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ORIGINAL ARTICLE

Comparison of Therapeutic Effect of Apheresis Platelets and Buffy Coat-Derived Platelet Concentrates

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SUMMARY

Background: **The study aimed to investigate the difference in clinical efficacy between apheresis platelets and buffy coat-derived platelet concentrates infusion in patients with hematological diseases.**
Methods: **A total of 218 patients with hematological diseases were enrolled in Xi'an Central Hospital, from January 2023 to October 2023, and randomly divided into two groups: 109 patients were treated with apheresis platelet transfusion (AP group) and 109 patients with buffy coat derived platelet concentrates (BC-PC group). Platelet counts were measured before and 24 hours after transfusion, and the corrected platelet ascending number (CCI) and platelet recovery rate (PPR) were calculated. The clinical efficacy and blood transfusion reaction were observed.**
Results: **After 24 hours of platelet transfusion, there was no significant difference in the platelet count between the AP and BC-PC groups ($p > 0.05$). However, CCI and PPR significantly differed between the two groups ($p < 0.05$). Moreover, the incidence of transfusion reaction in the AP group was significantly lower than in the BC-PC group.**
Conclusions: **The clinical efficacy of buffy coat-derived platelet concentrates is lower than that of apheresis platelets, but it can also improve the patient's condition and quality of life. Therefore, clinicians could rationally use BC-PC, according to the actual situation of the patients.**
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KEYWORDS

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INTRODUCTION

Platelet transfusion is a commonly used, supportive therapy in treating hematological diseases [1]. It is widely used to prevent and treat bleeding diseases caused by thrombocytopenia and dysfunction, and it can effectively reduce the mortality of bleeding caused by thrombocytopenia [2]. With the increasing clinical demand for platelet blood products, the supply of platelets is tight [3]. The main reasons for this are the short shelf life of platelets (5 days) and the limited resources. The preparation of platelet blood products mainly includes machine apheresis, provided by a single donor with

high platelet concentration, and manual separation, obtained by manual separation from multiple whole blood samples [4].

At present, apheresis platelets are commonly used in clinical practice. Due to the advantages of single donors; reduction of allergic reactions, high purity, and significant efficacy, a consensus has been reached [5,6]. However, there is a significant demand for apheresis platelets in the clinical treatment process, and apheresis platelets cannot meet the clinical demand, especially for patients with hematological diseases who often need repeated platelet transfusions to relieve clinical symptoms. Nonetheless, the hemostatic and clinical treatment effects of buffy coat-derived platelet concentrates are similar to those of apheresis platelets. When apheresis platelets cannot meet the clinical needs, buffy coat-derived platelet concentrates are an alternative treatment [7-9]. A single effective dose of buffy coat-derived platelet concentrates needs to be extracted from the whole blood of multiple blood donors, which, to some extent, increases the risk of allergic reactions. In recent years, with the continuous development of blood collection technology, the preparation process of buffy coat-derived platelet concentrates has been dramatically improved, improving the short-term transfusion effect [10-12]. In order to meet the needs of clinical treatment, the efficacy of platelet transfusion has also become a concern of clinicians [13]. Given this, we compared the efficacy of apheresis platelets with buffy coat-derived platelet concentrates in patients with hematological disorders, and the results will provide a basis for clinical doctors to choose platelet products in stressful situations.

MATERIALS AND METHODS

Study population

This study was approved by the ethics committee of the Xi'an Central Hospital, and all of the patients provided informed written consent forms. A total of 218 patients, diagnosed with hematological disorders and low platelets and admitted to the Xi'an Central Hospital, were selected from January 2023 to October 2023. All patients required timely platelet transfusions to prevent bleeding and to relieve clinical symptoms. They were randomly divided into two groups: 109 patients were treated with apheresis platelet transfusion (AP group) and 109 patients with Buffy coat-derived platelet concentrates (BC-PC group).

Inclusion and exclusion criteria

Inclusion criteria: 1) patients with hematological disorders accompanied by thrombocytopenia; 2) patients with peripheral blood platelet count $< 5 \times 10^9$/L, required immediate platelet transfusion to prevent bleeding; 3) patients with fever or coagulopathy; and 4) hepatosplenomegaly with abnormal function.

Exclusion criteria: 1) patients that have received medication for blood diseases; 2) patients with a history of bone marrow transplantation; and 3) other system diseases.

Apheresis platelets (AP)

The single-donor cell separator MCS+ 9000 (Haemonics, Boston, USA), Trima Accel (Terumo BCT, Denver, USA), and Amicus 4R4580 (Fresenius Kabi, Bad Hamburg, Germany) were used for platelet apheresis under standard procedures [14]. The MCS+ software version (UPP_A.2) was used for MSC+ instrument collections, with the setting parameters: AC ratio: 9:1; maximum inlet rate: 90 mL/minute; and maximum return rate: 110 mL/minute. Moreover, software version 7.0 was used for Trima Accel instrument collections, with the setting parameters as follows: AC management: 2; AC ratio: 1:11; minimum donor post-HCT: 32%; minimum donor post-platelet count: 100,000; maximum draw flow: moderate; draw management: 2; return management: 1; predicted yield: 5.0 - 9.6 x 10^{11}/μL; final concentration: 1,400 x 10^3 /μL; and collection volume: 290 - 310 mL. The amicus software version 3.21 (Fresenius-Kabi Company, Lake Zurich, USA) was used for Amicus instrument collections, with the setting parameters as follows: AC infusion rate: 1.5 mg/kg/minute; AC ratio: 9:1; maximum return rate: 137 mL/minute; maximum inlet rate: 110 mL/minute; and maximum cycle volume: 250 mL. AP were stored at 22 ± 2℃, with continuous agitation.

Buffy coat-derived platelet concentrates (BC-PC)

BC-PC was obtained by complying with the previous standard procedure [15]. Briefly, whole blood (WB) (400 ± 40 mL) was collected into 400 mL quadruple bags, containing CPDA-1 anticoagulant and red blood cell preservative (Nigale Biomedical Co., Ltd., Sichuan, China). WB was stored at 22 ± 2℃. Blood units were processed within 6 - 8 hours after collection. WB was centrifuged in Cryofuge (Heraeus Cryofuge 16, ThermoFisher Scientific, Germany), with “hard spin” centrifugation for 16 minutes at 2,600 rpm (2,390 g) at 22℃. After 2 minutes, the centrifuged blood was separated into multiple layers in the Blood Cell Separator (CompoMat G5 Plus, Fresenius Kabi AG, Deerfield, USA). The top, middle, and bottom layers were the platelet-poor plasma (PPP), BC, and packed red cells, respectively. The PPP supernatant and BC were transferred into other satellite bags. The BC was gently mixed with 74.48 - 74.64 mL plasma and subjected to “light spin” centrifugation at 918 rpm (298 g) for 8 minutes at 22℃, along with one empty satellite bag. After centrifugation, supernatant PRP was expressed into a satellite platelet storage bag, applying protocol VII Blood Cell Separator. After the appropriate volume (50 - 76 mL) was collected, air bubbles were removed, and the tubing was sealed. In order to meet the quality control standards, platelet content in platelet concentrates $\geq 2.0 \times 10^{10}$ and red blood cell infiltration $\leq 1.0 \times 10^{10}$, we mixed the BC-PC from 3 to 5 blood donors to achieve a therapeu-

tic dose. The platelet-concentrate bag was left at room temperature for approximately two hours before being stored at 22 ± 2°C, with reciprocal agitation.

Clinical treatment
Clinicians provide symptomatic and supportive treatment for patients with complications to ensure that patients' physical indexes and vital signs are stable. The patients in the AP group were given ABO and RH(D) isotype apheresis platelet transfusion (2.5 x 10^{11} per treatment dose), based on the above-mentioned treatment. Patients in the BC-PC group (2.0 x 10^{10} per bag) were given buffy coat-derived platelet concentrates transfusion of ABO and RH (D) isotype, based on the above-mentioned treatment.

Evaluation of platelet transfusion effect
The CCI value is significant in evaluating the efficacy of platelet transfusion. We carried out the CCI calculations by using individually measured platelet values in the concentrates. In the experiment, the blood flow cytometer 2E-2100/HST-N/SP1000 (Japan, SYSMEX Medical Electronics Association) was used to detect the count of platelets before and after transfusion. The same technician collected the patient's specimens simultaneously and in the same environment. Corrected count increment (CCI) > 4,500 or percentage platelet recovery (PPR) > 20% at 24 hours after infusion were defined as 20 units increase in platelet count at 24 hours after infusion. It was judged that the infusion was effective; otherwise, it was invalid. The corrected formula for rising platelet count: CCI = (platelet count after transfusion - platelet count before transfusion) x 10^{11} x body surface area (m^2)/number of infused platelets (x 10^{11}), Formula for recovery rate: PRP = (platelet count after transfusion - platelet count before transfusion) x blood volume/number of platelets infused (x 10^{11}) x 100%, and the patient's blood volume was calculated as 75 mL/kg.

Blood transfusion reaction
The typical transfusion reactions such as fever, chills, rash, pruritus, headache, nausea, and vomiting were recorded during or within 6 hours after transfusion.

Data analysis
All data were analyzed by using the SPSS 19.0 statistical software. Measurement data were expressed as x ± s, and Student´s *t*-test was used. $p < 0.05$ was considered statistically significant.

RESULTS

Comparison of platelet counts after transfusion
After 24 hours of apheresis and buffy coat-derived platelet concentrates transfusion, the platelet counts in the AP and BC-PC groups increased. However, the two groups had no statistically significant difference ($p > 0.05$), as is shown in Table 1.

Comparison of CCI and PPR effects of two kinds of platelet transfusion
The CCI and PPR in the AP and the BC-PC group were increased, and the CCI in the AP group was better than of the BC-PC group after transfusion, and the difference was statistically significant ($p < 0.05$) (Table 2 and 3). The PPR showed a trend similar to CCI's (Table 2 and 3).

Comparison of adverse reactions of two kinds of platelet transfusion
The number of cases of adverse reactions to blood transfusion in the AP group was less than in the BC-PC group, but there was no significant difference (Table 4).

DISCUSSION

Recently, the demand for platelets in clinical practice has gradually increased. Choosing platelets with substantial safety and high efficiency for infusion has become an important issue to be concerned about in clinical practice [16]. Due to the difficulty in obtaining single platelets, using other types as effective alternative treatments is significant for patient treatment. However, attention should be paid to the safety of platelet applications.

Apheresis platelets and buffy coat-derived platelet concentrates serve as the two primary forms of platelets [17]; there are specific differences in many aspects: 1) convenience of collection: in terms of convenience of collection, buffy coat-derived platelet concentrates are prepared from whole blood and can be collected through blood donation, with diverse sources [18]. Therefore, the difficulty of collection is relatively small, and the convenience of acquisition is vital. On the contrary, apheresis platelets collection is difficult to achieve through the above-mentioned channels, making collection difficult and time-consuming [19]. 2) Platelet quality: this study compared buffy coat-derived platelet concentrates with apheresis platelets to evaluate platelet quality. The results showed that after 24 hours of apheresis or buffy coat-derived platelet concentrates transfusion, the platelet counts in the AP and the BC-PC groups were increased. However, there was no statistically significant difference between the two groups ($p > 0.05$), which is consistent with previous research results [20]. The condition of the patients in the BC-PC group infused with buffy coat-derived platelet concentrates was also improved, achieving relatively satisfactory results. 3) Platelet transfusion effect: the CCI and PPR in the AP and the BC-PC groups increased, but the CCI and PPR in the BC-PC group were better than those of the AP group after transfusion. This indicates that both types of platelet applications are worthy of recognition for their effectiveness. 4) Infusion safety: the number of cases of adverse reactions to blood transfusion in the

Table 1. Comparison of counts, before and after platelet transfusion, between the control and observation group.

	n	Before infusion PLT (x 10^9)	After infusion PLT (x 10^9)
AP group	109	22.90 ± 11.40	42.24 ± 15.49
BC-PC group	109	26.38 ± 16.96	41.67 ± 25.19
t		-4.717	0.376
p		< 0.001	0.708

Table 2. Comparison of CCI and PPR, before and after platelet infusion, in the control and observation group.

	n	CCI	PPR (%)
AP group	109	14.50 ± 9.42	45.51 ± 28.27
BC-PC group	109	11.47 ± 17.98	25.81 ± 40.46
t		2.595	7.197
p		0.011	< 0.001

Table 3. Comparison of effective values of CCI and PPR, before and after platelet infusion, in the AP and BC-PC group.

	n	CCI > 5	PPR > 20
AP group	109	98 (89.90%)	95 (87.16%)
BC-PC group	109	85 (77.98)	54 (49.54%)
t		5.752	35.644
p		0.026	< 0.001

Table 4. Comparison of adverse reactions, after platelet transfusion, between the control and the observation group.

	Infusion (number of cases)	Adverse reactions (number of cases)	No adverse reactions (number of cases)	Transfusion adverse reaction rate (%)
AP group	109	2	107	1.8
BC-PC group	109	4	105	3.6
χ^2	1.022			
p	0.953			

AP group was less than in the BC-PC group, but there was no significant difference, which indicated that BC-PC has the same robust security as AP applications [21]. The quality control requirements for platelet concentrates are platelet content ≥ 2.0 x 10^{10} and red blood cell infiltration ≤ 1.0 x 10^{10}. According to current regulations, a therapeutic dose of platelets requires 3 to 5 blood donors to meet the requirements. Moreover, the quality control requirements for apheresis platelet collection are platelet content ≥ 2.5 x 10^{11}, erythrocyte infiltration ≤ 8.0 x 10^9, and leukocyte count ≤ 5.0 x 10^8, which suggests that the use of apheresis platelet collection is relatively safe. The cause of adverse reactions in patients undergoing concentrated platelet transfusion is related to nonhemolytic fever caused by leukocytes. Strengthening monitoring and prevention during infusion is the key to preventing adverse reactions.

In summary, with the support of advanced science and technology, the quality of buffy coat-derived platelet concentrates transfusion has been improved, which is

not only conducive to the full utilization of precious blood resources, but can also alleviate the pressure of the insufficient supply of apheresis platelets [22,23]. It can be used rationally, according to the needs in clinical practice, to ensure the realization of the effect of blood transfusion.

In conclusion, both platelet transfusions have a specific clinical value. In order to ensure the efficacy of blood transfusion, it is most important to improve the quality of platelets and avoid ineffective platelet transfusion caused by immune and non-immune factors. Given the current shortage of apheresis platelets, buffy coat-derived platelet concentrate can also improve the condition of patients with acute and severe blood diseases, which is worthy of clinical application.

Data Availability Statement:

Some or all data, models, or codes generated or used during the study are available from the corresponding author upon reasonable request.

Declaration of Interest:

The authors have no conflicts of interest to declare.

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