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Original Research Article

Immediate effect of Chest Proprioceptive Neuromuscular Facilitation on Respiratory Rate, Chest Expansion and Peak Expiratory Flow Rate in patients with Chronic Obstructive Pulmonary Disease

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ABSTRACT

Background: In Chronic Obstructive Pulmonary Disease (COPD), as result of dynamic hyperinflation, primary respiratory muscles go into weakness and length tension relationship of muscles is altered. This leads to decreased ability of primary respiratory muscles to generate muscle tension. COPD patients mostly use accessory muscle for breathing and there is lack of facilitation of intercostal muscle and weakness of diaphragm. Few studies are conducted to assess the immediate effect of Chest Proprioceptive Neuromuscular Facilitation (PNF) i.e. intercostal stretch among COPD patients. Therefore, there is need to find out immediate effect of chest PNF- intercostal stretch on Respiratory Rate (RR), Chest Expansion, Peak Expiratory Flow Rate (PEFR) among patient with COPD.

Objective: To find out immediate effect chest PNF on respiratory rate, chest expansion and peak expiratory flow rate.

Methodology: Ethical clearance and participant consent was taken. Study design was Qausi experimental study. The 65 subjects were taken by convenient sampling. Intercostal stretch was applied over 2nd and 3rd rib bilaterally for 10 breaths with 1 minute rest with a 10 repetitions and Outcome measures were assessed before and immediately after giving chest PNF. SPSS 16 software was used to analyse the data. The normality of the data was assessed using parametric paired t test. Significance level was set at 0.05 and 95% Confidence Interval.

Outcome Measures: Respiratory rate, Chest expansion, Peak expiratory flow rate. Immediate effect of chest PNF showed that there was statistically significant increase in PEFR and chest expansion at three level (P=0.000) and there was statistically significant decrease in RR (P=0.000).

Conclusion: There is immediate effect of Chest PNF- intercostal stretch on, Respiratory rate, Chest expansion at three level that is axillary, nipple and xiphisternal and Peak expiratory flow rate. It is an easy to use, less time consuming, easy to understand and cost effective technique.

KEY WORDS: Chest PNF, intercostal stretch, COPD.

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INTRODUCTION

Chronic Obstructive Pulmonary Disease (COPD) is a common, preventable and treatable disease that is characterized by persistent respiratory symptoms and airflow limitation that is due to airway, alveolar abnormalities usually caused by significant exposure to noxious particles or gases [1]. In modern world respiratory diseases are progressively important cause of morbidity and mortality [2, 3]. Prevalence of COPD was documented to be around 4.1% according to a four city multi-center survey by Indian Council of Medical Research around 2004-05. Incidence rate increased in last few years and the main two reasons are massive population included active smokers as well as passive smokers, second reason is many urban residents have occupational exposure to pollution [4, 5].

The major manifestation of COPD is damage to the airways and destruction of the alveolar walls which leads to diminished elastic recoil property of lung tissue. Passive exhalation is dependent upon this elastic recoil property and in patient with COPD; exhalation becomes ineffective in removing an adequate amount of air from thorax, leading to air trapping and hyperinflation [6]. Dynamic lung hyperinflation, as a result of chronic expiratory airflow limitation leads to impaired efficiency of diaphragm and overuse of accessory inspiratory muscles [1]. Hyperinflation reduces the ability of chest wall to inflate the lung and it also reduce length-tension relation of respiratory muscles, which place respiratory inspiratory muscles in mechanical disadvantage and thus rib cage movement is also reduced [7].

Proprioceptive Neuromuscular Facilitation (PNF) is a form of stretching in which a muscle alternatingly stretches passively and then contracts. The technique targets nerve receptors of a muscle to extend through its length [9]. In normal individual type I and type II fibres are equally present in diaphragm while intercostal muscles contain a higher proportion of type II fibres (fast fibres-very low resistance to get fatigue). That is why intercostal muscle easily gets fatigue in COPD [8]. It is seen that due to respiratory muscle fatigue and weakness, the physical activities in COPD patients are reduced. This will have an impact on the oxidative capacity of the skeletal muscles and it will reduce the proportion of muscle fibers. Therefore, this could have an impact on chest wall mobility and chest expansion in COPD [9].

Few studies are conducted to assess the immediate effect of Chest PNF i.e. intercostal (IC) stretch among COPD patients.Therefore, there is need to find out immediate effect of chest PNF- intercostal stretch on respiratory rate (RR), chest expansion, peak expiratory flow rate (PEFR) among patient with COPD.

METHODOLOGY

Total 65 participants were taken by convenient sampling. It is quasi experimental study with each patient took approximately 40 minutes. Institutional ethic committee approval was taken. The informed written consent was obtained.

Inclusion criteria-

· Both males and females of age greater than or equal to 40

· Pulmonary function test (PFT) done in last 2 months

· Patients with mild, moderate airway obstruction based on GOLD criteria :GOLD 1–(Mild: $FEV_1/FVC < 0.70$, $FEV_1 > 80\%$ of predicted)GOLD 2 –(Moderate: $FEV_1/FVC < 0.70$, $50\% < FEV_1 < 80\%$ of predicted)

· No exacerbation of symptoms in the last 4 months.

Exclusion criteria:

· Patients with severe orthopaedic problems related to spine, fracture of rib, neurological deficits affecting the respiratory muscles, unstable cardiac condition recent myocardial infarction, etc.

· Patients with severe and very severe airway obstruction based on GOLD criteria: GOLD 3–(Severe: $FEV_1/FVC < 0.70$,$30\% < FEV_1 < 50\%$ of predicted) GOLD4 –(Very severe: FEV1<30% predicted)

· Cor pulmonale

· Acute exacerbation of COPD

· Previous lung-volume reduction surgery, lung transplantation or Pneumonectomy

· Subject participation in yoga, gym activities, and physical fitness training activities

· Active lung disease which are contraindicated for exercise testing,Skin related disorder of upper back and chest.

Study procedure: Outcome measure; respiratory rate, chest expansion and peak expiratory flow rate were assessed before and immediately after giving chest PNF with the 10 repetitions.

Resting respiratory rate: Patient was seated comfortably in a chair, and with the use of a stop watch, his resting respiratory rate was calculated. For correct measures, the procedure was repeated 2-3 times, and then the approximate value was taken.

Chest expansion: The patient was seated in a chair. Marking were done at 3 level viz. axillary, nipple and xiphisternal level. He was asked to first take some normal breaths. Asked to exhale completely and then inhale maximally and hold the breath for a second. The difference between maximum exhalation and inhalation was noted during holding breath using a measuring tape at all three level mentioned above. The procedure was repeated 3 times and then the best value was taken [10].

Peak expiratory flow rate: The patient was seated in a chair. The entire procedure was explained and demonstrated to the patient. The patient was asked to breathe as deep as possible and quickly blow into the mouthpiece. For correct measures, the procedure was repeated 3 times, and then the best value was taken. (Figure 1)

Intercostal stretch technique:

Patient was in supine position with limbs in neutral position. The position of the therapist was behind the patient. First palpate the suprasternal notch. Then go downward about 5 cm and palpate the angle of Louis. 2nd rib lies at the level of angle of Louis. From angle of Louis trace the finger laterally. The intercostal stretch technique was applied over 2nd and 3rd rib bilaterally with the help of index and middle finger. The direction of the pressure was downward towards next rib in the mid-axillary line. Application of stretch was timed with patients exhalation and stretch maintained as he/she continues to breathe. Intercostal stretch was applied for 10 breaths with 1 minute rest and for 10 repetitions. Total treatment time was approximately 35- 40 minutes [3, 15] (Figure 2)

Statistical analysis: All analyzes were performed with SPSS Version 16 software. The normality of the data was assessed using parametric test- paired t. The test for significance was set at 0.05 for 95% confidence interval. Descriptive analysis of Demographic data, co-morbid factors, addiction and severity was done. According to GOLD criteria, severity of diseases was classified as mild and moderate.

Fig. 1: Peak flow meter using EU (European Union scale) with disposable mouth pieces.

Fig, 2: Intercostal stretch at 2nd and 3rd ribs bilaterally.

RESULTS

There were 46 males (70.8%) and 19 females (29.2%), the mean age of sample was 61.62 years ± 7.851 years and median 61 years. Total number of participants was 65. Distribution of subjects and descriptive statistics is seen in table 1 and 2.

Table 1: Distribution of subjects as per age (Years).

Age groups	No of subject
40- 50	10
51-60	18
61-70	32
> 71	5

Table 2: Descriptive analysis of age (years) of subjects.

Mean	61.62
Median	61
SD	7.851
Minimum	45
Maximum	65

The severity of airway obstruction graded according to GOLD's classification.29.2% of patients had mild airways obstruction and 70.8% of patient had moderate obstruction. (Figure 3)

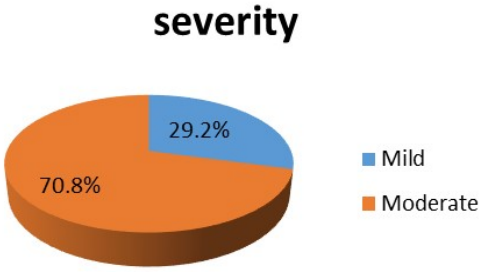

Fig. 3: The severity of airway obstruction graded according to GOLD's classification.

Immediate effect of chest PNF on RR showed that there was statistically significant decrease in RR after giving chest PNF (P=0.000) shown in table 3. Pre RR mean was 24.82bpm ±1.968 bpm and post it was 21.18 bpm ±1.828bpm. Immediate effect of chest PNF on PEFR and chest expansion shown in table 4 & 5, that there was statistically significant increase in PEFR and chest expansion at three level after giving chest PNF(P=0.000). Pre PEFR mean was 179.23± 37.679 and post it was 194.82 ±42.943, and Pre chest expansion mean at axillary level 3. 87±0.7081cm and post it was 4.90 ±0.8556cm, at Nipple level 3.87±0.7389cm and post it was 4.94 ±0.8355cm and at xiphisternum level 3.81±0.7390cm and post it was 4.90 ±0.8999cm

Table 3: Pre and post value of RR.

No		N	Mean (bpm)	SD	t	p
1	**Pre- RR**	65	24.82	1.968	21.824	0
2	**Post-RR**	65	21.18	1.828		

Table 4: Pre and post value of PEFR.

No		N	Mean	SD	t	p
1	**Pre-PEFR**	65	179.23	37.679	-9.48	0
2	**Post-PEFR**	65	194.82	42.943		

Table 5: Pre and post value of chest expansion.

No	Chest expansion	N	Mean (cm)	SD	t	p
1	Pre - axillary level	65	3.87	0.7081	-18.76	0
2	Post - axillary level	65	4.9	0.8556		
3	Pre- nipple level	65	3.87	0.7389	-19.507	0
4	Post- nipple level	65	4.94	0.8355		
5	Pre- xiphisternal level	65	3.81	0.739	-17.269	0
6	Post- xiphisternal level	65	4.9	0.8999		

DISCUSSION

This study has focused on comparing the effect of chest PNF- intercostal stretch on respiratory rate, chest expansion and peak expiratory flow parameters and has found that application of Intercostal stretch is more effective in reduction of RR, improve chest expansion and to increase peak expiratory flow rate. Similar results were seen in studies as follows. Findings of the study supported by Rajiv Sharma who compared the proprioceptive neuromuscular facilitation vs. resistance training of respiratory muscles on respiratory rate in 30 ICU patients. Result of the study shows that PNF was successful in reducing respiratory rate in ICU patients when compared with patients treated with abdominal weights placed on their upper abdomen [11]. The proprioceptive and tactile stimuli selected produce remarkably consistent reflexive responses in the ventilatory muscles. Inspiratory expansion of the ribs visibly increases epigastric excursion and often palpably increased tone in the abdominal muscles and helps in reducing respiratory rate, these responses are observed [12].

In another study, IC stretch was given as one of the sets of unsupported arm exercises. The IC may enhance the chest wall elevation and thus increase expansion to improve intrathoracic lung volume which contributes to improvement in flow rate percentage. This may contribute to the increase in ventilatory capacity such as tidal volume, minute ventilation and oxygen status [3]. N. B. Thakkar study statement also supports the results of our present study by suggesting that PNF technique in ICU based patient is showing improvement in patient's condition by decrease in respiratory rate, increase in SpO2 (Saturation of Oxygen), decrease in heart rate and helps in early weaning from mechanical ventilation [1].

The respiratory rate decreases after giving chest PNF because respiratory drive is regulated by information from sensory receptors within the airway, lungs and respiratory muscles as well as central and peripheral chemoreceptors. The respiratory muscles contraction and relaxation are under control of Golgi Tendon Organ (GTO) which is sensitive to muscle stretch (active or passive). Due to this there is a firing of muscle spindles, which gives this message to Central Nervous System via Alpha and Gamma motor neurons which are directly responsible for initiating muscle contraction [10, 14]. IC Stretch increases alpha motor neuron activity, causing the muscle fibers to contract and thus resist the stretch. Gamma motor neurons, which innervate intrafusal muscle fibers of muscle spindles, regulate the intensity of the stretch reflex. Application of a stretch to the chest wall just prior to inspiration, increases the gamma motor neuron discharge and enhances the activity of alpha motor neuron [10, 14].

Puckree et al. (2002) studied the effect of IC stretch on third and the eighth IC space in which they proved there was decrease in breathing frequency when a stretch performed on third and eighth IC spaces. This study did not have statistically significant values between the groups on respiratory rate. However, the rate of respiration was less only in the experimental group, which showed there was impact on respiratory rate when an IC stretch was performed and localized stretch in the third and eighth IC space showed a deeper breathing pattern, greater activities on parasternal IC stretch, electromyographic activities which resulted in an increase in tidal volume and a decrease in breathing frequency among healthy subjects [15].

Dharmesh Parmar, Anjali Bhise conducted a study on the immediate effect of chest mobilization technique on chest expansion in patients of COPD with Restrictive impairment. They conducted an experimental study on 30 COPD patients having vital capacity <80%, to assess the pre and post differences in modified chest expansion by applying chest mobilization technique- rib rotation, chest wall rotation, lateral flexion of chest wall, chest wall extension and pectoralis major muscle stretching. The study concluded that the chest wall mobilization has significant effect on chest expansion in COPD patients who are having restrictive impairment of chest wall in later stage of disease [16].

In COPD, Chest expansion is reduced due to decrease in the chest wall mobility and reduced lung compliance. Intercostal stretch may enhance the chest wall elevation and thus increase expansion to improve intra-thoracic lung volume which contributes to improvement in flow rate percentage. This may contribute to the increase in ventilatory capacity such as tidal volume, minute ventilation and oxygen status, thus improving the chest expansion, hyperinflation and air trapping, in turn reducing dyspnea. The changes in ventilatory parameters may be due to the firing of the muscle spindles during a passive stretch phase. Intercostal stretch may have activated the stretch receptors in the chest wall, thereby distending the thorax which could be neurologically linked to medulla with efferent nerve cells [3, 10].

Shibuya A found that Respiratory Muscle Stretch Gymnastics immediately reduces dyspnea at rest, and improves spirometric variables in patients with severe COPD. In this study, forced vital capacity and peak expiratory flow rate were significantly increased. Patients with COPD have lower chest wall compliance than normal subjects; vital capacity is reduced largely because of the diminished distensibility of the chest wall in patients with COPD. Chest wall compliance was not measured in these studies, it seems reasonable to assume that the patient with COPD in the present study had stiff chest walls, including the respiratory muscles [17].

Hagbarth et al. reported that muscle stretching causes a decrease in finger flexor stiffness [18]. Therefore, it is possible that respiratory muscle stretching similarly affected chest wall compliance and decreased chest wall stiffness. The chest PNF- intercostal stretch also gives the same result. The increase PEFR might also be explained by this mechanism. Mohan V, Badlisyah K studied effect of intercostal stretch on pulmonary function parameters among healthy males results of the study showed, FEV1/ FVC % and FEV1in the experimental group significantly improved with $p=0.017$ ($p<0.05$), which means IC stretch increased lung volume and lead to improved lung function [3]. Threlkeld (1992) reported that applying manual techniques such as IC stretch may produce a suitable amount of plastic deformation of connective tissue to enhance mobility at joints [19]. Therefore, the results of this study provide preliminary evidence where by IC stretch was an effective treatment to improve chest expansion, peak expiratory flow rate and to lower respiratory rate.

CONCLUSION

The present study provides the evidence that there is immediate effect on chest proprioceptive neuromuscular facilitation (PNF) – intercostal stretch on, respiratory rate, chest expansion at three level that is axillary, nipple and xiphisternal and peak expiratory flow rate. This study provides baseline information for the immediate change in RR, chest expansion and PEFR after intercostal stretch which could be useful in directing future studies on different patient populations.

ABBREVIATIONS

Chest PNF: Chest Proprioceptive Neuromuscular Facilitation
IC: Intercostal stretch
BMI: Body Mass Index
PEFR: Peak Expiratory Flow Rate
RR: Respiratory Rate
COPD: Chronic Obstructive Pulmonary disease
MET: Muscle Energy Technique
BPM: Breaths Per Minute
SD: Standard Deviation

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Conflicts of interest: None

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