

Effectiveness of Active Cycle of Breathing Technique (ACBT) for the Patients of Bronchiectasis: A Narrative Review Study

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Abstract

Bronchiectasis is an abnormal, irreversible condition of bronchus, which caused recurrent inflammation and infection, and characterized by chronic cough, and sputum. Its management aims to clear airways. The active cycle of breathing is considering as the utmost standard treatment for bronchiectasis patients as it can reduce the dependency on the drug. The study aimed to explore the effectiveness of the Active cycle breathing technique by review of the article. Review of 5 articles was done to fulfil this purpose. Randomized controlled trial study with PED ro score between 4 to 6 was taken. Studies compare the ACBT with other techniques like conventional therapy, Flutter device, Acapella device, ACBT with postural drainage, Test incremental respiratory endurance (TIRE) technique. From the review, it is found that ACBT causes a decrease in the amount of cough and sputum, increase lung function and quality of life of bronchiectasis patients. Although Flutter and Acapella show more preference to the patient for easy administration and cost-effectiveness, in terms of symptoms improvement ACBT shows a better outcome than these devices. Two article shows the use of ACBT with postural drainage has a more beneficial effect than the use of ACBT alone. One article shows TIRE technique is not effective by comparing with ACBT. So, from the overall review, it is shown that not superior to other technique but it can use as a most effective treatment technique for bronchiectasis patients.

Keywords: Bronchiectasis; ACBT; Airway clearance techniques; Lung function

Abbreviations

ABG: Acid Blood Gas Analysis; ACBT: Active Cycle of Breathing Technique; FEV1: Forced Expiratory Volume in one minute; FVC: Forced Vital Capacity; MMEF: Maximum Mid Expiratory Flow; mMRC: Modified Medical research Council; PFT: Pulmonary Function Test; PD: Postural Drainage

Introduction

Bronchiectasis is an abnormal, irreversible dilatation of bronchus caused by chronic inflammation or infection triggered by various microorganisms [1]. This condition is characterized by chronic cough and sputum production and associated with age (≥ 70 years), positive family history of respiratory diseases, suffered from respiratory disease in childhood, heart disease, lung disease, coal exposure, lung TB, pharyngitis, cystic fibrosis, primary ciliary dyskinesia, immunodeficiency [1-3]. Post-infectious onset is mostly seen in developed and developing countries and lung TB is mostly associated with bronchiectasis in Asian people followed by Europeans [4]. Features of bronchiectasis may vary from person to person. Excessive cough and sputum production, airway narrowing, fatigue, chest pain, breathing difficulty, exercise tolerance decrease is present in many patients. On the other hand, some patient shows symptoms only during the exacerbation of symptoms. If ≥ 4 of the following symptoms fever (more than 38°C , tiredness, change in sputum and cough rate, breathing difficulty, wheeze, decrease exercise tolerance, lassitude, decrease lung function, abnormal breath sound and chest x-ray shows in patients can be identified as an exacerbation [5].

Prevalence of bronchiectasis in USA 52, New Zealand 3.7 in per millions of people. In Finland, the incidence is about 4 per million people every year. From the year 2000 to 2007 prevalence of bronchiectasis increased by 8.17% among US people [6]. In China, 1.5% of men and 1.1% of women are affected by bronchiectasis [3]. In Asia, this rate is 7% [7]. Day by day it's increasing prevalence rate causing an increase of illness and death rate [8]. From the health care cost of the United

States (US) every year about the 630-million-dollar cost for treatment of bronchiectasis. Several pharmacological and non-pharmacological treatment approaches used to manage bronchiectasis patients. Pharmacological management includes a different form of antibiotics, bronchodilators, mucolytic agents, etc. Non-pharmacological management used to maintain the hygiene of bronchus [9]. As airways clearance impaired is a major feature of bronchiectasis, so during non-pharmacological management of such patient's airway clearance techniques gets most priority [10]. Different types of techniques are available to do airway clearance of bronchiectasis patient but the active cycle of breathing techniques (ACBT) is mostly used and evidence-based among them [11].

An active cycle of breathing technique (ACBT) used to facilitate the excessive secretion from the distal part of the lung. It is a combination of exercises. ACBT performed in different steps. Each cycle of ACBT should have the following 3 steps: control breath that can decrease airway narrowing and increase oxygen saturation, thoracic expansion exercises that mobile secretion and improve alveolar ventilation, and forced expiratory technique (FET). Exercise frequency and intensity may vary depending on the patient's conditions but every component should be present [12]. To the author's best knowledge, no review study was done to evaluate the effectiveness of active cycle breathing technique for bronchiectasis patients. A systematic review study was conducted where the researcher summarizes the effect of ACBT on some

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respiratory conditions with chronic cough where only four studies were about bronchiectasis [12]. Besides this, some randomized controlled trial study was conducted to compare the effect of ACBT with other treatment technique for bronchiectasis patients. Therefore, this study aims to review this RCT study to find out the importance of an active cycle of breathing techniques for bronchiectasis patients, where ACBT was compared with some other airway clearance techniques.

Result and Discussion

In bronchiectasis, abnormal permanent dilatation of airways causes excessive cough and sputum production, difficulty in breathing, lassitude, etc. with repeated exacerbation. Chest therapy helps to decrease these symptoms. Therefore, research was conducted to compare the effect of two different types of techniques of chest therapy, one is the Active cycle of breathing technique (ACBT) with postural drainage and another is conventional chest therapy. Study participants were 30 present with exacerbation of symptoms of bronchiectasis. Application of ACBT (2 min/cycle, total 15 to 20 min) with postural drainage for two times daily (minimum 6-hour gap between session) and conventional therapy including diaphragmatic breathing plus percussion and in gravity-assisted position for same duration up to 14 days shows that in ACBT-PD group significantly improve of Force vital capacity (FVC), maximum mid-expiratory flow (MMEF), increase partial pressure of oxygen (PaO_2), decrease P (Alveolar-arterial) O_2 gradient and sputum weight that ultimately improves quality of life more than conventional therapy group. Outcome measurement tools include Leicester cough questionnaire to measure health-related quality of life, modified medical research council (mMRC) Dyspnea scale to measure Dyspnea, Spirometry score to measure forced vital capacity (FVC), Forced expiratory capacity in 1 minute (FEV1), Maximum mid expiratory flow, ABG (Acid -blood gas)-analysis, PAO_2 , Alveolar-arterial oxygen gradient, Sputum weight [13].

To treat bronchiectasis patients different types of airway clearance techniques (ACT) has been used, ACBT is most commonly used and evidence-based among them. The use of the Acapella device is also suggested as an advantageous technique for airway clearance. To find out that which one is very effective for Bronchiectasis patient a study was conducted among 20 patients. Patients with stable condition i.e. expected forced expiratory volume in 1 minute not change more than 10% during 3 months before the study and productive cough was selected for the study and divided randomly into two groups. Treatment session was 3 days including assessment session and training session at 1st day and treatment application on 2nd and 3rd day. Components of ACBT include control breath, thoracic expansion exercise and huffing as a forceful expiration technique and Acapella includes control breath, breath through the device (10 repetition, inhalation to $\frac{3}{4}$ of maximum breathing capacity), hold the breath (2-3 second), active exhalation, cough or huff. Exhalation starts initially for 3 to 4 seconds with minimum frequency and resistance through the Acapella device, gradually frequency and resistance should increase. So, that expiratory pressure maintained between 10 and 20 cm of H_2O pressure. After every treatment session outcome was measured. Outcome measurement was include-lung function measured by spirometry, Peripheral capillary oxygen saturation (SpO_2) measured by pulse oximetry, breathlessness by 15-count breathlessness score, sputum production, number of coughs, preference measured by questionnaire. This measurement was taken after 10 minutes of treatment application. Total weight of sputum (during intervention amount was added with the amount after 30 minutes), the number of coughs was also included. After 2 days application of a treatment, outcome measurement shows almost

the same result in both groups. No remarkable difference in outcome between ACBT and Acapella. The average outcome in lung function, peripheral capillary oxygen saturation was almost the same in both groups. But Acapella was non- significantly preferable to the patient than the Active Cycle of Breathing Techniques [14].

Flutter is another device used for airway clearance of bronchiectasis patients. A study tries to compare the effectiveness of this device with ACBT and ACBT-Postural drainage. The researcher divided the 36 patients with productive cough in the following group: ACBT group, Flutter group, ACBT-PD (treatment details in the appendix-I) group by random allocation. Outcome measurement includes primarily acute efficacy by measuring sputum wet weight and volume, the physiological measure by cutaneous pulse oximetry, spirometry, Borg dyspnoea score, Forced vital capacity (FVC). Forced vital capacity in 1-minute (FEV1), acceptability and tolerability measured by Likert scale. Secondly patient preference for treatment was measured as shown in Table 1. After 3 sessions (1st, 4th and 7th day of the week) of treatment sputum production significantly decreased in the ACBT-PD group than only ACBT and only Flutter group. But it was less tolerable than other techniques due to discomfort. Between three techniques Flutter was more acceptable to the patient, followed by ACBT-Postural drainage and ACBT only [15].

Another study was conducted to compare the effects of ACBT and Flutter device on bronchiectasis patients. The purpose of their study was to find out the effect of both techniques on symptoms, expectoration, Dyspnea, and overall lung function and quality of patient life. 40 patients were divided randomly for the study. Patients were included if their condition is stable, they have no history of cystic fibrosis, and respiratory failure. ACBT performed in 3 steps- firstly control the breath by use of lower chest with normal depth, secondly, by putting a hand on epigastrium advice to a patient take a deep and slow breath then return to control the breath, lastly forceful breathing by using abdominal muscle and keeping the mouth open and O shape. Treatment session was 15-20 minutes 2 times daily (the minimum 6-hour gap between session). The outcome was measured after 10, 20, and 30 days. Outcome measurement includes symptoms, sputum production, pulmonary function test (PFT) by $V_{\text{max}} 22$ device, dyspnea by Medical research council (MRC) scale and Modified Borg scale, Quality of life by the SF-36 questionnaire. After 30 days, significant decrease of cough in the ACBT group and exhaustion in the Flutter group. In other parameters, no statistically significant difference was found between the two groups [16].

A randomized control trial study was conducted to compare the effectiveness of ACBT and test of incremental respiratory endurance (TIRE). Usually, TIRE techniques used for measurement purposes, sometimes use as a treatment purpose for the airway clearance technique of bronchiectasis patients. 20 patients were randomly assigned into two groups based on the following inclusion criteria- productive cough (half egg cup of sputum every day), Stable condition, complications to perform the exercise. Three steps of ACBT performed with two postural drainage positions in 2 consecutive days for 15 min or until tolerable to patients. Test of incremental respiratory endurance (TIRE) session consist of 3-6 consecutive trial with an interval between each inspiratory effort, interval time gradually decrease from 60 seconds to 5 second. Treatment details of TIRE shown in appendix-II. Study shows ACBT is more effective in the reduction of sputum production at a time or after half an hour of treatment than TIRE technique, but patients prefer both treatments equally [14]. A proper summary and its interventions can be stated in the Tables 2 and 3. (Tables 1-3)

This study was conducted to find out the effectiveness of the Active cycle of breathing techniques (ACBT) for the participant of bronchiectasis. The randomized controlled trial study was review to find out the result. By compare and contrast different articles, it can be decided that ACBT is the most useful, standard and effective treatment technique for bronchiectasis patients, but it is difficult to say that this is the most superior technique than others. Other techniques compare with ACBT were conventional chest therapy (diaphragmatic breathing with percussion), Acapella, Flutter, ACBT with Postural drainage, Test of incremental respiratory endurance (TIRE). Only in one research shows, ACBT is more effective than comparing treatment, all other study shows ACBT is effective like other clearance technique.

In contrast with Conventional therapy both Conventional and ACBT with postural drainage, treatment improves lung function, decreases breathing difficulties; improve oxygen saturation and quality of life of a patient. When compare with Flutter and Acapella device, ACBT shows almost the same effect as these devices, but the patient prefers the devices than an active cycle of breathing techniques because they can use it by self and easy to use. Besides this cost-effectiveness was also a matter. Acapella and Flutter considered as an almost similar

type of device with mostly similar functions on the lung. These can differentiate by frequency, intensity and mean pressure.

Two studies show combined use ACBT with postural drainage has a positive effect on patients' symptoms. Although it causes little discomfort and can hamper in functional activities, it shows more clearance of sputum than ACBT alone. Test of incremental respiratory endurance (TIRE) which is generally taken for measurement purpose is used as treatment purpose in one study. But it does not show effectiveness over the active cycle of breathing techniques. ACBT decreases the weight of sputum more than TIRE techniques. All of the treatment was tolerable to the patient and increase the lung function of the patient. Patient prefers all treatment more or less based on cost, the effect on symptoms and way of application. Exacerbation of symptoms occurs only in a few patients during the treatment session. Moreover, no study shows ACBT is harmful or less effective than other technique. So, it can consider as a standard and acceptable non-pharmacological treatment technique for treating bronchiectasis patients. Despite ACBT shows a positive effect on bronchiectasis but all of the studies were conducted for a short duration, only a short time outcome was measured. The sample number was small in the studies. Therefore the further study recommended evaluating the long term outcome of ACBT for bronchiectasis patients.

Conclusion

Bronchiectasis is an irreversible condition of airways and causes a major burden to a patient due to a decrease in lung function, sputum retention, and excessive cough. An active cycle of breathing technique (ACBT) is found as an advantageous management option for bronchiectasis. It can decrease chronic cough and sputum production and improve lung function. Appropriate application of ACBT can also minimize the exacerbation of symptoms and decrease morbidity and mortality of the patient. Due to cost-effectiveness, it is preferable to the patient and if trained properly patient can perform it at home by self. It is well tolerable to the patient and did not interfere in daily activities. Moreover, as it is a combination of exercises, it causes multiple effects on symptoms improvement of bronchiectasis patients. Other treatment of the airway also shows useful for the treatment of bronchiectasis patients, but ACBT shows a great effect on patient symptoms along with patient preference to take it. Besides these, ACBT can reduce the drug dependency of the patient, hence decrease the adverse effect of a

Author	Participants	Interventions	Preference
Halim A (2016) [1]	N=30	ACBT with postural drainage. Conventional therapy.	Not measure
Patterson et al. (2004) [10]	N=20	ACBT. Acapella.	Acapella more preferable than ACBT
Eaton et al. (2007) [4]	N=36	ACBT Flutter ACBT with postural drainage	Flutter (44%) ACBT-PD (33%) ACBT (22%)
Uzmezoglu et al. (2018) [15]	N=40	ACBT Flutter	Not measure
Patterson et al.(2004) [10]	N=20	ACBT TIRE (Test of incremental respiratory endurance)	ACBT and TIRE is equally preferable

Table 1: Patient preference for treatment.

Author	Title	Design	Outcome measured	PEDro score (0-10)
Halim A et al. (2016) [1]	Comparison between active cycle breathing with postural drainage versus conventional chest physiotherapy in subjects with bronchiectasis.	Randomized control trial	Health-related Quality of life (Leicester cough questionnaire), dyspnea (modified medical research council) Spirometry score (FVC, FEV1, Maximum mid expiratory flow), ABG –analysis, PAO ₂ , Alveolar-arterial oxygen gradient, Sputum weight.	4
Patterson et al. (2004) [10]	Airway clearance in Bronchiectasis: A Randomized Crossover Trial of Active Cycle of Breathing Techniques versus Acapella.	Randomized control trial	Lung function (Spirometry), SPO ₂ (Pulse oximetry), Breathlessness (15-count breathlessness score), the weight of sputum, number of coughs, preference (by questionnaire).	6
Eaton et al. (2007) [4]	A randomized evaluation of the acute efficacy, acceptability, and tolerability of Flutter and active cycle of breathing with or without postural drainage in non-cystic fibrosis bronchiectasis.	Randomized prospective study	Acute efficacy(sputum volume& weight), physiological measures (cutaneous pulse oximetry, spirometry, Borg dyspnea score, FVC, FEV ₁), Acute acceptability and tolerability (Likert scale), Preference.	5
Uzmezoglu et al. (2018) [15]	The Efficacy of Flutter and Active Cycle Breathing Techniques in patients with Bronchiectasis: A Prospective, Randomized, Comparative study.	Prospective, Randomized, Comparative study	Symptoms, sputum production rate, PFT (Vmax 22 device), Dyspnea (Medical research council scale, Modified Borg scale), Quality of life (SF-36).	5
Patterson et al. (2004) [10]	Airway clearance in bronchiectasis: a randomized crossover trial of active cycle of breathing techniques (incorporating postural drainage and vibration) versus test of incremental respiratory endurance.	Randomized crossover trial	Lung function (Spirometry), O ₂ –saturation (Pulse Oximetry), Sputum weight.	5

Table 2: Article summary.

Author	Mode	Frequency and Intensity	Duration	Result
Halim A et al. (2016) [1]	Active cycle of breathing techniques (ACBT) with postural drainage, Conventional chest physiotherapy	ACBT cycle was performed for 15 to 20 minutes (each cycle for 2 minutes) with postural drainage. And conventional therapy was also performed for the same duration two times daily. 15 to 20 minutes two times daily (minimum gap 6 hours between session)	14 days	Dyspnea significantly decreases in both group. Force vital capacity (FVC) and significantly improves in the ACBT-PD group, FEV1 improves in a conventional therapy group, Maximum mid-expiratory flow (MMEF) improve in both group significantly. Blood gas analysis shows a similar result in both groups. Before starting physiotherapy no significant difference was found in both group comparisons. After completing the session in ACBT group partial pressure of oxygen, alveolar-arterial oxygen gradient, physical status, and sputum production significantly changed.
Patterson et al. (2004) [10]	ACBT, Acapella	Both treatments should have finished after 15 minutes sustained in postural draining position/ when of exportation of sputum end/ when the patient gets fatigued.	3 days	No significant difference in outcome between the two techniques. The average outcome in lung function, peripheral capillary oxygen saturation was almost the same in both groups.
Eaton et al. (2007) [4]	ACBT, ACBT-PD, Flutter	ACBT& ACBT-PD: 1. 2 non-productive cycle+clear huff=time record & treatment continuation (10 min). 2. 2 non-productive cycle with a clear huff and Rx complete for 10 min 3. If productive and non-clear huff still present= Rx continues for a maximum of 30 minutes. Flutter: not mentioned	1 week	Sputum production significantly decreased in the ACBT-PD group than only ACBT and only Flutter group, but it was less tolerable than other techniques due to discomfort. The rate of dyspnea did not change in any group. Between 3 techniques Flutter was more acceptable to the patient, followed by ACBT-PD and ACBT only.
Uzmezoglu et al. (2018) [15]	ACBT, Flutter device	15 to 20 minutes two times daily (minimum gap 6 hours between session)	4 weeks	Significant decrease of cough in the ACBT group and exhaustion in the Flutter group, wheezing non-significantly decreased only in the ACBT group, in other parameters, no statistically significant difference was found between the two groups.
Patterson et al. (2004) [10]	ACBT, TIRE (Test of incremental respiratory endurance)	TIRE session consists of 3-6 consecutive trial with an interval between each inspiratory effort, interval time gradually decrease from 60 seconds to 5 seconds.	2 days	ACBT is more effective in the reduction of sputum production than the TIRE technique.

Table 3: Interventions summary.

drug and decrease the economic burden to the patient, patient family and country.

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