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# EFFECTS OF ACTIVE CYCLE OF BREATHING TECHNIQUE AND POSTURAL DRAINAGE VERSUS ACTIVE CYCLE OF BREATHING TECHNIQUE AND AUTOGENIC DRAINAGE ON PULMONARY FUNCTION TEST IN BRONCHIECTASIS PATIENTS

*Original Research*

**Muhammad Azam Ghaffar[1], M Behzad Ali[2]* Muhammad Tahir Akram[3], Omair Khan[4], Neelam Ashraf[5], Ahmar Zafar[6], Adnan Hashim[7]**
[1]Physiotherapist, Shifa Modern Physiotherapy Centre, Abha, Saudi Arabia.
[2]Clinical Physiotherapist, Health Physio Clinic Multan, Pakistan.
[3]Physiotherapist, Patients' Aid foundation (JPMC), Pakistan.
[4]Cureway Rehabilitation Center, Najran, Saudi Arabia.
[5]Physiotherapist, Jinnah Postgraduate Medical Centre Karachi, Pakistan, Coordinator Physiotherapy College JPMC, Pakistan.
[6]Physiotherapist, Department of Rehabilitation Sciences, Move Better, Faisalabad, Pakistan.
[7]University Institute of Physical Therapy, The University of Lahore, Pakistan.
**Corresponding Author:** M Behzad Ali, Physiotherapist, Shifa Modern Physiotherapy Centre, Abha, Saudi Arabia. azamghaffar9@gmail.com
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## ABSTRACT

**Background:** Bronchiectasis is a chronic respiratory disorder characterized by irreversible bronchial dilation, impaired mucociliary clearance, and recurrent infections, leading to progressive pulmonary dysfunction. Airway clearance techniques play a crucial role in managing symptoms and improving respiratory function. The active cycle of breathing technique (ACBT) is a widely used physiotherapy intervention, often combined with postural drainage (PD) or autogenic drainage (AD). However, comparative evidence regarding their efficacy remains limited. This study aimed to evaluate and compare the effects of ACBT combined with postural drainage versus ACBT combined with autogenic drainage on pulmonary function tests (PFTs), arterial blood gases (ABGs), and sputum profile in patients with bronchiectasis.

**Objective:** To compare the effects of ACBT with postural drainage versus ACBT with autogenic drainage on PFTs, ABGs, and sputum profile in patients with bronchiectasis.

**Methods:** A randomized clinical trial was conducted, enrolling 36 patients diagnosed with bronchiectasis. Participants were randomly assigned into two groups: Group A received ACBT combined with postural drainage, while Group B received ACBT combined with autogenic drainage. Pulmonary function parameters, including forced vital capacity (FVC), forced expiratory volume in one second (FEV1), FEV1/FVC ratio, and peak expiratory flow rate (PEFR), were assessed using spirometry. Arterial blood gases (pH, $PaO_2$, $PaCO_2$, $HCO_3^-$) were analyzed using the GEM Premier 3000. Cough and sputum severity were evaluated using the CASA-Q questionnaire. Assessments were conducted at baseline and after three weeks of treatment.

**Results:** Between-group comparisons showed no statistically significant differences ($p>0.05$) in PFTs, ABGs, or sputum parameters. However, within-group analysis revealed significant improvements in both groups. In Group A, FVC increased from 2.1L to 2.5L ($p=0.019$), FEV1 improved from 1.7L to 2.0L ($p=0.019$), and PEFR rose from 5.2L/sec to 5.8L/sec ($p=0.000$). In Group B, FVC increased from 2.2L to 2.6L ($p=0.019$), FEV1 improved from 1.6L to 2.1L ($p=0.019$), and PEFR rose from 5.0L/sec to 6.0L/sec ($p=0.000$). ABG analysis indicated significant improvements in pH ($p=0.001$), $PaO_2$ ($p=0.012$), and $HCO_3^-$ ($p=0.014$) within both groups, while $PaCO_2$ changes were insignificant ($p>0.05$). Cough and sputum severity significantly decreased in both groups ($p<0.05$), though between-group differences remained non-significant.

**Conclusion:** Both ACBT combined with postural drainage and ACBT combined with autogenic drainage proved to be effective in improving pulmonary function, arterial blood gases, and symptom severity in bronchiectasis patients. However, no significant differences were observed between the two techniques, suggesting that both can be utilized interchangeably based on patient preference and clinical feasibility.

**Keywords:** Active Cycle of Breathing Technique, Airway Clearance Therapy, Autogenic Drainage, Bronchiectasis, Postural Drainage, Pulmonary Function Tests, Respiratory Therapy.

 

## INTRODUCTION

Bronchiectasis is a chronic respiratory condition characterized by the permanent dilation of the bronchial airways due to recurrent or persistent damage to the airway walls. This structural alteration leads to impaired mucociliary clearance, accumulation of thick mucus, and an increased susceptibility to bacterial infections, contributing to symptoms such as chronic cough, sputum production, shortness of breath, and recurrent respiratory infections (1). The etiology of bronchiectasis is diverse, ranging from recurrent respiratory tract infections, cystic fibrosis, and immunodeficiency disorders to congenital abnormalities and autoimmune conditions (2). High-resolution computed tomography (HRCT) remains the gold standard for diagnosing bronchiectasis, enabling clinicians to identify underlying causes and determine disease severity based on radiological features and clinical history (3,4). The management of bronchiectasis is multifaceted, focusing on symptom control, infection management, and improving airway clearance. A comprehensive approach includes pharmacological therapy such as antibiotics, bronchodilators, and anti-inflammatory agents, alongside non-pharmacological interventions like pulmonary rehabilitation and airway clearance techniques. Effective long-term management is essential to prevent disease progression and enhance the quality of life of affected individuals (5-7). Physiotherapy plays a pivotal role in bronchiectasis management, aiming to optimize secretion clearance, reduce symptom burden, and improve pulmonary function. Given that mucociliary clearance is significantly impaired, patients often experience persistent coughing and excessive sputum production. Physiotherapy techniques help facilitate mucus mobilization, prevent airway obstruction, and enhance functional capacity (8).

The active cycle of breathing technique (ACBT) is a well-established airway clearance method that combines breathing control, thoracic expansion exercises, and forced expiration to enhance mucus clearance. It has been shown to be effective in improving sputum expectoration and respiratory function, making it a widely recognized physiotherapy intervention for bronchiectasis patients (9). However, its efficacy may be further optimized when combined with other airway clearance techniques, such as postural drainage or autogenic drainage (10,11). Postural drainage is a traditional airway clearance method that utilizes gravity-assisted positioning to facilitate mucus drainage from different lung regions. It is often employed in conjunction with techniques like percussion or vibration to enhance secretion mobilization. While generally effective, postural drainage may pose potential risks such as dizziness, increased coughing, or transient hemodynamic changes, necessitating individualized assessment before implementation (12). In contrast, autogenic drainage is a breathing control technique that enables patients to regulate lung volumes and airflow to mobilize secretions without inducing excessive coughing. This method emphasizes controlled breathing patterns to enhance mucus clearance while minimizing airway irritation (13).

Pulmonary function tests (PFTs) are integral to the assessment and monitoring of bronchiectasis, providing objective measures of lung function parameters, including airflow limitation, lung volumes, and gas exchange efficiency. These tests assist in evaluating disease severity, guiding treatment decisions, and tracking disease progression over time (14,15). While various chest physiotherapy techniques have demonstrated efficacy in managing bronchiectasis symptoms, their impact on pulmonary function parameters remains an area of ongoing research. The need to identify optimal airway clearance strategies that not only improve mucus expectoration but also enhance pulmonary function is critical for optimizing patient outcomes. Given the limited comparative research on the effectiveness of ACBT combined with postural drainage versus ACBT combined with autogenic drainage in bronchiectasis patients, this study was conducted to evaluate their relative impact on pulmonary function, contributing to the refinement of physiotherapy management strategies for this patient population.

## METHODS

This study was designed as a randomized clinical trial to evaluate the effects of the active cycle of breathing technique (ACBT) combined with postural drainage versus ACBT combined with autogenic drainage on pulmonary function in patients with bronchiectasis. Ethical approval was obtained from the Institutional Review Board (IRB), and informed consent was obtained from all participants before enrolment (16). Participants were recruited based on predefined inclusion and exclusion criteria. The inclusion criteria encompassed clinically diagnosed bronchiectasis patients confirmed through high-resolution computed tomography (HRCT), aged between 18 and 60 years, with stable disease and the ability to perform pulmonary function tests (PFTs). Exclusion criteria included patients with acute exacerbations, significant cardiovascular or neuromuscular comorbidities, active infections, recent thoracic surgery, or an inability to adhere to the intervention protocol (17).

Following recruitment, participants were randomly allocated into two intervention groups. Group A received ACBT combined with postural drainage, while Group B received ACBT combined with the autogenic drainage technique. Both interventions were performed under the supervision of a trained physiotherapist. The duration of treatment was three weeks, with assessments conducted at baseline (day 1) and after three weeks of intervention. The severity of cough and sputum production was recorded using the Cough and Sputum Assessment Questionnaire (CASA-Q), a validated self-administered tool for assessing symptoms and their impact on daily activities (18). Pulmonary function was assessed using spirometry, measuring forced vital capacity (FVC), forced expiratory volume in one second (FEV1), the ratio of FVC to FEV1 (FVC/FEV1), and peak expiratory flow (PEF). Spirometric assessments were performed using a portable spirometer, ensuring standardized procedures and calibration before each measurement. Arterial blood gas (ABG) analysis was conducted using the GEM Premier 3000 system (Instrumentation Laboratory, Germany), which provided measurements of pH, partial pressure of oxygen ($PaO_2$), partial pressure of carbon dioxide ($PaCO_2$), and bicarbonate ($HCO_3$) (19).

The sample size was calculated using EPITOOL software, with a power of 0.80, a margin of error of 0.05, and a confidence interval of 95%, resulting in a total of 36 participants. The study employed a difference between two independent means (two groups) analysis, ensuring statistical rigor (20). Data were analyzed using SPSS version 26, with a significance level set at P=0.05. Descriptive statistics, including frequency distributions, pie charts, bar charts, and histograms, were used to summarize the data. Normality of data distribution was assessed using the Shapiro-Wilk test. Comparative analysis between groups was performed using the Mann-Whitney U test, while within-group comparisons were conducted using the Wilcoxon rank test (21).

## RESULTS

The study evaluated the effects of the active cycle of breathing technique (ACBT) combined with postural drainage versus ACBT combined with autogenic drainage on pulmonary function and symptom severity in patients with bronchiectasis. The frequency distribution of age groups among participants was analyzed using a histogram. Baseline measurements for arterial blood gases (ABGs) and pulmonary function tests (PFTs) were recorded. Pre-treatment values showed significant differences across several parameters, including blood pH (p=0.004), partial pressure of carbon dioxide (PCO2) (p=0.001), bicarbonate (HCO3) (p=0.005), partial pressure of oxygen (PO2) (p=0.000), forced vital capacity (FVC) (p=0.019), forced expiratory volume in one second (FEV1) (p=0.019), FEV1/FVC ratio (p=0.000), and peak expiratory flow rate (PEFR) (p=0.000). Additionally, pre-treatment scores for cough symptom severity (p=0.000), impact of cough on quality of life (p=0.002), sputum symptom severity (p=0.000), and impact of sputum on quality of life (p=0.000) were significantly different. The p-values for all pre-treatment variables were <0.05, indicating that the data were not normally distributed.

Within-group analysis of ABG parameters using the Wilcoxon Rank test showed a significant improvement in blood pH, HCO3, and PO2 post-treatment in both groups, with p-values <0.05. However, PCO2 changes were not statistically significant in either group (p>0.05). In ACBT combined with postural drainage, post-treatment blood pH significantly improved (p=0.001), HCO3 levels also showed significant improvement (p=0.014), and PO2 levels increased significantly (p=0.012), whereas PCO2 levels remained statistically insignificant (p=0.654). Similarly, in ACBT combined with autogenic drainage, significant improvements were observed in HCO3 (p=0.002) and PO2 (p=0.014), while blood pH showed borderline significance (p=0.050), and PCO2 remained statistically insignificant (p=0.681). Within-group analysis of symptom severity and quality of life impact demonstrated significant improvements in most parameters post-treatment. Cough symptom severity showed significant improvement in both groups (p=0.000), while the impact of cough on quality of life improved significantly in the ACBT-autogenic drainage group (p=0.014) but was borderline significant in the ACBT-postural drainage group (p=0.052). Sputum symptom severity improved significantly in both groups (p=0.000). The impact of sputum on quality of life showed significant improvements in both groups, with p-values of 0.023 and 0.011 for ACBT-postural drainage and ACBT-autogenic drainage, respectively.

An inter-group comparison of post-treatment pulmonary function parameters revealed that both interventions led to significant improvements. Forced vital capacity (FVC) increased from 2.1L to 2.5L in the ACBT-postural drainage group and from 2.2L to 2.6L in the ACBT-autogenic drainage group, indicating a similar mean improvement of 0.4L. Forced expiratory volume in one second (FEV1) improved by 0.3L in the ACBT-postural drainage group (1.7L to 2.0L) and by 0.5L in the ACBT-autogenic drainage group (1.6L to 2.1L), suggesting a greater enhancement in expiratory function in the autogenic drainage group. The FEV1/FVC ratio increased by 2%

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in the ACBT-postural drainage group and by 4% in the ACBT-autogenic drainage group, indicating a more pronounced improvement in airway obstruction reduction in the latter. Peak expiratory flow rate (PEFR) showed greater enhancement in the ACBT-autogenic drainage group, increasing by 1.0L/sec (5.0 to 6.0L/sec) compared to a 0.6L/sec improvement in the ACBT-postural drainage group (5.2 to 5.8L/sec). The differences in post-treatment values suggest that while both interventions effectively enhanced pulmonary function, ACBT combined with autogenic drainage demonstrated slightly superior outcomes in terms of expiratory function and airway clearance. Further statistical analysis is required to determine whether these differences are statistically significant.

**Table 1: Baseline measurements for blood pH, PCO2, HCO3, PO2, FVC, FEV1, FEV1/FVC, PEFR, cough symptom severity**

| | **p- value** |
|---|---|
| Pre- treatment blood pH | .004 |
| Pre- treatment partial pressure of carbon dioxide (PCO2) | .001 |
| Pre- treatment bicarbonate (HCO3) | .005 |
| Pre- treatment partial pressure of oxygen (PO2) | .000 |
| Pre- treatment forced vital capacity (FVC) | .019 |
| Pre- treatment forced expiratory volume in 1 second (FEV1) | .019 |
| Pre- treatment FEV1/FVC Ratio | .000 |
| Pre- treatment peak expiratory flow rate (PEFR) | .000 |
| Pre- treatment cough symptom severity | .000 |
| Pre- treatment impact of cough on quality of life | .002 |
| Pre- treatment sputum symptom severity | .000 |
| Pre- treatment impact of sputum on quality of life | .000 |

**Table 2: Within group analysis of ABGs (Blood pH, PCO2, HCO3, PO2)**

| **Group** | **Treatment** | **Mean rank** | **Sum of rank** | **Z score** | **P value** |
|---|---|---|---|---|---|
| ACBT-PD | Pre-treatment blood pH | 12.00 | 192.00 | -3.277 | .001 |
| | Post-treatment blood pH | 4.50 | 18.00 | | |
| | Pre-treatment PCO2 | 15.50 | 93.00 | -.449 | .654 |
| | Post-treatment PCO2 | 8.36 | 117.00 | | |
| | Pre-treatment HCO3 | 12.21 | 171.00 | -2.470 | .014 |
| | Post-treatment HCO3 | 6.50 | 39.00 | | |
| | Pre-treatment PO2 | 7.50 | 105.00 | -2.000 | .012 |
| | Post-treatment PO2 | 17.50 | 105.00 | | |
| ACBT-AD | Pre-treatment blood pH | 11.83 | 142.00 | -1.910 | .050 |
| | Post-treatment blood pH | 6.86 | 48.00 | | |
| | Pre-treatment PCO2 | 14.50 | 116.00 | -.411 | .681 |
| | Post-treatment PCO2 | 7.83 | 94.00 | | |
| | Pre-treatment HCO3 | 10.44 | 188.00 | -3.120 | .002 |
| | Post-treatment HCO3 | 11.00 | 22.00 | | |
| | Pre-treatment PO2 | 4.88 | 39.00 | -2.465 | .014 |
| | Post-treatment PO2 | 14.25 | 171.00 | | |

 

**Table 3: Within group analysis of Cough symptom, Cough impact, Sputum symptom and Sputum impact on quality of life.**

| Group | Treatment | Mean rank | Sum of rank | Z score | P value |
|---|---|---|---|---|---|
| ACBT-PD | Pre-treatment cough symptom severity | .00 | .00 | -4.359 | .000 |
| | Post-treatment cough symptom severity | 10.00 | 190.00 | | |
| | Pre-treatment impact of cough on quality of life | 6.10 | 30.50 | -1.947 | .052 |
| | Post-treatment impact of cough on quality of life | 9.59 | 105.50 | | |
| | Pre-treatment sputum symptom severity | .00 | .00 | -4.041 | .000 |
| | Post-treatment sputum symptom severity | 10.50 | 210.00 | | |
| | Pre-treatment impact of sputum on quality of life | 5.50 | 16.50 | -2.276 | .023 |
| | Post-treatment impact of sputum on quality of life | 8.05 | 88.50 | | |
| ACBT-AD | Pre-treatment cough symptom severity | .00 | .00 | -3.742 | .000 |
| | Post-treatment cough symptom severity | 7.50 | 105.00 | | |
| | Pre-treatment impact of cough on quality of life | 7.25 | 29.00 | -2.468 | .014 |
| | Post-treatment impact of cough on quality of life | 10.14 | 142.00 | | |
| | Pre-treatment sputum symptom severity | .00 | .00 | -3.963 | .000 |
| | Post-treatment sputum symptom severity | 10.00 | 190.00 | | |
| | Pre-treatment impact of cough on quality of life | 9.50 | 19.00 | -2.551 | .011 |
| | Pre-treatment impact of cough on quality of life | 8.36 | 117.00 | | |

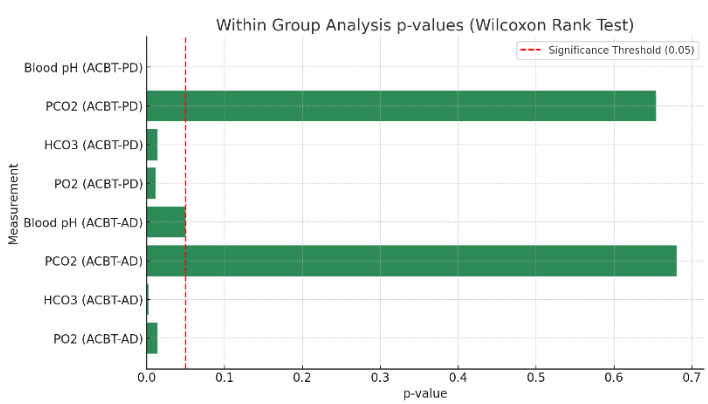


Figure 2 Within Group Analysis P-Values

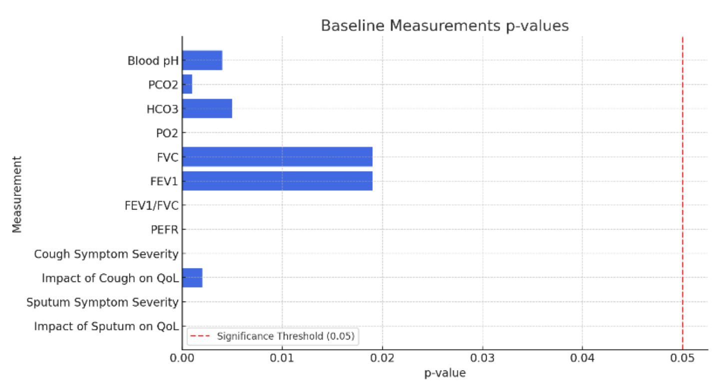


Figure 1 Baseline Measurements P-Values

 

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## DISCUSSION

This randomized clinical trial investigated the effects of the active cycle of breathing technique (ACBT) combined with postural drainage compared to ACBT combined with autogenic drainage on pulmonary function tests, arterial blood gases, and sputum profile in patients with bronchiectasis. The findings revealed that while both interventions significantly improved within-group parameters, there was no statistically significant difference between the two treatment modalities when directly compared (12,22). Previous research evaluating ACBT in cystic fibrosis patients found no substantial differences in pulmonary function parameters, oxygen saturation, sputum expectoration, pulmonary exacerbations, and quality of life when comparing ACBT with other airway clearance techniques. This aligns with the current study, which demonstrated no remarkable variations between ACBT combined with postural drainage and ACBT combined with autogenic drainage in pulmonary function parameters, peak expiratory flow rate, and symptom severity. However, within-group analysis showed significant improvements in both interventions, reinforcing their individual effectiveness (8,23).

The treatment duration in this study spanned 21 days with assessments conducted at the third week, mirroring previous studies evaluating the effects of autogenic drainage in patients undergoing elective upper abdominal surgery. Those studies demonstrated significant improvements in oxygenation parameters, such as arterial oxygen saturation and partial pressure of oxygen, within groups, but no significant differences between groups. Similarly, the current study found significant improvements in blood pH and bicarbonate levels in the ACBT-postural drainage group, while the ACBT-autogenic drainage group exhibited significant improvements in blood pH, bicarbonate, and partial pressure of oxygen. These findings suggest that both techniques contribute to arterial blood gas improvement, albeit without superiority of one over the other (14,24). Prior research on patients with chronic obstructive pulmonary disease (COPD) suggested that autogenic drainage resulted in greater improvements in pulmonary function tests and arterial blood gases compared to ACBT alone, with ACBT primarily benefiting forced vital capacity, peak expiratory flow rate, and arterial oxygenation. Contrary to those findings, the present study indicated a notable enhancement in pulmonary function tests in the ACBT-postural drainage group compared to the ACBT-autogenic drainage group. Conversely, greater improvements in arterial blood gases were observed in the ACBT-autogenic drainage group. These results suggest that while both techniques effectively improve pulmonary parameters, the nature of the physiological benefits may differ based on the intervention applied (25).

Previous investigations comparing postural drainage and autogenic drainage in chronic bronchitis patients found no significant differences in arterial oxygen saturation, rate pressure product, rate of perceived exertion, and peak expiratory flow rate, though both techniques were deemed effective. Similarly, the present study found that while no significant differences existed between the two groups, both interventions produced meaningful improvements in all assessed parameters except partial pressure of carbon dioxide. This suggests that both methods are clinically beneficial in airway clearance, despite the lack of a superior approach when directly compared (3,26). The results of this study also align with previous research evaluating the impact of airway clearance techniques on airway resistance in COPD patients, where no significant differences were noted between ACBT combined with postural drainage and ACBT combined with autogenic drainage. Nonetheless, both techniques independently yielded significant improvements, reinforcing the findings of this study that suggest their clinical effectiveness despite the absence of a substantial inter-group difference (11,20).

Studies on bronchiectasis patients have previously demonstrated significant improvements in pulmonary function when comparing conventional therapy with autogenic drainage over a 21-day treatment period. However, in the current study, despite the identical treatment duration, no significant differences in pulmonary function tests were observed between the two intervention groups. The within-group analysis, however, confirmed notable improvements in both groups, further emphasizing the individual efficacy of both approaches for pulmonary rehabilitation (9). The assessment of cough and sputum severity using the CASA-Q has previously been associated with a negative impact on quality of life in patients with cystic fibrosis. The current study found that mean values for cough and sputum symptom severity were greater in the ACBT-postural drainage group, while mean values for the impact of cough and sputum on quality of life were higher in the ACBT-autogenic drainage group. Despite these variations, within-group analysis showed significant improvements in cough and sputum severity and their impact on quality of life across both groups, highlighting the role of both techniques in symptom relief (19).

The study has several strengths, including its randomized controlled design, standardized intervention protocols, and comprehensive assessment of pulmonary function, arterial blood gases, and symptom severity. However, certain limitations should be considered. The study only assessed short-term effects, limiting the ability to determine long-term benefits or sustainability of improvements. Patient fatigue due to a sedentary lifestyle was also observed, which may have influenced treatment adherence. Additionally, while physiotherapy plays a significant role in managing bronchiectasis, patient referral to physiotherapy services remains limited, affecting broader clinical application (20). Future studies should explore the long-term efficacy of these airway clearance techniques to determine their sustainability in bronchiectasis management. The integration of physiotherapy rehabilitation as a routine intervention should be further encouraged to optimize airway clearance in bronchiectasis patients. Moreover, pulmonary function tests should be routinely assessed in clinical practice to ensure timely intervention and monitoring of disease progression. Expanding research to include additional pulmonary parameters and exploring advanced airway clearance techniques could provide further insight into optimizing pulmonary rehabilitation strategies for bronchiectasis management.

## CONCLUSION

The findings of this study indicate that both active cycle of breathing technique combined with postural drainage and active cycle of breathing technique combined with autogenic drainage are effective in enhancing pulmonary function, improving arterial blood gases, and alleviating cough and sputum severity in patients with bronchiectasis. The results highlight the clinical utility of both techniques as viable physiotherapy interventions for airway clearance, with neither method demonstrating clear superiority over the other. These findings reinforce the importance of physiotherapy in bronchiectasis management and suggest that individualized treatment approaches may optimize patient outcomes based on specific clinical needs.

### AUTHOR CONTRIBUTIONS

| Author | Contribution |
|---|---|
| Muhammad Azam Ghaffar* | Substantial Contribution to study design, analysis, acquisition of Data<br>Manuscript Writing<br>Has given Final Approval of the version to be published |
| M Behzad Ali | Substantial Contribution to study design, acquisition and interpretation of Data<br>Critical Review and Manuscript Writing<br>Has given Final Approval of the version to be published |
| Muhammad Tahir Akram | Substantial Contribution to acquisition and interpretation of Data<br>Has given Final Approval of the version to be published |
| Omair Khan | Contributed to Data Collection and Analysis<br>Has given Final Approval of the version to be published |
| Neelam Ashraf | Contributed to Data Collection and Analysis<br>Has given Final Approval of the version to be published |
| Ahmar Zafar | Substantial Contribution to study design and Data Analysis<br>Has given Final Approval of the version to be published |
| Adnan Hashim | Substantial Contribution to study design and Data Analysis<br>Has given Final Approval of the version to be published |

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