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EVALUATION OF PULMONARY FUNCTION TESTS IN CHRONIC KIDNEY DISEASE PATIENTS ON HAEMODIALYSIS AT NORTHERN RAILWAY CENTRAL HOSPITAL (NRCH), NEW DELHI

Dr Madhu Kaushal MBBS, MD(Med.) ACHD Physician NRCH, New Delhi.

Dr Pankaj Faujdar MBBS, DND Medicine, NRCH.

Dr Sanjay Joshi MBBS, MD, FICP, FISE, SENIOR Consultant, NRCH.

Dr Sunil Nagar MBBS, DNB, DTCD, IDCCM, FISM, EDARM, IDPPM, visiting Consultant NRCH.

ABSTRACT This study underscores the importance of regular haemodialysis in improving both renal and respiratory functions in individuals with CKD. The findings contribute to the growing evidence supporting the efficacy of haemodialysis as a vital intervention in managing CKD-related complications and improving overall patient outcomes. Further research is needed to explore additional factors influencing the efficacy of haemodialysis and to optimize treatment strategies for individuals with CKD.

KEYWORDS :

Chronic kidney disease (CKD) is commonly defined as a heterogeneous group of disorders characterised by alterations in kidney structure and function, which manifest in various ways depending upon the underlying cause or causes and the severity of disease. The term "end stage kidney disease" (ESRD) generally refers to chronic kidney failure treated with either dialysis or transplantation. As per KDIGO guidelines CKD is defined by the presence of kidney damage or decreased kidney function for three or more months, irrespective of the cause. Individuals diagnosed with CKD typically exhibit a glomerular filtration rate (GFR) below 60 mL/min/1.73 m² or albuminuria exceeding 30 mg/24 hours over this specified duration. Around 10% of the Indian population suffers from chronic kidney disease. Alarmingly, less than 10% of these individuals are not aware of their condition, resulting in diagnoses often occurring at later stages when interventions such as dialysis or transplantation may become imperative. In addition to the typical complications associated with CKD, lung diseases can significantly impact kidney function, particularly when accompanied by other health conditions, and are independently linked to increased mortality rates in CKD patients. Globally, lung diseases represent a significant cause of both mortality and morbidity, with chronic obstructive pulmonary disease (COPD) alone accounting for over 2.7 million deaths. This situation is further exacerbated by a prevalence rate of 4.7% for COPD among individuals with CKD. Individuals diagnosed with CKD face an increased risk of mortality attributed to respiratory diseases. Moreover, age is one among several specified risk factors between CKD and lung disease, indicating that the increasing aging population globally may contribute to a continued increase in the prevalence of these comorbidities. As kidney function decreases in CKD patients, there is a corresponding increase in the prevalence of comorbidities. Previous research indicates that CKD predisposes individuals to the development of lung diseases, with a rise in prevalence of obstructive lung dysfunction and restrictive lung dysfunction as renal function decreases. Presence of both CKD and restrictive lung dysfunction significantly increases the mortality risk, as compared to CKD alone.

Moreover, CKD patients with other lung diseases such as pulmonary hypertension also face increased mortality. The interaction between the kidneys and lungs involves a complex network of mechanisms. These include immune responses, phosphate metabolism, hormonal imbalances, acid-base balance regulation, fluid dynamics, and oxidative stress. Often, multiple pathways simultaneously contribute to inter-organ communication, leading to a poorer prognosis for individuals with chronic kidney disease and lung conditions. As chronic kidney disease advances, it eventually reaches end-stage renal disease (ESRD), patients need renal replacement therapy such as haemodialysis/ peritoneal dialysis or kidney transplantation for survival. With enhancements in dialysis technology leading to an improved life expectancy for ESRD patients, systemic complications are expected to gain greater significance. Chronic kidney disease affects nearly all organ systems, particularly in the advanced stages of the disease. Respiratory system disorders emerge as one of the most prevalent complications in patients with end-stage renal disease (ESRD). Chronic kidney disease is associated with a variety of lung diseases, both acute and chronic forms. Various pulmonary conditions, such as pulmonary oedema, pleural effusion, acute respiratory distress syndrome, pulmonary fibrosis, calcification, pulmonary hypertension, hemosiderosis, pleural fibrosis, and sleep apnoea syndrome, have been reported in individuals within these patient populations. Chronic Kidney diseases affect the mechanical and ventilation function of the lungs, with treatment modalities such as medication and haemodialysis (HD) contributing to this impact. Individuals with end-stage renal disease (ESRD) rely on dialysis, as a means of survival. These modalities of treatment partially compensate for the impaired kidney function, alleviating uremic toxins symptoms and sustaining ESRD patients while waiting for kidney transplantation for further improvement. Pulmonary function impairment in ESRD patients occurs directly from circulating uremic toxins. Studies have shown Comparisons of pulmonary function tests between individuals undergoing haemodialysis /peritoneal dialysis, and kidney transplant recipients revealed that pulmonary restrictive defect was the predominant dysfunction among all these groups. Fluid overload is a prevalent and significant issue in haemodialysis patients, often resulting in severe complications. During the interdialytic period, weight fluctuations are common due to fluid overload in individuals with end-stage renal disease (ESRD) undergoing regular haemodialysis. This excess fluid, coupled with a potential rise in pulmonary capillary permeability, can lead to pulmonary edema and pleural effusion, contributing to decreased pulmonary function. Haemodialysis, by removing excess body fluid, may also improve pulmonary function by reducing lung water content. In some cases, dialysis can offer beneficial effects, particularly in the early stages of certain respiratory disorders among CKD patients without primary lung disease, potentially improving respiratory symptoms and pulmonary function test. However, the immune response triggered by dialysis filter interactions may lead to complement activation, posing a risk of respiratory deterioration and even respiratory distress. Haemodialysis contributes to hypoxemia in ESRD patients.

It can reduce pulmonary edema around small airways, potentially resulting in the dilation of these airways. Additionally, haemodialysis facilitates enhanced ventilation and perfusion. Spirometry, along with the calculation of FEV1/FVC, aids in identifying obstructive or restrictive ventilatory defects. An FEV1/FVC ratio below 70%, with FEV1 reduced more than FVC, indicates an obstructive defect, typical of conditions like chronic obstructive pulmonary disease (COPD) and asthma. Conversely, an FEV1/FVC ratio above 70%, with FVC reduced more than FEV1, is characteristic of restrictive defects such as interstitial lung diseases (e.g., idiopathic pulmonary fibrosis) and chest wall deformities. Additionally, measuring the peak expiratory flow rate (PEFR) provides valuable insights into small airway function. Lang et al. investigated spirometric changes before and after haemodialysis using different dialyzer membranes, finding no significant difference in vital capacity between pre haemodialysis and post-haemodialysis. Conversely, Rahgoshai et al. conducted a similar study on the acute effects of haemodialysis, showing that pulmonary function, particularly forced vital capacity (FVC), improved following a haemodialysis session. However, they observed no significant

enhancements in forced expiratory volume in 1 second (FEV1), FVC, or the FEV1/FVC ratio. The impact of haemodialysis on CKD patients primarily involves alterations in body fluid volume, resulting in a reduction of lung water content post-dialysis. Consequently, it enhances respiratory status, yet it also has the potential to induce pulmonary complications results from multifaceted pulmonary injuries. Furthermore, malnutrition and degenerative changes in CKD patients persist, exacerbating muscle loss and predisposing individuals to fatigue, accompanied by elevated respiratory rate and workload. There is limited research on changes in pulmonary function among chronic kidney diseases patients undergoing haemodialysis treatment, and the findings from published studies are also inconsistent. Furthermore, the effects of haemodialysis remain poorly understood. Therefore, we have designed the study to find out the effects of haemodialysis on pulmonary functions in chronic kidney disease patients on haemodialysis.

A prospective observational study was carried out at the Department of Medicine, Northern Railway Central Hospital, New Delhi, 80 subjects undergoing haemodialysis at our institution and fulfilling the criteria for study were enrolled. There was a slight male preponderance among the study subjects, with 52.5%% males and 47.5% females. Similar findings were reported by Shailendra Mane et.al. With 51.46% male and 48.54% female subjects. Mohanty et.al. reported similar findings with male preponderance. However, Ravi Kumar P et al. observed a slightly higher proportion of female patients in his subjects, with 72% female subjects. Shaik et al. reported in his study that 71.2% subjects were male, while Sharma A et al. identified 62% of cases as male. Lim H et al. noted that 44% of CKD patients were male in his study. Majority of the study subjects had a normal (18.5- 22.9 kg/m2) BMI, while a smaller proportion were underweight (23 kg/m2) in our study. Of the total individuals studied, 73.75% (n=59) had normal BMI. 16.25% (n=13) were classified as underweight. Eight individuals 10% were overweight/obese. Similar results were observed by Sharma et.al in his study, he observed that mean BMI of the study group was 21.6 ± 3.0 kg/m^2, with 20% having a BMI < 18.5 kg/m2. Despite chronic illness, majority of the patients (64%) had a normal BMI. Among the study populations, 42 were in stage IV (52.5%), while 38 were in stage V CKD (47.5%). Similar to our study, Shailendra Mane et.al, reported 44.66% subjects of stage V and 55.34% of stage IV CKD. In contrast to our study, Ravi Kumar P et al. reported only one case (1.00%) of stage V CKD patient in his study. Rajapurkar et al. observed that 25.9% of cases were in stage IV and 48.1% in stage V in his study. Similarly, Sathayan S et al. observed that majority of the patients in his study were in stage V CKD, comprising (79.2%) of the cases. Among the 80 individuals studied, 7 (8.75%) had undergone haemodialysis for less than 6 months, 31 individuals (38.75%) for 6 months to 1 year, 36 individuals (45.00%) for 1 to 3 years, and 6 individuals (7.50%) were receiving haemodialysis for more than 3 years. Our results were comparable with the study done by Shailendra Mane et.al, who reported 4.85% subjects on haemodialysis for more than 3 years, 44.66% for 1 to 3 years, 39.81% for 6 to 12 months and 10.68% for less than 6 months. Sharma A et al. in his study observed that 90% 34 (n=45) patients had been on haemodialysis for six months to three years, while only 10% had been on haemodialysis for less than six months. In our study, 62 patients (77.50%) were undergoing dialysis twice a week, while 18 (22.50%) underwent dialysis thrice a week, indicating that majority of the subjects underwent dialysis twice a week, with a smaller proportion receiving dialysis thrice a week. Our results were comparable to study done by, Shaik et al. where it was observed that (85.2%) cases received haemodialysis two times per week and (14.8%) three times per week. Sharma A et al. reported that the majority (58%) of the study patients underwent HD twice a week, while 30% of all patients underwent HD three times a week. Mukakarangwa MC et al. observed in his that the majority of cases (26. 64%) received haemodialysis three days a week. Before haemodialysis, the mean urea level was 129.45 ± 57 mg/dl, which decreased significantly to 29.71 ± 24.9 mg/dl after haemodialysis ($p < 0.05$). Similarly, the mean creatinine level decreased from 8.59 ± 2.59 mg/dl before haemodialysis to 2.03 ± 1.41 mg/dl after haemodialysis ($p < 0.05$). Consistent with these findings, Sharma A et al. also reported similar improvements in kidney function. Steinhorst RC et al. observed significant improvement in kidney function after 40 haemodialysis sessions. However, RahgoshaI R et al. reported that urea levels did not significantly improve with haemodialysis. FVC There was an overall improvement in respiratory function in our study. Before haemodialysis, the mean forced vital capacity (FVC) was 52.91 ± 13.39 L, which increased to 57.01 ± 13.21 L after haemodialysis ($p < 0.05$). Shailendra Mane et.al, reported mean FVC before haemodialysis 53.04 ± 13.46L which was increased to 56.91 ± 13.17L after haemodialysis. Sharma et al. noted a significant increase in mean FVC from 45.8 ± 24.9% before haemodialysis to 51.1 ± 23.4% afterward. Similar findings were reported by Lang et al. and Kovelis et al., who also observed improvements in FVC measurements in their respective studies. Additionally, Yilmaz et al., Karacan et al., and Navari et al. reported improvements in pre-dialysis FVC values following haemodialysis. FEV1 Mean forced expiratory volume in one second (FEV1) increased from 52.44 ± 13.98 L before haemodialysis to 56.78 ± 12.76 L after haemodialysis ($p < 0.05$). Shailendra Mane et.al, 35 observed mean FEV1 52.54 ± 14.16L before and 56.83 ± 12.89L after haemodialysis. Sharma et al. observed a significant increase in mean FEV1 from 43.5 ± 25.9% before haemodialysis to 49.3 ± 25.5% afterward. Similar results were reported by Lang et al. and Kovelis et al., who noted improvements in FEV1 measurements. Yilmaz et al., Karacan et al., and Navari et al. also reported improvement in pre-dialysis FEV1 values following haemodialysis. FEV1/FVC The FEV1/FVC ratio also improved from 99.21 ± 15.81 before haemodialysis to 103.31 ± 14.78 after haemodialysis ($p < 0.05$). Shailendra Mane et.al, reported mean FEV1/FVC 98.72 ± 15.86L before and 102.98 ± 14.79L after haemodialysis. Sharma et al. observed a significant increase in mean FEV1/FVC% from 97.8 ± 20.8% before haemodialysis to 99.3 ± 20.1% afterward. Similar results were reported by Lang et al. regarding changes in FEV1/FVC, Kovelis et al. noted a decrease in values post-haemodialysis. Yilmaz et al., and Navari et al. reported negative correlation in value of FEV1/FVC before and after HD. PEFR Mean peak expiratory flow rate (PEFR) increased from 59.11 ± 12.36 L/s before haemodialysis to 62.97 ± 12.01 L/s after haemodialysis ($p < 0.05$). Shailendra Mane et,al, reported mean PEFR 59.22 ± 12.54 and 63.95 ± 12.07 before and after haemodialysis. Sharma et al. reported a significant increase in mean PEFR% from 43.8 ± 30.7% before haemodialysis to 49.1 ± 29.9% afterward. Similar observations were made by Lang et al. and Yilmaz et al. in their studies.

Present study is a hospital based, prospective observational cross-section study. Enrolment period was from August 2022 to December 2023. The aim of this study was to evaluate pulmonary functions tests in CKD patients on haemodialysis. A total of 80 patients were enrolled and PFT was performed. The summary of the findings are as follows:

- Total 80 patients were enrolled, 31(38.75%) were < 45 years old and 49(61.25%) > 45 years old.
- 42 subjects (52.5%) were male and 38 were female (47.5%).
- Diabetes mellitus was the leading cause of CKD in our study (43.75%), followed by HTN (20%), DM with HTN (16%), Chronic GN (8.75%), Nephrolithiasis (3.75%) and Idiopathic (7.50%).
- On the basis of BMI, 59(73.75%) had normal BMI, 13(16.25%) were underweight and 8(10%) were overweight. The mean difference in PFTs before and after haemodialysis in both BMI 23 groups was statistically significant.
- Study included the patients of stage IV and stage V of CKD, 42(52.5%) were in stage IV and 38(47.5%) of stage V CKD. There was a statistically significant improvement in PFTs in both the stages after haemodialysis.
- 7 patients (8.75%) had been undergoing haemodialysis for less than 6 months, 31 (38.75%) for 6 months to 1 year, 36 (45.00%) for 1 to 3 years, while only 6 (7.50%) for more than 3 years. 62 individuals (77.50%) were undergoing dialysis twice a week, while only 18 (22.50%) were receiving dialysis thrice a week.
- On comparison of PFTs before and after haemodialysis on the basis of both duration and frequency, results were statistically significant.
- There was a significant improvement in Blood urea/ creatinine level after HD. The study demonstrated notable improvements in pulmonary function tests following haemodialysis. Forced vital capacity (FVC), forced expiratory volume in one second (FEV1), FEV1/FVC ratio, and peak expiratory flow rate (PEFR) all showed significant enhancements post-haemodialysis. These improvements are crucial indicators of the beneficial effects of haemodialysis on respiratory function in individuals with CKD.
- Mean FVC (L) before haemodialysis was 52.91 ± 13.39 and 57.01 ± 13.21 after haemodialysis which was significant. Mean FEV1 (L) before haemodialysis was 52.44± 13.98 and 56.78 ± 12.76 after haemodialysis which was statistically significant. Mean FEV1/FVC (L/S) before haemodialysis was 99.21± 15.81 and 103.31 ± 14.78 after haemodialysis which was statistically significant. Mean PEFR (L/S) before haemodialysis was 59.11 ± 12.36 and 62.97 ± 12.01 after haemodialysis which was statistically significant.