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RESEARCH ARTICLE

HEMODIALYSIS AND ITS IMPACT ON HEMATOLOGICAL COMPONENTS IN END STAGE RENAL FAILURE PATIENTS IN A TERTIARY CARE HOSPITAL IN INDIA

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ABSTRACT

Chronic kidney disease is a global health burden with a high economic cost to health system and is an independent risk factor for cardiovascular disease. The final stage of chronic kidney disease is End-stage renal disease in which the kidneys no longer function well enough to meet the needs of daily life. Dialysis is a treatment that replaces many of the kidney's important functions. Hematological profiles are the main target in renal disease and this becomes more pronounced as the disease progresses. The study was conducted in a tertiary care hospital in Southern part of India taking a sample size of about 221 ESRD patients who are on dialysis with the main objective of evaluating the impact of hemodialysis on essential blood components after dialysis. The study revealed that there was a marked decrease in Hemoglobin concentration and platelet counts in 89.1% and 97% of patients respectively. The leukocyte count increased in 81.5% of patients, decreased in 13.6% of patients and remained stable in 4.9% of patients. This study concluded that there is a noticeable effect of hemodialysis on hemoglobin concentration (Hb), red cell count, leukocytes and platelet count. Hence extreme care must be taken in screening and directing the therapy to ESRD patients on dialysis to prevent serious complications.

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INTRODUCTION

Chronic kidney disease is a medical condition characterized by a slow progressive loss in kidney function over a period of months or years (Nathan *et al.,* 2016). The two main causes of chronic kidney disease are diabetes and high blood pressure, which are responsible for up to two-thirds of the cases. Other conditions that affect the kidneys are Glomerulonephritis; Inherited diseases, such as polycystic kidney disease; Lupus and other diseases that affect the body's immune system; Obstructions caused by problems like kidney stones, tumors or an enlarged prostate gland in men and repeated urinary infections; and Malformations that occur as a baby develops in its mother's womb. As kidney failure advances and the organ's function is seriously impaired, dangerous levels of waste and fluid can rapidly build up in the body. Treatment is aimed at stopping or slowing down the progression of the disease - this is usually done by controlling its underlying cause. If chronic kidney failure ends in end-stage kidney disease (Kidneys functioning below 10% of their normal ability), the patient will not survive without dialysis (artificial filtering) or a kidney transplant (National Kidney Foundation, 2006). According the 2010 Global Burden of Disease study, chronic kidney disease was ranked 27th in the list of causes of total number of deaths worldwide in 1990, but rose to 18th in 2010. This degree of movement up the list was second only to that for HIV and AIDs. It is estimated that number of cases of kidney failure will increase disproportionately in developing countries, such as China and India, where the number of elderly people are increasing[3]. Chronic kidney disease is a worldwide health crisis. For example, in the year 2005, there were approximately 58 million deaths worldwide, with 35 million attributed to chronic disease, according to the World Health Organization[3]. In India, it has been recently estimated that the age-adjusted incidence rate of ESRD to be 229 per million population, and >100,000 new patients enter renal replacement programs annually. The prevalence of CKD was observed to be 17.2% with ~6% have CKD stage 3 or worse[4]. According to the NHS (National Health Service), UK, approximately 1 to 4 in every 1,000 British people are affected by chronic kidney disease. The average age of a British person with the disease is 77. In the UK, health authorities report that people of South Asian, African and Afro-Caribbean descent

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are at a higher risk of developing the disease, compared to other people. With the prevalence of ESRD growing at a rate between 7 and 9 percent per year, it is projected that there will be more than 350,000 such patients by the year 2018. Although the overall incidence of ESRD is 242 cases per million population per year, blacks have a disproportionately high incidence (758 per million population per year), as compared with whites (180 per million population per year). Diabetes is the leading cause in most of the patients (Jha *et al.,* 2013; Ajay *et al.,* 2013). When the kidneys don't work properly, dialysis is used to perform the function of the kidneys. Dialysis is an artificial way of purifying blood. It is a treatment that filters and purifies the blood using a machine. This helps keep the body in balance when the kidneys can't do their job. Dialysis has been used since the 1940s to treat people with kidney problems. There are two different types of dialysis: Hemodialysis (HD) and peritoneal dialysis (PD). Hemodialysis is a process that uses an artificial membrane called dialyzer to remove biological wastes from the blood, restore electrolyte balance in the blood and to eliminate unwanted fluid from the body[5]. It works on the principle of diffusion of solutes across a semi permeable membrane (dialyzer). HD is of various kinds: In-center hemodialysis, home dialysis, nocturnal hemodialysis and daily hemodialysis. Before treatment can begin, the physician will need to create a site where the blood can flow in and out of an individual's body during the dialysis sessions. This is called the dialysis access (Yasir *et al.,* 2015).

The type of dialysis access a patient will have depends in part on how quickly he/she needs to begin hemodialysis. There are three main types of access for hemodialysis namely, Fistula, graft or venous catheter. With minor surgery, an artery is joined to a vein together through anastomosis under the skin. This is called Arteriovenous (AV) fistula and is most often done in an arm. Av graft refers to a soft plastic tube that is used to join the artery and vein under the skin with the help of a minor surgery. A venous catheter refers to a catheter that is introduced into the subclavian or femoral vein. It consists of two lumens which are inserted into a large vein to allow large flows of blood to be withdrawn from one lumen, to enter the dialysis circuit and to be returned via the other lumen. Av fistula or graft are reserved for permanent access while for temporary access a shunt is created in the arm, with one tube inserted in an artery and another in a vein. The tubes are then joined above the skin. Blood needs to flow through the dialyzer for several hours to adequately clean the blood and rid the body of excess fluid. Traditional, in-center hemodialysis is generally done three times a week for about four hours each session. Treatments will be, usually between 3 to 5 hours, but most common is 4 hours (Yasir *et al.,* 2015). A dialysis machine works by pumping small amount of blood out of the body, mixes it with anticoagulant and circulates blood through a filter called dialyzer. Inside the dialyzer, a porous artificial membrane separates blood from the dialysis fluid (dialysate). Diffusion on extra fluid and wastes from the blood into the dialysate takes place after which the purified blood is then pumped back into the body (Yasir *et al.,* 2015).

The average person has about 10 to 12 pints of blood; during dialysis only one pint (about two cups) is outside of the body at a time. Dialysis machine utilizes counter-current flow i.e., dialysate is flowing in the opposite direction to blood flow in the extracorporeal circuit. Counter-current flow maintains the concentration gradient across the membrane at a maximum and increases the efficiency of the dialysis. Although hemodialysis acts as an artificial kidney, it has some risks (Yasir *et al.,* 2015). The patient could have problems with vascular access, which is the most common reason for hospitalization for people on hemodialysis. Any type of vascular access may become infected or have poor blood flow or blockage from a blood clot. These problems can keep the treatments from working. The patients may need to have more procedures to replace or repair their access for it to work properly. Rapid changes in body's water and chemical balance during treatment can cause other problems as well. Muscle cramps and sudden hypotension a drop in blood pressure are two common side effects. Hypotension can make a person feel weak, dizzy, or sick to his/her stomach (Yasir *et al.,* 2015). Kidneys normally produce a hormone called erythropoietin (EPO) which triggers the production of red blood cells in bone marrow. RBCs are the cells which carry oxygen throughout the body. As kidney function deteriorates, there is no sufficient EPO to produce red cells and thus patients with CKD experience anemia-a decreased number of circulating red cells (Inagaki, 2001). Hemodialysis also has an impact on hemoglobin concentration, white blood cells and thrombocytes (platelets) in a patient suffering with chronic renal failure leading to anemia. Thrombocytopenia is a potential side effect of hemodialysis (Yasir *et al.,* 2015; Inagaki, 2001). The main aim of this study is to determine the impact of hemodialysis on essential blood components i.e., hemoglobin concentration, number of leukocytes and platelets in patients attending a tertiary care hospital in Southern part of India.

MATERIALS AND METHODS

Study site, duration and Study population

The study was conducted on patients attending a tertiary care hospital (Malla Reddy Hospital) in Secunderabad, Suraram, Telangana state, India from January 2016 to August 2016. There were about 221 patients who accepted to participate in the study.

Inclusion criteria and Exclusion criteria

Patients with end stage renal failure and on dialysis were included in the study after obtaining informed consent from them which was written in local language for their better understanding. Patients with blood related disorders, infection or inflammation, dehydration and patients who are unwilling to participate in the study were excluded.

Method

3ml of blood was collected in aseptical environment by a trained nurse and was sent to a laboratory for complete blood count in ethylenediamine tetra-acetic acid anticoagulant containers. The blood was collected both before and after dialysis. It was 15 minutes after dialysis that the blood was collected in order to record and analyze the changes in blood components.

Data collection and analysis

Both socio demographic (age, gender, education level and occupation level) and clinical information (cause of ESRD, duration & frequency of hemodialysis and vascular access) was collected from each patient. The collected data was analyzed using Microsoft Excel and GRAPHPAD PRISM software VI.

Ethical consideration: The study protocol was approved by Human Ethics Committee of Malla Reddy Institute of Pharmaceutical Sciences.

RESULTS AND DISCUSSION

Socio demographic characteristics of study subjects

Most of the subjects affected with chronic kidney disease were in the age group of above 50 years (43.8%). 80% of the study group constituted males while females were only 20% of the total study population. Among 221 subjects, majority of them are illiterate (35.2%) and about 23.9% of them were daily workers. About three-fourth of the study group were married.

Clinical characteristics

It was known that ESRD can result from a number of reasons. In our study sample, slightly above three-fourth of individuals had diabetes mellitus and hypertension the major reason for development of renal disease (79%) and others like Glomerulonephritis accounted for only 21%.

All 221 patients have an AV fistula as a chosen type of vascular access. About 96% of patients included in the study attended for two dialysis sessions per week and the duration since which each patient attended dialysis session was categorized into three types: twelve weeks, twelve to twenty-four weeks and greater than twenty-four weeks. Maximum proportion of subjects i.e., around 82 (37.1%) were on dialysis between 12-24 weeks, 32.1% were on dialysis since more than 24 week and 30.7% were on dialysis since twelve weeks.

Effect of dialysis on blood components

This study considered the effect of hemodialysis on five main blood values: Hemoglobin, red cell count, leukocyte count, hematocrit and platelet count. It was observed from this study that there was a considerable decrease in hemoglobin concentration and platelet count in about 89.1% & 97% of study subjects respectively. In addition, RBC count and hematocrit also were reduced. In opposite to these findings, there was an increase in leukocyte count in 81.5% of patients.

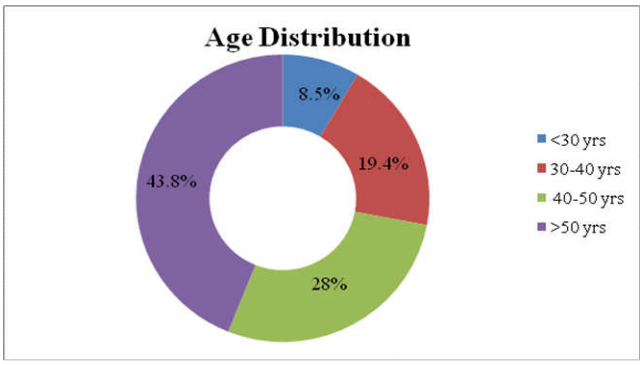

Figure 1. Age distribution

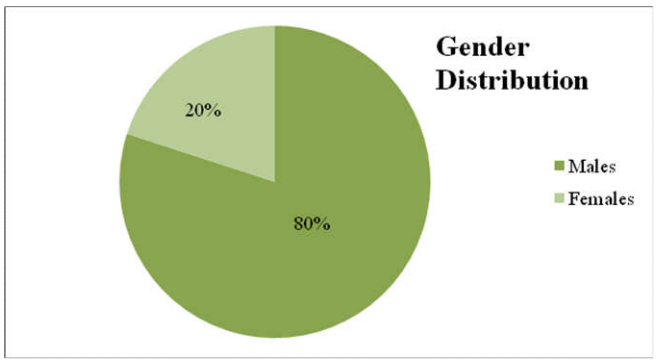

Figure 2. Gender distribution

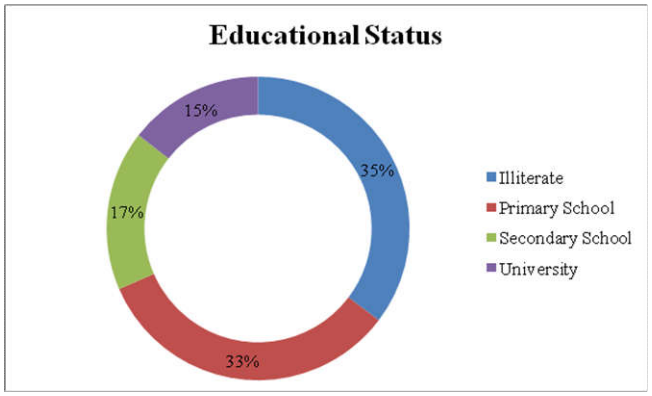

Figure 3. Educational level

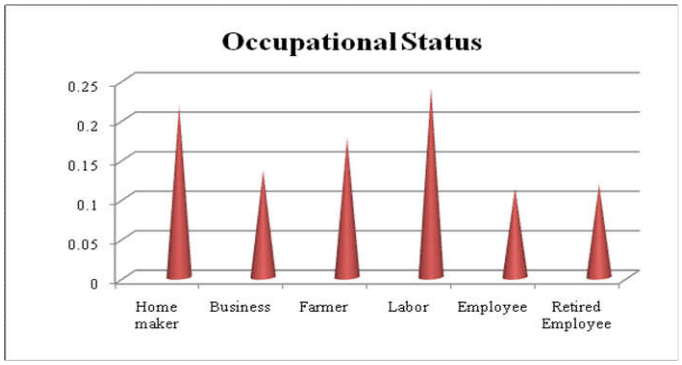

Figure 4. Occupational status

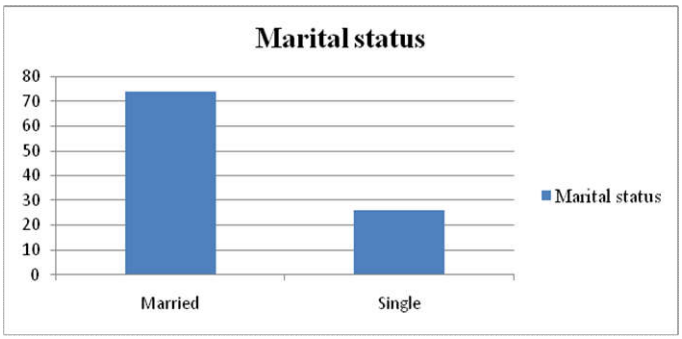

Figure 5. Marital status

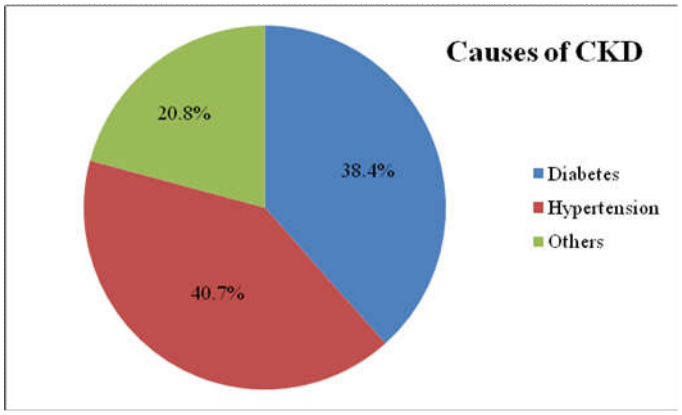

Figure 6. Causes of chronic kidney disease

With standard hemoglobin concentration of 11-18 g/dl, there were 85% of study subjects with normocytic normochromic anemia and the rest of 15% had hemoglobin concentration >11g/dl. 4.3 to 6 *106 mm^3 was considered as the normal reference range for red cell count. Generally in patients with chronic renal disease, Hb and red cell count fluctuates. In our study sample, Hb decreased (<4.3g/dl) in 89.1% people, increased in only 3.7% and remained stable in about 7.2%. While red cell count was found to be decreased in 94.6% and remained stable in 5.4% of study subjects with none of them having an increase in RBC count. As Hb and red cell count reduced, hematocrit which is the ratio of the volume of red blood cells to the total volume of blood also got reduced. Our study revealed that in patients with ESRD and on dialysis, total white blood count (leukocytes) increases. The normal reference range used was 4000 to 11000cells per micro liter. In our study sample, 81.5% demonstrated an increase in leukocyte count (Maximum value-3000cells/mcL, Minimum value-500cells/mcL), a decrease in 13.6% (decrease range-100-2000cells/mcL) and stable count in 4.9% of patients. The results indicated that dialysis patients are at an increased risk to infections. Hence, these findings suggest that total WBC count should be measured in future studies that evaluate the clinical outcome of HD patients and that dialysis patients with elevated WBC counts require further medical attention to reduce risks of mortality. A range of 130,000 to 400,000 cells per micro liter (mcL) was considered as a standard platelet count. Our study found a decrease in platelet count in majority (97%) of study population, an increase in only one patient (0.5%) and stable count in 2.5% of study subjects. The decrease in platelet count was more frequently noticed in study participants in the age group of 40-50 years (100,000/mcL) followed by the age group of above 50 years (range-1-200,000). This decrease in platelet count is called thrombocytopenia and is a potential side effect of hemodialysis.

Table I. The Effect of Hemodialysis on Blood Components

Sr. No.	Blood Component	Increase	Stable	Decrease
I	Red blood cells	None	5.4%	94.6%
II	Hemoglobin	37%	7.2%	89.1%
III	Hematocrit	None	3.1%	96.9%
IV	White blood cells	81.5%	4.9%	13.65%
V	Platelets	0.5%	2.5%	97%

DISCUSSION

The National Kidney Foundation Kidney Disease Outcomes and Quality Initiative guidelines recommend target Hemoglobin levels in the range of 11-12g/dl, whereas Hb>13g/dl should be avoided (National Kidney Foundation, 2006; Yasir *et al.,* 2015; Pastan and Bailey, 1998; Alan *et al.,* 2006). Recent Randomized Clinical Trials showed targeting Hb>13g/dl to normalize Hb in CKD may be associated with poor clinical outcomes. There are associations of blood Hb with mortality and morbidity in CKD patients. In addition, Hemoglobin over increase can be associated with various safety concerns like the development of hypertension with hypertensive encephalopathy risk, deficiency of iron, left ventricular dysfunction and thrombotic events (Weiss and Goodnough, 2005; Chi-Yuan Hsu *et al.,* 2002). In our study, only 15% of participants had Hb>11g/dl and the rest 85% with normocytic normochromic anemia. Thrombocytopenia is the most common side effect of Hemodialysis (Remuzzi, 1995; Drueke *et al.,* 2006). Platelets have been known to interact with dialysis membranes and these membranes have been shown to result in platelet adhesion, aggregation and activation (Mohsin *et al.,* 2010; Mo *et al.,* 1987). Elevated levels of thromboxane and platelet factor 4 are also responsible for platelet activation following hemodialysis. Apart from Platelet activation, complement activation too results in thrombocytopenic episodes during hemodialysis (Schafer & Hakim) (Posadas, 2011; Stewart, 1967). A study conducted by Chandrasekhar et al on 50 renal disease patients revealed that the values of hematological parameters (RBC, Hemoglobin, Hematocrit and Platelets) were decreased while the total leukocyte count is increased (Chandrasekhar *et al.,* 2012; Strippoli, 2004; Drueke *et al.,* 2006). In the present study, platelet count reduced in 97% of the study population with an increase in only one patient which is almost negligible and leukocyte count was increased (81.5%). A study conducted in Bangladesh concluded that mean hemoglobin concentration, packed cell volume and total count of red cells were lower in mild and moderate stages of chronic renal failure compared to the severe stage in which the values were even lowered (Khanam *et al.,* 2007; Hsu *et al.,* 2010). Islam MN et al study demonstrated a reduction in hematological values in renal failure and there was a negative correlation of serum creatinine with most of the hematological values but no correlation with platelet count (Islam *et al.,* 2015; Jon *et al.,* 2004). Previously published studies suggested that Hemodialysis resulted in significant prolongation in prothrombin and activated partial thromboplastin times (Mohamed Siddig Mohamed Ali *et al.,* 2008; Alghythan *et al.,* 2012; Dodds and Nicholls, 1983). In conclusion, the findings of this study suggests that dialysis, in particular Hemodialysis has a remarkable effect on blood components. The levels of Hemoglobin, Red cells, Leukocytes, platelets and Hematocrit fluctuated in patients of ESRD after Hemodialysis and there is a need of proper care to be instituted during screening and treatment of these patients as their renal function is compromised putting them at a risk of various types of morbidities. Our study might provide useful data to help health care professionals initiate some important precautions prior to Hemodialysis and also after dialysis procedure. Therefore, it is recommended that each and every patient with chronic renal disease must be screened appropriately with utmost care before and after dialysis sessions to prevent unnecessary complications and risk of morbidity, thus, improving the quality of life of CKD patients.

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Conflict of interest: None declared.

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