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Research Article

IMMEDIATE EFFECT OF MANUAL DIAPHRAGM RELEASE TECHNIQUE ON PULMONARY FUNCTIONS IN PATIENTS WITH CHRONIC OBSTRUCTIVE PULMONARY DISEASE (COPD)

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A R T I C L E I N F O

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Chronic obstructive pulmonary disease, Manual therapy, pulmonary functions, diaphragm.

A B S T R A C T

Aim: To study the immediate effects of manual diaphragm release technique on pulmonary functions in patients with Chronic obstructive pulmonary disease (COPD).
Objectives: To evaluate the immediate effects of manual diaphragm release technique on pulmonary functions in COPD and to know the duration/extent of effect of manual diaphragm release on pulmonary functions in COPD post 24hours, 48hours and 72hours.
Background: COPD refers to a disease state characterized by the presence of incompletely reversible airflow obstruction. Several manual therapy techniques have been administered in patients with different stages COPD which confirmed to have a noteworthy change in pulmonary functions, thoracic kinetics, exercise capacity. More evidence needs to be gathered before manual therapy to be implemented as a treatment protocol for patients with COPD, one such technique is Manual Diaphragm Release technique.
Results and Conclusion: Data was collected and analyzed. Parametric tests were used according to normality tests. The pulmonary functions significantly improved after the manual diaphragm release technique having a p value of less than 0.05 but there is only an immediate effect of the technique seen. The study concludes that there is an immediate effect of Manual diaphragm release technique on pulmonary functions in patients with moderate Chronic obstructive pulmonary disease.

INTRODUCTION

Chronic obstructive pulmonary disease (COPD) is currently defined as a common preventable and treatable disease but decreases the quality of life, in which exacerbations and co morbidities contribute to the overall severity in the individual[(1)] and is considered as a systemic disease disturbing the lungs and peripheral muscular system which leads to decreased oxygen delivery. It is one of the leading causes of mortality and morbidity as the disease prevalence rate is underestimated due to the delay in diagnosis of the disease .[(1)]

In India, COPD is the second most common lung disorder after pulmonary tuberculosis[(2)] and is seen in mostly males over the age of 40 years who have been chronic and heavy smokers. It may occasionally be seen in non-smoker who have been exposed to prolonged atmospheric pollution. [(3)] Another most risk factor is alpha antitrypsin deficiency, certain occupational exposures also cause chronic obstructive pulmonary disease.[(4)] However, only 10 – 20% of smokers develop clinically significant Chronic Obstructive Pulmonary Disease (COPD) while approximately half never develop a clinically significant physiological deficit.[(5)]

All patients with chronically significant emphysema are smokers. Heavy smokers are greater risk of developing COPD than moderate smokers.[(5)]The rate of expiratory airflow in cigarette smokers, decreases twice as fast in smokers (40 ml a year) as in non-smokers. (20 ml a year).[(5)] Most population studies have reported a higher prevalence of respiratory symptoms in men than in women.[(6)]But the prevalence gap between male and female is narrowing due to increased rate of cigarette smoking in the last 20 – 30 years. Females are more susceptible to the effect of smoking than males since female have lower FEV1 than male. [(3)]

COPD causes chronic inflammation of the airways, which results in structural changes, dynamic collapse in the small airways and destruction of lung tissues leading to impaired lung function. Most prominent feature being inability to perform complete exhalation, causing air trapping which leads to lung hyperinflation i.e. Expiratory airflow limitation. [(7)]Airflow during forced exhalation is the result of the balance between the elastic recoil of the lungs promoting flow and the resistance of the airways that limits flow. Maximal expiratory flow reduces as the lungs vacant because the lung parenchyma delivers progressively less elastic recoil and the cross-sectional

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area of the airways falls so that resistance to airflow increases which is seen in normal lungs and lungs affected by COPD. [8] Persistent reductions in FEV1 and FEV1/FVC are the characteristic physiological abnormalities of COPD.[9]

The appearance of signs of breathlessness indicates moderate to severe impairment of airway function. By the time the patients seeks medical advice the FEV1 has usually fallen to 1-1.5L in an average man.[10] In the later stages of COPD the chest is often barrel shaped with kyphosis and an apparent increased antero-posterior diameter, horizontal ribs, prominence of the sternal angle and a wide subcostal angle. As a result of elevation of sternum, the distance between the suprasternal notch and the cricoid cartilage may be reduced and an inspiratory tracheal tug may be detected, due to contraction of the low flat diaphragm.[11] The horizontal position of diaphragm acts to pull in the lower ribs during inspiration (Hoovers sign) [12]

Hyperinflation displaces the diaphragm to a flattened position so as the radius of diaphragm curvature increases with diaphragm flattening, the tension required to develop a trans-pulmonary pressure to generate tidal breathing must increase. Also, with hyperinflation, the thoracic cage, in general, must operate at a mechanical disadvantage.[8]As a result of hyperinflation, the diaphragm muscle fibers which are vertically oriented become more transversely oriented making the diaphragm's contraction comparatively inadequate in raising the lower rib cage leading to a decrease in its expandability.[13,14] Due to this change in orientation, diaphragm undergoes a reduction in the number of sarcomeres to compensate for its pressure generating capacity, as a result of which diaphragmatic mobility is reduced. Diaphragm being the major muscle for inspiration, reduction in its mobility becomes a major risk factor for increased mortality in population with COPD.[15]

Lung function remains the most important objective outcome in assessing the severity and prognosis of patients with COPD. Spirometer is suggested by the Global initiative for Chronic Lung Disease (GOLD) for the diagnosis of COPD. Changes in the spirometer values are of utmost importance in diagnosis and for the severity of the condition. Many pulmonary function abnormalities occur in COPD, but persistent reduction in maximal forced expiratory flow is the defining physiological feature. [8]

Although the main treatment approaches for COPD are pharmacological therapy and pulmonary rehabilitation, there are a number of published studies in the osteopathic and chiropractic literature describing the use of manual therapy techniques. [16,17]

Rationale for providing manual therapy for treatment or even as an adjunct recognizes COPD patient's frequent occurrences of various musculoskeletal disorders. This has been linked to causing impaired or reduced physical performance and a gradual decline in physical activity in patients with COPD. Various manual therapy techniques have been administered in patients with different stages COPD proven to have a significant change in pulmonary functions, exercise capacity, thoracic kinetics and quality of life but majority of literature have focussed on mild and severe COPD. On the contrary, it is very clearly established about the diaphragm dysfunction in COPD, still there are very limited studies which focused on individual manual therapy techniques done on this major respiratory muscle i.e. the diaphragm. While pulmonary rehabilitation as a part of the routine treatment is been proven to improve symptoms of patients suffering from COPD, evidence that manual therapy can have same or near similar effects still remains unconvincing. More evidence needs to be gathered before manual therapy to be implemented as a treatment protocol for patients with COPD in different stages. Therefore this study targets to evaluate the effects of manual diaphragm release technique in patients affected with moderate COPD and to assess the extent/duration of the effects of the above technique on the pulmonary functions to evaluate its longevity.

METHODOLOGY

Research design: Experimental study.

Sample population: Patients Diagnosed with Moderate COPD

Duration of study: 12 months.

Type of sampling: Purposive sampling.

Source of sampling: Tertiary care hospital and chest OPD and physiotherapy Chest OPD in Metropolitan city.

Sample size: 55

Selection criteria

Inclusion criteria

1. Age group: 40 to 60years.
2. Clinically diagnosed with COPD (Moderate COPD according to GOLD criteria)
3. Clinically stable (no acute exacerbation in the previous 6 weeks)
4. No bronchodilator taken within 6hrs of the session.
5. Body mass Index 18.5- 24.9kg/m^2

Exclusion Criteria

1. Any unstable medical condition
2. Any Systemic pathologies interfering with pulmonary rehabilitation,
3. Unstable Hypertension, Recent postoperative patients.
4. Received any form of manual therapy given to thorax in the previous 4 weeks
5. Any neurological conditions
6. Thoracic spinal deformities, previous thoracic surgeries
7. Rib fractures.

Materials Used: Recording sheet, weighing scale, stadiometer, Pulmonary function test machine

Outcome Measure: Pulmonary function tests:

1. Forced vital capacity (FVC)
2. Forced expiratory volume in one second (FEV1)

Technique of application of manual diaphragm release

Patient position: The participant lay supine with relaxed limbs.

Therapist position: Positioned at the head end of the participant.

Procedure: Therapist will make manual contact with the pisiform, hypothenar region and the last three fingers bilaterally to the underside of the seventh to tenth rib costal cartilages, with the therapist's forearms aligned toward the participant's shoulders. In the inspiratory phase, the therapist will gently pull the points of contact with both hands in the direction of the head and slightly laterally, accompanying the elevation of the ribs. During exhalation, the therapist will deepen contact toward the inner costal margin, maintaining resistance. In the subsequent respiratory cycles, the therapist will progressively increase the depth of contact inside the costal margin. The manoeuvre will be performed in two sets of 10 deep breaths, with a 1-minute interval between them.

PROCEDURE OF THE STUDY

The approval for the study was taken from the ethics committee and research board prior to the commencement of the study. A total of 70 subjects having COPD were screened for the study; out of which 62 patients met the inclusion criteria were enrolled. 3 refused to participate in the study and 4 did not complete the follow up. Written informed consent was obtained from individuals participating in the study. Pre-treatment the PFT readings i.e. FVC and FEV1 were taken from all the enrolled participants of moderate COPD. Pulmonary functions were measures with the help of a portable spirometer. Prior to taking the measurements the procedure was demonstrated to the participants. After taking pre or baseline measurements of FVC and FEV1, two sets of the manual diaphragm release technique was applied and immediate post measurements were recorded. Following 24 hours the outcome measure FVC and FEV1 were recorded again taking into consideration the timings of medication. The same was repeated for subsequent 48 hours and 72 hours.

DATA ANALYSIS AND RESULTS

The outcome measures for both the groups were collected, the data sheet was prepared and statistically analysed using IBM SPSS software 19.0. The data on categorical variables is shown as n (% of individuals) and the data on continuous variables is presented as mean and standard deviation (SD). Descriptive data analysis for age, gender, number of smoking participants and baseline FVC and FEV1 measurements was done and mean and standard deviation was calculated. Data were tested for normality using the Shapiro Wilk Test. Parametric tests were used to test data as it was passing normality.

Paired t-test was used for comparison of pre and post-immediate values of pulmonary function test for all the participants. Paired t- test was used for comparison of data of pre and post data values for post 24 hours,48 hours and 72 hours of pulmonary function tests for all the participants. The Confidence interval was set at 95% and level of significance was set as 0.05.

Demographic Data

The mean ± SD of age of the participants studied was 57.07 ± 3.877 years out of which 46 were male and 9 were female participants. Out of the total participants, 34 were smokers and 21 were non-smokers.

Table 1 Descriptive Statistics for Baseine Pulmonary Function Test (FEV1 and FVC)

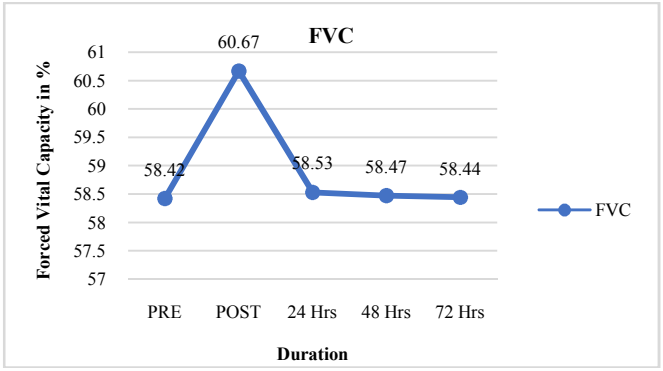
	N	Mean	Standard Deviation	Standard Error	95%confidence interval for Mean Lower bound	Upper Bound	Minimum	Maximum	P value
FVC	55	58.42	4.099	0.553	57.31	59.53	50	69	0.11
FEV1	55	58.40	4.053	0.547	57.30	59.50	50	68	0.16

Inference: The above tables states that the p value is >0.05, which is not significant indicating baseline of the variable that is FVC and FEV1.

Table 2 Pre Post Immediate Analysis of Pulmonary Functions

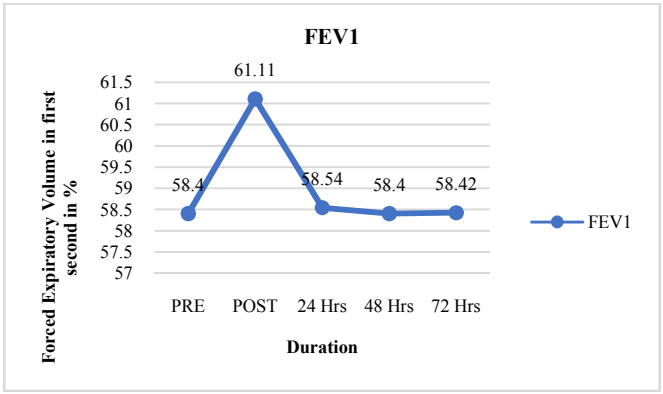
Pulmonary Function Test – FVC And FEV 1					
	PRE		POST		P value
	MEAN	SD	MEAN	SD	
FVC	58.42	4.099	60.67	4.243	<0.01
FEV1	58.40	4.053	61.11	4.396	<0.01

Inference: The above table states that by using paired t test for pre and post-test comparison the p value <0.05 for FEV1 and FVC which is considered to be statistically significant.



Graph 1 Trend of FVC Over Time- After 24 Hours, 48 Hours And 72 Hours

Inference: The above line graph represents that within less than 24 hours the FVC has returned to its baseline ie pre values and has remained same till 72 hours. The mean values of FVC after 24 hours is 58.53 ± 4.091, after 48 hours is 58.47 ± 4.122 and after 72 hours is 58.44 ±4.104. By using paired t-test between baseline i.e. pre values with post 24hrs, post 48 hrs and post 72 hrs individually and respectively is considered to be statistically insignificant as p value is more than 0.05 for Forced vital capacity (FVC).



Graph 2 Trend of Fev1 over Time- After 24 Hours, 48 Hours And 72 Hours

Inference: The above line graph represents that within less than 24 hours the FEV1 has returned to its baseline ie pre values and has remained same till 72 hours.The mean values of

FEV1 after 24 hours is 58.45 ± 4.059 , after 48 hours is 58.40 ± 4.144 and after 72 hours is 58.42 ±4.153 . By using paired t-test between baseline i.e pre values with post 24hrs, post 48 hrs and post 72 hrs individually and respectively is considered to be statistically insignificant as p value is more than 0.05 for Forced vital expiratory volume in first second (FEV1).

DISCUSSION

The results suggested that our study is based on the sample of elder population with clinically diagnosed moderate COPD and is male dominated. This can be correlated with findings of GOLD guidelines on COPD which states that the disease is more prevalent in 40 years and above age group and with males more commonly affected than females. [8]

Many literatures have picked up on the relationship between good breathing pattern and health maintenance.[18-22] The diaphragm plays an important role in maintaining efficient quiet breathing pattern,[22] with the normal diaphragmatic contribution to tidal volume is about two-thirds and three-fourths during erect and supine positions .[23]

COPD displays itself in reduced diaphragm mobility, as inspected by Yamaguti *et al*, who objectively assessed diaphragm displacement in COPD patients using ultrasound and found significant reduction in diaphragm mobility compared with normal healthy subjects.[13]

Manipulative therapy of the diaphragm increases its excursion and hence improves breathing mechanics [24] facilitates bronchial tree lymphatic flow and so reduces airways congestion [25] and beneficially reduce the hypertonicity of the diaphragm shown in COPD by stretching it [26] so increasing its efficacy during inspiration as well as in expiration.[27] Other studies also adds that Manipulative treatment is efficient treatment alternative in health as well as in disease.. Manipulative treatment significantly improves FVC and FEV1 in normal individuals. [28] Manipulative techniques for COPD can increase thoracic cage and ribs mobility, mobilize thoracic spine [29] and so can improve pulmonary functions; not only in adults but also in pediatrics [30] and postoperative patients. [31]

The main purpose of the study was to evaluate the effects of a technique called manual diaphragm release used to stretch the diaphragm on pulmonary functions and the extent of those effects on the same. Our results showed a significant increase of forced vital capacity, forced expiratory volume in the first second immediately after the technique was administered. Indeed, the Manual Diaphragm Release Technique has undergone little research at all. The lack of studies on manual therapy in people with COPD was highlighted by Heneghan and colleagues in their systematic review [32]

Manual therapy aims to stimulate proprioception, increase the elasticity of adhered fibers, stimulate synovial fluid and reduce pain. Fascia release has its efficacy based on the elimination of tension in the soft tissues, trigger points and muscle defense status, through low speed movements, which when applied over the area, act on the sensory system via the Golgi tendon organs .[33]The acute effects of the experimental intervention might seem to be an important outcome. However, the analysis of the overtime effect may be more relevant because it might reflects a sustained effect developing over the course of treatment.

In the study done by Rocha *et al*, it is considered that the mean diaphragmatic mobility in healthy individuals was 79 mm (SD 14), the cumulative effect of the repeated administration of the Manual Diaphragm Release Technique (i.e., approximately 18 mm) seemed surprisingly to be enough to bring people with COPD close to the normal range of diaphragmatic mobility. Given this beneficial effect on diaphragmatic mobility, it can be hypothesized that the manual action on the underside of the last four costal cartilages allows the traction of the lower rib cage in a cranial direction and that the manual compression of the tissues in the area of insertion of the anterior costal diaphragm fibres lengthens the diaphragm in its insertional zone. [15]

The Manual Diaphragm Release provided an improvement in the length tension relationship and enhanced the flexibility of the ventilatory muscles and the thoracic cavity, which allowed a beneficial effect on the performance of respiratory mechanics.

Followed by taking the pulmonary functions after an interval of 24 hours and taking into consideration the effects of medication (bronchodilators) there was a significant decline in pulmonary functions by returning to the baseline or the pre technique parameters. The similar trend was seen when the pulmonary functions were taken after a duration of 48 hours and 72 hours which is suggestive of the manual diaphragm technique having only an immediate but not sustained effect on the pulmonary functions.

A study done by Gonza´lez-A ´lvarez FJ *et al* showed the 5- and 20-min values in FEV1 which demonstrated the duration of the effects of stretching on the increase in pulmonary function with a decline at 20 min .These changes across time after a single stretching session can be attributed to changes in the elastic region of the muscle that are not permanent. [34] Relatively short time of increased flexibility may be due to several factors. The most prominent is the viscoelastic properties of the musculotendinous unit. It suggest that a single session of stretching does not deform tissues enough to produce a permanent change (i.e., a plastic deformation in the musculotendinous unit). Therefore, the temporary improvement in flexibility may be attributed to changes in the elastic region caused by a single session of stretching. Stretching programs leads to elastic deformations that allow the tissue to return to its original length if the stretching routine is not continued. Studies of similar PNF stretching techniques suggest that autogenic inhibition of the stretched muscle provides increased ROM. [34,35]

The above study shows a similar result i.e. a reduction in FEV1 after 20 minutes and is in line with the current study that the changes excursion of the diaphragm only has an immediate effect and expiratory volume in 1 s is closely associated with the diaphragmatic excursion [36]

Limitations

Few limitations of the study could be that long term effects of the technique were not seen. Exact contribution of the bronchodilators in the improvement of the pulmonary functions was not considered.

Suggestions

Similar studies can be done on severe COPD according to GOLD's criteria. Long-term effects of the manual diaphragm

release technique on the pulmonary functions should be assessed. Effects of this technique can be studied on other respiratory conditions as well. For Example asthma, ILD. Comparative studies of similar techniques on a larger group can be done. Other outcome measures such as oxygen saturation, functional and exercise capacity could be targeted.

CONCLUSION

The study concludes that there is an immediate effect of Manual diaphragm release technique on pulmonary functions in patients with moderate COPD, but there is no long-term effect seen of a manual diaphragm release technique post 24 hours. Comprehensive rehabilitation can be planned with adding manual diaphragm technique along with conservative physiotherapy treatment which can benefit in improving pulmonary functions in patient with COPD. For achieving the maximum benefits this technique should be administered to the patient daily along with the ongoing pulmonary rehabilitation.

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