ORIGINAL ARTICLE

DELINEATION OF HEMATOLOGICAL CHANGES OCCURRING IN STORED CITRATE PHOSPHATE DEXTROSE ADENINE CPDA-1 BLOOD

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ABSTRACT

Objectives: To study the changes in red cell indices and counts over a period of 42 days in blood stored in blood bags.

Materials and Methods: This research was done in Blood Bank, Khyber Teaching Hospital, Peshawar in collaboration with the main laboratory, Khyber Teaching Hospital, Peshawar. About 450 ml of whole blood was taken from 200 donors into Citrate Phosphate Dextrose Adenine blood bags. The storage temperature for the blood bags was maintained between 2–8°C. Blood samples were collected from blood bags. At days 1 and 42, using a haematology analyser, parameters including haemoglobin, RBC count, WBC count, haematocrit, mean corpuscular volume, mean corpuscular haemoglobin, mean corpuscular haemoglobin concentration and platelet counts were measured. Mean and standard deviation were used for quantitative variables. Frequency and percentages were used for qualitative variables.

Results: Through days 1 to 42, Haemoglobin (Hb) level decreased from 13.4gm/dl to 12.78 gm/dl, white cell count (WBC) decreased from 6.03x109/l to 2.95 x109/l, platelets count fell from 207 x109/l to 121 x109/l, neutrophils decreased from 59.6% to 23.8% while lymphocyte count increased from 28.36% to 66.3%.

Conclusion: There is a decrease in haemoglobin level and white cell count over a period of 42 days of storage of blood bags. Lymphocyte counts increased during the storage duration of blood bags.

Keywords: White cell Count, CPDA, Blood Bank

This article may be cited as: Idrees M, Waqas M, Rehman MU, Riaz H, Khan MI, Rahman IU. Delineation Of Hematological Changes Occurring In Stored Citrate Phosphate Dextrose Adenine CPDA-1 Blood. J Med Sci 2024 january;32(1):95-98

INTRODUCTION

Blood products collected from donors need to be stored at appropriate temperatures in Blood Banks. As per the recommendations of the FDA, the blood and products are stored for a duration of 35 days. [1] If blood products are stored for a duration beyond the recommended duration, then the risk of transfusion reaction increases. This is because of the increased incidence of haemolysis in blood bags. [1] With increased duration of storage, the capacity of red blood cells to carry oxygen also decreases. [2]

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Date Received: 28/09/2023
Date Revised: 17/10/2023
Date Accepted: 08/11/2023

If blood is stored at inappropriate temperatures or for a duration longer than recommended, there happen certain abnormal changes in the blood cells. These changes are called storage lesions. [3] The commonest storage lesion is haemolysis. As a result of the haemolysis of red cells, the contents of red cells are released into circulation. [3] The contents released into plasma include haemoglobin molecules and potassium ions. This leads to effects on several organs, the most important of which is the kidney. [4, 5]

There are various ways to store blood. Most commonly, blood is stored in a refrigerator. However, red blood cells (RBCs) can be frozen by cryoprotection with glycerol, also known as cryopreservation. Blood can be stored in a refrigerator as whole blood, or it can be divided into red blood cell concentrate (RBC) and plasma (plasma) with or without leukocytes removed. One option that is easy to use and doesn't require professional blood transfusion

equipment is to store whole blood in CPDA (Citrate Phosphate Dextrose Adenine) blood bags (4°C). However, the blood stored in these bags contains platelets as well as leukocytes which, over time, can cause oxidative damage to erythrocytes.

The blood is collected in bags that contain citrate, phosphate, dextrose and adenine as preservatives. The blood bags are therefore called CPDA blood bags. Each of the constituents mentioned has a specific function. The citrate functions to bind and inactivate the calcium and thus prevent blood clotting. Dextrose provides energy for blood cells. Phosphate maintains the normal pH of the blood. Adenine helps to increase the longevity of red cells. [6]

The blood counts and haemoglobin levels are not constant during storage duration of the blood bag in blood bank refrigerators. The blood counts change during the 42-day storage period of blood bags. There is no data available regarding how the cell counts change in blood bags over storage duration. This is why the purpose of this study is to look at the haematological alterations in whole blood collected in the CPDA-1 blood bags.

MATERIALS AND METHODS

The current study was done in Blood Bank, Khyber Teaching Hospital, Peshawar in collaboration with Main laboratory, Khyber Teaching Hospital, Peshawar. This study span was from July 2022–December 2022. Ethical approval for the study was obtained from the institutional ethical review board. The donor was laid in a transfusion chair. The needle of the CPDA bag was inserted in the antecubital vein and blood was collected in the bags. The blood bags were subjected to screening for hepatitis B, C, and HIV. The screened products were stored in refrigerators at 4C for a period of 42 days. Blood samples were drawn from blood bags on days 1, 7, 14, 21, 28, 35 and 42. The samples were run on Sysmex XP 100, Japan, a haematology analyser to determine haemoglobin levels, Red cell count, White Cell Count, platelet counts, Mean cell volume, Mean cell Haemoglobin, Mean corpuscular Haemoglobin concentration along with counts of Neutrophil, lymphocytes, Eosinophil and monocytes.

RESULTS

The white cell counts and platelet counts show a decrease with time. Haemoglobin, MCV, and Haematocrit showed rising values. Red cell count and mean cell haemoglobin were constant while MCHC decreased. Lymphocyte count increased while the counts of Neutrophils, Eosinophils and Monocytes decreased.

(Hb: Haemoglobin, WBC: White blood cells, RBC: Red blood cells, MCH: Mean corpuscular haemoglobin, MCV: Mean corpuscle volume, MCHC: Mean cell haemoglobin concentration)

DISCUSSION

A red blood cell in the human body has a half-life of about 180 days. [7] The present study showed no significant changes in Red cell count haemoglobin levels and MCH. This finding is the same as reported by Chaudhary S in 2017. [8] However, there was a sudden dip in the haemoglobin curve at day 14. A similar fall on day 14 was observed by Adias TC in his study. [9] This fall in haemoglobin is due to haemolysis during storage of the blood bags. Other contributing factors are high-temperature exposure and improper mixing of blood bags before drawing samples for haemoglobin estimation. However, this is in contrast to a study conducted in Iran which showed that MCH reduced over the storage period. [10]

No changes were seen in haematocrit value in our study. A similar finding is reported by Adias TC. [9] Abella B also reported the same findings. [11] A slow increase

Table 1: Haematological values from days 1, 7, 14, 21, 28 and 42

Parameter	Day 1	7	14	21	28	35	42	Mean value	St Deviation	sig or non sig
WBC ×10^9/L	6.03	5.3	4.73	4.01	3.66	3.49	2.95	4.10375	1.0915349	sig
RBC ×10^12/L	4.47	4.16	4.13	3.99	3.79	3.91	4.26	4.13125	0.212452201	non sig
Hb g/dl	13.4	12.9	12.3	12.5	12.6	12.8	12.8	12.7875	0.313996417	non sig
Platelets ×10^9/L	207	179	165	144	132	123	121	147.375	31.53148228	sig
Neutrophils %	59.6	51	44.3	41.56	26.23	25.53	23.83	36.883	13.21541991	sig
Lymphocytes%	28.36	40.53	42.96	48.16	52.8	56.03	66.33	50.187	12.18695589	sig
Monocytes %	6	5	5	4	3	3	3	3.87	1.26861254	non sig
Eosinophils %	4	4	3	3	2	2	1	2.62	0.992158142	non sig
MCH (FL)	32	31.6	30.9	30.4	29.6	29.2	28.7	29.975	1.448059046	sig
MCV (pg.)	92.6	95	97.7	101.2	102.8	103.9	104.1	100.4	4.470458589	non sig
MCHC (g/L)	34.6	33.7	33.2	32.6	31.5	30.2	29.4	31.675	2.100446381	sig
HCT %	36.17	36.42	37.02	38.09	39.45	41	42.4	39.196	2.525583783	non sig

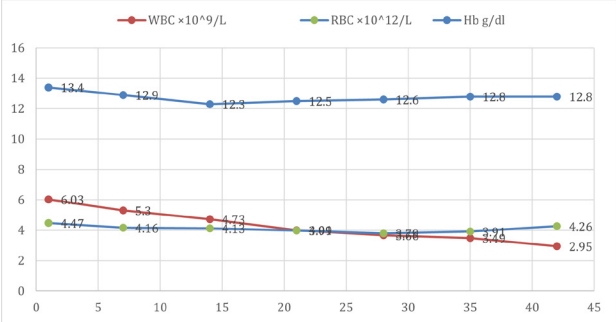

Fig 1: Changes in WBC, RBC and Hb levels from day 1 to day 42

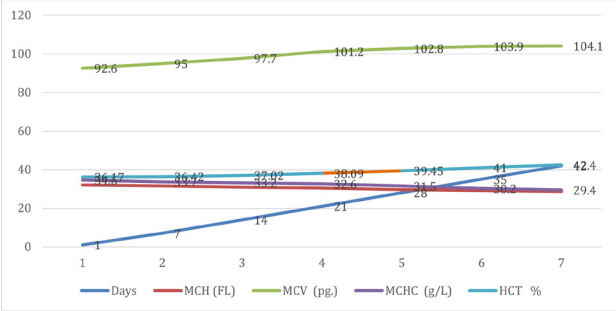

Fig 3: Changes in MCV, MCH, MCHC and HCT values from day 1 to 42

was seen in MCV value in our study. A similar trend was observed and reported by Chaudhary S. [8] An increase in MCV shows that red blood cells swell up during storage.

The study showed that there was a decrease in the value of MCHC and White cell count during the storage duration of 42 days. Similar findings are furnished by Chaudhary S. [8] Bhargava P also reported a decrease in levels of MCHC and white cell count. [11] The reason for the fall in white cell count is the depletion of ATPs in white cells.

The present study showed that polymorph nuclear cell count was decreased while Lymphocytes increased the number. Bhargava reported the same findings in his study.[12] The clinical implications of this finding are that the blood stored for transfusion may not be so effective as a clinical treatment in aplastic anaemia and other patients with leucopenia, as the most critical condition in these patients is almost always neutropenia. [13] The platelets count was decreased during the study period. A similar decrease in platelet count was found by Chaudhary S. [8] Karama also reported similar findings of low platelet count. [14] The reason for low platelet count is that the white cells release hydrolytic enzymes which cause destruction of platelets membrane and destruction of platelets. Our results are also comparable to those abstained in the L.N. Medical College study and J.K. Hospital Bhopal India, which showed a significant decrease in platelets over the

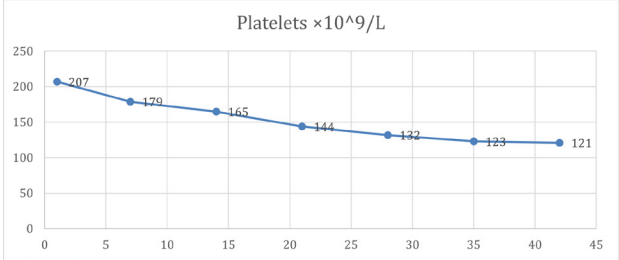

Fig 2: Changes in Platelet count

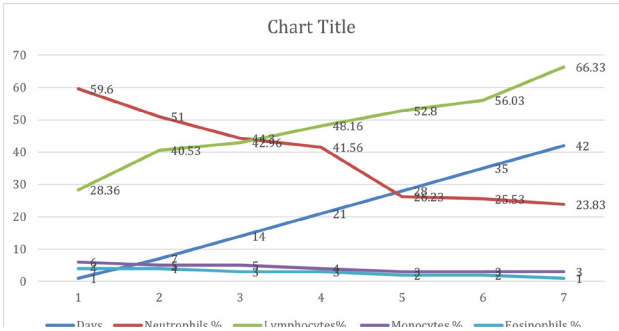

Fig 4: Changes in DLC

storage period. [15] Similar findings were observed in a study conducted by Nihal AB Almokhtar and Nour MA Ali. [16]

CONCLUSION

Most of the cellular components studied in this study show significant changes in platelets, WBCs, RBCs and indices in stored blood, particularly when stored for more than 2 weeks. The platelet counts in stored blood components displayed a significant decrease. Platelet-pheresis must be considered in patients where platelet transfusion is required. Fresh whole blood that has not been stored for longer than two weeks is advised as the best option for whole blood transfusion, yet blood components may differ on how much each blood parameter or index has changed.

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Authors Contribution:

Following authors have made substantial contributions to the manuscript as under

Authors	Conceived & designed the analysis	Collected the data	Contributed data or analysis tools	Performed the analysis	Wrote the paper	Other contribution
Idrees M	✓	×	✓	×	✓	×
Waqas M	✓	✓	×	✓	✓	×
Rehman MU	✓	×	×	✓	×	×
Riaz H	×	×	✓	✓	×	✓
Khan MI	✓	✓	×	×	✓	×
Rahman IU	×	✓	✓	×	✓	×

Authors agree to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

Ethical Approval:

This Manuscript was approved by the Ethical Board, Khyber Medical College, Peshawar Vide No. 544/DME/KMC. Dated: 18 08 2022