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Original Article

Pulmonary Function Test Abnormalities in Patients of Chronic Kidney Disease at a Tertiary Care Hospital of Lahore

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Abstract

Objective: To evaluate the pulmonary function test abnormalities in patients of chronic kidney disease (CKD).

Methods: This prospective study was conducted at the Department of Pulmonology and Critical Care, Central Park Teaching Hospital, Lahore, from June 2023 to December 2023. A total of 61 patients were enrolled after getting an informed consent. Spirometry pulmonary function tests were done for all enrolled patients before and after hemodialysis.

Results: Out of the total 61 patients, there were 28 male (45.9%) and 33 (54.1%) female participants with a mean age of 45.40±8.45 years. The mean FVC% of the enrolled patients before hemodialysis was 47.8 ± 27.9% and after hemodialysis was 58.2±5.2% with a statistically significant P-value. The mean FEV1% of the enrolled patients before hemodialysis was 40.24±2.37% and after hemodialysis was 48.2±4.2% with a statistically significant P-value. The mean FEV1/FVC (%) of the enrolled patients before hemodialysis was 68.0±2.70% and after hemodialysis was 81.9±1.9% with a statistically significant P-value. The mean FEF 25-75% of the enrolled patients before hemodialysis was 53.34±2.46% and after hemodialysis was 57.8±2.1% with a statistically significant P-value. The mean PEF% of the enrolled patients before hemodialysis was 46.8±3.3% and after hemodialysis was 51.7±2.7% with a statistically significant P-value.

Conclusion: We concluded that there were significant improvements in pre- and post-hemodialysis spirometry parameters. Therefore, this study will help the clinical practitioner to consider treatment strategies keeping in mind the comorbidities in CKD patients.

Keywords: Pulmonary function abnormalities**,** CKD, Hemodialysis, BMI, Forced vital capacity, Peak expiratory flow rate.

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Introduction

Chronic kidney disease (CKD) has become an important concern in recent times as the number of patients affected by it is constantly on the rise. Its rising prevalence is linked to increasing risk factors like Diabetes Mellitus, Hypertension and various drug sided adverse effects. CKD has the syndromic effects and can impact the functionality of various organs. The stage and severity of the disease are important markers to gauge its effects on other systems. Respiratory system disorders are common complications in patients with chronic kidney disease especially those who are on hemodialysis.[1] Patients suffering from CKD face changes in their pulmonary functions when on long-term dialysis.[2] Globally, it is a common health issue, the incidence of which is progressively increasing day by day in South Asian countries like Pakistan.[3] In our Pakistani population, more than 100 per million people are affected by end-stage renal disease (ESRD) annually.[4] In the United States, about 11% of the adults are suffering from CKD.[5,6] The other important causes include glomerulonephritis and renal stones, along with lack of primary healthcare and lack of health care education. Kidneys are responsible for the regulation of body's vital functions such as water, acid-base and

electrolyte balance. They also play a role in hormonal functions and blood pressure regulation.

ESRD is a single organ disease but it can lead to a number of complications which resul in multi-organ involvement including respiratory system dysfunction. In most of the cases, the renal disease compromises the function of other bodily systems contributing to premature mortality.[7] The mechanical and ventilatory functions of the lungs are affected by the renal system of the body either directly or indirectly. The conditions that affect both renal and pulmonary functions are classified under pulmonary-renal syndromes. They are characterized by hemoptysis from diffuse alveolar hemorrhage, renal insufficiency that is associated with either acute glomerulonephritis or vasculitis. CKD patients undergoing dialysis therapy also face respiratory issues. These pulmonary issues may develop due to a number of factors including: interstitial and alveolar edema, pulmonary hypertension, hemosiderosis, pleural effusion due to volume overload or increased capillary permeability and weakness of the pulmonary muscles.[7-9]

The respiratory issues are underrated due to the other overwhelming symptoms of CKD and addressing them may lead to an improvement in the overall health status of the patients, as well as have an impact on the prognosis. Hence, the main aim of this research study was to evaluate or assess the pulmonary functions in patients with CKD after undergoing hemodialysis.

Methods

This prospective study was done at the Department of Pulmonology and Critical Care, Central Park Teaching Hospital, Lahore, from June 2023 to December 2023. Sample size of 161 was statistically calculated taking FEV1/FVC% at baseline as 67.8±20.8% and FEV1/FVC% after hemodialysis as 82.3±20.1%.[10] CKD patients, aged 20-60, of either gender who were on renal replacement therapy in the form of hemodialysis, for at least 3 months, were included in the study after the ethical approval. Patients who were suffering from an acute infection or acute kidney failure, chronic pulmonary disease, tuberculosis, heart failure, arrhythmias and liver cirrhosis, had a history of smoking or who were unable to perform spirometry testing, were excluded. They were explained about the procedure of the study and pulmonary function test technique. Cockcroft-Gault equation was used to determine the glomerular filtration rate (GFR). Creatinine clearance = (((140 - age in years) x (wt. in kg)) x 1.23) / (serum creatinine in micromole/L). Before and after 3 to 4 days of hemodialysis, spirometry PFTs were done by a spirometer of all the enrolled patients. The subjects were well explained about the technique of the procedure. PFTs were performed by a trained technician using Spirodoc machine using portable turbine and was performed in the standard sitting position. At least 3 acceptable readings were counted to assess the results. Forced vital capacity (FVC), forced expiratory volume in the 1st second (FEV1), peak expiratory flow rate (PEFR), mean forced expiratory flow between 25% and 75% of the FVC (FEF25–75), and the FEV1/FVC ratio were measured and calculated as % predicted and were examined against multiple effect modifiers of this study. For data analysis, SPSS (version 25.0) was used. The data was presented in the form of tables and graphs. Stratification was done in percentages for qualitative and mean and standard deviation for quantitative data.

Results

In this study, there was a total of 161 participants. Female participation dominated our study (male=28 (45.9%) and female=33 (54.1%)) with a mean age of 45.40±8.45 years Table 1, Fig I). The mean height and weight were 160.0±9.89cm and 68.93±8.31kg respectively. Patients were distributed on the basis of BMI: 7 (11.5%) were found to be underweight, 49 (80.3%) were normal and 5(8.2%) were overweight. (Table 2, Fig II).

Table 1: *Distribution of patients according to gender and the mean age of patients (n=161)*

Variable	Frequency	Percentage
Gender		
Male	28	45.9
Female	33	54.1
	Mean	**SD**
Age (Years)	45.4	8.45
Height (cm)	160	9.89
Weight (kg)	68.93	8.31

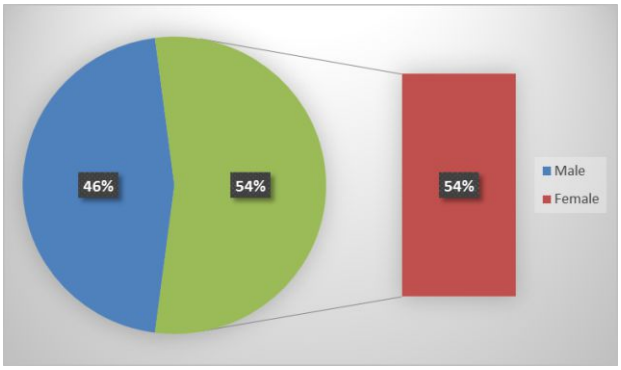

Figure I: *Graphical representation of gender*

Table 2: *Distribution of patients according to the age group (n=61)*

BMI (kg/m2)	Frequency	%
Underweight (< 18.5)	7	11.5
Normal (18.5-24.99)	49	80.3
Overweight (25-29.99)	5	8.2
Total	61	100

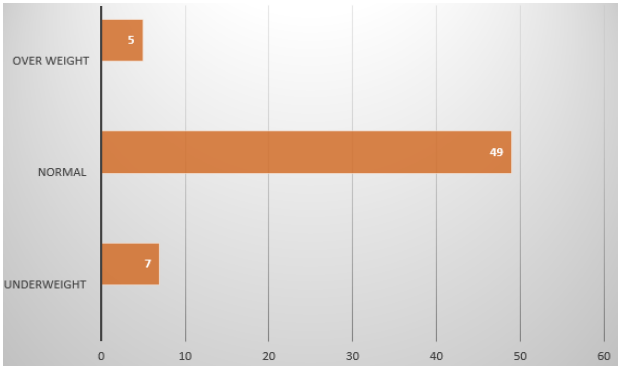

Figure II: *Graphical representation of patients according to BMI (n=61).*

18%, 41%, 26.2, 14.8% of the enrolled patients were on dialysis for less than 3 month, 3 months-6 months, 6 months-1 year and > year respectively (Table 3-0). 86.9% patients were on hemodialysis for once a week, 9.8% were on 2 times a week and 3.3 % were on 3 times a week (Table 3).

Table 3: *Frequency and the duration of hemodialysis among enrolled patients.*

Hemodialysis	Frequency	Percentage
Once a week	53	86.9
2 times a week	6	9.8
3 times a week	2	3.3
Duration of Hemodialysis		
< 3 months	11	18
3 months-6 months	25	41
6 months-1 year	16	26.2
>1 year	9	14.8

The mean FVC% of the enrolled patients before hemodialysis was 47.8±27.9% and after hemodialysis was 58.2±5.2% with a statistically significant P-value. The mean FEV1% of the enrolled patients before hemodialysis was 40.24±2.37% and post dialysis, it was 48.2±4.2% with a statistically significant P-value as well. The mean FEV1 / FVC (%) of the enrolled patients before and after hemodialysis was 68.0±2.70% and 81.9±1.9% respectively, with a statistically significant P-value. The mean FEF 25-75% of the enrolled patients before hemodialysis was 53.34±2.46% and after dialysis was 57.8±2.1% with a statistically significant P-value. The mean PEF% of the enrolled patients before hemodialysis was 46.8±3.3% and after hemodialysis was 51.7±2.7% with a statistically significant P-value.

Table 4: *Predicted spirometry parameters in % in the study patients before and after hemodialysis (n = 61)*

Spirometry parameters	Before Hemodialysis	After Hemodialysis	P-Value
FVC%	8.11±0.93%	58.2±5.2%	0
FEV1%	40.24±2.37%	48.2±4.2%	0
FEV1 / FVC (%)	68.0±2.70%	81.9±1.9%	0
FEF 25-75%	53.34±2.46%	57.8±2.1%	0
PEF%	46.8±3.3%	51.7±2.7%	0

Discussion

Respiratory related disorders are common complications in patients with CKD. The present study was conducted in order to assess the pulmonary functions in patients with CKD. In our study, there were more female patients than male, indicating a high prevalence of CKD in the female Pakistani population. One of the main causes of this high prevalence among females is the poor availability of the highly costly regular renal treatment. Our study is supported by the study conducted in Egypt by Ahmed Muhammed Hasan et al.[10] in which female patients were also in a greater number. The other factors contributing to this can be the rising trend of DM in Pakistani population and also across the globe which is a significant risk factor for renal diseases.

The mean age in our study group was 45.40±8.45 years which is supported by other studies where again the mean age of such cases ranged between 45-50 years which is again less than the developed world. This can be explained by the same factors of developing world where trends of DM are increasing and there is lack of quality food and access to standard of care treatment is limited. As a result, the acute problems get unnoticed to chronic kidney disease issues.[10,11] It has been stated in literature that high BMI is associated with a progressively increased risk of CKD.[12] However, in our study, majority of patients were in the normal BMI range and only 8.2% patients fell in the category of overweight group. CKD mostly affects raised BMI patients. The reason of this can be increased insulin resistance leading to metabolic syndrome which is a real point of concern.[13,14] Statistically significant differences were observed in various parameters of pulmonary functions tests in this study.

The normal predicted values of FVC% for pulmonary function > 80%. In our studied patients, it was low before hemodialysis but after hemodialysis treatment, it increased up to 58.2±5.2% with a highly significant p-value. These findings are consistent with other studies. This can be explained by multiple reasons; when subjects are in fluid overload, there is fluid accumulation in the lungs and that decreases the area for gas exchange, and hence, the total FVC is decreased and as ultrafiltration is a major component of hemodialysis, once after dialysis, the extra fluid is removed this leads to improvement in the pulmonary function, and ultimately to a better FVC after dialysis.[10,15] In our study, patients mean FEV1% was low before hemodialysis but after treatment, it increased up to 48.2±4.2% with a highly significant p-value. This finding is supported by Ahmed Muhammed Hasan et al., and can also be well described due to the above discussed pathophysiology. With extra fluid accumulation in lungs causing interstitial fluid accumulation and compression of the airways along with patient already being short of breath, the quality of FEV1 is impaired pre dialysis.[10]

We also observed an increase in the post-hemodialysis values of FEV1 / FVC (%) with a significant p-value. This improvement was most likely due to the wash off of the extra fluid which reflected on the intra-alveolar fluid, that may be because of the increased capillary permeability. FVC is the amount of air exhaled forcefully and quickly after inhaling while FEV is the amount of air expired during the 1st, 2nd and 3rd second of the FVC test.[16,17] Normal values for PFTs vary from person to person. The study of Mahmoud et al.15 also goes parallel to our finding as in our study we found out that the mean value of FEF 25-75% before dialysis was 53.34±2.46% and after dialysis was 57.8±2.1% with a statistically significant p-value. Mahmoud et al.[15] in his study finding stated that these decreased values indicated the presence of respiratory disease. Another study conducted by Muhammed Hasan et al.[10] also shares the views of Mahmoud et al.[15] in his study that supported the our study findings.

In our findings, the mean Peak expiratory flow rate% (PEFR %) of the enrolled patients before dialysis treatment was 46.8±3.3 and after dialysis treatment was 51.7±2.7, with a statistically significant P-value. The mean PEFR% value of our finding was below the normal range (normal range >80%). Our study is supported by studies done previously.[10,15] Davenport described his results as he stated that the low PEFR% value is due to the activation of the complement system for neutrophils, monocytes and platelets following blood membrane interaction, and so leads to airway constriction.[18]

Conclusion

It was concluded that there were multiple PFT abnormalities observed in CKD patients and these changes were significantly impacted after dialysis.

Ethical Approval: The IRB/EC approved this study via letter no.Nil Dated: 8/1/2023.

Conflict of Interest: *None*

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Authors' Contribution:

MA, SUM: Conception

AI, SF: Design of the work

UA, SR: Data acquisition, analysis, or interpretation

AI, SF, UA, SR: Draft the work

MA, SUM: Review critically for important intellectual content

All authors approve the version to be published

All authors agree to be accountable for all aspects of the work

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