

The Effectiveness of Haemodialysis in Removing Urea and Creatinine in Patients with Chronic Renal Failure in Port Harcourt, Nigeria

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Abstract

Background: Chronic renal failure is the progressive loss of function of kidney and patient requires a long treatment in the form of renal replacement therapy. Haemodialysis is one of the renal replacement therapies, during which the body's waste products, including creatinine, urea and excess water, are removed. The purpose of the study is to elucidate the effect of haemodialysis on the removal of excess body waste and haemoglobin concentration of patients.

Materials and Methods: Seventy-four ESRD patients who are undergoing haemodialysis were randomly analyzed. 5mls of venous blood was collected from each patient pre- and post-dialysis to estimate the level of urea, creatinine and haemoglobin.

Results: Before haemodialysis, 71% of patients had serum urea level above 15 mmol/L but after the session of haemodialysis, 81% of patients had urea level below 15 mmol/L. Also, on the effect of dialysis on creatinine, it was observed that 92% had a value above 300 $\mu\text{mol/L}$ before dialysis whereas the post-dialysis creatinine value of most of the patients was reduced to below 300 $\mu\text{mol/L}$ (54%). The result also confirmed that haemodialysis is a contributing factor for chronic anaemia.

Conclusion: Haemodialysis has a positive effect on the reduction of urea and creatinine in patients with ESRD who are undergoing haemodialysis hence decreasing the burden on the Kidneys and also mortality.

Key Word: Chronic renal failure, Haemodialysis, Creatinine, Urea, End-stage renal disease

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I. Introduction

Chronic renal disease (CKD) is an increasing public health concern and it is among the most important cause of disability and death in many countries worldwide [1, 2]. Diseases of the kidney is a systemic disease that induces a slow and progressive decline in renal function due to various factors such as infection (HIV as a leading cause), hypertensive diseases, diabetes Mellitus, autoimmune diseases, cancer and nephrotoxic substances or chemicals [3]. Chronic renal failure occurs gradually over a period ranging from weeks, months, or years eventually leading to end-stage renal disease (ESRD) when the kidneys stop [4, 5].

Haemodialysis is a renal replacement therapy where urea, creatinine, electrolytes and free water from the blood are removed when there is impairment of renal function. The survival of patients with end-stage renal disease (ESRD) is made possible by removal of ureamic solutes by dialysis. The amount of dialysis that a patient receives and the amount of ureamic toxin removal can impact morbidity and mortality [6, 7].

Haemodialysis is recommended at least two to three times in a week and the time of dialysis (which is the time the patient stay on dialysis per session) ranges from two to four hours. Several factors determine the time of dialysis these include kidney function, amount of waste in the body, level of salts, co-morbidity and bodyweight yet mortality rate with haemodialysis remains high approximately eighteen to twenty percent per year due to some complication that may arise during the procedure [7].

Creatinine one of the metabolic wastes is a renal biomarker and is produced by the non-enzymatic changes of creatine and phosphocreatine in the muscles. The liver also has a significant role in the assemblage of creatinine through the process of methylation of guanidine aminoacetic acid. The normal serum creatinine level is between 60 to 110 $\mu\text{mol/L}$ [8]. Another renal biomarker is urea, which is an organic compound, playing an important role in the metabolism of nitrogen-containing compounds. The normal serum urea level is 2.5 to 7.1 mmol/L [9]. The purpose of this study was to elucidate the effects of haemodialysis on chronic renal failure patients (ESRD), removal of creatinine and urea.

II. Materials and Methods

Human Subjects

This study was a prospective study of patients living with end-stage renal disease (ESRD) who were able to undergo two or three sessions per week of haemodialysis in some dialysis centers in Port Harcourt, Rivers state. The study was conducted after ascertaining that all patients met the criteria for ESRD. The study was conducted between January and December 2019. All the patients were in stage five chronic kidney disease with glomerular filtration rate persistently below 15mls/min/1.73m² for three months and patients are already undergoing haemodialysis. Patients that had regular 4 hourly sessions of dialysis for at least twice a week in two consecutive months were also included in the study. A total of 74 out of 110 patients (67%) with ESRD met the inclusion criteria.

Sample collection

Blood sample was collected for pre and post dialysis analysis of urea, creatinine and haemoglobin, from the 74 patients. 5 ml of the blood was obtained from each patient before and after dialysis. Half of the blood was placed in tubes containing an anticoagulant (K3/EDTA) and a half in clot activator tubes. Clotted blood was centrifuged to separate serum and was used for the estimation of creatinine and urea. Non-clotted blood was used for haemoglobin in haematology analyzer Sysmex KX-21n.

Determination of Biochemical parameters

A. Creatinine estimation

Creatinine was estimated by the Jaffe reaction [10], a calorimetric procedure in which creatinine forms a yellow-orange complex in alkaline solution with picric acid. This coloured complex is determined photometrically. The intensity of the colour was measured using a fully automated Cobas C311 analyzer for detection of serum creatinine.

B. Urea estimation

Urea was measured by diacetylmonoximecolourimetric method and Berthelot reaction. In this method, the urea is converted to ammonia by an enzyme called urease. The ammonia produced is combined with 2-oxoglutarate and NADH in the presence of glutamate dehydrogenase (GDH), which yields L- Glutamate and NAD. The decrease in NADH absorbance is proportional to the urea concentration. The rate of decrease in the NADH concentration was directly proportional to the urea concentration in the serum sample which was photometrically determined using fully automated Cobas C311 analyzer [11].

Determination of Haemoglobin concentration

The mean haematological value of the packed cell volume (PCV) and haemoglobin concentration level was determined using haematology autoanalyzer (Sysmex KX-21n, Kobe, Japan) pre- and post-dialysis of all the participants [12].

III. Results

Demographic characteristic of patients

A total of 74 patients were randomly selected for this study. Venous blood samples were collected for the estimation of their serum urea level, serum creatinine level and haemoglobin level. Figure 1 showed the age and gender-wise distribution. The highest occurrence of CKD was in the age group of 51-60 with 40% (24% male and 16% female).

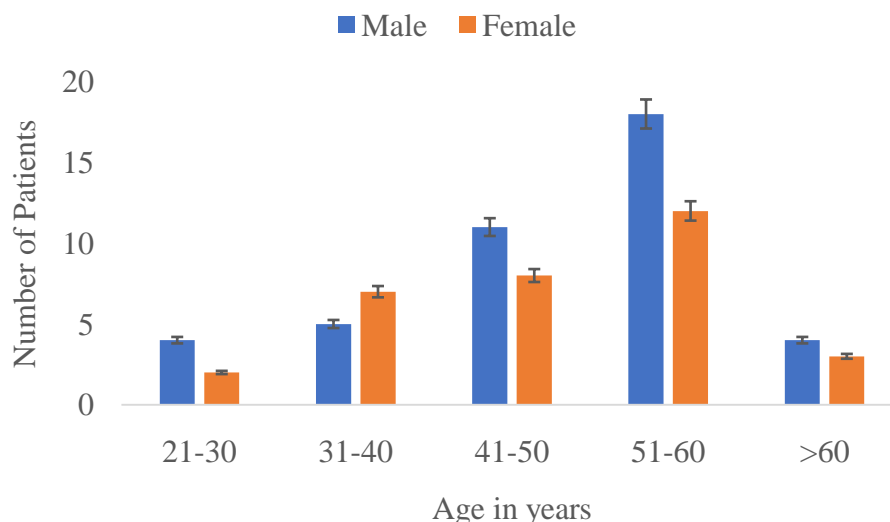


Fig 1: Age and gender wise distribution of CKD patients undergoing haemodialysis

Effect of Haemodialysis on Serum Urea Level

In chronic kidney disease (CKD) patients undergoing haemodialysis, the pre-dialysis serum urea level was significantly higher than the normal range (up to 31.8 mmol/L). Most of the patients (53 %) had a serum urea level of more than 15 mmol/L (Fig. 2). After haemodialysis there was a remarkable reduction in serum urea level as shown in Fig 2. The serum urea level in most of the patients was reduced to 6-10mmol/L (54 %) and 11-15 mmol/L (27%) and this fall below 15 mmol/L (81%) (Fig. 2).

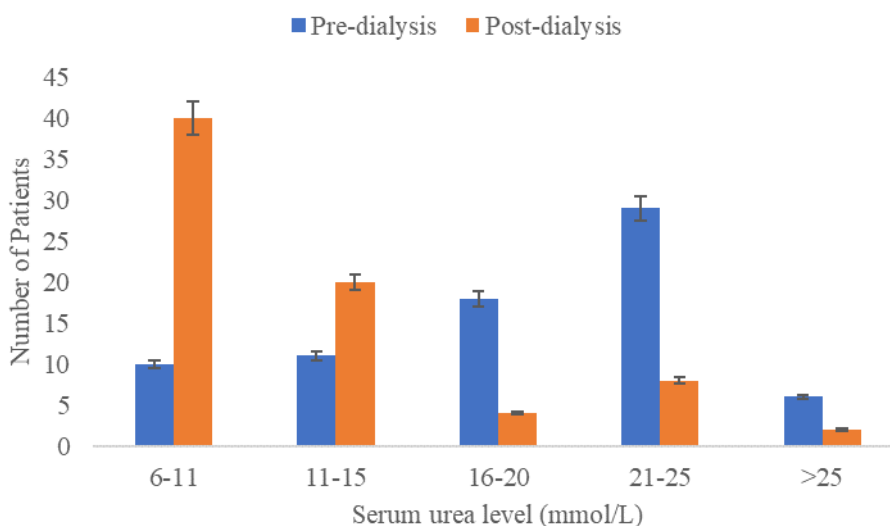


Fig 2: Pre- and Post-dialysis serum urea level of CKD patients undergoing haemodialysis

Effect of Dialysis on Serum Creatinine Level

The serum creatinine level was higher than the normal range (up to 1064 µmol/L) in CKD patients undergoing haemodialysis. Most of the patients have serum creatinine levels between 501-600 µmol/L (32%) and more than 600 µmol/L (24%) before dialysis. The result also showed that most of the patients have a serum creatinine level above 300 µmol/L (92%) pre-dialysis (Fig. 3). The haemodialysis done has a positive effect on serum creatinine levels and reduced its level towards normal value. Results showed that most of the patients (54%) had serum creatinine below 300 µmol/L post-dialysis (Fig. 3).

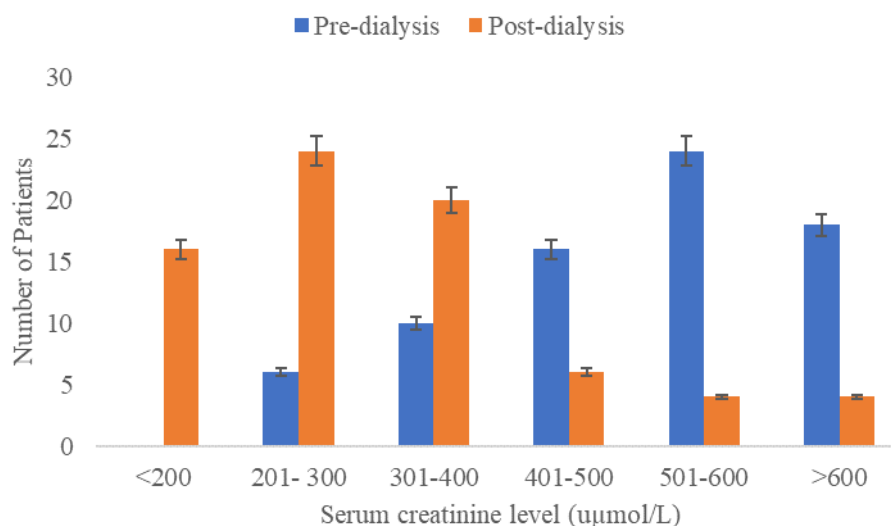


Fig 3: Pre- and Post-dialysis serum creatinine level of CKD patients undergoing haemodialysis

Haemoglobin Level in CKD patients

The haemoglobin (Hb) concentration was found to be low in chronic kidney disease patients due to removal of blood during dialysis. In the current study 60 patients (75%) had Hb between 5-11 g/dl, other 14 between 11-14 g/dl. The reduced haemoglobin level in the most case contributes to the development of anaemia.

IV. Discussion

The present study confirmed the effects of haemodialysis in urea and creatinine clearance in patients with end-stage renal disease. The result of the study shows that CKD is more come in male than female. it has been observed that people between the age of 40-60 years are more at risk of developing CKD [13]. The reason may be attributed to the increased incidence of chronic medical diseases such as hypertension, diabetes, hyperlipidemia and ag-related changes in this population.

According to a review in the USA from 1988-1994, CKD leads to chronic anaemia in most patients [16]. This is consistent with our findings in this study. Several factors may be attributed to the reduced haemoglobin concentration such as deficiency of erythropoietin, clotting of blood and blood loss in the tubing during haemodialysis [17].

During haemodialysis, excess urea and creatinine from the patient's blood are removed in order to avoid accumulation. It is observed that leafy green vegetables and meat might lead to an increase in the burden on the kidney and cause an increase in serum urea and creatinine level [18]. The haemodialysis process carried out in the studied patients was seeming to be efficient, because significantly reduced levels of creatinine and urea were recorded when comparing the pre-dialysis and post dialysis level. In a study done by Draczevski and Teixeira [19], the assessed pre- and post-haemodialysis urea and creatinine levels, reflected a substantial reduction in serum levels, indicating hemodialysis as an efficient technique.

Other factors such as timings of dialysis, patient awareness, and appropriate dialyzer and dietary habits of patients contribute to the accumulation and clearance of waste (urea and creatinine) [20]. Urea and creatinine levels are the two most important renal biomarkers as they play a crucial role in the diagnosis and follow-up of renal failure.

V. Conclusion

Patients with CKD have higher serum urea and creatinine levels. Accumulation of the waste leads to various forms of complications and worsening the progression of the disease. Haemodialysis has a positive effect on the reduction of urea and creatinine in patients with ESRD who are undergoing haemodialysis hence decreasing the burden on the Kidney and also mortality.

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