ORIGINAL RESEARCH

Study of Pulmonary Function Tests in Diabetic Nephropathy

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ABSTRACT

Background: Diabetic nephropathy is a common and serious complication of diabetes mellitus, characterized by renal dysfunction and a range of pulmonary complications. Pulmonary function tests (PFTs) play a crucial role in assessing the respiratory health of diabetic nephropathy patients. This study aimed to investigate the impact of diabetic nephropathy on PFT parameters and their clinical significance. **Materials and Methods:** We conducted a cross-sectional study involving 120 diabetic nephropathy patients and 60 age-matched healthy controls. PFTs, including forced vital capacity (FVC), forced expiratory volume in one second (FEV1), FEV1/FVC ratio, peak expiratory flow rate (PEFR), and total lung capacity (TLC), were measured using standardized techniques. Glycemic control, duration of diabetes, and renal function parameters were also assessed. **Results:** In diabetic nephropathy patients, pulmonary function tests revealed impaired respiratory parameters, with a mean forced vital capacity (FVC) of 2.95 ± 0.45 L, a mean forced expiratory volume in one second (FEV1) of 2.45 ± 0.38 L, a mean FEV1/FVC ratio of 82.3% ± 4.2%, a mean peak expiratory flow rate (PEFR) of 450 ± 60 L/min, and a mean total lung capacity (TLC) of 5.9 ± 0.7 L. When compared to healthy controls, diabetic nephropathy patients exhibited significantly lower FVC ($p < 0.001$), FEV1 ($p < 0.01$), and PEFR ($p < 0.05$). Importantly, the FEV1/FVC ratio and TLC remained within normal limits and did not significantly differ from controls. Furthermore, these pulmonary impairments were found to be negatively correlated with the duration of diabetes ($p < 0.05$) and HbA1c levels ($p < 0.01$), suggesting a potential association with glycemic control. Conversely, no significant correlations were observed between pulmonary function test parameters and renal function parameters, such as serum creatinine and estimated glomerular filtration rate (eGFR), indicating that the observed respiratory changes may not be directly linked to the severity of renal dysfunction. **Conclusion:** Diabetic nephropathy patients showed impaired pulmonary function, as evidenced by reduced FVC, FEV1, and PEFR. The duration of diabetes and glycemic control were associated with these impairments. Regular monitoring of pulmonary function in diabetic nephropathy patients is essential for early detection and management of respiratory complications.

Keywords: Diabetic nephropathy, pulmonary function tests, forced vital capacity, forced expiratory volume in one second, peak expiratory flow rate, total lung capacity, glycemic control, renal function, respiratory complications.

INTRODUCTION

Diabetic nephropathy (DN) is a well-recognized and serious microvascular complication of diabetes mellitus (DM), characterized by progressive renal dysfunction and the development of albuminuria (1). DN is a major contributor to end-stage renal disease (ESRD), cardiovascular morbidity, and mortality in individuals with DM, particularly type 1 and type 2 diabetes (2). While the primary focus of DN research has traditionally been on renal outcomes, growing evidence suggests that it exerts systemic effects, impacting various organ systems, including the respiratory system (3).

Pulmonary function tests (PFTs) are valuable clinical tools used to assess the function of the respiratory system and diagnose pulmonary disorders (4). Recent studies have indicated that DN patients may be at an increased risk of experiencing alterations in PFT parameters, reflecting impaired lung function (5). These alterations may manifest as reduced forced vital capacity (FVC), forced expiratory volume in one second (FEV1), peak expiratory flow rate (PEFR), or other PFT metrics.

Understanding the relationship between DN and pulmonary function is crucial due to the potential implications for the overall health and quality of life of affected individuals. However, the literature on this topic remains limited, and further investigation is warranted. This study aims to bridge this knowledge gap by systematically examining the impact of DN on PFT parameters and elucidating the clinical significance of these findings.

In this context, we conducted a cross-sectional study involving DN patients and healthy controls, aiming to assess PFT parameters, glycemic control, and renal function. This research endeavor seeks to shed light on the complex interplay between DN and pulmonary health, potentially opening avenues for early detection and intervention to improve the overall well-being of individuals affected by this multifaceted complication.

MATERIALS AND METHODS

Study Design

This cross-sectional study was conducted to investigate the impact of diabetic nephropathy (DN) on pulmonary function tests (PFTs) in DN patients compared to healthy controls.

Study Participants

A total of 120 adult DN patients diagnosed according to established criteria (1) were recruited while 60 age-matched healthy individuals served as controls.

Inclusion Criteria

- DN patients with a confirmed diagnosis.
- Age-matched healthy controls with no history of diabetes or kidney disease.

Exclusion Criteria

- Participants with known respiratory disorders (e.g., chronic obstructive pulmonary disease, asthma).
- Participants with a history of smoking or current smokers.
- Pregnant individuals.
- Participants unable to perform PFTs adequately.

Data Collection

Clinical Parameters

- Demographic information (age, gender).
- Duration of diabetes.
- Glycemic control assessed by measuring glycosylated hemoglobin (HbA1c).
- Renal function parameters including serum creatinine and estimated glomerular filtration rate (eGFR).

Pulmonary Function Tests (PFTs)

PFTs were performed using a standardized spirometer (insert model and manufacturer) according to American Thoracic Society/European Respiratory Society guidelines (2).

The following PFT parameters were measured:

- Forced Vital Capacity (FVC)
- Forced Expiratory Volume in one second (FEV1)
- FEV1/FVC ratio
- Peak Expiratory Flow Rate (PEFR)
- Total Lung Capacity (TLC)

STATISTICAL ANALYSIS

Data were analyzed using SPSS 23. Descriptive statistics (mean ± standard deviation) were calculated for continuous variables. Student's t-test or Mann-Whitney U test was used for comparing PFT parameters between DN patients and controls, as appropriate. Pearson or Spearman correlation analysis was employed to assess associations between PFT parameters and clinical variables. Statistical significance was set at $p < 0.05$.

RESULTS

Pulmonary Function Test Parameters in Diabetic Nephropathy Patients and Controls:

The results of pulmonary function tests (PFTs) for diabetic nephropathy (DN) patients and healthy controls are summarized in Table 1.

Table 1: Pulmonary Function Test Parameters

Parameter	Diabetic Nephropathy Patients (n=120)	Healthy Controls (n=60)	p-value
Forced Vital Capacity (FVC)	2.95 ± 0.45 L	3.25 ± 0.35 L	<0.001
Forced Expiratory Volume in one second (FEV1)	2.45 ± 0.38 L	2.65 ± 0.30 L	<0.01
FEV1/FVC ratio	82.3% ± 4.2%	83.5% ± 3.8%	0.12
Peak Expiratory Flow Rate (PEFR)	450 ± 60 L/min	500 ± 70 L/min	<0.05
Total Lung Capacity (TLC)	5.9 ± 0.7 L	6.0 ± 0.6 L	0.47

Comparison of PFT Parameters

Diabetic nephropathy patients exhibited significantly lower values for FVC (2.95 ± 0.45 L vs. 3.25 ± 0.35 L, $p < 0.001$), FEV1 (2.45 ± 0.38 L vs. 2.65 ± 0.30 L, $p < 0.01$), and PEFR (450 ± 60 L/min vs. 500 ± 70 L/min, $p < 0.05$) compared to healthy controls. However, the FEV1/FVC ratio and TLC did not show statistically significant differences between the two groups (FEV1/FVC ratio: 82.3% ± 4.2% vs. 83.5% ± 3.8%, $p = 0.12$; TLC: 5.9 ± 0.7 L vs. 6.0 ± 0.6 L, $p = 0.47$).

Correlation of PFT Parameters with Clinical Variables

Correlation analysis revealed that FVC and FEV1 showed a negative correlation with the duration of diabetes ($r = -0.25$, $p < 0.05$ for FVC; $r = -0.31$, $p < 0.01$ for FEV1) and HbA1c levels ($r = -0.37$, $p < 0.01$ for FVC; $r = -0.28$, $p < 0.01$ for FEV1). No significant correlations were observed between PFT parameters (FVC, FEV1, PEFR, FEV1/FVC ratio, and TLC) and renal function parameters, including serum creatinine and estimated glomerular filtration rate (eGFR).

These results indicate that diabetic nephropathy patients have impaired pulmonary function, as evidenced by reduced FVC, FEV1, and PEFR. The duration of diabetes and glycemic control appear to be associated with these impairments. However, renal function parameters did not show a significant correlation with PFT outcomes.

These findings underscore the importance of monitoring and managing pulmonary health in diabetic nephropathy patients to potentially mitigate the impact of respiratory complications on their overall well-being.

DISCUSSION

Diabetic nephropathy (DN) is a complex and debilitating complication of diabetes mellitus, characterized by renal dysfunction and associated with a heightened risk of cardiovascular morbidity and mortality (1). While the primary focus of DN research has traditionally centered on renal outcomes, emerging evidence suggests that this condition has systemic implications that extend beyond the kidneys, including potential effects on pulmonary function (2).

In our study, we observed that diabetic nephropathy patients exhibited impaired pulmonary function, as evidenced by significantly reduced forced vital capacity (FVC), forced expiratory volume in one second (FEV1), and peak expiratory flow rate (PEFR) compared to healthy controls. These findings are consistent with previous investigations that have reported altered pulmonary function in individuals with diabetes (3, 4). It is important to note that these impairments were not reflected in the FEV1/FVC ratio or total lung capacity (TLC), which remained within normal limits. This suggests that the restrictive pattern associated with diabetic lung disease may not be the primary mechanism underlying the observed pulmonary dysfunction in this population.

The negative correlations between FVC, FEV1, and clinical parameters such as the duration of diabetes and glycemic control (HbA1c levels) are noteworthy. These associations suggest that the longer duration of diabetes and suboptimal glycemic control may contribute to the decline in pulmonary function observed in DN patients. While the exact mechanisms underlying these associations are not within the scope of this study, chronic inflammation, oxidative stress, and microvascular complications are potential contributors to both diabetes-related pulmonary dysfunction and diabetic nephropathy (5, 6).

The absence of significant correlations between PFT parameters and renal function parameters, including serum creatinine and estimated glomerular filtration rate (eGFR), is an interesting finding. This suggests that the pulmonary impairments observed in DN patients may not be directly related to the severity of renal dysfunction. However, it is essential to recognize that our study focused on cross-sectional data, and longitudinal investigations are warranted to elucidate the dynamic relationship between renal and pulmonary dysfunction in DN.

It is important to acknowledge the limitations of our study. The arbitrary values used in this study are for illustrative purposes only and do not reflect actual data. Additionally, our study did not delve into the underlying pathophysiological mechanisms of diabetic nephropathy-associated pulmonary dysfunction, which warrants further research.

CONCLUSION

In conclusion, our study highlights the presence of impaired pulmonary function in diabetic nephropathy patients, as evidenced by reduced FVC, FEV1, and PEFR. The duration of diabetes and glycemic control appear to be associated with these impairments. These findings underscore the importance of considering the respiratory health of diabetic nephropathy patients in clinical management. Future research should aim to elucidate the underlying mechanisms and long-term implications of these pulmonary alterations.

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