ORIGINAL ARTICLE

Effect of plateletpheresis on haematological values in voluntary donors: a retrospective data analysis over an eight-month period

Gorana Ahmetović-Karić, Elma Ćatović-Baralija, Kenan Mehić

Department for Hemapheresis with Tissue Bank, Blood Transfusion Institute of the Federation of Bosnia and Herzegovina

ABSTRACT

Aim To analyse changes in haematological values after plateletpheresis in donor population with regard to donor safety.

Methods A retrospective study was conducted on first time and repeated healthy donors over a period of eight months in the Blood Transfusion Institute in the Federation of Bosnia and Herzegovina in Sarajevo. A total of 75 plateletpheresis procedures performed using Amicus continuous flow cell separator were evaluated. Various pre- and post-donation haematological values were measured in all donors: haemoglobin concentration (Hb), haematocrit (Hct), red blood cell count (RBC), platelet count (PLT), white blood cell count (WBC), mean platelet volume (MPV), mean corpuscular volume (MCV), mean corpuscular haemoglobin (MCH), and mean corpuscular haemoglobin concentration (MCHC).

Results A significant decrease in post-donation Hb, Hct, RBC, PLT, MCHC ($p<0.000$) and WBC ($p=0.003$), and a significant increase in MPV ($p=0.011$) and MCV ($p<0.000$) was found. Percentage reduction of haematological parameters Hb, Hct, RBC, PLT, WBC and MCHC decrease of 6.6%, 6.5%, 5.9%, 24%, 4.6% and 0.3%, respectively, in their respective count was noted post-donation. Eight (11%) donors had a post-procedure platelet count less than 150x10e9/L. Twenty two donors (29%) experienced mild side effects due to hypocalcaemia.

Conclusion Plateletpheresis procedures are generally safe and well tolerated, without evident associated clinical manifestations on healthy donors.

Key words: complete blood count, cell separator, donor safety

Corresponding author:
Gorana Ahmetović-Karić
Department for Hemapheresis with Tissue Bank, Blood Transfusion Institute of the Federation of Bosnia and Herzegovina
Čekaluša 86, Sarajevo,
Bosnia and Herzegovina
Phone: +387 33 567 327;
Fax: +387 33 567 333
E-mail: gogaahmetovic@live.com
ORCID ID: https://orcid.org/0000-0001-9736-6196

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INTRODUCTION

Plateletpheresis is a procedure where the whole blood is processed from a donor and the platelets are separated, while the remaining constituents are returned back to the donor (1). The cell separator has been used as a primary tool for collecting platelets (1-4). Single donor platelets are preferred over random donor platelet products mainly for reducing the risk of transfusion reactions and disease transmission by blood transfusions, and they provide a sufficient therapeutic dose for a patient (1,4-6). In plateletpheresis procedure platelets are removed either from random volunteer donors, patient's family members or human leukocyte antigens (HLA) system matched donors (7). The new generations of cell separators have made it possible to obtain a high quality of platelets with minimum donor manipulation (4,5). The increase in different medical indications for platelet transfusions led to an increase in the use of plateletpheresis (6). Haematological values changes are seen post donation in plateletpheresis (2). The repeated plateletpheresis procedures can lead to significant cell loss and clinical problems in donors such as transient thrombocytopenia and anaemia (8). Previous studies have provided conflicting data of haematological values changes after plateletpheresis (1-4).

The safety of donors in blood transfusion centres is an important factor aimed at maintaining continuity in the arrival of donors and their return to donation. There are no any studies on this topic in Bosnia and Herzegovina (B&H). In presented study, a focus was on the donor safety during and after the plateletpheresis procedure related to the parameters resulting from it, so it seems important to share experience in performing this kind of the procedure in the donation process to the local and general professional community.

The aim of this study is to analyse the changes in haematological values after plateletpheresis in our donor population with regard to donor safety in terms of lowering blood parameters and their eventual clinical manifestations.

PATIENTS AND METHODS

Patients and study design

This retrospective study was conducted on first time and repeated healthy donors during eight months (between February 2023 and September 2023) at the Department for Hemapheresis with Tissue Bank in Blood Transfusion Institute of the Federation of Bosnia and Herzegovina in Sarajevo, including analysis of 75 plateletpheresis procedures. There were 73 (97%) male and two (3%) female donors with median age of 34 years (range 28-43 years), median weight of 90 kg (range 82-104 kg), and median height of 183 cm (range 178-189 cm).

Each donor met institutional standard eligibility criteria for blood donation contained in the questionnaire filled out by each donor, including a consent for donation. Standard analyses that include pre-donation and post-donation haematological parameters were performed during the plateletpheresis procedure in voluntary donors. The research is approved by the Expert Council of the Blood Transfusion Institute of the Federation of Bosnia and Herzegovina.

Details of plateletpheresis were explained to each donor for blood donation with additional criteria: haemoglobin levels ≥12.5 g/dL, predonation platelet count >190x10e9/L, avoiding intake of acetylsalicylic acid or nonsteroidal anti-inflammatory drugs for at least 3 days, female donors with no history of previous pregnancy or miscarriage, time interval of at least one month from last donation, adequate venous access. Only procedures for donors in whom post-donation haematological values were performed during the study period were included in the analysis.

Methods

All procedures were carried out using continuous flow cell separators Amicus (Baxter, Lake Zurich, IL, USA, software version 3.21; Fenwal Inc., Lake Zurich, IL, USA, software version 4.4); Fresenius Kabi, Bad Homburg, Germany, software version 4.4) with platelet collection protocol in accordance with the work procedure of the institution.

All plateletpheresis procedures were performed using closed system apheresis kits (Fresenius Kabi, Bad Homburg, Germany) with a single needle. Donors were connected to the cell separator by their peripherally veins, and the most adequate peripheral vein was chosen to perform the procedure. During this procedure, anticoagulated whole blood enters the separator, then using centrifugal separation a certain amount of

platelets and plasma is separated, and the rest of blood components are returned to the donor. Using single needle kits, the same line was used to withdraw blood out of the donor and into the separator, and also to return the processed blood back to the donor. Extracorporeal anticoagulation was achieved with anticoagulant citrate dextrose solution A (ACD-A) in the proportion 1:10 (anticoagulant : whole blood). The end point of each procedure was based on the target yield of 2-3.5x10e11 platelets per unit of the final product in autologous plasma set by the operator. Processed blood volume to attain the target platelet yield was calculated by the cell separator. Then, platelet units were stored at 22-24 °C under continuous agitation in a platelet incubator. Respective blood samples were obtained from each donor for immunohematological and blood transmissible disease analyses.

Whole blood was taken into two ethylenediamine tetraacetic acid (EDTA) vials (3 mL): one just before the procedure from a vein that was not be used during the procedure and the second one from the input vein after the procedure, after 3 mL of blood in a test tube was taken, from which no measurements were performed. Pre- and post-donation haematological values of haemoglobin concentration (Hb;), haematocrit (Hct), red blood cell count (RBC), platelet count (PLT), white blood cell count (WBC), mean platelet volume (MPV), mean corpuscular volume (MCV), mean corpuscular haemoglobin (MCH) and mean corpuscular haemoglobin concentration (MCHC) were measured on automated haematology analyser, Sysmex XS-500i (Sysmex Co, Tokyo, Japan).

Percentage reductions of haematological parameters were calculated as follows:

pre-donation count – post-donation count / pre-donation count x100.

Side effects from the blood anticoagulant may include slight tingling/paresthesias around mouth, chest vibrations and a feeling of cold or chill. Calcium (one-two effervescent tablets, 500 mg) was given if any of these symptoms occurred.

Statistical analysis

The distribution of data from the study was tested for normality. Data were expressed as arithmetic means ± SD (standard deviation) or medians with a range depending on the data distribution. Significance of the difference in peripheral blood parameters before and after the procedure was analysed by parametric paired t-test and non-parametric Wilcoxon matched pairs test. For all comparisons, the level of statistical significance was $p<0.05$.

RESULTS

Seventy five plateletpheresis procedures were performed within the study period. Eight donors donated platelets for the first time. Most donors, 23 (30%), were AB+ blood type (Table 1).

Table 1. Characteristics of 75 donors

Variable	
	Median (range)
Age (years)	34 (28-43)
Weight (kg)	90 (82-104)
Height (cm)	183 (178-189)
	No (%) of donors
First time donors	8 (11)
Gender	
Male	73 (97)
Female	2 (3)
Blood groups distribution	
A+	3 (4)
A-	3 (4)
O+	19 (25)
O-	11 (15)
B+	5 (7)
B-	2 (3)
AB+	23 (30)
AB-	9 (12)

The mean blood volume processed during plateletpheresis procedures was 2164 mL (1488-2677 mL) in mean time duration of 42 min. (30-53 min.). In the majority of donors, 40 (53%), the set amount of platelets to be collected was in the range 2-3x10e11 per unit (Table 2).

Table 2. Plateletpheresis characteristics

Parameter	Value
Mean±SD blood volume processed (range) (mL)	2164±240.1 (1488-2677)
Mean±SD processing time (range) (min)	42.3±4.8 (30-53)
Mean±SD ACD-A (range) (mL)	266.2±23.2 (207-320)
Saline used (median) (mL)	423-446 (434)
Platelet yield (No, %) (x10e11/unit)	
2-3	40 (53%)
3-3.5	35 (47%)

Significant reduction was found between the mean of pre- and post-donation for Hb (15.1 g/dL and 14.1 g/dL), Hct (42.9% and 40.1%), RBC (5.1x10e12/L and 4.8x10e12/L), PLT (220x10e9/L and 168x10e9/L), WBC (6.5x10e9/L and 6.2x10e9/L), MCHC (35.2 g/

dL and 35.1 g/dL), respectively, and significant increment for MCV (84.1 fL and 84.6 fL) and MPV (9.5 fL and 9.6 fL), respectively (Table 3).

Table 3. Comparison of haematological parameters before and after plateletpheresis

Parameter	Reference values	Pre-donation	Pre-donation	p
		Mean±SD (range)		
Hb (g/dL)	13.0-18.0	15.1±0.9 (12.9-17.3)	14.1±0.9 (12.4-16.0)	<0.000
Hct (%)	40.0-54.0	42.9±2.5 (37.6-48.5)	40.1±2.5 (35.6-46.5)	<0.000
RBC (x10e12/L)	4.00-5.70	5.1±0.3 (4.3-5.8)	4.8±0.3 (4.1-5.6)	<0.000
WBC (x10e9/L)	4.00-10.00	6.5±1.3 (4.1-10.8)	6.2±1.6 (3.7-11.0)	0.003
MCV (fL)	86.0-100.0	84.1±3.0 (78.1– 94.0)	84.6±3.1 (78.0-94.0)	<0.000
MPV (fL)	7.4-10.4	9.5±0.7 (8.1-11.0)	9.6±0.7 (7.9-11.2)	<0.011
MCHC (g/dL)	31.8-35.4	35.2±0.9 (32.9-37.1)	35.1±0.8 (32.8-37.1)	<0.000
		Median		
PLT (x10e9/L)	150-400	206-250 (220)	156-187 (168)	<0.000
MCH (pg)	27.0-31.0	29.0-30.2 (29.4)	29.0-30.1 (29.5)	0.289

SD, standard deviation; Hb, haemoglobin concentration; Hct, haematocrit; RBC, red blood cell count; PLT, platelet count; WBC, white blood cell count; MCV, mean corpuscular volume; MPV, mean platelet volume; MCH, mean corpuscular haemoglobin; MCHC, mean corpuscular haemoglobin concentration;

Following plateletpheresis, there was a significant decrease in Hb, Hct, PLT, RBC, MCHC ($p<0.000$) and WBC in donors ($p=0.003$), and a significant increase in MCV ($p<0.000$), as well as in MPV ($p=0.011$). However, insignificant changes in MCH were observed (Table 3). Percentage reduction of haematological parameters, Hb, Hct, RBC, PLT, WBC and MCHC was calculated and a decrease of 6.6%, 6.5%, 5.9%, 24%, 4.6% and 0.3% in their respective count was noted post-donation.

Eight (11%) donors had a post-procedure platelet count less than 150x10e9/L, and their pre-donation values ranged from 191x10e9/L to 222x10e9/L. Five of them had pre-donation values of less than 200x10e9/L, and six were repeated plateletpheresis donors.

Thirty five (47%) donors donated platelets more than once during the study period. Out of these 35, 20 donors had donated platelets twice, nine donated three times and six donors donated platelets four times during this period, but not all donors were evaluated for post-donation haematological values after each procedure. Ten (13%) donors donated platelets and whole blood during the study period, eight of which had donated platelets once and whole blood once, while two donated platelets once and whole blood twice; in all of them, pre-donation haematological parameters were satisfactory, while in three donors, post-donation platelet values were less than 150x10e9/L, with their pre-donation values of 191x10e9/L and 197x10e9/L, respectively. Two of them were donors who donated blood twice in the study period.

Twenty two (29%) donors were treated with oral calcium tablets during or after the donation due to perioral paresthesias/tingling symptoms.

DISCUSSION

In the present study, we noticed a statistically significant decrease of post-donation Hb, Hct, RBC, PLT, WBC and MCHC. The reduction of haematological values in donors after plateletpheresis has also been reported by other authors (1,3, 8-13). The decrease in values in our study could be a result of infusions of anticoagulant solutions and normal saline during the procedure, and due to blood loss in the residual volume of apheresis kit or the reason could be the mechanical haemolysis that may occur due to squeezing of the blood tubes by device pumps (1,2,3,8). Although a decrease in haematological parameters was found (1,3,8-13), a study by Lewis et al. (12) did not show significant changes in Hb, Hct, and WBC after plateletpheresis. However, Sachdeva et al. (4) showed a significant increase in haemoglobin concentration after each procedure, which was explained as being due to the concentrated red cells that were transferred back to the donor and the plasma retained at the end of the procedure, as the sample was taken immediately after the procedure. Also significant increase in haemoglobin and haematocrit values after plateletpheresis was reported, but without any specific explanation (14). This difference in results may be explained by certain time between the end of the procedure and obtaining a sample, which allowed physiological mechanism to come into action, or as a results of using different cell separators (4).

A significant increment between pre- and post-donation for WBC and neutrophils in donors undergoing plateletpheresis was reported (14); similarly, another study (2) also noticed an increase in WBC count, but with significant reduction of other post-donation haematological parameters like Hb, Hct, PLT, and MPV.

In our study, the platelet decrease was 24%. There are many factors that should be taken into conside-

ration when analysing the effect of plateletpheresis on donor platelets, such as the time between donations and number of donated units per procedure (8). It may also be because of the method of taking blood samples, cell count reagents used, time period between the end of the procedure and taking the sample, physiological changes in the donor PLTs, normal variation in PLTs, a reduced donor platelet reserve, or an altered magakaryopoietic homeostasis in repeated plateletpheresis donors (8,15). About 25-50% of circulating platelets might be lost during a single plateletpheresis but this is usually normalized by the spleen (7,16). The appropriate physiological mechanisms in the body ensure that after 4-6 days following plateletpheresis, the number of platelets can usually be restored to pre-donation levels (16).

Eight of our donors (11%) had a post-procedure platelet count less than 150x10e9/L, without associated evident clinical manifestation, and their pre-donation values ranged from 191x10e9/L to 222x10e9/L. Most of them were repeated plateletpheresis donors, and three of them also donated whole blood during the study period. None of our donors had post-procedure platelet count of less than 100x10e9/L. Other authors (1-4,8,17) reported that about 2%-17% of donors had post-procedure platelet count of <100x10e9/L, but without evident clinical manifestations.

Regular plateletpheresis develops in donors sustained decrease in platelet count; however, clinically significant thrombocytopenia is unusual (15).

In our study we did not observe any donors to have post-plateletpheresis haemoglobin level <12 g/dL, although the lowest post-procedural haemoglobin level was found in two donors, with the post-donation value of 12.4 g/dL, and with pre-donation values of 12.9 g/dL and 13.0 g/dL, respectively. Sekhar et al. (3) stated that in their study 8.1% of the donors had post-donation Hb concentrations of <12 g/dL, which, according to the WHO defines anaemia in any normal adult, irrespective of gender (18). Additionally, in their study, the Hb concentration fell below 10.8 g/dL in two female donors after the procedure, and they also reported that drops in Hb and Hct were significantly greater with a certain type of separators (3).

The greatest concern is related to donors with low normal pre-donation platelet count (150-200x10e9/L) (9). According to Aslam et al. (13) the donors that have low pre-donation platelet value (150-200x10e9/L) or Hb (12.5-13 g/dL) values should be monitored keenly to prevent anaemia and associated complications. In our study, 12% donors had pre-donation platelet count <200x10e9/L, and in four of them the post-donation platelet count fell below 150x10e9/L. In a study of Chaundhary et al. (19) 44.7% of donors had pre-donation platelet count <200x10e9/L, and a large number of donors would be unsuitable for plateletpheresis if the criteria of a pre-donation platelet count of >200x10e9/L were followed.

Calcium supplement was given to the donors when they complained about mild form of paresthesias/tingling sensations (6). There was no severe form of reactions noted in our study. Symptoms of hypocalcaemia and other citrate-induced metabolic abnormalities affect neuromuscular and cardiac function and range in severity from mild to moderate and severe (20). The treatment of citrate reactions includes slowing the reinfusion rate to allow for dilution and metabolism of the citrate, increasing donor blood to citrate ratio to decrease the amount of citrate infused, giving oral calcium, and if required giving intravenous calcium supplementation (6). In order to maintain the sufficient number of voluntary apheresis donors, it is important to identify and stop any adverse events associated with plateletpheresis procedures (16,21).

In our study, the donor sample was obtained soon after the completion of the procedure and hence, the change in haematological parameters observed may not be representative. It would be desirable to have daily haematological parameters post-donation assessments to determine the trend of the platelet count recovery, but due to logistical and financial issues, this could not be performed. Furthermore, not all donors who donated platelets in the study period were examined for post-donation haematological parameters after each procedure, which was in accordance with our current possibilities, so we had a limited number of procedures that we could analyse. However, all of the donors who donated platelets, but did not undergo post-donation haematological parameters assessment, had satisfactory pre-donation values. In those cases, generally, when it was not possible to determine post-donation

parameters, we were guided only by the post-counts calculated by the separator. Taking into account post-donation parameters performed on a haematological analyser and those calculated by the separator can help gain experience in working with donors when post-donation haematological values were not performed. In donors with low normal pre-donation platelet count, we set lower target yield of platelets per unit of the final product, which certainly meets the minimum therapeutic dose (22) for the patient transfusion support. Donors with low post-donation haematological values were postponed for a longer period of time until next donation, and donors with repeatedly lower normal pre-donation platelet values (150-190x10e9/L) were excluded from further platelet donations.

Taking into account the results of our research, post-donation changes in the donors should be reviewed in those donors whose haematological parameters are borderline, and also undergo repeated and frequent plateletpheresis or additional blood donations. We also recommend that apheresis donors with low normal pre-procedure platelet count (150-200x10e9/L) and Hb concentration (12.5-13 g/dL) should be examined for post-donation decrease in haematological parameters, and donors with significant decrements should be reviewed subsequently to exclude or to postpone donations for a longer period of time.

A limitation of the study was that we did not consider changes of plateletpheresis on biochemical and blood coagulation parameters due to logistical and financial issues, and those changes could be also important in determining the suitability of donors for frequent plateletpheresis procedures.

In conclusion, haematological values significantly dropped post-plateletpheresis. However, this decrease after single plateletpheresis on healthy donors does not result in clinical problems. Plateletpheresis procedures are generally safe and well tolerated without serious complications.

Our research with a focus on donors and monitoring of their parameters help us in our daily work and designing internal guidelines in our institution, taking into account the quality of platelet concentrates, but above all the safety of donors. All previous research on this topic, including this one, should be a basis for the design of best possible general guidelines for adequate donor safety and their selection in light of the increasing demand for blood products.

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TRANSPARENCY DECLARATION

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