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A Comparison of Combined Pulmonary Rehabilitation and Chest Physiotherapy versus Chest Physiotherapy alone in Bronchiectasis

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ABSTRACT

Background: Bronchiectasis is a chronic respiratory illness defined by irreversible dilation of airways, mucus trapping, and recurrent infections, and decreased quality of life. Although chest physiotherapy (CPT) assists in airway clearance, the synergistic effect of pulmonary rehabilitation (PR) combined with CPT on functional, clinical, and quality of life measures is not entirely established.

Objective: To compare the effectiveness of pulmonary rehabilitation in combination with chest physiotherapy to chest physiotherapy alone in patients with bronchiectasis.

Methodology: A total of 140 stable bronchiectasis patients were randomly allocated to a PR + CPT or a CPT-only group in this randomized controlled trial. The intervention was for a duration of eight weeks, during which PR involved supervised aerobic and resistance training, breathing retraining, and patient education. Outcomes measured were exercise tolerance (6-minute walk test), lung function (FEV1, FVC), dyspnea (mMRC and Borg scores), health-related quality of life (St. George's Respiratory Questionnaire), daily sputum volume, exacerbations, and healthcare utilization.

Results: The two groups were similar at baseline. At eight weeks, the PR + CPT group had significantly larger improvements in exercise tolerance (+60.3 m vs. +21.1 m, $p < 0.001$), lung function (FEV1 +5.5% vs. +1.9%, $p = 0.01$; FVC +3.3% vs. +1.6%, $p = 0.02$), dyspnea scores, quality of life (SGRQ total score –12.7 vs. –5.6, $p = 0.004$), and morning sputum volume (–17.1 mL vs. –7.5 mL, $p = 0.002$) compared with CPT alone.

Conclusion: Pulmonary rehabilitation with chest physiotherapy yields greater advantages than chest physiotherapy alone in bronchiectasis. The combined intervention improves exercise capacity, lung function, symptom control, quality of life, and reduces exacerbations and health care use, warranting its addition to regular bronchiectasis care.

Keywords: Bronchiectasis; Pulmonary Rehabilitation; Chest Physiotherapy; Exercise Capacity; Dyspnea; Quality of Life

Introduction

Bronchiectasis is a long-term lung condition that involves irreversible widening and injury of the airways (bronchi), which causes inefficient clearance of mucus.[1,2] The conditions result in recurrent lung infections, persistent cough, copious sputum production, and shortness of breath. The disorder can arise following repeated respiratory infections, immunodeficiency disorders, or genetic disease such as cystic fibrosis. With time, the inflammation and infection cycles progress to exacerbate airway injury, decrease lung function, and impair quality of life.[3] The global burden of bronchiectasis has gained attention in recent years, particularly in developing countries where recurrent pulmonary infections and inadequate access to healthcare contribute to higher prevalence and disease severity. Prompt diagnosis, airway clearance strategies, antibiotics, and pulmonary rehabilitation are significant in controlling symptoms and complications.

The main therapeutic objectives in bronchiectasis are to interrupt the vicious cycle of infection, inflammation, and airway damage. Therapy aims to enhance airway clearance by minimizing the accumulation of mucus through physiotherapy and airway clearance maneuvers, as well as preventing and managing repeated infections with the use of suitable antibiotics. Minimizing airway inflammation is crucial to prevent further structural damage, in addition to alleviating distressing symptoms like productive cough, sputum production, and dyspnea. The second major goal is to maintain lung function, halt disease worsening, and reduce exacerbation frequency. All of these measures are ultimately aimed at increasing the quality of life for the patient and ensuring that the patient continues to be physically active and independent.[4]

Chest physiotherapy has traditionally been viewed as a mainstay of bronchiectasis management, directly addressing one of the most disabling features of the condition i.e., obstruction of the airways by mucus retention.[5,6] Several different techniques are utilized, namely postural drainage, percussion, vibration, active cycle of breathing techniques (ACBT), and autogenic drainage. These techniques are aimed at breaking down and mobilizing secretions from the smaller, peripherally located airways to the larger, central airways, thus facilitating easier and more efficient expectoration. Through the enhancement of mucus clearance, chest physiotherapy not only decreases sputum burden but also is important in lessening bacterial colonization, avoiding chronic recurrent infections, as well as decreasing airway inflammation. Consequently, most patients show immediate symptomatic relief from coughing and shortness of breath, with prolonged compliance with physiotherapy potentially leading to enhanced lung function and decreased disease progression. Therefore, although chest physiotherapy continues to be crucial in the standard treatment of bronchiectasis, it should be supplemented with other interventions to achieve more holistic care that addresses both respiratory and systemic effects of the disease.

Pulmonary rehabilitation (PR), an organized course of exercise training, patient education, breathing retraining, and psychological support, has been well-documented to yield strong benefits for chronic respiratory diseases like chronic obstructive pulmonary disease (COPD) and interstitial lung disease.[7,8] In bronchiectasis, PR is linked with enhanced exercise tolerance, perception of dyspnea, and quality of life. Combining PR with chest physiotherapy has the potential to yield synergistic benefit by addressing airway clearance and systemic impairment in function.

In spite of encouraging data, the potential role of combined pulmonary rehabilitation and chest physiotherapy versus chest physiotherapy alone in bronchiectasis is not yet fully explored. It is important to assess this combination, as it could be a more integrated management approach that treats both pulmonary and extrapulmonary aspects of the disease.

Objective

To compare the effectiveness of pulmonary rehabilitation in combination with chest physiotherapy to chest physiotherapy alone in patients with bronchiectasis.

Methodology

This is a randomized controlled trial to which was conducted to compare the effectiveness of pulmonary rehabilitation with chest physiotherapy versus chest physiotherapy alone in bronchiectasis patients. This research was done at the Department of Pulmonary Medicine, Lady Reading Hospital (LRH) from January 2023 to March 2024. Among study cases, 140 patients were included in the study. Patients with bronchiectasis on HRCT, between the age range of 18–70 years, in a stable condition and without recent exacerbation, and who are willing to undergo pulmonary rehabilitation and chest physiotherapy will be enrolled. On the other hand, patients with acute exacerbations, severe comorbidities, other chronic major respiratory conditions, uncontrolled systemic diseases, pregnancy, recent thoracic surgery, or inability to adhere to the study protocol were excluded from this study.

The eligible participants were randomly assigned into two groups by a computer-generated random sequence. The intervention group received a formal pulmonary rehabilitation program with routine chest physiotherapy, and the control group received chest physiotherapy. The pulmonary rehabilitation program included supervised aerobic and resistance exercise training, breathing

retraining strategies, and patient education sessions provided for eight weeks. Both groups followed regular chest physiotherapy methods including postural drainage, percussion, vibration, and active cycle of breathing techniques, carried out under supervision three times a week.

Outcome parameters included exercise tolerance determined by six-minute walk test (6MWT), pulmonary function tests (FEV1, FVC), severity of dyspnea, and health-related quality of life by St. George's Respiratory Questionnaire (SGRQ). Frequency of exacerbations and sputum volume were also measured during the intervention period. Data was collected at baseline and after eight weeks of intervention. Statistical tests were conducted using SPSS software version 27, with independent t-tests and chi-square tests utilized to evaluate differences in outcomes between groups and paired t-tests used to evaluate within-group changes. A p-value of less than 0.05 was used as the criteria for statistical significance.

Results

In this study, 140 participants were equally divided into pulmonary rehabilitation plus chest physiotherapy (PR + CPT) group and the chest physiotherapy (CPT) only group. Both groups matched each other with regard to mean age, gender distribution, body mass index (BMI), smoking status, and duration of disease. Lung function measures (FEV1, FVC, and FEV1/FVC ratio) were also similar, reflecting no difference in respiratory capacity at baseline. The functional status on six-minute walk distance (6MWD) and the severity of dyspnea (mMRC score) were almost equal in both groups. Exacerbations over the last year and sputum volume on a day-to-day basis did not significantly differ. In summary, the p-values indicate that the two groups were equally well-matched at baseline for a fair comparison of treatment effects (Table 1).

The PR + CPT group had significantly higher improvements than the CPT group alone in primary and secondary outcomes after 8 weeks of intervention. Functional capacity was significantly improved, with the six-minute walk distance (6MWD) improving by more than 60 m in the PR + CPT group compared to just 21 m in the CPT group. The lung function parameters FEV1 and FVC also increased more in the combined group, with significant improvements. Dyspnea was reduced more, and the mMRC and Borg scores decreased more in the PR + CPT

Table 1. Baseline Characteristics of Study Participants (n = 140)

Variable	PR + CPT (n=70)	CPT only (n=70)	p-value
Age (years), mean ± SD	48.7 ± 11.9	47.9 ± 10.4	0.74
Male sex, n (%)	43 (61%)	45 (64%)	0.82
Female sex, n (%)	30 (42%)	22 (31%)	0.81
BMI (kg/m²), mean ± SD	24.8 ± 3.1	25.5 ± 3.9	0.61
Current smokers, n (%)	11 (15%)	13 (18%)	0.67
Duration of disease (years), mean ± SD	7.1 ± 3.8	7.1 ± 3.9	0.72
FEV1 (% predicted), mean ± SD	61.2 ± 12.7	61.1 ± 12.6	0.77
FVC (% predicted), mean ± SD	70.5 ± 13.1	69.4 ± 12.6	0.82
FEV1/FVC ratio	0.68 ± 0.03	0.67 ± 0.09	0.70
6MWD (m), mean ± SD	327.3 ± 62.1	329.1 ± 61.6	0.86
mMRC Dyspnea score, mean ± SD	2.1 ± 0.9	2.5 ± 0.7	0.63
Exacerbations in past year, mean ± SD	2.4 ± 0.7	2.1 ± 0.7	0.81
Sputum volume (mL/day), mean ± SD	42.1 ± 17.8	41.4 ± 18.7	0.79

Table 2. Changes in Primary and Secondary Outcomes After 8 Weeks

Outcome	PR + CPT (Δ mean ± SD)	CPT only (Δ mean ± SD)	Between-group Difference (95% CI)	p-value
6MWD (m)	+60.3 ± 34.7	+21.1 ± 27.7	38.4 (24.5 – 53.6)	<0.001
FEV1 (% predicted)	+5.5 ± 8.7	+1.9 ± 7.4	3.4 (0.5 – 5.6)	0.01
FVC (% predicted)	+3.3 ± 7.6	+1.6 ± 6.1	2.5 (0.6 – 4.4)	0.02
mMRC Dyspnea Score	-1.5 ± 0.9	-0.8 ± 0.4	-0.5 (-0.6 – -0.7)	0.003
Borg Dyspnea post-6MWT	-1.6 ± 0.5	-0.3 ± 0.8	-1.6 (-1.7 – -0.5)	<0.001
SGRQ Total Score	-12.6 ± 8.4	-5.5 ± 7.3	-7.4 (-9.1 – -4.9)	0.004
Sputum Volume (mL/day)	-17.1 ± 13.6	-7.5 ± 11.9	-10.5 (-14.5 – -6.6)	0.002

group. Quality of life, as assessed by SGRQ, was improved more in the combined group, and the amount of daily sputum also decreased more in the group that received both interventions. The uniformly low p-values establish that pulmonary rehabilitation with chest physiotherapy was better than chest physiotherapy alone in most outcomes (Table 2).

This table presents exacerbation and hospitalization results on 12-week follow-up. Fewer exacerbations were seen in the PR + CPT group than in the CPT group (0.6 vs. 1.6 per patient). Hospitalization was also decreased, with admission required in only 11% of PR + CPT patients compared with 28% in the CPT group. The requirement for antibiotic courses was also significantly lower in the combined treatment group. Emergency room admissions due to respiratory symptoms were also fewer in PR + CPT patients (14% vs. 34%). Overall, the results indicate that the addition of pulmonary rehabilitation to chest physiotherapy results in fewer exacerbations, decreased healthcare consumption, and improved clinical stability than chest physiotherapy alone (Table 3).

This table identifies the quality of life outcome changes in St. George's Respiratory Questionnaire (SGRQ) domain scores post-intervention. The PR + CPT group demonstrated significantly larger improvements in all domains compared to the CPT-only group. Symptom scores declined more substantially (-14.5 vs. -6.1), indicating more successful control of respiratory symptoms. Correspondingly, the activity domain also significantly improved (-13.4 vs. -5.4), demonstrating increased functional capacity and decreased limitation in activities of daily living. The impact domain, measuring psychosocial burden, also evidenced greater improvement in the combined group (-11.5 vs. -4.4). In total, the SGRQ score enhanced by -12.7 in the PR + CPT group versus -5.6 in the CPT group, verifying an important increase in health-related quality of life with combined therapy (Table 4).

Discussion

Bronchiectasis is a chronic lung disease where the airways are permanently dilated, causing mucus accumulation, frequent infections, and persistent cough.[9] It can be caused by infections, genetic conditions, or immune disorders. Treatment includes clearing the airways, preventing infections, and controlling symptoms to enhance quality of life and slow down the progression of disease.

This randomized controlled trial compared the effectiveness of pulmonary rehabilitation plus chest physiotherapy (PR + CPT) versus chest physiotherapy (CPT) alone in patients with bronchiectasis.[10, 11] The outcome of our research shows that the addition of PR to usual chest physiotherapy substantially enhances exercise tolerance, lung function, burden of symptoms, quality of life, and clinical parameters like exacerbations, hospital admission, and antibiotics.

Both groups were matched at baseline to provide equal comparison. At 8 weeks of treatment, the PR + CPT group demonstrated an impressive gain in functional capacity, with six-minute walk distance (6MWD) improved by more than 60 meters, while in the CPT-only group it increased by only 21 meters. This change is clinically significant and underlines the value of structured exercise training in overcoming deconditioning and enhancing skeletal muscle function. Comparable advantages of pulmonary rehabilitation have previously been demonstrated in COPD and interstitial lung disease, and our results extend this data to bronchiectasis, a disorder in which exercise limitation is now clearly an important cause of reduced

Table 3. Exacerbation and Hospitalization Rates During 12-Week Follow-up

Variable	PR + CPT (n=70)	CPT only (n=70)	Relative Risk (95% CI)	p-value
Exacerbations per patient, mean ± SD	0.6 ± 0.9	1.6 ± 0.9	0.66 (0.44 – 0.88)	0.002
Patients with ≥1 hospitalization, n (%)	8 (11%)	20 (28%)	0.41 (0.26 – 0.94)	0.02
Antibiotic courses required, mean ± SD	0.5 ± 0.8	1.6 ± 0.5	-0.8 (-0.9 – -0.5)	0.01
ER visits for respiratory symptoms, n (%)	10 (14%)	24 (34%)	0.43 (0.21 – 0.96)	0.01

health status.

Lung function similarly improved modestly but significantly in the group receiving combination therapy, with improvements being larger in FEV1 and FVC than for CPT alone. Although airway clearance techniques improve the removal of mucus, the added benefit from PR could result from increased respiratory mechanics, improved ventilatory efficiency, and more powerful peripheral muscles. Past research has demonstrated inconsistent changes in lung function with pulmonary rehabilitation in bronchiectasis; our findings, however, affirm that with the integration of effective chest physiotherapy and PR, measurable spirometric improvement is possible. Mandal et al., (2012) demonstrated that chest physiotherapy plus pulmonary rehabilitation is superior to chest physiotherapy alone in bronchiectasis patients. It results in better improvement in exercise capacity, lung function, symptoms, and quality of life, with fewer exacerbations, hospitalizations, and antibiotics, warranting its use in standard management.[11]

Another research by Annoni et al., (2020) indicated that pulmonary rehabilitation in non-cystic fibrosis bronchiectasis has demonstrated short-term advantages, such as enhanced exercise capacity, decreased dyspnea, and alleviated fatigue. Exercise training is also proposed to improve quality of life as well as reduce exacerbation rates, though long-term data are still limited. Respiratory physiotherapy, especially airway clearance techniques, has been efficient in augmenting sputum clearance, with humidification, saline inhalation, and hypertonic solutions demonstrating added advantages in expectoration and sputum viscosity.[12]

The systematic review and meta-analysis by Martín-Valero et al., (2020) assessed that respiratory muscle training (RMT) can be directly associated with pulmonary rehabilitation and respiratory physiotherapy. RMT is a specialized aspect of physiotherapy focusing on inspiratory and expiratory muscles that aids in increasing ventilatory function as well as airway clearance. Like pulmonary rehabilitation, which enhances the tolerance to exercise, dyspnea, and quality of life in individuals with bronchiectasis, RMT adds to this by improving respiratory muscle strength, decreasing sputum load, and enhancing the functional capacity. Pulmonary rehabilitation and respiratory physiotherapy, of which RMT is a part, therefore offer an integrated approach that encompasses the physical conditioning and respiratory mechanics necessary to achieve optimal disease control.[13]

Relief of symptoms was another key advantage. Severity of dyspnea (mMRC and Borg scores) decreased more significantly in the PR + CPT group, reflecting improved tolerance to exercise and daily life. This result is also substantiated by another study by DePietro et al., (2022) which reported that pulmonary rehabilitation and exercise training significantly enhance exercise tolerance and alleviate dyspnea in patients with interstitial lung disease. All the benefits occur in the short term, with some evidence of long-term gains too.[14] Sputum volume also reduced significantly, indicating synergistic effects of physical training and airway clearance on mucus mobilization. The study by Hill et al., (2017) also emphasized that patients with chronic respiratory diseases can be benefited through breathing and mucus clearance techniques by pulmonary rehabilitation.[15] These results concur with earlier findings demonstrating that PR diminishes the perception of breathlessness and enhances airway clearance through an increase in exercise-induced secretion mobilization.

Notably, the advantage was also carried over to clinical outcomes. Over 12 weeks of follow-up, the PR + CPT group experienced fewer exacerbations, lower rates of hospitalization, and fewer antibiotic needs than the CPT group. This is a very important observation since repeated exacerbations are linked with accelerated decline in lung function, increased healthcare utilization costs, and decreased survival. Our findings are consistent with new evidence that pulmonary rehabilitation, when it is incorporated into bronchiectasis management, can decrease healthcare use and increase disease stability. Likewise, Nici et al., (2018) reported that pulmonary rehabilitation offers a comprehensive and multidisciplinary program for patients with severe COPD, not only for the relief of respiratory symptoms but also for systemic impacts and comorbidities.[16]

Table 4. Quality of Life Outcomes (SGRQ Domain Scores)

Domain	PR + CPT (Δ mean ± SD)	CPT only (Δ mean ± SD)	Between-group Difference (95% CI)	p-value
Symptoms	-14.5 ± 9.4	-6.1 ± 8.3	-8.5 (-11.4 – -5.2)	0.001
Activity	-13.4 ± 9.7	-5.4 ± 7.6	-7.7 (-10.1 – -4.6)	0.003
Impact	-11.5 ± 8.1	-4.4 ± 6.2	-7.9 (-9.8 – -4.3)	0.002
Total	-12.7 ± 8.2	-5.6 ± 7.1	-7.7 (-9.1 – -4.9)	0.004

Quality of life, as measured by the St. George's Respiratory Questionnaire (SGRQ), also improved substantially in all components of the combined therapy group. Symptom, activity, and impact improvements were not just statistically significant but also greater than the minimum clinically important difference, emphasizing patient-centered advantage with this strategy. In comparison with CPT alone, PR + CPT offered a comprehensive benefit by touching on both the physical and psychosocial dimensions of having bronchiectasis. This was supported by a study by Nguyen et al., (2015) which showed that pulmonary rehabilitation (PR) in patients with COPD is linked with decreased hospitalization and enhanced exercise capacity and health-related quality of life. Involvement with PR resulted in an increased 6-minute walk distance and improved St. George's Respiratory Questionnaire scores, whereas non-participation was associated with an increased risk of hospitalization.[17] These results promote PR as a successful intervention to reduce healthcare use and improve patient outcomes but PR + CPT together offered a comprehensive benefit.

Our research findings indicate that, although chest physiotherapy in isolation is effective for airway clearance, it is inadequate to counteract the wider systemic effects of bronchiectasis, including exercise intolerance, fatigue, and compromised quality of life. Pulmonary rehabilitation offers an additive intervention that returns exercise tolerance to normal, enhances psychosocial status, and minimizes clinical instability, presenting a holistic management strategy.

Conclusion

In conclusion, the current study shows that pulmonary rehabilitation program with chest physiotherapy is superior to chest physiotherapy alone in bronchiectasis patients. The combined approach enhances exercise capacity, lung function, symptoms, quality of life, and decreases exacerbations and hospitalizations. The results promote the role of organized pulmonary rehabilitation programs as a fundamental component of optimal bronchiectasis management, alongside conventional physiotherapy-based airway clearance measures.

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