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A Comparative Analysis of Pulmonary Function Tests Before and After Major Abdominal Surgeries Performed Under General Anaesthesia among Diabetic Individuals

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KEYWORDS

Diabetes mellitus, pulmonary function tests, abdominal surgery, general anesthesia.

ABSTRACT:

Introduction: Diabetes mellitus is a chronic condition characterized by both microvascular and macrovascular complications. While the pulmonary manifestations of diabetes mellitus have not been extensively studied, pulmonary function tests (PFTs) serve as valuable noninvasive tools for assessing lung function.This study aimed to compare the pulmonary function tests before and after surgery among individuals with type 2 diabetes and those without diabetes undergoing elective major abdominal surgeries under general anesthesia.

Materials & Methods: A cohort of 100 patients (comprising 50 with diabetes and 50 without diabetes) undergoing elective major abdominal surgeries under general anesthesia participated in this study. Pulmonary function tests were conducted 60 minutes before and after surgery which included forced expiratory volume in one second (FEV1), forced vital capacity (FVC), FEV1/FVC ratio, forced expiratory flow at 25% of FVC (FEF 25%), and peak expiratory flow rate (PEFR).

Results: The majority of participants fell within the 51-55 years age bracket, with mean ages of 52.9 ± 4.8 years for the diabetic group and 51.3 ± 4.8 years for the non-diabetic group. Male participants outnumbered females in both groups. Baseline characteristics did not significantly differ between the two groups. However, diabetic patients exhibited significantly reduced PFT parameters post operatively compared to pre-operative values, except for the FEV1/FVC ratio.

Conclusion: Among individuals with type 2 diabetes undergoing elective major abdominal surgeries, there was a notable decrease in mean scores of PFTs post operatively when compared to pre-operative values, except for the FEV1/FVC ratio.

INTRODUCTION

Diabetes mellitus (DM) represents a systemic metabolic anomaly characterized by persistent elevation in blood glucose levels, accompanied by alterations in lipid, carbohydrate, and protein metabolism, which arise from deficient insulin secretion, compromised tissue responsiveness to insulin, or a combination of both. Globally, diabetes mellitus poses a significant health challenge, contributing to chronic impairment, malfunction, and organ failure, primarily stemming from macrovascular and microvascular complications [1-3].

Given the extensive microvascular network and abundant connective tissue in the lungs, there exists a potential for lung tissue to be impacted by microangiopathy and non-enzymatic glycosylation of tissue proteins induced by prolonged hyperglycemia, thereby rendering the lungs susceptible as a "target organ" in diabetic individuals, leading to observed abnormalities in pulmonary function. Spirometry, which measures the mechanical aspects of lung function—specifically air volume and flow rates during inhalation and exhalation—is the most commonly

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employed method for pulmonary function testing (PFTs) [4-6]. Some studies have noted an association between elevated HbA1c levels and diminished lung function parameters such as forced vital capacity (FVC) and forced expiratory volume in one second (FEV1). They have postulated that impaired glucose regulation might be linked to impaired lung function [7-9]. A significant correlation has been established between spirometric pulmonary function tests and metabolic control in type 2 diabetes mellitus [10].

Despite considerable global research on the impact of diabetes mellitus on pulmonary parameters, there is a relative scarcity of literature on this topic from India.Hence, this study aims to assess and compare pulmonary function tests before and after surgery in diabetic and non-diabetic patients undergoing major abdominal surgeries under general anesthesia.

MATERIALS AND METHODS

This prospective case-control study was conducted in the Department of Anesthesiology at Madurai Medical College and its affiliated Rajaji Hospital, Madurai. The study group, comprising diabetic patients with a diabetes duration of 5-15 years undergoing elective major abdominal surgeries, was compared with a control group consisting of non-diabetic patients undergoing similar surgeries.

Inclusion criteria encompassed patients aged 40-60 years of both sexes, classified under American Society of Anesthesiologists (ASA) grade I & II, scheduled for elective major abdominal surgeries not exceeding 4 hours, and providing informed consent for participation. Exclusion criteria included surgeries lasting over 4 hours, necessity for post-surgery mechanical ventilation, pre-existing cardio-respiratory diseases, or significant illnesses, and patient unwillingness to participate.

Pulmonary function tests were conducted 60 minutes before and after surgery using a spirometer. These tests included Forced Expiratory Volume in 1 second (FEV1), Forced Vital Capacity (FVC), FEV1/FVC ratio, Forced Expiratory Flow at 25% of FVC (FEF 25%), and Peak Expiratory Flow Rate (PEFR).

Statistical analysis was performed using the Statistical Package for the Social Sciences (SPSS) version 22.0. Mean and standard deviation were calculated for continuous variables, with comparison conducted using Student's t-test. Categorical variables were analyzed by generating frequencies and employing the chi-square test. A significance level of $p<0.05$ was deemed statistically significant.

RESULTS

50 diabetic cases and 50 non-diabetic controls undergoing major abdominal surgery under general anesthesia were included in the study. In both groups, males outnumbered females slightly. The majority of patients fell within the 51-55 years age bracket. Statistical analysis revealed no significant differences in mean age, gender distribution, body mass index (BMI), or duration of surgery between the two groups. Thus, both groups were deemed comparable at baseline for the purposes of our study (Table 1).

Statistically significant differences were observed in the mean FEV1, FVC, FEF25%, and PEFR (L/min) before and after surgery in the diabetic group. However, the difference in the mean FEV1/FVC ratio was not found to be statistically significant. These findings suggest that diabetic patients undergoing major abdominal surgery exhibit impaired pulmonary function compared to their non-diabetic counterparts, particularly in terms of FEV1, FVC, FEF25%, and PEFR, while the ratio of FEV1 to FVC remains relatively unaffected by diabetes in this context (Table 2).

No statistically significant differences were observed in the PFTs before and after surgery in the non-diabetic group (Table 3).

Table 1: Baseline characteristics ofstudyparticipants

Parameter	**Diabetics**		**Non-diabetics**		**P Value**
Age Groups (years)	**n**	**%**	**n**	**%**	
41 - 45	6	12.00	7	14.00	0.10
46 – 50	9	18.00	14	28.00	
51 – 55	17	34.00	16	32.00	
56 – 60	18	36.00	13	26.00	
Mean ± SD, years	52.9 ± 4.8		51.3 ± 4.8		
Gender					

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Male	26	52.00	28	56.00	0.42
Female	24	48.00	22	44.00	
BMI Kg/m^2(Mean ± SD)	22.7 ± 1.7		23.2 ± 3.0		0.31
Duration of Surgery in minutes (Mean ± SD)	129.0 ± 24.2		132.6 ± 20.9		0.43

Table 2: PFTs before and after surgery in Diabetics

PFTs	Pre-operative (Mean±SD)	Post-operative (Mean±SD)	P value
FEV 1	84.5 ± 3.5	69.1 ± 4.1	<0.05
FVC	80.6 ± 3.0	63.1 ± 4.6	<0.05
FEV1/FVC	105.8 ± 7.0	108.8 ± 6.3	0.06
FEF 25%	80.9 ± 4.6	62.6 ± 4.3	<0.05
PEFR	74.4 ± 4.4	59.1 ± 3.4	<0.05

Table 3: PFTs before and after surgery in non-diabetics

PFTs	Pre-operative (Mean±SD)	Post-operative (Mean±SD)	P value
FEV 1	88.3 ± 3.7	86.6 ± 3.6	0.31
FVC	82.4 ± 2.6	80.4 ± 3.5	0.45
FEV1/FVC	107.2 ± 4.4	107.8 ± 4.9	0.91
FEF 25%	83.4 ± 4.1	81.9 ± 3.4	0.67
PEFR	77.1 ± 6.8	76.3 ± 5.6	0.81

DISCUSSION

The precise connection between diabetes mellitus and pulmonary function remains incompletely elucidated. The compromised pulmonary function observed in individuals with diabetes may stem from diabetic microangiopathy affecting the lungs. A plausible mechanism contributing to diminished lung function involves non-enzymatic glycosylation of proteins, such as lung and chest wall collagen [11].

The mean age of our diabetic study cohort was 52.9 ± 4.8 years, while that of the non-diabetic group was 51.3 ± 4.8 years. This finding aligns with previous investigations conducted by Tesema et al [12] and Irfan M et al [13]. In our study, males predominated in both groups compared to females, though this difference was not statistically significant, consistent with findings reported by Kumari R et al [14] and Mahendra Kumar K et al [15]. The mean Body Mass Index (BMI) in the study group was 22.7 ± 1.7 kg/m², whereas in the control group it was 23.2 ± 3.0 kg/m², with no significant difference observed. Our study's BMI distribution falls within normal ranges, as also noted by Borst et al [16] and Klein O et al [17]. This underscores the potential necessity for ethnically tailored BMI standards.

While Li AM et al [18] documented a significant association between BMI and reduced lung function, our study did not find a significant impact of BMI on lung function. The influence of BMI on decreasing lung function may arise from decreased chest wall compliance and increased airway resistance.

In our investigation, pre- and post-operative measurements revealed significantly lower mean values of Forced Vital Capacity (FVC), Forced Expiratory Volume in one second (FEV1), Forced Expiratory Flow at 25% (FEF 25%), and Peak Expiratory Flow Rate (PEFR) in the diabetic group compared to the non-diabetic group. Similar findings have been reported by other researchers including ShravyaKeerthi G et al [19], Aparna A et al [20], and Kaur S et al [21], indicating reduced pulmonary function tests in diabetic individuals compared to non-diabetic counterparts. Chronic hyperglycemia may induce glycosylation of lung collagen, resulting in less compliant lung parenchyma and restrictive lung changes.

In our study, the FEV1/FVC ratio was slightly increased in type 2 diabetics compared to non-diabetics, although this increase was not statistically significant, consistent with findings reported by Taha EH et al [22] and Walter R et al [23]. The elevated FEV1/FVC ratio suggests that the impairment of pulmonary functions in type 2 diabetics may primarily manifest as restrictive in nature, possibly due to alterations in the alveolar-capillary network in the lungs leading to microangiopathic changes.

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CONCLUSION

Post-operative pulmonary function tests (except FEV1/FVC ratio) displayed significant reductions in diabetic patients compared to their non-diabetic counterparts. These findings underscore the importance of early detection of pulmonary functional impairment in diabetic individuals. Implementing appropriate treatment strategies upon detection can potentially mitigate associated morbidity and improve patient outcomes. By closely monitoring pulmonary function in diabetic patients, healthcare professionals can intervene proactively to address any decline in lung function, thereby enhancing overall patient well-being.

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