Haematological Changes Before And After Haemodialysis At Tertiary Care Hospital

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Abstract

Background: Over the years, the global burden of patients with renal failure continues to rise, raising the morbidity and mortality. Available treatment modalities for this include renal transplant and haemodialysis. Among these, haemodialysis remains the mainstay of treatment because of less availability of suitable donors. Hence, it is necessary to study the changes in haematological parameters during haemodialysis, to prevent complications. **Methods**: 150 patients undergoing haemodialysis were included. After obtaining their written and informed consent, their blood samples were collected in the dialysis ward, before the start of, and at the end of the procedure. Samples were labeled and processed further in the hematology laboratory. Results were noted. Pre-dialysis results were compared with post-dialysis results. Statistical analysis was performed to check if the difference was statistically significant. **Results**: In this study, a significant increase in haemoglobin concentration, RBC count, and haematocrit was observed. WBC count also increased significantly post-haemodialysis. However, there was a significant decline in platelet count after dialysis. Among red cell indices, a non-significant rise in MCV, but significant decline in MCH and MCHC values was observed after haemodialysis. A significant decline in prothrombin time was also observed. However, there was a significant rise in activated partial thromboplastin time and fibrinogen after haemodialysis. ESR value decreased significantly post-dialysis. **Conclusion**: It can be concluded that haemodialysis causes a significant change in many haematological parameters. These parameters should be regularly monitored to prevent complications like bleeding and coagulopathy, and consequently to decrease morbidity and mortality.

Keywords: Coagulopathy, Haemodialysis, Renal failure

Introduction

Acute kidney injury (AKI) and Chronic kidney disease (CKD) are global public health problems, wherein deterioration in kidney function may cause haematological and biochemical dysfunction. An estimated 5-10 million people die from acute kidney injury.[1] Renal replacement therapy (including haemodialysis, peritoneal dialysis, and kidney transplantation) is the mainstay of treatment.[2]

Haemodialysis improves the fluid environment of erythrocytes by partial correction of electrolyte disequilibrium, acid-base status and removal of a number of uremic substances, which disturb the biochemical and physical properties of cell. [3]

Considering these factors, the present study was conducted to study effects of haemodialysis on various haematological parameters.

Materials And Methods:

The present study was conducted in the Haemodialysis ward and Central Pathology Laboratory of tertiary care hospital, after obtaining ethical approval from the institutional review board. The study was conducted over a period of two years. Written and informed consents of all patients were taken. 150 patients admitted for haemodialysis and giving consent were included in the study. Patients receiving blood transfusion during haemodialysis were excluded. Each patient was included in the study only once. After taking written informed consent, in the dialysis ward, blood samples were collected in 3 vacutainers (1 EDTA and 2 citrate), before the start of, and at the end of haemodialysis procedure. These samples were immediately transported to the hematology laboratory, and processed without delay, for complete blood count (CBC), prothrombin time (PT), activated partial thromboplastin time (aPTT), fibrinogen and erythrocyte sedimentation rate (ESR). The results of these parameters before haemodialysis and after haemodialysis were noted, compared and analyzed statistically. For blood counts, 2 ml blood was collected in EDTA vacutainer. Blood was processed in the automated cell counter and verified by peripheral smear examination. Pre-dialysis and post-dialysis data regarding haemoglobin (Hb), total leukocyte count (WBC), platelet count, red blood cell count (RBC), Haematocrit (HCT), Red blood cell indices (including mean corpuscular volume [MCV], mean corpuscular haemoglobin [MCH], and mean corpuscular haemoglobin concentration [MCHC]) was obtained. For coagulation profile, 2 ml blood was collected in 3.2% sodium citrate (in the ratio of 1:9) vacutainer (blue capped). It was centrifuged. It was further processed in an automated coagulometer (Stago Compact Max), for evaluation of pre-dialysis and post-dialysis prothrombin time [PT], activated partial thromboplastin time [aPTT] and fibrinogen. For erythrocyte sedimentation rate (ESR), 2 ml blood was collected in 3.8% sodium citrate (in the ratio of 1:4) vacutainer (black capped). It was mixed properly and processed further in an automated ESR analyzer for evaluation of pre-dialysis and post-dialysis ESR.

Pre-dialysis and post-dialysis data of all the required parameters was tabulated in Microsoft Office Excel (2019) worksheet, and descriptive statistics were calculated as mean and standard deviation at 95% confidence interval. Comparison of pre-dialysis and post-dialysis groups, with regard to these parameters was carried out using Student's paired t-test. All statistical analysis was done using computer-based software Microsoft Excel Office 2019 for Windows. The difference was considered statistically significant when the calculated p-value (two-tailed) was less than 0.05.

Results:

Total 150 patients undergoing dialysis were included in this study.

Table 1: Difference between mean of Hb, WBC, Platelet, RBC & HCT before and after haemodialysis.

Parameters	Pre-Dialysis Mean ± SD	Post-Dialysis Mean ± SD	p-Value
Hb (gm/dl)	11.2 ± 2.46	11.8 ± 2.64	0.021
WBC (/mm^3)	7.89 ± 2.97	8.01 ± 3.03	0.022
Platelet count (lacs/ mm^3)	2.75 ± 1	2.66 ± 1.01	0.001
RBC (million/mm^3)	4.15 ± 0.94	4.41 ± 0.96	<0.00001
HCT (%)	35.56 ± 8.06	37.82 ± 8.6	<0.00001

Table 1 highlights the mean values of Hb, WBC, Platelet count, RBC count, and HCT parameters in the pre-dialysis group and post-dialysis group. Haemoglobin concentration was significantly increased in patients after undergoing the process of haemodialysis, compared to the value before haemodialysis. Total leukocyte count too, significantly increased after haemodialysis, compared to that before haemodialysis. However, platelet count decreased significantly post- haemodialysis, compared to pre-haemodialysis value. Furthermore, RBC count and HCT showed significant increase after haemodialysis, compared to that before haemodialysis.

Table 2: Difference between mean of MCV, MCH & MCHC before and after haemodialysis.

Parameters	Pre-Dialysis Mean ± SD	Post-Dialysis Mean ± SD	p-Value
MCV (fL)	85.86 ± 7.47	85.97 ± 7.77	0.463
MCH (pg)	27.06 ± 2.49	26.77 ± 2.41	0.004
MCHC (gm/dl)	31.56 ± 1.71	31.27 ± 1.68	0.01

Table 2 highlights the mean values of RBC indices, namely MCV, MCH & MCHC in the pre- dialysis and post-dialysis groups. MCV shows a non-significant increase post-haemodialysis, compared to the pre-haemodialysis group. MCH however, shows a significant decrease in the post-haemodialysis group, compared to the pre-haemodialysis group. MCHC also shows a significant decline post-haemodialysis, in comparison to pre-haemodialysis value.

Table 3: Difference between mean of PT, aPTT& Fibrinogen before and after haemodialysis.

Parameters	Pre-Dialysis Mean ± SD	Post-Dialysis Mean ± SD	p-Value
PT (INR)	1.16 ± 0.19	1.11 ± 0.22	0.005
aPTT (sec)	30.79 ± 11.86	37.93 ± 18.29	<0.00001
Fibrinogen (mg/dl)	478.76 ± 140.5	509.76 ± 150.47	<0.00001

Table 3 highlights the mean values of parameters of coagulation profile, namely PT, aPTT and fibrinogen in the pre-dialysis and post-dialysis group. PT shows a significant decrease post-haemodialysis, compared to pre-haemodialysis. This is in contrast to aPTT, which shows a significant increase in the post-haemodialysis patients, compared to that in pre-haemodialysis patients. Fibrinogen also shows a significant rise post-haemodialysis, compared to the value before haemodialysis.

Table 4: Difference between mean of ESR before and after haemodialysis.

Parameters	Pre-Dialysis Mean ± SD	Post-Dialysis Mean ± SD	p-Value
ESR (mm/1 hr)	37.38 ± 34.03	27.64 ± 33.1	<0.00001

Table 4 highlights the mean values of ESR in the pre-dialysis and post-dialysis groups. ESR decreases significantly after haemodialysis, compared to that before haemodialysis.

Discussion:

According to various surveys (Kumar and Jha, Clin Nephrol 2016[4], Jha et al, Lancet 2015[5]), the population prevalence of CKD in India varies from 8-17%. The number of deaths due to kidney failure in India rose by 50% over a 10-year period between 2001-03 and 2010- 13, with an age-standardized death rate of 40 per lakh population amongst the 45-69 year-olds. [6] Hence, the timely identification and management of acute kidney injury and chronic kidney disease, represent the most effective strategy to address the growing global burden sustainably.[7]

The barriers to universal transplantation as the therapy for end-stage kidney disease include economic limitations, consequences of immunosuppression, but in most cases, the shortage of donated organs, as well as the limited medical, surgical and nursing workforces with the required expertise.[8] However, patients can undergo dialysis, till a suitable kidney donor is available.

The number of patients on dialysis in India is increasing rapidly. Most haemodialysis (HD) units are situated in cities. Hence, patients from rural areas have difficulty in accessing them for regular dialysis. For such patients, home-based dialysis like peritoneal dialysis (PD) can be used. However, it is not cost- effective.[9]

Besides correcting the fluid environment of erythrocytes, haemodialysis also influences the transport of water through the erythrocyte membrane and induces morphologic and functional modifications.[10]

The present study was carried out to observe and compare the effects of haemodialysis on various haematological parameters, namely complete blood counts, coagulation parameters, and ESR, in patients on maintenance haemodialysis. Various studies have shown changes in haematological parameters in renal failure patients, compared to the control group. The process of haemodialysis further significantly changes these parameters, as observed in our study.

Effect of haemodialysis on haemoglobin:

The increase in Hb concentration in this study correlates with that of Mohammad et al. [11] and Ahmed et al. [12], but contradicts with that of Hakim et al. [13], Habib et al. [14] & Latiwesh et al. [15]

This increase in Hb concentration can be explained by the fact that haemoglobin levels are lower before dialysis, since patients are usually hypervolemic at that time. An increase in RBC count post-dialysis may also explain the increase in Hb concentration.

Effect of haemodialysis on WBC count:

The statistically significant increase in WBC count after the process of haemodialysis, in this study, correlates with that of Alghythan et al. [16], Ahmed et al. [12], Habib et al. [14], & Hakim et al. [13], but contradicts with that of Latiwesh et al. [15], as compared to pre-dialysis values.

This increase in WBC count can be explained by the fact that blood-dialyzer interaction in haemodialysis has the potential to activate mononuclear cells, leading to the production of inflammatory cytokines. The extent of interaction, however, is dependent on the dialyzer material used.[17]

Effect of haemodialysis on platelet count:
The decrease in platelet count after haemodialysis in this study correlates with that of Latiwesh et al. [15], Alghythan et al. [16], Hakim et al. [13], & Habib et al. [14], whereas contradicts with that of Ahmed et al.[12]
This decrease in platelet count after haemodialysis can be explained by the fact that dialysis membranes cause adhesion, aggregation and activation of platelets, which can be demonstrated by raised levels of platelet factor 4 and thromboxane, following haemodialysis. [18,19] Hakim and Schafer suggested that thrombocytopenic episodes occurring with haemodialysis were associated with C3a complement activation, in addition to activation of platelets themselves. Complement activation was specifically associated with cuprophane membranes. Thrombocytopenia was observed only in the presence of complement activation. [20]

Effect of haemodialysis on RBC and HCT:
The increase in RBC & HCT in this study correlates with that of Mohammad et al. [11] & Ahmed et al. [12], whereas contradicts that of Habib et al. [14], Latiwesh et al. [15] & Chowdhury et al. [9]
This increase in RBC count and haematocrit after haemodialysis in our study can be explained by the fact that RBC and HCT are lower before dialysis, since patients are usually hypervolemic at that time. Increase in HCT can also be explained by the increase in RBC count.

Effect of haemodialysis on red cell indices:
The non-significant rise in MCV and decrease in MCHC in this study correlate with that of Ahmed et al. [12], but contradict that of Chowdhury et al.[9] The decrease in MCH in studies by Ahmed et al. [12] & Chowdhury et al. [9] was non-significant, compared to significant decrease in this study.

Effect of haemodialysis on coagulation parameters:
The decrease in PT, increase in aPTT & increase in fibrinogen correlate with that of Alghythan et al.[16] Khalid et al. [6] also noted an increase in aPTT, however, an increase in PT was observed in their study.
These changes in coagulation parameters post-dialysis can be explained by use of systemic anti-coagulant (heparin) during conventional HD for extra-corporeal procedures, which binds to the enzyme inhibitor anti-thrombin III, resulting in the inactivation of thrombin and other proteases involved in blood clotting, most notably FXa. [21] Another possible factor that could account for the increased haemostasis parameters would be the elevated levels of TFPI (potent inhibitor of the extrinsic coagulation pathway) and the reduced activity of several coagulation factors during HD, including factors II, IX, X, and XII. [22, 23, 11]

Effect of haemodialysis on erythrocyte sedimentation rate (ESR):
The decrease in ESR after haemodialysis in this study correlates with that of Habib et al. [14] Decreased levels of chronic inflammatory mediators during haemodialysis may lead to a significant decline in ESR value. [14]

Conclusion:

From this study, it can be observed that it is very much crucial to monitor the platelet count, as well as coagulation parameters, in order to prevent complications like bleeding or coagulopathy. This in turn can minimize the morbidity as well as mortality in renal failure patients.

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Abbreviations:

RBC - Red Blood Cell

WBC – White Blood Cell

MCV – Mean Corpuscular Volume

MCH – Mean Corpuscular Haemoglobin

MCHC – Mean Corpuscular Haemoglobin Concentration

ESR – Erythrocyte Sedimentation Ratio

AKI – Acute Kidney Injury

CKD – Chronic Kidney Disease

HD – Haemodialysis

PD – Peritoneal Dialysis

EDTA – Ethylene Diamine Tetraacetic Acid

CBC – Complete Blood Count

PT – Prothrombin Time

aPTT – Acivated partial Thromboplastin Time

Hb – Haemoglobin

HCT – Hmeatocrit

C3a – Complement 3a

TFPI – Tissue Factor Pathway Inhibitor