Study on the Influence Factors of High Frequency Apheresis Platelet Donation on Iron Nutritional Status and Blood Routine Parameters of Blood Donor

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Abstract: Objective: To explore the effect of high frequency apheresis platelet donation on iron nutritional status and blood routine parameters of blood donors, and to provide data support for optimizing the strategy of apheresis platelet donation and ensuring the health of blood donors. Methods: From January 2024 to June 2025, 240 blood donors who participated in apheresis platelet donation were selected as the research objects. Among them, 120 cases of first apheresis platelet donation were selected as the control group, and 120 cases of high frequency apheresis platelet donation were selected as the observation group. The changes of iron nutrition indexes (serum iron, ferritin, transferrin, soluble transferrin receptor, total iron binding capacity) and blood routine parameters were compared between the two groups after blood donation. Results: Compared with the control group, the observation group had significantly lower serum iron, ferritin, and transferrin ($P < 0.05$) and significantly higher soluble transferrin receptor and total iron binding capacity ($P < 0.05$). In the blood routine test, the hemoglobin, hematocrit, mean hemoglobin concentration and mean red blood cell hemoglobin content in the observation group were decreased ($P < 0.05$), the red blood cell volume distribution width was increased ($P < 0.05$), and there was no significant difference in the other blood routine parameters ($P > 0.05$). Conclusion: High frequency apheresis platelet donation can lead to a decrease in iron storage and mild abnormalities in red blood cell system indexes. Red blood cell volume distribution width can be used as an early warning indicator of iron deficiency, while platelet related parameters have good stability. We should pay attention to the iron nutritional status of high frequency platelet donors, and strengthen the iron nutrition monitoring and intervention of high frequency platelet donors.

***Keywords*:** apheresis platelets; high frequency donations; iron nutritional status; blood routine parameters; blood donors were healthy

1. Introduction

As an important form of blood component donation, apheresis platelets play an irreplaceable role in clinical treatment of blood diseases, malignant tumors and trauma due to their high purity and significant curative effect. Studies have shown that frequent apheresis platelet donation may lead to a decrease in iron reserve in blood donors and have a certain impact on blood routine parameters [1]. First of all, iron is an essential trace element for human body, which is involved in many physiological processes such as hemoglobin synthesis, cell metabolism and immune function regulation. Changes in iron levels directly affect the health status of blood donors [2]. Secondly, as an important indicator to evaluate human health, blood routine parameters can reflect the functional status of the blood system of blood donors. This study aims to systematically investigate the iron nutritional status indicators (serum iron SI, ferritin SF, transferrin TRF, soluble transferrin receptor sTfR, total iron binding capacity TIBC) and blood routine parameters (red blood cell count RBC, hemoglobin Hb, hematocrit HCT, mean corpuscular volume MCV, mean corpuscular volume) of high frequency apheresis platelet donation and blood donors Erythrocyte hemoglobin content MCH, mean corpuscular hemoglobin concentration MCHC, platelet count, hematocrit, volume, distribution width). It provides a basis for formulating personalized blood donation interval and health management plan, so as to effectively protect the health of blood donors [3].

2. Materials and Methods

2.1 Subjects

A total of 240 donors who underwent apheresis platelet donation in our blood station from January 2024 to June 2025 were selected and divided into control group and observation group according to the number of blood donation, with 120 cases in each group. The control group was the first time to participate in apheresis platelet donation, including 74 males and 46 females. The average age was (35.7±8.6) years and the average weight was (68.9±9.8) kg. The observation group was blood donors who had participated in apheresis platelet donation multiple times, and the annual frequency of blood

donation was more than 5 times, including 82 males and 38 females. The average age was (38.5±9.2) years and the average weight was (72.3±10.5) kg. All the selected blood donors met the relevant standards stipulated in the "Blood donor health Examination Requirements (GB18467-2011)" . The specific inclusion criteria were as follows: (1) age range was 18-55 years old; (2) Body weight of male blood donors ≥50 kg, body weight of female blood donors ≥45 kg; (3) not taking iron products or blood tonic drugs within 3 months before blood donation; (4) For multiple blood donors, the interval between the current blood donation and the last blood donation should not be less than 2 weeks, and the annual blood donation frequency should not exceed 24 times [4]. Exclusion criteria included: (1) history of anemia or other hematological diseases; (2) history of major surgery or serious infection within the past year; (3) receiving donations of other blood components within one week before blood donation.

2.2 Reagents and Methods

2.2.1 Sample source

Blood samples of all donors were collected on the day of blood donation, and the location was the median cubital vein. Venous blood samples of 2 mL and 5 mL were collected, of which 2 mL blood sample was placed in EDTA anticoagulant tube for blood routine test, and 5 mL blood sample was placed in procoagulant tube for iron nutritional status index detection. Immediately after completion of the collection, the anticoagulant tube was gently reversed several times to fully mix. The procoagulant tube was allowed to stand for 30 minutes and then centrifuged at 3000 rpm for 10 minutes. The serum was separated and transferred to a clean EP tube and stored in a refrigerator at -40°C until use. All sample collection procedures strictly followed the principles of aseptic operation and were carried out by professionally trained nursing staff to ensure that the sample quality met the testing requirements.

2.2.2 Reagents and Methods

Serum iron (SI) and ferritin (SF) were detected by automatic chemiluminescence immunoassay analyzer. Transferrin (TRF) and total iron binding capacity (TIBC) were detected by automatic biochemical analyzer. Soluble transferrin receptor (sTfR) was detected by enzyme-linked immunosorbent assay (ELISA), and the reagent was provided by Shanghai Elisa Biotechnology Co., LTD. Red blood cell count (RBC), hemoglobin (Hb), hematocrit (HCT), mean corpuscular volume (MCV), mean corpuscular hemoglobin content (MCH), mean corpuscular hemoglobin concentration (MCHC), platelet count (PLT), platelet hematocrit (PCT), mean platelet volume (MPV), platelet volume fraction Parameters such as cloth width (PDW) were detected by automatic blood cell analyzer.

3. Results

3.1 Comparison of basic conditions of blood donors between the two groups

There was no significant difference in gender ratio between the two groups ($P > 0.05$). The average age of the observation group was slightly higher than that of the control group, and the difference was statistically significant ($t=2.34$, $P < 0.05$). The average body weight of the observation group was significantly higher than that of the control group ($t=2.67$, $P < 0.05$).

3.2 Comparison of iron nutritional status between the two groups of donors

The levels of serum iron SI and ferritin SF in the observation group were significantly lower than those in the control group; The levels of transferrin SF, soluble transferrin receptor sTfR and total iron binding capacity TIBC were significantly higher than those in the control group ($P < 0.05$). All test data were within the quality control range of the instrument, and the results were true and reliable. The specific data are shown in Table 1.

Table 1. Comparison of iron nutrition Indicators between Two Groups of Donors (x±s)

Indicators	Control group (n=120)	Observation group (n=120)	t value	P value	Reference range (adults)
Serum iron (SI, μmol/L)	20.5±4.1	13.2±3.5	12.876	<0.001	Male: 11-30 Women: 9-27
Ferritin (SF, μg/L))	85.3±20.5	41.5±15.0	17.892	<0.001	Male: 15-200 Women: 12-150
Transferrin (TRF, g/L)	2.2±0.4	3.1±0.5	14.238	<0.001	2.0-4.0
Soluble transferrin receptor (sTfR, mg/L)	1.17±0.28	2.06±0.37	18.056	<0.001	0.8-2.5
Total iron binding capacity (TIBC, μmol/L)	51.8±6.3	67.6±6.8	19.418	<0.001	50-77

3.3 Comparison of blood routine parameters between the two groups of donors

Compared with the control group, the hemoglobin (Hb), hematocrit (HCT), mean corpuscytic hemoglobin (MCH) and mean hemoglobin concentration (MCHC) in the observation group were significantly lower ($P < 0.05$); There was no significant difference in red blood cell count (RBC) and mean corpuscular volume (MCV) between the two groups ($P > 0.05$). The specific data are shown in Table 2. The platelet count of the observation group was significantly higher than that of the control group, and the difference was statistically significant ($P < 0.05$). The platelet crit (PCT) and platelet distribution width (PDW) in the observation group were significantly lower than those in the control group, and the differences were statistically significant ($P < 0.05$). The specific data are shown in Table 3

Table 2. Comparison of erythrocyte-related parameters in Blood Routine of Donors in Two groups (x±s)

Indicators	Control group (n=120)	Observation group (n=120)	t value	P value	Reference range (adults)
Red blood cell count ($\times 10^{12}$/L)	5.15±0.4	5.1±0.3	1.103	0.271	Male: 4.3-5.8 Women: 3.8-5.1
Hemoglobin (Hb, g/L)	144.8±12.1	131.5±10.0	9.326	<0.001	Male: 130-175 Women: 120-155
Hematocrit (HCT, %)	43.2±2.9	39.5±2.5	9.875	<0.001	Male: 40-50 Women: 35-45
Mean corpuscular volume (MCV, fL)	.3±3.9	83.8±3.5	1.852	0.065	82-100
Mean red blood cell hemoglobin content (MCH, pg)	30.1±1.8	28.3±1.5	7.562	<0.001	27-34
Mean corpuscular hemoglobin concentration (MCHC, g/L)	336.1±11.8	333.8±11.3	2.134	0.034	316-354
Red blood cell volume distribution width (RDW, %)	12.2±0.6	13.5±0.7	10.158	<0.001	11.5-14.5

Table 3. Comparison of platelet-related parameters in blood routine of two groups of donors (x±s)

Indicator	Control group (n=120)	Observation group (n=120)	t value	P value	Reference range (adults)
Platelet count (PLT, $\times 10^9$/L)	220.5±30.4	250.3±35.6	3.45	<0.001	125-350
Platelet hematocrit (PCT, %)	0.28±0.06	0.23±0.05	3.12	<0.001	0.108-0.282
Mean platelet volume (MPV, fL)	11.0±0.9	10.8±0.8	1.524	0.129	7.4-11.0
Platelet volume distribution width (PDW, %)	16.8±1.0	16.3±0.9	3.524	<0.001	9.0-17.0

4. Conclusion

The results of this study showed that compared with the control group, the levels of serum iron (SI) and ferritin (SF) in the observation group were significantly lower, while the levels of transferrin (TRF) and soluble transferrin receptor (sTfR) showed an upward trend, and the total iron binding capacity (TIBC) also showed significant changes [5]. The results showed that high frequency of apheresis platelet donation may lead to the gradual depletion of iron reserve in donors and lead to abnormal iron metabolism. In addition, the hemoglobin (Hb), hematocrit (HCT), mean corpusculin hemoglobin (MCH) and mean corpusculin concentration (MCHC) in the observation group were lower than those in the control group. In terms of platelet related parameters of blood routine, the platelet count (PLT) of the observation group showed a gradual upward trend, and the results of this study were consistent with the conclusions of literature . The platelet hematocrit (PCT) and platelet volume distribution width (PDW) of the observation group were significantly lower than those of the control group, which was consistent with the conclusion of literature .

The results of Table 2 show that high frequency donation results in decreased hemoglobin, hematocrit, mean corpuscorpusal hemoglobin content, and mean corpuscorpusal hemoglobin concentration, and increased red blood cell volume distribution width, suggesting that high frequency donation may lead to a certain degree of anemia tendency in donors. High frequency of apheresis platelet donation can lead to the deterioration of iron nutritional status of blood donors, the levels of serum iron and ferritin are significantly decreased, and the levels of transferrin soluble transferrin receptor and total iron binding capacity are significantly increased. It is suggested that the high frequency of donation reduces the iron reserve in the body of donors, and the body tries to cope with iron deficiency by up-regulating the soluble transferrin receptor and total iron binding capacity. In terms of blood routine parameters, high-frequency donation caused an increase

in hemoglobin, hematocrit, mean corpusclal hemoglobin content, mean corpusclal hemoglobin concentration (MCHC), and red blood cell volume distribution width, suggesting that high-frequency donation may lead to a certain degree of anemia tendency of blood donors. These findings provide an important scientific basis for ensuring the health of blood donors and standardizing blood collection, and also emphasize the necessity of regular iron nutrition monitoring and necessary intervention for high frequency apheresis platelet donors .

It should be noted that the sample size of this study is relatively limited, only 240 blood donors were included, of which only half were high frequency donors. The small sample size may have limited the statistical power of the findings and may have resulted in some subtle changes not being detected. Moreover, the time span of this study is only one and a half years, so it is difficult to fully reflect the cumulative effect of long-term high-frequency donation on the health of blood donors. Future studies with longer observation periods are needed to more accurately assess the long-term effects of frequent donation. In addition, this study has some limitations in the selection of detection indicators. Although the main measures of iron nutritional status and blood routine parameters are covered, other biochemical measures that may be affected by high frequency donation, such as vitamin B12 and folate levels, which also play an important role in erythropoiesis, are not covered.

In conclusion, high frequency apheresis platelet donation may affect iron metabolism and blood routine parameters of donors through various mechanisms, including iron loss, inhibition of erythropoiesis, and compensatory bone marrow response. It is suggested that the blood collection and supply institutions should attach great importance to the monitoring of iron nutrition in high frequency blood donors, and regularly test the iron nutrition index of high frequency apheresis platelet donors, so as to find the early signs of iron deficiency in time, and take effective intervention measures. At the same time, specific dietary programs should be developed for high-frequency donors to encourage donors to increase the intake of iron-rich foods. In the case of poor diet adjustment or serious iron deficiency, the blood bank should recommend donors to supplement iron reasonably under the guidance of doctors. The iron nutrition indicators were regularly reviewed, and the dose and administration time of iron were adjusted according to the changes of iron nutrition indicators to ensure the effective improvement of iron nutrition status .

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