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Comparison between Centrifugation and Apheresis Methods of Platelet Concentrate Preparation

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Abstract: *Achieving a rich platelet concentrate (PC) from blood donation procedure remains a great challenge in blood banking practice. Two preparation methods with variable efficiency exists, which are blood unit centrifugation and apheresis. The aim of this study was to compare between centrifugation and apheresis methods of platelet units' preparation. A total of 90 Platelets donors attending the blood bank of Khartoum oncology hospital during June 2019 were enrolled for this study. Body weight, height in addition to Hematocrit and platelets count were measured for all participants before donation. PC was prepared by centrifugation from 60 donors, collected into bags containing citrate and nutrient phosphate and dextrose (CPD), while the rest 30 donors were subjected for platelet apheresis (Trima accel) and PC units were collected into bags containing Acid citrate dextrose (ACD). Platelets count was performed on samples from PC units using fully automated haematology analyzer (Sysmex KX-21N, Japan). Data were analyzed by statistical package for social science (SPSS) program. Results showed no statistically significant difference in Platelets count before donation between the two study groups (p. value = 0.289). While Platelets count was significantly different between samples of PCs of the two preparation methods (p. value = 0.002). For PC using aphersis, the Platelets count of the unit was significantly predicted by a model consisting of donors Platelets count, Hematocrit, body weight and height (p. value < 0.05). Among the covariates used in the model, donor's Hematocrit was the strongest predictor of Platelets count in the PC.*

Keywords — apheresis, centrifugation, Platelets count, Platelets concentrate.

1. Introduction:

Platelets, the smallest of the human blood cells (~3.6×0.7 mm), are central players in the processes of hemostasis and thrombosis. In addition, platelets are involved in clot retraction, vessel constriction and repair, inflammation, including promotion of atherosclerosis, host defense, and even tumor growth/metastasis. They are produced by differentiation of the bone marrow derived megakaryocytes and are released as non-nucleated fragments into the circulation [1].

Platelets transfusion play an important role in prevention or treatment of bleeding in patients with thrombocytopenia or severely impaired platelet function [2]. Low platelet counts frequently lead to bleeding complications and even death. Platelet transfusion is indicated either prophylactically or therapeutically to reduce the risk of bleeding, promote hemostasis or to control active bleeding [3].

Platelets concentrate (PC) preparations are frequently used to treat thrombocytopenic and/or bleeding patients [4]. They could be obtained either by centrifugation of whole blood unit or by apheresis [3]. In the centrifugation method, PC is prepared by pooling platelets obtained through centrifugation from individual units of whole blood [5]. While in apheresis method, PC is collected from whole blood after several stages of processing through the apheresis (plateletpheresis) using cell separators. Apheresis is a technique performed on donors or patients where by a particular component of the blood is separated ex vivo and the remainder of the blood is returned to the donor or patients, this technology is based on either filtration or centrifugal systems with combination of either continuous- or intermittent-flow technology [6]. Apheresis method is disclosed for increasing the purity and yield of platelets separated from donated whole blood in a centrifuge. The whole blood in the centrifuge is diluted by recirculating fluid, such as plasma or saline, at a first flow rate, to mix with further withdrawn whole blood prior to entering the centrifuge. As plasma is collected, it is recirculated through the centrifuge at a second flow rate to further improve the separation between the intermediate density components i.e. platelets and white blood cells in the "buffy coat." The plasma is then recirculated through the centrifuge at a third flow rate and platelets are displaced out of the centrifuge while the plasma is recirculating through the centrifuge at the third flow rate [7].

As the greater the number of Platelets per unit; the greater outcome of transfusion procedure, therefor the preparation method with higher Platelets yield is preferable. Accordingly, the aim of the current study was to compare between centrifugation and apheresis methods in terms of number of Platelets per unit.

2. Material and Methods:

2.1 Study design:

This was an observational case study.

2.2 Study area and study period:

The study was conducted in the blood bank of Khartoum oncology hospital (Khartoum – Sudan) during the period from June to December 2019.

2.3Sample size:

A total of 90 donors were enrolled for this study, 60 donors of them subjected for manual platelet concentrates procedure and the rest 30 donors were subjected for Platelet apheresis procedure of platelet donation**.**

3. Methods:

3.1 Sample analysis:

Body weight and height were measured for all participants in this study. Moreover, venous blood samples were collected before donation in EDTA tubes, and analyzed for Platelets count and Hematocrit (Hct) using fully automated haematology analyzer (Sysmex KX- 21N, Japan). PCs were prepared by centrifugation from 60 donors, collected into Citrate, nutrient phosphate and dextrose (CPD) bags. While the rest 30 donors were subjected to apheresis using automated Plateletpheresis apparatus (Trima accel), then units were collected into Acid citrate dextrose (ACD) bags. Samples from each PC bag were drawn into plain tubes, platelets count was performed for all samples.

3.2 Statistical analysis:

Data were analyzed using statistical package for social science (SPSS), version 23. Independent sample t-test was applied for comparisons. Multiple linear regression was applied to test the ability of a set of donor covariates to predict Platelets count in PC as an independent variable. Covariates included in regression were donor's Platelet count, Hematocrit and body weight. For all tests, *p*. values of less than 0.05 were considered statistically significant.

3.3 Ethical considerations:

This study approved by Sudan International University – Faculty of Medical Laboratory Sciences. Ethical clearance obtained from the research ethics committee. Informed consent obtained from donors before participation. Data kept confidentially and only used for the purpose of the study.

Results:

A total of 90 healthy donors (60 for PRP-PC and 30 for apheresis-PC) were enrolled for this study. For the apheresis donation procedure, the weight of donors ranges between (67—93) kg and the height range between (169--182cm) while the hematocrit ranges between (38—50%).

Platelet count were performed for both procedures before and after donation. Comparison of Platelets count between the two groups before donation showed no statistically significant difference (*p*. value = 0.289) (Table 1). While comparison of Platelets counts of PC units after collection between the two procedures revealed a statistically significant difference between apheresis-PC vs. PRP-PC units (*p*. value = 0.002).

Multiple linear regression was applied to test the contribution of donor's Platelets count, Hct, body height and weight for the prediction of Platelets yield in apheresis PC dependent variable.

The model which include the above predictors was statistically valid to predict the value of Platelets yield in apheresis PC (F score = 33.15, *p*. value = .000) (Table 3). The combination of the four predictors account for 81.6% (R^2 = 0.816), which means the compensation of independent variables (Platelet, Hct, height, weight) to make change in dependent variable (Platelets yield in PC) equal 81%, and 19% for other variables not included in the model (Table 4). All the independent variables have significant effect on Platelet yield (*p*. values < 0.05) except the variable (height) which had insignificant effect (*p* .value = 0.279). Among the covariates used in the model, donor's Hct was the strongest predictor of Platelets yield in the PC unit (B = 29.3) (Table 5).

Table (1): The mean of Platelet counts before donation:

Platelet count in donors before collection	Mean ± STD	*p* .value
Aphaeresis donors Platelet count	291 ± 56	0.289
Manual donors Platelet count	288 ± 66	

Table (2): The mean of Platelet yield on PC units:

Preparation method	Mean ± STD	*p*. value
Apheresis	139 ± 15.5	.002
Centrifugation	22 ± 8	

Table (3) Analysis of Variance test:

Model	Sum of Squares	Df	Mean Square	F	Sig.
Regression	687256.987	4	171814.247	33.148	.000[b]
Residual	129582.213	25	5183.289		
Total	816839.200	29			

Table (4): Regression model summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.917[a]	.841	.816	71.99506

Table (5) Predictors of Platelets yield in apheresis method:

Model	Unstandardized Coefficients		Standardized Coefficients	t	Sig.
	B	Std. Error	Beta		
Constant	347.118	1186.266		.293	.772
Platelet	1.738	.343	.582	5.063	.000
Hct	29.257	7.715	.548	3.792	.001
High	-8.477	7.659	-.179	-1.107	.279
Weight	10.372	3.817	.391	2.717	.012

5. Discussion:

This study aimed to compare between centrifugation and apheresis methods of platelet units' preparation.

The result showed statistically significant difference between the mean of platelet count of the PCs prepared by the two procedures (*p*. value = 0.002). This finding is totally agree with the previous study conducted by Hao, Baolan, et al. in China in 2017 which found that, the mean Platelet content of a bag of Plateletpheresis was $2.34\pm0.37 \times 10^{11}$, and the mean platelet content of manual PCs from one donor was $0.61\pm0.23 \times 10^{11}$. Approximately four handmade platelets are equivalent to a bag of apheresis platelets [3]. also study by Singh, Ravindra Pratap, et al. in India 2008 concluded that, patients transfused with apheresis-PC had received higher platelet dosage than PRP-PC and BC-PC and this difference was statistically significant ($p < 0.001$) [8].

The current r study showed that there is a statistically significant effect on the platelet outcome of the apheresis procedure by a combination of donor's variables including Platelet count, Hct, body weight and height. When considering these variables separately, the height of the donor was insignificant predictor of Platelets yield. This finding agree with previous study by Khan, Irfan et al, in India 2017, which observed a positive correlation between Platelet yield and donor either hemoglobin ($r = 0.063$) or Hct ($r = 0.021$) and also found a positive correlation between BMI and Platelet yield ($r = 0.268$, $p< 0.01$) [9]. Also our finding is in accordance with another study done by Mangwana, S. in Nepal 2014, which showed that, Platelet yield of Plateletpheresis correlated positively with pre-donation Platelet count, height, weight and BMI [10].

6. Conclusion:

Greater Platelets yield was achieved in this study when using apheresis compared with centrifugation method for the preparation of Platelets concentrate. The Platelets yield of apheresis was related to donor's Platelets count, Hct and body weight.

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