Non-pharmacological approach of bronchiectasis – the results of respiratory rehabilitation in two clinical cases

Abordare nefarmacologică a bronșiectaziilor – rezultatele reabilitării respiratorii în două cazuri clinice

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Abstract

Background. *Respiratory rehabilitation (RR) represents an important part of bronchiectasis therapeutic management. The aim of our paper is to present two cases of patients with bronchiectasis who participated in a RR program and, based on this experience, to describe a respiratory rehabilitation protocol for bronchiectasis.*
Case 1: *A 66-year-old male, with left lower lobe cystic bronchiectasis and many infectious exacerbations, who entered in a 4-week respiratory rehabilitation program mainly based on physical training, respiratory physiotherapy and aerosol therapy, nutritional support and psychological counseling. The RR program brings benefits in terms of symptoms (cough, bronchial secretions) and the number of infectious exacerbations in the next year following the rehabilitation.*
Case 2: *A 32-year-old male, diagnosed with cystic fibrosis, with severe obstructive respiratory dysfunction, chronic respiratory failure and cachexia. He benefited from an inpatient individualized rehabilitation program with aerosol therapy, respiratory physiotherapy, physical training, cough correction, breathing reeducation and high protein intake, with positive effects: reducing dyspnea, decreased amount of sputum and clarifying its appearance, better effort tolerance, and overall improved quality of life.*
Conclusions. *The respiratory rehabilitation can be successful when used in this type of patients. The RR program is multidisciplinary – airway clearance techniques, aerosol therapy, muscular training, nutritional support, psychological counselling, and therapeutic education – and must be adapted to each patient's needs.*
Keywords: ***rehabilitation, bronchiectasis, effort tolerance***

Rezumat

Introducere. *Reabilitarea respiratorie (RR) este o componentă importantă a managementului terapeutic al bronșiectaziilor. Scopul lucrării noastre a fost de a prezenta două cazuri de pacienți cu bronșiectazii care au participat la un program de RR și, pornind de la aceste două cazuri, să descriem un protocol de reabilitare respiratorie pentru bronșiectazii.*
Cazul 1: *Un bărbat în vârstă de 66 de ani, cu bronșiectazii chistice la nivelul lobului inferior și multiple exacerbări infecțioase, care a intrat într-un program de reabilitare respiratorie de 4 săptămâni, bazat în principal pe antrenament fizic, fizioterapie respiratorie și aerosoloterapie, sprijin nutrițional și consiliere psihologică. Programul de RR a adus beneficii în ceea ce privește simptomele (tuse, secreții bronșice) și numărul de exacerbări infecțioase în anul următor după reabilitare.*
Cazul 2: *Un bărbat de 32 de ani, diagnosticat cu fibroză chistică, cu disfuncție respiratorie obstructivă severă, insuficiență respiratorie cronică și cașexie. El a beneficiat de un program de reabilitare personalizat, inpatient, cu aerosoloterapie, fizioterapie respiratorie, antrenament fizic, corectarea tusei, reeducarea respirației și cu un consum ridicat de proteine, cu efecte pozitive: reducerea dispneei, scăderea cantității de spută, decolorarea aspectului sputei și îmbunătățirea calității vieții.*
Concluzii. *Reabilitarea respiratorie poate fi utilizată cu succes la acești pacienți. Programul de RR este multidisciplinar – tehnici de eliminare a secreților din căile respiratorii, aerosoloterapie, antrenament muscular, sprijin nutrițional, consiliere psihologică, educație terapeutică – și trebuie adaptat nevoilor fiecărui pacient.*
Cuvinte-cheie: ***reabilitare, bronșiectazii, toleranță la efort***

Background

Bronchiectasis represents a chronic heterogeneous and multidimensional condition of abnormal and permanent dilatation of medium and small airways with main clinical manifestation represented by chronic daily cough, exteriorization of large amounts of thick mucus every day, haemoptysis and sometimes dyspnea[1,2,3,4].

The causes of bronchiectasis can be genetic or acquired, the most common known causes of non-CF bronchiectasis being the respiratory infections (post-tuberculous bronchiectasis, *Bordetella pertussis* infection, allergic bronchopulmonary aspergillosis). The bronchiectasis infectious exacerbations are involved in disease progression with functional and quality of life impact. At this moment, nonsurgical cases benefit of a small number of treatment options and severe forms of disease can lead to patient disability.

Respiratory rehabilitation (RR) represents an important part of bronchiectasis therapeutic management. It is a multidisciplinary program[5], whose purpose is relieving the symptoms, better effort tolerance, overall improved quality of life, decrease of relapses and hospitalization time and, most important, to give the patient the opportunity to be socially reintegrated[1,6].

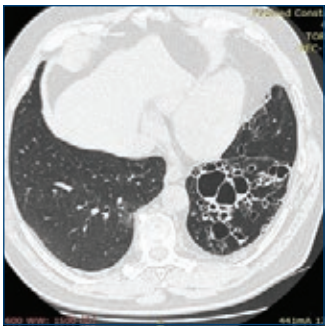

Figure 1. *Thoracic CT scan: cystic bronchiectasis in the lower left lobe*

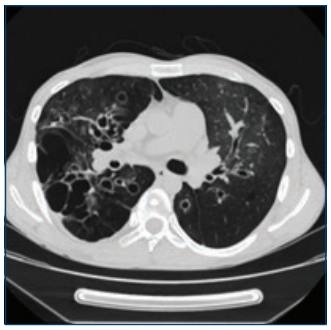

Figure 2. *Thoracic CT scan: pseudocystic and cylindrical bronchiectasis in both lungs (cystic fibrosis)*

Respiratory rehabilitation addresses to any patient suffering from pulmonary conditions whose quality of life is affected by the respiratory symptoms, regardless of the degree of functional impairment. Although the main indication of respiratory rehabilitation is the chronic obstructive pulmonary disease (COPD), several studies suggest the positive role of rehabilitation in bronchiectasis[7].

The main components of the bronchiectasis management are: confirmation of the positive diagnosis and severity of the disease, treatment of the specific etiology (when it is possible), therapeutic education including avoiding the risk factors for exacerbations, techniques of airway clearance, kinetotherapy and exercise, aerosolotherapy, antibiotherapy, bronchodilator and mucolytic therapy, surgical indication and treatment of complications[1].

The aim of the present paper is to describe a respiratory rehabilitation protocol for bronchiectasis, starting from the experience of two clinical cases that are presented.

Case 1: A 66-year-old male, nonsmoker, with clinical history of coughing up large amounts of thick mucus every day for 5 years, with many infectious exacerbations and frequent antibiotic treatment. After the CT scan (Figure 1), the patient was diagnosed with cystic bronchiectasis in the lower left lobe.

Bacterial sputum examination showed a chronic infection with *Pseudomonas aeruginosa*, with multiple antibiotic resistances. Although the localization of bronchiectasis was in only one lobe and surgical treatment was indicated, the patient refused. Under these circumstances, the participation in a respiratory rehabilitation program was proposed. It is mentioned that the patient has never had hemoptysis. In this case, the rehabilitation program lasted 4 weeks and it was mainly based on physical training, respiratory physiotherapy (postural drainage) and aerosol therapy. The additional therapy used was represented by nutrition support and psychological counseling[1]. The results were positive: a decreased amount of symptoms (cough and bronchial secretions) and of infectious exacerbations in the next year following the rehabilitation.

Case 2: A 32-year-old male, nonsmoker, diagnosed at the age of 14 with cystic fibrosis, came to the hospital with chronic cough and daily yellow sputum, resting dyspnea stage IV on mMRC scale, with clinical history of frequent infectious exacerbation (6-7 per year). At pulmonary function test, he had a severe obstructive respiratory dysfunction, with FEV1 0.95 L (22% predicted) and respiratory failure with oxygen saturation 85% (arterial blood gas showed decrease of oxygen level - hypoxemia, normocapnia). The CT scan revealed pseudocystic and cylindrical bronchiectasis in both lungs (Figure 2). As comorbidities, he presented stable chronic cor pulmonale and cachexia (BMI=15.7 kg/m^2).

The patient followed a respiratory rehabilitation program in hospitalized conditions (inpatient), 5 days per week, 3 consecutive weeks, mainly based on aerosol therapy (sodium chloride), respiratory physiotherapy (postural drainage), physical training for arms with dumbbells 0.5 kg weight and for legs (active movements, walk and counterweight). The patient also learnt to correct the cough in order to improve sputum clearance - breathing reeducation (diaphragmatic breathing). In addition, he orally received high protein intake. The benefits of rehabilitation program were reflected in symptoms relieve (reducing dyspnea, decreasing amount of sputum and clarifying its appearance), better effort tolerance, and overall improved quality of life. The patient followed the rehabilitation program with supplemental oxygen.

Discussions

In clinical practice, we encounter different phenotypes of patients with bronchiectasis: with bronchorrhea, bronchorrhea associated with dyspnea, hemoptysis, frequently infectious exacerbation, associated comorbidities such as cachexia, obesity and cardiovascular disease[8]. For this reason, the respiratory rehabilitation program associated to pharmacological therapy needs to be individualized.

Clinical and paraclinical evaluation

The patient assessment is the first step in clinical and paraclinical evaluation made by the respiratory physician. That's the reason why the first consultation spans approximately more than one hour in order to explain the patient his medical situation, to do the anamnesis, physical examination, paraclinic evaluation and the specific assessment for respiratory rehabilitation. It also includes the training in respiratory rehabilitation techniques, identifying the techniques preferred by the patient.

The anamnesis includes demographic data, gender, age, BMI, family and personal medical history, symptoms, comorbidities (fertility, rhinosinusal pathology, and pancreatic disease). The duration of disease and the history of exacerbations, along with social and psychological impact are also important. Particular attention is given to the daily amount of sputum (usually measured by tablespoon per day) and macroscopic sputum aspect[1,9-13], dyspnea assessment with mMRC and BORG scale, the evaluation of psychological status with HADS (Hospital Anxiety and Depression Scale)[14].

Figure 3. *Respiratory muscle testing*

Paraclinical assessment is represented by identifying (if possible) the bronchiectasis etiology, blood inflammatory markers and immunological tests, sputum bacteriology, but from the respiratory rehabilitation point of view is the CT scan is more important, in order to identify bronchiectasis localization and extension (useful data for the postural drainage positions)[15].

The pulmonary function tests show the severity of disease and the effects of therapy, and the arterial blood gas can identify the respiratory failure, with the indication of home oxygen therapy.

In addition to standard respiratory evaluation comes the physiotherapist assessment which identifies posture changes, type of breathing or changes in body positions. At the same time, we can use the quality of life questionnaire – the most common and validated is St. George's Respiratory Questionnaire[1,16,17], being repeatable and correlated with the degree of disease severity. Also, there are questionnaires that can quantify sputum production, as well a specific questionnaire for cystic fibrosis (Leicester cough questionnaire; LCQ)[18,19].

Strating from these questionnaires, we can calculate the disease severity scores: FACED (that combines the values of FEV1, age, chronic colonization, extension of lesions on CT and dyspnea) and BSI (bronchiectasis severity index – that uses FACED and BMI score, and the number of infectious exacerbation in the last year)[20,22].

Bronchiectasis is a chronic and invalidant disease that can lead to cachexia, muscular weakness (peripheral and respiratory muscles) and limited exercise tolerance. The mechanisms of bronchial collapse with viscous and adherent secretions, and bronchoplegia are added to all of the above, all together leading to a poor disease prognosis. Therefore, some specific tests need to be done before starting respiratory rehabilitation program in order to evaluate exercise tolerance and muscle strength.

In studies, the exercise capacity is measured in adults with bronchiectasis using:

a) incremental effort testing (gradually increased effort up to a maximum level) - cycle ergometry[22] and incremental shuttle walking test[23-25];

b) constant effort testing (these tests are using the same speed, 60-80% of the maximum power obtained in the incremental tests: the 6-minute walking test (6MWT)[26,27], endurance shuttle test, and constant cycle ergometry).

The gold standard to prescribe training exercise is represented by ergospirometry, but incremental shuttle walking test is easier to use in any specialized clinic. 6MWT is very useful, accessible, easy to learn and easy to apply in any hospital[27], and it correlates with the pulmonary rehabilitation effects[5].

Respiratory and skeletal muscle strength evaluation is performed for:

a) upper extremity skeletal muscle strength, using dynamometers;

b) respiratory muscles strength, which includes the diaphragm and intercostal muscles. We measure the maximum inspiratory pressure (MIP), generated at the mouth, after a maximum expiration, then the patient makes a forceful inspiration, and the maximum expiratory pressure (MEP) is calculated, which is the maximum pressure measured at the mouth that can be generated during expiration after a complete inspiration (Figure 3)[5].

In bronchiectasis, the respiratory rehabilitation program has the following goals: mobilizing the bronchopulmonary secretions, improving physical status affected by musculoskeletal dysfunction, reducing dyspnea and pain, medical education[28].

The main components of RR in bronchiectasis, according to guidelines

Airways clearance technique – it represents the main component in bronchiectasis for patients with chronic productive cough and mucus plugging on HRCT (evidence class A)[1]. The positive effects of regular airway clearance are: mobilization and removal of viscous and adherent secretions, with decreased respiratory effort, better ventilation, decrease of relapses, atelectasis prevention, better effort tolerance with a relief in symptoms[6]. The choice of the technique depends on the centers equipment, but the devices require a small investment and some of them are for personal use.

Controlled cough – we need to educate patients to achieve an effective cough with the physiotherapist assistance: abdominal or thoracic compressions. With cough exercises is obtained the mobilization and removal of viscous and adherent secretions from the respiratory airways, with less respiratory effort.

The active cycle of breathing techniques (ACBT) is represented by breathing reeducation (diaphragmatic and abdominal breathing). It is a simple technique, easy to use even for severely impaired patients[29], in association with manual techniques and postural drainage. Thoracic expansion exercises increase lung volumes with the decrease on flow resistance and are achieved by deep inhalation to total lung capacity, followed by 3-4 seconds of apnea and a maximum exhalation.

The forced expiration technique (huff breathing) – 1-2 discontinuously exhaling through open mouth after a complete inhale. This simple breathing technique can be

Figure 4. *Thoracic percussion*

Figure 5. *Vibra Vest*

applied to both types of patients – inpatients and outpatients – in order to obtain the mobilization and secretions removal from the respiratory airways. Postural drainage and manual techniques (e.g., chest clapping and shaking) could be added together with ACBT[30,31].

Autogenic drainage is a drainage technique that uses controlled expiratory airflow to mobilize secretions. The patient learns to breathe in three steps: first, to breath at low lung volumes to remove peripheral secretions; second, to breathe at low to middle lung volumes for collecting central secretion; third, to breathe at mid to high lung volumes to remove central secretion.

Postural drainage is a method to mobilize secretion from lung segments using one or more different position, for example:

For apical areas of upper lobe: the patient sits on a bed in a comfortable position and leans on a pillow. Gravity and percussion help him to move the secretion.

Middle lobe: the patient sits in the Trendelenburg position to drain the left lung; the patient sits on right side and drain right side; the patient sits on left side.

Lower lobe: the patient is in ventral decubitus position, with a pillow under his abdomen.

The frequency and duration of postural drainage techniques are different, depending on sputum volume, program and patient lifestyle[1]. Each session can last between 10-15 and 30 minutes, with a frequency of 1-2 times per day, but they may increase in exacerbations. However, studies show that only one third of patients agree on the postural drainage associated or not with other techniques[1].

Clapping/percussion: rhythmically clapping on the chest wall, 3-5 minute on each affected area (Figure 4), then the patient coughs easily to expectorate.

Vibration is a method applied only during expiration, in which both hands are applied directly to the thorax of each other and compressing easily and quickly, vibrating the chest wall. These methods are applied simultaneously with postural drainage. There are devices that automatically deliver chest wall vibrations – high frequency chest wall oscillation (Vibra Vest, Figure 5). These devices can be used when the patient cannot cooperate, in patients with severe forms of disease and in children with cystic fibrosis[1,6].

The contraindications of these methods are: hemoptysis, acute pulmonary edema, pneumothorax, unstable arrhythmia under treatment, uncontrolled arterial hypotension, arterial hypertension, acute myocardial infarction and recent neurosurgical interventions. We underline the importance of interdisciplinary team, because every comorbidity must be evaluated before starting the program.

Positive expiratory pressure (PEP): it can be achieved by means of devices (Threshold, Thera-PEP), which have a unidirectional valve in their structure that opposes an expiratory resistance (Figure 6). The patient makes respiratory exercises with this type of devices for 10-15 minutes, two times per day.

Oscillating PEP (oscillating positive expiratory pressure – flutter technique): this method combines the PEP technique with high frequency oscillating therapy. For these exercises, is used one type of device which has inside a ball or a membrane that vibrates during the expiration, resulting in detachment of the tracheobronchial secretions. The method is preferred by patients and can have the same results as ABCT in association with postural drainage[32,33].

Intermittent positive pressure breathing – there are adapted devices that can be used in the intensive care unit, for patients with ineffective cough. The Cough Assist Machine helps clearing the secretions from respiratory airways and helps the patient to breathe. When the patient makes an inspiration, the device gives positive pressure to help expanding the lungs. In expiration time, the machine creates a negative pressure that gets the air out of the lungs. This method makes the cough stronger and effective.

In Table 1 we present a comparison between different techniques used in patients with bronchiectasis.

Aerosol therapy is a method that helps to hydrating and evacuating secretions, treats the bronchial inflammatory process, removes the infectious process, regenerates the bronchial epithelium and allows the administration of inhaled bronchodilator medication. It depends on particle diameter (1-6 microns) and breathing pattern (low frequency, mouth breathing, apnea after inspiration). The advantages of the method are: osmolarity (increased in bronchi level and increasing the secretion clearance), local effects (higher local concentrations with low doses of drugs), minimal systemic effects, quick local action.

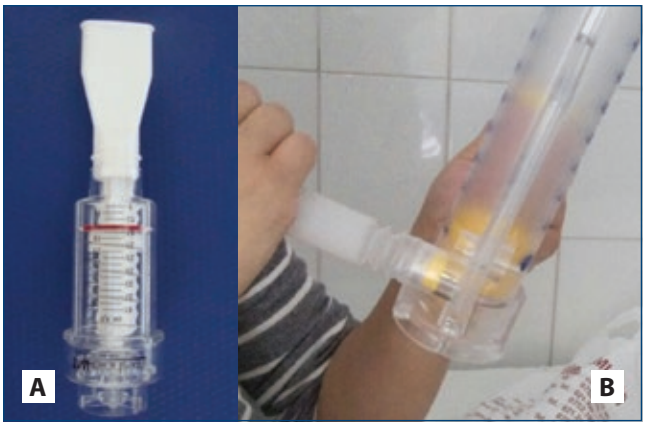

Figure 6. *A. Treshold device. B. PEP method*

Figure 7. *Lower limb training on treadmill*

Figure 8. *Class of physical exercises for upper limb*

Usually, at first administration of a hypertonic saline solution, a spirometry is performed before and 5 minutes after treatment to avoid possible bronchoconstriction[1].

The drugs used for aerosol therapy are: normal or hypertonic (3-14%) saline solution, manitol, mucolytic drugs (acetylcysteine solution, carbocisteine) or antibiotics (uncertain results). Hypertonic saline solution seem to be the most effective to improve the clearance of sputum, but for patients with bronchial hiper-responsivity a pretreatment with a bronchodilator is needed[34-36].

Physical training represents the main component of respiratory rehabilitation, especially in patients with important dyspnea during daily activities (class D)[1]. It also has an additive effect on drainage techniques, and improves muscle strength and mobility. Physical training addresses to peripheral muscles (for upper limbs endurance exercises with dumbbells, and for lower limbs: ergometer bike, treadmill and walk – Figures 7 and 8) and to respiratory muscles, using specific devices (Threshold Inspiratory Muscle Training [IMT], Treshold Expiratory Muscle Training [EMT], Power Breath, Spirotiger). For the peripheral muscles, the frequency of these exercises is 3-5 times per week for 6-8 weeks, 30 minutes per session[37]. The effort intensity is prescribed at 75% of the maximal work rate achieved on the walk test (Incremental Shuttle Walk Test) or 60-80% of the maximal work achieved at cardiopulmonary exercise test (CPET)[38]. Patients are advised to continue physical training with 30 minutes of daily walk after finishing a respiratory rehabilitation program[7].

The parameters recommended for assessing the benefits of respiratory rehabilitation are: the amount of sputum expectorated per day, dyspnea scales (mMRC, Borg), effort tests and the number of exacerbations in next year.

It is proved that the maximum work rate evaluated by cycle ergometry is correlated with the dyspnea score, FEV1 and High Resolution Computer Tomograph (HRCT) score[1,39]. The distance obtained at the walking test is significantly higher after inspiratory muscle training[1,26] and pulmonary rehabilitation in bronchiectatic patients[1,25].

The duration of maintaining the benefits of the respiratory rehabilitation program has not been demonstrated in patients with bronchiectasis. Regarding effort tolerance, the patients have benefits immediately after ending the program, but at the 6-month and 12-month follow-up visits the benefits have not been maintained. The studies showed that respiratory rehabilitation increases the interval until the first exacerbation (up to 12 months)[24,40].

Two major studies on respiratory rehabilitation in bronchiectasis are recorded: a retrospective one o general rehabilitation and another one on peripheral and respiratory muscle training which showed increasing distance at incremental walk test and endurance effort time. The benefits have been maintained at 3-month follow-up visit after rehabilitation program[41].

Regarding the benefit of respiratory rehabilitation in patients with cystic fibrosis, a Cochrane review showed a better effort tolerance and overall improving quality of life after physical training[42].

Considering that in bronchiectasis patients bacterial sputum examination can reveal chronic infection, it is recommended that the respiratory rehabilitation is made in separated rooms from patients with other diseases.

Conclusion

Bronchiectasis represents a chronic respiratory condition, sometimes progressive and irreversible, so each patient must have a complex therapeutic program, adapted to his personal needs. The pulmonary rehabilitation can be successful in these studied types of patients. The respiratory rehabilitation program includes: therapeutic education (including the avoiding the risk factors for exacerbations), techniques of airway clearance, aerosolotherapy, vaccination, psychological counseling and nutrition advice. ■

Table 1 Rehabilitation techniques used in bronchiectasis

Technique	Advantages	Disadvantages
Assisted (controlled) cough	Simple, inexpensive, easy to instruct patients	Limited by chest pain, hemoptysis
Forced expiration (huff respiration)	Helps control breathing	Require patient collaboration
Autogenic drainage	Control breathing	Require patient collaboration
Chest physical therapy (postural drainage, hand and mechanical chest clapping)	The main indication in cystic fibrosis	Needs assistance Hard to position Hypoxemia, aggravation of gastro-esophagian reflux
PEP	Easy, inexpensive	Risk of nosocomial infection
Oscillatory PEP	Easy, inexpensive, adds vibration to airways	Device needs cleaning
High frequency chest wall compression	Better tolerated than chest physiotherapy	Expensive, can cause pain
Regular exercises	Inexpensive, increase respiratory and peripheral muscles strength	Noncompliance

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