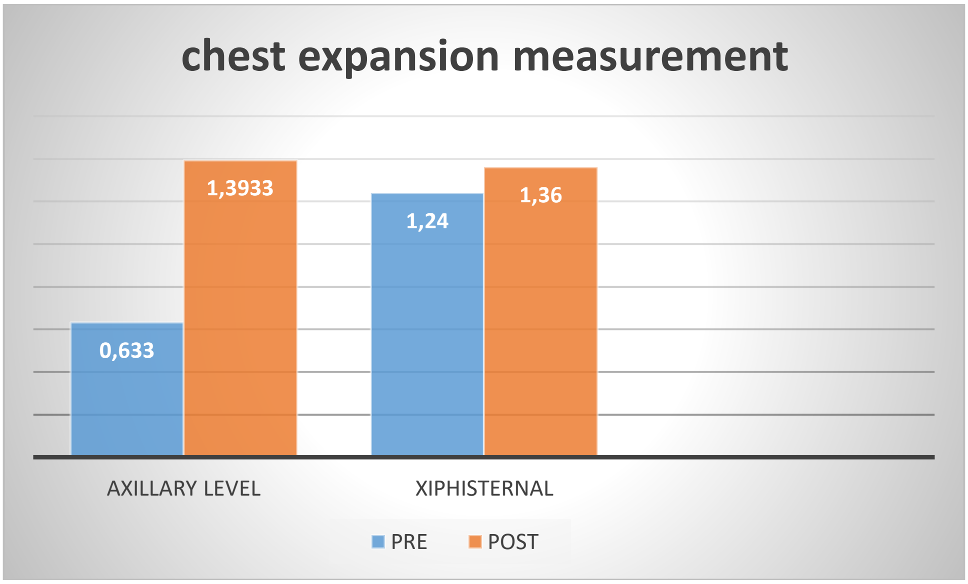
Parameter	Pre intervention	Post intervention	t value	P value
	Mean± SD	Mean± SD		
FEV1	2.06± 0.49	2.19± 0.50	-5.154	P <0.000**
FVC	3.02± 0.73	3.05± 0.74	-0.698	P =0.503 (NS)
FEV1/FVC	0.682± 0.01	0.718± 0.01	-4.796	P <0.000**



Graph 1: Showing the mean values of pulmonary function test pre and post intervention

Table 3: Comparison of pre and post values of chest expansion

Parameter	Pre intervention	Post intervention	t value	P value
	Mean± SD	Mean± SD		
Axillary level	.6333±.09223	1.3933±.08277	-30.734	.000
Xiphisternal level	1.2400±.08550	1.3600±.07240	-8.163	.000



Graph 2: Showing the chest expansion measurement at axillary and xiphisternal level pre and post intervention

The statistical analysis of the data shows that there is significant improvement in the pulmonary function and chest expansion post intervention at the level of significance $p < 0.05$. Table 1 shows the mean and standard deviation of demographic data such as age, height and weight. The results of the table 2 shows the mean and standard deviation of FEV1, FVC and FEV1/FVC. The mean ± SD of FEV1 pre intervention is 2.06± 0.49 and the post intervention is 2.19± 0.50. There is a significant improvement in the FEV1 value at the level of significance $p < 0.05$. The mean ± SD of FVC pre intervention is 3.02± 0.73 and the post intervention is 3.05± 0.74. There is no significant improvement in the FVC value post intervention at the level of significance $p=0.503$.

The mean ± SD of FEV1/FVC pre intervention is 0.682± 0.01 and the post intervention is 0.718± 0.01. There is significant improvement in the FEV1/FVC value post intervention at the level of significance $p<0.05$. Graph 1 shows the mean and standard deviation of FEV1, FVC and FEV1/FVC values pre and post intervention. Table 2 shows the measurement of chest expansion at axillary and at xiphisternal level. The results of the table shows the mean and standard deviation of chest expansion pre intervention at axillary level is .6333±.09223 and the post intervention 1.3933±.08277. There is a significant improvement in the chest expansion at axillary level at the level of significance $p<0.05$.

The results of the table shows the mean and standard deviation of chest expansion pre intervention at axillary level is 1.2400±.08550 and the post intervention 1.3600±.07240. There is a significant improvement in the chest expansion at xiphisternal level at the level of significance $p<0.05$.Graph 2 shows the mean and standard deviation of chest expansion measurement at axillary and xiphisternal level.

Discussion

The results of the present study shows that there is improvement in the pulmonary function values i.e FEV1/FVC and chest expansion measurement at axillary and xiphisternal level post intervention by PNF stretch of pectoralis major muscle in COPD patients. Michael T. Putt *et al* has proved that lengthening of the pectoralis major muscle by the hold relax technique helped in improving the restrictive component of COPD. The mean increase in VC from the day 1 to day 2 in the intervention group was 9.6%. In our study also there is improvement of the pulmonary function values which can be due the lengthening of pectoralis major muscle with the hold relax PNF technique [8].

According to the theory of Laplace's law the ventilation of lung is affected by the length of the muscle and the maximum force exerted by the diaphragm and intercostal muscles. The results of the some studies shows that stretching of certain muscles around the shoulder joint helps in increasing the vital capacity of lungs [15]. Few studies have reported the acute effects of stretching. A single session of stretching of a muscle increases the extensibility of the muscle fibers by affecting the contractile and visco elastic properties of soft tissues [16, 17]. Active chest mobilizations help to increase chest wall mobility, flexibility, and thoracic compliance [18].

Wang from his study on effect of proprioceptive neuro muscular facilitation on the gait of patients with hemiplegia concluded that the cumulative effects are more beneficial than immediate effects [19]. PNF with autogenic stretch improves the inspiration and expiration in next inspiration- expiration cycle by stretch reflex. This helps in increasing the inspiration and expiration by the active initiation or participation in respiration resulting in increased chest expansion [11].

In our study comparison of pre and post intervention means shows that there is statistically significant difference in the means of chest expansion at axillary and xiphisternal level and FEV1/FVC values post intervention. The results of our study are similar to the study conducted by Gopi parth Mehta on one week of hold relax PNF stretch of pectoralis major muscle with chest mobility exercise along with supervised active assisted exercises has shown a significant increase in the chest expansion at axillary level from 1.29± 0.15 to 1.45±0.17, xiphisternal level from 1.15± 0.18 to 1.25±0.18 and FEV1/FVC from 0.68± 0.00 to 0.69± 0.01 post intervention compared to the control group who received only active assisted exercises [12].

Stretching of a muscle with PNF technique improves the length and range of motion via the mechanism of autogenic inhibition. The golgi tendon organs that are present in the muscle will respond to the changes in muscle tension. When the muscle contracts Ib afferent nerve fibers are activated and the impulses will be carried to the spinalcord by those afferent fibers activate inhibitory interneurons. These interneurons will transmit the inhibitory signals to α motor neurons which causes the decrease in the nerve excitability and muscle tension [20]. When the muscle were stretched again there will be decrease in the overlap of actin and myosin filament with increase in the length of muscle fiber, improved muscle viscoelasticity, increased muscle contraction, decrease in the excitability of motor nerve and decreased energy consumption [21]. All these factors contribute to the transformation of information to the central nervous system. So stretching is beneficial to proprioception and for the motor control of nervous system [22].

Conclusion

The results of the study concludes that there is increase in the chest expansion and FEV1/FVC values after 6 weeks of hold relax PNF stretch of pectoralis major muscle in COPD patients. The results of the study also provides evidence that PNF stretching of pectoralis major can be used in the rehabilitation of COPD patients. The limitation of the study includes smaller sample size, other parameters such as PEFR, 6MWD and dyspnoea can be studied in different population. Further studies can be done by adding the diaphragmatic breathing component in addition to stretching of pectoralis major

Acknowledgements

I would like to specially acknowledge to all the patients for their cooperation in carrying out the study. I would like to thank my colleagues for their help and suggestions in conducting the study.

Conflict of interest: No

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References

1. Liu K, Yu X, Cui X, Su Y, Sun L, Yang J, Han W. Effects of Proprioceptive Neuromuscular Facilitation Stretching Combined with Aerobic Training on Pulmonary Function in COPD Patients: A Randomized Controlled Trial. International Journal of Chronic Obstructive Pulmonary Disease. 2021;16:969..
2. Alwan A. Global status report on noncommunicable diseases 2010. Global status report on noncommunicable diseases 2010.. 2011.
3. Mathers CD, Loncar D. Projections of global mortality and burden of disease from 2002 to 2030. PLoS medicine. 2006 Nov 28;3(11):e442.
4. Han MK, Dransfield MT, Martinez FJ. Chronic obstructive pulmonary disease: Definition, clinical manifestations, diagnosis, and staging. Uptodate. May. 2018;14.
5. de Sá RB, Pessoa MF, Cavalcanti AG, Campos SL, Amorim C, de Andrade AD. Immediate effects of respiratory muscle stretching on chest wall kinematics and electromyography in COPD patients. Respiratory physiology & neurobiology. 2017 Aug 1;242:1-7.
6. Rehman A, Ganai J, Aggarwal R, Alghadir AH, Iqbal ZA. Effect of Passive Stretching of Respiratory Muscles on Chest Expansion and 6-Minute Walk

Distance in COPD Patients. International Journal of Environmental Research and Public Health. 2020 Jan;17(18):6480.

7. Courtney R. The functions of breathing and its dysfunctions and their relationship to breathing therapy. International Journal of Osteopathic Medicine. 2009 Sep 1;12(3):78-85.
8. Putt MT, Watson M, Seale H, Paratz JD. Muscle stretching technique increases vital capacity and range of motion in patients with chronic obstructive pulmonary disease. Archives of physical medicine and rehabilitation. 2008 Jun 1;89(6):1103-7.
9. Potter HM. Musculoskeletal dysfunction in respiratory disease. In:Pryor JA, Prasad SA, editors. Physiotherapy for respiratory and cardiac problems. 3rd ed. London: Churchill Livingstone; 2002. P 161-70.
10. Cabral LF, D'Elia TC, Marins DS, Zin WA, Guimarães FS. Pursed lip breathing improves exercise tolerance in COPD: a randomized crossover study. Eur J Phys Rehabil Med. 2015 Feb;51(1):79-88.
11. EMCHRC P, Giri JU. Efficacy of Retraining Diaphragm by Proprioceptive Neuromuscular Facilitation versus Diaphragmatic Breathing Exercises in Reducing Dyspnoea in the Copd Patients.
12. Mehta GP, Babu VK, Akalwadi A, Kumar SN. Combined effect of PNF stretching with chest mobility exercises on chest expansion and pulmonary functions for elderly. International Journal of Physiotherapy. 2015 Jun 1;2(3):563-71.
13. Wanderley D, Lemos A, Moretti E, Barros MM, Valença MM, de Oliveira DA. Efficacy of proprioceptive neuromuscular facilitation compared to other stretching modalities in range of motion gain in young healthy adults: a systematic review. Physiotherapy theory and practice. 2019 Feb 1;35(2):109-29.
14. Slupska L, Halski T, Żytkiewicz M, Ptaszkowski K, Dymarek R, Taradaj J, Paprocka-Borowicz M. Proprioceptive neuromuscular facilitation for accessory respiratory muscles training in patients after ischemic stroke. InAdvances in Pulmonary Medicine: Research and Innovations 2019 (pp. 81-91). Springer, Cham.
15. Ong KC, editor. Chronic Obstructive Pulmonary Disease: Current Concepts and Practice.
16. Marek SM, Cramer JT, Fincher AL, Massey LL, Dangelmaier SM, Purkayastha S, Fitz KA, Culbertson JY. Acute effects of static and proprioceptive neuromuscular facilitation stretching on muscle strength and power output. Journal of athletic training. 2005 Apr;40(2):94.
17. Taylor DC, Dalton JR JD, Seaber AV, Garrett JR WE. Viscoelastic properties of muscle-tendon units: the biomechanical effects of stretching. The American journal of sports medicine. 1990 May;18(3):300-9.
18. Ganesh BR, Goud A. Short term effects of respiratory muscle stretch gymnastics versus hold relax PNF on pulmonary functions and chest expansion in elderly individuals-a randomized clinical trial. Int J Appl Res. 2017;3(7):1018-22.

19. Wang RY. Effect of proprioceptive neuromuscular facilitation on the gait of patients with hemiplegia of long and short duration. Physical Therapy. 1994 Dec 1;74(12):1108-15.
20. Sharman MJ, Cresswell AG, Riek S. Proprioceptive neuromuscular facilitation stretching. Sports medicine. 2006 Nov;36(11):929-39.
21. Hindle KB, Whitcomb TJ, Briggs WO, Hong J. Proprioceptive neuromuscular facilitation (PNF): Its mechanisms and effects on range of motion and muscular function. Journal of human kinetics. 2012 Mar;31:105.
22. Abdel-aziem AA, Draz AH, Mosaad DM, Abdelraouf OR. Effect of body position and type of stretching on hamstring flexibility. International Journal of Medical Research & Health Sciences. 2013;2(3):399-406.