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Original Article

Transfusion Medicine Section

Comparative Evaluation of Single-donor Plateletpheresis using Haemonetics® MCS® Plus and Trima Accel®: A Retrospective Study from a Tertiary Cancer Centre, India

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ABSTRACT

Introduction: Single-Donor Platelets (SDPs) collected through automated apheresis systems are essential for transfusion support in thrombocytopenic patients. The performance of cell separators varies with their centrifugation technology and operating protocols.

Aim: To compare the procedural efficiency, product quality, and donor safety of single donor plateletpheresis performed using Haemonetics® MCS® Plus and Trima® Accel systems at a tertiary cancer centre in India.

Materials and Methods: A retrospective analysis was conducted at the Division of Transfusion Medicine, Regional Cancer Centre, Thiruvananthapuram, Kerala, India, on 414 SDP procedures (207 with each system) performed between January and March 2023. Donor demographics, procedural parameters, and product quality were assessed. Key metrics included platelet yield, collection efficiency, blood volume processed, procedure duration, anticoagulant use, and donor reactions. Data were analysed using t-test or Wilcoxon rank-sum test for continuous variables and Chi-square or Fisher's-exact test for categorical variables, with p-value < 0.05 considered significant.

Results: The Trima Accel® system demonstrated a shorter procedure time (49.25±7.67 minutes vs 62.55±8.00 minutes; p-value <0.001), lower blood volume processed (2489.25±154.26 mL vs. 2668.87±268.85 mL; p-value < 0.001), higher collection efficiency (64.0±12.0% vs. 60.0%±8.0; p-value=0.003), and fewer adverse reactions (9.2% vs. 16.4%; p-value=0.039) compared with Haemonetics® MCS® Plus. Platelet yield and product quality were comparable between both systems.

Conclusion: Trima Accel® demonstrated better procedural efficiency, donor safety, and product consistency compared to Haemonetics® MCS® Plus, while maintaining comparable platelet yield and quality.

Keywords: Apheresis, Blood donors, Platelet count, Transfusion reaction

INTRODUCTION

Platelet transfusion remains a critical intervention in haematology, oncology, and critical-care medicine, particularly for patients with thrombocytopenia or dysfunctional platelet activity. Single-donor plateletpheresis has evolved to become a preferred modality over pooled random donor platelet concentrates, owing to predictable dosing, reduced donor exposures, lower risks of alloimmunisation, and enhanced opportunities for antigen-compatible matching in alloimmunised recipients [1-3]. The quality parameters of SDP heavily depend on the apheresis platform employed. Contemporary cell separators utilise either intermittent-flow or continuous-flow centrifugation modalities, each governed by proprietary algorithms that modulate anticoagulant infusion, separation cycles, feedback controls, and process pacing [4,5]. Key performance metrics include platelet yield, collection efficiency, anticoagulant consumption, procedure duration, and overall donor safety and comfort [6,7].

Several apheresis platforms are in routine use worldwide, including the Haemonetics® MCS® Plus (Haemonetics Corp., Braintree, MA, USA), COBE® Spectra and its successor Spectra Optia® (Terumo BCT, Lakewood, CO, USA), Fresenius AS 104 and COM.TEC® (Fresenius Kabi, Germany), Baxter/Fenwal Amicus (Baxter Healthcare Corp., Deerfield, IL, USA), and Trima Accel® (Terumo BCT, Lakewood, CO, USA). Among the most widely deployed platforms, Haemonetics® MCS® Plus and Trima Accel® occupy prominent positions in both developed and developing settings. The Haemonetics® MCS® Plus is fundamentally an intermittent-flow system that accomplishes product separation in cyclical draws and returns, while Trima Accel® uses continuous flow technology with integrated algorithms for yield prediction and donor management [6,8].

Comparative studies from various centres have indicated that Trima® Accel often achieves shorter procedural times, and higher collection efficiency, with less anticoagulant usage in many instances [6,8]. On the other hand, Haemonetics® MCS® Plus has been favoured in certain contexts for its reliability, cost-effectiveness, and adaptability to lower throughput settings, with reports variably suggesting a higher collection efficiency relative to Trima Accel® [8,9]. Differences in outcomes across studies are influenced by donor selection criteria, such as baseline platelet count, donor body weight, and institutional protocols for processed blood volume and target yield [10]. To comprehensively assess the performance of SDP, both procedure-related and product-related factors need to be taken into account. These determinants influence donor safety, product quality, and overall cost-effectiveness of transfusion services.

Despite several comparative evaluations of intermittent-flow and continuous-flow plateletpheresis systems, important gaps remain in the available literature. Many studies are limited by small or uneven sample sizes, heterogeneous donor selection criteria, variable target yields, and fragmented assessment of outcomes, with procedural efficiency, donor safety, and product quality often evaluated in isolation [2,5,8,11,12]. Moreover, much of the existing evidence is derived from settings that do not fully reflect high-demand tertiary oncology transfusion services operating within public-sector healthcare systems, where sustained platelet requirements, high procedure volumes, resource constraints, donor pool characteristics, and local operational protocols may substantially influence device

performance and service delivery [13,14]. Comparative data from such real-world settings in India- particularly from high-volume centres in South India- remain sparse, limiting the generalisability of existing evidence to this context.

In this setting, the present study provided a detailed single-centre evaluation of plateletpheresis practice within a high-volume tertiary care cancer centre. The novelty of this study lies in several key aspects: first, the inclusion of a large, balanced cohort with equal numbers of procedures performed on each platform; second, the use of a uniform target platelet yield across all procedures, reducing protocol-related variability; third, the integrated evaluation of procedural efficiency, anticoagulant exposure, donor safety, and platelet product quality within a single, standardised study framework; fourth, the generation of real-world data from a high-volume tertiary oncology centre operating under resource-constrained conditions in South India; fifth, the assessment of both systems using contemporary software versions reflective of current practice; and finally, restriction to male donors to minimise biological variability related to sex-based differences in platelet counts and body composition. Together, these features address key limitations of prior studies and provide robust, context-specific evidence to inform transfusion practice in high-demand oncology settings.

Accordingly, this study aimed to compare the performance of Haemonetics® MCS® Plus and Trima Accel® plateletpheresis systems with respect to procedural efficiency, anticoagulant usage, donor safety, and platelet product characteristics under standardised operating conditions in a high-volume tertiary oncology setting.

MATERIALS AND METHODS

This was a retrospective, single-centre, observational comparative study conducted in the Division of Transfusion Medicine at the Regional Cancer Centre, Thiruvananthapuram, Kerala, India. Plateletpheresis data recorded during a 3-month period from January to March 2023 were retrospectively analysed. The study was planned, approved, and executed between March 2025 and December 2025, including data extraction, analysis, and interpretation. The study protocol was reviewed and approved on 16th July 2025 by the Institutional Ethics Committee of the Regional Cancer Centre for retrospective analysis of data obtained from existing plateletpheresis records (HEC approval no. 40/25).

Inclusion criteria: Donors were required to meet the following criterions: age within the accepted donation range, male sex, body weight ≥55 kg, haemoglobin ≥12.5 g/dL, total leukocyte count within normal limits, and a predonation platelet count ≥150 × 10^9/L. Eligibility required compliance with the Transfusion Medicine Technical Manual (2022), issued by the Directorate General of Health Services, Government of India [15]. Additional criteria included written informed consent, suitable veins in both cubital fossae, achievement of a minimum target yield of 3 × 10^{11} platelets, and availability of postdonation samples.

Exclusion criteria: Donors were excluded if they screened reactive for transfusion-transmitted infections (hepatitis B, hepatitis C, Human Immunodeficiency Virus (HIV), syphilis, or malaria) or if their haematological indices were abnormal. Malaria was tested using a rapid card assay, while the remaining infections were assessed by chemiluminescence immunoassay.

Sample size: The sample size was determined by the number of eligible plateletpheresis procedures performed during the study period. All consecutive donations that met the inclusion and exclusion criteria and had complete records were included in the analysis. A total of 414 plateletpheresis procedures were analysed, comprising 207 procedures performed using the Trima Accel® and 207 using the Haemonetics® MCS® Plus system. As this was a retrospective observational study, no a priori sample size calculation was performed.

Procedure and testing: The Haemonetics® MCS® Plus was operated using the Label Distribution Protocol with software version LN-9000, while the TRIMA Accel® employed the 80300 protocol. Both separators were run with single-needle venous access, maintaining a blood-to-anticoagulant ratio between 9:1 and 10:1.

For each donor, demographic details and baseline haematological parameters were recorded. The device software was initialised with donor sex, weight, height, and count, and the system calculated the blood volume required to achieve the target yield of 3 × 10^{11} platelets. Peripheral blood samples were collected in EDTA tubes: Five mL preprocedure for complete blood counts, grouping, and infection screening. Products were stored in standard SDP bags in a platelet agitator until day-1 of collection for postprocedure platelet count estimation, two mL product samples were aseptically withdrawn after gentle mixing. Counts were performed on automated haematology analyser (Automatic Medonic Haematology Analyser, M32).

Variables: The following donor, procedural, and product-related parameters were recorded: donor age, sex, weight, haemoglobin, pre- and post-donation platelet counts, total blood volume processed, product platelet count and volume, procedure duration, volume of Acid Citrate Dextrose-A (ACD-A) used, and occurrence of adverse effects.

Three derived parameters were calculated from these measurements [6,16].

Yield=Product volume×platelet count/μL.

Total platelet processed=(Pre platelet count + Post platelet count)/2 × Total blood volume processed (mL)×conversion factor

Collection efficiency=(Platelet yield ÷ Total platelet processed)×100.

Quality control and monitoring: Quality control included platelet count, volume, pH, residual leukocyte count, and swirling. Swirling was assessed visually, pH measured using a portable pH meter (Eutech Ion 2700) and residual leukocytes enumerated by Nageotte chamber. Product acceptance followed DGHS recommendations: Platelet count ≥3×10^{11}, pH ≥6.0, and residual WBC <5×10^6/unit [15]. Donor adverse effects and equipment alarms were documented. Ionised calcium was not measured, prophylactic calcium supplementation was given, and no monetary compensation was provided.

STATISTICAL ANALYSIS

Continuous variables were summarised as mean with Standard Deviation (SD) or with other descriptive statistics (median, interquartile range, minimum, maximum) as appropriate. Categorical variables were expressed as counts and percentages. Normality of continuous data was assessed using the Shapiro-Wilk test and visual inspection of histograms. Comparisons between machines were made using the Independent samples t-test for normally distributed variables and the Wilcoxon rank-sum test for non normally distributed variables. Categorical variables were compared using the Chi-square test or Fisher's-exact test, as appropriate. All analyses were performed using R software (version 4.5.1; R Foundation for Statistical Computing, Vienna, Austria), and a two-sided p-value <0.05 was considered statistically significant.

RESULTS

Baseline donor characteristics, including age, weight, and pre-donation platelet counts, were comparable between the two groups, with no statistically significant differences observed [Table/Fig-1], indicating a well-matched donor population for subsequent comparisons.

The comparative procedural characteristics of the two apheresis systems are summarised in [Table/Fig-2]. Trima Accel® required a significantly lower processed blood volume to achieve the target platelet yield compared with Haemonetics® MCS® Plus (p-value <0.001).

Parameter		n	Median	Minimum	Maximum
Age (years)		414	26.0	19.0	46.0
Weight (kg)		414	73.4	59.0	98.0
Parameter	**Machines**	**n**	**Mean±SD**		**p-value**
Age (years)	Trima	207	26.12±4.76		0.481
	MCS	207	26.45±4.78		
Weight (kg)	Trima	207	73.40±4.66		0.897
	MCS	207	73.59±4.29		
Pre platelet count (×10⁹/L)	Trima	207	227.85±26.67		0.329
	MCS	207	225.29±23.26		
Post platelet count (×10⁹/L)	Trima	207	190.60±44.03		0.011*
	MCS	207	181.41±37.12		

[Table/Fig-1]: Donor characteristics by apheresis machine.
SD: Standard deviation. Comparisons between groups were performed using the Wilcoxon rank-sum test.
*p<0.05, **p<0.01

Variables	Machine	n	Mean±SD	p-value
Volume processed (mL)	Trima	207	2489.25±154.26	< 0.001**
	MCS	207	2668.87±268.85	
Platelet volume (mL)	Trima	207	273.78±15.10	0.678
	MCS	207	270.81±19.33	
Yield (×10¹¹ platelets per unit)	Trima	207	3.18±0.33	0.237
	MCS	207	3.22±0.16	
ACD used (mL)	Trima	207	300.09±37.24	< 0.001**
	MCS	207	325.19±34.35	
Procedural time (minutes)	Trima	207	49.25±7.67	< 0.001**
	MCS	207	62.55±8.00	
Collection efficiency (%)	Trima	207	64.0±12.0	0.003**
	MCS	207	60.0±8.0	

[Table/Fig-2]: Procedural characteristics by apheresis machine.
SD: Standard deviation; ACD: Acid-citrate-dextrose. Comparisons between groups were performed using the Wilcoxon rank-sum test. *p<0.05, **p<0.01.

Although platelet yield and mean platelet volume were comparable between the two platforms, collection efficiency was significantly higher with Trima Accel® (p-value=0.003). In addition, the mean procedure duration was significantly shorter with Trima Accel® than with Haemonetics® MCS® Plus (p-value <0.001). The mean volume of anticoagulant (Acid-citrate-dextrose-A (ACD-A) used was also significantly lower with Trima Accel® (p-value <0.001). Target platelet yield was achieved in a higher proportion of procedures performed with Trima Accel® (91.3%) compared with Haemonetics® MCS® Plus (76.8%).

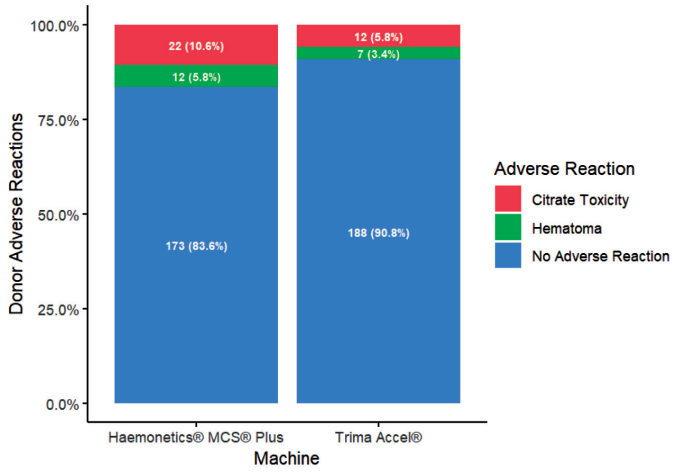
Platelet product quality was assessed using routine quality control parameters. All plateletpheresis units collected on both the Haemonetics® MCS® Plus and Trima Accel® platforms met established quality standards, with adequate swirling observed in all units, platelet product pH maintained at ≥ 6.4, and residual leukocyte counts consistently below 1×10^6 WBC per unit. A small proportion of units collected with Haemonetics® MCS® Plus demonstrated visible red blood cell contamination (n=6; 2.9%), whereas no such contamination was observed with Trima Accel®.

Postdonation platelet counts were significantly higher following procedures performed with Trima Accel® compared with Haemonetics® MCS® Plus (p-value=0.011) [Table/Fig-1]. Accordingly, the reduction in platelet counts from pre- to postdonation was greater with Haemonetics® MCS® Plus, indicating higher platelet removal per procedure.

Adverse donor reactions by apheresis platform are summarised in [Table/Fig-3]. The overall incidence of adverse reactions was significantly lower with Trima Accel® compared with Haemonetics® MCS® Plus (9.2% vs. 16.4%; p-value=0.039). As shown in [Table/Fig-4], citrate-toxicity constituted the most frequent adverse reaction in both systems, followed by local haematoma, while the majority of procedures were completed without any complications.

Adverse reaction	Machine	N (%)		p-value
		Yes	No	
Presence of adverse reactions	Trima	19 (9.2)	188 (90.8)	0.039*
	MCS	34 (16.4)	173 (83.6)	

[Table/Fig-3]: Adverse reactions by apheresis machine.
Comparisons between groups were performed using the χ^2 (Chi-square) test.
*p<0.05, **p<0.01



[Table/Fig-4]: Adverse donor reaction by apheresis machine.

DISCUSSION

The present study provides a contemporary comparative evaluation of the Haemonetics® MCS® Plus and Trima Accel® plateletpheresis systems, utilising a large real-world dataset of 414 procedures performed during 2023 in a high-volume tertiary cancer care centre in India. These findings contribute to a growing body of evidence regarding the relative performance, safety, and efficiency of these widely utilised cell separators. Several key observations emerge: Trima Accel® achieved significantly shorter procedural times, required lower blood volume processing, consumed less anticoagulant, and demonstrated higher collection efficiency compared with Haemonetics® MCS® Plus, while maintaining comparable platelet yield and quality. Furthermore, the incidence of adverse donor reactions was significantly lower with Trima, underscoring its potential advantages for both operational efficiency and donor safety.

In this study, Trima Accel® achieved both shorter procedure times (49.2 vs 62.6 minutes) and higher mean collection efficiency (64.0 % vs 60.0 %) compared with Haemonetics® MCS® Plus. Reduced duration has practical significance in high-demand centres, facilitating greater donor throughput and minimising fatigue, while improved efficiency reflects more effective utilisation of circulating platelets and potentially reduced frequency of donor recruitment in high-demand settings. Comparable findings have been reported previously. Baruah S and Bajpai M demonstrated shorter collection times with Trima Accel®, attributing this to continuous-flow design and integrated yield-prediction algorithms [6]. Similarly, the study attributed the lower efficiency of Haemonetics® MCS® Plus to its older software version, which required a greater number of cycles and higher processed blood volume to achieve the target yield of 3×10^{11} platelets. This higher processing demand likely contributes to both longer duration and lower efficiency. Arcot PJ et al., further confirmed that Trima required less time and achieved greater efficiency than MCS Plus in a five-machine comparison from Indian tertiary care practice [8]. Prior comparative studies have consistently demonstrated superior procedure efficiency and shorter collection times with continuous-flow plateletpheresis platforms compared

with intermittent-flow systems [2,11,17,18]. In a retrospective study of 219 apheresis procedures stratified by donor haematocrit comparing Haemonetics MCS with Trima Accel, Trima showed markedly higher collection efficiency and, consistent with its higher collection rate/yield-per-hour, reached the target dose in less time [19]. These findings reflect the inherent advantage of continuous-flow technology, which permits simultaneous draw and return and avoids the pause cycles that prolong intermittent-flow procedures [7,20]. The findings of the present study closely corroborate their observations, though the larger sample size in this study provides greater statistical robustness.

In this study cohort, the Haemonetics® MCS® Plus required substantially greater blood volume processing compared with Trima Accel®, resulting in longer procedure times and lower procedural efficiency. This mechanistic link was clearly evident in this dataset and reinforces observations from prior studies [6-8]. Importantly, these process-related drawbacks did not compromise product performance, as platelet yield and component volume were comparable between the two platforms, confirming that the clinical quality of the final product remains preserved.

However, the interpretation of collection efficiency warrants caution. Chaudhary R et al., in their five-platform study, noted that efficiency is not an ideal metric for comparing machines, as donor-related variables- such as baseline platelet count and body size- significantly influence this parameter [2]. Similar concerns were raised by Arcot PJ et al., who emphasised that efficiency values may not be directly comparable across studies because of heterogeneity in donor pools and operational settings [8]. Taken together, these reports suggest that while Trima consistently performs better than MCS in terms of procedure duration and apparent efficiency, absolute efficiency figures should be interpreted in the context of donor and protocol variables rather than as standalone indicators of device performance.

While donor-related characteristics such as baseline platelet count, weight, sex, and age are known to influence yield, the donor pool in this study was broadly comparable to that reported in Indian plateletpheresis [2,6,8,21,22], and these variables were evenly distributed across procedures performed on both platforms. Within the study dataset, none of these donor factors showed statistically significant differences between Trima and MCS procedures, indicating that the observed inter-machine differences in efficiency, duration, processed volume, and yield-related measures cannot be attributed to systematic donor variation. Thus, the performance advantage of Trima Accel® in this study is best explained by device-specific factors rather than underlying donor characteristics.

In this study, postdonation platelet counts were higher with Trima Accel®, and the pre-to-post decline was significantly larger with Haemonetics® MCS® Plus, indicating less platelet depletion when using Trima for an equivalent product. Mechanistically, this aligns with Trima's lower processed blood volume and reduced ACD-A usage, both of which mitigate physiologic stress and platelet exposure. Importantly, these differences echo findings in prior work: Baruah S and Bajpai M, documented lower ACD use with Trima and a smaller postprocedure platelet drop and attributed the higher incidence of citrate toxicity in MCS partly to greater anticoagulant load [6]. Arcot PJ et al., further substantiated this by showing that MCS required a higher effective collection volume to reach the same yield, which implicitly increases platelet exposure and depletion risk [8]. Consistent with the lesser platelet drop, adverse reactions in this data were significantly lower for Trima (9.2% vs 16.4%), with citrate symptoms predominating followed by haematoma, echoing the reaction profiles in earlier comparative studies [23,24].

Beyond donor safety, Trima also demonstrated superior product quality. Both platforms produced leukoreduced platelet components, but Trima achieved target yields more reliably and completely avoided visible Red Blood Cell (RBC) contamination. For high-volume centres, this translates into more predictable inventory and reduced product wastage, while reinforcing transfusion safety. Combined with greater efficiency and fewer donor reactions, these findings position continuous-flow platforms as advantageous for operators, donors, and recipients alike.

The principal strengths of this study are its large sample size from a high-volume tertiary cancer centre, conferring both statistical robustness and real-world relevance. In addition, multiple domains including procedure efficiency, platelet yield, donor safety, and product quality were evaluated, allowing for a broader comparison rather than a narrow focus. Overall, the findings indicate that Trima Accel® demonstrated better procedural efficiency, donor safety, and product consistency compared with Haemonetics® MCS® Plus, while maintaining equivalent platelet yield and quality.

Limitation(s)

However, several limitations should be acknowledged. Being a single-centre, retrospective study, the findings may not be generalisable and are subject to reporting bias. The donor pool was predominantly male, and only one version of each device was assessed, so newer software improvements were not captured.

Larger multicentre and prospective studies are warranted to confirm these findings across diverse settings.

CONCLUSION(S)

In this study comparing Haemonetics® MCS® Plus and Trima Accel® plateletpheresis systems in a high-volume oncology setting, Trima Accel® demonstrated superior procedural efficiency, with shorter procedure times, lower processed blood volumes, reduced anticoagulant usage, and higher collection efficiency, while maintaining comparable platelet yield and product quality. Trima Accel® was also associated with a significantly lower incidence of adverse donor reactions and less post-donation platelet depletion. Under standardised operating conditions, continuous-flow plateletpheresis with Trima Accel® provides efficiency and donor-safety advantages over intermittent-flow systems, making it better suited for high-demand, resource-constrained transfusion services.

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