Pulmonary Rehabilitation in COPD

Sheetu Singh*, Virendra Singh**

Introduction

What is the difference in the lungs of an athlete and a clerk. Lungs of both of them are normal. Athlete has trained his lungs and body to perform rigorous exercise and able to run 20 kilometre (km) in one stretch while the clerk working in an office is hardly able run for 2 km. Even in normal lungs training and exercise result in a ten fold improvement in performance. Similarly a patient with chronic obstructive airway disease (COPD) who is unable to walk 100 metres can be trained under the pulmonary rehabilitation programme to walk greater distances and perform tasks which he could not do previously.

Exercise training and rehabilitation have been shown to reduce disability in many chronic respiratory diseases.1,2 COPD is progressive disease3 with poor prognosis. In severe cases patients treatment options are limited and oxygen is the only modality that prolongs survival.4 With disease advancement, co-morbidities and recurrent exacerbations a patient becomes disabled. Disability is a cause of decreased activity, social isolation and depression. Further, decreased activity is an independent predictor of mortality in COPD.5 The aim of pulmonary rehabilitation is to break this vicious cycle and help the COPD patients to participate in daily activities. It is known to improve quality of life and exercise tolerance in COPD.6

Why COPD Patient Develop Dyspnoea?

Dyspnoea and exercise intolerance in COPD are due to multiple factors. Expiratory airflow obstruction7 is an important cause but not the only one. Inspiratory muscle dysfunction,8 gas exchange abnormalities9 and cardiac dysfunction10 are other causes. Exercise intolerance can be best explained by the concept of dynamic hyperinflation11. The motion of thorax is restricted due to hyperinflation and thereby capacity to increase tidal volume during exercise is limited. Hyperinflation also compromises the ability of inspiratory muscles to generate pressure12 and weakens them.

Pulmonary Rehabilitation

American thoracic society and European respiratory society proposed the most acceptable definition in 2006. It states

"Pulmonary rehabilitation is an evidence-based, multidisciplinary, and comprehensive intervention for patients with chronic respiratory diseases who are symptomatic and often have decreased daily life activities. Integrated into the individualized treatment of the patient, pulmonary rehabilitation is designed to reduce symptoms, optimize functional status, increase participation, and reduce health care costs through stabilizing or reversing systemic manifestations of the disease."8

A lot of research has been done in various aspects of pulmonary rehabilitation in patients with COPD. This review analyzes the methods of pulmonary rehabilitation and various aspects as follows (Table 1).

1. Smoking cessation

With age lung functions decline and usually forced expiratory volume one second (FEV1) declines 20 ml every year after 20 years of age. In smokers annual decline in FEV1 is 35 to 40 ml. None of the existing medicines can reduce the faster rate of decline in lung functions in a smoker. Only strategy to prevent faster rate of decline is cessation of smoking. It has been observed that in former smokers annual decline in FEV1 is around 20 ml per year. These observations emphasize the need of counselling smokers to quit at the time of every consultation.

2. Clearing of secretions

Cough and sputum production are key symptoms of COPD. Traditional definition of chronic bronchitis is also based on chronic production of sputum. Presence of secretions in airways not only interferes in ventilation but also in physical capacity. Therefore clearing of airways from secretions is an important step before performing exercises. Good hydration, smoking cessation, avoidance of irritants and bronchodilator therapy are prerequisites. Chest physiotherapy is helpful in clearing secretions and subsequently preventing sequelae like dyspnoea and hypoxemia. Controlled cough and forced expiration are two techniques found useful13. Patients with severe COPD may tolerate the latter technique better. The techniques should be practised every morning ten minutes after the dose of short acting bronchodilator. They may be practised more frequently in patients with problem of copious sputum. Postural drainage is practised in patients with localised disease. Gravity helps in drainage of secretions. A combination of chest physiotherapy and postural drainage may provide adequate clearance of secretions, but has no effect on lung functions. Mucolytics have doubtful role in management of cough sputum in a COPD patient. Cough suppressants that depress the cough centre should be used with caution because these may also cause respiratory depression.

3. Breathing techniques

Some breathing techniques are useful in providing relief in dyspnoea in patients with severe COPD. The patient is advised to breathe slowly and deeply to reduce dead space and improve carbon dioxide elimination. This pattern of breathing reduces physiological dead space, improves carbon dioxide removal and consequently ventilation.

Table 1: Methods of pulmonary rehabilitation

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*Chest Consultant, Asthma Bhawan, Jaipur; **Professor and Head, Division of Allergy and Pulmonary Medicine, SMS Medical College, Jaipur
Pursed lip breathing (Figure 1) is assumed by some COPD patients instinctively during an exacerbation. It is a pulmonary rehabilitation approach employed to relieve patient of dyspnoea. Pursed lip breathing involves active expiration against resistance.\(^{14}\) Resistance may be provided at level of lips or tongue and a whistling is produced during expiration.\(^{15}\) It is called as pursed lip breathing. When resistance imposed at level of vocal cords it is called as grunting. This procedure reduces the respiratory rate and improves tidal volume.\(^{16}\) Other theories to explain improvement in ventilation with pursed lip breathing are alteration in respiratory muscle recruitment\(^{17}\) and development of positive pressure in the airways during breathing, thereby preventing dynamic airway collapse.\(^{18}\)

Diaphragmatic breathing (Figure 2) is another pattern of breathing which distracts the patient from the distress of dyspnoea and alleviates the anxiety.\(^{19}\) This form of breathing is practised when patient is comparatively less distressed. One hand is kept on the chest and another on the abdomen. Patient is instructed to take abdominal breathing by taking a deep slow inspiration and allow the abdominal wall to move outward. The possible mechanism of action of this method is altered respiratory muscle recruitment and reduction in respiratory frequency.\(^{20}\)

4. Exercises

Exercise improves vigour, health status\(^{13}\) and life expectancy\(^{21}\) in normal healthy individuals. The role of exercise in COPD as a treatment modality was introduced around twenty years before. A number of studies and meta-analysis have been performed to decide the indications, intensity, duration and long term effects of exercise.

It has been observed that around 30% of muscle mass gets wasted in an average COPD patient.\(^{22}\) Poor muscle mass leads to early fatigue and decreased exercise tolerance. Muscle wasting is also an indicator of poor survival. Exercise training replaces type II muscle fibres (fast, fatigable, low oxidative) with type I fibres (slow, fatigue-resistant, high oxidative).\(^{23}\) Thus, exercise training builds up muscle mass and strength. It has been known to increase exercise capacity, improve health related quality of life measures and reduces symptoms of dyspnoea. Exercise also has psychosocial benefits with reduced prevalence of depression.\(^{24}\) However, there is inadequate evidence that indicate improvement in survival in COPD patients.

a. Type of exercises

The muscle strength and endurance are increased for the specific group of muscle trained. Thus, both upper limb and lower limb exercise training are advised.\(^{24}\) Lower limb training includes treadmill, cycle ergometry and corridor walking.\(^{3}\) Various studies have reported an increase in peak exercise capacity, walking distance and endurance.\(^{25}\) Many COPD patients have difficulty in performing activities involving use of upper limbs. Upper extremity training is required in these cases and it includes ergometry, throwing and weights.\(^{(9)}\) Unsupported weights have been found superior to supported exercises in form of ergometry. Similar to lower limb muscle training arm endurance and strength are increased by upper limb muscle training.

b. Who should undertake exercises of pulmonary rehabilitation?

Usually patient of COPD with severe dyspnoea interfering with lifestyle, reduced tolerance to exercise and patients in pre-operative period are suitable candidates for a rehabilitation program. Some guidelines refer patients with medical research council (MRC) dyspnoea scale of more than III-IV.\(^{24}\) However, one study observed benefit in COPD patients of any GOLD stage by pulmonary rehabilitation.\(^{26}\)

Patients with recent myocardial infarction (past three months), unstable angina, uncontrolled blood pressure, debilitating arthritis, congestive heart failure, dementia, neurological and peripheral vascular disease are not prescribed pulmonary rehabilitation.\(^{27}\)

c. Intensity and duration of exercise

Depending on the underlying COPD, co-morbidities and muscle wasting patients are assigned either high or moderate intensities of exercises. High intensities of exercise include training at 90-100% of maximum exercise capacity\(^{27}\) or heart rate. Alternatively a Borg
scale index of dyspnoea of more than 4-6° or presence of blood lactate may be taken as indicators of intensity of the exercise. Performing high intensity exercise for short interval increases the strength of the muscles and performing less intense exercise for a longer interval increases the endurance. Moderate intensity of exercise includes training at 60-80% of maximum exercise capacity.

Training programmes of longer duration have been known to produce more benefits as compared to shorter duration programmes. Outpatient training sessions of at least three sessions per week (out of which at least two should be supervised) are followed. Minimum of 6-7 week duration of programme is followed. Training of less than 6 weeks duration is of less benefit.

d. Outcome measures

The outcome can be measured by subjective and objective methods. Since most patients are referred for pulmonary rehabilitation due to decreased exercise tolerance, poor quality of life and increased dyspnoea, the assessment of outcome by the patient is important. Subjective methods include symptom improvement in terms of questionnaires like chronic respiratory disease questionnaire and St George’s respiratory questionnaire. Borg scale and visual analogue scale can also be used to assess the degree of breathlessness. Objective methods include cardiopulmonary exercise testing (CPET), six minute walk test (6MWT), incremental shuttle walk test (ISWT) and endurance shuttle walk test. CPET is the gold standard as it measures maximal exercise capacity. However it is expensive and not easily available. 6MWT is a simple test and can be used to evaluate distance walked in six minutes. The results of 6MWT can be variable so alternative tests like incremental and endurance shuttle walk test have evolved. ISWT uses a 10 meter long corridor in which the patient walks while increasing the speed every minute. The test is continued till the patient is fatigued. Outcome is measured in terms of total distance travelled. Endurance shuttle walk test is similar to ISWT except that the patient walks at a set pace. It is a measure of sub-maximal exercise capacity.

e. Maintenance exercises

The benefits of exercise programme after stopping wanes with time. Various maintenance programmes have been studied with variable results. Foglio et al. had studied the effect of pulmonary rehabilitation programme held yearly. They found gains similar to the standard eight week programme. Similarly other studies have found modest effects of maintenance programmes on long term results. Further research is needed to decide the duration, type and intensity of maintenance programmes.

f. Adjuncts to exercise training

i. Nutrition

Caloric supplementation to meet increased energy requirements has to be done. Adequate carbohydrates have to be provided in COPD patients with a BMI of less than 21kg/m² or loss of more than 10% body weight in past six months. Proteins are also required to build fat free mass. Anabolic hormones including growth hormone and testosterone have also shown increase in muscle mass; however the transformation of increased muscle mass in increased exercise tolerance is uncertain.

ii. Oxygen therapy

It has been known to improve survival in COPD patients. COPD patients already on domiciliary oxygen require it during exercise at higher flow rates. Oxygen is also indicated in patients with normal oxygen saturation at rest but with exercise induced hypoxemia. Oxygen leads to increase in the exercise capacity, intensities and endurance. However the long term benefits are not known. Carrying an oxygen cylinder during exercise is also cumbersome and may discourage the patient.

iii. Non invasive ventilation (NIV)

NIV during exercise acts by unloading of the respiratory muscles thereby reducing the work of breathing. The results of various trials are ambiguous regarding the role of NIV during exercise. However it can be recommended that NIV provides benefit in exercise tolerance in patients with advanced COPD.

iv. Inspiratory muscle training

It is another pulmonary rehabilitation strategy with equivocal results. It is indicated in patients with inspiratory muscle weakness. There are three types of inspiratory muscle training namely voluntary isocapnic hyperventilation, inspiratory threshold loading and inspiratory resistive loading. Results of various studies with the above three techniques are inconclusive with no distinct advantage of one technique over the other.

v. Neuromuscular electrical stimulation (NMES)

It is applied in the patients who are bed-ridden with severe peripheral muscle weakness. Patients with severe muscle weakness who are deemed unfit for pulmonary rehabilitation, after NMES are able to participate in rehabilitation programmes.

Correction of nutrition, electrolyte imbalance and withdrawal of high dose steroids are measures adopted to correct the primary cause.

5. Energy conservation and fatigue obviation

COPD patients have impaired lung functions, co-morbidities and muscle weakness due to which they have fatigue and dyspnoea on performing routine day to day activities. To overcome the airway obstruction and structural lung changes these patients have to spend more energy on the work of breathing. The anaerobic threshold is reduced in these patients, with glycolysis occurring in the muscles sooner than that in a healthy individual thereby restricting exercise. Earlier studies have shown that leg fatigue and dyspnoea are the major limiting factors restricting exercise. Difficulty in carrying out daily activities leads to withdrawal of the patient and depression. The degree of restriction of day to day activities has to be assessed and management has to be planned accordingly. Learning new behaviour
strategies forms the integral component of conserving energy. Patient should manage time accordingly with proper hours of rest so that fatigue does not occur. The pace of performing activities should be slowed down with rest of about 30 minutes after every meal and proper rest during night. Similarly work should be performed in such a way that it consumes less energy. Unsupported arm movements consume more energy and should be avoided. In breathing energy is spent less during expiration than inspiration. Therefore exertional activities should be coordinated and performed during expiration.

6. Rehabilitation in exacerbations
Exacerbation of COPD nullifies the gains of pulmonary rehabilitation programme by increasing dyspnoea, disabling the patient and dipping the quality of life. Patients are not able to reach the pre exacerbation levels and are therefore referred for rehabilitation. Post exacerbation rehabilitation has been found useful in improving exercise capacity. However they included small number of study subjects and further trials are required.

7. Patient education
Patient education also requires a multidisciplinary approach and includes information on exercise, diet, energy conservation, drugs and inhaler device technique. It starts with diagnosis, smoking cessation and extends up to end-of-life discussions. Educating the patient regarding the premonitory signs of an exacerbation may help patient in identifying the signs early and avoiding severe exacerbations. Psycho-social support is also required because of chronic and progressive nature of the disease.

8. Future direction
Pulmonary rehabilitation has come a long way from an unknown entity to becoming the cornerstone of management of COPD. However it still needs to be implemented for all the COPD patients, which requires the physicians to be trained in this sub-speciality. We also do not know the proper intensity, duration and maintenance regimes of the exercise training which will be beneficial to the patient. The effect of pulmonary rehabilitation is another issue which has to be studied.

Conclusion
Pulmonary rehabilitation is a multidisciplinary approach which requires active participation of the patient as well as the physician. It has been known to improve exercise capacity, dyspnoea and health related quality of life index in COPD. However further research is required to establish exercise regimes which will benefit all the patients.

References


