Review Article

Recent advances in platelet distribution width

Sheetal Kumari, R. Priyadharshini, Sinduja Palati

Department of Pathology, Saveetha Dental College and Hospitals, Saveetha Institute of Medical and Technical Sciences, Saveetha University, Chennai, Tamil Nadu, India

Abstract
Platelet distribution width (PDW) is a regular parameter in blood routine examination which reflects the variation of platelet size distribution with a range from 8.3% to 56.6%. PDW is a measure of platelet anisocytosis dependent on individual platelet volume distribution. Thrombocrit (or plateletcrit) is the percentage of blood volume occupied by platelets and is an assessment of circulating platelet mass. Platelets in whole blood can be detected using the same electrical or electro-optical measurement methods that are being used to count red cells. Platelets must be separated from red cells using an upper threshold, whereas debris and electrical noise must be separated using a lower threshold. Many recent advancements in terms of PDW have been demonstrated in this research. First, it was tested whether the PDW was based on both mean platelet volume and Platelet (Thrombocyte) count Test (PLT) in a population of patients with high PLTs. In the second stage, we looked into whether combining these three parameters could help differentiate between patients with reactive and autonomous thrombocytosis. Other studies are needed to validate these preliminary findings, and they should be expanded to include PDW tested on other automated blood counters.

Keywords: Innovative technique, mean platelet volume, platelet count, platelet distribution width platelets, thrombocythemia

INTRODUCTION

Platelets in whole blood can be counted using the same electrical or electro-optical measurement methods that are used to count red cells. Separating platelets from red cells necessitate an upper threshold, whereas separating platelets from debris and electrical noise necessitate a lower threshold. Red cell recirculation near the aperture should be avoided because the pulses emitted can be mistaken for platelet pulses.[1] Giant platelets being mistaken for red cells or ethylenediaminetetraacetic acid-induced platelet clumping or satellitism can cause falsely low impedance platelet counts. Fast platelet counts may be due to microcytic or broken red cells, white cell fragments in leukemia 84, or bacteria or fungi, which is misleading.[2] The present study is a review-based study.

Total number of articles collected was twenty. Qualitative analysis of these twenty articles was done, and the details were represented. Data were collected through sources such as ResearchGate, Google Scholar, and PubMed. The duration of the article's publication period was from January 2000 to March 2021. Number of articles selected was verified, filtered, and identified. Five steps in

Access this article online	
Quick Response Code:	**Website:** www.ijcpc.org
	DOI: 10.4103/ijcpc.ijcpc_12_21

article selection include identification of relevant articles, selection, and data extraction and charting. Analysis was done, and a report was prepared. Only those articles were included which had specific alternatives and recent advancements in platelet distribution width (PDW). Articles that did not fit the selection criteria were excluded.

PLATELET DISTRIBUTION WIDTH

PDW is a regular parameter in blood routine examination which reflects the variation of platelet size distribution with a range from 8.3% to 56.6%. PDW can be also termed as a measurement of platelet anisocytosis calculated from the distribution of individual platelet volumes. Thrombocrit (or plateletcrit) is said to be the percentage of blood volume occupied by platelets which can be carried out for the circulation of platelet mass.[3] An optical fluorescence platelet count has been introduced on some Sysmex analyzers, in addition to the traditional impedance count.

The RNA of reticulocytes and platelet membranes and granules is stained with a dye. The fluorescent staining of the platelets allows the exclusion of nonplatelet particles from the count and also allows the inclusion of large or giant platelets. The impedance count is sometimes more precise for samples from patients receiving cytotoxic chemotherapy. This is probably due to the erroneous staining of white cell fragments following apoptosis.[4] In health, there are approximately $150–400 \times 10^9$ platelets per liter of blood. The counts are somewhat higher in women than in men, and there is cycling, with slightly lower counts at about the time of menstruation. In apparently healthy Afro-Caribbean and Africans, platelet counts are lower than in Caucasians. The PDW, which is a measure of platelet anisocytosis, and the "plateletcrit," which is the product of the mean platelet volume (MPV) and platelet count and, like the hematocrit, can be used to estimate the amount of circulating platelets per unit volume of blood.[5]

CLINICAL CORRELATION OF PLATELET DISTRIBUTION WIDTH

The platelet-large cell ratio (P-LCR) was reported by some of the instruments, and the number of platelets falling above the 12 fl threshold on the platelet size histogram was divided by the total number of platelets. A high P-LCR or PDW indicates peripheral immune destruction of platelets. The PDW helps in distinguishing essential thrombocythemia (PDW increased) from reactive thrombocytosis (PDW normal). The plateletcrit does not provide any information of clinical value. All derived platelet parameters are highly specific to the individual technologies, with different analyzers having different

normal ranges.[6] In terms of reticulated platelets and immature platelet fraction (IPF), once the labeling is done with specific immunological markers and a fluorescent dye that binds RNA, it is possible to identify young platelets with a higher RNA content by flow cytometry. By correlation with the reticulocyte count, these have been called "reticulated platelets," and it has been suggested that an increased number in the circulation is a sensitive and early indication of recovery of thrombopoiesis in aplastic anemia. However, because there is a constant exchange of platelets between the circulation and the spleen, it is not clear whether their presence in the blood has the same significance as reticulocytes.

On some Sysmex instruments, a new automated method for quantifying reticulated platelets, known as the IPF, has been developed. A fluorescent dye-containing polymethine and oxazine are used to calculate the IPF. These two dyes penetrate the cell membrane, staining some RNA in red cells and platelets, before passing the stained cells through a semiconductor diode beam laser. Reticulocytes and reticulated platelets are characterized by measuring the forward light scatter (cell volume) and fluorescence intensity (RNA content). Patients with peripheral platelet consumption/destruction (autoimmune thrombocytopenic purpura and thrombotic thrombocytopenic purpura) have a higher IPF value, whereas patients with marrow failure have an average or low value. Larger platelets and increased MPV consistently are inversely correlated to platelet numbers, which thus may assure the clinician that a thrombocytopenia in the patient is real and not a laboratory error. Since large platelets are more mechanically involved, some dogs with platelet counts <10,000/l do not bleed excessively. Platelets on blood smears often have pseudopodia and an irregular shape, indicating platelet activation during blood collection and handling.[7]

INCLUSION OF PLATELET DISTRIBUTION WIDTH IN 5 PART AUTOMATED ANALYSER

A fully automated full blood count, including a platelet count, first became available in the 1970s, and it rendered possible the ability to additionally measure other important parameters. The MPV, PDW, and platelet wide cell ratio are all dependent on platelet distribution (P-LCR). With the ultimate technological convergence of flow cytometric and aperture impedance principles, platelet counting can now also be performed by either optical (one-dimensional or two-dimensional scatter and fluorescence) or immunological methods (e.g.,-CD61 ImmunoPLATE), which may be more accurate in some samples, the latter providing the basis of a new, very precise flow cytometric reference method for platelet counting (i.e., the platelet/RBC ratio).[8]

MPV and PDW are termed as platelet indices, which increase during platelet activation. To obtain a larger surface platelet, a change in shape is observed during activation. Their shape changes from discoid to spherical. Pseudopodia are formed as well at the time of activation. PDW is a more specific indicator of platelet activation than MPV since it is not elevated during single platelet distension caused by platelet swelling. The combined use of MPV and PDW could predict the activation of coagulation more efficiently and effectively.[9]

MEAN PLATELET VOLUME AND PLATELET DISTRIBUTION WIDTH

Platelets can be counted using the same techniques of electrical or electro-optical detection and are used for counting red cells. PDW can be termed as a measurement of platelet anisocytosis calculated from the distribution of individual platelet volumes. PDW is also said to be a regular parameter in blood routine examination which shows the variation of platelet size distribution with a range from 8.3% to 56.6%.

Despite the fact that platelet parameters such as the MPV and PDW have been available to clinicians for some time, their importance in patient diagnosis and management is still unknown.[10] Several studies tried to use MPV and (or) PDW to distinguish between RT and thrombocytosis associated with MPD. Although they constantly gave out significant differences between the two groups with respect to MPV and PDW, the sensitivity was not sufficient to allow differential diagnosis in an individual patient. All of these researches, on the other hand, interpreted PDW separately from MPV and PLT. Despite the fact that platelet parameters such as MPV and PDW have been available for some time, their clinical utility has been limited due to the likelihood that they are affected by the time between blood collection and examination. Furthermore, PDW was calculated differently on various instruments.[11] PDW expresses the distribution of the size of platelets produced by the megakaryocyte. In cases of autonomous platelet hyperproduction, the megakaryocyte's influence over platelet size is likely to be impaired, as demonstrated by an expanded dispersion. Intuitively, it seemed preferable in such cases to explain that, for a given PLT and MPV value, the PDW was high, and thereby for a given PDW, the MPV, or the PLT was too low.

The increased PDW residual probably reflects a dysregulation in thrombopoiesis, which is also translated by the multiple abnormalities of platelet reactivity and the change in platelet membrane and adenine nucleotide content that have been previously described. By using a parameter such as PDW, we were able to achieve a fairly interesting resolution between reactive and autonomous thrombocytosis.[12] This approach is costless and effortless and requires only the creation of a laboratory database and the use of a simple linear multiple regression model; the megakaryocyte's control over platelet size is likely to be compromised in cases of autonomous platelet hyperproduction, as evidenced by an increased dispersion. These preliminary data need to be confirmed by other studies for future purposes and should be extended to PDW measured on other automated blood counters.[13] Our team has extensive knowledge and research experience that has translated into high-quality publications[14-33]

CONCLUSION

This review overviewed the PDW in different aspects including its analysis and principle, clinical implications, and synergistic use of MPV. PDW is a regular parameter in blood routine examination which reflects variation of platelet size distribution with a range from 8.3% to 56.6%. It should be analyzed along with other hematological parameters as a theranostic and prognostic factor.

Conflicts of interest
There are no conflicts of interest.

REFERENCES

1. Bommenahalli Gowda S, Gosavi S, Ananda Rao A, Shastry S, Raj SC, Menon S, *et al*. Prognosis of COVID-19: Red cell distribution width, platelet distribution width, and C-reactive protein. Cureus 2021;13:e13078.
2. Li H, Jiao J. Association of gender difference to Platelet Count (PC), Mean Platelet Volume (MPV) and Platelet Distribution Width (PDW) Levels in Non-alcoholic Fatty Liver Disease (NAFLD) patients. J Coll Physicians Surg Pak 2021;31:115-6.
3. Institute NC, National Cancer Institute. Platelet Distribution Width. Definitions; 2020;17. doi: 10.32388/5tj6pu.
4. Koc I, Dogan Y, Dogan S. Importance of mean platelet volume, platelet distribution width and red blood cell distribution width in asthmatic subjects. European Respiratory Journal 2015;46:1113-30.
5. Sachdev R, Tiwari A, Goel S, Raina V, Sethi M. Establishing biological

reference intervals for novel platelet parameters (immature platelet fraction, high immature platelet fraction, platelet distribution width, platelet large cell ratio, platelet-X, plateletcrit, and platelet distribution width) and their correlations among each other. Indian J Pathol Microbiol 2014;57:231.

6. Kiratli K, Çevik E. Investigation of mean platelet volume, platelet distribution width and erythrocyte distribution width in patients with hepatitis B virus infection. Viral Hepatit Dergisi 2017;23:60-3.
7. Demir S. Redcell distribution width, mean platelet volume, platelet distribution width parameters and disease severity relationship in patients with obstructive sleep apnea syndrome. J Turk Sleep Med 2016;3:39-42.
8. Khairkar PS, Pandey A, More S, Pandey M. Platelet Distribution Width (PDW) – A rarely studied platelet indice for determining the causes of thrombocytopenia. Ann Int Med Dent Res 2016;2:49.
9. Jaman S. Association of mean platelet volume and platelet distribution width with Hba1c. J Endocrinol Diabetes 2017;4:1-6.
10. N S, Sinem N. Mean platelet volume is associated with coronary artery disease and cardiovascular risk factors, but platelet distribution width not. Med J Clin Trials Case Stud 2018;45:108-13.
11. Joshi AA, Jaison J, *et al*. The study of platelet parameters – Mean Platelet Volume (MPV) and Platelet Distribution Width (PDW) in type 2 diabetes mellitus. Ann Pathol Lab Med 2019;6:A407-13.
12. Cheng S, Han F, Wang Y, Xu Y, Qu T, Ju Y, *et al*. The red distribution width and the platelet distribution width as prognostic predictors in gastric cancer. BMC Gastroenterol 2017;17:163.
13. Institute NC, National Cancer Institute. Platelet Mass Distribution Width. Definitions; 2020;46:125-32.
14. Anita R, Paramasivam A, Priyadharsini JV, Chitra S. The m6A readers YTHDF1 and YTHDF3 aberrations associated with metastasis and predict poor prognosis in breast cancer patients. Am J Cancer Res 2020;10:2546-54.
15. Jayaseelan VP, Paramasivam A. Emerging role of NET inhibitors in cardiovascular diseases. Hypertens Res 2020;43:1459-61.
16. Sivakumar S, Smiline Girija AS, Vijayashree Priyadharsini J. Evaluation of the inhibitory effect of caffeic acid and gallic acid on tetR and tetM efflux pumps mediating tetracycline resistance in *Streptococcus* sp, using computational approach. J King Saud Univ Sci 2020;32:904-9.
17. Smiline Girija AS. Delineating the immuno-dominant antigenic vaccine peptides against gacS-Sensor kinase in *Acinetobacter baumannii*: An *in silico* investigational approach. Front Microbiol 2020;11:2078.
18. Iswarya Jaisankar A, Smiline Girija AS, Gunasekaran S, Vijayashree Priyadharsini J. Molecular characterisation of csgA gene among ESBL strains of *A. baumannii* and targeting with essential oil compounds from *Azadirachta indica*. J King Saud Univ Sci 2020;32:3380-7.
19. Girija AS. Fox3⁺CD25⁺CD4⁺T-regulatory cells may transform the nCoV's final destiny to CNS! J Med Virol 2021;93:5673-5.
20. Jayaseelan VP, Ramesh A, Arumugam P. Breast cancer and DDT: Putative interactions, associated gene alterations, and molecular pathways. Environ Sci Pollut Res Int 2021;28:27162-73.
21. Arumugam P, George R, Jayaseelan VP. Aberrations of m6A regulators are associated with tumorigenesis and metastasis in head and neck squamous cell carcinoma. Arch Oral Biol 2021;122:105030.
22. Kumar SP, Girija AS, Priyadharsini JV. Targeting NM23H1mediated inhibition of tumour metastasis in viral hepatitis with bioactive compounds from Ganoderma lucidum: A computational study. Pharm Sci 2020;43:1115-21.
23. Girija SA, Priyadharsini JV, Paramasivam A. Prevalence of carbapenem-hydrolyzing OXA-type β-lactamases among *Acinetobacter baumannii* in patients with severe urinary tract infection. Acta Microbiol Immunol Hung 2019;67:49-55.
24. Priyadharsini JV, Paramasivam A. RNA editors: Key regulators of viral response in cancer patients. Epigenomics 2021;13:165-7.
25. Mathivadani V, Smiline AS, Priyadharsini JV. Targeting Epstein-Barr virus nuclear antigen 1 (EBNA-1) with *Murraya koengii* bio-compounds: An *in-silico* approach. Acta Virol 2020;64:93-9.
26. Girija As S, Priyadharsini JV, Paramasivam A. Prevalence of Acb and non-Acb complex in elderly population with Urinary Tract Infection (UTI). Acta Clin Belg 2021;76:106-12.
27. Anchana SR, Girija SA, Gunasekaran S, Priyadharsini VJ. Detection of csgA gene in carbapenem-resistant *Acinetobacter baumannii* strains and targeting with *Ocimum sanctum* biocompounds. Iran J Basic Med Sci 2021;24:690-8.
28. Girija AS, Shoba G, Priyadharsini JV. Accessing the T-cell and B-cell immuno-dominant peptides from *A. baumannii* Biofilm Associated Protein (BAP) as vaccine candidates: A computational approach. Int J Pept Res Ther 2021;27:37-45.
29. Arvind TR, Jain RK. Skeletally anchored forsus fatigue resistant device for correction of Class II malocclusions – A systematic review and meta-analysis. Orthod Craniofac Res 2021;24:52-61.
30. Venugopal A, Vaid N, Bowman SJ. Outstanding, yet redundant? After all, you may be another choluteca bridge! Semin Orthod 2021;27:53-6.
31. Ramadurai N, Gurunathan D, Samuel AV, Subramanian E, Rodrigues SJ. Effectiveness of 2% Articaine as an anesthetic agent in children: Randomized controlled trial. Clin Oral Investig 2019;23:3543-50.
32. Varghese SS, Ramesh A, Veeraiyan DN. Blended module-based teaching in biostatistics and research methodology: A retrospective study with postgraduate dental students. J Dent Educ 2019;83:445-50.
33. Mathew MG, Samuel SR, Soni AJ, Roopa KB. Evaluation of adhesion of *Streptococcus mutans*, plaque accumulation on zirconia and stainless steel crowns, and surrounding gingival inflammation in primary molars: Randomized controlled trial. Clin Oral Investig 2020;24:3275-80.