ORIGINAL RESEARCH PAPER

Physiotherapy & Rehabilitation

PULMONARY FUNCTION TEST: A REVIEW

KEY WORDS: PFT, Obstructive Lung Diseases, Restrictive Lung Diseases, Lung Capacity, Lung Compliance, Pulmonary Rehabilitation.

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ABSTRACT

Pulmonary function test (PFT) is a crucial diagnostic tool used to evaluate the functional capacity of the lungs and to help diagnose, monitor, and manage a variety of respiratory disorders. This test provide objective data on the flow of air in and out of the lungs, the volume of air the lungs can hold, and how efficiently the lungs exchange gases. PFT is vital in assessing diseases like asthma, chronic obstructive pulmonary disease (COPD), restrictive lung diseases, and interstitial lung disease (ILD). The review examines the anatomy relevant to PFT, epidemiological trends, clinical presentations, differential diagnoses and the medical management of patients based on PFT results.

INTRODUCTION

Pulmonary function test (PFT) is designed to assess the ventilation capacity, gas exchange, and overall function of the lungs. It plays a key role in diagnosing and monitoring a range of pulmonary conditions. PFT can detect early stages of respiratory diseases, guide treatment strategies, and evaluate the progression of lung disorders. Given the increasing prevalence of chronic respiratory diseases worldwide, understanding the role and importance of PFT is essential in clinical practice.

Anatomy

The respiratory system includes structures that facilitate the inhalation and exhalation of air, as well as the exchange of oxygen and carbon dioxide in the lungs. The main anatomical components relevant to pulmonary function testing include:

- **Upper Respiratory Tract**: Nasal cavity, pharynx, larynx, and trachea.
- **Lower Respiratory Tract**: Bronchi, bronchioles, alveoli, and the diaphragm.
- **Lungs**: The lungs contain alveoli where gas exchange occurs, and the bronchioles that distribute air to the alveolar sacs. The lung's compliance, elasticity, and resistance to airflow are key factors that PFT assesses.
- **Thoracic Cage And Diaphragm**: The chest wall and diaphragm work together to generate airflow by creating negative pressure to draw air into the lungs and positive pressure to expel air.

The test assess lung volumes, airway resistance, and the gas exchange efficiency between the alveoli and bloodstream, giving insight into conditions affecting these anatomical structures (Miller et al., 2015).

Epidemiology

Respiratory diseases are among the leading causes of morbidity and mortality globally. Chronic diseases such as asthma, COPD, and interstitial lung diseases have become more prevalent due to factors like smoking, environmental pollutants, and aging populations. According to the World Health Organization (WHO), COPD is the third leading cause of death worldwide, affecting millions globally (Rabe et al., 2017). Asthma affects approximately 235 million people, with a significant global burden in both developed and developing countries (Global Initiative for Asthma, 2020). Lung cancer, a major cause of respiratory morbidity, also necessitates PFT for assessment and management. PFT thus remain a cornerstone in assessing the impact of these diseases on lung function.

Characteristics/Clinical Presentation

The clinical presentation of patients requiring PFT varies depending on the underlying condition:

- **Asthma**: Patients typically present with intermittent wheezing, shortness of breath, chest tightness, and cough, often triggered by allergens or exercise. PFTs may reveal reversible airflow obstruction (decreased FEV1 and increased FEV1/FVC ratio after bronchodilator administration) (Global Initiative for Asthma, 2020).
- **Chronic Obstructive Pulmonary Disease (COPD)**: COPD presents with persistent respiratory symptoms like cough, sputum production, and dyspnea, often in patients with a history of smoking. PFT often show irreversible airflow obstruction (decreased FEV1, decreased FEV1/FVC ratio, and increased total lung capacity).
- **Restrictive Lung Disease**: Patients with restrictive lung diseases (e.g., pulmonary fibrosis) typically experience progressive shortness of breath and nonproductive cough. PFT will show reduced lung volumes (low FVC and TLC).
- **Interstitial Lung Disease (ILD)**: Characterized by progressive dyspnea and a dry cough, ILD often shows restrictive patterns on PFT with a reduced diffusion capacity (DLCO) (Raghu et al., 2021).

Differential Diagnosis

PFT plays a critical role in differentiating between various respiratory conditions:

- **Obstructive vs. Restrictive Patterns**: PFT can distinguish between obstructive (e.g., asthma, COPD) and restrictive (e.g., interstitial lung disease, pulmonary fibrosis) patterns. In obstructive diseases, the forced expiratory volume (FEV1) is reduced more than the forced vital capacity (FVC), leading to a decreased FEV1/FVC ratio. In restrictive diseases, FVC is reduced along with normal or increased FEV1/FVC ratio.
- **Asthma Vs. COPD**: Asthma and COPD can share similar symptoms but differ in reversibility. Asthma typically shows significant improvement in airflow obstruction after bronchodilator use, while COPD shows less or no reversibility.
- **Early Stage Disease Vs. Normal**: PFT help detect early-stage diseases where symptoms may be subtle, such as in mild obstructive sleep apnea or early COPD.

Medical Management

The management of patients with abnormal PFT results varies depending on the underlying diagnosis:

- **Asthma**: Management includes bronchodilators (e.g., short-acting beta-agonists), inhaled corticosteroids, leukotriene modifiers, and biologics for severe cases (Global Initiative for Asthma, 2020).
- **COPD**: The cornerstone of COPD management includes smoking cessation, bronchodilators, inhaled corticosteroids, and pulmonary rehabilitation. Long-term oxygen therapy is indicated in severe disease (Rabe et al.,

2017).

- **Restrictive Lung Diseases**: For diseases like pulmonary fibrosis, management focuses on antifibrotic agents like pirfenidone, nintedanib, and supportive care (Raghu et al., 2021).
- **Lung Transplantation**: In cases of advanced COPD or restrictive lung diseases unresponsive to treatment, lung transplantation may be considered (Snyder et al., 2018).

Physiotherapy Management in Pulmonary Function Disorders

Physiotherapy plays a vital role in managing patients with pulmonary diseases, particularly those with chronic respiratory conditions such as Chronic Obstructive Pulmonary Disease (COPD), asthma, and restrictive lung diseases like pulmonary fibrosis. Pulmonary rehabilitation, airway clearance techniques, and exercises aimed at improving lung function are central to improving patients' quality of life, reducing symptoms, and enhancing functional capacity. Physiotherapists utilize a range of therapeutic interventions tailored to the needs of each patient based on their clinical presentation and pulmonary function.

1. Pulmonary Rehabilitation

Pulmonary rehabilitation (PR) is a comprehensive, multidisciplinary program that includes exercise training, education, and psychosocial support aimed at improving the physical and emotional well-being of individuals with chronic respiratory conditions. Physiotherapists play a key role in the delivery of PR by designing individualized exercise programs, monitoring progress, and providing education on self-management.

- **Exercise Training**: Aerobic exercise (e.g., walking, cycling) and resistance training (e.g., weightlifting) improve the functional capacity and strength of patients. Studies show that regular exercise in COPD patients increases exercise tolerance, improves quality of life, and reduces hospitalizations (Spruit et al., 2013).
- **Strength Training**: Strengthening respiratory muscles, including the diaphragm and intercostals, can help reduce breathlessness and fatigue, which are common symptoms in respiratory diseases (Wijkstra et al., 2017).
- **Incentive Spirometry**: Used to improve lung volume and reduce atelectasis, particularly following surgery or exacerbations of lung conditions.

2. Airway Clearance Techniques

Airway clearance techniques (ACTs) are important in managing patients with obstructive airway diseases, such as COPD, cystic fibrosis, or bronchiectasis, where there is an accumulation of secretions that can impair gas exchange.

- **Postural Drainage (PD):** Patients are positioned in ways along with maneuvers (percussions and vibrations) that help gravity assist in draining mucus from different lung segments, improving airflow.
- **Active Cycle of Breathing (ACBT)**: This involves techniques to improve airway clearance through controlled breathing patterns, including deep breathing and forced expirations. ACBT has shown benefits in COPD and asthma patients in managing secretions (Clarke et al., 2017).
- **Positive Expiratory Pressure (PEP) Therapy**: This therapy uses a mask or mouthpiece that provides resistance during exhalation, helping to open airways, reduce secretions, and improve oxygenation.

3. Breathing Retraining and Relaxation Techniques

Breathing exercises and relaxation techniques are essential for improving ventilation efficiency and reducing symptoms like dyspnea (shortness of breath). These techniques are particularly effective for individuals with asthma, COPD, and panic-induced breathlessness.

- **Pursed-lip Breathing**: This technique helps to control the exhalation phase, slowing the expiration and preventing early airway collapse, which is beneficial in COPD and asthma (Tzelepis et al., 2015).
- **Diaphragmatic Breathing**: Encourages use of the diaphragm rather than accessory muscles to increase lung expansion and reduce the work of breathing. It helps improve ventilation and oxygenation, particularly for patients with COPD.
- **Buteyko Breathing**: A technique involving slow and controlled breathing to promote nasal breathing, reduce hyperventilation, and improve oxygen efficiency, which has shown benefits in asthma management (McHugh et al., 2016).

4. Patient Education and Self-Management

An essential aspect of physiotherapy for pulmonary disease involves educating patients about their condition and how to manage it effectively. Education typically includes:

- Proper use of inhalers and medications
- Energy conservation techniques to manage fatigue
- Home-based exercise programs tailored to the patient's condition and functional capacity
- Breathing techniques to cope with dyspnea and reduce anxiety

Studies have shown that patient education improves adherence to treatment and reduces hospital admissions (Celli et al., 2015).

5. Ventilatory Support and Non-invasive Ventilation

For patients with advanced COPD or respiratory failure, non-invasive positive pressure ventilation (NIPPV) is a key intervention. Physiotherapists often assist in the initiation and ongoing management of NIPPV, helping patients adjust to the device and ensuring its effective use during exacerbations.

6. Exercise Prescription for Pulmonary Rehabilitation

Exercise is an essential component of pulmonary rehabilitation, and specific guidelines help physiotherapists design individualized programs based on the patient's severity of disease, physical condition, and exercise tolerance. The typical approach includes:

- **Intensity**: Moderate intensity (50-70% of maximum heart rate) is recommended
- **Duration**: At least 20-30 minutes per session, at least 3 times a week.
- **Progression**: Gradually increasing the intensity and duration as tolerated.

7. Monitoring and Assessment

Ongoing assessment is vital in guiding therapy and adjusting exercise programs. Physiotherapists use various tools, such as:

- **Six-Minute Walk Test (6MWT)**: To assess functional capacity and endurance, commonly used in COPD patients (Nici et al., 2016).
- **Modified Borg Scale of Perceived Exertion (Borg RPE)**: A subjective tool used to measure intensity levels during exercise.

8. Outcome Measures

Outcome measures such as the COPD Assessment Test (CAT), Modified Medical Research Council (MMRC) Dyspnea Scale, and the St. George's Respiratory Questionnaire (SGRQ) can be used to assess baseline symptoms, functional limitations, and the impact of physiotherapy interventions.

CONCLUSION

Pulmonary function test is an indispensable tool in diagnosing and managing various respiratory diseases. By providing objective data on lung function, PFT help clinicians monitor disease progression and assess the effectiveness of treatment. PFT continue to be a fundamental aspect of clinical pulmonary care, with evolving techniques and applications that assist in addressing the increasing global burden of respiratory diseases. Physiotherapy management of

pulmonary conditions focuses on improving physical activity levels, enhancing airway clearance, reducing symptoms, and increasing overall quality of life. A multidisciplinary approach, combining physiotherapy with medical treatments, ensures optimal care for patients with respiratory diseases.

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