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Effect of Manual Diaphragmatic Release Technique to Increase Chest Mobility in Copd Patients

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Abstract
COPD patients have breathing pattern abnormality due to inflammation in the alveoli and there is decrease in the mobility of chest leading to breathing abnormality.

INTRODUCTION

The chest wall of the human being consists of rib cage and the abdomen, and is separated by each other by the diaphragm and they are arranged in parallel mechanically. The expansion of the lung is accommodated by the expansion of the ribcage or the abdomen or by expanding both the compartments simultaneously.

The description of the chest wall is a three compartmental model in which the rib cage is modelled as two sub-compartments, the part which is opposed to the lung, the rib cage and the part which is apposed to the diaphragm and the abdominal rib cage considering the level of xiphisternum at the Functional Residual Capacity. The rib cage consists of the upper ribs (1 to 6) that are tightly attached with the sternum and it forms a part of the pulmonary rib cage, while the lower ribs (7 to 12) they have freedom to move from the sternum independently through the longer costal cartilages.

The two parts of the rib cage are exposed with different pressures, the pulmonary cage being exposed to the inner surface pleural pressure over the lung surface. As the pleural pressure becomes negative while inspiration it tends to decrease the rib cage volume to prevent the paradoxical movements. The other inspiratory rib cage muscles get inserted in the inner surface of the diaphragm. The lower part of the rib cage has been exposed with the inner surface of the diaphragm and it generally rises in inspiration.

The respiratory system in the human body is a combined set of organs which is responsible in the process of taking in the oxygen and leaving out the carbon- dioxide. It is composed of the airways as well as the parenchymal tissues and is divided into an upper and a lower respiratory tract. The upper part consists of nasal passages, the pharynx, larynx and the upper part of the trachea. The lower respiratory tract is made up of the lower portion of the trachea, the bronchial tree and the alveoli. The main organ of the respiratory system is the lungs. The lungs carry out the interchange between the gases as we breathe. The oxygen from the lungs combines with the RBCs and it is carried to the various parts of the body. Along with the process the red blood cells also carry carbon- dioxide back to the lungs and is expelled from the body during expiration. The human body needs constant oxygen supply to sustain itself.When oxygen declines,it is known as hypoxia.It can be fatal for the vital organs,without oxygen supply and can result in permanent damage or even death.

In order to breathe, the lungs should expand and this expansion is brought by the alterations in the capacity of the thoracic cavity to allow the air during inspiration and expelled during the expiration that cause ventilation of the lungs. This lung capacity is increased in 3 dimension which is antero-posteriorly,laterally and vertically with the help of primary muscle of inspiration and expiration.When we breathe,the diaphragm flattens and descends which increases the vertical diameter of the lungs when the intercostals contract and when there is upward movement of the upper ribs which results in the increased antero posterior diameter and outward movement of the lower ribs which results to increase lateral diameter.The amount of air which enters the lungs during inspiration depends upon the depth of the respiration.Any alteration from the normal breathing mechanics results from inadequate volume of air,reduced expansion of the lungs,shortness of the breath,decreased or increased respiratory rate,mismatch of the ventilation and perfusion ratio,fatigue of respiratory muscles and the use of accessory muscles.

Diseases of the respiratory system fall into two major categories-

1. Obstructive lung diseases and
2. Restrictive Lung diseases.

The feature of Restrictive disease is the reduction in the lung volume due to the lung parenchyma of the pleura, chest wall, the neuromuscular system, whereas the obstruction are characterized by the obstruction of the airways due to the inflammation.

In India, the Obstructive disease is more common than the restriction. The Obstructive Disease is classified as;

1. Chronic bronchitis
2. Emphysema

In India,COPD is the second most frequent lung disorder following the tuberculosis of the lung.COPD is characterized by the airflow limitation which is temporarily reversible. This condition can be prevented and as well as treated. The GOLD has defined the COPD as a disease which has characteristic of airflow limitation and which is not reversible.It basically comprises of both chronic bronchitis and emphysema.

Chronic bronchitis is the disease identified by chronic cough with expectoration that can last for atleast 3 months of a year for 2 successive years,whereas emphysema is persistent and abnormal inflation of the air spaces located at the terminal bronchioles,accompanied by the destruction of the walls of air spaces without fibrosis.They can both occur frequently,since they share common etiological factors.

Chronic Obstructive Pulmonary Disease-

COPD is the major health problem and it ranks fourth in the United States for its cause for morbidity and mortality. It remains to be unknown, unrecognized by the public as well as by World health organizations. So therefore GOLD Guidelines help to increase the awareness of COPD among millions of people worldwide.

COPD is the disease of the lung which is mainly caused by the chronic obstruction and which leads to morbidity and mortality among millions.

The people with this disease suffer for many years and die prematurely too.

COPD is a preventable and treatable disease with some significant extra pulmonary effects that contribute can contribute to the severity of individual patients. This airflow limitation is not reversible and is usually progressive with abnormal response of inflammation of the lung to noxious gases and particles. Its pulmonary component is characterized by by airflow limitation which is irreversible.This airflow limitation of COPD is caused by mixture of airway disease and parenchymal destruction,the relative contributions which can vary from person to person.

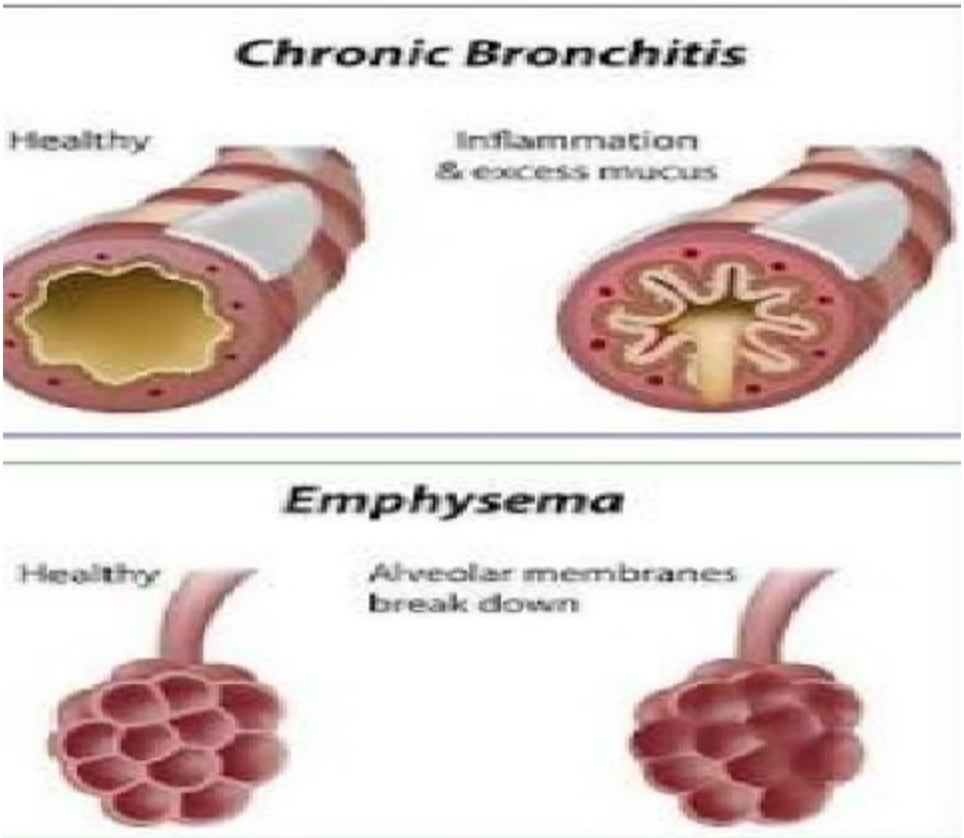
Because it develops in long time smokers,middle age,patients often have variety of other disease related to either smoking or aging.COPD itself has significant extrapulmonary effects that can further lead to comorbid conditions.

Thus it should be managed with careful attention to pay to comorbidities and their effect on quality of life also.

Pathology, Pathogenesis and Pathophysiology The pathologic changes which are the characterstics of COPD they are found in the proximal airways,peripheral airways,lung parenchyma and the vasculature of the lungs.

This changes include chronic inflammation, with increased number of specific cell types which results in repeated injuries and repaires.In general, this inflammatory and structural changes in the airways they increase with the disease severity and persist on the cessation of smoking.The inflammation in the respiratory tract of the patients they appear to be an amplification of the inflammatory response to the irritants such as smoke.

Lung inflammation is further amplifies by the oxidative stress and an excess of the proteinases in the lung.Therefore these mechanisms lead to the characterstic changes in the copd.There is now a good understanding of how the underlying disease will progress in COPD that can lead to abnormalities and symptoms.For example decreased FEV1 results from inflammation and narrowing of the airways of periphery and dynamic collapse in severe emphysema,whereas decreased gas transfer arises from the parenchymal destruction of emphysema.This extent of inflammation and fibrosis and luminal exudates is correlated with reduction of FEV1 and FEV1/FVC.



BURDEN OF COPD

The prevalence of morbidity and mortality varies across the countries and across different groups within countries but in general directly related to tobacco smoking, in many countries, air pollution resulting from wood burning has become a risk factor. The prevalence and burden of COPD they project to increase due to continued exposure of COPD risk factors.

Epidemiology

In the past,the imprecise and variable definitions of COPD,it has made it difficult to quantify the prevalence,morbidity and mortality.Furthermore,the underdiagnosis and underrecognition of COPD lead to the significant under reporting.

Prevalence

Many sources of the variation can affect the estimation of COPD prevalence, including the response rates, quality control and whether spirometer is performed pre or post bronchodilator. Despite the complexities, data are emerging that enable some conclusions to be drawn regarding the prevalence of COPD.A prevalence study showed meta-analysis performed in 28 countries and an additional study from Japan,they provide an evidence of COPD higher in smokers and ex-smokers compared to non-smokers in those older than 40 years compared with those younger than 40 years, in men compared with women.

MORBIDITY

Morbidity measures the traditional visits and hospitalizations. Although COPD databases for these outcome parameters are readily available and usually reliable than mortality databases, the limited available data indicate morbidity due to COPD which increases with age and is greater in men than women.COPD in its early stages is not recognised, diagnosed or treated and therefore may not be included as a diagnosis in patient's medical record.

Morbidity from COPD may be affected by other comorbid chronic conditions which will be not directly related to COPD,but nevertheless and may have an impact on patient's health status,or may interfere with COPD management.In the patients with more advanced disease,morbidity can be misattributed to another comorbid condition.

Social burden of COPD

It is a costly disease. In the countries which are developed ,the exacerbations account for the greatest burden on the health care system. In the Union the total direct costs accounts to be 6% of the total health budgets with COPD accounting for 56% of this cost of the respiratory diseases.

Risk Factors

There are various risk factors of COPD and the most common encountered factor is the cigarette smoking.However although smoking is the best studied COPD risk factor,there are evidences from the studies that the non-smokers can develop chronic airflow obstruction.

1. Genes

As the understanding of the risk factors has grown,the recognition that essentially resulted this condition is the gene environment interaction.The genetic risk factor that is best to identify the COPD is the deficiency of the alpha 1 antitrypsin deficiency which is the major circulating inhibitor of serine proteases.Therefore this recessive trait is most commonly seen in individuals of the European origin.

Genetic association studies have implementation of variety of genes in the pathogenesis of COPD.However this results of association studies have been inconsistent and functional genetic variants influencing the development of COPD. Inhational exposures

TOBACCO SMOKE

Cigarette smokers mainly have the main prevalence of respiratory systems and lung function abnormalities, which have a annual rate of decline in the FEV1 and a greater COPD mortality rate than the non-smokers. The pipe and cigar smokers have a greater COPD morbidity and mortality, although the rates are lower for non-smokers than smokers.

Tobacco smoking in other countries are also risk factors of COPD.The passive exposure to cigarrete smoke may also contribute to the respiratory systems.It increases the total burden of inhaled particles and gases.Smoking in the pregnancy is also a risk for the fetus,by affecting the lung development in utero and possibly by affecting the immune system.

INDOOR AND OUTDOOR AIR POLLUTION

The evidence of the indoor pollution from biomass cooking and heating in poorly ventilated dwellings is an important risk factor for the COPD which continues to grow with case control studies and other designed studies.Higher levels of urban air pollution are harmful to the individuals with existing heart or the lung disease,but the role of the outdoor air pollution cause is unclear.

COPD is further classified into four stages according to the spirometry findings:

Stage	Spirometric findings
Mild	FEV1/FVC<0.70 FEV1>80% predicted.
I- Moderate	❖ FEV1/FVC<0.70 ❖ 50%<FEV1<80% predicted
II- Severe	❖ FEV1/FVC<0.70 ❖ 30%<FEV1<50% predicted
III- Very severe	❖ FEV1/FVC<0.70 ❖ FEV1<30% predicted or <50%predicted+ chronic respiratory failure.

Chronic bronchitis shows the inflammation of the bronchial tubes and these inflamed airways starts producing a significant amount of the mucus which leads to coughing along with expectoration which leads to difficulty in breathing.Also there is a loss of elastic recoil of the lungs in emphysema through loss of support of airways which produces narrowing.

The lungs are stretched to the elastic limit and therefore more amount of effort is required to make the inflated lungs to stretch further.This is the hyperinflated lungs.The chest wall along with the primary muscle of breathing was stretched to their elastic limits and furthermore they are involved in the stiffening problem related to the barrel chest deformity which increases the work of breathing.The end result is the small volume of air taken in and out of the lungs.Because of reduced Tidal Volume and in order to provide enough oxygen the respiratory rate becomes high.As this disease progresses,the use of the accessory muscles are becoming evident.

The normal I:E ratio in the COPD patients is disturbed because of the obstruction of the airways and the emptying of the lung during the expiration is slowed,and the expiration is also interrupted by the inspiratory effort and the cycle leads to an altered ratio of 1:1.

The lung function of these patients of COPD is also altered and is confirmed by the pulmonary function test. The forced expiratory volume in 1 second and the forced vital capacity,both are reduced in COPD.Also the ABG analysis shows a reduced PaO2 and increased PaCO2 which leads to a reduced functional capacity of the individuals with COPD which exhibits remarkable exercise induced loco motor fatigue of the muscle.Therefore peripheral factors also play a significant part in the exercise limitation and this influence is heightened by the effect of increased muscle work of respiration,which compromises oxygen delivery.

In the COPD patients, the demand as well as the capacity curve of the inspiratory muscle is being skewed in such a way that there is overloading of the muscle severely. This does not have a disproportion but only has an effect on the blood flow through the limbs during the exercise, but also has a significant contribution to dyspnoea.

As described, the patients with COPD have a marked muscle weakness, exacerbated by the hyperinflation.

CONTRACTILE PROPERTIES OF THE HUMAN DIAPHRAGM IN COPD CONDITION

Hyperinflation of the lungs can impair the functions of the diaphragm which places it with a mechanical disadvantage with shortens its operating length and which changes its mechanical linkage between its various parts. These factors decrease the tension which develops the amount of transdiaphragmatic pressure which produces in response to any given muscle tension.

The action of the diaphragm is altered in patients with COPD and can contribute to their to their disability and can lead to respiratory failure.Only a little is known about the properties and the function of the diaphragm.The reported values for the transdiaphragmatic pressure ranges from -80 to -170cm of water.The diaphragm functioning can now be obtained with the supramaximal bilateral phrenic nerve stimulation,which produces the uniform contractions of the entire diaphragm independently of any voluntary effort.

Used in the isolation,it provides information about the properties of the diaphragm and its mechanical interactions with the chest wall.Used in combination with the naturally occurring or voluntary contraction,it helps to distinguish with the intrinsic function of the diaphragm from the level of its activation by the Central Nervous System.

EFFECT OF THE ACUTE HYPERINFLATION OF THE DIAPHRAGM

The influence of the acute hyperinflation on the behaviour of the diaphragm as a pressure generator is primarily determined by the length tension relationship. This relation is initially established by the invitro studies of single fibres from the amphibian muscles. It basically describes the property whereby the isometric tension developed by the muscle during contraction varies as a function of the resting length of the muscle before the stimulation.

Therefore the relaxed length of the muscle increases, then the tension is also increased. The resting length at which the greatest tension is reached, that is referred to as the optimal length. The properties of the exercise bundles of muscle fibres is measured from five animal species which shows that the diaphragm possess similar characterstics.

Thus the diaphragm produces progressively less force as the length is gradually decreased and no active force can be generated when the muscle is shortened to approximately 50%.

THE DIAPHRAGM IN THE CONDITION OF EMPHYSEMA

The hyperinflation develops slowly over many years and the landmark have shown that limb muscles have been extensively remodelled.Thus when a limb muscle is immobilized in the shortened position

,the sarcomeres get lost.Consequently, whereas the acute reductions in muscle fibre length will decrease,the length of all the sarcomeres as well as the force decreases.The physiological result of this adaptation is that the active length tension relationship is shifted towards the shorter length but the maximal tension will remain normal.
The changes in the lung volume and in static pressure volume curve are similar in the direction which is seen in severe emohysema

DIAPHRAGM IN COPD
STRUCTURAL CHANGES;
Studies of the structure of the diaphragm done in an autopsy shows that the structure had reduced in thickness,volume and the area.Also there was reduced surface area of the diaphragm,particularly in the muscular portion and was greater reduction in the diaphragm area when the emphysema was more severe.The thickness in the COPD conditions was maintatined.The author Thurbleck also observed a reduction in the weight of the diaphragm.
There are a number of factors that accounts for the structure of diaphragm.Firstly in an autopsy rigor mortis can occur and excision can lead to muscle shortening.Secondly,COPD has been assessed by the severity of the condition whether bronchitis or emohysema which may not be closely related to the degree of airflow obstruction and the disability in life.Thirdly many of the series consists of the effect of body weight and gender,being study saying that the diaphragm weighs more in men than in women.Furthermore, it is also related to body weight and thickness is decreased in underweight patients with chronic respiratory illness compared to patients dying suddenly from acute illness.
Length of the diaphragm
The diaphragmatic muscle fibre length in COPD has been estimated from the thoracic radiographs.It has been found out that the FRC of COPD patients is 40% shorter than the normal.This value is 30-40% shortened in healthy people on inspiration from RV to TLC.As anticipated,the shortening was greater when the hyperinflation was more severe,but the relationship between the length and the lung volume was essentially similar.
Volume displacement during breathing.
Although the pressure generating ability in COPD is better than the basis of hyperinflation alone, the muscle cannot increase lung volume like a normal diaphragm.Indeed the primary mechanism of diaphragmatic contribution to tidal volume,in the normal humans is like piston like axial displacement of the dome which is related to the shortening of the apposed muscle fibers,and compared with the patient in COPD and hyperinflation, the diaphragm is flatter and much lower than compared to the healthy individuals.
Thus the zone of apposition is reduced in size, so when the muscle contracts, the ability of the dome to descend down is lesser. As a result, the rise in the abdominal pressure and the expansion of the ventral of the abdomen is smaller. Because of the reduced zone of the apposition and a smaller rise in the abdominal pressure the expansion of the lower rib cage due to the contraction of the diaphragm is smaller than the normal subjects. In some patients with the severe inflation, the normal curvature is reversed at TLC with the concavity facing upward,rather than in the downward direction.
The fact that patients with the severe COPD may have a rib cage expansion with an inward motion of the abdomen during resting inspiration had been recognized in the earliest way possible.

DETECTION, MEASUREMENT AND DEFINITIONS OF LUNG HYPERINFLATION

Lung hyperinflation is present when the gas volume in the lungs,or in a region of the lung is increased when compared with the predicted value.The thorasic hyperinflation in COPD could be detected by physical examination.The recognized clinical features of the hyperinflation includes the inward motion of the lower lateral ribcage during inspiration and the paradoxical inward motion of the anterior wall of the abdomen in synchrony with the inspiratory flow.

Hyperinflation in its earlier stage is underestimated even after the clinical assessment.High resolution CT has confirmed that the airspace dilatation can be either localised or homogenously distributed.

On the other hand,hyperinflation is said to exist when the TLC is less than 120% of the predicted value.Hyperinflation of the other volume compartments is usually increased in an elevated .However increased EELV and RV are often present in the settings of the preserved or it is slightly elevated.In these circumstances with large elevations of these volume compartments,the dynamic mechanisms are likely to be instrumental.

Thus,the net increase in the RV may reflect reduced duration of the forced expiratory manoeuvre because of the development of intolerable respiratory discomfort.The gas compression effects and the possible negative effort dependence may also can contribute to increased RV in flow limited patients.

The increased EELV ,RV are the upper limits of the natural variability.In practice, the values exceeding 120-130% pred are deemed to be cinically important.No standardised stratification system is existing currently for the assessment of the severity as well as the hyperinflation.

The natural history of the development of the lung hyperinflation is unknown in the COPD patients, but the clinical experience includes an insidious process.It would appear that the RV is the prior volume component to increase which reflects airway closure.

However it is that the time course of the change in the various volume comprtments in this respect,its impact of the frequency and the severity of the exacerbations is important.

MEASURING DYNAMIC HYPERINFLATION

The rate and the magnitude of DH during exercise is usually measured using IC measurements. Changes in the EELV during exercise is tracked with the newer methods such as plethysmography. The IC is the maximal volume of air that can be inhaled after spontaneous expiration.

Since the TLC does not change during the activity ,the change in the IC reflects the change in the EELV or the extent of dynamic hyperinflation. The rate of the hyperinflation was steeper in patients with the severe EFL, the lowest diffusing capacity for carbon monoxide and the ventilator demand.

CONSEQUENCES OF HYPERINFLATION.

The development of the flow limitation and the hyperinflation allows adaptive mechanisms into play to preserve the functional strength of the overburdened inspiratory muscles. Studies show several structural adaptations to chronic mechanical loading which includes:

1. The reduction in the sarcomere length which improve the ability of muscle to generate the higher force at higher lung volumes.
2. An increase in the relative proportion of the type 1 fibres and which are slow twitch and fatigue resistant.
3. Increase in the mitochondrial concentration and efficiency of the electron transport chain, which improves the oxidative capacity.

Chest wall kinematic determinants and evaluvation by ultrasonography Diaphragmatic mobility evaluvations have been traditionally performed using fluoroscopy.Although this method is the gold standard,it has certain limitations.This limitations include diaphragm visualization with single angle of incidence,requirement to perform the corrective calculations and patient exposure to ionizing radiations.Over the past few years ultrasound has been used to measure the diaphragm mobility,since this offers some advantage over fluoroscopy,also portability and no exposure to radiations and direct quantification of the diaphragmatic movement.

Despite certain advantages of the ultrasound scanning, the direct visualization of the muscle presents with methodological difficulties that depends on the position of the transducer. A recent study which is validated worldwide places the transducer perpendicular to the cranio caudal axis using the subcostal abdominal window to see the displacement of the left branch of the hepatic vein as an indirect measurement for the displacement of the right diaphragm.

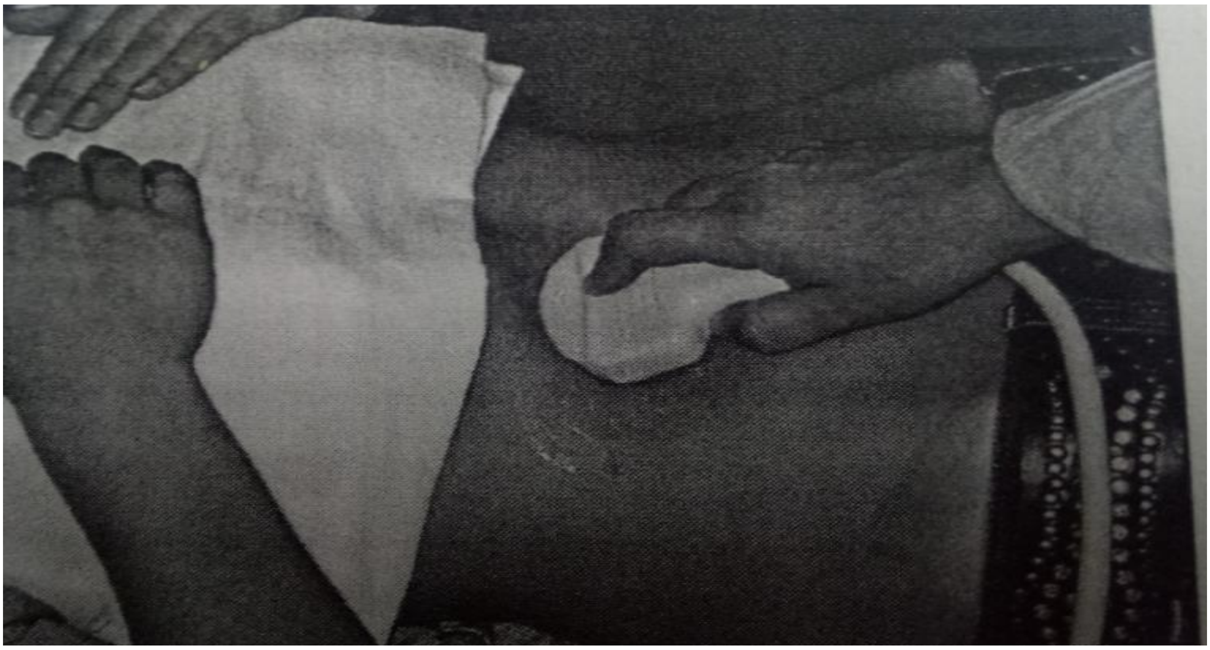
Modes of the information about the chest wall kinematics is based on two compartmental chest wall model composed of the rib cage and the abdomen with each behaving as a single degree of freedom,so that the change in volume of the each compartment is measured by a single dimension.

Because of the movable parts of the antero-lateral abdominal wall and the diaphragm,the volume of the abdominal contents displaced under the diaphragm must be equal and opposite to the volume displaced by the anterolateral abdominal wall.

Thus the diaphragmatic displacements are closely linked to the abdominal wall displacements and it has been assumed that the diaphragm fiber length would be related to the displacement of the abdominal wall and unrelated to the rib cage displacements.

Subsequent studies have been shown that the displacements of the abdominal content under the diaphragm are being more complex than those measured simply by the displacement of the anterior abdominal wall.

METHOD OF THE ULTRASONOGRAPHY OF THE DIAPHRAGM



The diaphragm motion was visualized by a general purpose echo camera which is equipped with a linear probe of 3.5MHz,128mm.As the intrapulmonary air greatly attenuates the transmission of the ultrasound waves,the abrupt discontinuity in the image at the level the diaphragm reflects from the chest wall,the lung intervenes was used to identify the position of the cephalic margin of the zones of apoosition. The caudal border was measured by the markers along with the costal margin.

The probe is being placed in a plastic frame fixed to the skin by the tape and manually kept in fixed position during the experiments. The probe had been aligned axially and placed between the markers which define the right lateral border.Three additional markers were placed on the probe and tracked.

Ultrasonographic images were synchronized with the analyser by generating a trigger that created a symbol at a frequency of 0.5Hz on the ultrasonographic image and that was recorded on digital cell.Small movements of the margin of the zone of apposition could be detected if the margin was obscured by a rib at the initial or the final position.

Therefore due to the physiological concepts that relate to the diaphragm in patients with COPD which develops hyperinflation,their diaphragm becomes flatter and shorter and this mobility had been detected using ultrasonography as a primary indicator and had been treated using manual release technique.

NEED OF THE STUDY

COPD,this condition decreases the quality of life and also increases the risk of mortlity.Also this condition is chronic,preventable and also treatable.

The airway and the pulmonary abnormalities of the COPD has an adverse effects on the respiratory muscle pump.At first there is airflow resistance and decreased dynamic pulmonary compliance,which is the main characterstic of the muscles which work chronically against the increased load.Secondly due to the inefficiency of the lungs as gas exchangers,minute ventilation is slightly greater in the normal subjects.So when the normal participants are given a resistance externally the maximum breathing capacity and exercise tolerance are small,while in the COPD patients it imposes a stress on the muscles and there is an evidence that the diaphragm being the main muscle is the most severely affected muscle of the rib cage.Also the length of this muscle becomes shorter due to hyperinflation and due to this the chest mechanics are changed.

The truth that the patients with this chronic condition,may have a rib cage expansion with the downward motion of the abdomen during resting inspiration is recognized in measuring the thoracoabdominal motion and has been known to be believed that that these patients have the least amount of diaphragm use than the healthy subjects mainly because of diaphragm fatigue.

Manual therapy is a new emerging technique which makes the release of the diaphragm and increases the lung function in short term.It also includes soft tissue release as well as adjacent thoracic joint mobilization leading to proprioception.It also has an immediate effect on increasing the pulmonary function,inspiratory muscle strength and patient’s satisfaction also decreasing the dyspnoea.

Therefore there is a need to apply the manual techniques in COPD patients.

AIMS AND OBJECTIVES

AIMS:- To study the effect of manual diaphragm release technique to improve the diaphragm mobility in patients with COPD.

OBJECTIVES:

1. To find out the effect of diaphragm mobility by the technique of manual diaphragmatic release technique in patients with COPD.
2. To find out the mobility of the diaphragm by measuring the difference between pre and post values of maximum inspiratory as well as expiratory forced breaths by Ultrasonography.
3. To compare the effect of diaphragmatic mobility by measuring difference between pre and post values of maximum inspiratory and expiratory breaths at rest and comparing the mobility's at the end of the treatment sessions.

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HYPOTHESIS

The COPD patients are treated with manual diaphragmatic release technique along with breathing exercises and upper as well as lower limb mobility exercises.

Since the breathing exercises which are given to the patients as well as the treatment administered by the therapist is different, the hypothesis is proposed as;

NULL HYPOTHESIS- There is no significant difference in the diaphragm excursion during forced breaths by using manual diaphragm release technique in patients with COPD.

ALTERNATIVE HYPOTHESIS- There is a significant difference in the diaphragm excursion during forced breaths by using manual diaphragmatic release technique in patients with COPD.

REVIEW OF LITERATURE

1. Tachiano Rocha et al, did a study in the Journal Of Physiotherapy in the year 2015,in which the purpose of the study was to check the diaphragm mobility, inspiratory capacity and exercise capacity in people with COPD where the study concluded to have a significant result in increasing the diaphragm mobility so that the patients will have an increased pulmonary function.
2. James et al did a study in the topic named Analysis of diaphragmatic movement before and after pulmonary rehabilitation using fluoroscopy imaging where the study concludes that the analysis of the diaphragm activation and length using fluoroscopy is an efficient way and technique compared to CT and MRI and has mentioned the study is needed to evaluate optimal effectiveness incorporating larger series.
3. The US National Library of Medicine created a study and posted on 8th August 2014,which studied Diaphragm Release Manual Technique Efficacy in COPD Patients which concluded that Manual

Therapy is known to increase joint mobility, administering with the potential to influence lung function.

4. The Ultrasound in Med and Biology Journal did a study on Ultrasound Assessment of Diaphragmatic kinetics by Anterior Transverse scanning on 7th October 2010 which gave a conclusion to set an effective standardized method to assess diaphragmatic kinetics by ultrasound.
5. The Manual Diaphragm Release Technique improves diaphragm mobility, inspiratory capacity and exercise capacity in people with COPD,was the study done by Taciano Rocha, Helga Souza gave a conclusion that manual techniques improved the chest mobility over the course of treatments with a mean group difference.
6. A.Aliverti,M.Quaranta did a study on Paradoxical movement of the lower ribcage at rest and during exercise in COPD patients, which says that lower ribcage paradox at rest is reproducible and is associated with early onset hyperinflation and dyspnoea at end exercise.
7. Gul Deniz et al published a study in International Journal of COPD which was Immediate effect of manual therapy on respiratory functions and muscle strength in patients with COPD which concluded that a single manual therapy session immediately improved pulmonary function, muscle strength and oxygen saturation and reduced dyspnoea in patients with COPD. MT should be added in the treatment protocol as a new alternative.
8. L.Chaitow did a study on Breathing pattern disorders, motor control, and low back pain in the school of Integrated Health, University of London in the Journal of Osteopathic Medicine,2004 which concluded that there is evidence of effects of breathing pattern disorders such as hyperventilation resulting in negative psychological, biochemical influences on the patient.
9. A.Aliverti,Dellaca et al did a study named Chest Wall kinematic determinants of diaphragm length by optoelectronic plethysmography and ultrasonography which concluded ultrasonography was effective, non -invasive and cheap method to determine muscle length.
10. Kazuhiro Ito,and Peter did a study on COPD as a disease of Accelarated Lung published in Basic Research into Clinical Practice which concluded COPD is increasing evidence for close relationship between aging and inflammatory disease which progresses slowly and majority are people are elderly.
11. Troyer did a study on Effect of hyperinflation on the diaphragm which says the ability of the diaphragm to generate pressure is also better than anticipated on the basis of hyperinflation alone.
12. D.E Donell and Laveneziana did a study on physiology and Consequences of lung hyperinflation in COPD which states that the lung hyperinflation commonly accompanies expiratory flow limitation in patients with copd and contributes to morbidity and impoverished quality of life.
13. De Troyer did a study on the effect of hyperinflation on the diaphragm which has the ability of the diaphragm to increase lung volume and the act of breathing is dependent on rib cage and inspiratory muscles.
14. Andrea Aliverti did a study on the topic named Chest wall mechanics in COPD which signifies the chest wall biomechanics and recreation of the chest wall.
15. Klaus Rabe,Suzanne,Antonio,Peter did a study on the Global Stratergy for the Diagnosis,Management,and Prevention of the Chronic Obstructive Pulmonary disease which was Gold Summary and had it states that COPD remains a major health problem among the people and is one disease which is ignored by the people

16. N.M Siafakas,P.Vermeire did a study on the optimal assessment and management of COPD in which the guidelines are intended for the se by physicians involved in the care of COPD
17. Rossana,Samantha did a study on the high reliability of measure of diaphragmatic mobility by radiographic method in healthy individuals which had the objective to analyse the reliability of radiographic measurement as a method to analyse the mobility of left and right hemidiaphragms.
18. Amal Aziz,Rabab Elwahsh,Gehan Abdelaal did a study on the diaphragmatic assessment in COPD patients by different modalities which had the study of diaphragm considered as a key point in the evaluvation of COPD patients and ultrasonography is used for the assessment of the site,structure and the motion of the diaphragm.
19. Marcia Aparecida,Bruna Estima,Liseane Lisboa did a study on the comparison of the diaphragmatic mobility between COPD patients with and without thorasic hyperkyphosis which states that the mobility was significantly lower in the group of COPD patients with thoracic hyperkyphosis than in that of those without it.
20. Paulin,Yamaguti,Chammas did a study on the influence of diaphragmatic mobility on exercise tolerance and dyspnoea in patients with COPD which presents increased airway resistance,air trapping,pulmonary hyperinflation and diaphragm muscle alterations,and all of which affect pulmonary mechanics.
21. **Mead J and Loring SH** did a study on the Analysis of the volume displacement and the length changes of the diaphragm during breathing,which analysed the breathing pattern of the respiratory system and concluded that the diaphragm had volume changes and was studied by pulmonary function testing.
22. **Bruno Bordoni** did a study on the Manual evaluvation of the diaphragm muscle which describes the stratergy of manual evaluvation in particular to the attention to anatomical fundamentals,in order to stimulate the muscle for the same.
23. **Bruno Bordoni,Fabiola** did a study on the review of analgesic and emotive breathing which intervenes to facilitate cleaning of the upper airways through coughing,facilitates the evacuvation of the intestines and promotes the redistribution of the body’s blood.Diaphragm also has the ability to affect the perception of pain and the emotional state of the patient.
24. **Caruana L,Petrie MC** did a study on the altered diaphragm position and function in patients with chronic heart failure,which states the diaphragm position was measured,relative to the renal pelvis,by ultrasound matched for age and body mass.The extent and velocity of the diaphragm movement was also measured during quiet breathing and sniffing.
25. **Salito.C,Luoni** did a study on the alterations of the diaphragm and rib cage morphometry in severe COPD patients by CT analysis which stated that the radius of curvature was significantly higher in COPD than normal,and the range of diaphragm position was invariantly below the xiphoid level,while in control group,the top of the diaphragm dome was above it.
26. **Hellebandova,Bunc** did a study on the Airflow limitation accompanied by diaphragm dysfunction in which the results states that the diaphragmatic movement fails to contribute sufficiently to the change in the volume in emphysema.The tests of the respiratory muscle function was related to the position of the diaphragm in deep expiration.
27. **Michael R.Baria** did a study on the B-Mode Ultrasound Assessment of the Diaphragm Structure and Function in Patients with COPD and this study stated there was no significant difference in diaphragm thickness or thickening ratio between sides within the groups.

28. **Heunks,**did a study on the Diaphragm muscle fiber dysfunction in chronic obstructive pulmonary disease:towards a pathophysiological concept which states the diaphragm force generation at single fiber level is associated with loss of myosin content and moreover the diaphragm is associated and exposed to oxidative stress and sarcomeric injury.
29. 29.**El-Tantawi** did a study on the Phrenic Nerve Conduction Abnormalities which co-relate with Diaphragmatic Descent in Chronic Obstructive Pulmonary Disease,which states that parameters of phrenic nerve conduction differed significantly in patients compared to the control group.Phrenic nerve abnormalities were detected in this study.Nerve stretching associated with diaphragmatic descent can be a suggested mechanism for the nerve lesion.
30. **Carlos,Diego** did a study on the Immediate effect of soft tissue manual therapy intervention on lung function in severe chronic pulmonary disease published in the International Journal of Chronic Obstructive Disease which concludes that a single application of STMTP appears to have a potential to produce immediate clinically meaningful improvements in lung function with severe COPD.
31. **Gul Deniz** studied the immediate effect of manual therapy on respiratory functions and inspiratory muscle strength in patients with COPD published in the International Journal of Chronic obstructive disease which has the objective to investigate immediate effect of manual therapy and proved to get a significant result in the forced expiratory volume in the first,second,forced vital capacity and vital capacity values.The maximal inspiratory and maximal expiratory pressure increased significantly after the manual therapy sessions.
32. **Walsh** did a study on the structural change of the thorax in COPD which examines the structural changes of thorax in the hyperinflated subjects with COPD.The change in the rib cage dimensions in COPD was not different from that in the normal subjects whereas the change of diaphragm position in COPD was reduced and hyperinflation is confined to the diaphragm with no appreciable structural change in the rib cage.
33. **Falsh,Blenk** did a study on the high prevalence of vertebral deformities in COPD patients:relationship to disease severity and the authors wanted to compare the prevalence of deformities and related to the severity as well as the use of oral corticosteroids.They concluded that the prevalence was high in the people with COPD.
34. **Papandrinopoulou** conducted a study on the lung compliance and COPD which studied the mechanical properties of the respiratory system and its component parts by determining volume-pressure relationships.
35. **O'Donnell** conducted a study on the dyspnea and activity limitation in COPD in which the strength of the association has been confirmed by therapeutically manipulated variable.
36. **Alverti** did a study on the human model of the pathophysiology of chronic obstructive pulmonary disease which summarizes a series of studies on the effects of expiratory flow limitation during incremental exercise to maximal workload in normal subjects on exercise performance,respiratory muscle dynamics and control and CO2 elimination.

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MATERIALS AND METHODOLOGY

STUDY DESIGN: Experimental Study

In an experimental study,a treatment,procedure or a program is intentionally introduced and results or outcomes are observed to find any changes.in this study,the manual diaphragm release techniques is introduced to one group along with breathing exercises and to other group,only the conventional treatment is provided.The chest mobility is measured by ultrasonography.

STUDY TYPE: Exploratory Analysis.

STUDY SETTING: Dr.D.Y Patil Medical College,Hospital and Research Centre,Pimpri,Pune,with support of the department of Pulmonary medicine and Radiology.When the patients were diagnosed with COPD and were admitted in the pulmonary ward,there the pre sonography ,spirometry and level of exertion is checked and included in the study according to inclusion and exclusion criteria.Patients were trained and given exercises and the post tests are measured in the ward itself.

TARGET POPULATION: Diagnosed COPD patients at Dr.D.Y Patil Medical College, Hospital and Research Centre,Pimpri,Pune.

SAMPLE POPULTION: Diagnosed COPD Patients at stage 1 and 2 fulfilling the inclusion and exclusion criteria.

SAMPLING TECHNIQUE: Random Technique

SAMPLE SIZE: 30 patients (15 patients in the experimental group and 15 in the control)

INCLUSION CRITERIA:

1. Both males and female patients.
2. Patients diagnosed with Copd by the department of Pulmonary Medicine.
3. Conscious,oriented and stable patients.

EXCLUSION CRITERIA:
1. Patients with severe stage of COPD.
2. Patients who are prone to spread infection and who are not able to perform spirometry.
3. Patients who has had any previous Thoracic surgeries.
4. Patients with severe dyspnoea.
5. Patients who are not willing to participate.
6. Patients with unstable medical conditions.
7. Patients with cognitive or physical impairments.
8. Any substantial chest deformity.
9. Vertebral or Rib fractured patients.
10. Patients with Thoracic or Spinal Scoliosis.
11. Patients with excessive Bowel gases.
12. Persons who cannot understand verbal commands

MATERIALS USED
1.Sphygmomanometer
2. Sthescope
3. Pulse oximeter
4. Cones
5. Stopwatch
6. Spirometry
7. Chair

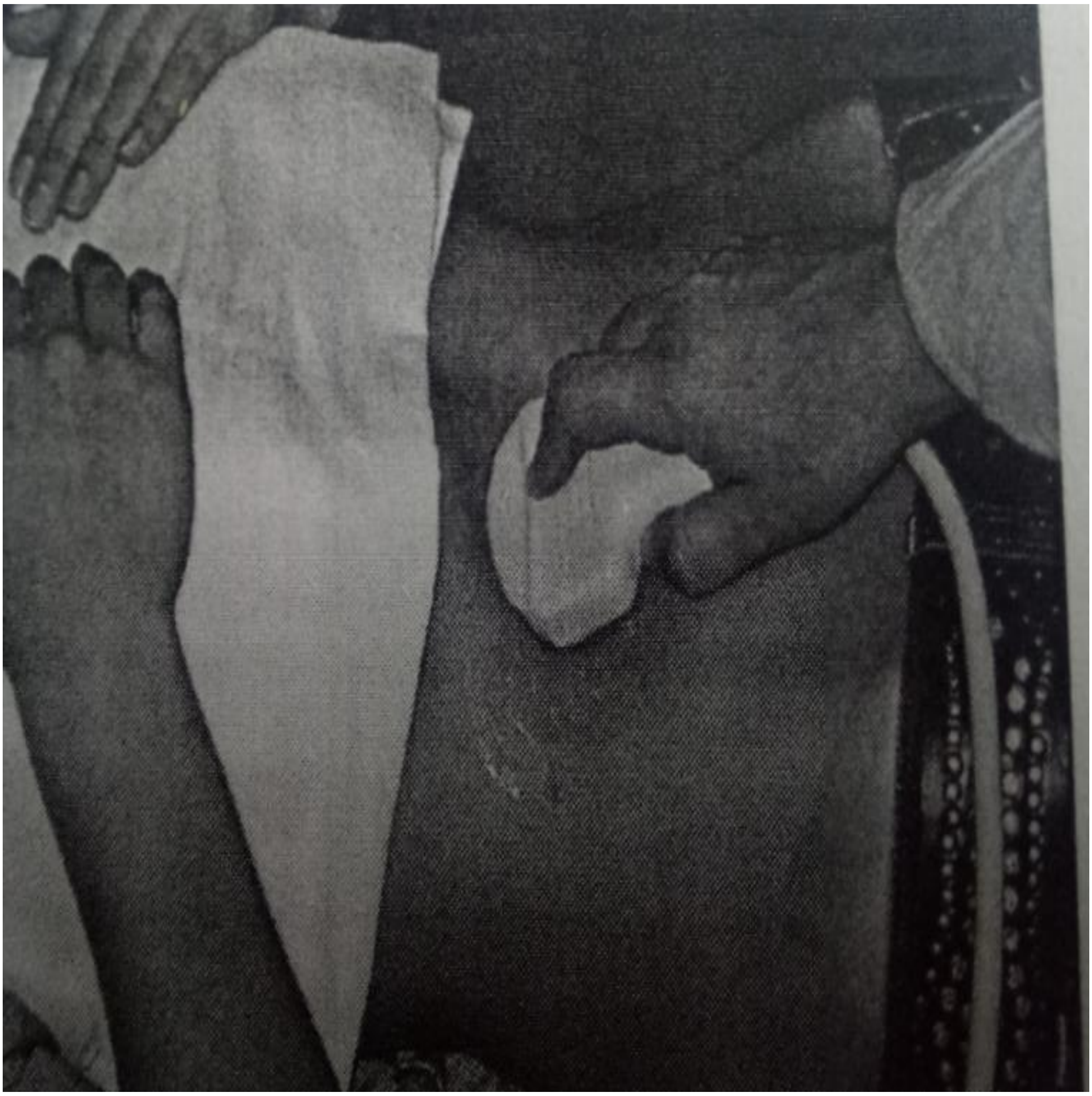
OUTCOME MEASURES
In this study three outcome measures were used for the betterment of the research process.
The three outcome measures includes:
1. Ultrasonography of the diaphragm
2. Pulmonary function Tests.
3. Level of perceived Exertion.

1. Ultrasonography of the diaphragm:

The diaphragmatic motion was analysed by a general purpose echo camera,equipped with a linear probe which is 3.5MHz.As the intrapulmonary air enters starts attenuating the transmission of the ultrasound waves , resulting in the abrupt images at the level at which the diaphragm reflects from the chest wall and the lung intervenes are used further.It is used to identify the position of the cephalic margin of the zones of apposition.Then the caudal border was measured by the costal margin.

The ultrasonographic probe was placed in the plastic frame which is fixed to the skin by adhesive tapes and manually kept in the fixed position during the experiment.The probe was aligned approximately axial and placed between the middle zone defining the lateral border completely.Tracking is done by the probe to measure its position and orientation.

The images were synchronized with the motion analyser and generated by a trigger signal that created frequency of 0.5 Hz on the ultrasonic image and that was recorded in the monitor.The images were recorded on recorder and was digitalized.Small movements of the margin of the zone of the apposition were detected and was obscured by rib at the initial or final position and the distance was measured in mm.



Pulmonary Function Tests:

A previously calibrated digital spirometer was used in order to assess the lung function,in accordance with the methods and the criteria recommended by the American Thoracic Society and The European Respiratory Society.

The parameters in the lung Tests involves:

1. FVC
2. FEV1
3. FEV1/FVC
4. Total Lung Capacity
5. Inspiratory Capacity
6. Functional Residual Capacity
7. Residual Volume

8. Airway Resistance.

The parameters used in the study includes:
1. Forced Vital Capacity
2. Forced Expiratory Volume

The reported spirometry results were presented as a percentage of the predicted values according to Knudson et al.
In order to obtain the three acceptable manoeuvres were used and two reproducible manoeuvres.
The highest values of the three correctly performed manoeuvres was being considered
Reports of the pre as well as post tests were obtained after a gap of three days.
Lung tests used in the diagnosis of COPD tells the severity,progression and prognosis.The presense of the airflow limitation is recognized by a reduction in the ratio of FV1 to the vital capacity.
In moderate to the severity of the airflow limitation,the best assessed is the FEV1 in relation to the reference values.
Suggested categorization of the patients in term of FEV1 is:

Severity	FEV1(% pred)
Mild	>-70
Moderate	50-69
Severe	<50

Severity of COPD based on Fev1.
FEV1 and FVC values are predicted pre and post tests with a gap of three days and the result is being compared with the pre to the post.

The level of Perceived Exertion is determined by the Borg Scale.This includes various grading systems.A six minute walk test is perfomed at a 30 m stretch placed with two cones,one at the start and one at the end.

A six minute carried out in 30m long corridor

.Subjects were instructed to walk from end to end of the corridor to cover the greatest distance possible in the allotted six minutes.

Patients who stopped walking during the test and who need a rest due to dyspnoea were then instructed to continue walking as soon as they felt comfortable, but the timer was not stopped.

The subjects received verbal motivation once every minute and the heart rate,respiratory rate,oxygen saturation and subjective dyspnoea was determined.

Pre as well as post tests were performed in a gap of three days and greatest distance covered was recorded as baseline value.

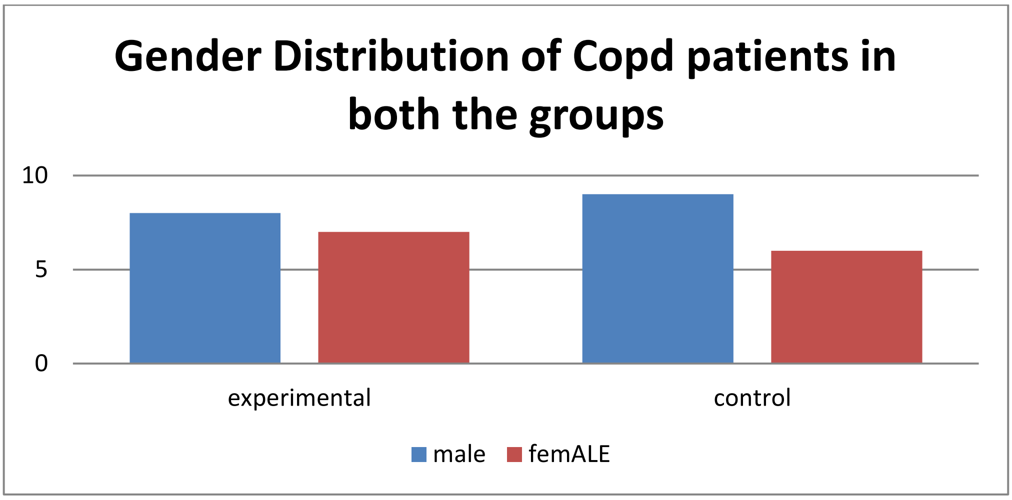
Modified Borg scale for dyspnoea:

0	
0.3	Nothing at all
0.5	Extremely weak
1	
1.5	Very weak
2	
2.5	Weak
3	
4	Moderate
5	
6	Strong
7	
8	Very strong
9	
10	Extremely strong

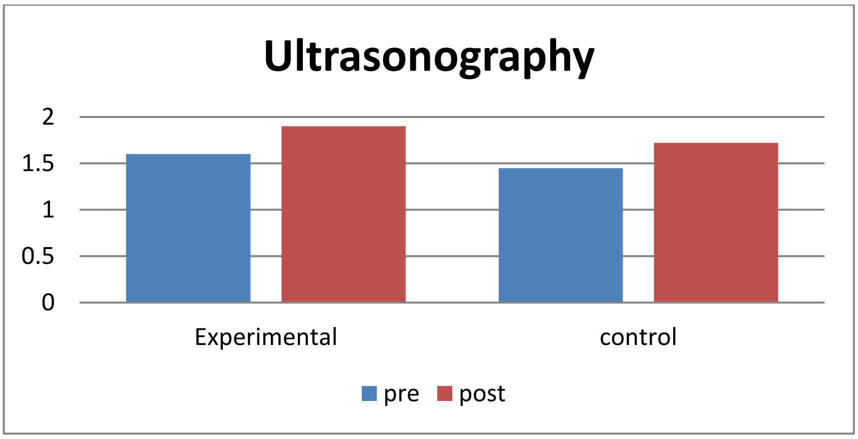
STATISTICAL ANALYSIS

Statistical Analysis was done using Winpepi and Primer Software for the pre and post values.To determine the normal distribution of the data Shapiro-Wilk test was used.Later for the normally distributed data paired and unpaired t-test was used,whereas Wilkoxan and Mann Whitney U test was applied for the normally distributed data for within and between group comparison respectively.

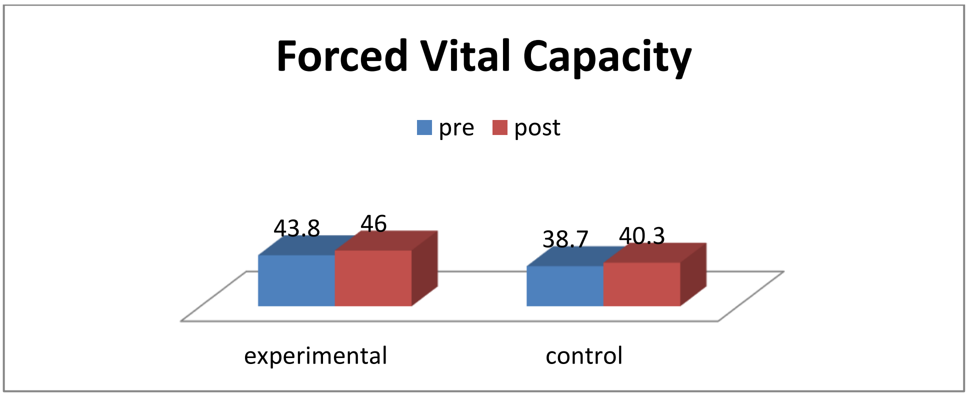
RESULTS



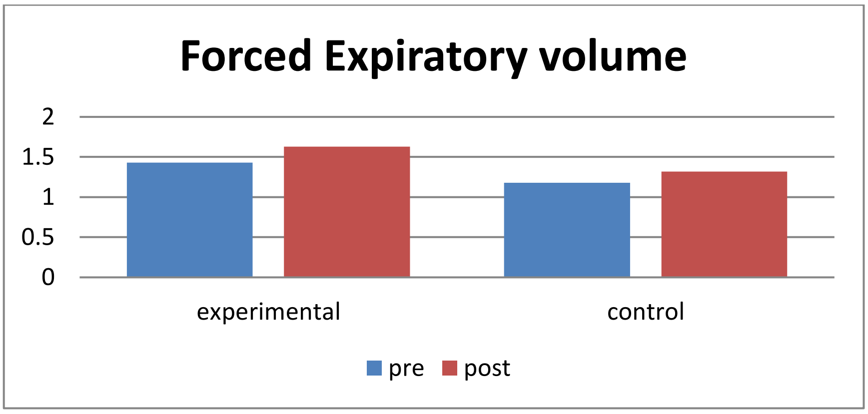
In this graph,this signifies the gender distribution in both the experimental as well as the control groups.In the sample size of 30 participants, 8 were males and 7 were females in the experimental group and 9 were males and 6 were females in the control group.



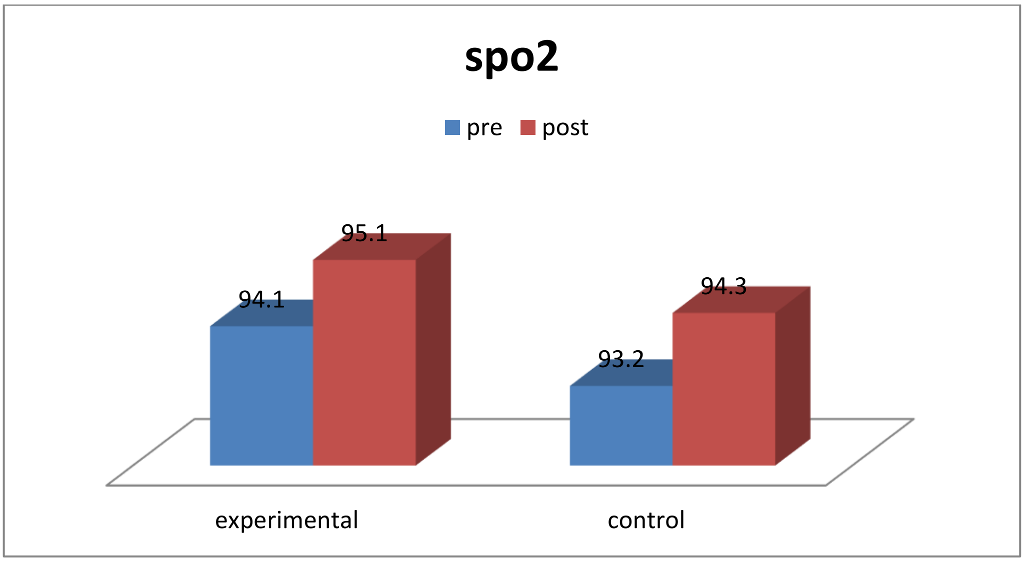
In this graph, the sonography of the diaphragm was done to check the net increase in the mobility which is measured in mm.There was a significant rise in the mobility in both the experimental as well as the control groups,ie; there was a net mobility of 1.6mm pre treatment session, which increased to 1.9mm in the experimental group,whereas the net average distance pre treatment session of the control group was 1.45mm which increased to 1.72mm post treatment session.



In this graph,the forced vital capacity is measured in both the groups which is expressed in percentage. In the experimental group,pre treatment session the forced vital capacity of the participants calculated average showed 43.8%,which had a significant increase post treatment session by 46%,whereas in the control group,pre treatment session there was an average of 38.7% FVC which increased till 40.3% post treatment session.



In this graph,the forced expiratory volume is measured in both the groups which is expressed in percentage. In the experimental group,pre treatment session the forced expiratory volume of the participants calculated average showed 1.43%,which had a significant increase post treatment session by 1.63%,whereas in the control group,pre treatment session there was an average of 1.18% FVC which increased till 1.32% post treatment session.



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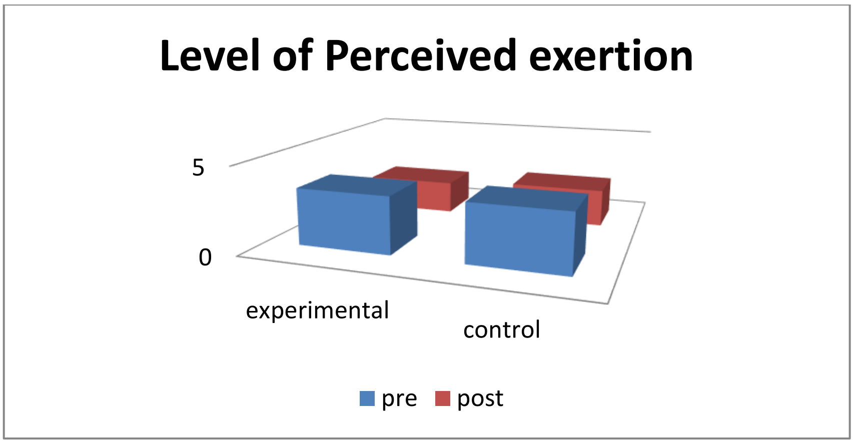
In this graph,the pre and post values of SpO2 are analysed.This is assessed using pulse oximeter.In the experimental group,the pre and post values of SpO2 had a significant increase from 94.1% to 95.1%, whereas in the control group,it increased from 93.2% to 94.3%.



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This graph signifies the level of perceived exertion through modified borg scale which has 15 components.This is done while the participant is performing a 6 minute walk test,the average values pre and post treatment sessions in the experimental group decreased from 3.33 to 1.93 and in the control group ranging from 3.4 to 2.2.

DISCUSSION

The diagnostic use of the ultrasound is widely known,since it provides bedside,non invasive and low cost examination assessment.This ultrasonography was mainly used in the study to check the mobility of the diaphragm from the baseline position.This has been used to detect pleural effusion as well as pneumothorax recently,along with the acute respiratory distress as well as pneumonia.

Although the role of the sonography in the qualitative assessment of the diaphragmatic motion is established,it also has technical difficulties and conflicting datas.This study proposes the quantitative as well as the qualitative movements of the diaphragm of the right with the help of M-mode application in the COPD patients.Its innovation consists of first the identification of the right hemidiaphragm and the placement of the transducer at the subcostal region anterior to the midclavicular line to achieve an ascending B-mode scanning which is transverse in the direction and considering the Inferior venacava and the gall bladder as the landmarks. This approach provides a reproducible and easily panoramic survey of the right hemidiaphragm.

Secondly,the target point can be easily found by just steering the transducer head over the dome in the craniocaudal direction,until the maximum distance of the diaphragm line is visible from the baseline in the top of the monitor.Patient is told to breathe deep in and out and the line is marked Thus the sonographic beam approximately intercepts the midposterior portion of the diaphragm,which gives the greatest diaphragmatic displacement during the forced breathing.

The intraobserver variability values of the excursion movements during the forced breathing is on average calculated pre as well as for the post increased from 1.60mm upto 1.90mm and the difference being 0.297mm.The maximum value of the pre tests is 3.1mm and the minimum is 0.86,whereas the maximum and the minimum post tests after a treatment of three days included 3.61mm and 1.05 respectively.

The evaluvation of the excursion done indirectly by the kidney,liver or spleen are less reliable with the M or B mode and their reporting consist of the lower values,

M-Mode techniques records a uni dimensional time depending pattern of the diaphragmatic cranio-caudal excursion,which gives a reproducible permanent trace on various parameters compared with the B mode.There was difficulties in obtaining the excursion in patients who are obese,or dyspneic,poor collaborating,who cannot understand commands or patients with painful abdomen.The greatest limitation was to observe the left diaphragm during forced breaths because of the gastric contents and the acoustic window by the spleen.So therefore a lateral intercostal approach was considered.Also on the other hand,the feasibility of the sonographic examination and its precision as well as the observer variability are accepted for the inexperienced investigator.

The safety of the technique is considered and confirmed in my study and all the participants performed this techniques without any discomfort.Furthermore,it took less time in assessing the distance of the diaphragm from the baseline when performed by experienced sonographer.

Further,this study included 30 participants of which 15 were in the experimental and 15 were in the control group.Every COPD patient was given the breathing exercise as well as upper limb and lower limb mobility exercises.The experimental group was provided with an additional treatment of Manual Diaphragmatic Release technique.

The other two outcome includes the pulmonary function testing, the saturation of the oxygen and also the level of the perceived exertion. The mean values of both the groups' pre and post of the forced vital capacity increased from 43% to 46% in the experimental group and from 45% to 46% in the control group. The saturation of the oxygen increased from 93% to 94% in the control group and from 94% to 95% in the experimental group. The forced expiratory volume significantly increased from an average of 1.43% to 1.63% in the experimental group whereas it increased from 1.18 to 1.32% in the control group.The level of perceived exertion being decided by the modified borg scale decreased from 3.3 to 1.3 in the experimental group which significantly reduced the dyspnoea levels and reduced from 3.4 to 2.2 in the control group.

This study showed a significant increase in the chest mobility,saturation of oxygen and pulmonary function in COPD patients and a decrease in the dyspnoeic levels at exertion.

CONCLUSION

This study concludes that there was a significant increase in both the diaphragmatic excursions as well as the pulmonary function tests in both the groups and both the treatment proved to be effective in their own unique way.

There was rapid rise in the experimental group which has the treatment of releasing the diaphragm manually and it proved to be effective.

CLINICAL IMPLICATION

The diaphragm being the most important respiratory muscle,used for the breathing contributes to various other process like vomiting,expectoration of the sputum.The clinical implication of this study can be used to manually assess the diaphragm.

By manual assessment,one can come to know roughly the chest mobility and this can help facilitate the proprioceptors,venous and lymphatic return and can help the diaphragm to work properly.

Also can be assessed in various positions like side lying and sitting when assessed clinically.

Also while assessing it can improve the local vascular supply and can help the patient to breathe properly.

FUTURE SCOPE

Because this study, has been conducted in a small group of population, in the further study a large group can be included.

This study has only included COPD patients and in the future study, the other set of the obstructive conditions as well as restrictive conditions can be experimented and studied. This study can be used to assess the diaphragm as well as to facilitate it.

By facilitating the diaphragm, the proprioceptors are increased leading to a relaxed breathing. This technique in the further study can be used to assess the quality of living of the patients as well as to assess a change in the overall posture of an individual.