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ORIGINAL ARTICLE

Post COVID-19 Spirometric Changes in Patients Under Regular Hemodialysis

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Abstract

Background: **The prognostic impact of end-stage renal disease (ESRD) on individuals with COVID-19 is not yet well understood.**

Aim and objectives: **To match spirometric changes in cases with end-stage renal illness who had or did not have COVID-19.**

Patients and methods: **In this study patients were categorized as follows: Twenty individuals with ESRD due to COVID-19 infection (Group A). A total of 20 ESRD cases who tested adverse for COVID-19 made up Group (B). The 'control' (group C) individuals are those who are otherwise healthy.**

Result: **There was no significant difference ($P = 0.644$) in the relation of forced expiratory volume in 1 s to pushed vital capacity (FEV1) between the post COVID-19 group (FEV1/FVC scaled from 69 to 90%) and the negative for the COVID-19 group (FEV1/FVC scaled from 69 to 80%; mean SD = 74.45 3.66%) and the control group (FEV1/FVC scaled from 70.01 to. Three months after COVID-19 infection, the FVC, FEV1, and PEFR of ESRD patients receiving conventional HD were all considerably reduced. These findings provide support for a restricted pattern of pulmonary function after COVID-19 in a large subset of individuals. There was no discernible variation in FVC/FEV1. Thus, there was no discernible variation in FVC/FEVI across the three groups.**

Conclusion: **Patients who underwent the Covid procedure after the study were free of obstructive pulmonary disease. In restrictive lung disease, the ratio does not improve; on the contrary, it improves. Search terms: spirometric; hemodialysis; ESRD; postCOVID-19; cases; end-stage renal illness.**

Keywords: Spirometric, Hemodialysis, ESRD, Post-covid-19, Cases, End-stage renal illness

1. Introduction

Incidences of ESRD are rising all over the world. The costs of kidney transplants and renal replacement treatment (RRT) are rising rapidly. In nations with little access to healthcare, this illness can have devastating effects. As the yearly incidence rate rises to 8%, the expected number of patients getting RRT worldwide rises to almost 1.4 million.[1]

Age, diabetes, high blood pressure, and certain drugs, such as the long-term, repeated use of analgesics that can cause a condition called analgesic nephropathy and permanent kidney damage, are among the leading causes of CKD. The genetic predisposition to develop polycystic kidney disease is one such inherited cause of chronic kidney failure.[2]

Due to their compromised immune systems and frequent use of healthcare facilities, people with ESRD have a greater danger of contracting COVID-19 than the general people. However, these patients are typically older and have other chronic diseases, making them more vulnerable to the negative effects of COVID-19.[3]

The lack of data prevents us from drawing any firm conclusions on ESRD's prognostic influence on COVID-19 patients at this time. Therefore, the goal of this study was to quickly decide whether or not

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there was a correlation between COVID-19 infection and changes in values for breathing in ESRD patients on routine dialysis.

Comparing spirometric changes in ESRD patients with and without COVID-19 was the focus of this investigation.

2. Patients and methods

Patients were categorized as follows: Twenty individuals with ESRD due to COVID-19 infection (Group A). A total of 20 ESRD cases that tested -ve for COVID-19 made up Group (B). Group (C): Normative Health.

Condition(s) for acceptance: The following factors influence which cases are chosen: Kidney failure is so severe that only dialysis can restore function; treatment typically lasts for at least 6 months. Chronic obstructive pulmonary disease (COPD) 19 patients on dialysis after 3 months of infection.

Patients were selected from the Dialysis Unit at Nasser Institute Hospital in Cairo, Egypt. Exclusion criteria included smokers, those with chronic lung disease, pulmonary TB, chest wall deformities, heart failure, patients with immune-mediated renal disease, patients undergoing immunosuppression, and those with a history of malignancy.

The following lab tests were performed on the indicated patient groups.

Focused complete blood count, evaluation of neutrophil and lymphocyte count, C-reactive protein, serum ferritin, D-dimer, and spirometry for measurement of forced vital capacity, forced expiratory volume, and peak expiratory flow rate.

Ethical considerations and patient permission: All treatments were done in agreement with the guiding principle set out by the AL-Azhar University Ethics Committee. Only the data collector and their superiors will see the information gathered.

The acquired data was reviewed, recoded, and put into IBM's Statistical Package for the Social Sciences, version 23 for statistical analysis.

For qualitative data, we compared groups using the Chi-square test and/or the Fisher exact test, where the predicted count in any cell was <5. When comparing three or more groups using quantitative data with a parametric distribution, we used the one-way ANOVA test, with a post hoc analysis using the LSD test for significant differences.

3. Results

Patients with end-stage renal illness were split into two groups: those with and without COVID-19. Cases in this study were divided into the following categories: Twenty individuals with ESRD due to COVID-19 infection (Group A). A total of 20 ESRD cases that tested -ve for COVID-19 made up Group (B). Twenty healthy people made up group (C).

Patients were chosen from the Dialysis Unit at Nasser Institute Hospital in Cairo for this study. Selected cases of end-stage renal disease (ESRD) were on dialysis for more than 6 months. End-stage renal patients who are affected by COVID-19 after 3 months of infection (Table 1).

The age in the PostCOVID-19 group scaled from 35 to 66 yrs with a mean ± SD = 50.5 ± 7.24, while in the negative COVID-19 group the age scaled from 39 to 68 yrs with a mean ± SD = 48.85 ± 7.03, while in the control group the age scaled from 37 to 68 yrs with a mean ± SD = 48.65 ± 6.82, with no statistically significant difference (P = 0.661) among the three groups. Regarding sex, there was not a significant difference among the three studied groups (P = 0.626) (Table 2).

FVC in the Post COVID-19 group scaled from 2 to 3.5 L with a mean ± SD = 2.86 ± 0.51 L, while in the negative COVID-19 group the FVC ranged from 3 to 5 L with a mean ± SD = 3.97 ± 0.69 L, although in the control group the FVC scaled from 3.25 to 5.5 L with a mean ± SD = 4.40 ± 0.69 L with highly statistically significant difference (P= <0.001) among the three groups (Table 3).

FEV1 in the Post COVID-19 group ranged from 2 to 3 L with a mean ± SD = 2.70 ± 0.36 L, while in the negative COVID-19 group the FEV1 ranged from 3 to 4.2 L with a mean ± SD = 3.76 ± 0.37 L, although in the control group the FEV1 scaled from 3 to 4.52 L with a mean ± SD = 3.75 ± 0.48 L, with highly statistically significant difference (P=<0.001) among the three groups (Table 4).

FEV1/FVC in the Post COVID-19 group ranged from 69 to 90% with a mean ± SD = 83.4 ± 5.92%, while in the negative COVID-19 group the FEV1/FVC ranged from 69 to 80% with a mean ± SD = 74.45 ± 3.66%, although in the control group the FEV1/FVC scaled from 70.01 to 85% with a mean ± SD = 77.63 ± 4.70%, with no statistically significant difference (P = 0.644) among the three groups (Table 5).

PEFR in the Post COVID-19 group ranged from 210 to 400 L/Min with a mean ± SD = 295 ± 60.39 L/Min, while in the negative COVID-19 group the PEFR ranged from 310 to 500 L/Min with a mean ± SD = 397.75 ± 52.73 L/Min.

4. Discussion

End-stage renal disease (ESRD) affects>497 million adults aged beyond the age of 20 years

Table 1. Demographic characteristics among the study population.

	Post COVID-19 group Number = 20	Negative COVID-19 group Number = 20	Control group Number = 20	Test value	*P* value	Sig.
Sex						
Male	11 (55%)	12 (60%)	9 (45%)	0.238[a]	0.626	NS
Female	9 (45%)	8 (40%)	11 (55%)			
Age (years)						
Mean ± SD	50.5 ± 7.24	48.85 ± 7.03	48.65 ± 6.82	0.417[b]	0.661	NS
Range	35–66	39–68	37–68			

P-value more than 0.05: Nonsignificant; *P*-value less than 0.05: Significant; *P*-value <0.01: Highly significant.
SD, standard deviation.
[a] Chi-square test.
[b] One-way ANOVA test.

Table 2. Comparison between the study group as FVC among the study population.

FVC (L)	Post-COVID-19 group Number = 20	Negative COVID-19 group Number = 20	Control group Number = 20	Test value	*P* value	Sig.
Mean ± SD	2.86 ± 0.51	3.97 ± 0.69	4.40 ± 0.69	31.224[a]	<0.001	HS
Range	2–3.5	3–5	3.25–5.5			
Post Hoc analysis						
Post COVID-19 versus negative COVID-19		Negative COVID-19 versus control group		Post COVID-19 versus control group		
<0.001 (HS)		<0.001 (HS)		0.038 (S)		

P-value >0.05: Nonsignificant; *P*-value,< 0.05: Significant; *P*-value <0.01: Highly significant.
F, ANOVA test; **IQR,** interquartile range; **p,** *P* value for comparing among the studied groups; **SD,** standard deviation.
P-value >0.05: Nonsignificant; *P*-value <0.05: Significant; *P*-value <0.001: Highly significant.
P_1: Group 1 versus Group 2; P_2: Group 2 versus Group 3; P_3: Group 1 versus Group 3.
[a] One-way ANOVA test.

worldwide,[4] with a growing prevalence over the last decade reaching 19.6%.[5] Similar data were reported in Egypt, as Barsoum reported a prevalence of 264 individuals per million populations.[6]

In the current study, we conducted a cross-sectional study including 40 ESRD and 20 in the control group. The age in the Post COVID-19 group showed a mean of 50.5 ± 7.24 years versus 48.85 ± 7.03 years among the COVID-19-negative patients and 48.65 ± 6.82 years among the healthy control group. All groups exhibited no statistically significant difference in terms of oldness and gender distribution with *P* values > 0.05.

Our data indicated that there was a statistically significant difference in hemoglobin level among study groups favoring COVID-19 negative and health controls over the COVID-19 +ve group with a *P* value < 0.001. TLC was significantly advanced in both COVID-19 +ve and -ve groups versus controls with *P* value < 0.001. Neutrophil count showed a statistically significant difference between groups with the highest level reported in COVID-19

Table 3. Comparison between the study group as FEV1 among the study population.

FEV1 (L)	Post COVID-19 group Number = 20	Negative COVID-19 group Number = 20	Control group Number = 20	Test value	*P* value	Sig.
Mean ± SD	2.70 ± 0.36	3.76 ± 0.37	3.75 ± 0.48	45.252[a]	0.000	HS
Range	2–3	3–4.2	3–4.52			
Post hoc analysis						
Post COVID-19 versus negative COVID-19		Negative COVID-19 versus control group		PostCOVID-19 versus control group		
<0.001 (HS)		<0.001 (HS)		0.960 (NS)		

P-value >0.05: Nonsignificant; *P*-value <0.05: Significant; *P*-value <0.01: Highly significant.
F, ANOVA test; IQR, interquartile range; p, *P* value for comparing among the studied groups; SD, standard deviation.
P-value >0.05: Nonsignificant; *P*-value <0.05: Significant; *P*-value <0.001: Highly significant.
P_1: Group 1 versus Group 2.
P_2: Group 2 versus Group 3.
P_3: Group 1 versus Group 3.
[a] One-Way ANOVA test.

Table 4. Comparison between the study group as FEV1/FVC among the study population.

FVC/FEV1 (%)	Post COVID-19 group Number = 20	Negative COVID-19 group Number = 20	Control group Number = 20	Test value	*P* value	Sig.
Mean ± SD	83.4 ± 5.92	74.45 ± 3.66	77.63 ± 4.70	17.508[a]	0.000	HS
Range	69−90	69−80	70.01−85			
Post hoc analysis						
Post COVID-19 versus negative COVID-19		Negative COVID-19 versus control group		PostCOVID-19 versus control group		
<0.001 (HS)		<0.001 (HS)		0.043 (S)		

P-value more than 0.05: Nonsignificant; *P*-value less than 0.05: Significant; *P*-value <0.01: Highly significant.
F, ANOVA test; IQR, interquartile range; p, *P* value for matching among the studied groups; SD, standard deviation.
P-value >0.05: Nonsignificant; *P*-value <0.05: Significant; *P*-value <0.001: Highly significant.
P_1: Group 1 versus group 2.
P_2: group 2 versus group 3.
P_3: group 1 versus group 3.
[a] One-Way ANOVA test.

Table 5. Comparison between the study group as PEFR among the study population.

PEFR (L/sec.)	Post COVID-19 group Number = 20	Negative COVID-19 group Number = 20	Control group Number = 20	Test value	*P* value	Sig.
Mean ± SD	295 ± 60.39	397.75 ± 52.73	445.25 ± 77.47	28.473[a]	0.000	HS
Range	210−400	310−500	350−620			
Post Hoc analysis						
Post COVID-19 versus negative COVID-19		Negative COVID-19 versus control group		Post COVID-19 versus control group		
<0.001 (HS)		<0.001 (HS)		0.023 (S)		

P-value more than 0.05: Nonsignificant; *P*-value less than 0.05: Significant; *P*-value <0.01: Highly significant.
F, ANOVA test; IQR, interquartile range; p, *P* value for comparing between the studied groups; SD, standard deviation.
P-value >0.05: Non significant; *P*-value <0.05: Significant; *P*-value <0.001: Highly significant.
P_1: Group 1 versus Group 2.
P_2: Group 2 versus Group 3.
P_3: Group 1 versus Group 3.
[a] One-Way ANOVA test.

positive followed by COVID-19 -ve and finally thr control group with a *P* value of 0.034.

These findings were consistent with many studies such as **Ng *et al.***,[7] **Hakami *et al.***,[8] **and Rastad *et al.***,[9] which revealed that the hemoglobin level was significantly lower among patients who were infected with COVID-19, as well among those who have been hospitalized against patients who were managed at home with a mean hemoglobin level <8 versus <9, respectively.

Regarding TLC and neutrophil count, our findings were consistent with **Alberici *et al.***,[10] who conducted a cross-sectional study including ESRD cases infected with COVID-19. Their results showed that TLC and neutrophil count were higher in infected patients compared with negative patients; however, this did not reach a statistically significant difference.

The main results of the current study are FVC, which showed a greatly statistically significant difference (*P* = <0.001) among the three groups as the post COVID-19 group showed a 2−3.5 L mean of 2.86 ± 0.51 L versus from 3 to 5 L 3.97 ± 0.69 L in the negative COVID-19 group and 3.25−5.5 L with a mean 4.40 ± 0.69 L among controls.

FEV1 showed a mean from 2 to 3 L with a mean of 2.70 ± 0.36 L among the post COVID-19 group. The decrease in both FEV1 and FVC in patients positive for Covid when compared with negative Covid patients' months after acquiring the disease clearly points to the delirious residual restrictive pattern on pulmonary function among patients who acquire the disease. For how long it will persist? What will be the course and the scenario for this process? How to manage these patients? are questions to be answered with time.

Other respiratory function tests were also done. Regarding FEV1/FVC, it was found to be 69−90% with a mean SD 83.4 ± 5.92% in patients with positive Covid versus from 69 to 80 with a mean SD 74.45 3.66% in negative patients and 70.01−85% with a mean SD 77.63 in controls ± 4.70 post COVID-19, respectively. These results exclude the presence of obstructive function in the post Covid patients studied. In fact, the ratio did not decrease or even it increase in restrictive lung disease. Of notice, in restrictive lung disease, both (FEV1) and (FVC) are lowered; however, the drop in FVC is > that of FEV1, resulting in a greater than 80% FEV1/FVC ratio.

Regarding FEV1/FVC from 69 to 90% with a mean SD 83.4 ± 5.92% versus from 69 to 80 with a mean SD 74.45 ± 3.66% and 70.01–85% with a mean SD 77.63 ± 4.70 post COVID-19 group versus the negative COVID-19 group and control group, respectively.

Regarding PEFR, there was no statistically significant difference among the three groups.

To our knowledge, this is the first study to assess pulmonary functions among patients with ESRD who are under regular hemodialysis post COVID-19 recovery. There is an ongoing similar study (NCT05348759); however, no results have been posted yet.

Of notice, it should not miss that ESRD patients are commonly presented with respiratory system complications that may lead to respiratory function test abnormality, to name a few, are pulmonary edema, pleural effusion, acute respiratory distress syndrome, pulmonary fibrosis and calcification, pulmonary hypertension, hemosiderosis, pleural fibrosis, and sleep apnea syndrome.[11]

In ESRD patients, pulmonary dysfunction can be caused either directly by circulating uremic toxins or indirectly by fluid overload, anemia, lowering the immune system, extraosseous calcification, malnutrition, electrolyte abnormalities, and/or acid–base imbalances.[12]

Excess fluid can pose serious issues for people with ESRD who use traditional HD. Overloading the body with fluids has been linked in studies to respiratory difficulties in HD patients, namely those that are restrictive and obstructive. In addition, pulmonary function tests show improvement after starting hemodialysis, which may be due to the elimination of excess fluid.[13]

4.1. Conclusion

FVC, FEV1, and PEFR were significantly impaired among ESRD under regular HD 3 months post COVID-19 infection. These results are in favor of a restrictive pattern of pulmonary function post Covid in a larger section of patients. FVC/FEV1 showed no statistically significant difference. Thus, FVC/FEVI presented no statistically significant change among the three groups. These results exclude the presence of obstructive pulmonary disease in post Covid patients studied. In fact, the ratio did not decrease increase in restrictive lung disease.

Authorship

All authors have a substantial contribution to the article.

Disclosure

The authors have no financial interest to declare concerning the content of this article.

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Conflicts of interest

The authors declared that there were no conflicts of Interest.

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