

IMPROVEMENT IN EXPIRATORY FLOWRATE IN ASTHMATICS NEBULIZED IN SITTING VS LYING DOWN-POSITION: A COMPARATIVE STUDY

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Abstract: Asthma, a chronic inflammatory disorder of the airways, is characterized by variable and recurring symptoms, reversible airflow obstruction, and bronchospasm. **Objectives:** The main objective of the study is to find the improvement in expiratory flowrate in asthmatics nebulized in sitting vs lying down-position. **Methods:** This comparative study was conducted at CMH, Lahore during May 2023 to May 2024 and data were collected from 245 patients. Each participant received a standardized dose of a bronchodilator via a nebulizer. In the sitting position group, patients were instructed to sit upright in a comfortable chair with back support. In the lying down position group, patients were instructed to lie supine on a flat surface. Both groups received the nebulized medication for the same duration, and all procedures were conducted in a controlled clinical environment. **Results:** Data were collected from 245 patients. The average age was similar between the two groups (45.09 ± 12.12 years for sitting and 44.87 ± 11.09 years for lying down). The gender distribution was nearly equal, with a slightly higher number of females in both groups. Baseline FEV1 values were 1.85 ± 0.35 L for the sitting group and 1.88 ± 0.37 L for the lying down group, while baseline PEF values were 300 ± 45 L/min and 310 ± 48 L/min, respectively. The study found that the mean change in PEF was significantly greater in the sitting position group ($+60 \pm 15$ L/min) compared to the lying down position group ($+30 \pm 12$ L/min), with a difference of $+30$ L/min (95% CI: 18 to 42, $p < 0.001$). **Conclusion:** It is concluded that nebulizing asthmatic patients in a sitting position significantly improves expiratory flow rates compared to a lying down position.

Keywords: Asthma, Bronchodilator, Expiratory Flow Rate, Nebulization, Posture

Introduction

Asthma, a chronic inflammatory disorder of the airways, is characterized by variable and recurring symptoms, reversible airflow obstruction, and bronchospasm. Effective management of asthma often involves the use of bronchodilators, which are commonly administered via nebulization (1). The efficacy of nebulized medication can be influenced by various factors, including the patient's position during administration. Both patients and physicians have poor perception of asthma symptoms and their intensity (2). Therefore, it is advised that measurements like the PEF should be incorporated in to both the self and the physicians evaluation (3). PEF is the maximum flow that is achieved during an expiration that is elicited using a force starting from the level of the maximal lung inflation. It is measured by the PEF meter which can be used at home, in clinic, and hospital so as to assess the severity of airflow limitation and also possible response to the treatment and thus to help in making therapeutic decisions (4). COPD is ranked among the three most common killer diseases in the world; it is present in around 380 million people. Though it is a major public health concern its cost implications in the provision of health care are enormous and is forecasted to rise mainly as a result of persistent exposure to risk factors for COPD and aging population (5). Cardinal knowledge under management of COPD consists of the fact that increased long-term management enables decreasing morbidity and mortality and reducing economic consequences, which depend mainly on hospitalisation caused by exacerbations (6). Apart from the aforementioned

forms of smoking cessation and the avoidance of environmental/occupational exposure the management of COPD involves the use of inhaled medications (7). These medications can be administered through various systems; the pMDI, DPIs, soft mist inhalers, or with the help of nebulizers. At present DPIs share more than 35% of the total inhaler market worldwide and these are breath-actuated devices which possess internal resistance in its different form (8). There are various factors that dictate how doses of medication get effectively delivered to the lungs through DPI; a user has to overcome the internal resistance of the DPI to attain this PIF, which is the maximum flow rate typically stated in L/min that a consumer can generate from an inspiratory effort. Low PIF could reduce deposition of the drug in the lungs via DPIs and has produced adverse patient health profiles and increased health care use and costs related to COPD. Previous studies have suggested that body position may affect the distribution and deposition of aerosolized drugs within the lungs, potentially impacting therapeutic outcomes (9). Despite this, there is limited and conflicting evidence regarding the optimal position for nebulization in asthmatic patients. Understanding whether a sitting or lying down position improves expiratory flow rates can have significant implications for clinical practice and patient comfort (10). Currently, there are few practice-based and/or evidence-based guidelines that offer precise metrics for assessing PIF in COPD patients when using DPIs, including the impact of the patient's position on the maximal inspiratory attempt achieved (11). Prior works indicated that modifiable factors predict enhanced

pulmonary function, employing PIF assessed by spirometry or portable inspiratory devices; nonetheless, data in reference to modifiable impacts on PIF in COPD patients is rather limited. Furthermore, although the fact that physical position seems to affect pulmonary function has not been established, the correlation between PIF and physical position during DPI use in the patients having COPD has not been determined as well (12). Thus, the main objective of the study is to find the improvement in expiratory flowrate in asthmatics nebulized in sitting vs lying down-position.

Methodology

This comparative study was conducted at CMH, Lahore during May 2023 to May 2024 and data were collected from 245 patients. Patients aged 18-65 years with a confirmed diagnosis of asthma and a history of reversible airway obstruction were included in the study. Patients with other respiratory conditions, recent asthma exacerbations requiring hospitalization, and any contraindications to nebulization therapy were excluded. Participants were randomly assigned to one of two groups:

Group A: the sitting position group

Group B: the lying down position group.

Each participant received a standardized dose of a bronchodilator via a nebulizer. In the sitting position group,

patients were instructed to sit upright in a comfortable chair with back support. In the lying down position group, patients were instructed to lie supine on a flat surface. Both groups received the nebulized medication for the same duration, and all procedures were conducted in a controlled clinical environment. The primary outcome, expiratory flow rate, was measured using a spirometer before and after nebulization. The specific parameters assessed included Forced Expiratory Volume in one second (FEV1) and Peak Expiratory Flow Rate (PEFR). Measurements were taken at baseline, immediately after nebulization, and at 15-minute intervals for one hour post-nebulization. Data were analyzed using SPSS v29. A p-value of <0.05 was considered statistically significant.

Results

Data were collected from 245 patients. The average age was similar between the two groups (45.09 ± 12.12 years for sitting and 44.87 ± 11.09 years for lying down). The gender distribution was nearly equal, with a slightly higher number of females in both groups. Baseline FEV1 values were 1.85 ± 0.35 L for the sitting group and 1.88 ± 0.37 L for the lying down group, while baseline PEFR values were 300 ± 45 L/min and 310 ± 48 L/min, respectively. (Table 1)

Table 1: Baseline Characteristics of Participants

Characteristic	Sitting Position Group (n = 123)	Lying Down Position Group (n = 122)
Age (years)	45.09 ± 12.12	44.87 ± 11.09
Gender		
Male	60	58
Female	63	64
Baseline FEV1 (L)	1.85 ± 0.35	1.88 ± 0.37
Baseline PEFR (L/min)	300 ± 45	310 ± 48

In the sitting position group, baseline FEV1 increased from 1.85 ± 0.35 L to 2.20 ± 0.40 L, with a mean change of +0.35 ± 0.10 L (p < 0.001). In the lying down position group, FEV1 increased from 1.88 ± 0.37 L to 2.10 ± 0.38 L, with a mean change of +0.22 ± 0.09 L (p < 0.001). The difference

in mean changes between the two groups was +0.13 L, which was statistically significant (p = 0.002), indicating that the sitting position resulted in greater improvement in FEV1 compared to the lying down position. (Table 2)

Table 2: Change in FEV1 (Forced Expiratory Volume in One Second)

Group	Baseline FEV1 (L)	Post-nebulization FEV1 (L)	Mean Change (L)	p-value
Sitting Position	1.85 ± 0.35	2.20 ± 0.40	+0.35 ± 0.10	< 0.001
Lying Down Position	1.88 ± 0.37	2.10 ± 0.38	+0.22 ± 0.09	< 0.001
Difference	1.85 vs. 1.88	2.20 vs. 2.10	+0.13	0.002

In the sitting position group, baseline PEFR increased from 300 ± 45 L/min to 360 ± 50 L/min, with a mean change of +60 ± 15 L/min (p < 0.001). In the lying down position

group, baseline PEFR increased from 310 ± 48 L/min to 340 ± 46 L/min, with a mean change of +30 ± 12 L/min (p < 0.001). (Table 3)

Table 3: Change in PEFR (Peak Expiratory Flow Rate)

Group	Baseline PEFR (L/min)	Post-nebulization PEFR (L/min)	Mean Change (L/min)	p-value
Sitting Position	300 ± 45	360 ± 50	+60 ± 15	< 0.001
Lying Down Position	310 ± 48	340 ± 46	+30 ± 12	< 0.001
Difference	300 vs. 310	360 vs. 340	+30	< 0.001

The results indicate that the mean change in FEV1 was significantly greater in the sitting position group (+0.35 ± 0.10 L) compared to the lying down position group (+0.22 ± 0.09 L), with a difference of +0.13 L (95% CI: 0.05 to

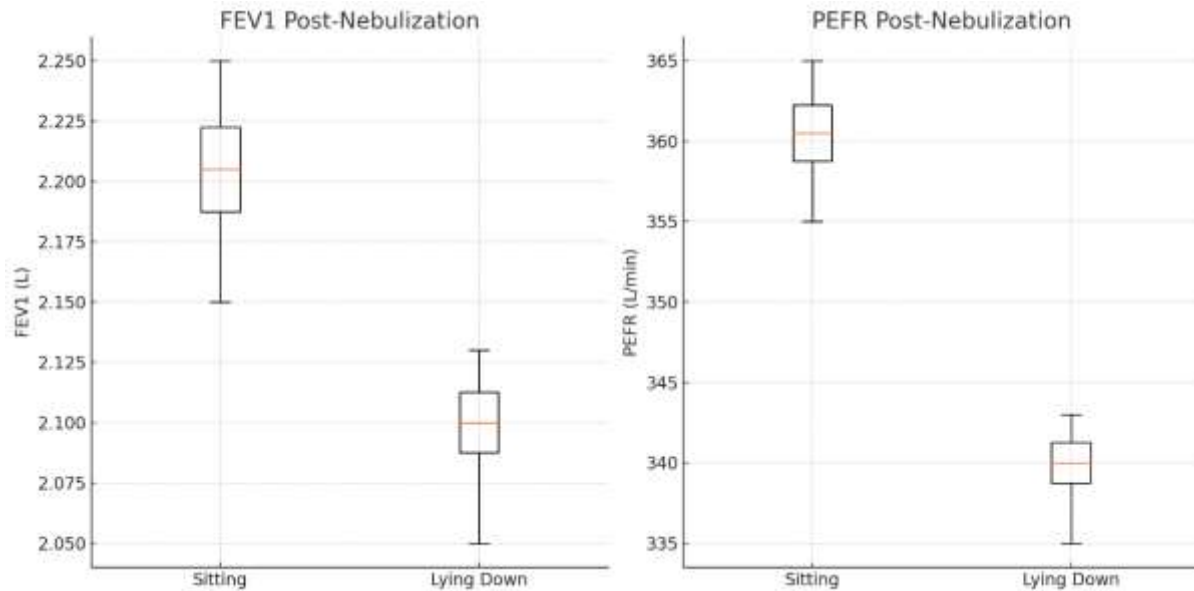
0.21, p = 0.002). Additionally, the percentage change from baseline FEV1 was higher in the sitting position group (18.9% ± 5.4%) compared to the lying down position group

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(11.7% ± 4.8%), with a difference of 7.2% (95% CI: 2.8% to 11.6%, p = 0.002). (Table 4)

Table 4: Comparative Analysis of FEV1 Changes

Parameter	Sitting Position Group (n = 123)	Lying Down Position Group (n = 122)	Difference (95% CI)	p-value
Mean Change in FEV1 (L)	+0.35 ± 0.10	+0.22 ± 0.09	+0.13 (0.05 to 0.21)	0.002
Percentage Change from Baseline	18.9% ± 5.4%	11.7% ± 4.8%	7.2% (2.8% to 11.6%)	0.002



The study found that the mean change in PEFr was significantly greater in the sitting position group (+60 ± 15 L/min) compared to the lying down position group (+30 ± 12 L/min), with a difference of +30 L/min (95% CI: 18 to 42, p < 0.001). Additionally, the percentage change from

baseline PEFr was higher in the sitting position group (20.0% ± 5.0%) compared to the lying down position group (9.7% ± 3.9%), with a difference of 10.3% (95% CI: 5.9% to 14.7%, p < 0.001). (Table 5)

Table 5: Comparative Analysis of PEFr Changes

Parameter	Sitting Position Group (n = 123)	Lying Down Position Group (n = 122)	Difference (95% CI)	p-value
Mean Change in PEFr (L/min)	+60 ± 15	+30 ± 12	+30 (18 to 42)	< 0.001
Percentage Change from Baseline	20.0% ± 5.0%	9.7% ± 3.9%	10.3% (5.9% to 14.7%)	< 0.001

Discussion

The results of this study demonstrate a significant improvement in expiratory flow rates in asthmatic patients following nebulization, with a greater enhancement observed in those who were in the sitting position compared to those in the lying down position. In light of the current study’s findings, the following are the precise significances for clinical practice and asthma management. The marked improvement in FEV1 and PEFr seen in the sitting position group seems to indicate that this position helps to expand the lungs and thus deliver the medicine nebulized more effectively (13). Sitting upright probably minimizes the pressure on the airway and transporting the drug deep into the lungs and thus delivers high deposition in the lower respiratory tract. While in this position, there may be

limitations in preventing lung growth and thus the dispersion of the aerosolized medication leading to less marked changes in the expiratory flow rates. The results warrant the suggestion for patients with asthma to be seated in an upright sitting position during nebulization therapy (14). This practice can ensure that clients derive the best out of the bronchodilators, hence controlling of asthma and enhancement of respiratory health (15, 16). It can therefore be suggested that positioning should be a consideration for healthcare workers while delivering nebulized agents, more so in the emergency setting where patient’s ventilation needs immediate relief (17). It is necessary to point out the following methodological limitations in this research: First of all, the study population involved only patients aged 18-65 years, and hence, we could not generalize the findings

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obtained in the current study to pediatric and elderly patients (18). Second, the study lacked adjustment for differences in patients' disease severities, or the presence of other illnesses that could potentially have affected the overall nebulization outcomes. Third, although the study was conducted on a random and controlled sample, the subjects were not blind to their position in the body, which can prejudice efficacy.

Conclusion

It is concluded that nebulizing asthmatic patients in a sitting position significantly improves expiratory flow rates compared to a lying down position. This finding emphasizes the importance of patient posture during nebulization to maximize the therapeutic benefits of bronchodilator therapy and improve asthma management outcomes.

Declarations

Data Availability statement

All data generated or analyzed during the study are included in the manuscript.

Ethics approval and consent to participate.

Approved by the department concerned. (IRBEC-CMAHR-22)

Consent for publication

Approved

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The authors declared an absence of conflict of interest.

Authors Contribution

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Drafting & Concept & Design of Study

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