Research Article

A comparative study of pulmonary function in chronic kidney disease patients pre and post hemodialysis

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Abstract

Introduction: Chronic kidney disease(CKD) is a multisystem disorder, the major pulmonary alterations seen in CKD patients are obstructive disorders such as air flow limitation in distal airways and reduced pulmonary diffusion capacity. Hemodialysis can reduce the incidence and severity of many of these disturbances so much so that the overt and florid manifestations of uremia have largely disappeared in modern health setting. **Aims and objective:** The present study was undertaken to assess the changes in pulmonary function in CKD patients following dialysis. **Material and Methods:** The study was conducted on 30 patients within age group of 20-50 years suffering from ESRD undergoing regular hemodialysis for more than 3 months. Spirometry was performed on subjects before dialysis and was repeated after dialysis. **Results:** There was a significant improvement of pulmonary function, Forced Vital Capacity(FVC), Forced Expiratory Volume in first second (FEV1) and Maximum Expiratory Pressure(MEP) from pre to post dialysis. **Conclusion:** Uremia in ESRD patients causes obstructive pulmonary dysfunctions such as pulmonary edema, small air way obstruction and decreased diffusion capacity of the alveoli. Hemodialysis by removing and reducing uremic products improves the obstructive changes in the lungs. It reduces pulmonary edema (residual edema), improves pulmonary capillary permeability and elevates respiratory muscle functions.

Keywords: Chronic kidney disease, Pulmonary function test, Hemodialysis.

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INTRODUCTION

Chronic kidney disease (CKD) encompasses a spectrum of different pathophysiologic processes associated with abnormal kidney functions and a progressive decline in glomerular filtration rate[1]. It has become a major cause of global morbidity and mortality even in developing countries[2]. In this multisystem disorder, there are disturbance in fluid and electrolyte balance, cardio vascular, gastrointestinal, hematological and immunologic, neuromuscular and endocrine systems. Apart from this, the major pulmonary alteration in CKD patients is obstructive type disorders such as airflow limitations in distal airways and reduced pulmonary diffusion capacity[3, 4]. Some respiratory problems in this group of patients include coughing, wheezing, shortness of breath and sleep apnea that are mainly due to volume overload[5]. Dialysis is a process for removing waste and excess water from the blood and is used primarily as an artificial replacement for the lost kidney function in patients with renal failure. Three primary types of dialysis are hemodialysis, peritonealdialysis and hemofiltration. The decision to initiate dialysis therapy or hemofiltration in patients with renal failure depends on several factors that can be divided into acute and chronic indications. Chronic dialysis can reduce the incidents and severity of many of the above-mentioned disturbances so that the overt and florid manifestations of uremia have largely disappeared in the modern health setting[6]. However, the impact of uremia and the effects of hemodialysis treatment are not well understood. Several mechanisms may impair pulmonary function and alter bronchial responsiveness in patients on longterm regular hemodialysis treatment, some of which are trapping of neutrophils, increased extravascular lung water, left ventricular hypertrophy, anemia, metastatic lung

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calcification, malnutrition, electrolyte disturbance and iron deposition[7,8]. On the other hand, hemodialysis can result in better respiratory function[9]. Regarding this controversy about the acute effects of hemodialysis in End Stage Renal Disease (ESRD) sufferers, this study was conducted to address the definite short-term role of hemodialysis on pulmonary function tests like Forced Vital Capacity (FVC), Forced Expiratory Volume in first second (FEV_1), Maximun Expiratory Pressure (MEP) in patients with ESRD on maintenance hemodialysis for more than three months.

METHODOLOGY

Selection of participants

The study was carried out on 30 patients within age group of 20-50 years suffering from ESRD due to different etiologies undergoing regular hemodialysis for more than 3 months. The study sample was selected after screening for age, history of hypertension, cardiac or pulmonary diseases, smoking and alcohol consumption. The Ethical committee of the JSS University had approved the study and each participant provided informed consent.

Procedure

The study was conducted in the dialysis unit of JSS Hospital, Mysore. Spirometry was performed on subjects immediately before the start of dialysis and was repeated after the dialysis (within 20 mins) to observe the acute effect of haemodialysis in CKD patients using Helios 702 Medspiror. The subjects were familiarized with the set up and detailed instructions and demonstrations were given to their satisfaction. The subjects were made to breathe out forcefully following deep inspiration into the mouthpiece attached to the pneumatachometer. Expiration was maintained for a minimum period of 3-4 seconds. Three to four trials of maximal inspiration and expiratory efforts were made and the highest reading was taken for data processing. As recommended by Snowbird workshop all the readings were taken in standing position. All the tests were carried out at the same time of the day, at 12 noon and 4 pm to avoid possible diurnal variations. The tests were done in dialysis unit of nephrology department, JSS Hospital in order to alleviate the emotional and psychological stresses. During the tests, maximum effort from the subjects was ensured by adequately motivating them to perform at their optimum level. MEP was recorded through pressure vaccummeter following the same protocol.

STATISTICAL ANALYSIS

The mean and standard deviation were used for descriptive statistics. Paired t test was used for the comparison of means of pre and post dialysis values. One sample Kolmogorov- Smirnov test was used to test the normality of the data. p-values <0.05 was fixed for the statistical significance.

RESULTS

There was a significant improvement of FVC, FEV_1 and MEP from pre to post dialysis (Table 1).

Table 1: Comparison of FVC (litres), FEV_1(litres/sec) and MEP (mmHg) between pre and post dialysis session in ESRD patients

Parameter	Predialysis	Postdialysis	't' test	p value
FVC	2.10 ± 0.63	2.33 ± 0.56	-5.040	0.000*
FEV_1	1.98 ± 0.57	2.19 ± 0.50	-3.89	0.001*
MEP	35.96 ± 11.72	49.40 ± 11.96	-4.589	0.000*

All the values are mean ± SD, n= 30 in each group, *p< 0.05

DISCUSSION

Chronic kidney disease is the persistent and progressive deterioration of glomerular function rate with consequent uremic syndrome represented by a set of disorders that affect several body systems. As the life expectation of patients with chronic renal failure increases, the systemic complications of kidney disease are likely to become increasingly important. Chronic renal failure may affect virtually every system in the body, including the lungs. Pulmonary oedema and pleural effusions, attributed to fluid overload and an increase in pulmonary capillary permeability, are relatively common. Rarer complications include pulmonary fibrosis and calcification, pulmonary hypertension, haemosiderosis, pleuritis, and pleural fibrosis[10]. A study has shown that the permeability of lung capillaries for sodium and water changes when pulmonary oedema develops in renal failure. It was shown that the extravascular water space in the lung may increase tenfold when pulmonary oedema is present. The reverse process occurs when the patient recovers and the oedema disappears[11]. In hemodialysis, usually performed 3 times per week, blood is drawn out of and returned to the circulation through a variety of accesses. Uremic nitrogenous waste, potassium, phosphate, and magnesium move from blood into the dialysate down the concentration gradient, and calcium and bicarbonate (present in higher concentration in the dialysate) move into the circulation. It also corrects the fluid overload in patients with ESRD by removing enough water and salt to achieve their estimated body weight[12]. In a study, only FVC was significantly improved in patients on hemodialysis after a hemodialysis session, and the other factors, including Vital Capacity(VC), FEV_1, and FEV_1/FVC ratio, had no significant changes in comparison with the before-hemodialysis stage[13]. Hemodialysis partially replaces kidney function, reverses the uremic symptoms, and preserves the life of patients with end-stage CKD, but degenerative alterations, such as malnutrition, which can

occur in CKD patients persist worsening muscle loss and predisposing to fatigue with an increase in respiratory rate and work. The most frequent pulmonary alterations found in end stage CKD are obstructive disorders, such as air flow limitation in distal airways and reduced pulmonary diffusion capacity[14]. A study reported decreased pulmonary function in patients on maintenance hemodialysis. The findings showed that spirometry is not sensitive enough to detect lung damage in chronic kidney failure. Moreover, acute changes of spirometric parameters have been reported to be generally negligible. The probable explanation for the improvement in FVC, but not in VC after hemodialysis is an improvement in small airway resistance after hemodialysis[15]. One more study evaluated patients on hemodialysis and observed ventilation disturbances of restrictive type, which were demonstrated with a decreased VC, a reduced maximal breathing capacity, an increased residual volume and a lower FEV_1[16]. In the present study, it was observed that there is a significant improvement of pulmonary function (FEV1, FVC, MEP) in post dialysis session. The acute effect of dialysis on renal function test is highly controversial. Studies have shown that uremia resulting from CKD causes obstructive changes in the bronchoalveolar tract. Our study was done on those patients who were clinically not having pulmonary edema. That means no crackles or crepitations were found on the chest wall. Hemodialysis may improve residual edema, alters obstructive changes and helps to open closed pulmonary capillaries. Obstructive changes such as air flow limitations in distal airways and reduced pulmonary diffusion capacity have shown to have undergone improvement in post dialysis session as compared to pre dialysis in a variety of studies. How uremia alters respiratory muscle strength and the role of dialysis on respiratory muscle strength still lacks clarity. However it is time to take proper respiratory care in CKD patients to arrest the reversible pulmonary changes to the irreversible one and to do a proper evaluation as to how hemodialysis can alter respiratory functions. Thus proper respiratory care needs to be an integral part of nephrology and dialysis unit.

CONCLUSION

The pulmonary function test parameters showed a significant improvement after a session of four-hour hemodialysis. Uremia in ESRD patients causes obstructive pulmonary dysfunctions such as pulmonary edema, small air way obstruction and decreased diffusion capacity of the alveoli. Hemodialysis by removing and reducing uremic products improves the obstructive changes in the lungs, reduces pulmonary edema by decreasing pulmonary capillary permeability and also improves the respiratory muscle functions.

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