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Original Research Article

Transfusion effect of random donor platelet and single donor platelet in thrombocytopenic patients at tertiary care hospital of South Gujarat

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ABSTRACT

Background: Platelet transfusion plays a key role in therapy for the patients with thrombocytopenia. Superiority of Single donor platelet (SDP) over Random donor platelet (RDP) transfusions is largely assumed, but unproven. Platelet Rich Plasma-Platelet concentrate (PRP-PC) and Apheresis-PC were prepared and their therapeutic efficacy were assessed in thrombocytopenic patients.
Methods: This study included 60 transfusion episodes consisting of 30 SDP and 30 RDP (147units of RDP). The post transfusion efficacy of transfused platelets was assessed at 1 hour and 24 hours by corrected count increment (CCI) and percentage recovery (PR). Paired 't'-test was used for statistical analysis and a probability of $p<0.05$ was used to reject null hypothesis.
Results: The mean platelet dose of SDP (n=30) and RDP (n=30) was 2.86±1.05 x 10^{11} and 2.36±0.54 x 10^{11} respectively. The mean platelet increments of SDP at 1 hour and 24 hours were 38±18.1 x 10^3/µl and 37.3±20.7x 10^3/µl. The mean platelet increments of RDP at 1 hour and 24 hours were 28.5±11.4 x 10^3/µl and 26 ±11.6 x 10^3/µl. The mean CCI of SDP at 1hour and 24 hours were 21.4 ±7.3 x 10^3/µl and 20.8±7.4 x 10^3/µl respectively. The mean CCI of RDP at 1hour and 24 hours were 18.5±6.3x 10^3/µl and 17.4±7.6 x 10^3/µl respectively.
Conclusions: Post-transfusion increments were significantly higher in patients who received SDP as compared to RDP, but the CCI and PR were comparable in both groups of patients.

Keywords: Corrected count increment, Percentage recovery, Platelet apheresis, Random donor platelet, Single donor platelet

INTRODUCTION

Since Platelets were first identified in 1881, there has been continuous and accelerating progress in our basic understanding of platelet function.[1] Platelets are enucleating discoid shape cells. Despite this relatively small size platelets play essential role in the maintenance of haemostasis. The first successful attempt to raise the platelet count in thrombocytopenic patients by transfusion of whole blood was described by Duke in 1910. Two types of platelet concentrates are available for transfusion; one which is the co-product of normal blood donation i.e. Random donor platelet (RDP) include platelet rich plasma-platelet concentrate (PRP-PC), Buffy coat- platelet concentrate (BC–PC) and second is Single donor platelet (SDP- Aphaeresis-PC) collected from voluntary thrombocytapheresis donors with the help of an automated cell separator. Platelet transfusions are the primary therapy for thrombocytopenia due to various causes. Superiority of SDP over RDP transfusions is

largely assumed, but unproven. Now a day, there has been an increasing trend toward using SDP by Apheresis as an alternative to pooled RDP for platelet transfusion therapy.[2,3] The use of SDP is preferred over RDP as it represents fewer donor exposures and, therefore, lowers risk of virus transmission, alloimmunization, and transfusion-associated septic reactions and "better" platelet quality.

The objective of this study was to find out which method of platelet preparation is better in terms of post transfusion recovery in patients.

METHODS

This platelet study was done during time of August 2014 to December 2015 at Blood bank and clinical departments after obtaining the ethical committee clearance from the same institute. During this period, total number of 86 Single Donor Platelet apheresis procedure were done on Baxter CS 3000 plus with AMS cell separator (Fenwal, USA) and com.tec cell separator (Fresenius Kabi, Germany) using closed system apheresis kits and studied with respect to details of voluntary blood donors, patients and test procedures. During this period, a total of 14,295 blood units were collected, and from which 2,257 random donor platelets prepared (PRP-PC-15.7 %).

Study design - prospective study

The study groups

Patients with different diseases with severe thrombocytopenia who require therapeutic platelet transfusion were subjects of the study. 30 patients were evaluated for therapeutic efficacy of RDP prepared by PRP method and 30 patients were evaluated for SDP. Patient with idiopathic thrombocytopenic purpura (ITP) and thrombotic thrombocytopenic purpura (TTP) are excluded from the study.

Sample collection and analysis

2-3 ml of sample from platelet concentrates was collected aseptically in EDTA vial prior to the transfusion to the patients. 2-3 ml of patient's blood was collected in EDTA at three different times; one sample prior to the transfusion and the other two samples were collected at 1 hour and 24 hours post-transfusion respectively. Platelet counting was done by automated cell counter (Horiba ABX Micros 60, France). The main outcomes measured by CCI and PR. These both parameters can be calculated according to following formula.

$$CCI = \frac{(\text{Platelet increment}/\mu l)x\ (\text{Body surface area in } m^2)\times 10\text{^}11}{\text{Number of platelet transfused}}$$

$=\text{Platelets}/\mu l/m^2$

$$PPR = \frac{[(\text{Platelet increment}/\mu l)\ x\ (\text{weight in Kg} \times 75\ ml)]\ x\ 100}{\text{Platelet count of product}/\mu l\ x\ \text{Volume of platelet in ml}}$$

= Platelet count %

Platelet increment= Post transfusion platelet count- Pre-transfusion platelet count

Estimation of body surface area=

$$\frac{\sqrt{\text{Height (cm)}\times\text{Weight (kg)}}}{60}$$

Statistical analysis

All data were expressed as mean±SD. We performed statistical comparison by using paired 't'-test for multiple groups. A probability of $P<0.05$ (two sided) was used to consider the difference as significant and to reject null hypothesis. Microsoft Excel 2013 software was used to do all statistical analysis.

RESULTS

This study included 60 patients for transfusion episodes (30 patients each for SDP and RDP) consist of 30 SDP and 147 RDP units. Table 1 show majorities of RDP transfusion were done for hematological malignancy and SDP for dengue fever. It shows RDP and SDP transfusion in various diseases.

Table 1: RDP and SDP transfusion in various diseases.

Diagnosis	RDP (n=30)	%	SDP (n=30)	%
Malignancy	7	23.4	1	3.3
Pancytopenia	5	16.7	0	0
Dengue fever	6	20	8	26.7
Snake bite	1	3.3	3	10
Malaria	2	6.7	3	10
Leptospirosis	4	13.3	4	13.3
Aplastic anemia	4	13.3	5	16.7
DIC	0	0	1	3.3
Purpura	0	0	1	3.3
Thrombocytopenia	0	0	4	13.3
Hematemesis	1	3.3	0	0

Ideally the platelet dose to be transfused needs to be calculated according to weight of patient. The mean weight of the patients who received SDP and RDP were 54.06±6.0 kg and 53.9±8.08 kg (mean±SD) and ranged from 37-62 kg, and 35-67 kg respectively. The dose of RDP was calculated by 10 ml/kg body weight of the patients.

The mean platelet dose of SDP and RDP were $2.86\pm1.05\times10^{11}$ and $2.36\pm0.54\times10^{11}$ (mean±SD) and ranged from 1.7-4.6× 10^{11} and 1.1-4×10^{11} respectively.

All SDP transfusions were ABO identical and RDP transfusions were ABO compatible whenever possible but also given other group. On analyzing the parameters in total numbers of patients for each platelet preparation, it was observed that the dosage available from SDP was significantly higher (P<0.023).

While post transfusion platelet increments at 1 hr and 24 hrs were significantly higher with SDP transfusion as compared to transfusions with RDP (P<0.01 for 1 hr and 24 hrs post transfusion period). However, the CCI and PR in both the groups were comparable and the difference was statistically not significant.

The overall platelet counts and increments of the both groups are shown in detail in Table 2.

Table 2: Platelet counts in RDP and SDP transfusions.

Parameters		SDP (n=30)	RDP (n=30)	'p' value
Platelet dose		$2.86\pm1.05\times10^{11}$ $1.7\text{-}4.6\times10^{11}$	$2.36\pm0.54\times10^{11}$ $1.1\text{-}4\times10^{11}$	0.023
Pre-transfusion count		$18.8\pm14.2\times10^{3}/\mu l$ $1\text{-}76\times10^{3}/\mu l$	$25.2\pm11.8\times10^{3}/\mu l$ $9\text{-}66\times10^{3}/\mu l$	
Post transfusion count	1 hour	$54.3\pm23.2\times10^{3}/\mu l$ $10\text{-}92\times10^{3}/\mu l$	$51.2\pm13.6\times10^{3}/\mu l$ $26\text{-}90\times10^{3}/\mu l$	
	24 hours	$51.9\pm24.9\times10^{3}/\mu l$ $12\text{-}96\times10^{3}/\mu l$	$49.3\pm14.1\times10^{3}/\mu l$ $25\text{-}80\times10^{3}/\mu l$	
Post transfusion increment	1 hour	$38\pm18.1\times10^{3}/\mu l$ $4\text{-}92\times10^{3}/\mu l$	$28.5\pm11.4\times10^{3}/\mu l$ $10\text{-}68\times10^{3}/\mu l$	0.01
	24 hours	$37.3\pm20.7\times10^{3}/\mu l$ $6\text{-}89\times10^{3}/\mu l$	$26\pm11.6\times10^{3}/\mu l$ $5\text{-}65\times10^{3}/\mu l$	0.01
Corrected count increment	1 hour	$21.4\pm7.3\times10^{3}/\mu l$ $3.4\text{-}42.1\times10^{3}/\mu l$	$18.5\pm6.3\times10^{3}/\mu l$ $10.8\text{-}33.4\times10^{3}/\mu l$	NS*
	24 hours	$20.8\pm7.4\times10^{3}/\mu l$ $5.15\text{-}40\times10^{3}/\mu l$	$17.4\pm7.6\times10^{3}/\mu l$ $2.8\text{-}36.8\times10^{3}/\mu l$	NS*
Percentage of recovery	1 hour	54±18.3% 9-99 %	47±16.1% 27-93.6%	NS*
	24 hours	53±19.7% 14-108%	44.9±20.1% 7-92%	NS*

DISCUSSION

The ability of transfused platelets to circulate and function is dependent on both the effect of the *ex-vivo* storage lesions that undermines platelet functionality and the status of the *in vivo* milieu of the transfused individual.[4] Changes in platelets fall into three broadly defined categories: platelet activation, metabolic alterations and platelet senescence. PCs that have been gently prepared and then immediately transfused without a significant storage interval (within 24-48 hours of donation) have uniformly high recovery, good survival and preserved function.[5]

A single donor platelet concentrate containing approximately 3×10^{11} platelets is expected to raise platelet count by 30,000- 60,000/µl, while random donor platelets containing approximately 7×10^{10} platelets increase the platelet count by 5,000- 10,000/µl in an average sized adult. Most institution adopted policies for "standard" platelet dose to give one platelet concentrate / 10 kg of body weight and this should increase the platelet count by approximately 40,000/µl.

O'Connel et al reported no difference between 10 minutes and 1 hour post-transfusion platelet count and this provide a quick and accurate method of determining platelet recovery. Post-transfusion platelet recovery is usually about 60% of the number of autologous platelets transfused, but may be as low as 20% to 40% after homologous transfusion in patients with factors affecting platelet recovery. The post-transfusion platelet count is affected by the viability of the platelets as well as the number of platelets in the platelet concentrates. It is also affected by the dilution of platelets in the patient's blood volume. CCI and PR are measures that have been used to correct the post-transfusion platelet count for the patient's blood volume and for the number of platelets in the platelet concentrates.[6]

In this study patients who received SDP, the post-transfusion platelet counts increments achieved were significantly higher as compared to patients who received RDP ($P< 0.01$). However, when CCI and PR were calculated, the results with both preparations were comparable (p values are not statistically significant).

Anderson et al demonstrated that the actual CCI at 1-6 and 18-24 hrs post-transfusion for all three types of PC (SDP, PRP-PC, BC-PC) did not differ significantly. They concluded that transfusion of PRP-PC is associated with a significant increase in non-hemolytic febrile transfusion reaction. The results of Anderson et al study was also comparable to present study and we found that those patients who received RDP had significantly low post-transfusion platelet count increments at 1 hr and 24 hrs as compared to patients who received SDP. The post transfusion therapeutic efficacy assessed by CCI and PR at 1 hour and 24 hours were comparable in both groups of patients.[7]

Singh RP et al had concluded that patients transfused with apheresis PC had received higher platelet dosage than PRP-PC and Buffy Coat PC (BC-PC) and this difference was statistically significant ($P<0.001$). The post transfusion platelet counts and increments at 1 hour and 20 hours were significantly higher with apheresis-PC than PRP-PC and BC-PC ($P<0.001$). However, the CCI and PR in all three groups were comparable. This study was also comparable with present study.[8]

Norol et al comparing the platelet doses, increments and PR in AML patients who had undergone allogenic BMT, it was observed that higher the dosage, higher was the platelet counts, increments but PR was similar. Three platelet doses [(medium dose ($2\text{-}4 \times 10^{11}$ platelets), high dose ($4\text{-}6 \times 10^{11}$ platelets) and very high dose ($>6 \times 10^{11}$ platelets)] were transfused. The author showed that increments in 12 hours post-transfusion platelet count and the time to next transfusion increased with higher platelet doses and this difference was statistically significant ($P<0.01$ to 0.05), but the percentage recovery was similar in all three groups and statistically not significant. The results of Norol et al study was also comparable to present study and we found that those patients who received lower doses (i.e. RDP recipients) had significantly low post-transfusion platelet counts and increments at 1 hour and 24 hours as compared to patients who received medium dose (SDP recipient). The post transfusion therapeutic efficacy assessed by CCI and PR at 1 hour and 24 hours were comparable in both groups of patients and statistically not significant.[9]

Gurkan E et al, had performed study to find out superiority of single-donor apheresis platelets (SDP) over pooled platelet concentrates (PPC) transfusions in AML/MDS patients receiving allogeneic hematopoietic stem cell transplantation. The Author was unable to detect any clinical relevant difference between SDP and PPC transfusions when used as bleeding prophylaxis after allogeneic hematopoietic stem cell transplantation. SDP provided better post-transfusion platelet counts and CCI (p values are 0.0004 and 0.0001) but this did not translate into clinically important parameters. The author concluded that in the context of allogeneic hematopoietic stem cell transplantation, PPC are as clinically effective as SDP. This study also comparable with present study in all aspects except one matter, CCI was comparable in both the groups (SDP and RDP transfusions) in present study.[10]

Paul N et al stated that SDP offers major advantages over PC for most of the issues, particularly when improved patient care is given primary emphasis.[11]

CONCLUSION

From present study, it can conclude that the platelets prepared by the both methods are highly satisfactory after preparation. Although post-transfusion increments were significantly higher in patients who received SDP as compared to RDP, but the CCI and PR were comparable in both groups of patients.

Thus, according to logistic terms, SDP are better than RDP when considering numbers of donors exposed to patient and leukoreduction. However, in developing countries SDP because of their high cost and more technical expertise required may be recommended only in selected patients either when RDP in adequate doses are not available or when HLA-matched platelet transfusions are indicated.

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