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EFFECT OF DIAPHRAGM MANUAL RELEASE VERSUS CHEST PROPRIOCEPTIVE NEUROMUSCULAR FACILITATION ON PULMONARY AND PHYSICAL FUNCTION IN MALE SMOKERS – AN INTERVENTIONAL STUDY

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ABSTRACT

Background: Cigarette smoking is single most preventable cause of death and disability across globe which impairs pulmonary function and reduce physical performance. Manual therapy techniques such as Diaphragm Manual Release (DMR) and Chest Proprioceptive Neuromuscular Facilitation (PNF) have shown promise in enhancing respiratory mechanics.

Methods: A randomized controlled trial was conducted involving 60 male smokers aged more than 18 years, in which Group A received DMR, while Group B underwent Chest PNF techniques for period of 4 weeks. Primary outcomes : Pulmonary function was assessed using spirometry (FVC, FEV_1, FEV1/FVC ratio), and physical function was evaluated via the Queen college step test which calculated VO2max. Secondary **Outcome:** Quality of life was assessed using Respiratory Symptom Experience Scale (RSES).

Results: Both groups demonstrated statistically significant improvements in FVC, FEV_1, FEV1/FVC ratio,VO2max post-intervention ($p<0.05$).In between Group analysis,Group A showed superior effect in improving VO2max compared to Group B($p>0.05$).

Conclusion: Hence, it concludes that diaphragm manual release and chest PNF are equally effective in improving pulmonary function and also improves quality of life, but diaphragm manual release is more effective in improving physical function when compared to chest PNF.

Keywords: Male smokers, Diaphragm manual release, Chest PNF, pulmonary, physical function.

INTRODUCTION

Cigarette smokers: They are persons who are engaged in the inhalation and exhalation of fumes of burning tobacco in cigarettes.[(1)]According to the Global Adult Tobacco Survey (GATS) India, there are 24.3% of male and 14% of smokers were females, which includes 10.3% of cigarette smokers, 16.0% of bidi smokers and 1.9% smoked tobacco in some other form[(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.[(3,4)] This may lead to wheezing, frequent coughing with or without sputum, increased breathlessness, reduced endurance and strength of respiratory muscles and tightness in the chest.[(3)]With increasing smoking load, the production of diaphragm muscle

maintenance-related proteins decreases, leading to a reduction in muscle mass and alteration in length-tension relationship.[5]However, as a consequence, diaphragmatic mobility is reduced which increases the risk factor to cause COPD.[4,5] When individuals smoke cigarettes, various components, including aldehydes, reactive oxygen species (ROS) and reactive nitrogen species (RNS), which are both volatile and soluble, allowing them to enter the bloodstream and reach the skeletal muscles of smokers.[6,7] Once in the skeletal muscle, cigarette-smoking (CS) components increase oxidative stress either directly or by activating nicotinamide adenine dinucleotide phosphate (NADPH) oxidase (NOX), resulting in the production of ROS and increased oxidative stress.[6,7,8] Smoking induced oxidative stress leads to increased skeletal muscle protein degradation, thus accelerating the progression of sarcopenia in smokers.[6,7,8]

AIMS:

To compare the effects of Diaphragm manual release versus Chest PNF on pulmonary and physical function in male smokers.

LITERATURE REVIEW

1.**Apoorva Bhatnagar etal (2022)**, conducted a study on "Effectiveness of Chest PNF and Breathing exercises on pulmonary function and chest expansion in male smokers", performed on 50 subjects with average age of 18-30 years and concluded significant improvement in Chest PNF group after 2 weeks.[9]

2.**Gopala Krishna Alaparthi etal (2019)**, conducted a study on "Comparison of Diaphragmatic stretch technique and Manual diaphragm release technique on diaphragmatic excursion in COPD", performed on 20 subjects with mild and moderate COPD and concluded significant improvement in diaphragmatic excursion in both groups.[10]

MATERIALS & METHODS

Ethical approval was obtained from the institutional ethics committee prior to the study. The study design was experimental design in which 78 subjects were screened from which 60 subjects were included according to inclusion and exclusion criteria, who agreed to participate and signed written informed consent form. Inclusion criteria were: Current male smokers, age ≥18 years[11], Smoking duration between 1-10 years[12], BMI ≤ 30kg/m^2. Exclusion criteria were subjects having any cardiorespiratory impairment, have recently undergone abdominal surgery, have any neuromuscular diseases, psychological issues, obstructive diseases, peripheral arterial disease, hiatus hernia, Gastroesophageal reflux disease , have recent history of chest wall trauma , alchol addiction. The sample size was calculated with the formula given below:

- **n: $(\sigma / \Delta)^2 (z_a + z_{1-\beta})^2$**

  n =Number of Subjects in each group

  σ = Pooled Standard deviation of outcome measure from previous study

  Δ = Critical difference

  Z_α = critical value of normal distribution at α

  (eg: for a confidence level of significance = 95%, α is 0.05 and the critical value is 1.96)

Subjects were randomly divided into two groups using odd and even method. Group A (n=30) was given the Diaphragm manual release and Group B (n=30) was given chest PNF for 3 days per week for 4 weeks. Two subjects from Group A and Three subjects from Group B discontinued the sessions due to timing issues and health illness. The purpose and whole methodology of the study were thoroughly explained to subjects. On the first day, a complete assessment was done which included age, height , weight, vitals, FEV_1, FVC,FEV_1/FVC ratio ,VO_{2max}, Respiratory symptom experience scale (RSES).Outcome measures FEV_1, FVC,FEV_1/FVC ratio ,VO_{2max}, Respiratory symptom experience scale (RSES) was taken again post intervention.(after 4 weeks).

Intervention:

Group A : Diaphragm manual release

- **Patient Position:** Supine with arms by their side relaxed.
- **Therapist Position:** By head side of the subject.
- **Therapist Hand Placement:** The therapist made manual contact with pisiform, hypothenar region and the last three fingers bilaterally to the underside of 7th to 10th rib costal cartilages with therapist forearm aligned towards shoulders.
- **Procedure:** During inspiration, the therapist gently pulls point of contact with both hands in direction of head and slightly laterally accompanying elevation of ribs while subject performs deep breathing. During expiration, the therapist deepens contact towards inner costal margin maintaining resistance.
- **Progression:** During subsequent respiratory cycles, the therapist progressively increased depth of contact towards inner costal margin.
- **Dosage:** The manoeuvre was performed in 5 sets of 10 deep breaths with 1 minute interval in

between each set. Total treatment duration is for 4 weeks.[13,14,15]

Group B: Chest PNF

1.Supine lying: Therapist hand placement: Therapist's both the hands placed over the sternum and applying oblique downward stretch on sternum. The stretch position is then maintained while subject continues to breathe in his usual manner. The therapist will observe stretched area results in increased movements

2.Side lying: Therapist hand placement: Therapist both hands are placed over the lateral intercostal area to apply caudal medial pressure in side-lying position. The stretch position is then maintained while subject continues to breathe in his usual manner. The therapist will observe stretched area results in increased movements.

3.**Prone lying**: **Therapist hand placement**: Therapist both hands are placed over the posterior basal intercostal area to apply caudal pressure in prone. The stretch position is then maintained while subject continues to breathe in his usual manner. The therapist will observe stretched area results in increased movement.

Dosage: Total treatment duration is 15 minutes/session for 3 days per week for 4 weeks.[16,17]

Primary Outcome measures:

1. Pulmonary function test: Procedures were explained to the participants and PFT were carried out sitting on chair by assuming ideal posture. Then nose clip was attached and participants were asked to inhale completely and rapidly with a pause of one sec at Total lung capacity. Mouthpiece was placed in mouth and subjects were asked to tightly close lips around mouth. They were asked later to exhale maximally until no air can be expelled while maintaining posture. Average of 3 times was repeated but not more than 8 times. [18,19]

2. Queen college step test: Ask subject to step up and down on the platform at a rate of 24 steps per minute for males. The subjects has to step using a four-step cadence, 'up-up-down-down' for 3 minutes. The subject stops immediately on completion of the test, and the heart beat was counted for 1 min.[20,21]

Secondary Outcome measures:

Quality of life was assessed with help of Respiratory symptom experience scale (RSES) which consists of 5 items : morning cough, cough frequently, shortness of breath, easily winded, wheezing.[22]

STATISTICAL ANALYSIS:

Statistical analysis was done using SPSS version 20. Prior to the application of statistical tests, data was tested for the normal distribution by Shapiro wilk test .Baseline characteristics were similar for both the groups. p values was >0.05 hence it shows that normal distribution is found for variables Age, BMI, FVC, FEV_1 , FEV_1/FVC and VO_{2max} of both the groups. p value of all items of RSES of both groups were <0.05, hence it is not normally distributed. Level of significance was kept at 5% and confidence interval at 95%. Within group analysis of FVC, FEV_1 , FEV_1/FVC and VO_{2max} was done using Paired 't' test and between group analysis was done using Unpaired 't' test. Within group analysis for RSES was done using Wilcoxon signed rank test and between group analysis was done using Mann-Whitney U test.

RESULTS:

Within group analysis showed significant difference in FVC, FEV_1 , FEV_1/FVC, VO_{2max} and RSES ($p<0.05$). So null hypothesis was rejected. In between group analysis, FVC, FEV_1 , FEV_1/FVC and RSES showed no significant difference between the groups ($p>0.05$). So null hypothesis was accepted, but for VO_{2max} Group A showed significant improvement compared to Group B ($p<0.05$) . So, null hypothesis was rejected. Based on effect size calculation between groups showed large effect size for FEV_1, medium effect size for FVC and small effect size for FEV_1/FVC, VO_{2max} and RSES.

DISCUSSION:

The results of the current study showed that diaphragm manual release and chest PNF showed significant improvement in terms of FVC, FEV_1, FEV_1/FVC ratio, VO_{2max} and also decrease in symptoms measured with help of respiratory symptom experience scale (RSES) providing insights into their therapeutic potentials for individuals with smoking related dysfunction. However none of them proved to be superior to each other in terms of improving pulmonary function, but diaphragm manual release shown to be superior in improving physical function compared to chest PNF. In the present study, all subjects taken were male smokers. In National Journal of Community Medicine, July 2020, a study done by **Rinkal Viradiya etal** on "Tobacco consumption patterns of selected districts of Gujarat" concluded that prevalence of smoking was more in males (38.10%) than in females (14.29%).[23] **Anand mistry etal**

(2014) conducted "Comparison study of pulmonary function tests in smokers and non smokers" which brings out substantial variations in most of the parameters of PFT between smokers and non smokers confirming FEV1,FVC,FEV1/FVC ratio, PEFR,MVV values are less in smokers due to toxic effects of tobacco smoking on respiratory system and is major cause of obstructive lung disease in Indian population.[24] The Manual Diaphragm Release Technique was found to have statistically significant within group difference, after which it may be hypothesised that the technique provided an improvement in the flexibility of the respiratory muscles and the thoracic cavity as well as improvement in the length tension relationship, which allowed a beneficial effect on the performance of respiratory mechanics.[25,26,27] These results align with previous studies: For instance, **Campos et al. (2015)** conducted study on "The Manual Diaphragm Release Technique improves diaphragmatic mobility, inspiratory capacity and exercise capacity in people with chronic obstructive pulmonary disease who concluded that manual diaphragm release technique improved diaphragmatic mobility and inspiratory capacity which was estimated by ultrasonography and optoelectronic plethysmography respectively in individuals with COPD.[15] **Lajwanthi Andhe et al** (2024) conducted a narrative review on "Effect of Proprioceptive Neuromuscular Facilitation (PNF) Techniques in COPD patients" who concluded that PNF serves as a valuable adjunct or alternative to traditional therapies, effectively improving respiratory function and overall quality of life (QOL) for patients. She concluded that PNF exercises play a significant role for improving pulmonary function, with their therapeutic benefits based on the stretch reflex theory.[29]Most of the subjects in this study belonged to cardiorespiratory fitness group were fair or average which could be due to detrimental effects of smoking on VO_{2max}, the carbon monoxide in cigarette smoke binds to hemoglobin in red blood cells, displacing oxygen. This reduces the amount of oxygen available to muscles and other tissues, lowering aerobic capacity and VO2 max.

Similar observation was found by **Chatterje** et al, which indicated that majority of male smokers had VO_{2max} as average that is 38.9 ml/kg/min which was significantly lower than of non-smokers that is 42 ml/kg/min . It also found negative correlation with number of cigarettes smoked per day, no. of years through which smoked and pack years.[30,31]

CONCLUSION:

The present study was conducted on 60 male smokers for 4 weeks of duration to compare the effectiveness of diaphragm manual release and chest PNF on pulmonary and physical function along with quality of life in male smokers. Results shows significant effect on FVC, FEV_1, FEV_1/FVC ratio,VO_{2max} and reduction in symptoms. Hence, it concludes that diaphragm manual release and chest PNF are equally effective in improving pulmonary function which includes FEV_1 , FVC , FEV_1/FVC ratio and also alleviating symptoms like morning cough, fatigue, shortness of breath etc which improves quality of life, but diaphragm manual release is more effective in improving physical function when compared to chest PNF.

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Declaration by Authors

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FIGURES:

FIG 1. Pulmonary Function Testing

FIG 2.Queen college step test

FIG 3. Diaphragm manual release

FIG 4.1 Chest PNF Supine-Lying

FIG 4.2.Chest PNF in Side lying

FIG 4.2.Chest PNF in Prone-lying

TABLES: WITHIN GROUP ANALYSIS:

FVC	Pre intervention MEAN±SD	Post intervention MEAN±SD	p value
Group A	2.77 ± 0.20	3.03 ±0.22	0.00
Group B	2.79 ± 0.16	2.93±0.14	0.00

FEV_1	Pre intervention MEAN±SD	Post intervention MEAN±SD	p value
Group A	2.44 ± 0.16	2.93 ± 0.14	0.00
Group B	2.48 ± 0.16	2.66 ± 0.12	0.00

FEV_1/FVC ratio	Pre intervention MEAN±SD	Post intervention MEAN±SD	p value
Group A	88.37 ± 4.59	90.15 ± 4.26	0.03
Group B	88.69 ± 5.26	90.60 ± 3.56	0.02

VO_{2MAX}	Pre intervention MEAN±SD	Post intervention MEAN±SD	p value
Group A	38.69 ± 5.97	39.64 ± 6.29	0.01
Group B	37.29 ± 4.22	38.46 ± 4.22	0.01

ITEM: 1	Pre intervention MEAN±SD	Post intervention MEAN±SD	(2 tailed) p value
Group A	1.21 ± 0.83	0.71 ± 0.71	0.001
Group B	1.37 ± 0.629	0.74 ± 0.52	0.001

ITEM:2	Pre intervention MEAN±SD	Post intervention MEAN±SD	(2 tailed) p value
Group A	1.46 ± 0.744	0.88 ± 0.66	0.001
Group B	1.48 ± 0.70	0.96 ± 0.70	0.001

ITEM: 3	Pre intervention MEAN±SD	Post intervention MEAN±SD	(2 tailed) p value
Group A	1.46 ± 0.744	0.88 ± 0.66	0.001
Group B	1.48 ± 0.70	0.96 ± 0.70	0.001

ITEM:4	Pre intervention MEAN±SD	Post intervention MEAN±SD	(2 tailed) p value
Group A	1.03 ± 0.83	0.67 ± 0.77	0.002
Group B	1.15 ± 0.77	0.66 ± 0.62	0.001

ITEM:5	Pre intervention MEAN±SD	Post intervention MEAN±SD	(2 tailed) p value

Group A	0.60 ± 0.628	0.17 ± 0.39	0.001
Group B	0.37 ± 0.56	0.22 ± 0.42	0.04

BETWEEN GROUP ANALYSIS:

FVC	**Post intervention MEAN±SD**	**p value**
Group A	3.03 ± 0.22	0.07
Group B	2.93 ± 0.14	

FEV_1	**Post intervention MEAN±SD**	**p value**
Group A	2.93 ± 0.14	0.28
Group B	2.66 ± 0.12	

FEV_1/FVC ratio	**Post intervention MEAN±SD**	**p value**
Group A	90.15 ± 4.26	0.65
Group B	90.60 ± 3.56	

VO_{2MAX}	**Post intervention MEAN±SD**	**p value**
Group A	39.64 ± 6.29	0.04
Group B	38.46 ± 4.22	

RSES SCALE:	**GROUP**	**POST INTERVENTION**	**p value**
ITEM:1 MORNING COUGH	Group A	0.71 ± 0.71	0.70
	Group B	0.74 ± 0.5	
ITEM:2 COUGH FREQUENTLY	Group A	0.88 ± 0.66	0.45
	Group B	0.96 ± 0.70	
ITEM:3 SHORTNESS OF BREATH	Group A	0.88 ± 0.66	0.45
	Group B	0.96 ± 0.70	
ITEM:4 EASILY WINDED	Group A	0.67 ± 0.77	0.83
	Group B	0.66 ± 0.62	
ITEM : 5 WHEEZE	Group A	0.17 ± 0.39	0.68
	Group B	0.22 ± 0.42	