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Comparative Study of the Transfusion Effect of Single Donor Apheresis Platelets Versus Random Donor Platelets in the Management of Severe Dengue Infection in Children

D Abdul Shareef

Post Graduate, Department of Paediatrics, A.C.S Medical College and Hospital, Chennai

Abstract: ***Background: Severe dengue with thrombocytopenia often necessitates platelet transfusion. Both random donor platelets (RDP) and single donor apheresis platelets (SDP) are used, but comparative pediatric data are limited. Objective: To evaluate and compare the transfusion efficacy of SDP and RDP in children with severe dengue. Methods: This prospective study (Jan–December 2024) included 60 pediatric patients at ACS Medical college and Hospital Chennai India, requiring platelet transfusion for severe dengue (30 SDP, 30 RDP). Platelet increments, corrected count increment (CCI), and percentage recovery (PR) were measured 24 hours post-transfusion. Results: SDP recipients had significantly higher platelet increments at 24 hours compared to RDP ($p<0.01$). However, CCI and PR were comparable between groups, with no statistically significant difference. Mean hospital stay was similar (SDP: 7.50±2.07 days; RDP: 7.0±1.82 days). Conclusion: While SDP achieved higher immediate platelet count increments, both SDP and RDP showed similar CCI and PR outcomes. SDP offers advantages in reducing donor exposure and enabling leukoreduction, but due to higher cost and technical demands, its use in resource-limited settings should be selective.***

Keywords: Severe dengue, thrombocytopenia, platelet transfusion, single donor apheresis platelets, random donor platelets

1. Introduction

Epidemics of dengue are not new during every monsoon in India. So also, an acute shortage of platelets. Both random donor platelets and single donor platelets (SDP) are indicated to treat bleeding manifestations in dengue. random donor platelets (RDP) are prepared from donated blood within 4 to 6 hrs of collection by centrifugation and it contains approximately 5.5×1010 platelets. Single donor platelets are prepared by platelet apheresis machine. One unit of SDP is equivalent to 5 to 10 units of RDP. RDP of the same blood group is recommended; in case of an emergency random donor platelets of any blood group can be transfused. Indications of platelet transfusion in dengue are platelet count less than 10000/cu.mm in absence of bleeding manifestations and Prophylactic platelet transfusion in patients with hemorrhage with or without thrombocytopenia.1 It should be noted that prophylactic platelet transfusions for severe thrombocytopenia in otherwise hemodynamically stable dengue patients are not effective and are not necessary. Thrombocytopenia in dengue has many causes. In the early stage, bone marrow hypocellularity followed later by immune-mediated destruction of platelets is proposed as the mechanism for thrombocytopenia. Immune mediated destruction of platelets in dengue fever may lead to poor or no or short-term response to platelet transfusions. This study aimed to study the transfusion effect of single-donor apheresis platelets and random donor platelets (RDPs) on dengue management. Patient profile, overall impact of this transfusion support, effectiveness of current guidelines, further requirement of platelet transfusions, length of stay and cost of the stay in hospital were studied.

2. Methods

This was a prospective study conducted on confirmed cases of dengue infection attending the inpatient Pediatric Department of the ACS medical college and Hospital Chennai, Tamilnadu, between January 2021 and December 2024. According to specific inclusion criteria, 425 clinically suspected patients with dengue fever and fulfilling the case definition criteria of DF/DHF/DSS of WHO were included in this study.2-4 The patients with severe dengue with thrombocytopenia who required platelet transfusion were subjects of the study. The sample size was calculated considering the specificity of the SDP with the RDP of 93.3%, with 95% confidence interval and 5% of absolute precision. 30 patients were evaluated for therapeutic efficacy of RDP and 30 patients were evaluated for SDP. Patients with other causes of thrombocytopenia were excluded from the study. The study was started after obtaining ethical clearance from the ethical committee of the institution. Two ml of the patient's blood was collected in EDTA tubes at two different times; one sample before the transfusion and the other sample was collected at 24 hours post-transfusion. Platelet counting was done by an automated cell counter. The main outcomes measured are platelet increment (PI), corrected count increment (CCI), percentage recovery (PR) and duration of hospital stay.

The parameters can be calculated using the following formula,

CCI in platelets/µl/m2
$= (platelet\ increment/\mu l) \times (body\ surface\ area\ in\ m2\ /number\ of\ platelet\ transfusions \times 1011$.

PPR
= $(platelet\ increment/\mu l)\times(weight\ in\ kg\times 75\ ml)\times 100/$ $pplatelet\ count\ of\ the\ product\ per\ \mu l\times volume\ of\ platelet\ in\ ml$.

Platelet increment [PI]=Post transfusion platelet count - pretransfusion platelet counts.

Data entry was done using Microsoft excel 2013 and analysis was done using SPSS V 16. Qualitative data were expressed in frequencies and percentages and quantitative data in mean and standard deviation. Statistical tests include unpaired t test for intergroup comparison was used. Bar diagrams and pie charts were used to represent the data. The $p<0.05$ was considered statistically significant.

3. Results

During the period of study 425 dengue children were diagnosed having dengue fever. The epidemiological profile of these children is shown in Table 1. Out of 80 children with severe dengue this study included 60 patients for transfusion episodes (30 patients each for SDP and RDP) consisting of 30 SDP and 87 RDP units. Ideally, the platelet dose to be transfused needs to be calculated according to the weight of the patient. The dose of RDP was calculated by the 10 ml/kg body weight of the patient. All SDP transfusions were ABO identical and RDP transfusions were ABO compatible whenever possible but also given other groups.

Table 1: Epidemiogical profile of dengue children admitted in ACS Medical College and hospital Jan 2024 to Dec 2024

Variables	N	Percent (%)
Age (Years)		
< 4	68	16
4- 10	238	56
11- 18	119	38
Sex		
Male	289	68
Female	136	32
Classification (WHO)		
Mild/ Undifferentiated Dengue	22	5
Moderate Dengue	323	76
Severe Dengue	80	19

While post-transfusion platelet increments at 24 hrs were significantly higher with SDP transfusion as compared to transfusions with RDP ($p<0.01$ for 24 hrs post transfusion period). The overall platelet counts and post transfusion increments of both groups shown Figure 1.

However, the CCI and PR in both the groups were comparable and the difference was statistically not significant. The overall corrected count increment and percentage recovery of both groups are shown in Table 2.

In the present study, the duration of hospital stay ranged between 4-13 days and the overall mean duration of stay was 7.40±2.38 days. The mean duration of stay in cases with RDP was 7.0±1.82 days, in cases with SDP it was 7.50±2.07 days and the difference was statistically not significant. The length of hospital stay in both groups is shown in Table 3.

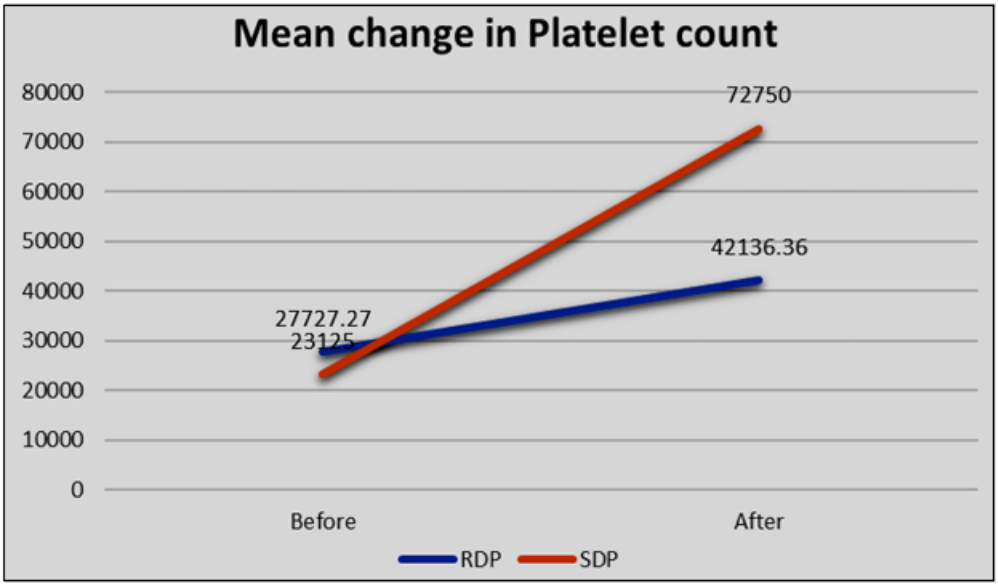

Figure 1: Mean change in platelet count before and after transfusion

Table 2: Corrected count increments and percentage recovery in both groups

Parameters	SDP	RDP	P Value
Corrected Count Increments	20200 ± 7400	17800 ± 7600	NS
Percentage Recovery	53 ± 19.7%	44.9 ± 20.1%	NS

Table 3: Mean duration of hospital stay in both groups

Platelet Type	Mean ± SD (days)
RDP	7.0 ± 1.82
SDP	7.50 ± 2.07

4. Discussion

The ability of transfused platelets to circulate and function is dependent on both the storage of transfused platelets and the status of the transfused patient. Platelet concentrates that have

been properly prepared and then immediately transfused within 24 to 48 hours have uniformly high recovery, good survival and preserved function. A single donor platelet concentrate was expected to raise platelet count by 30,000-60,000 /µl, while random donor platelets increased the platelet count by 5,000-10,000 /µl in an average-sized adult. The institution adopted the policy for standard platelet dose to give one RDP concentrate/10 kg of body weight or 10 ml per kg SDP and this should increase the platelet count by approximately 30000 to 40,000/µl. O'Connell et al reported no difference between 10 minutes and 1-hour post-transfusion platelet count and this provides a quick and accurate method of determining platelet recovery.9 Post-transfusion platelet recovery was usually about 60% of the number of autologous platelets transfused, but maybe as low as 20% to 40% after homologous transfusion in patients with factors affecting platelet recovery. The post-transfusion platelet count was affected by the viability of the platelets as well as the number of platelets in the platelet concentrates. It was also affected by the dilution of platelets in the patient's blood volume. CCI and PR were measures that had been used to correct the post-transfusion platelet count for the patient's blood volume and the number of platelets in the platelet concentrate.

In this study of 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.10 They concluded that transfusion of PRP-PC is associated with a significant increase in a non-hemolytic febrile transfusion reaction. The results of the Anderson et al study was also comparable to the 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.
Singh 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.11 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 ($p<0.01$). However, the CCI and PR in all three groups were comparable. This study was also comparable with the present study

Our department had a stringent policy for the transfusion of blood and blood products. Hence in our study, the rate of inappropriate platelet transfusion was less than 10% as opposed to 35% documented by ND Kumar et al in their study thus reducing the cost of treatment, as well as all the risks associated with transfusion of blood products.12 Moreover, it was considered that above a threshold of 10,000 platelets, the platelet dose has no significant effect on the incidence of bleeding, probably because few platelets are needed to maintain homeostasis.Some reports also suggest that endothelial integrity can be maintained with platelet counts of as low as 5000 per cubic millimeter. The PLADO study concluded that low dose platelet transfusion, according to body surface area, is equivalent prophylactically to the high dose, and the corrected count increment did not differ significantly in patients transfused low, medium, or high.

In the present study, the duration of hospital stay ranged between 4-13 days and the overall mean duration of stay was 7.40±2.38 days. The mean duration of stay in cases with RDP was 7.0±1.82 days; in cases with SDP, it was 7.50±2.07 days which was not statistically significant. Kansay et al observed the mean duration of hospital study to be significantly lower in the people who have received SDP when compared to the cases who have received RDP.18 In this study also the mean duration of hospital stay is less in patients who received SDP but statistically not significant. The limitations of the study are other modalities (FFP, steroids etc.) of treatment given that affected recovery of patient are not considered and to very sick patients option of SDPs only given and many patients received pre transfusion prophylaxis with antihistamine or steroid.

5. Conclusion

Cost-effectiveness, availability, disease transmission, and alloimmunization associated with platelet transfusion need to be considered while transfusing platelets. Hence proper guidelines for platelet transfusion should be followed considering the long-term effects rather than the immediate benefit to the patient. From the present study, it can conclude that the platelets prepared by both methods are highly satisfactory after preparation. Although post-transfusion increments were significantly higher in patients who received SDP as compared to RDP, the CCI and PR were similar in both groups of patients. Thus, according to logistic terms, SDP is better than RDP when considering the number of donors exposed to patients and leukoreduction. However, in developing countries SDP because of their high cost and more technical expertise required may be recommended only in selected patients based on availability and affordability or when HLA-matched platelet transfusions are indicated.

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