Original Article

Efficacy Of Energy Conservation Techniques On Pulmonary Functions In Children With Cystic Fibrosis

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Abstract

Background: Cystic fibrosis (CF) has a wide-ranging impact on health, but the lungs in particular suffer. It produces fatigue and shortness of breath, both of which interfere with ADL performance; patient training in energy conservation techniques (ECTs) may help improve ADL tolerance and performance. **Objectives**: The purpose of this research was to determine if patients with CF might lower their energy use during an activity by practicing educational ECTs after a 12-week ECT teaching period. **Methods**: Forty CF children, (24 boys and 16 girls), with ages range from six to eight years were randomly divided into 2 groups: content group and study group. Pulmonary functions were assessed by spirometry before and after 12 weeks of treatment using forced expiratory volume (FEV_1) which measures how much air a person can forcefully exhale in the first second of forced expiration. The forced expiratory flow 25 (FEF 25) test assesses the rate of airflow when between 25% and 72% of the air in the lungs has been expelled, providing insight into how clear or obstructed the tiny airways are. The third pulmonary function test was forced vital capacity (FVC) how much air a someone can expel quickly as well as forcefully after taking a deep inhalation. Control group received pulmonary rehabilitation programe (postural drainage, breathing exercises study group received energy conservation programe in addition to the traditional pulmonary rehabilitation, postural drainage, pursed-lip breathing and an ergonomic way of performing activities & the used of assistive devices. **Results**: When comparing the mean values of the two groups before and after treatment, there was a statistically significant increase in all of the measured parameters. After treatment, however, a statistically significant difference favouring the energy-conservation group developed. **Conclusion**: Findings from the data suggest that the energy conservation techniques were beneficial to improve lung function in children with CF.

Key words: Cystic fibrosis, pulmonary functions, Energy conservation techniques.

INTRODUCTION:

Cystic fibrosis (CF) is a multisystem disorder passed down from generation to generation; affected individuals experience high sweat electrolyte levels, obstructive lung disease, as well as malnutrition due to insufficient pancreatic function. This disease is the result of a genetic mutation on the long arm of chromosome 7 in the CFTR known as (cystic fibrosis trans member conductance regulator) protein[2]. While lung injury is the most critical factor in determining a CF patient's prognosis, respiratory dysfunction is a progressive condition with variable intensity that affects 95% of adult CF patients[3]. Defects in the CFTR protein cause the airways to produce less chloride ions and increase their absorption of sodium and water, resulting in thick, sticky mucus that is unable to do its responsibility of ensuring the lungs moist. Excess mucus in the lungs makes recurrent lung infections more likely[4]. Furthermore, the ventilator defect in CF is primarily obstructive, with a restrictive component emerging in the later stages when pulmonary fibrosis leads to decreased lung capacities[1]. Pulmonary function tests (PFT)

play a crucial part in the management of CF patients of all ages, including those in school[5]. PFT evaluate both lung capacity and airflow dynamics. When monitoring lung function, the medical team will pay special attention to the PFT results. Infections can cause changes in PFT levels, therefore it's important to monitor them closely. Long-term lung damage and CF progression can both be tracked using these measurements. PFTs are not performed on infants and preschool-aged children who have CF. These tests are reserved for those over the age of 5, 6, and adults since they require the CF patient to perform the specific breathing technique[7]. Some people with CF may develop a dependency on their medical care as their disease worsens because of the following issues: increased anxiety, which makes patients less likely to try even mild exercise; and chronic shortness of breath regardless of physical activity level. In addition, CF patients may experience diminished lung functions, resulting in decreased metabolic needs and functional capabilities[8]. Through the application of energy conservation strategies, such as coordinated breathing and correct body mechanics, individuals with dyspnea would experience a reduction in their symptoms and a consequent improvement in their capacity to carry out daily tasks[9].

MATERIALS AND METHODS:

Subjects

Forty CF children from both sexes, aged 6-8 years old, were recruited from the outpatient clinics at Kafr El Shaikh University's Faculty of Physical Therapy and the Chest Department of the University Hospital at Kafr El Sheikh's Faculty of Medicine. Two groups of children, group I (the controls) and group II (the study group), were created through random assignment.

The method of assigning participants to groups was a random draw from an opaque envelope. In Group I (control group), there were 20 children with the mean age of 6.6 (1,4).

Children received chest physical therapy programe which included airway clearance; diaphragmatic breathing exercise.
In Group II (study group), there were 20 children (11 boys & 9 girls) with the mean age of 6.5 (1,3). Children received energy conservation technique (Coordinated breathing; an ergonomic way of performing the activity with the use of assistive devices).

The following were used to choose the participants:

1- Medical diagnosis of cystic fibrosis was conducted by a specialist in chest disorders.
2- The children could understand.
3- follow the verbal instructions that are part of both the test and the training.

a. Exclusion criteria

1- Children who had a history of their illness getting worse in the four weeks before the study.
2- Children who were unable to perform pulmonary function tests.
3- Children had IQ<70.

The study was approved by the research ethics committee of Kafr El Shaikh University. Before the study, the parents of the children who took part gave their permission for them to take part.

Evaluation procedure

Age, gender, height, and weight were all written down. Date of birth was used to figure out age, weight was measured using a standard calibrated spring-type weight scale. Height was also measured in centimeters. Pulmonary function tests had been measured by spirometry (Koko spirometer, PDS instrumentation, INC., Louisville, Co, USA). In the pulmonary function testing lab at the Kafr El Shaikh University hospital, pulmonary function tests were done. All PFT were supervised by the same well-trained physiotherapist. Spirometric measurements would include FEV_1, FEV25-75 %, and FVC. Because none of the children had ever done a spirometry test before each child was taught by a pulmonary function physiotherapist who had lot of experience. If the child seemed scared, we made them feel safe by talking to them and easing them into the process by having them blow or whistles. We started by telling them that to make a mountain on the computer, they had to take a big breath and blow it into the mouth piece. Once they got the general idea, we added details as blowing all the air out as well as blowing the air out as hard as the child can. All of the kids were tested while they sat and wet their nose clips. The child was happy to keep trying, but the testing stopped if he or she got scared, cried, or seemed tired. The stopping point varied from child to child and was determined by the pulmonary function specialist's judgment as to how long to continue to attempt to obtain there technically acceptable efforts. No session lasted more than 15 minutes.

Treatment procedures

I- Pulmonary rehabilitation program (chest physical therapy) comprised airway clearance, diaphragmatic breathing exercises.

1- Postural drainage for both groups I & II, postural drainage is a widely accepted technique to help people with cystic fibrosis breathe with less difficulty and stay healthy. Postural drainage is a mean of clearing the airways from secretions by placing the patient in various positions so that the gravity will assist in the flow of mucus and secretions. The positions are based on the anatomy of the trachea bronchial tree and designed to drain specific areas of the lung so the mucus in moved from the affected bronchioles to the larger bronchi and trachea. Inhaled bronchodilator would be taken before postural drainage to open the airways and aerosolized antibiotics would be taken after postural drainage to treat the opened airways.

2- Diaphragmatic breathing exercises to perform basic diaphragmatic breathing,

- Patient should be asked to lie down on a flat surface with a pillow below their head and another under their legs In time, the child was able to use the diaphragmatic breathing technique whether seated in a chair or standing with his knees bent and his shoulders, head, and neck relaxed.
- To feel diaphragm movement, the therapist put one hand on the child's upper chest and the other on the child's abdomen.
- The hand on the child's chest should remain as motionless as possible while the child slowly inhale through his nose and feel his stomach move out against it.
- Pull the child's stomach in toward his spine and tighten his abdominal muscles as he expire through the mouth. Using his diaphragm effectively requires some effort, and the child may feel fatigued when using this technique at first. However, if the child continue with it, diaphragmatic breathing would eventually become natural and effortless. Start with 5-10 minutes, 3-4 times daily; as the child get stronger, he can increase the time spent exercising.

II- **Energy conservation:** the idea behind conserving energy is to cut down on the amount of oxygen used by the body when it's not required to do so.

Examples of of breathing exercises:

1- Pursed-lip breathing by inhale through his nose and softly exhale (don't force the air out). As if the child's were going to whistle or blow out a candle. The child should hold his breath out for at least twice as long as he did when he breathed it in. Whenever he feel out of breath, whether during exercise or otherwise, try pursed-lip breathing.

2- Coordinated breathing proper body machine in order to save energy while doing these activities:

A- Bending

Children need to be taught that bending over cane cause shortness of breath due to the diaphragm being compressed. It's important to maintain an upright posture. The child exhale slowly with using his legs.

B- Stooping and reaching

Instruct children to exhale when leaning forward and inhale when sitting up straight.

C- Lifting

It's easier to handle if the work is broken up. The child keep his back from getting strained by using his leg muscles instead. Do not forget to breathe. Teach children to exhale as they work hard or lift something heavy.

D- Pushing & pulling

Teach children to coordinate their breathing with their movements. They should exhale when pushing and inhale when pulling, for instance

E- Carrying

Children are taught to only carry one bag at a time and to avoid putting any weight on their chest.

F- Crouching

Crouching makes it more difficult to breathe because the child's legs are pressing against his chest, restricting the diaphragm's range of motion. When doing an activity that will take a long time, it is preferable to sit or get down on his hands and knees.

G- Climbing stairs

As a part of our breathing instruction, we remind kids to exhale as they walk. Try breathing in while they're resting. Maintain a regular, easy breathing pattern.

H- Using his arms and hands

We teach kids how to use a wall or a chair's back support to steady themselves when they need to lean. Lean on the edge of a table or desk, or use a t-shirt to prop up his pants that don't have buttons. To save his back from straining every time the child tie his shoes, try a pair of shoes without laces.

3- Grooming

In front of the sink, the child wash his face, sit down. When doing personal hygiene tasks like brushing teeth & combing hair, it is important to keep elbows propped up on the edge of the sink or tub, to use a small towel, and to breathe in a coordinated fashion while wringing the towel out. Never put his finger over his mouth and nose at the same time when washing his face.

4- Toileting

- Put in an exhaust fan & open the bathroom window to improve ventilation.
- Maintain rhythmic breathing during a bowel movement to avoid feeling breathless.
- To guarantee that the toilet bowl is at the right height, either raise the height of the seat or use a raised toilet seat.

5- Bathing

- Before the child hop in the tub, make sure he has everything he will need, like clean towels, soap, and clothing, set up and ready to go. Just chill out.
- Provided that the children are able to. The children welcome to use a shower chair if they like. Use a long-handled sponge and a long towel to wash their body, and practice coordinated breathing as they do so (inhale for upward wand motions, exhale for downward wand motions, etc.).
- Postural exercises connected with breathing.
- Those exercises that combine active movements of trunk & extremities with deep breathing.

Statistical analysis

While both groups showed increases in post-treatment measures like FEV_1, FEF25-75 %, and FVC, the study group improved at a higher rate. Over the past 70 years, we have made great strides in treating cystic fibrosis. Babies born today have a much better chance of surviving into adulthood than those born even 70 years ago did. Recent developments in the management of CF have allowed people with the disease to lead more normal lives. Protective treatment for airway infection, pulmonary rehabilitation, and lifestyle promotion are the cornerstones of management (14).

Results

The collected data from this study represent the statistical analysis of forced expiratory volume (in one record), (FEV_1), forced expiratory flow 25-25% (FEV_{25}-75%) and forced vital capacity (FVC). Data were obtained from both groups, control & study groups before and after three months of treatment for the two groups. Demographic and clinical characteristics of the patients in both groups :

In control group, 12 boys & 8 girls while in study group, 11 boys & 9 girls. No statistical significant differences were detected between both groups regard in mean age, height and as shown in **Table (1).**

Table (1): demographic and clinical characteristic of the patients in both groups

Variables	Control group (N=20)	Study group (N=20)	Significant p-value
Sex[a] (M:F)	12: 8	11: 9	0.7
Age[b] (yrs)	7.2 (1.4)	7.1 (1.3)	0.6
Weight[b] (KG)	21.88 (3.9)	20.58 (2.84)	0.436
Height [b](cm)	121.59(5.4)	119.98(4.84)	0.245
Forced expiratory volume (FEV_1)	0.511(0.22)	0.513 (0.23)	0.933
Forced expiratory flow	0.341	0.342	0.645
25-75% (FEB25-27%)	0.13	0.14	

Forced vital capacity (FVC)	0.647(0.24)	0.649 (0.25)	0.437

[a]: date represented as numbers & percentages; [b]: data represented as mean & SD; significant at P<0.05.

There were no statistical differences between both groups for any pretreatment measures, **(table 1).**

In control & study groups, there were statistically significant improvements in forced expiratory volume in one second (FEV_1) , forced expiratory flow 25-75% *FEV25-75%) and forced vital capacity (FVC) as compared to initial values (Table2).

Table (2): Comparison between pre and post treatment of forced expiratory volume in one second (FEV_1) forced expiratory flow between 25-75% (FEF 25- 75%) and forced vital capacity (FVC)

Variables	Pre treatment	Post treatment	p-Value
Forced expiratory volume (FEV1)			
Control group	0.511(0.22)	0.639(0.27)	<0.01
Study group	0.513(0.33)	0.749(0.33)	<0.001
Forced expiratory flow 25-75% (FEV25-75%)			
Control group	0.341(0.13)	0.466(0.17)	<0.01
Study group	0.342(0.14)	0.579(0.23)	<0.001
Forced vital capacity (FVC)			
Control group	0.647(0.24)	0.754(0.27)	<0.01
Study group	0.649(0.25)	0.898(0.34)	<0.001

Values indicated mean (standard deviation), paired T-test, significant P<0.05).

Data presented in tables showed that there were statistically significant difference between both groups in their post treatment mean values of FEV_1, FEV25-75% and FVC in favor of the study group.

Table (3): comparison between both groups post treatment as regards FEV1, FEV25-75% and FVC

Variables	Control group (n=20)	Study group (n=20)	P	Significant
(FEV_1)	0.639 (0.27)	0.749(0.33)	<0.01	S
(FEV25-75%)	0.466 (0.17)	0.579 (0.23)	<0.01	S
(FVC)	0.754(0.27)	0.898 (0.34)	<0.01	S

Values indicated mean (standard deviation), independent T-test, significant at P<0.05.

Discussion

Treatment of cystic fibrosis (CF) is lifelong and is conducted with the goal of improving organ function and, by extension, the patient's quality of life. Treating and preventing the lung damage caused by the constant buildup of mucus and infection is the primary focus of CF treatment. Overproduction of mucus in the airways and the accompanying development of chronic obstructive pulmonary disease are hallmarks of cystic fibrosis, the most prevalent fatal hereditary disease. The accumulation of secretions in the airways can cause inflammation, which in turn can restrict the airways, raise airflow resistance, and trap gases. This leads to uneven ventilation and poor gas mixing, both of which can reduce gas exchange and hence functional capacity (16). Treatment-related improvements in both groups' post-treatment mean values were probably attributable to increased airway mucus production. Creatinine and mucus in the respiratory system encourage loosening and expulsion (17). This is consistent with the findings of Warnock and Gates, who found that airway clearance is an integral part of CF therapy. The most popular method of airway clearance is a type of physical therapy known as chest physiotherapy. This method incorporates deep breathing, gravity assisted postural drainage, & manual percussion as well as vibration treatments. ECT may have helped the research group's post-treatment values improve because they were used throughout the rehabilitation of people with cystic fibrosis. ECT used in the this study are coordinated breathing (pursed lip breathing), an ergonomic way of performing activities of daily living (proper body mechanics) & the use of assistive devices to reduce energy expenditure. Because of the chronic lung infections

that CF patients have, they often feel tired and breathless, so any way to lessen the amount of effort they have to put into daily activities is welcome (19). Expiration is resisted by closing the mouth tightly in a pursed-lip breath. Exhalation is facilitated by this mechanism because the increased pressure at the mouth is conveyed to the airways and keeps them open. Premature airway closure is assumed to be prevented by the higher airway pressure seen during expiration, resulting in less gas being trapped in the lungs. Together with maintaining an open airway and extending the expiratory phase of breathing. For patients with cystic fibrosis, pursed-lip breathing has been demonstrated to be an efficient method of secretion elimination because it facilitates the proximal migration of mucus. Many people have found success with pursed-lip breathing since it is widely accepted by patients, simple to implement, and efficient with both time and money (20). The findings were compatible with the study group's interpretation of of **Wingardh et al.** the results after therapy. (21). A group of researchers came to the conclusion that individuals having chronic obstructive pulmonary disease could be taught to reduce their energy consumption during daily tasks by teaching them how to employ energy-saving strategies. Energy conservation, they explained, is the practice of organizing and doing tasks in a way that reduces the amount of effort expended by the body and so helps people with CF do more with less.

Conclusion

Work simplification and energy conservation principles would allow C.F. patients to remain independent & be less frustrated by their unless when their & energy lasts throughout the day. Energy conservation techniques allow C.F. patients to redistribute efforts to complete tasks that are most important to them.

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