

The Effect Of Platelet Apheresis On Hematological And Biochemical Parameters In Donors

Zelly Dia Rofinda

zellydiarofinda@med.unand.ac.id

Universitas Andalas / Dr. M. Djamil Hospital

Dwi Yulia

Universitas Andalas / Dr. M. Djamil Hospital

Sri Nurul Huda

Universitas Andalas / Dr. M. Djamil Hospital

Short Report

Keywords: Biochemistry, Hematological Parameters, Platelet apheresis donors

Posted Date: October 9th, 2026

DOI: <https://doi.org/10.21203/rs.3.rs-11030131/v1>

License:   This work is licensed under a Creative Commons Attribution 4.0 International License. [Read Full License](#)

Additional Declarations: No competing interests reported.

Abstract

The demand for platelet transfusions using apheresis-derived platelet concentrates is increasing due to the minimal side effects experienced by donors.^{1,2} However, platelet apheresis results in a decrease in specific circulating cells, and other cellular components may also be affected.³ Anticoagulants are required during apheresis to prevent activation of cellular and plasma components and maintain blood fluidity. Citrate anticoagulants act as chelators of ionized calcium and magnesium.^{4,5} Although platelet apheresis provides benefits to recipients, it may cause donor-related changes that require monitoring.

A prospective cross-sectional analytical study was conducted among 40 platelet apheresis donors at Dr. M. Djamil General Hospital Padang. Hematological and biochemical parameters were measured before and after the procedure.

Significant differences were observed in hemoglobin, erythrocytes, hematocrit, mean corpuscular hemoglobin, red cell distribution width, leukocyte count, platelet count, platelet distribution width, mean platelet volume, plateletcrit, and platelet large cell ratio ($P < 0.05$). No significant differences were found in mean corpuscular volume or mean corpuscular hemoglobin concentration ($P > 0.05$). Calcium and magnesium levels significantly decreased ($P < 0.05$), whereas ferritin showed no significant change ($P > 0.05$). Regular monitoring, particularly among frequent donors, is necessary to ensure donor safety and comfort.

INTRODUCTION

Platelet apheresis is a procedure in which platelets are separated from a donor's blood using an anticoagulant, while the remaining components are returned to the donor's circulation. This procedure yields a therapeutic adult dose (equivalent to 6–8 units of random donor platelets), also known as single-donor platelets.^{6,7,8} The advantages of platelet apheresis include leukocyte reduction, decreased exposure to multiple donor antigens which reduces the risk of alloimmunization and a lower chance of microbial contamination. However, the drawbacks include higher costs, longer donation times, and the need for trained technical staff and specialized equipment.^{8,9,10} In addition, platelet apheresis may cause discomfort to the donor.

The principle of apheresis lies in the separation of blood components, which can be achieved through various techniques, such as centrifugation and filtration.^{6,8,11} The apheresis procedure itself may cause hemodynamic changes and hemodilution in both donors and patients, and the resulting physiological effects may lead to side effects.⁶

The anticoagulant of choice for apheresis is citrate, which binds calcium ions and effectively blocks calcium-dependent coagulation factor reactions. Citrate mixes with the blood immediately after it is withdrawn from the donor's (or patient's) vein and effectively prevents coagulation before the blood enters the apheresis machine.^{6,12} Ionized calcium concentrations drop to 0.2–0.3 mmol/L, which inhibits

coagulation.⁶ Citrate anticoagulants also act as chelators of magnesium, leading to hypomagnesemia. A decrease in magnesium levels occurs in approximately 30–40% of platelet apheresis donors.^{4,5}

Platelet apheresis procedures result in a reduction of specific circulating cells, although other cellular components may also be affected. A platelet donor typically experiences an acute decrease in platelet count of about 20% to 29% after an apheresis donation.^{6,7} Each platelet apheresis procedure results in the loss of approximately 80–100 mL of blood due to residual blood left in the tubing.³ In some cases, hemolysis of erythrocytes may also occur as a result of the apheresis procedure.¹³

A good understanding of the physiology involved in apheresis is essential to minimize adverse reactions in donors and patients. Identifying the causes of these reactions can aid in prevention and help maintain donor retention for sustainable platelet apheresis programs. Preventive efforts, such as administering calcium supplements before or during the procedure, may help reduce adverse reactions such as citrate toxicity.⁵

METHODS

This study was an analytical study with a prospective cross-sectional approach conducted at Dr. M. Djamil General Hospital Padang from February to July 2024. The study subjects were all platelet apheresis donors. Informed consent was obtained from all participants. Donors who met the platelet apheresis criteria and completed the procedure were included in the study. Hematological and biochemical parameters were measured before and 30 minutes after the platelet apheresis procedure. Ethical approval was granted by the Health Research Ethics Committee of Dr. M. Djamil General Hospital with reference number DP.04.03/D.XVI.XI/274/2024.

Hematological parameters were analyzed using the Sysmex XN 1500 automated hematology analyzer, while serum calcium and magnesium levels were measured using the Cobas Integra 400 analyzer. Ferritin levels were assessed using the Vidas analyzer. Data were processed using IBM SPSS Statistics software. Data normality was evaluated using the Shapiro-Wilk test. Since the hematological parameters, platelet count, and calcium levels were not normally distributed, the Wilcoxon Signed Rank Test was used. A p -value > 0.05 was considered to indicate no significant difference before and after the platelet apheresis procedure.

RESULTS AND DISCUSSIONS

A total of 40 platelet apheresis donors participated in this study. The differences in hematological parameters before and after the platelet apheresis procedure are presented in Table 1.

The analysis revealed significant differences in hemoglobin (Hb), erythrocyte count, hematocrit (HCT), mean corpuscular hemoglobin (MCH), red cell distribution width (RDW), leukocyte count, platelet count, platelet distribution width (PDW), mean platelet volume (MPV), plateletcrit (PCT), and platelet large cell ratio (PLC-R) (P value < 0.05) before and after the platelet apheresis procedure. However, there were no

significant differences in mean corpuscular volume (MCV) and mean corpuscular hemoglobin concentration (MCHC) (P value > 0.05) before and after the procedure.

Table 1
The Differences In Hematological Parameters Before and After The Platelet Apheresis Procedure

Variable	Before Platelet Apheresis	After Platelet Apheresis	P value
	median (min-max)	median (min-max)	
Hb (g/dL)	15.40 (12.6–16.4)	14.40 (11.9–16.0)	< 0.001*
Erythrocytes (jt/uL)	5.42 (4.8–6.8)	5.23 (4.29–6.72)	< 0.001*
HCT (%)	45.10 (38.3–48.1)	43.50 (35.0–53.7)	< 0.001*
MCV (fL)	82.10 (60.5–88.0)	83.05 (60.4–101.0)	0.900
MCH (pg)	28.15 (19.0–29.5)	27.70 (19.1–29.4)	0.001*
MCHC (g/dL)	33.90 (30.9–44.4)	33.85 (31.6–37.70)	0.249
RDW (%)	12.80 (12.1–18.5)	14.10 (12.3–19.1)	< 0.001*
Leukocyte count (/mm ³)	8.35 (5.4–10.0)	8.11 (1.9–9.9)	< 0.001*
Platelet count (/mm ³)	257.00 (228.0–365.0)	177.0 (116.0–324.0)	< 0.001*
PDW (%)	9.10 (6.4–15.1)	10.1 (4.9–14.4)	< 0.001*
MPV (fT)	9.00 (7.6–11.0)	9.0 (7.3–11.5)	0.005*
PCT (%)	0.23 (0.20–0.33)	0.17 (0.1–0.3)	< 0.001*
PLC-R (%)	17.30 (10.8–29.1)	18.60 (12.8–29.2)	< 0.001*

*Note: *P value < 0.05; analysis was performed using the Wilcoxon Signed Rank Test.

This study showed a decrease in median Hb levels following the platelet apheresis procedure. The median Hb level decreased from 15.40 (12.6–16.4) g/dL to 14.90 (12.0–16.0) g/dL ($p < 0.001$), with a reduction of approximately 0.5 g/dL during the procedure. A study by Lokhande et al. (2021) reported similar findings, showing a decrease in Hb from 15.44 ± 1.01 to 15.32 ± 1.03 during platelet apheresis ($p < 0.05$).

In this study, there was also a decrease in platelet count following the procedure, from a median of 275,000 (228,000–365,000)/mm³ to 177,000 (116,000–324,000)/mm³, with an average decrease of approximately 80,000/mm³. Syal et al. (2022) reported a decrease in platelet count with an average reduction of 27.4%. The purpose of platelet apheresis is to remove platelets from the donor's body; therefore, platelet levels naturally decrease following the procedure. A platelet donor typically experiences an acute decrease in platelet count of 20% to 29% after apheresis donation. However, this decrease is not correlated with the

procedural outcomes of platelet apheresis.⁶ The differences in biochemical parameters before and after the platelet apheresis procedure are presented in Table 2.

Table 2

The Differences In Biochemical Parameters Before And After The Platelet Apheresis Procedure

Variable	Before Platelet Apheresis	After Platelet Apheresis	P value
	median (min-max)	median (min-max)	
Calsium levels (mg/dL)	9.20 (7.9–10.2)	9.15 (7.4–10.0)	0.018*
Magnesium levels (ng/dL)	2.30 (1.90–2.50)	2.06 (1.8–2.44)	< 0.001*
Feritin (g/dL)	43.16 (29.50-100.10)	43.1 (28.9–101.0)	0.336
Note: P value < 0.05; analysis was performed using the Wilcoxon Signed Rank Test.			

There were significant differences in calcium and magnesium levels (P value < 0.05) before and after the platelet apheresis procedure. However, there was no significant difference in ferritin levels (P value > 0.05) before and after the procedure.

In this study, total calcium levels decreased during the platelet apheresis procedure, from a median of 9.20 (7.90–10.60) mg/dL to 9.15 (7.40–9.90) mg/dL. The decrease in calcium after the procedure was 0.05 mg/dL. Magnesium levels also declined from a median of 2.30 mg/dL (1.9–2.5 mg/dL) to 2.06 mg/dL (1.8–2.4 mg/dL).

The findings of Syal et al. (2022) showed a 1.5% decrease in total calcium, from a mean of 9.91 ± 0.39 mg/dL to 9.75 ± 0.38 mg/dL. Citrate anticoagulant acts as a chelator of ionized calcium, thereby interfering with the coagulation cascade. Ionized calcium concentrations can drop to 0.2–0.3 mmol/L, which inhibits coagulation. A compensatory mechanism involving citrate metabolism by the liver, kidneys, and muscles releases chelated calcium, enhancing calcium release from albumin, mobilization from bone, and reabsorption from the kidneys to protect against severe hypocalcemia. Hypocalcemia stimulates the release of parathyroid hormone to regulate serum calcium levels, which can affect bone mineral density in platelet apheresis donors due to the shift of calcium from bone tissue.^{4, 5, 15}

Citrate anticoagulants are also magnesium chelators and can cause hypomagnesemia. A decrease in magnesium levels occurs in approximately 30–40% of platelet apheresis donors. The clinical symptoms of hypomagnesemia are indistinguishable from those of hypocalcemia; however, unlike hypocalcemia, magnesium deficiency does not improve with calcium supplementation.⁴⁻⁵

CONCLUSIONS AND SUGGESTIONS

Regular monitoring is necessary for platelet apheresis donors, especially frequent donors, to ensure their safety and comfort.

LIMITATIONS

This study has several limitations. The relatively small sample size and single-center design may limit the generalizability of the findings. In addition, laboratory parameters were assessed only 30 minutes after platelet apheresis, preventing evaluation of the duration and recovery of these changes. Total serum calcium was measured instead of ionized calcium, and citrate levels and parathyroid hormone were not assessed. Furthermore, the study did not evaluate the cumulative effects of repeated platelet apheresis donations. Future multicenter studies with larger samples and longer follow-up are needed to assess the recovery and potential long-term effects of platelet apheresis on donor health.

Declarations

Conflict of Interest

The authors declare no competing interests.

Ethics Approval and Consent to Participate

This study was conducted in accordance with the principles of the Declaration of Helsinki and was approved by the Health Research Ethics Committee of Dr. M. Djamil General Hospital, Padang, Indonesia (Reference No. DP.04.03/D.XVI.XI/274/2024). Written informed consent was obtained from all participants prior to their participation in the study.

Consent to Publish

Consent to Publish declaration not applicable.

Note

P value < 0.05; analysis was performed using the Wilcoxon Signed Rank Test.

Funding

This research was funded by the Faculty of Medicine, Universitas Andalas, under the Fundamental Research Scheme (Contract No. 03/UN16.02/FD/PT.01.03/FK-UPPM/2024, dated July 15, 2024).

Author Contribution

ZDR and DY conceived and designed the study. ZDR and SNH collected the data and performed the laboratory procedures. ZDR analyzed the data and drafted the manuscript. DY and SNH critically reviewed and revised the manuscript. All authors read and approved the final manuscript.

Acknowledgement

The authors would like to thank the staff of the Clinical Pathology Laboratory and Blood Bank Unit of Dr. M. Djamil General Hospital Padang for their assistance and support during the data collection and laboratory procedures. The authors also express their gratitude to all platelet apheresis donors who participated in this study.

Data Availability

The datasets generated and/or analyzed during the current study are available from the corresponding author upon reasonable request

References

1. Bassi R, Thakur KK, Bhardwaj K. Plateletpheresis adverse events in relation to donor and plateletpheresis session profile. *Iraqi J Hematol.* 2017;6(2):38–42.
2. Gottschall J, Wu YY, Triulzi D, Kleinman S, Strauss R, Zimrin AB, et al. The epidemiology of platelet transfusions: an analysis of platelet use at 12 US hospitals. *Transfusion.* 2020;60(1):46–53.
3. Sab PC, Kaur G, Kaur P, Tahlan A, Bedi RK, Mittal K, et al. Assessment of serum iron stores in regular plateletpheresis donors. *Transfus Apher Sci.* 2022;61(1):103291.
4. Garg K, Kaur P, Bedi RK, Gupta S. Alteration in biochemical parameters during plateletpheresis in healthy donors: A compendious analysis. *Transfus Clin Biol.* 2021;28(3):239–45.
5. Syal N, Kukar N, Arora H, Kaur A, Handa A, Maharishi RN. Assessment of pre and post-donation changes in hematological parameters and serum calcium and magnesium levels in plateletpheresis donors. *J Fam Med Prim Care.* 2022;11(4):1489–92.
6. Hartwell BA. Apheresis. In: *Modern Blood Banking and Transfusion Practices*. 7th ed. Leger RM, Rhees JR, Suwe G, editors. Philadelphia: FA Davis; 2019. p. 415–8.
7. Yazdani MS, Ahmad S, Rathore MA, Iqbal H. Plateletpheresis: A donor's perspective. *Pak Armed Forces Med J.* 2022;72(2):493–6.
8. Acker J, Razatos A. Whole blood and apheresis collection of blood components intended for transfusion. In: *Technical Manual*. 20th ed. Cohn CS, Delaney M, Johnson S, Katz MD, editors. AABB; 2020. p. 141–72.
9. Vaught HM. Component preparation. In: *Modern Blood Banking and Transfusion Practices*. 7th ed. Leger RM, Rhees JR, Suwe G, editors. Philadelphia: FA Davis; 2019. p. 352–415.
10. Gniadek T. Production of components by apheresis. In: *Transfusion Medicine*. 5th ed. McCullough J, editor. John Wiley & Sons; p. 90–110.

11. Dierickx D, Macken E. The ABC of apheresis. *Acta Clin Belg.* 2015;70(2):95–9.
12. Monchi M. Citrate pathophysiology and metabolism. *Transfus Apher Sci.* 2017;56(1):28–30.
13. Gil-Betacur A, Mantilla-Gutiérrez CY, Cardona-Arias JA. Effect of plateletpheresis on hematocrit, hemoglobin and erythrocyte count: Meta-analysis 1980–2018. *Sci Rep.* 2019;9(1):19770.
14. Lokhande T, Thomas S, Kumar G, Bajpai M. The play of citrate infusion with calcium in plateletpheresis donors. *Indian J Hematol Blood Transfus.* 2021;37(2):295–301.
15. Bialkowski W, Blank RD, Zheng C, Gottschall JL, Papanek PE. Impact of frequent apheresis blood donation on bone density: A prospective, longitudinal, randomized, controlled trial. *Bone Rep.* 2019;10:100188

Supplementary Files

This is a list of supplementary files associated with this preprint. Click to download.

- [Table2.TheDifferencesInBiochemicalParametersBeforeAndAfterThePlateletApheresisProcedure.docx](#)
- [Table1.TheDifferencesInHematologicalParametersBeforeandAfterThePlateletApheresisProcedure.docx](#)