

Original Article

Effects of Costophrenic Assisted Cough and Anterior Chest Compression on Outcomes in COPD

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ABSTRACT

Background: Chronic obstructive pulmonary disease (COPD) significantly impairs respiratory function due to airflow limitation, leading to symptoms like dyspnea, cough, and mucus production. Assisted coughing techniques, such as costophrenic assisted cough and anterior chest compression, are critical in managing secretion clearance, thus potentially reducing exacerbations and improving quality of life in COPD patients.

Objective: This study aims to compare the effectiveness of costophrenic assisted cough and anterior chest compression techniques on clinical outcomes such as sputum production, oxygen saturation, expiratory flow rate, and perceived dyspnea in patients with COPD.

Methods: In a randomized clinical trial, 36 patients diagnosed with COPD were allocated into two groups. Group A (18 patients) received costophrenic assisted cough, and Group B (18 patients) received anterior chest compression. Interventions were administered on alternate days for one week. Outcome measures included sputum diary, oxygen saturation (SaO₂), peak expiratory flow rate (PEFR), and the Borg dyspnea scale, assessed at baseline, after the intervention week, and at a follow-up four weeks later. Statistical analyses were performed using SPSS version 25.0, with significance set at $p < 0.05$.

Results: The study comprised 72.2% males with an average age of 53.38 ± 6.07 years. Post-intervention, Group B showed a more significant improvement in SaO₂, with mean values rising from 90.94 ± 1.109 to 95.50 ± 1.689 , compared to Group A, which improved from 91.50 ± 1.46 to 94.83 ± 1.61 . PEFR increased from 284.50 ± 48.04 L/min to 389.50 ± 26.69 L/min in Group B, outperforming Group A's increase from 286.66 ± 49.391 L/min to 340.00 ± 32.03 L/min. Borg dyspnea scores decreased more in Group B, from 7.44 ± 1.65 to 2.55 ± 1.096 , versus Group A's decrease from 7.27 ± 1.526 to 4.00 ± 0.84 . All results were statistically significant ($p < 0.05$).

Conclusion: While both costophrenic assisted cough and anterior chest compression effectively improved pulmonary outcomes in COPD patients, anterior chest compression was more effective across all measured parameters. This technique could be considered a preferable method for enhancing airway clearance in COPD management.

INTRODUCTION

Chronic obstructive pulmonary disease (COPD) is a progressive respiratory condition characterized by persistent airflow limitation and difficulty breathing, typically caused by long-term exposure to irritants such as cigarette smoke, air pollution, or occupational hazards (1, 2). COPD encompasses two main conditions: chronic bronchitis, which involves inflammation and narrowing of the airways, and emphysema, which involves damage to lung tissue and loss of elasticity. This disease is a

significant global health burden, responsible for early mortality, high death rates, and substantial healthcare costs. Projections indicate that by 2025, COPD will be the third leading cause of death worldwide and the fifth leading cause of years lost due to early mortality or disability (disability-adjusted life years) (3,4). COPD is defined as chronic airflow obstruction that is progressive and only partly reversible (5).

The hallmark symptoms of COPD include shortness of breath, chronic cough, excessive mucus production, and wheezing, which often worsen over time and significantly impact the quality of life (6). Diagnosis typically involves

a combination of medical history, physical examination, lung function tests (such as spirometry), and imaging studies (7, 8). Pulmonary rehabilitation, which includes physical education programs, patient education, psychosocial support, and breathing exercises, is a crucial aspect of managing COPD (9). The two main conditions under the COPD umbrella, chronic bronchitis and emphysema, although sharing similarities, contribute differently to respiratory impairment. Chronic bronchitis is marked by chronic inflammation and narrowing of the airways, leading to a persistent cough and difficulty in clearing the airways (10). Emphysema involves damage to lung tissue and loss of elasticity in the alveoli, reducing surface area for gas exchange and impairing the removal of carbon dioxide from the body (11). The combination of both conditions results in significant respiratory symptoms, including shortness of breath, coughing, and reduced exercise tolerance. Treatment options for COPD aim to alleviate symptoms, reduce exacerbations, and improve exercise tolerance, often involving lifestyle changes, medication, and pulmonary rehabilitation (12). Smoking cessation is critical in managing COPD, significantly slowing disease progression (13).

COPD can cause lungs to produce excess mucus, leading to frequent coughing, although not all coughs are effective in clearing mucus from the lungs. In COPD, the function of cilia, tiny hair-like structures in the airways, can be compromised, leading to decreased mucus clearance and reduced coughing effectiveness (14). Effective coughing is crucial for clearing the airways of foreign bodies and secretions. However, in COPD patients, the effectiveness of this protective reflex is often impaired due to respiratory muscle weakness and cilia dysfunction (15). Retained secretions in the lungs can obstruct the airways, impede gas exchange, and increase the risk of respiratory infections, contributing to decreased oxygen levels in the blood. Atelectasis, the partial or complete collapse of a lung, can result from retained secretions blocking the smaller airways, further impairing lung function and increasing infection risk.

To enhance the effectiveness of coughing in clearing mucus, manually assisted coughing techniques are often employed in pulmonary rehabilitation. These techniques help patients expectorate secretions, reducing exacerbations and hospital stays. Costophrenic assist, also known as the "huff cough" technique, involves applying manual pressure to the lower ribs and upper abdomen during the coughing maneuver to enhance the effectiveness of the cough. Anterior chest compression involves applying manual pressure to the anterior chest wall during the coughing maneuver to provide external support and aid in the forceful expulsion of air and mucus from the airways. These techniques are often used in combination with other airway clearance techniques and

may be part of a comprehensive respiratory care plan supervised by healthcare professionals.

In this study, we aimed to compare the effects of costophrenic assisted cough and anterior chest compression techniques on sputum diary, oxygen saturation, expiratory flow rate, and dyspnea in patients with chronic obstructive pulmonary disease. The collected data can help medical professionals understand the efficacy of these techniques in sputum expectoration, airway clearance, and improving oxygen saturation and dyspnea in COPD patients. The study hypothesized that while both techniques are effective, anterior chest compression may offer superior benefits in improving these outcome measures, thus providing a basis for more effective management strategies for COPD.

MATERIAL AND METHODS

The study was designed as a randomized clinical trial (NCT05922241), conducted over a period of 10 months following the approval of the synopsis. A sample size of 36 patients was calculated based on previous studies using Epitools software, with an attrition rate of 10%, resulting in 18 patients in each group. The study was carried out at Sheikh Zayed Hospital, Rahim Yar Khan. Patients aged 40 to 60 years, with mild to moderate COPD according to the GOLD criteria, decreased oxygen saturation levels (below 60mmHg), and immobilized mucus, were included. Exclusion criteria encompassed tachycardia (above 100 beats per minute), tachypnea (above 20 breaths per minute), cardiovascular pathology, myopathy, and neurogenic disease.

Non-probability convenient sampling was employed to recruit patients who met the eligibility criteria. Upon recruitment, patients provided informed consent in accordance with the Declaration of Helsinki, ensuring ethical standards were upheld. Randomization was performed using a simple random sampling method, assigning participants to either Group A (costophrenic assist) or Group B (anterior chest compression). The study was single-blinded, with patients unaware of their assigned interventions.

Data collection tools included the Breathlessness, Cough, and Sputum Scale (BCSS), Modified Borg Dyspnea (RPE) Scale, Peak Flow Meter, and Pulse Oximeter. The BCSS rated symptoms of dyspnea, cough, and sputum on a Likert scale from 0 (no symptoms) to 4 (severe symptoms). The RPE scale ranged from 0 (no exertion) to 10 (maximum effort) (51). The Peak Flow Meter measured forced air flow in liters per minute, providing readings on a scale of 1 to 10. Pulse oximetry was used to measure oxygen saturation levels non-invasively, detecting minute variations in oxygen levels.

Baseline treatment for both groups included chest percussion and tapping in the side-lying position. Group

A participants received costophrenic assist, wherein patients were positioned upright or slightly inclined, and manual pressure was applied to the lower ribs and upper abdomen during the coughing maneuver. The pressure was applied in an upward and inward motion, facilitating the upward movement of the diaphragm and enhancing cough effectiveness. Group B participants received anterior chest compression, involving manual pressure applied to the anterior chest wall during the coughing maneuver. Pressure was applied in a downward and inward motion, targeting the sternum and lower chest, to provide external support during forceful cough expulsion. Each session lasted 30 to 40 minutes and was performed once daily on alternate days (days 1, 3, 5, and 7), with post-intervention readings taken on the seventh day and follow-up data collected on the twentieth day

Data analysis was conducted using SPSS version 25.0. Demographic and categorical variables were presented as frequencies, percentages, mean, and standard deviation. The normality of data was tested using the Shapiro-Wilk test, confirming normal distribution ($p > 0.05$). Parametric tests, including paired t-tests and independent t-tests, were utilized for within-group and between-group comparisons, respectively. The level of significance was set at $p < 0.05$.

The study adhered to ethical guidelines, obtaining approval from the institutional review board. All participants provided informed consent, and confidentiality was maintained throughout the study. The findings aimed to provide insights into the comparative effectiveness of costophrenic assisted cough and anterior chest compression in improving sputum diary, oxygen saturation, expiratory flow rate, and dyspnea in COPD patients.

RESULTS

A total of 36 participants were enrolled in the study, with 26 males (72.2%) and 10 females (27.8%), and the mean age was 53.38 ± 6.07 years. The data were normally distributed as verified by the Shapiro-Wilk test ($p > 0.05$). Both within-group and between-group analyses were conducted using paired and independent t-tests, respectively. The significance level was set at $p < 0.05$.

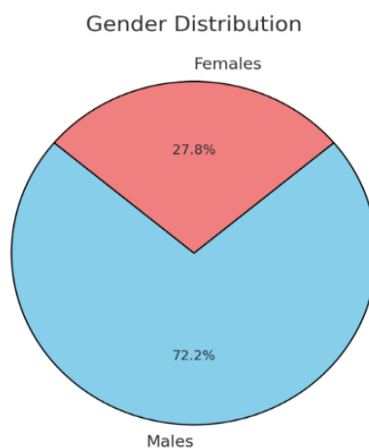


Figure 1 Gender Distribution

The results indicate statistically significant improvements in both groups for all measured parameters post-intervention and at follow-up, with the anterior chest compression (ACC) group showing superior results in oxygen saturation, expiratory flow rate, and reduction in dyspnea as measured by the BCSS and RPE scales ($p < 0.05$).

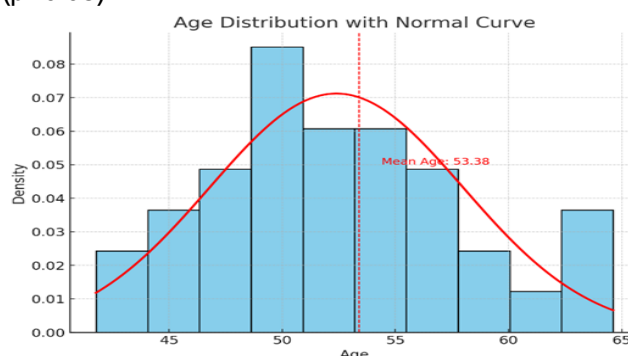


Figure 2 Age Histogram

The normality of the data was analyzed using the Shapiro-Wilk test:

Table 1 Normality Tests

Measure	Kolmogorov-Smirnova	Sig	Shapiro-Wil	Sig
Pretreatment RPE	36	0.312*	36	0.082
Pretreatment SaO2	36	0.200*	36	0.092
Pretreatment PEFR	36	0.200*	36	0.234
Pretreatment BCSS	36	0.230*	36	0.095

Table 2 Within-Group Comparison – CA Group

Measure	Mean ± SD (Pre)	Mean ± SD (Post)	Mean ± SD (Follow-up)	p-value (Pre vs Post)	p-value (Post vs Follow-up)
SaO2 (%)	91.50 ± 1.46	94.83 ± 1.61	94.00 ± 0.766	0.000	0.325
RPE	7.27 ± 1.526	4.00 ± 0.84	5.11 ± 1.23	0.000	0.001
PEFR (L/min)	286.6 ± 6	340.00 ± 32.03	332.00 ± 31.992	0.000	0.02

Measure	Mean ± SD (Pre)	Mean ± SD (Post)	Mean ± SD (Follow-up)	p-value (Pre vs Post)	p-value (Post vs Follow-up)
	49.39				
	1				
BCSS	8.00 ± 2.65	3.83 ± 1.68	6.00 ± 1.846	0.000	0.004

Table 3 Within-Group Comparison – ACC Group

Measure	M±SD (Pre)	M±SD (Post)	M±SD (F-up)	Sig (Pre vs Post)	Sig (Post vs F Up)
SaO2 (%)	90.94 ± 1.109	95.50 ± 1.689	96.00 ± 0.970	0.000	0.096
RPE	7.44 ± 1.65	2.55 ± 1.096	3.55 ± 0.704	0.000	0.002
PEFR (L/min)	284.5 ± 48.04	389.50 ± 26.69	387.11 ± 26.506	0.000	0.000
BCSS	8.50 ± 2.23	3.55 ± 2.22	3.00 ± 1.847	0.000	0.000

Table 4 Between-Group Comparison

Measure & Group	M±SD (Pre)	M±SD (Post)	M±SD (F-up)	Sig (Pre)	Sig (Pos)	Sig (F up)
RPE CA	7.27 ± 1.526	4.00 ± 0.84	5.11 ± 1.23	0.75	0.00	0.000
AC C	7.44 ± 1.65	2.55 ± 1.096	3.55 ± 0.704			
PEFR (L/min) CA	286.6 ± 49.39	340.0 ± 32.03	332.0 ± 31.99	0.89	0.00	0.000
AC C	284.5 ± 48.04	389.5 ± 26.69	387.1 ± 26.50			
BCSS CA	8.00 ± 2.65	3.83 ± 1.68	6.00 ± 1.846	0.54	0.01	0.000
AC C	8.50 ± 2.23	3.55 ± 2.22	3.00 ± 1.847			
SaO2 (%) CA	91.50 ± 1.46	94.83 ± 1.61	94.00 ± 0.766	0.20	0.01	0.000
AC C	90.94 ± 1.109	95.50 ± 1.689	96.00 ± 0.970			

The findings support the efficacy of both costophrenic assisted cough (CA) and anterior chest compression (ACC) techniques in managing COPD, with ACC demonstrating greater overall effectiveness in enhancing respiratory function and symptom relief.

DISCUSSION

The study aimed to evaluate the comparative effects of costophrenic assisted cough and anterior chest

compression on sputum diary, oxygen saturation, expiratory flow rate, and dyspnea in patients with chronic obstructive pulmonary disease (COPD). The findings demonstrated significant improvements in all measured parameters post-intervention and at follow-up in both groups, with the anterior chest compression group showing superior results. These results aligned with previous research that highlighted the efficacy of manually assisted coughing techniques in enhancing mucus clearance and improving respiratory function in COPD patients (16, 17).

The improvement in sputum clearance, as evidenced by significant changes in the sputum diary, suggested that both techniques were effective in mobilizing and expelling mucus from the airways, thereby reducing the risk of respiratory infections and exacerbations. This finding was consistent with studies that reported the benefits of airway clearance techniques, including manually assisted cough and mechanical insufflation-exsufflation, in managing respiratory muscle weakness and improving mucus clearance (18)

Enhanced oxygen saturation levels observed in the study participants corroborated previous findings that assisted coughing techniques could significantly improve blood oxygen levels by facilitating better ventilation and gas exchange (19). The results showed that anterior chest compression had a more pronounced effect on oxygen saturation compared to costophrenic assist, suggesting that the former might be more effective in optimizing pulmonary function and reducing hypoxemia in COPD patients.

The significant increase in peak expiratory flow rate (PEFR) in both groups indicated that both techniques effectively enhanced expiratory muscle strength and airflow during forced exhalation. This outcome supported earlier research that emphasized the role of manually assisted cough and chest compression in improving expiratory flow rates and overall respiratory mechanics in patients with obstructed airways (20). The study also found that the anterior chest compression group exhibited greater improvements in PEFR, highlighting its potential as a more effective intervention for enhancing expiratory flow in COPD patients.

The reduction in dyspnea, as measured by the Borg rate of perceived exertion (RPE) and Breathlessness, Cough, and Sputum Scale (BCSS), further validated the effectiveness of both interventions in alleviating respiratory distress. These findings were in line with previous studies that demonstrated significant reductions in dyspnea and improvements in quality of life following the application of assisted coughing techniques in COPD patients (20). The greater reduction in dyspnea observed in the anterior chest compression group suggested that this technique might offer additional benefits in managing breathlessness and enhancing patient comfort.

Despite these positive outcomes, the study had several limitations. The small sample size and single-centered design might have limited the generalizability of the findings. Conducting the study in a single center could introduce bias and reduce the diversity of the patient population, potentially impacting the external validity of the results. Moreover, the study did not include a long-term follow-up period, which would have been essential to assess the sustained impact of the interventions on COPD management. Future research should consider expanding the sample size and including multiple centers to enhance the representativeness of the study population. Incorporating a follow-up period would provide valuable insights into the long-term efficacy and safety of the interventions (21).

Another limitation was the lack of blinding at the therapist or assessor level, which could introduce bias in outcome assessments. Implementing blinding in future studies could help reduce potential biases and improve the reliability of the findings. Additionally, expanding the range of outcome measures to include parameters such as quality of life, exacerbation rates, and hospitalization rates would offer a more comprehensive assessment of the interventions' effects.

CONCLUSION

In conclusion, the study provided evidence that both costophrenic assisted cough and anterior chest compression were effective in improving sputum diary, oxygen saturation, expiratory flow rate, and dyspnea in copd patients. However, anterior chest compression demonstrated superior efficacy in enhancing these outcomes. These findings underscored the importance of incorporating effective airway clearance techniques in the management of copd to improve respiratory function and patient well-being. Future research should address the study's limitations and explore the long-term benefits of these interventions to further inform clinical practice.

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