Original Article

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# Effect of Short-term Respiratory Proprioceptive Neuromuscular Facilitation on Peak Expiratory Flow Rate and Six-minute Walk Test in Patients with Stable Chronic Obstructive Pulmonary Disease: A Quasi-experimental Study

Physiotherapy Section

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## ABSTRACT

**Introduction:** Proprioceptive Neuromuscular Facilitation (PNF) of respiratory muscles was found to improve lung function and haemodynamic parameters in mechanically ventilated patients. It has been proven that respiratory PNF had immediate significant effects in Chronic Obstructive Pulmonary Disease (COPD) patients. As pulmonary rehabilitation for COPD patients is a long-term hospital based service, there arises a need to provide a therapy that provides optimal benefit in short term.

**Aim:** To study the effect of short term respiratory PNF on Peak Expiratory Flow Rate (PEFR) and six-minute walk test in patients with stable COPD.

**Materials and Methods:** This quasi-experimental study was carried out in the Department of Physical Medicine and Rehabilitation, Rajah Muthiah Medical College and Hospital at Annamalai University, Chidambaram, Tamil Nadu, India. Twelve male COPD patients attending Medicine Department outpatient service between December 2020 to January 2021 were conveniently recruited. They were assessed for their PEFR using peak flow meter and exercise tolerance by six-minute walk test. They were treated with three respiratory PNF techniques namely, intercostal stretch, vertebral pressure high and anterior stretch by lifting posterior basal area for five consecutive days. Each treatment session lasted for about 30-40 minutes. The post intervention assessment of PEFR and six-minute walk was made. The pre and post intervention data were statistically analysed using paired samples t-test.

**Results:** In this study, the mean age of the participants was 63.0±5.80 years. The mean post intervention measurement of PEFR (226.67±51.09 L/min) and six-minute walk distance (271.92±50.55 m) was found to be significantly higher (p=0.001) than the mean pre interventional values (165.42±46.19; 219.58±43.24 respectively).

**Conclusion:** Implementation of respiratory PNF techniques on short term basis optimally improves the functional exercise capacity and PEFR in patients with stable COPD.

**Keywords:** Anterior stretch lift, Functional exercise capacity, Intercostal stretch, Vertebral pressure high

## INTRODUCTION

The burden of Chronic Obstructive Pulmonary Disease (COPD) is increasing and it accounts for the second most common cause of non communicable disease related deaths in India. The mean rise in disability adjusted life years (DALYs) for COPD was found to be 36% from year of 1990-2016 [1,2]. Chronic obstructive pulmonary disease is a preventable and treatable disease mainly characterised by limitation in airflow which is progressive and not fully reversible. The anatomical and inflammatory changes in the lungs affect the elastic support which traps the air during expiration. It results in dynamic hyperinflation of the lungs [3].

Pharmacological therapy for COPD reduces the symptoms and prevents complications. The Global Initiative for Chronic Obstructive Lung Disease (GOLD) report, 2018 recommends the appropriate non pharmacological therapies to complement the management strategies in stable COPD patients. The COPD is considered as being 'stable' when its symptoms are well managed and decline in lung function is minimal. The reduced functional capacity in COPD hints at the progression of the disease severity, frequent hospitalisation and mortality [4].

The pulmonary rehabilitation is a well known multidisciplinary non pharmacological intervention in COPD patients. It reduces dyspnea, hospital admissions and improves exercise tolerance and health related quality of life [4-6]. The common techniques used to improve breathing pattern in COPD were purse lip breathing, relaxed diaphragmatic breathing and thoracic mobility exercises [6,7]. Recent literatures suggest that Proprioceptive Neuromuscular Facilitation (PNF) of respiratory muscles have some role in gaining chest expansion and improving lung function in patients with COPD [3,8].

The PNF techniques improve respiratory muscle strength through three dimensional spiral large scale resistive exercises. The PNF pattern of exercises induces large scale spiral movements in the lower rib cage and promotes pulmonary function in young adults [9]. The Intercostal stretch technique of respiratory PNF has profound effects on improving oxygen saturation and reducing respiratory and heart rate in mechanically ventilated patients. The PNF provides a facilitatory stimulus that produces reflex respiratory movement as a response. This alters the rate and depth of respiration [10-12]. The proprioceptive and tactile stimulus applied during respiratory PNF induces the reflex respiratory movement. In addition, intercostal stretch restores the normal breathing pattern, improves chest wall mobility thereby improving the chest expansion [13,14].

The British Thoracic Society Standards of Care proposed that in pulmonary rehabilitation any intervention is said to be effective when it was implemented for 20-30 minutes, 2-5 sessions per week over a period of 4-12 weeks [9]. On considering the practical issues of visiting the healthcare setup and adherence to the therapy, a therapy with optimal benefit in short term basis should be identified. Mistry HM and Kamble RV assessed the immediate effect of PNF in COPD

by applying the intercostal stretch alone over the 2nd and 3rd rib only. It was found that the respiratory rate was reduced and the chest expansion, peak expiratory flow rate was improved [8].

The literature evidence on PNF stretching of respiratory muscles in patients with COPD was limited. Among the six facilitatory stimuli, most studies applied intercostal stretch technique and some involved the anterior stretch basal lift as well [3,8,10,11]. Other techniques of respiratory PNF's are underutilised and their effects still has to be studied. The present study involved three techniques of respiratory PNF namely the intercostal stretch, anterior basal lift and vertebral pressure high and was designed to find out the short term effects of respiratory PNF on PEFR and six-minute walk test in patients with stable COPD.

## MATERIALS AND METHODS

A quasi-experimental pilot study was carried out in the Department of Physical Medicine and Rehabilitation at Rajah Muthiah Medical College and Hospital, Annamalai University, Chidambaram, Tamil Nadu, India, from December 2020 to January 2021. The present study was a part of doctoral research work whose protocol had been approved by Institutional Human Ethics Committee (IHEC/596/2019), Rajah Muthiah Medical College and Hospital. The subjects and their attendees were clearly explained about the purpose and procedure of the study and the informed written consent was obtained.

Twelve stable COPD patients attending the Medicine outpatient Department on Mondays and Tuesdays at Rajah Muthiah Medical College and Hospital were recruited by convenient sampling method as per the selection criteria.

**Inclusion and Exclusion criteria:** Males, age between 45-70 years, normal BMI (18.5-24.9), COPD grade 1 and 2 (as per GOLD standards) [4], those who could ambulate independently were included while patients on dyspnoeic episodes, $SpO_2$ <85%, patients on supplemental $O_2$ therapy, associated lung and cardiac diseases, any orthopaedic limitations to walk like surgeries, fractures, disabling deformities, intake of oral steroids and psychiatric illness were excluded from the study.

The pre and post interventional evaluation of peak expiratory flow rate [15] and six-minute walk test [16] was made using standard protocols.

### Study Procedure

In this study, peak expiratory flow rate was measured by mini peak flow meter. The six-minute walk was performed by the participants (barefoot) on a levelled corridor of 30 m long. The corridor was calibrated at every 5 metres. The PNF techniques like intercostal stretch, vertebral pressure high and anterior stretch by lifting posterior basal area were applied over the bare chest of participants [13].

**Intercostal stretch:** A firm downward pressure was applied over the upper border of the ribs. The intercostal stretch was given bilaterally using the therapist fingers. The stretch force applied during the expiration was maintained as the patient continues to breath. The intercostal stretch was maintained for 10 breaths at 2nd, 3rd, 4th, 5th and 6th intercostal areas on both sides [Table/Fig-1].

**Vertebral pressure high:** Therapist stood at the head end of the couch. A firm manual pressure was applied by the therapist hands over the T2-T5 thoracic vertebrae while the patient was lying in supine position. The stretch was performed thrice and maintained for five breaths [Table/Fig-2].

**Anterior stretch by posterior basal lift:** Therapist hands were placed bilaterally around the lower ribs of patient. A gentle upward lift was given.The technique was performed thrice with the stretch maintained for five breaths [Table/Fig-3].

The intervention session lasted for about 30-40 minutes with appropriate rests. The post intervention evaluation was made an hour later the treatment session on 5th day. The outcome variables were peak expiratory flow rate (PEFR) in L/minute and six-minute walk distances in metres.

**[Table/Fig-1]:** Intercostal stretch.
**[Table/Fig-2]:** Vertebral pressure high. (Images from left to right)

**[Table/Fig-3]:** Anterior stretch by posterior basal lift.

## STATISTICAL ANALYSIS

The pre and post intervention assessment data were analysed using Statistical Package for the Social Sciences (SPSS) version 21. Descriptive statistics were used for age and pre and post values of outcome variables. The comparison of mean values was made using paired t- test at 5% level of significance.

## RESULTS

Almost 50% of the study samples (n=6) were in the age range of 61-70 years and 75% of the COPD patients (n=9) were of grade 2 severity [Table/Fig-4].

| Variables | Frequency n (%) |
|---|---|
| **Age group (in years)** | |
| 40-50 | 2 (16.6%) |
| 51-60 | 4 (33.4%) |
| 61-70 | 6 (50%) |
| **Grades of COPD** | |
| Grade 1 | 3 (25%) |
| Grade 2 | 9 (75%) |

**[Table/Fig-4]:** Frequency distribution of variables.

The mean pre intervention PEFR was 165.42±46.19 L per minute and six-minute walk distance was 219.58±43.24 metres. The mean post intervention PEFR and six-minute walk distance was found to be increased by 61.25 L/min and 52.34 metres respectively [Table/Fig-5].

| Variables | Assessment time | Mean±SD | Minimum | Maximum |
|---|---|---|---|---|
| Age (in years) | | 63.0± 5.80 | 48 | 69 |
| Six-minute walk distance (in metres) | Pre | 219.58 ±43.24 | 120 | 280 |
| | Post | 271.92±50.55 | 148 | 320 |
| Peak expiratory flow rate (in Litres/ minute) | Pre | 165.42±46.19 | 80 | 240 |
| | Post | 226.67±51.09 | 120 | 310 |

**[Table/Fig-5]:** Descriptive statistics of age and outcome measures.

It was observed that both the outcome variables differ significantly between their pre and post assessment values with the p-value of 0.001 [Table/Fig-6].

| Outcome variables | Pre-post mean difference | t-value | p-value |
|---|---|---|---|
| Six-minute walk distance (in metres) | 52.33 | 9.36 | 0.001* |
| Peak expiratory flow rate (L/minute) | 61.25 | 11.40 | 0.001* |

**[Table/Fig-6]:** Comparison of pre and post outcome means.
p<0.05 is significant*

## DISCUSSION

Any intervention advocated in pulmonary rehabilitation requires a minimal time frame of four weeks to establish its effect. It has been observed that respiratory PNF performed for four weeks increased exercise tolerance, chest expansion at nipple and xiphi sternal level and decreases the dyspnoea score in patients with stable COPD [3,8]. Kyochul seo and Misuk Cho performed respiratory PNF patterns in normal young adults and reported a significant improvement in pulmonary function parameters [9]. Though many studies [8-12] support the use of respiratory PNF in improving the pulmonary function parameters, a review by Gupta S and Mishra K concluded that PNF respiratory exercise is no superior than pursed lip breathing and diaphragmatic breathing in COPD patients [14].

The present study showed a significant improvement in post evaluation PEFR values whose performance was effort dependent. This coincides with the findings of Mistry HM and Kamble RV (2021) who studied the immediate effect of PNF in COPD patients. In addition, the mean difference in PEFR of the present study showed four fold increased from their study [8]. This might be due to the increased treatment sessions. It has been observed that the improvement in six-minute walk distance in the present study was obviously greater than the observations made by Dangi A et al., who implemented PNF for four weeks in stable COPD [3].

On comparing the observations of present study with the findings of Dangi A et al., Mistry HM and Kamble RV [3,8], the obtained difference in the outcomes were found to be greater, irrespective of the duration of intervention. The above studies delivered PNF technique of intercostal stretch alone to COPD patients whereas the present study involves vertebral pressure high and anterior stretch by lifting posterior basal area in addition to Intercostal stretch. Gupta P, et al established intercostal stretch as good in improving respiratory rate, $SpO_2$ and heart rate than anterior basal lift in Intensive Care Unit (ICU) patients [17]. In COPD no such comparison has been made.

Abstaining from work to participate in pulmonary rehabilitation on long-term basis and frequent hospital visits might be difficult for COPD patients. The findings of the present study signify the role of respiratory PNF techniques in COPD patients. It was also observed that combination of respiratory PNF techniques produced a better effect than treating with single technique alone. In the present study the PNF was applied to the whole chest by intercostal stretch. The upper chest was treated by vertebral pressure high and the lower chest by anterior stretch by lifting posterior basal area. This can be applied to the inpatients who got admitted during acute exacerbations of COPD after they get medically stable.

### Limitation(s)

The present study had only experimental group and involved male patients with COPD. The pressure applied on chest wall mainly depended on patient's tolerance and comfort. It has not been quantified objectively. Further studies on long-term effects and follow-up effects of respiratory PNF with control group should be carried out for better understanding. Sample size was small , so the findings of the study could not be generalised.

## CONCLUSION(S)

The administration of respiratory PNF techniques on short term basis was found to improve the PEFR and six-minute walk distance in patients with stable COPD. This might help in reducing the length of optimal period of pulmonary rehabilitation for patients.

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