STM JOURNALS

Research & Reviews: Journal of
Oncology and Hematology

ISSN: 2319–3387
Volume 13, Issue 2, 2024
DOI (Journal): 10.37591/RRJoOH

https://journals.stmjournals.com/rrjooh/

Review RRJoOH

# Platelets A Tiny Cell Fragments

Jagrati shakya[1], Ajit Pal Singh[2,*]

**Abstract**

*Platelets are disc-shaped, anucleate cells that are approximately 2-3 µm in diameter. Their primary function is to control hemostasis, or blood clotting, but they also play important roles in angiogenesis (the formation of new blood vessels) and innate immunity (the body's first line of defence against infection). With a diameter of just 2-3 microns, platelets are tiny, disc-shaped cells that lack a nucleus. While their main responsibility is to ensure proper blood clotting, they also contribute to wound healing and immune function. Platelets, disc-like cells measuring around 2-3 µm in diameter and lacking a nucleus, are essential for blood clotting (hemostasis). However, their roles extend beyond this, as they also support the formation of new blood vessels (angiogenesis) and the body's innate immune response. While adult humans have about one trillion platelets constantly circulating, their regeneration mechanism remains largely unknown. Platelets originate from nucleated cells known as megakaryocytes, primarily located in the bone marrow. These cells range in size from 30 to 100 µm. During development, megakaryocytes extend proplatelet elongations into sinusoidal blood vessels, releasing platelets. These platelets develop distinct structural features, including a well-defined plasma membrane, an open canalicular system (OCS), a dense tubular system (DTS), and various organelles like peroxisomes, lysosomes, mitochondria, and dense granules. Understanding the increasingly varied and numerous biological roles of circulating platelets requires an understanding of the complex and multiple process of proplatelet elongation and platelet formation, which defines the morphology and ultrastructure of circulating platelets. Physiological hemostasis involves the quick formation of a platelet plug to stop bleeding following arterial injury. High platelet residual reactivity promotes thromboembolic problems in individuals on antiplatelet medication, whereas qualitative and/or quantitative platelet abnormalities promote bleeding. The molecular mechanisms behind the different phases of platelet activation—adhesion, shape change, release reaction, and aggregation—have been well-defined, although their complete translation into laboratory experiments has not yet been accomplished. Laboratory tests of platelet function, such as bleeding time, Lumi aggregometry, light transmission platelet aggregation, impedance aggregometry on whole blood, and platelet activation assessed by flow cytometry, have historically been used to diagnose hemostatic disorders and treat patients with platelet and hemostatic defects.*

**Key words**: Cells, Bleeding, membrane, morphology, adhesion.

***Author for Correspondence**
Ajit Pal Singh
E-mail: ajit.singh1@sharda.ac.in

[1]Student, Department of Medical Lab Technology, SSAHS, Sharda University, Gr. Noida, U.P, India
[2]Assistant Professor, Department of Medical Lab Technology, SSAHS, Sharda University, Gr. Noida, U.P, India.

Received Date: February 26, 2024
Accepted Date: March 04, 2024
Published Date: August 22, 2024

**Citation:** Jagrati shakya, Ajit Pal Singh. Platelets A Tiny Cell Fragments Research & Reviews: Journal of Oncology and Hematology. 2024; 13, Issue 2, 22–28p

## INTRODUCTION

Proplatelets, finger-like extensions from megakaryocytes in the bone marrow, fragment into small, disc-shaped platelets that enter the bloodstream**.** These platelets, measuring 2-4 µm in diameter, have a typical count of 150,000 to 450,000 per microliter of human blood and a lifespan of 8-10 days. Although lacking a nucleus, platelets remain metabolically active thanks to their mitochondria, Golgi apparatus, endoplasmic reticulum, and ability to synthesize proteins from mRNA. Notably, platelets rely more heavily on their mitochondria for energy production than other

 

cells**,** highlighting their unique role in blood clotting and function**.** Healthy platelets typically contain only 5 to 8 mitochondria, each playing a crucial role in their function [1,2]**.** Maintaining the integrity of these mitochondria is essential for proper platelet activity. Recent scientific advancements, fueled by the discovery of their rich granular content, have revealed a new understanding of platelets beyond their traditional role in blood clotting. These granules, packed with growth factors, cytokines, and other signaling molecules, suggest broader functions in areas like immunity, inflammation, and tissue repair. Platelets are no longer solely seen as blood-clotting agents; they harbor a diverse arsenal of signaling molecules within their granules. These molecules, including growth factors, cytokines, and other modulators, can interact with various cell types like endothelial cells, mesenchymal cells, osteoblasts, and fibroblasts, exerting a broad range of effects beyond coagulation [34].

**Key Functions of these Platelet-Derived Modulators Include**

- *Regulating Diverse Biological Processes***:** Inflammation, angiogenesis (blood vessel formation), stem cell migration, and cell proliferation are all influenced by these molecules [5].
- *Promoting Tissue Repair and Regeneration:* Specific growth factors within platelets can stimulate the growth and migration of cells involved in healing processes.
- *Modulating Immune Responses:* Platelets can contribute to both inflammatory and anti-inflammatory processes, depending on the context.
- *Participating in Host Defence:* Acid proteases and glycohydrolases in platelet lysosomes can directly combat bacteria and contribute to the clearance of platelet aggregates.

However, the multifaceted roles of these modulators also come with potential downsides**.** For instance, their involvement in angiogenesis and cell proliferation might contribute to the development of certain pathologies [6].

Therefore, understanding the complex interplay between platelet-derived modulators and other cellular components is crucial for various fields, including:

- Developing targeted therapies for conditions like inflammation, wound healing, and cancer.
- Designing strategies to prevent or treat pathological angiogenesis.
- Optimizing the use of platelet-derived products in regenerative medicine [7].

Fig 1. Overall, platelets represent a fascinating reservoir of bioactive molecules with diverse functions beyond their traditional role in hemostasis**.** Future research in this area holds immense potential for advancing our understanding of various physiological and pathological processes.

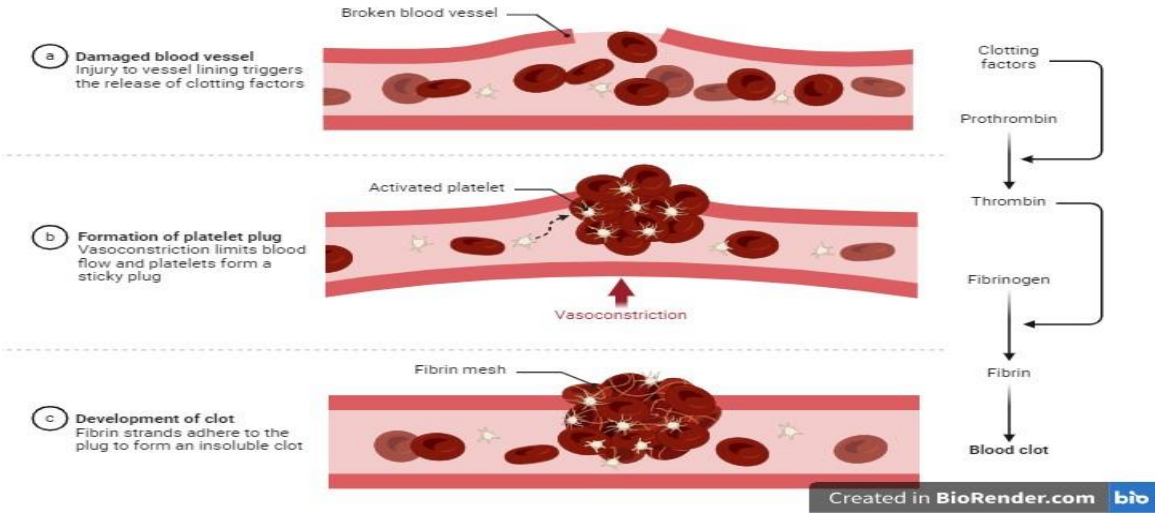


**Fig 1.** Image showing the functioning of platelets

 

**Implications of Platelet Formations**

Balanced thrombopoiesis is crucial, directly impacting platelet levels and their associated challenges. Insufficient platelets lead to excessive bleeding, even from minor wounds, while excess platelets can cause blood clots (thrombosis) that block arteries and trigger ischemic events like myocardial infarction, stroke, pulmonary embolism, and tissue infarction. Maintaining balanced thrombopoiesis is essential for regulating platelet levels and preventing the complications they pose [8]. Too few platelets lead to excessive bleeding, while too many can cause blood clots (thrombosis), blocking arteries and causing ischemic events like heart attacks, strokes, and tissue infarction. Platelet disorders, also known as thrombocytopathies, can manifest as thrombocytopenia (low platelet count), thrombocytopathy (impaired platelet function), or thrombocytosis (high platelet count)**.** These issues often arise from abnormalities in the regulation of thrombopoietin feedback, but can also be caused by genetic factors, certain medications, and underlying medical conditions**.** For example, thrombocytopenia is a common symptom of acute myeloid leukemia, where malignant myeloid cells in the bone marrow crowd out healthy cells, hindering platelet production (thrombopoiesis) [9].

**Morphology of Platelet Formation**

Platelets in EDTA-anticoagulated blood are spherical or oval in form, with a diameter of 1-3 μm. In blood smears made from native capillary blood, platelets tend to cluster and take on the appearance of stars due to activation. The cytoplasm of platelets contains tiny, azurophilic granules called granulomeres, which can be distributed or concentrated in the platelet's core. There are functional analogues between the granulomere and secretome. The peripheral, granule-free, colourless, or mildly basophilic area of the cytoplasm is known as the hyalome [10].

**Assessment of Platelets Size**

For diagnostic purposes, the platelet size becomes even more significant when compared to the platelet count. Platelet size can be easily interpreted by comparing the diameter of the platelets with the diameter of the red blood cells in peripheral blood smears. While enormous platelets are classified as platelets greater than 7 μm and up to 20 μm, which resemble erythrocytes or lymphocytes, macrophages are large platelets. In healthy subjects, the percentage of big platelets is usually less than 5. Accurate interpretation of the platelet size assessment requires knowledge of the physiological heterogeneity of platelet diameters and any preanalytical influencing factors (e.g., storage artefacts) [11]. Platelets may enlarge and degranulate when blood is held in EDTA-anticoagulated blood, looking big and hypogranular on peripheral blood smears. Neonates exhibit a broad variability in platelet size, known as platelet anisocytosis, which is more pronounced than in adults due to the presence of larger-size platelets after birth. When thrombopoiesis is enhanced, larger, younger platelets are more frequently seen. As a result, platelet size plays a crucial role in the diagnosis of thrombocytopenia in patients. Large platelets are more likely to be associated with greater platelet turnover, which may be a sign of thrombotic microangiopathies, immunological thrombocytopenia, or disseminated intravascular coagulation. Reduced production of platelets in the bone marrow due to megaloblastic anaemia, chemotherapy, ionising radiation, drug toxicity, or bone marrow invasion may be indicated by small platelets in thrombocytopenia [12].

**Causes Related to Platelet Size**

*Acquired Causes of Large Platelets: - [13]*

1. Immune Thrombocytopenia.
2. Myelodysplastic Syndromes.
3. Myeloproliferative neoplasms.
4. Megakaryoblastic Leukaemia.
5. Disseminated Intravascular Coagulation.

*Causes of Small Platelets: - [14]*

1. Inherited Thrombocytopenia.
2. FYB related thrombocytopenia.

 

3. CYCS related thrombocytopenia.
4. X-linked thrombocytopenia.

**Methodology**

*Platelet Function Methodology*

In many therapeutic contexts, the evaluation of platelet function has grown in significance in recent years. 1) transfusion medication; 2) response monitoring to antiplatelet therapy; 3) assessment of perioperative hemostasis; and 4) patient identification for bleeding problems. Due to the multiple roles that platelets play and the wide range of professions that study platelet function, various approaches have been created. As a matter of fact, several platelet methods are based on distinct operating principles, and there are very few assays that can investigate "all in one device" platelet activation pathways. The many operating modes of the devices may be based on the assessment of platelet adhesion and aggregation, the submission of platelets under specific shear circumstances, the analysis of the physical properties of the clot, and the measurement of platelet compounds. In addition to the wide range of assays and instruments available for researching platelet function, a number of preanalytical conditions can result in platelet artefacts that effect the various platelet functions since platelets are cells that can be easily triggered during blood collection. Consequently, a high degree of experience and competence is needed to execute and interpret PFT. Based on the idea that all platelet function methodologies are laboratory-based, this review aims to compare and contrast the various approaches [15].

The different platelet function tests reported in this review are grouped by the various methodological method of some platelet tests are discussed here:

**Bleeding Test**

- *Sample:* Native WB
- *Method Application:* Screening Test
- *Method Principle:* In vivo measurement of bleeding block

BT is the original test developed to evaluate primary hemostasis in vivo. 10 BT assesses platelets' capacity to form a hemostatic plug by measuring the time it takes for them to occlude an in vivo skin wound and stop the bleeding. Without requiring WB processing, the approach can be swiftly and readily performed. However, it is susceptible to a number of factors, such as patient variations in skin thickness and temperature, as well as incorrect administration of the test procedure. Nonetheless, the test is still not very accurate, its relationship to the clinical patient condition is not entirely evident, and it is standardized using easily accessible instruments [16].

**Impedance Platelet Aggregation**

- *Sample:* Citrated WB
- *Method Application:* Screening test for bleeding tendency Diagnostic for platelet defects Monitoring antiplatelet treatment effect
- *Method Principle:* Measurement of electrical impedance increase in relation to agonist-induced platelet aggregation.

Impedance Whole blood aggregometry (WBA) assesses platelet function using the anticoagulated WB as the milieu without the need for sample preparation. Forty It functions on the basis that active platelets use their surface receptors to attach to two artificial electrode surfaces in the WB sample that are separated by a predefined distance. Platelet aggregation is measured by measuring the increase in electrical impedance caused by other platelets aggregating on those attached to the electrodes. Consequently, when the current intensity drops, the electrical impedance increases. The impedance increase is expressed in terms of 14 ohms [17].

 

**Light Transmission Platelet Aggregation**

- *Sample:* Citrated PRP
- *Method Application:* Screening test for bleeding tendencyDiagnostic for platelet defects Monitoring antiplatelet treatment effect.
- *Method Principle:* Photo-optical measurement of light transmission increase in relation to agonist-induced platelet aggregation.

Born developed LTA in the 1960s, and it operates within the PRP.Twelve, Twenty-Four It remains the gold standard test for assessing the various platelet functions. In fact, mixing PRP with a wide range of agonists can yield a wealth of knowledge on the many mechanisms of platelet activation.

**Lumiaggregometry**

- *Sample:* Citrated WB
- *Method Application:* Detection of storage/release disorders
- *Method Principle:* LTA or WB aggregometry combined with luminescence.

Luminaggregometry allows for the simultaneous assessment of platelet aggregation and the release of adenine nucleotides**,** particularly adenosine triphosphate (ATP), from platelet granules. This measurement is achieved using a luminescence approach in platelet-rich plasma (PRP)**,** washed platelets (WP), or whole blood (WB). The conversion of ATP, released upon activation of platelet dense granules, into a luciferin-luciferase reagent generates light, which is measured by the lumi-aggregometer and correlated with ATP concentration. This technique provides insight into specific problems with degranulation, also known as storage pool defects, or deficiencies in the quantity and composition of dense granules [18].

**Platelet Works**

- *Sample:* Citrated WB
- *Method Application:* Monitoring of the platelet response to antiplatelet agents
- *Method Principle:* Platelet counting pre- and post-activation in whole blood.

This WB POC test method counts platelets both before and after aggregation. The Ichor blood counter (Helena Laboratories, Beaumont, TX, USA) and the platelet work aggregation kit, which consists of citrate tubes and EDTA used with agonists (ADP or AA), make up this system. The Platelet Works method compares the platelet count assessed in the control sample (EDTA tube) with those obtained after aggregation in citrate blood using ADP or AA (citrate tube plus agonist).

**TEG/Platelet Mapping System**

- *Sample:* Citrated WB
- *Method Application:* Assessment of global hemostasis plus monitoring antiplatelet treatments effect
- *Method Principle:* Evaluation of rate of clot formation based on low shear-induced and agonist addition.

Tools for assessing the hemostatic process as a whole include thromboelastography and thromboelastometry. These assays examine the whole clotting formation process, based on an examination of WB variations in viscoelastic forces.

**Flow Cytometry:**

- *Sample:* Citrated WB, PRP, W-Plt.
- *Method Application:* Cell counting, detection platelet activation by extent of expression of surface and/or cytoplasmic biomarkers.
- *Method Principle:* Engineering laser-based detection of suspending fluorescent label platelets in a flowing solution.

 

The technique known as flow cytometry (FC) makes it possible to rapidly evaluate the granularity and cell size of a wide range of cells, including platelets. FC analysis is a technique that includes multiple assays for different purposes, such as thrombopoiesis assessment, specific disorder diagnosis, activation state assessment (platelet membrane-associated IgG assessment), and antiplatelet agent monitoring. It can be used to determine the functional status of platelets in vivo.

**Global Thrombosis Test (GTT):**

- *Sample:* Native WB
- *Method Application:* Evaluation of platelet function and thrombolysis
- *Method Principle:* Measurement of time cessation of WB flow by high shear-dependent platelet plug formation.

Because the global thrombosis test (GTT) is conducted using native nonanticoagulated WB without the addition of agonists, it is a recent test that evaluates platelet function in a manner similar to physiological conditions [19].

**Discussion**

*Production of Platelets: Thrombopoesis*

A sub process of hematopoiesis that yields platelets is called thrombopoiesis, or the production of thrombocytes. In the bone marrow, common myeloid progenitor cells develop into promegakaryocytes and then megakaryocytes, a process known as thrombopoiesis. Megakaryocytes that are still in the bone marrow are hypothesised to manufacture proto platelets in their cytoplasm, which are then released in cytoplasmic extensions when they are triggered by cytokines. Macrophages consume the leftover nucleus of the ruptured megakaryocyte, causing the proto platelets to fragment into hundreds of individual platelets that circulate throughout the bloodstream.

Megakaryocyte and platelet production are regulated by the hormone thrombopoietin, which is produced by the liver and kidneys. Thrombopoietin stimulates the development of myeloid progenitor cells into megakaryocytes and causes the release of platelets. Thrombopoietin levels are regulated by a negative feedback process that is dependent on platelet levels in the body. Specifically, elevated platelet levels cause a decrease in thrombopoietin levels, and decreased platelet levels cause a rise in thrombopoietin levels. Before all of its biological components are gone, a megakaryocyte can create up to 10,000 platelets. A healthy adult makes roughly 10^11 platelets per day. The average life of a platelet is only five to 10 days. Older platelets are eliminated by macrophage phagocytosis in the spleen and kupffer cells in the liver. In cases of severe injury, sympathetically triggered spasms of the splenic muscle release a reserve of up to 40% of platelets that are stored in the organ [20].

**CONCLUSION**

Platelets have evolved from being thought of as only combatants that clot blood to being diverse members of the body's ensemble. Their small size belies a powerful armamentarium of signaling chemicals that affect everything from immunological responses to tissue healing. These microscopic superpowers coordinate processes like angiogenesis and stem cell migration by interacting with a variety of cells. Although their complex roles have great therapeutic potential, their position in some illnesses emphasises the need for a more comprehensive understanding. As investigations into the intricate movements of platelet-derived modulators continue, promising avenues for treating a range of ailments and realising the complete potential of these tiny miracles become apparent. Platelet function tests (PFTs) are being developed and improved by researchers in order to make them more accurate diagnostic instruments for assessing bleeding risks and tracking the efficacy of antiplatelet treatments. This is especially encouraging since point-of-care (POC) PFTs provide the benefit of quickly determining platelet function at the patient's bedside in a variety of therapeutic contexts.

 

## REFERENCES

1. Singh AP, Saxena R, Saxena S. A study on the working of blood bank. Journal of Medicine and Health Research. 2022 Jan 10;7(1):1-5.
2. Singh AP. Importance of papanicolaou staining in gynecologic cytology. EPRA International Journal of Multidisciplinary Research (IJMR). 2022 Sep 21;8(9):216-9.
3. Litjens G, Sánchez CI, Timofeeva N, Hermsen M, Nagtegaal I, Kovacs I, Hulsbergen-Van De Kaa C, Bult P, Van Ginneken B, Van Der Laak J. Deep learning as a tool for increased accuracy and efficiency of histopathological diagnosis. Scientific reports. 2016 May 23;6(1):26286.
4. Ismail SM, Colclough AB, Dinnen JS, Eakins D, Evans DM, Gradwell E, O'Sullivan JP, Summerell JM, Newcombe RG. Observer variation in histopathological diagnosis and grading of cervical intraepithelial neoplasia. British Medical Journal. 1989 Mar 18;298(6675):707-10.
5. Van Den Bent MJ. Interobserver variation of the histopathological diagnosis in clinical trials on glioma: a clinician's perspective. Acta neuropathologica. 2010 Sep;120(3):297-304.
6. Singh AP, Saxena R, Saxena S. Cytopathology: An Important Aspect of Medical Diagnosis. Research & Reviews: Journal of Oncology and Hematology. 2023; 12 (3): 13–18p. Cytopathology: An Important Aspect of Medical Diagnosis Singh et al. STM Journals. 2023:2.
7. Singh AP, Mouton RJ, Sharma MK, Ihotu-Owoicho AI. When will this pandemic end? A review. Journal of Basic and Applied Research International. 2021 Dec 29;29(27):10.
8. Singh AP, Batra J, Saxena R, Saxena S, Kumar C. Alarming rise in professional Blood donors and its repercussions. Cardiometry. 2022 Dec 1(25):1394-6.
9. Batra J, Singh AP, Saxena R, Saxena S, Goyal K. Blood components and its usage: A clinical insight from diagnostic lens. Journal of Pharmaceutical Negative Results. 2022 Oct 12:1747-50.
10. Obiajulu CV, Ochanya OE, Singh AP. Adverse reaction after blood donation in blood bank. International Journal of Pure Medical Research. 2022 Oct 1;7(10).
11. Singh AP, Batra J, Khan SS, Saxena R, Saxena S. Diagnosis and treatment of Wilson disease: An update. Cardiometry. 2022 Dec 1(25):1397-400.
12. Singh AP, Saxena R, Saxena S, Batra J. An update on emergency contraceptives. IJFANS. 2012;11(2):65-70p.
13. Singh AP, Heldaus J, Msaki AP. Hemodialysis Complications: A Clinical Insight. IJARESM. 2023;11(3):640-7.
14. Singh AP, Saxena R, Saxena S. An elaborate study on bio-medical waste and its successful administration. International journal of Recent Scientific Research vil. 2022 Jun; 13:2121-6.
15. Ajit P, Rahul S, Suyash S. Cytopathology: An important aspect of medical diagnosis. Research & Reviews: Journal of Oncology and Hematology. 2024 Jan 24;12(03):13-8.
16. Singh AP, Saxena RA, Saxena SU. Hemoglobin estimation by using copper sulphate method. Asian Journal of Current Research. 2022 Jul 13;7(1):13-5.
17. Singh AP, Saxena RA, Saxena SU. Protocols for blood collection in a blood bank. Journal of Medicine and Health Research. 2022 Sep 1;7(2):16-21.
18. Harrison P. Platelet function analysis. Blood reviews. 2005 Mar 1;19(2):111-23.
19. Singh AP, Batra J, Saxena S, Saxena R. A curse of Lassa fever: An update. Journal of Survey in Fisheries Sciences. 2023 Apr 27:1143-50.
20. Thon JN, Italiano JE. Platelet formation. InSeminars in hematology 2010 Jul 1 (Vol. 47, No. 3, pp. 220-226). WB Saunders.

 