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PULMONARY REHABILITATION FOR CHRONIC OBSTRUCTIVE PULMONARY DISEASE: A CASE REPORT

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Abstract

Introduction: Global Initiative for Chronic Obstructive Lung Disease (GOLD) defined chronic obstructive pulmonary disease (COPD) as a common, preventable, and treatable disease characterized by persistent respiratory symptoms and airflow limitation. In COPD, the respiratory muscles remain contracted for prolonged periods to meet the increased demand of ventilatory flow causing hyperinflation and increasing load on the respiratory muscle. Pulmonary rehabilitation (PR) is defined as a comprehensive individualized intervention provided by an interdisciplinary team that targeting COPD patients to achieve the maximal level of independence, functioning and, autonomy. PR is a key component of managing COPD because it has been shown to improve exercise capacity, dyspnea, and quality of life in patients with moderate to severe COPD. Physical therapy is a part of PR that can improve multiple aspects of physical function and the performance of functional activities in COPD Patients

Case Presentation: A 56-year-old female patient with a longstanding history of asthma, was referred to Balai Besar Kesehatan Paru Masyarakat (BBKPM) Bandung due to shortness of breath. The shortness of breath worsened three days ago when performing activities and was not affected by changes in the body position. The shortness of breath limits the patient's ability to walk more than 50 m. The patient must stop and rest for a while before being able to walk again

Management and Outcome: A pulmonary rehabilitation program twice a week in 3 weeks was given which consists of breathing exercise, respiratory muscle stretching, and aerobic training. After 6 sessions of physical therapy, there is improvement in chest expansion, 6MWT distance, mMRC score, and CAT score.

Discussion: Patients with chronic obstructive pulmonary disease usually having shortness of breath, reduced functional capacity, and quality of life. Evidence suggests that PR is an effective intervention for patients with COPD. Expected benefits from physical therapy are reduced dyspnea level, improved exercise tolerance, and maximized patient's health-related quality of life.

Conclusion: A pulmonary rehabilitation program consisting of breathing exercise, respiratory muscle stretching, and aerobic training was able to improve chest expansion, improve 6MWT distance, reducing mMRC dyspnea scale, and reducing CAT score.

Keywords: Chronic Obstructive Pulmonary Disease, COPD, Pulmonary Rehabilitation, Breathing exercise, Aerobic exercise, Respiratory muscle stretching.

Introduction

Global Initiative for Chronic Obstructive Lung Disease (GOLD) defined chronic obstructive pulmonary disease (COPD) as a common, preventable, and treatable disease characterized by persistent respiratory symptoms and airflow limitation (GOLD, 2021). In COPD, the respiratory muscles remain contracted for prolonged periods to meet the increased demand of ventilatory flow causing hyperinflation and increasing load on the respiratory muscle (Wada *et al*., 2016).

The airflow limitation in COPD is progressive, caused by smoking, or by significant exposure to harmful particles or gases. COPD doesn't only affect the lung but also having extrapulmonary manifestations that contributing significantly to a decrease in functional capacity and health status, a reduction in perceived health status, and an increase in mortality (Torres-sanchez *et al*., 2018).

Pulmonary rehabilitation (PR) is defined as a comprehensive individualized intervention provided by an interdisciplinary team that targeting COPD patients to achieve the maximal level of independence, functioning and, autonomy. PR is a key component of managing COPD because it has been shown to improve exercise capacity, dyspnea, and quality of life in patients with moderate to severe COPD. Physical therapy is a part of PR that can improve multiple aspects of physical function and the performance of functional activities in COPD Patients (Fastenau *et al*., 2020) (Wouters *et al*., 2020).

Physical therapy intervention that been used in this article is exercise training and breathing exercise. Several studies reported that physical therapy improves symptoms of COPD patients including peripheral muscle strength, exercise capacity, quality of life, and perceived health status without major changes in physiologic function (Torres-sanchez *et al*., 2018). Exercise is a key component of pulmonary rehabilitation based on American Thoracic Society guidelines. Exercise training such as aerobic training combined with respiratory muscle stretching can reduce dyspnea and increases functional and ventilatory capacities in patients with COPD. Breathing exercise's role is to managing breathlessness

in patients with COPD and can also aim to improve ventilation and gas exchange, optimize chest wall motion, and reduce hyperinflation (Paneroni *et al*., 2017).

Case Presentation

A 56-year-old female patient, resident in Bandung (Indonesia), with a longstanding history of asthma was referred to Balai Besar Kesehatan Paru Masyarakat (BBKPM) Bandung due to shortness of breath. About three days ago, she began presenting with persistent shortness of breath that worsened when performing activities and was not affected by changes in the body position. The shortness of breath limits the patient's ability to walk more than 50 m, which is normally well tolerated by the patient. The patient must stop and rest for a while before being able to walk again. She did not require oxygen or any assistive devices with ambulation.

In terms of past medical history, she had a history of asthma since she was 10 years old. The patient had no medical history of diabetes, hypertension, tuberculosis, or heart disease. The patient is a retired hotel clerk, an active smoker for 30 years, but has stopped since 2016. In the past, she can spend about one pack of cigarettes in a day.

The patient's height and weight are 155 cm and 48.5 kg respectively. Her blood pressure was 100/70mmHg, heart rate (HR) was 88bpm, respiratory rate (RR) was 22rpm, and peripheral oxygen saturation (SpO2) at rest was 96%. Her body temperature was normal at 37^0C. The inspection showed hyperinflation of the chest wall (barrel chest). The patient was using accessory muscles to breathe, and the chest movements are symmetrical with equal expansion of both hemithoraces. Pulmonary auscultation revealed a prolonged expiratory sound and wheeze in the apical zone of the right lung, no rhonchi sound in all lung fields on the left and right side.

The patient was submitted to a pulmonary function test using spirometry. The result of the spirometry test can be seen in table 1. There was no significant improvement after the administration of the bronchodilator(Ventolin). The result was indicating that the patient has an obstructive pulmonary disease. The FEV1 pre-bronchodilator was 34%

predicted indicates a severe airflow limitation and was classified into The Global Initiative for Chronic Obstructive Lung Disease (GOLD) 3 classification.

Table 1. Pulmonary Function Test

Assessment	Pre bronchodilator	Pre bronchodilator
FVC	1.27(51% predicted)	1.85(74% predicted)
FEV1	0.72(34% predicted)	0.74(35% predicted)
FEV1/FVC	56(72% predicted)	40(51% predicted)

The examination of the chest expansion was performed using a meter line and the result is listed in table 2. There was a decrease in the expansion of the thoracic wall during the ventilation process with a difference of 2-3 cm with a normal reference value of 5 cm.

Table 2. Chest expansion measurement

Location	Inspiration	Expiration	Difference
Axilla	94 cm/	97 cm	3 cm
ICS 4	94 cm	96 cm	2 cm
Proc. Xypoideus	80 cm	82 cm	2 cm

A 6MWT was administered to examine the patient's functional activity tolerance and peripheral oxygen saturation. Based on the American Thoracic Society (ATS) reports, the minimally clinically important difference in 6MWT distance for individuals with COPD is between 25-35 m. The patient ambulated went through a total of 370 meters (44% of predicted), VO_2 max 15,08 cc/kg, O_2 saturation stable at 97%, HR increased to 92 BPM, with minimal changes in BP of 100/80 mmHg

The Modified Medical Research Council Dyspnea Scale (mMRC) was used to measure the degree of disability that breathlessness poses on day-to-day. Higher scores indicating a decreasing quality of life and increased burden from symptoms. The patient scored a 3 out of 4 on the mMRC indicates that she stops for breathe after walking 100 yards (91 m) or after a few minutes.

Table 3. mMRC Dyspnea Scale

Grade 0	Dyspnea only with strenuous exercise
Grade 1	Dyspnea when hurrying or walking up a slight hill

Grade 2	Walks slower than people of the same age because of dyspnea or has to stop to breathe when walking at their own pace
Grade 3	Stops for breath after walking 100 yards (91 m) or after a few minutes
Grade 4	Too dyspneic to leave house or breathless when dressing

The COPD Assessment Test (CAT) was used to assess the effects of COPD symptoms on quality of life. GOLD considers a patient that scores a 10 or above on the CAT to be symptomatic. In this case, the patient scored a 6 which means the symptom has a low impact on the quality of life of the patient.

Management and Outcome

Management

After the initial assessment, the patient was given the pulmonary rehabilitation program. The program lasted one month and consisted of two weekly training sessions. During the program, the patient was instructed to maintain the use of any medications he had been taking previously. The pulmonary rehabilitation program is :

1) Breathing Exercise (Breathing control and diaphragmatic breathing plus pursed lips breathing)

The position of the patient is sitting or half lying. The therapist then asked the patient to place one hand on the patient's chest region and the other on the abdomen. The patient was asked to breathe in slowly and comfortably from the nose, with the abdomen moving predominantly, reducing the movement of the rib cage. Then exhale the air with lips partially closed. The frequency was 4 times/week with 10 repetitions/3 set in a day (Mendes *et al*., 2019)

2) Respiratory muscle stretching

The program consisted of hold-relax and passive stretching techniques of the respiratory muscles with a coordinated breathing exercise. The hold–relax stretching begins with performing a passive stretch up to the maximum range of motion(ROM), the patients then hold the movements for around 10 seconds and then relax. During a hold and relax time, the patient was asked to breathe in and

breath out respectively. The procedure for each muscle is explained below (Rekha *et al*., 2016):

•Upper trapezius

The patient sitting on a chair comfortably. The therapist asked the patient to laterally flex the neck and head from the side being stretched and slightly flex the neck forward and depress the shoulder. Do the same on the other side also.

• Sternocleidomastoid

The patient sitting on a chair comfortably and align the spine and neck in a neutral position. The therapist asked the patient to moved her head position to flexion, ipsilateral side flexion, and contralateral rotation. . Do the same on the other side also.

•Pectoralis major

Patient standing straight near a wall. The therapist asked the subject to place the forearm against a wall and the elbow to bend 90° on the side to be stretched, then gently turn the body away from the wall until a mild to moderate stretch is felt across the chest. Do the same on the other side also.

• Lattismus dorsi

The therapist asked the patient to stand tall and put one arm overhead and use the other arm to grasp the elbow or wrist and gently pull down toward the opposite shoulder. Do the same on the other side also.

•Scalene

The patient sitting on a chair comfortably. The therapist asked the subject to place her hand over the head and pull it to the side to stretch the muscle. Do the same on the other side also.

•Serratus anterior

The patient Standing straight and places both hands at the back. The therapist asked the patient to reach behind the back and hold hands together and pull the

involved side across the back at waist level. Do the same on the other side also.

3) Aerobic exercise

Aerobic training was walking on the ground for 30 minutes beginning at 60% and reaching up to 85% of the average speed achieved during the 6MWT. The intensity was gradually increased and was associated with a perception effort between 4 and 7 points on the modified Borg scale. At the beginning of a program, the patient aims to start with 10 minutes of continuous walking and build up to 30 minutes. When the patient reached the level of exercise at 10 minutes without intolerable dyspnea, the duration was increased 5 to 10 minutes every week for the 4 weeks (Wada *et al*., 2016).

Outcome

Table 4. Results of pulmonary rehabilitation after 6 sessions

Assessment	**T1**	**T6**
Chest expansion		
• Axilla	3 cm	4 cm
• ICS 4	2 cm	3 cm
• Proc. Xypoideus	2 cm	3 cm
6MWT	37m (65,4 predicted)	418.1 m(73.9 predicted)
mMRC	3	2
CAT	6	4

The patient went through a total of 6 training sessions, twice a week for 3 weeks. After 6 training sessions, the pulmonary rehabilitation program showed an improvement in the measurement of chest expansion,6MWT distance, mMRC score, and CAT score. The difference in chest expansion measurement increased by about 1cm in each measurement. The distance in 6MWT increasing from 370m to 418.1m indicating improvements in the functional activity tolerance. The mMRC

score is decreased from 3 to 2 indicating the patient's shortness of breath is reduced to a lower degree of impairment and increased tolerance for daily physical activity. The CAT score was reduced from 6 to 4 indicating that the symptoms of COPD were not a burden on the patient's quality of life.

Discussion

Pulmonary rehabilitation is defined as a comprehensive intervention targeting complex needs in patients with chronic respiratory conditions to improve physical, psychological, and social outcomes. Evidence suggests that PR is undoubtedly an effective intervention for patients with COPD, both in the stable and acute setting. Physical therapy efficacy and clinical relevance as a part of PR had also been proven. Expected benefits from physical therapy are reduced dyspnea level, improved exercise tolerance, and maximized patient's health-related quality of life (Wouters *et al*., 2020) (Lopez-lopez *et al*., 2019)

In patients with severe COPD, diaphragm dysfunction is common because of decreased mechanical efficiency of respiratory muscles. Due to the dysfunction of the diaphragm, the activity of the respiratory accessory muscle plays a major role. Retraction of these muscles

around the chest wall limits the chest expansion causing hyperinflation, severe breathlessness, and poor exercise tolerance level (Rekha *et al.*, 2016).

Respiratory physical therapy can improve the function of the diaphragm as the most essential respiratory muscle resulting in improved tidal volume. Respiratory muscle stretching during exercise reduces the accumulation of metabolites and delays the response of metabolic receptors. This exercise lengthens the external and internal intercostals muscle spindle, promotes an increase in the number of sarcomeres, and minimizes the atrophy. In COPD patients, muscle stretching helps efficiently in the contraction force and will increase the efficacy of respiratory muscles and promote respiratory mechanics (Rekha *et al.*, 2016).

Breathing exercises are effective in managing breathlessness in patients with COPD. These exercises aim to reduce dyspnea, improve ventilation and gas exchange, optimize chest wall motion, and reduce hyperinflation. In this article, breathing exercises consist of breathing control, and a combination of diaphragmatic and pursed-lip breathing (Mendes *et al*., 2019).

Diaphragmatic breathing consists of a smooth and deep nasal inspiration that emphasizes the action of the diaphragm. Diaphragmatic breathing in COPD patients will cause improvement in the tidal volume and oxygen saturation, reducing breathing frequency, and improvements in ventilation and hematosis. Pursed-lips breathing consists of a soft exhalation performed against the resistance of partially closed lips. Previous studies have shown that pursed-lips breathing in subjects with COPD can decrease breathing frequency and lung hyperinflation, improvements in tidal volume, and oxygen saturation. A combination of this exercise showed a significant decrease in breathing frequency and oxygen consumption compared with normal breathing (Rekha *et al*., 2016).

Patients with COPD report walking as one of the most problematic activities in daily life. They walk less in daily life and achieve shorter walk distances during the 6-min walk test (6MWT) as compared to healthy subjects. Exercise training showed clinically relevant improvements in 6MWT distance and also improvements in COPD symptoms such as dyspnea, physical capacity, physical activity, and quality of life in patients with COPD (Fastenau *et al*., 2020).

Exercise training can change the response of the cardiovascular and pulmonary mechanics. During exercise, the intrathoracic pressure will increase and consequently reduces cardiac preload by reducing venous return and left ventricular volume, and it is likely that in patients with COPD an improvement in ventilation is associated with increased volume during the exercise, consequently enabling more efficient exercise for a longer time (Teixeira *et al*., 2018)

Exercise training can reduce the shortness of breath, improve the quality of life, and activity perceived tolerance in COPD patients. dyspnea. Aerobic exercise along with

breathing exercise can help the opening of collapsed alveoli and prevents decreased lung function resulting in improved perfusion-to-ventilation ratios (Wada *et al*., 2016)

Conclusion

This case report showed that a pulmonary rehabilitation program consisting of breathing exercise, respiratory muscle stretching, and aerobic training was able to improve chest expansion, improve 6MWT distance, reducing mMRC dyspnea scale, and reducing CAT score.

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