



HEMATOLOGICAL CHANGES DURING AND AFTER CARDIOPULMONARY BYPASS IN PATIENTS UNDERWENT VALVULAR HEART SURGERY

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Abstract:

Objective: The objective of this study is to investigate the hematological changes that occur during and after cardiopulmonary bypass in patients undergoing heart surgery. The study aims to analyze various hematological parameters, such as Hemoglobin (Hb), Activated Clotting Time (ACT), Prothrombin Time (PT), Activated Partial Thromboplastin Time (aPTT), International Normalized Ratio (INR), RBC count, WBC count, Platelet Count, Adenosine Diphosphate (ADP) induced aggregation, Arachidonic Acid (AA) induced aggregation, Fibrinogen Concentration, Albumin, Total Protein, and Urine Output.

Method: This study aimed to compare the complete blood profile of patients undergoing valvular heart surgery with cardiopulmonary bypass. Blood samples were collected at different time points, including before initiating cardiopulmonary bypass, on bypass, post CPB, and on post-operative days (POD) I, II, and III. Hemoglobin (Hb), Activated Clotting Time (ACT), Prothrombin Time (PT), Activated Partial Thromboplastin Time (aPTT), International Normalized Ratio (INR), RBC count, WBC count, Platelet Count, Adenosine Diphosphate (ADP) induced aggregation, Arachidonic Acid (AA) induced aggregation, Fibrinogen Concentration, Albumin, Total Protein, and Urine Output were measured and compared between the study and control groups. Additionally, post-operative chest drain outputs were monitored in the intensive care unit. The study's findings provide valuable insights into hematological parameters in patients undergoing valvular heart surgery with cardiopulmonary bypass.

Result: This study analyzed hematological indicators in heart surgery patients with cardiopulmonary bypass. Haemoglobin, clotting factors, blood counts, and platelets showed significant changes during and after surgery. Heparinization maintained clotting time, but haemoglobin levels declined. Red blood cells disintegrated due to poly vinyl tubing, suggesting the use of silicon tubing. Surgery induced inflammation affecting white blood cells and platelets, but they returned to normal by postoperative day two. Prothrombin time and international normalized ratio were significantly impacted, especially in mechanical valve replacements.

Keywords: *Valvular heart surgery, Cardiopulmonary bypass, Hematology, Complete blood profile*

Introduction:

Deoxygenated blood is removed from the venous system and returned to aorta through the Cardiopulmonary Bypass (CPB). Heart and lung function are replaced by CPB [1,2]. A roller (twin roller) or centrifugal pump is typically positioned close to the membrane oxygenator. [3,4,2] Blood from the heart is drained by gravity through cannulas placed in the superior and inferior vena cavae or right atrium to the venous reservoir. Gas exchange relies heavily on membrane oxygenators [1,3,5].

Additionally, a variety of different disposables, including reservoirs, oxygenators, bubble traps, blood cardioplegia chambers, tubings, and connectors, are utilised for connections. The reservoir is filled with a variety of fluids, such as crystalloids and blood, as well as medications [5].

Hematology

The human body's arteries and veins carry blood, a vital fluid that transports nutrients and other essentials to all the body's tissues and organs [6]

Functions

The purpose of blood is to transfer nutrients to the cell and oxygen- carbon di oxide exchange in capillaries, as well as waste products like urea, ammonia, and carbon dioxide. Blood also aids in regulating body temperature.

Plasma makes up 55% of blood and blood cells make up 45% of blood. 91% of plasma is made up of water, 7% of it of proteins, and 2% of other things. About 99% of the blood's cells are red blood cells, with the remaining 1% being platelets and white blood cells [6]

Plasma serves as the medium for carrying proteins, hormones, and other nutrients throughout the body. its role is to maintain oncotic volume and pressure, to supply clotting agents, to provide an immunological response, and to exchange sodium chloride and potassium in the body to maintain electrolyte balance. plasma is composed of approximately 91% water, 7% proteins, and 2% miscellaneous components [7]

About 95% of a red blood cell is made up of the protein component haemoglobin. Healthy adult males usually have haemoglobin levels between 14 and 18 grammes per deciliter (g/dL), whereas healthy females typically have levels between 12 and 16 g/dL. Haemoglobin makes up about 280 million molecules per red blood cell. The two primary components of haemoglobin are: the globin portion, which is made up of four polypeptide chains called "globin chains," and the haemoglobin portion. The second element is the core molecule known as the heme group molecule, which gives blood cells their red colour. Iron (Fe²⁺) atoms are found in each of the four units that make up the Heme group. Four protein chains make up the globin component [6,7]

The bone marrow produces platelets, also known as thrombocytes, from stem cells. Platelets are fragments of cytoplasm without nuclei. Their average life span is nine to ten days. Platelets, which are the smallest blood components, have a diameter of roughly 2-3 μ m. To stop bleeding at the site of wounds, coagulation factors and platelets collaborate to form hemostasis. They adhere to blood vessel walls and repair vascular wall tears, encouraging the growth of blood clots to stop excessive bleeding. Between 150,000 to 350,000 platelets per cubic centimetre of blood are considered normal [8]

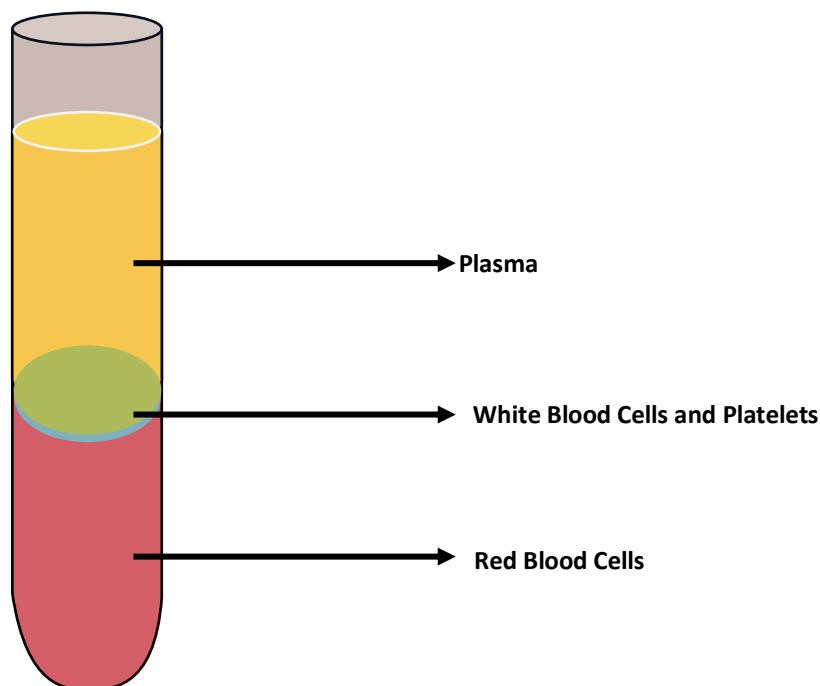


Figure 1- Components of blood

Hematologic changes

Cardiopulmonary bypass (CPB) causes a hemostatic defect that increases morbidity and mortality and can result in severe postoperative bleeding[7] Although there have been a few reports of hemostasis changes with CPB [7-11] it is now believed that the main defect in hemostasis after the institution of CPB is a defect in the formation of the platelet plug manifested by an extension of the template bleeding time[9,10,12-18]

Materials and methodology

This prospective observational study was conducted on patients who required On-bypass cardiac surgeries. The study involves 20 patients underwent cardiac surgeries with the use of cardiopulmonary bypass. The inclusion criteria included patients aged 19 to 70 years with normal hemoglobin levels, of any gender. On the other hand, patients with impaired left ventricular function, emergency surgeries, anemia, and those above 70 years of age were excluded from the study. The equipments used in this study are heart lung machine-Stockert S-III and Sarns 8000, Membrane oxygenator-Sorin inspire- 6F, Adult filter –bubble trap named Spictra AF, Custom pack named BL life sciences, Cardioplegia reservoir named Spictra.

Methodology

All study participants get the standardized anaesthetic methods. Vecuronium promotes relaxation while midazolam and fentanyl are used to induce general anesthesia. Fentanyl is used during the procedure to maintain intravenous anesthesia. Either a median sternotomy or a minimally invasive procedure was used for all patients' routine valvular heart surgery. Heparin is delivered intravenously at a dosage of 400 IU/kg. The commencement of cardiopulmonary bypass occurs when the activated clotting time gets higher than 480 seconds. A Sans 8000 perfusion pump, a Spectra AF arterial line filter, and a Sorin Inspire adult membrane oxygenator are used to perform extracorporeal circulation. The flow rate of non-pulsatile perfusion is kept between 2.2 and 2.4 l/m²/min.

The perfusionist uses a computer-generated random number chart to patients. The circuit is primed with one litre of Plasmalyte A solution, three milligrams per kilogramme of 20% mannitol, and 10,000 IU heparin. Packed red cells are added if necessary, and the hematocrit is kept between 20% and 25%. During CPB, the mean arterial pressure (MAP) is maintained between 40 and 60 mmHg. The management of acid-base balance involves the Alpha-stat. All patients in this study were cooled down to 28°C. Following aortic cross-clamp, intermittent antegrade cold blood cardioplegia which is given at 08–10 °C is used to protect the myocardium. Rewarming is started before removing the aortic cross-clamp, and patients are warmed to 37 °C. Protamine sulphate injections (dosage of 1–1.3 mg for every 100 IU of heparin) are used to reverse heparinization. After surgery, patients are weaned off CPB once their hemodynamics are stable, and they are then moved to the Cardiothoracic Intensive Care Unit.

Blood samples are collected at various time points: before initiating cardiopulmonary bypass, on bypass, post CPB, and on post-operative days (POD) I, II, and III. The parameters observed include Hemoglobin (Hb), Activated Clotting Time (ACT), Prothrombin Time (PT), Activated Partial Thromboplastin Time (aPTT), International Normalized Ratio (INR), RBC count, WBC count, Platelet Count, Adenosine Diphosphate (ADP) induced aggregation, Arachidonic Acid (AA) induced aggregation, Fibrinogen Concentration, Albumin, Total Protein, and Urine Output. Post-operative chest drain is also monitored in the intensive care unit.

Statistics

SPSS 16.0 was used to analyse the data that had been collected. The frequency analysis, percentage analysis, mean, and standard deviation of the data were used. Paired sample t-test for parametric data to determine the significance difference between the bivariate samples in paired groups (ON& POD). The probability value P0.05 is considered as a significant threshold in all the mentioned statistical methods.

Demographic data:

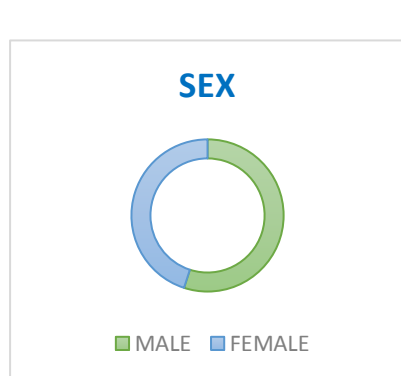


Figure 2- Sex

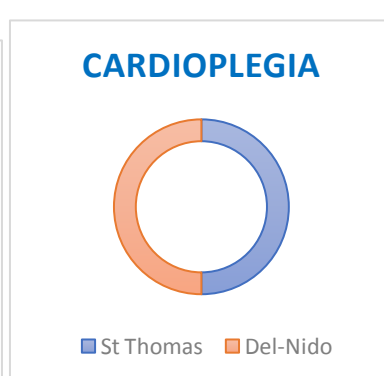


Figure 3- Cardioplegia

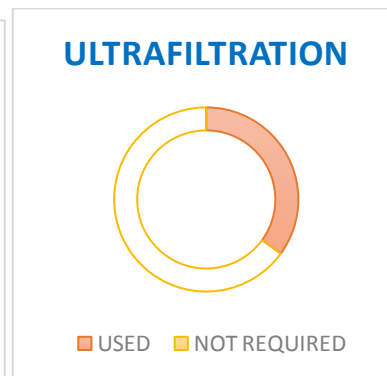


Figure 4- Ultrafiltration

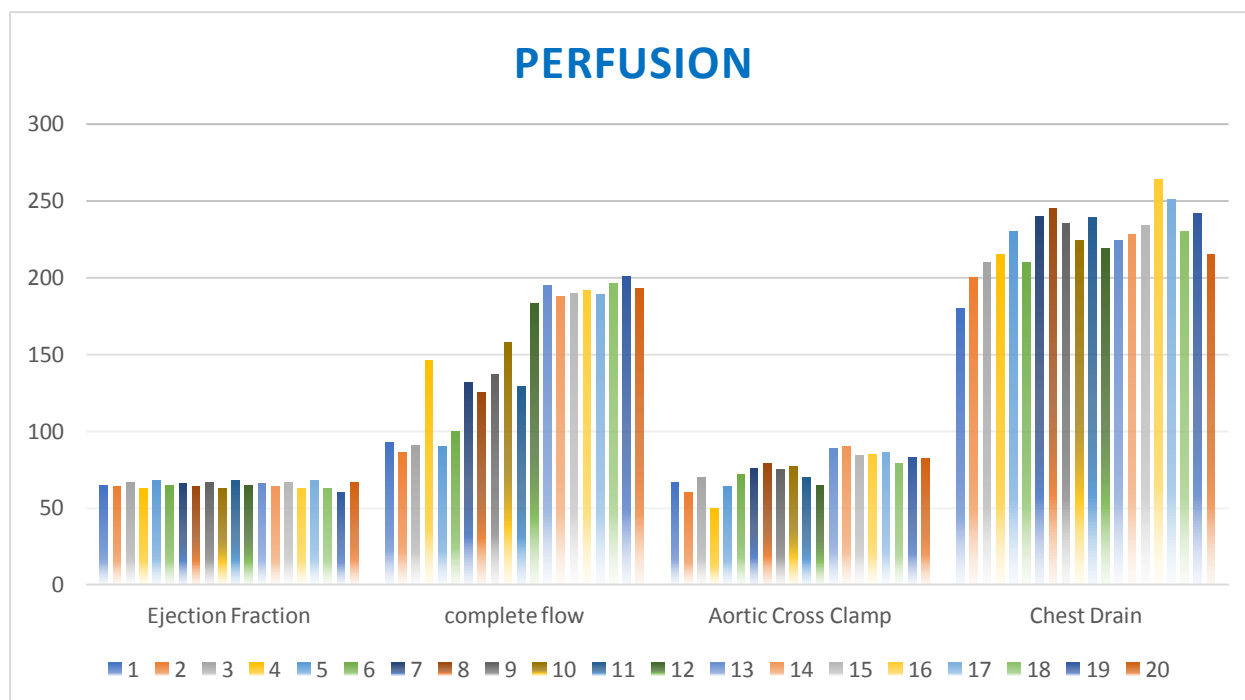


Figure 5- Ejection fraction, Complete flow, Aortic cross clamp, Chest drain- Column graph

Hematological parameters

Parameters	Pre- OP	ON- CPB	Post CPB	POD
Hemoglobin (g/Dl)	13.6	11.4	12.4	12.5
Activated Clotted Time	937.65	933.75	165.65	159
Prothrombin Time	14.15	Not- monitored	23.85	21.35
Activated Partial Thromboplastin Time	41.3	Not- monitored	47	44.7
International Normalized Ratio	1.5	Not- monitored	1.5	2.2
Red Blood Cells	5.3	4.21	4.24	6.1
White Blood Cells	8.64	10.46	12.9	13.17
Platelets	367	171.35	221.9	322
Albumin	3.69	4.30	4.27	4.12
Urine output	0	0.171	1.82	1.939

Table 1

Graphical Representation- Hematological parameters

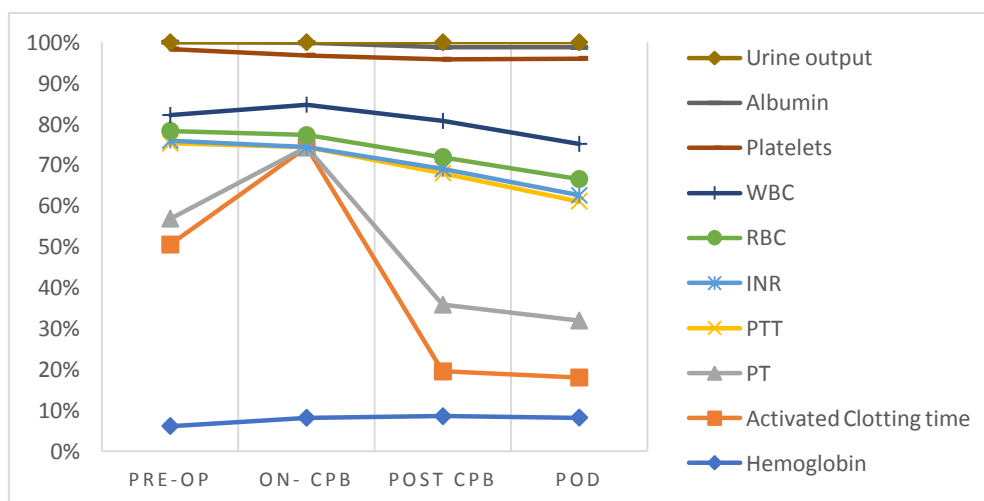


Figure 6- Hematological parameters

DISCUSSION:

All twenty participants who participated in our prospective trial study received standardized General anesthesia. Intravenously, heparin was delivered at a dosage of 400 IU/kg. Cardiopulmonary bypass was initiated when the activated clotting time exceeded 480 seconds. Complete blood cell count (CBC) with Hct, PT, aPTT, and INR were assessed using conventional laboratory procedures prior to surgery (preoperative) and on the first, second, and third postoperative days (1st, 2nd, and 3rd POD), respectively. These haematological parameters were taken into consideration in this investigation. Enabled clotting Time, The monitoring of arterial blood gases occurred both before and during cardiopulmonary bypass. Aortic cross clamp time and the length of cardiopulmonary bypass are also considered. All patient data, including the kind of operation, the patient's age, sex, clinical factors, preoperative drugs, intraoperative blood loss and transfusion, and any intraoperative problems, were documented. Additionally noted are the amount of blood transfused and postoperative blood outflow.

All data were collected, compiled and then statistically analyzed using SPSS 16.0 version, paired P test done accordingly. P value In our study, Group of 35% underwent Double Valve Surgery (DVR), 30% underwent Aortic Valve Replacement (AVR) and 35% were Mitral Valve replacement (MVR) surgeries. St-Thomas solutions and Del-nido cardioplegia were given for myocardial protection. According to statistical analysis mentioned above hemoglobin, red blood cells and albumin were significant; whereas there was more significant difference in Activated Clotting Time, prothrombin time, partial thromboplastin time, international normalized ratio, white blood cells and platelets. in this study 7 patients required ultrafiltration, So ultrafilter was connected to the reservoir.

RESULT

Haematological indicators such haemoglobin, activated clotting time, prothrombin time, partial thromboplastin time, international normalised ratio, total blood count, platelets, and albumin showed substantial alterations in this study. Heparinization kept the ACT above 480 seconds as haemoglobin steadily declined throughout surgery. Poly vinyl tubing in the double roller pump during CPB caused red blood cells to disintegrate; this tubing can be replaced with silicon in the roller pump. Due to SIRS, there was an increase in white blood cell counts and a reduction in platelets during surgery. However, following the second postoperative day, the fluctuation in these parameters returned to normal; the prothrombin time, partial thromboplastin time, and international normalised ratio that were measured after surgery revealed grave significance. International normalised ratio is eventually kept above 1.5 following mechanical valve replacement procedures.

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Conflict of interest: None declared

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