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Original Research Article

Positive Expiratory Pressure (PEP) Therapy in Patients with Diseases of the Pleura

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ABSTRACT

Background: Diseases of the pleura such as pleural effusion, pneumothorax, hemothorax or hydropneumothorax are characterized by collection of air or fluid in the pleural space and are managed by draining the pleural space using an intercostal drain. Physiotherapeutic interventions such as breathing exercises and postural drainage are used to reduce work of breathing and improve ventilation. However, there is no established evidence on the effects of positive expiratory pressure (PEP) therapy in such patients.
Objectives: To assess the effectiveness of Positive Expiratory Pressure (PEP) therapy in patients with an intercostal drainage tube.
Materials and Methods: A quasi experimental pre-test and post-test design was used for the study. Thirty subjects were selected and randomly divided into two groups of fifteen subjects each. One group was given conventional breathing exercises and the other group was given conventional therapy along with bottle PEP therapy twice a day for 5 days continuous days. Chest expansion at 2^{nd}, 4^{th} and 6^{th} intercostal space, dyspnoea at rest and on activity, SPO_2 i.e. oxygen saturation and respiratory rate were assessed prior to and after intervention.
Results: Post PEP therapy there was improvement in respiratory rate, chest expansion at 2^{nd}& 4^{th} intercostal space, oxygen saturation, dyspnoea at rest and on activity. The mean difference of these parameters was statistically significant (p value<0.05).
Conclusions: Positive Expiratory Pressure therapy along with conventional therapy is more effective than only conventional therapy on respiratory parameters in patients with intercostal drain.
Keywords: Breathing exercises, Bottle Positive Expiratory Pressure, Conventional therapy, Intercostal drain, Physiotherapy

INTRODUCTION

The thoracic cavity is lined by the pleural membrane and the space between the layers of pleura contains pleural fluid. In diseases like pleural effusion, pneumothorax, hydropneumothorax there is collection of air or fluid in the pleural space. [1-3] Intercostal drain (ICD) is inserted to drain this fluid. This may include a water seal chamber, suction tube or gravity assisted drainage. The accumulation of fluid results in increased respiratory demands i.e. increased respiratory rate, decreased chest expansion and dyspnoea. [3] Physiotherapy exercises i.e. conventional breathing exercises are suggested as they maintain chest expansion, decrease dyspnoea and assist drainage of fluid. One school of thought suggests the use of only inspiratory exercises while the other suggests the use of both inspiratory as well as expiratory exercises. Positive Expiratory Pressure

(PEP) Therapy is a form of expiratory exercise. PEP therapy provides constant back pressure to the airways during expiration. It improves ventilation and the length tension relationship of muscles of inspiration. [4,5] PEP therapy is administered using PEP devices like flutter or acapella. [6,7] These devices like acapella and flutter work on the same mechanism as PEP bottle. But they are relatively more expensive. [1,2,6] Studies have documented the effects of PEP therapy in COPD, cystic fibrosis and bronchiectasis. [4,5,8] In these, PEP therapy helps in facilitating removal of secretions and thus improving ventilation. However, there is no established evidence on the effects of positive expiratory pressure (PEP) therapy in patients with intercostal drain.

MATERIALS AND METHODS

A quasi experimental pre-test and post-test design was used for the study and was conducted among the patients admitted in a government hospital of Pune city. The study was approved by the ethical committee of Deccan Education Society's Brijlal Jindal College of Physiotherapy. Prior to the study written consent was taken from all the subjects involved in the study. Patients with intercostal drain (1st or 2nd day of insertion) and reason for drain insertion being respiratory with pleural involvement were only included in the study. Patients on mechanical ventilator, patients with respiratory failure, patients with cognitive impairment, unconscious patients, patients having associated cardiovascular disease (congestive cardiac failure, myocardial infarction) were excluded from the study.

Thirty subjects were selected for the study. Patients were randomly divided into 2 groups. Fifteen subjects each in each group. The intervention was administered twice a day for 5 continuous days. One group was given conventional therapy i.e. diaphragmatic breathing, thoracic expansion exercises and pursed lip breathing -10 repetitions, 3 sets each. [9] Other group was given conventional therapy + PEP therapy (10 repetitions, 3 sets each). [10] The procedure was explained and demonstrated. For diaphragmatic breathing patient was told to sit straight and take a deep breath through the nose and exhale. The abdomen should rise during inhalation. For thoracic expansion exercise, patient was told to raise his arms during inhalation and bring down during exhalation (shoulder flexion during inhalation and getting it back to original position during exhalation and abduction during inhalation and back during exhalation). Pursed lip breathing involved inhaling through the nose and slow and sustained exhalation through the mouth. [7] PEP therapy was administered using a PEP bottle.

Figure 1: Bottle PEP device

Bottle PEP device was made using a 1 liter bottle. A tube of 8mm diameter was inserted through the cap of the bottle. In order to blow 3-4 cm tubing was outside the bottle. The length of the tubing as well as the flow significantly affect PEP pressure i.e. the system will not be a threshold resistor, with a tubing of 2-6mm. 4mm and 6mm increased the PEP pressure. A study done shows that the PEP pressure differences are not significant with any of the tubing lengths or flows tested with the inner tube diameter being 8mm or greater and is an efficient threshold resistor system. [11] Patient was told to blow through the pipe so that bubbles were formed in the water. A new disposable pipe and bottle was used for every patient. Pre and post treatment SpO2

(using pulse oximeter), respiratory rate (for a minute), chest expansion at the end of maximum inspiration (using measuring tape at 2nd, 4th, 6th intercostal space were taken)and dyspnoea at rest and on activity was assessed using the Borg scale. Data was entered and analysed using Statistical Package of Social Sciences (SPSS) version 21. In order to compare the two groups, unpaired t test was used for parametric measurements and Mann Whitney test was used for non-parametric measures.

Statistical analysis

Unpaired t test was used to assess whether mean difference of two groups (conventional and conventional + PEP therapy groups) were statistically significant.

Mann Whitney test was used to check for level of significance for the non-parametric parameter i.e. dyspnoea at rest and on activity

RESULTS

In the present study, 70% of the subjects were males and the remaining females (30%). The cause of intercostal drain insertion was pleural effusion and pyopneumothorax in 10%, empyema in 20%, hydropenumothorax in 27% and pneumothorax in 33 % of the subjects. The subjects were divided in two groups, 15 subjects were given conventional breathing exercises and 15 subjects were given conventional along with Bottle PEP therapy.

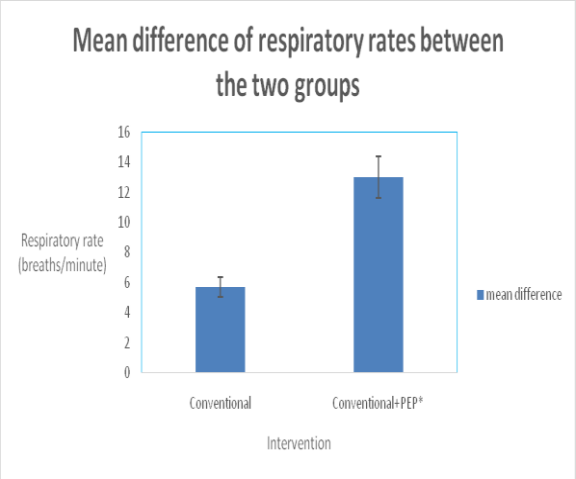

Figure2: Mean difference of respiratory rates between the two groups

Figure 2 shows that mean difference of respiratory rate was higher in the group receiving conventional along with PEP therapy.

Figure 3 shows that mean difference of oxygen saturation was higher in the group receiving conventional along with PEP therapy.

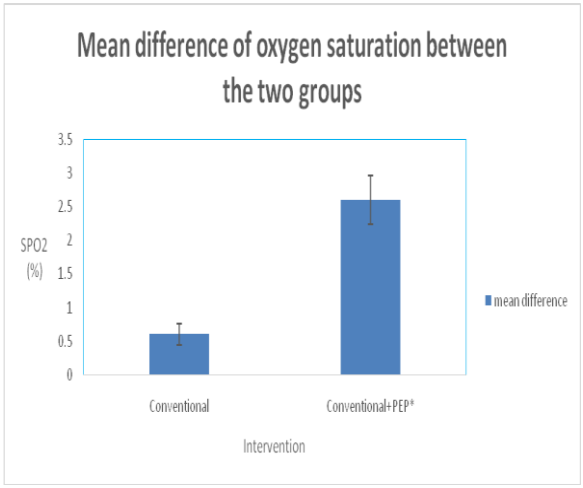

Figure 3: Mean difference of oxygen saturation between the two groups

Figure 4 shows that mean difference of chest expansion at 2nd intercostal space during maximum inspiration was higher in the group receiving conventional along with PEP therapy.

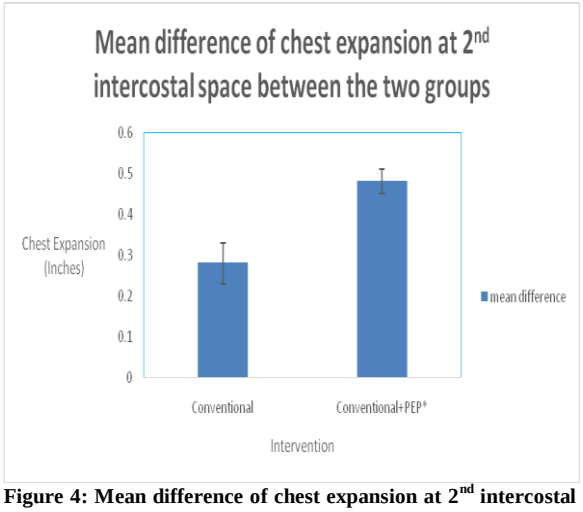

Figure 4: Mean difference of chest expansion at 2nd intercostal space between the two groups

Figure 5 shows that mean difference of chest expansion at 4th intercostal space during maximum inspiration was higher in the group receiving conventional along with PEP therapy.

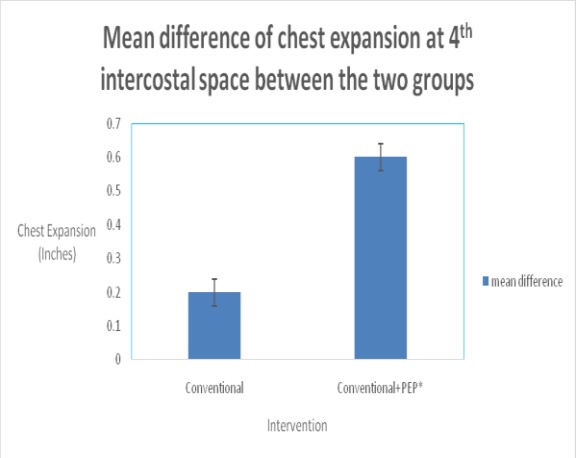

Figure 5: Mean difference of chest expansion at 4th intercostal space between the two groups

Figure 6 shows that mean difference of chest expansion at 6th intercostal space during maximum inspiration was higher in the group receiving conventional along with PEP therapy.

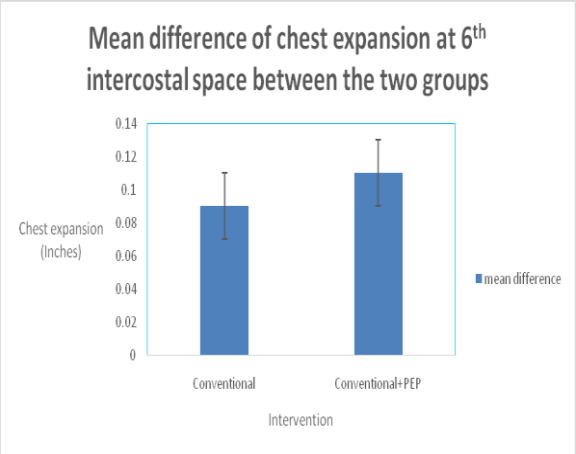

Figure 6: Mean difference of chest expansion at 6th intercostal space between the two groups

Figure 7 shows that mean difference of dyspnoea at rest was higher in the group receiving conventional along with PEP therapy.

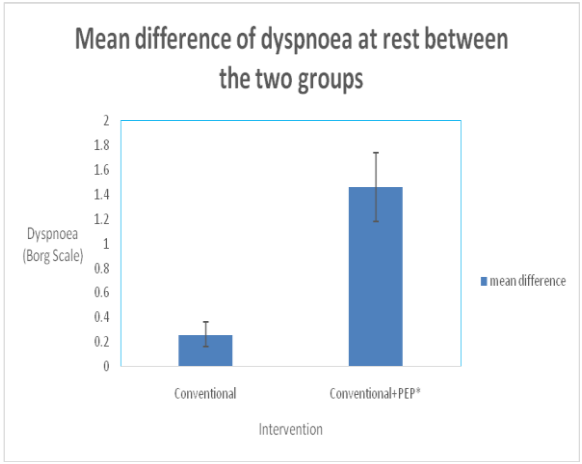

Figure 7: Mean difference of dyspnoea at rest between the two groups

Figure 8 shows that mean difference of dyspnoea on activity was higher in the group receiving conventional along with PEP therapy.

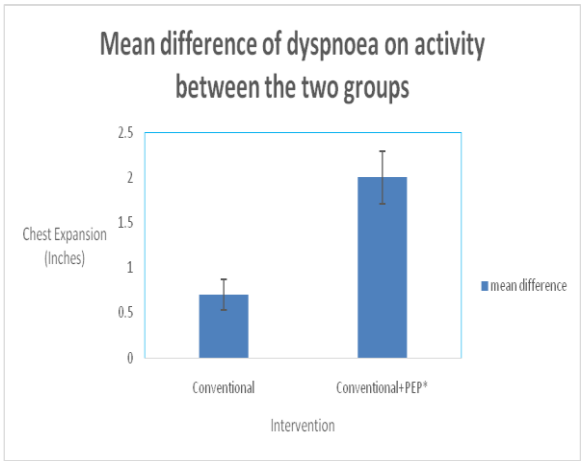

Figure 8: Mean difference of dyspnoea on activity between the two groups

The mean difference between pre-test and post-test was higher in the group receiving PEP therapy as compared to the group receiving only conventional breathing exercises.

Table 1: Effectiveness of conventional and conventional + PEP therapy on respiratory parameters

Parameters	Therapy	Mean difference	SE of mean	P value
Respiratory Rate (breaths/minute)	Conventional therapy	5.7	0.65	<0.0001
	Conventional therapy+PEP	13	1.38	
SPO2 (Oxygen Saturation) %	Conventional therapy	0.60	0.16	<0.001
	Conventional therapy+PEP	2.6	0.36	
Chest expansion-2nd intercostal space (inches)	Conventional therapy	0.28	0.05	<0.008
	Conventional therapy+PEP	0.48	0.03	
Chest expansion-4th intercostal space (inches)	Conventional therapy	0.2	0.04	<0.0001
	Conventional therapy+PEP	0.6	0.04	
Chest expansion-6th intercostal space (inches)	Conventional therapy	0.09	0.02	<0.458
	Conventional therapy+PEP	0.11	0.02	
Dyspnoea-at rest (Borg Scale)	Conventional therapy	0.26	0.10	<0.0016
	Conventional therapy+PEP	1.46	0.28	
Dyspnoea-on activity (Borg Scale)	Conventional therapy	0.7	0.17	<0.0009
	Conventional therapy+PEP	2.00	0.29	

Table 1 gives the mean difference, standard error of mean difference of respiratory rate, SPO2, chest expansion at 2^{nd}, 4^{th}& 6^{th}intercostal space, dyspnoea at rest and on activity. Respiratory rate, SPO2, chest expansion at 2^{nd}, 4^{th}& 6^{th} intercostal space, dyspnoea at rest and on activity were significant (p value <0.05). Chest expansion at 6^{th} intercostal space was not significant. Thus, showing that conventional along with PEP therapy is more effective in improving the respiratory parameters in patients with intercostal drain.

DISCUSSION

The purpose of the study was to compare the effects conventional breathing exercises and PEP therapy on respiratory parameters in patients with intercostal drains. The effects of conventional breathing exercises have been documented. But no study has been done to check the effectiveness of PEP therapy on patients with intercostal drain. Conventional exercises assist in causing lung expansion by the phenomenon of alveolar interdependence. [1] Conventional exercises create a negative pressure thus allowing expansion of the adjacent alveoli. Thus, helping in chest expansion and reducing the intensity of dyspnoea. [12,13] Positive-expiratory-pressure (PEP) therapy uses positive airway pressure generated by a either a fixed-orifice resistor or a threshold resistor. [1,14] Patient-administered Positive Expiratory Pressure (PEP) breathing has been promoted as an effective therapeutic modality for removing mucus and improving ventilation distribution in these patients. Improvements in gas mixing may lead to increase in oxygenation and thus increase in functional exercise capacity. [9] PEP Therapy opens the airways during exhalation by creating a back pressure. [1-3] It allows more air to enter through the peripheral airways and collateral channels, thus allowing reinflation of collapse alveoli. Pressure is built up distal to an obstruction thus causing movement of fluid outside. Even in patients with unstable airways this proves to be effective. [1] PEP therapy also maintains airway stability promoting improved ventilation, gas exchange and airway clearance. It has effects on ventilation, gas mixing, maintaining lung volumes, inspiratory as well as expiratory airflow, percentage of arterial blood oxyhemoglobin saturation (SpO2). [1,11,15] The main cause of dyspnoea is the functional weakening of respiratory muscles due to dynamic hyperinflation thus contributing to an aggravating dyspnoea. [1] PEP facilitates chest expansion and improves the contractile properties of respiratory muscles that are mainly responsible for dyspnoea i.e. pattern of tension development, functional weakening (hyperinflation) and fatigue. It improves lung function and reduces pulmonary hyperinflation which is an important factor contributing to dyspnoea. [7,13] It also prevents dynamic airway compression and improves airflow acceleration by increasing the airway diameter thus reducing the intensity of dyspnoea. PEP therapy decreases perception of respiratory effort sensation as well as decreases perception of dyspnoea during exercise and loaded breathing. [13,15] This occurs via a reduction in the level of motor outflow. It promotes greater expiratory rib cage and abdominal muscle recruitment due to the pressure that is built up. [16] Immediate improvements in forced expiratory flow during the middle half of the forced vital capacity are also seen after PEP therapy.

Implications

It decreases duration of hospitalization, self-treatment is possible because of its small size and it is very easy to learn. Blow-bottles were found preferable because they are not time-consuming. [10,15,17,18] It is also effective, easy and safe to monitor. [17,18] Thus, inspiratory exercises as well as expiratory exercises along with PEP therapy are more effective on respiratory parameters. [19]

Limitations

The limitation of the study was that it was done on a small sample size and did not evaluate the effect of Positive Expiratory Pressure therapy on drainage. Also the confounders like effect of drugs or other interventions were not assessed. Amount of fluid drained was not compared. Another limitation of the study was lack of blinding of the therapist which may be a cause of bias in the study.

CONCLUSION

PEP + conventional therapy were more effective than only conventional therapy on respiratory parameters in patients with intercostal drain (ICD).

Recommendations

Studies can be done on a larger sample size using various radiological findings and fluid level assessment.

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