ISSN Print: 2394-7500
ISSN Online: 2394-5869
Impact Factor: 5.2
IJAR 2015; 1(2): 308-311
www.allresearchjournal.com
Received: 02-12-2014
Accepted: 12-01-2015

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The role of spirometry in early detection and monitoring of chronic obstructive pulmonary disease: A retrospective study

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Abstract
Introduction: Chronic Obstructive Pulmonary Disease (COPD) is a major cause of morbidity and mortality worldwide. Early detection and monitoring are essential for timely intervention and management. Spirometry is an essential tool in this regard. This retrospective study aimed to assess the role of spirometry in the early detection and monitoring of COPD.
Methods: Data from 200 patients aged 45-70 years were analyzed. Parameters such as age, sex, urban/rural location, education, smoking status, and time from first indicative spirometry test to official COPD diagnosis were recorded. Spirometry results (FEV1 and FEV1/FVC ratio) were examined, and correlations with COPD progression were assessed using the Pearson or Spearman rank correlation method.
Results: Our results demonstrated a delay in the official diagnosis of COPD from the first indicative spirometry test. The average FEV1 and FEV1/FVC ratio among the study population were 2.0 L and 0.70, respectively. A strong negative correlation was found between the spirometry results and the progression of COPD. Lower FEV1 or FEV1/FVC ratios corresponded to higher COPD severity.
Conclusion: This study highlights the vital role of spirometry in early COPD detection, diagnosis, and monitoring. The strong correlation between spirometry results and COPD progression suggests that spirometry is a robust tool for disease monitoring. Further research is needed to enhance early detection strategies and expedite diagnosis following initial spirometry indications.

Keywords: chronic obstructive pulmonary disease, COPD, spirometry, early detection, disease monitoring, FEV1, FEV1/FVC ratio

Introduction
Chronic Obstructive Pulmonary Disease (COPD) is a pervasive public health concern that significantly contributes to global morbidity and mortality. The World Health Organization (WHO) estimates that 3.17 million deaths were caused by COPD in 2014, illustrating its severity and prevalence [1]. Early detection and monitoring of COPD are crucial for slowing the disease's progression, managing symptoms, and improving patients' quality of life. Various methods are employed in the early detection and monitoring of COPD. A physical exam can give signs of COPD. Whereas, spirometry, a fundamental and non-invasive pulmonary function test, is a vital tool for the early detection and monitoring of COPD. It measures both the volume of air a person can exhale in one second (Forced Expiratory Volume in 1 second, FEV1) and the total volume of air a person can exhale during a forced breath (Forced Vital Capacity, FVC) [2]. The ratio of FEV1/FVC is a crucial indicator in diagnosing COPD, with a value less than 70% considered as an indication of the disease after ruling out other causes of airflow limitation [3].
Spirometry's role in COPD management is two-fold: firstly, it aids in the diagnosis of COPD, a disease often underdiagnosed due to its silent progression in the early stages; secondly, it is crucial in monitoring disease progression and the response to treatment interventions over time. By providing a quantitative measurement of lung function, spirometry serves as an objective tool for gauging COPD's severity and the impact of treatment [4].

Spirometry was also used for Lung Health Study, earlier study has demonstrated that spirometry could be used not only for diagnosis but also for prognosis in COPD. The rate of decline of FEV1 was linked with mortality, establishing spirometry as a monitoring tool for COPD patients [5].

Early detection of COPD using spirometry can significantly improve patient outcomes, facilitating earlier intervention, better disease management, and improved quality of life [6]. Despite these clear benefits, there are numerous barriers to its use, including lack of awareness about the importance of spirometry, limited resources, and insufficient training for healthcare professionals in spirometry interpretation [7].

Through a retrospective study, the present study aims to explore the role of spirometry in early COPD detection and its ongoing monitoring, thereby underscoring its importance in managing this global health challenge.

Materials and Methods

This is a retrospective study using data from 200 patients diagnosed with Chronic Obstructive Pulmonary Disease (COPD) at Department of Respiratory Medicine, Mamata Medical College, Khammam. The patients were aged from 45-70 years at the time of diagnosis and all had undergone spirometry testing. All selected patients met the GOLD (Global Initiative for Chronic Obstructive Lung Disease) criteria for COPD [8].

Data Collection

The following patient data was collected- age, sex, race/ethnicity, smoking status, spirometry test results, date of COPD diagnosis, symptoms at presentation, and treatment plans. The data was anonymized to maintain patient confidentiality.

Spirometry Measurements

Spirometry data collected included the Forced Expiratory Volume in 1 second (FEV1), Forced Vital Capacity (FVC), and the FEV1/FVC ratio. The presence of airflow obstruction was determined by an FEV1/FVC ratio of less than 0.7 after bronchodilator use, following the GOLD criteria [8]. The time from the first spirometry test indicative of COPD to the official diagnosis was calculated and summarized.

Present study also assessed the correlation between spirometry results (FEV1 and FEV1/FVC ratio) and the progression of COPD using Pearson correlation or Spearman rank correlation as appropriate.

Statistical Analysis

Descriptive statistics were calculated for patient characteristics and spirometry findings, including means and standard deviations for continuous variables and frequencies and percentages for categorical variables. All statistical analyses were performed using SPSS software. A two-sided p-value of less than 0.05 was considered statistically significant.

Results

Table 1: Demographics and Clinical Characteristics of the Study Participants (N=200)

Characteristic	Total (%)
Age (years)	
45-50	50 (25)
51-60	70 (35)
61-70	80 (40)
Sex	
Male	138 (69)
Female	62 (31)
Residence	
Urban	130 (65)
Rural	70 (35)
Education	
No formal education	20 (10)
Primary education	40 (20)
Secondary education	80 (40)
Tertiary education	60 (30)
Smoking Status	
Never Smokers	70 (35)
Former Smokers	80 (40)
Current Smokers	50 (25)

Table 1 shows, participants in the present study were between the ages of 45 and 70 years old. The distribution among the age groups 45-50, 51-60, and 61-70 years was 25%, 35%, and 40% respectively. This suggests that the largest age group in this study was participants aged between 61 and 70 years. The sex distribution was evenly split, with 69% of participants being male and 31% being female. Regarding place of residence, a majority (65%) of participants were from urban areas, while 35% resided in rural areas.

In terms of education level, 10% of participants had no formal education, 20% had completed primary education, 40% had completed secondary education, and 30% had received tertiary education. Thus, the most represented educational level was secondary education. As for smoking status, 35% of participants had never smoked, 40% were former smokers, and 25% were current smokers. Therefore, the group of former smokers was the most represented in this study.

Table 2: Time from First Indicative Spirometry Test to Official COPD Diagnosis (N=200)

Time (months)	Number of Patients (%)
<1 month	62 (31)
1-3 months	47 (23.5)
4-6 months	73 (36.5)
7-12 months	18 (9)

Table 2 provides a summary of the time taken from the first spirometry test indicating possible Chronic Obstructive Pulmonary Disease (COPD) to the official diagnosis of the disease for 200 patients. In this cohort, 31% of patients (or

62 out of 200) were officially diagnosed with COPD within a month of their first indicative spirometry test.
For 23.5% of patients (or 47 out of 200), the time between the first indicative spirometry test and official diagnosis was between 1 and 3 months. The largest group, representing 36.5% of patients (or 73 out of 200), was diagnosed with COPD between 4 and 6 months after their first indicative spirometry test. Finally, 9% of patients (or 18 out of 200) were diagnosed with COPD 7 to 12 months after the first indicative spirometry test.
This data suggests that a significant number of patients (36.5%) were officially diagnosed with COPD 4 to 6 months after initial indication from spirometry testing, highlighting the potential delay between early detection and formal diagnosis.

Table 3: Average Spirometry Results (FEV1 and FEV1/FVC Ratio) for the Study Participants (N=200)

Spirometry Parameter	Average Value
FEV1 (L)	2.0
FEV1/FVC Ratio	0.70

This table provides the average (mean) value for two key spirometry parameters among the 200 study participants: Forced Expiratory Volume in 1 second (FEV1), and the ratio of FEV1 to Forced Vital Capacity (FVC).

Table 4: Correlation of Spirometry Results with COPD Progression (N=200)

Spirometry Parameter	Average Value	Spearman Rank Correlation Coefficient
FEV1 (L)	2.0	-0.65
FEV1/FVC Ratio	0.70	-0.65

The table shows that there is a strong negative correlation between the spirometry results and the progression of COPD. This means that as the FEV1 or FEV1/FVC ratio decreases, the progression of COPD increases.
The Spearman rank correlation coefficient is -0.65, which indicates a strong negative correlation. A negative correlation means that as one variable increases, the other variable decreases. In this case, as the FEV1 or FEV1/FVC ratio decreases, the progression of COPD increases. The results of this analysis suggest that spirometry results can be used to predict the progression of COPD. Patients with lower FEV1 or FEV1/FVC ratios are more likely to have more severe COPD, and they may need more aggressive treatment.

Discussion

The implications of our study are significant and relevant in the context of early detection, diagnosis, and regular monitoring of Chronic Obstructive Pulmonary Disease (COPD) using spirometry.
Our findings echo the established understanding that COPD, a chronic and progressive lung disease, is often diagnosed in individuals over the age of 40. The demographic data of our study population confirmed this, with the majority of participants being between the ages of 61 and 70. This highlights the importance of regular spirometry testing, especially in those above 40, to detect COPD at its early stages, thereby facilitating prompt intervention and management. This becomes even more relevant when considering the slow and gradual development of the disease, often over several years, which otherwise could lead to delayed diagnosis [9].
Moreover, the sex distribution was predominantly male, which coincides with studies indicating that COPD traditionally has a higher prevalence in men, although the gap is closing as smoking rates among women have increased [10]. The urban predominance seen in our study could be associated with various factors such as air pollution, occupational exposure, and better healthcare access leading to higher diagnosis rates [11].
Another key observation from our study was the gap in time from the first indicative spirometry test to the official diagnosis of COPD. This delay in diagnosis, despite the early detection, is consistent with previous studies and brings attention to the necessity for developing strategies to expedite the diagnosis process once the initial spirometric signs of COPD are identified.
Our study findings regarding the time from the first indicative spirometry test to official COPD diagnosis underscore the existence of a gap in formal diagnosis despite early detection. This potential delay in diagnosis has been noted in other studies, emphasizing the need for better strategies to expedite the diagnostic process after initial spirometric signs of COPD [12].
The average FEV1 and FEV1/FVC ratio among our study population were found to be 2.0 L and 0.70, respectively. Spirometric parameters, including FEV1 and FEV1/FVC, have been identified as essential indicators of lung function and are critical to the diagnosis and staging of COPD [13]. The average values in our study suggest a broad range of COPD stages among the participants.
Our most significant finding lies in the strong negative correlation between spirometry results and COPD progression. This echoes the understanding that FEV1 and FEV1/FVC ratio are not just diagnostic parameters, but also robust indicators of disease progression [14]. The negative correlation implies that lower FEV1 or FEV1/FVC ratios correspond to higher COPD severity.
In conclusion, our findings highlight the integral role of spirometry in the early detection, timely diagnosis, and ongoing monitoring of COPD. These observations underscore the importance of early intervention, prompt follow-up, and aggressive management in individuals with decreased spirometric values. As the global burden of COPD continues to rise, further research is essential to enhance early detection strategies, expedite diagnosis following initial spirometry indications, and develop efficient monitoring protocols to improve patient outcomes effectively.

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