“Mean Platelet Volume and Platelet-to-Lymphocyte Ratio as Indicators of Coronary Artery Disease Severity: A One-Year Observational Study."

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ABSTRACT

Background: Coronary artery disease (CAD) remains one of the leading causes of morbidity and mortality worldwide. Inflammation and platelet activation play a pivotal role in the initiation, progression, and complications of atherosclerosis. Mean Platelet Volume (MPV), a marker of platelet activity, and Platelet-to-Lymphocyte Ratio (PLR), an indicator of both inflammation and thrombosis, have emerged as potential biomarkers for assessing the severity of coronary artery disease. Identification of simple, inexpensive, and routinely available markers capable of predicting disease severity may facilitate early risk stratification and clinical decision-making in patients with suspected CAD.

Aim and Objective: [redacted]

Materials and Methods: [redacted]

Results: [redacted]

Discussion: [redacted]

Conclusion: [redacted]

Keywords: Coronary Artery Disease, Mean Platelet Volume, Platelet-to-Lymphocyte Ratio, Coronary Angiography, Platelet Activation, Inflammation, Atherosclerosis, Single Vessel Disease, Triple Vessel Disease, Cardiovascular Risk Stratification.

LIST OF ABBREVIATIONS

Abbreviation	Full Form
CAD	Coronary Artery Disease
MPV	Mean Platelet Volume
PLR	Platelet-to-Lymphocyte Ratio
SVD	Single Vessel Disease
DVD	Double Vessel Disease
TVD	Triple Vessel Disease
ECG	Electrocardiogram
LVEF	Left Ventricular Ejection Fraction
AWMI	Anterior Wall Myocardial Infarction
IWMI	Inferior Wall Myocardial Infarction
NSR	Normal Sinus Rhythm
COPD	Chronic Obstructive Pulmonary Disease
LDL	Low-Density Lipoprotein
HBsAg	Hepatitis B Surface Antigen
SPSS	Statistical Package for the Social Sciences
fL	Femtoliter
mmHg	Millimetres of Mercury
g/dL	Grams per Decilitre
mg/dL	Milligrams per Decilitre
FFR	Fractional Flow Reserve
iFR	Instantaneous Wave-Free Ratio
CI	Confidence Interval
IHD	Ischaemic Heart Disease
MI	Myocardial Infarction
WPW	Wolff–Parkinson–White Syndrome
CBC	Complete Blood Count

Abbreviation	Full Form
ACS	Acute Coronary Syndrome
BP	Blood Pressure
LV	Left Ventricle / Left Ventricular
CAG	Coronary Angiography
SD	Standard Deviation
PVD	Peripheral Vascular Disease
HOCM	Hypertrophic Obstructive Cardiomyopathy

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INTRODUCTION

INTRODUCTION

According to the World Health Organization (WHO), cardiovascular diseases (CVDs) are a group of disorders of the heart and blood vessels and remain the leading cause of death globally. [redacted]

[redacted]Hence, the present study was undertaken to evaluate the association between Mean Platelet Volume, Platelet/Lymphocyte Ratio, and coronary artery disease severity among patients undergoing invasive coronary angiography at a tertiary care centre (9).

Global Epidemiology

Coronary artery disease (CAD), also known as ischemic heart disease (IHD), is the most common cardiovascular disorder and remains a major global public health challenge. [redacted]Despite advances in preventive cardiology, pharmacotherapy, and interventional procedures, CAD continues to be associated with significant morbidity, mortality, and healthcare expenditure globally (10).

Indian Epidemiology

India is experiencing a rapidly growing epidemic of coronary artery disease. [redacted]

[redacted]

The burden of ischemic heart disease has increased across all states of India, making CAD one of the most important non-communicable diseases requiring urgent preventive and therapeutic interventions (14).

Karnataka Epidemiology

Karnataka mirrors the national trend of increasing cardiovascular disease burden and has witnessed a steady rise in coronary artery disease over the past two decades. [redacted]

Given the substantial burden of CAD in Karnataka, identification of inexpensive and readily available biomarkers such as Mean Platelet Volume and Platelet/Lymphocyte Ratio may aid in early risk stratification and assessment of disease severity among affected patients (18).

AIMS AND OBJECTIVES

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OBJECTIVE OF THE STUDY:

[redacted]

REVIEW OF LITERATURE

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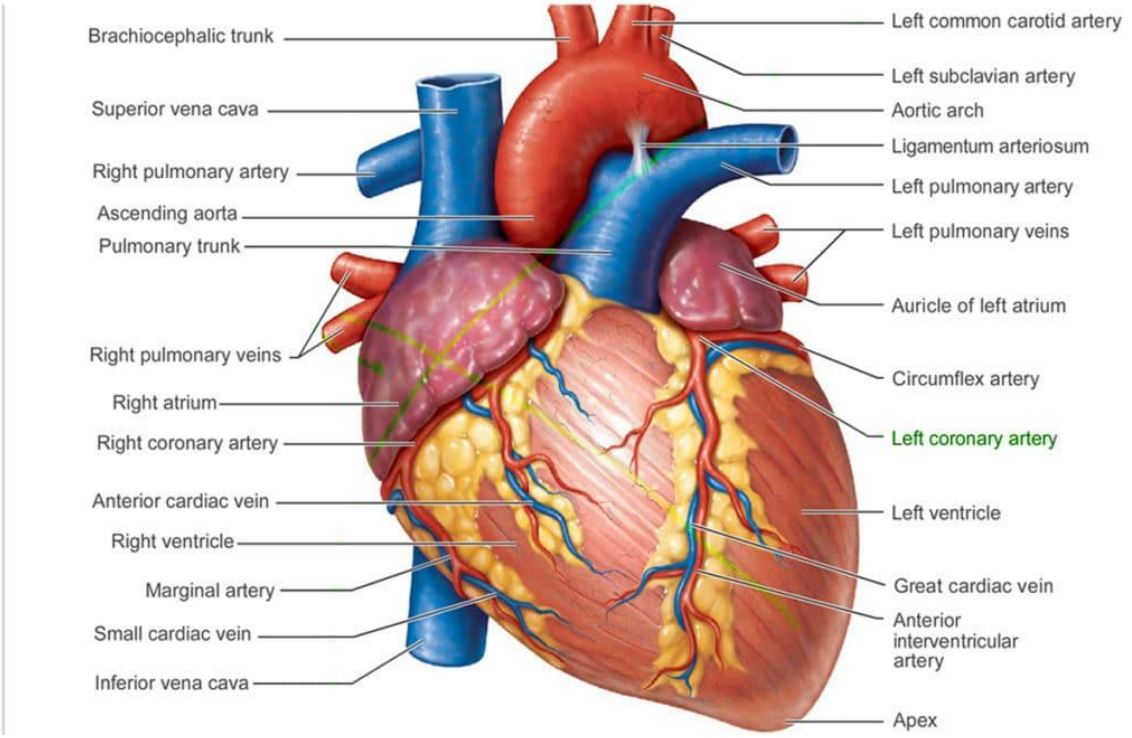


Figure 1: Anatomy of Human Heart

Coronary artery disease is one of the most important cardiovascular disorders encountered in clinical practice and remains a major cause of morbidity and mortality worldwide. [redacted]

Definition of Coronary Artery Disease

Coronary artery disease is defined as a pathological condition in which the coronary arteries become narrowed, obstructed, or functionally impaired, leading to reduced blood supply to the heart muscle (2). [redacted]

Burden of Coronary Artery Disease

Coronary artery disease represents a major health burden because it is one of the leading causes of death, hospitalization, disability, and healthcare expenditure. [redacted]

Anatomy of Coronary Circulation

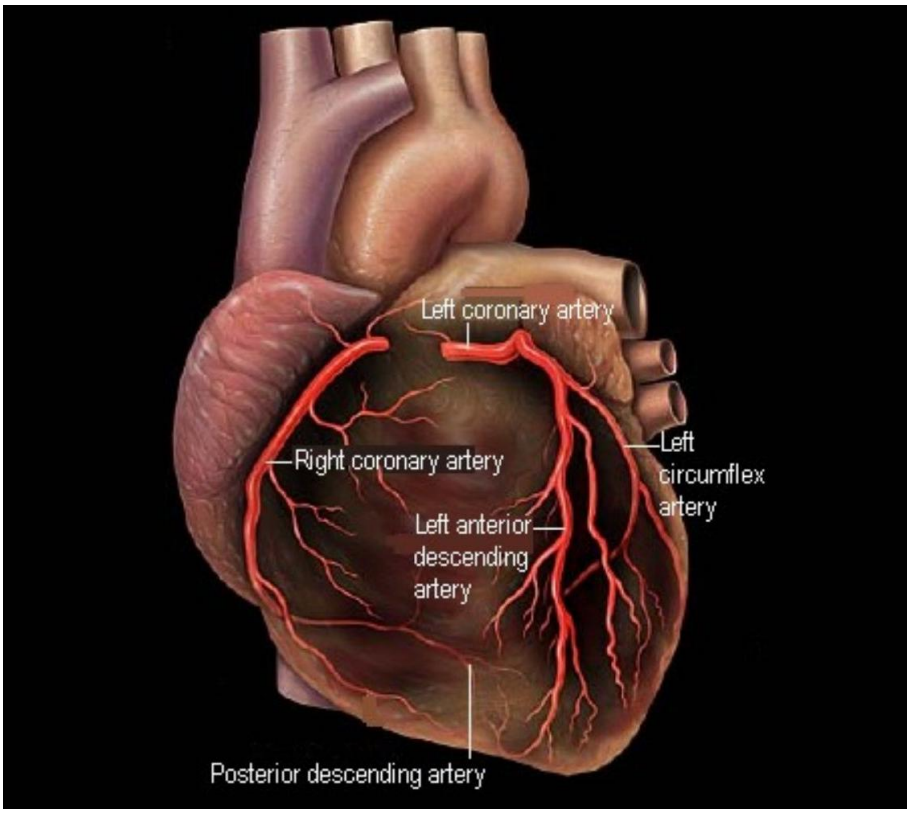


Figure 2: Coronary Arteries

The coronary circulation is the vascular system that supplies blood to the myocardium. [redacted]

[redacted]

[redacted]The right coronary artery arises from the right coronary sinus and commonly supplies the right atrium, right ventricle, inferior wall of the left ventricle, and atrioventricular nodal region (23).

Pathogenesis of Coronary Artery Disease

The pathogenesis of coronary artery disease is a progressive process involving endothelial dysfunction, lipid accumulation, inflammation, plaque formation, and thrombosis.

[redacted]

Atherosclerosis and Atherothrombosis

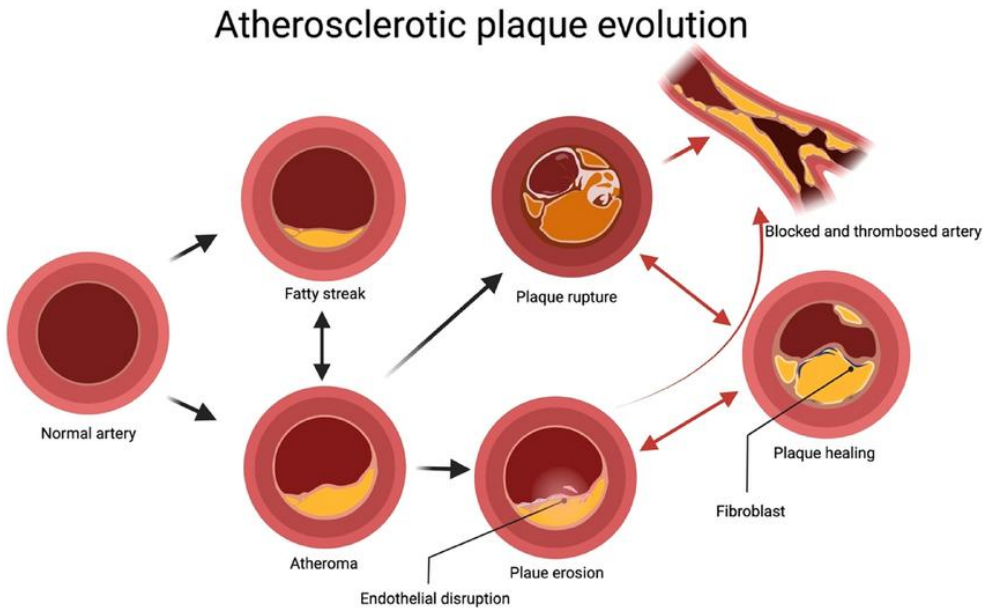


Figure 3: Formation of Atherosclerotic Plaque and it's evolution

Atherosclerosis and atherothrombosis are the fundamental pathological processes responsible for the development and progression of coronary artery disease. [redacted]

[redacted]

[redacted]The interplay between vascular inflammation, platelet activation, coagulation pathways, and endothelial injury determines disease severity and clinical outcomes (26).

Endothelial Dysfunction

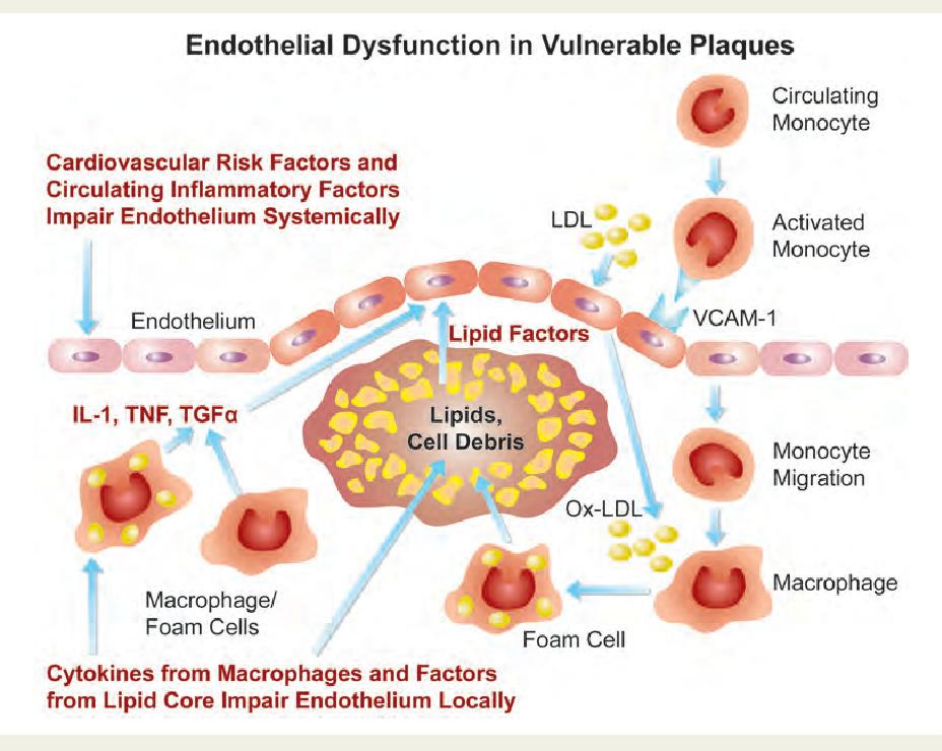


Figure 4 Endothelial dysfunction and inflammation

Endothelial dysfunction is considered the earliest and most important event in the development of atherosclerosis and coronary artery disease. [redacted]Endothelial dysfunction therefore represents

the critical link between cardiovascular risk factors and the development of atherosclerosis (30).

Lipid Accumulation and Fatty Streak Formation

Lipid accumulation within the arterial wall is a fundamental step in the development of atherosclerosis. [redacted] Fatty streaks can be detected even in young individuals and represent the initial stage of plaque development (33).

Inflammatory Response in Atherosclerosis

Inflammation plays a central role throughout every stage of atherosclerosis, from initiation of endothelial injury to plaque rupture and thrombosis. [redacted] The lymphocytes modulate immune responses through secretion of various cytokines that influence macrophage activity and vascular remodeling (36).

Plaque Formation and Progression

Atherosclerotic plaque formation is a gradual process that evolves from fatty streaks into complex fibrofatty lesions capable of obstructing coronary blood flow. [redacted]

[redacted]

[redacted]These smooth muscle cells synthesize extracellular matrix components including collagen, elastin, and proteoglycans, which contribute to the formation of a fibrous cap over the lipid-rich core (37).

Plaque Instability and Rupture

Plaque instability is the pathological process responsible for most acute coronary syndromes. [redacted]

Thrombus Formation in Coronary Artery Disease

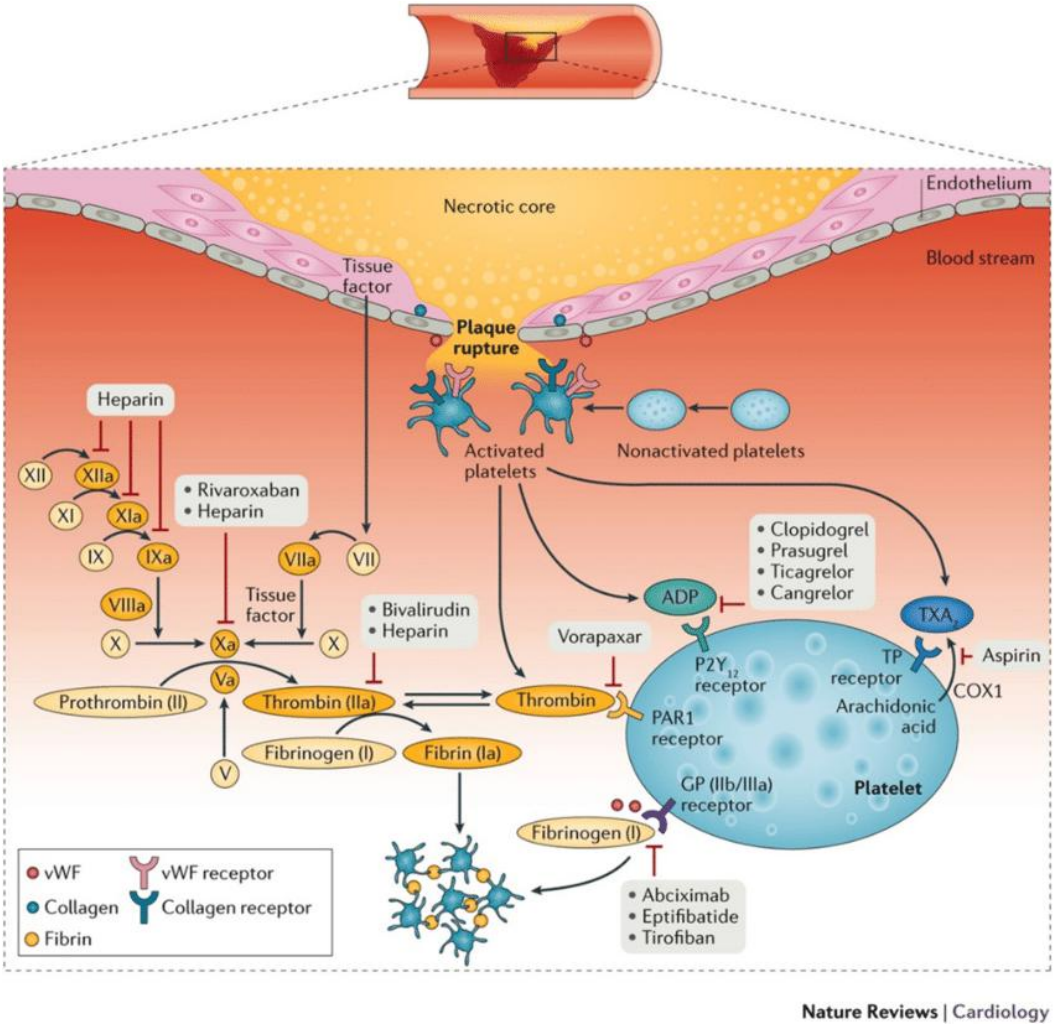


Figure 5 Mechanism of Thrombus formation

Thrombus formation represents the final stage in the pathogenesis of coronary artery disease and is directly responsible for most acute coronary syndromes. [redacted] Because platelet activation is central to thrombus formation, markers such as Mean Platelet Volume and Platelet-to-Lymphocyte Ratio are biologically relevant indicators of the thrombo-inflammatory activity associated with coronary artery disease severity (40).

Risk Factors for Coronary Artery Disease

Coronary artery disease develops as a result of the interaction of multiple risk factors that influence the initiation, progression, and complications of atherosclerosis. [redacted] Recognition of these factors is therefore essential for both primary and secondary prevention of cardiovascular events (20).

Non-Modifiable Risk Factors

Non-modifiable risk factors are inherent characteristics that cannot be altered through lifestyle modification, pharmacological treatment, or medical intervention. [redacted] Individuals

possessing one or more non-modifiable risk factors often develop coronary artery disease earlier and may experience more severe forms of atherosclerotic disease (20).

Age

Age is one of the strongest predictors of coronary artery disease. [redacted]

Sex

Sex is an important determinant of coronary artery disease risk and clinical presentation. [redacted] Estrogen exerts beneficial effects on lipid metabolism, endothelial function, vascular tone, and inflammatory responses, thereby delaying the onset of atherosclerosis (44).

Family History

A positive family history of coronary artery disease is a well-established non-modifiable risk factor that reflects the contribution of genetic and shared environmental influences. [redacted]

Modifiable Risk Factors

[redacted]

Hypertension

Hypertension is one of the most important and well-established risk factors for coronary artery disease. [redacted]

[redacted]These changes initiate inflammatory responses and contribute to plaque formation (46).

Diabetes Mellitus

Diabetes mellitus is a major metabolic disorder that substantially increases the risk of coronary artery disease. [redacted]

Dyslipidemia

Dyslipidemia refers to abnormalities in plasma lipid concentrations that contribute to the development of atherosclerosis and coronary artery disease. [redacted]

Smoking and Tobacco Use

Smoking is among the most powerful preventable risk factors for coronary artery disease. [redacted]

Obesity and Metabolic Syndrome

Obesity is a major contributor to cardiovascular disease and is closely linked to the development of coronary artery disease. [redacted]

Physical Inactivity

Physical inactivity is an important but often overlooked risk factor for coronary artery disease. [redacted]

Clinical Spectrum of Coronary Artery Disease

Coronary artery disease encompasses a broad range of clinical manifestations resulting from reduced coronary blood flow and myocardial ischemia. [redacted] Understanding these clinical entities is important for accurate diagnosis, risk stratification, and management (2).

Chronic Coronary Syndrome

Chronic coronary syndrome refers to a stable clinical condition resulting from fixed atherosclerotic narrowing of the coronary arteries. [redacted] Despite significant stenosis, coronary blood flow at rest is often adequate due to compensatory mechanisms; however, the inability to augment blood flow during increased demand results in myocardial ischemia (2).

Acute Coronary Syndrome

Acute coronary syndrome represents a group of clinical conditions resulting from sudden reduction in coronary blood flow due to plaque rupture, plaque erosion, or thrombus formation. [redacted]

[redacted]

Acute coronary syndrome is characterized by acute myocardial ischemia and may progress rapidly if not treated promptly (40).

Unstable Angina

Unstable angina is a clinical condition characterized by myocardial ischemia occurring without detectable myocardial necrosis. [redacted]

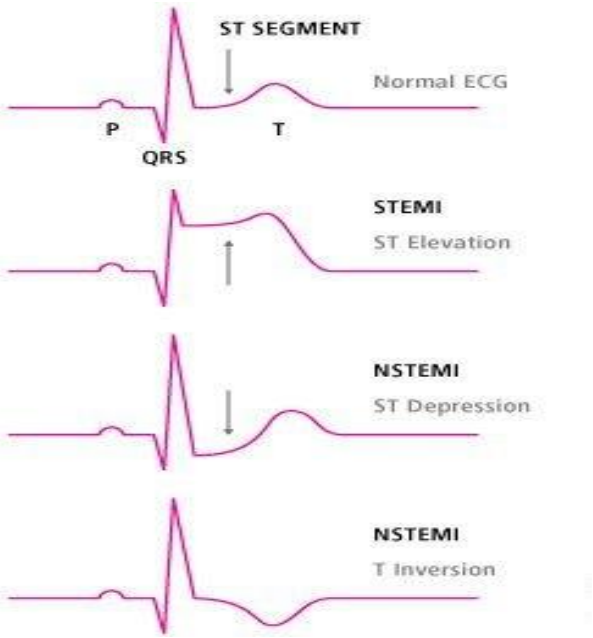


Figure 6: Non-ST Elevation Myocardial Infarction (NSTEMI)

NSTEMI is a form of acute myocardial infarction characterized by myocardial necrosis without persistent ST-segment elevation on electrocardiography. [redacted]

Troponin elevation reflects cardiomyocyte injury and distinguishes NSTEMI from unstable angina (56).

ST-Elevation Myocardial Infarction (STEMI)

STEMI represents the most severe manifestation of acute coronary syndrome and results from complete and sustained occlusion of a coronary artery. [redacted] Because STEMI reflects profound platelet activation, inflammation, and thrombosis, it represents the most dramatic clinical expression of advanced atherothrombotic coronary artery disease (58).

Diagnostic Evaluation of Coronary Artery Disease

The diagnosis of coronary artery disease requires a comprehensive evaluation that integrates clinical assessment, laboratory investigations, non-invasive imaging, and invasive diagnostic procedures. [redacted]

Clinical Assessment

Clinical assessment forms the cornerstone of coronary artery disease diagnosis and remains the first step in evaluating patients with suspected myocardial ischemia. [redacted]

Electrocardiography

Electrocardiography (ECG) is one of the most widely used and readily available investigations for the evaluation of coronary artery disease. [redacted]

Cardiac Biomarkers

Cardiac biomarkers are biochemical substances released into the bloodstream following myocardial injury. [redacted]Other biomarkers may provide supplementary information regarding myocardial stress, inflammation, and cardiovascular risk (62).

Echocardiography

Echocardiography is a non-invasive imaging modality that uses ultrasound waves to visualize cardiac structures and assess cardiac function. [redacted]Detection of these abnormalities assists in identifying ischemic territories and evaluating the functional impact of coronary artery disease (64).

Stress Testing

Stress testing is a non-invasive diagnostic method used to detect inducible myocardial ischemia. [redacted]

[redacted]

Pharmacological stress testing is used in patients unable to perform adequate physical exercise (66).

Coronary Angiography

Coronary angiography is considered the gold standard investigation for the diagnosis and assessment of coronary artery disease. [redacted]Injection of radiographic contrast material allows visualization of the coronary arteries under fluoroscopic imaging (68).

Coronary Angiography and Assessment of Disease Severity

Coronary angiography is the definitive diagnostic procedure for evaluating coronary artery disease and remains the gold standard for assessing the anatomical severity of coronary artery involvement. [redacted]Angiographic findings are therefore widely used for risk stratification and clinical decision-making (2).

Principles of Coronary Angiography

Coronary angiography is an invasive imaging technique used to visualize the coronary arterial system. [redacted]

[redacted]

Coronary angiography not only confirms the diagnosis of coronary artery disease but also helps determine the need for percutaneous coronary intervention or coronary artery bypass graft surgery (71).

Interpretation of Coronary Angiography

Interpretation of coronary angiography involves systematic evaluation of the coronary arterial tree to identify the presence, location, extent, and severity of atherosclerotic lesions. [redacted]

Coronary Artery Stenosis and Severity Assessment

Coronary artery stenosis refers to narrowing of the arterial lumen caused by atherosclerotic plaque formation. [redacted]

Single Vessel Disease

Single vessel disease refers to significant atherosclerotic narrowing involving only one major epicardial coronary artery. [redacted]

Figure 7: Single Vessel Disease

Double Vessel Disease

Double vessel disease is defined as significant stenosis involving two major epicardial coronary arteries.

[redacted]

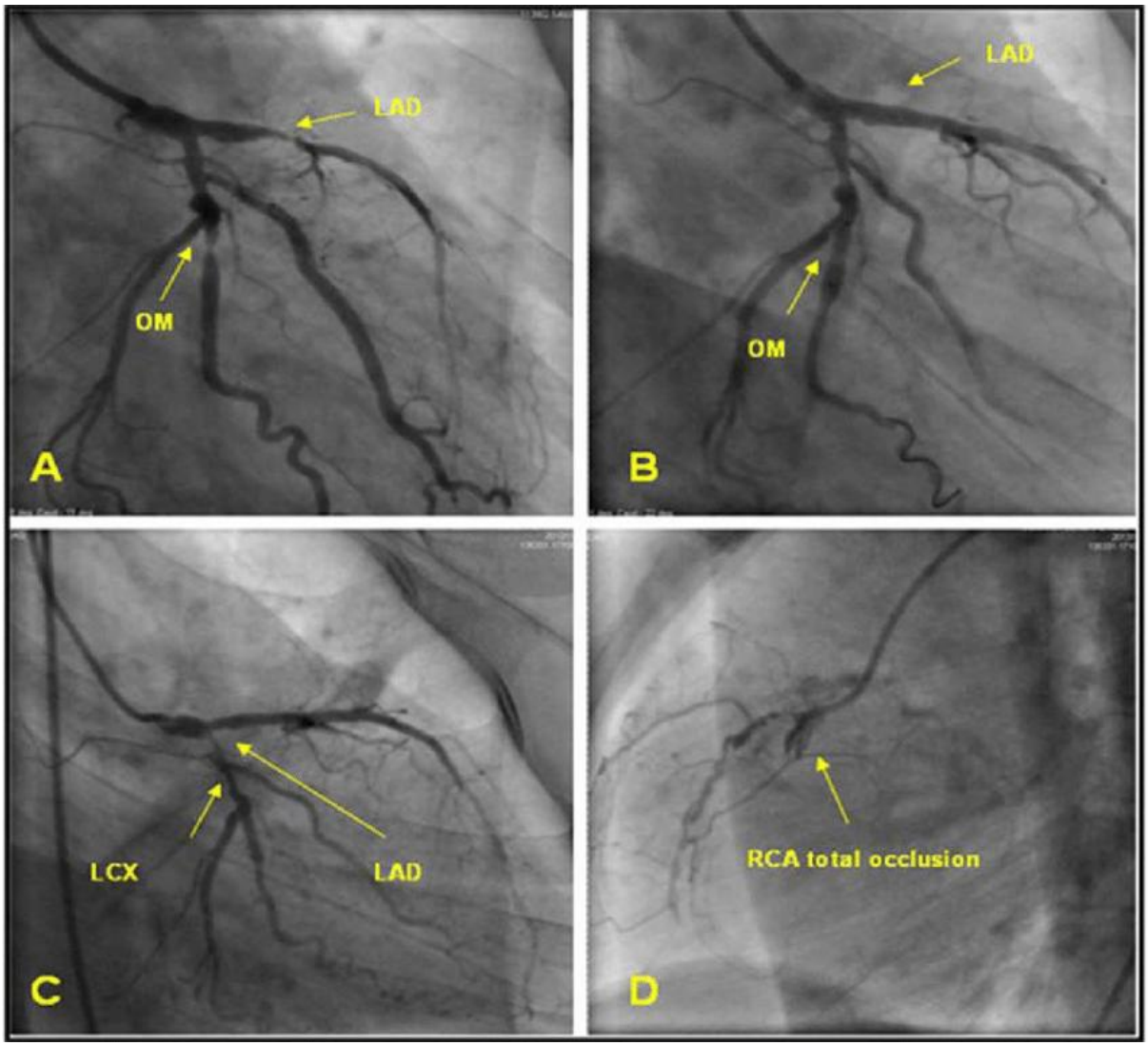


Figure 8: (A) First coronary angiography revealed double vessel disease; (B) PostPCI of double vessel disease; (C) & (D) Coronary angiograph demonstrated triple vessel disease after three years of first PCI.

Triple Vessel Disease

Triple vessel disease refers to significant stenosis involving all three major epicardial coronary arteries: the left anterior descending artery, left circumflex artery, and right coronary artery. [redacted]

Figure 9: Tripple Vessel Disease

Left Main Coronary Artery Disease

Left main coronary artery disease is one of the most serious forms of coronary artery disease because the left main coronary artery supplies a large proportion of the myocardium through its major branches, namely the left anterior descending artery and left circumflex artery.

- Major prognostic significance

Angiographic Scoring Systems in Coronary Artery Disease

Angiographic scoring systems have been developed to provide objective and reproducible assessment of coronary artery disease severity.

In clinical research, angiographic scoring systems are

valuable tools for evaluating associations between biomarkers and disease severity, thereby providing objective measures of coronary atherosclerotic burden (79).

Inflammation in Coronary Artery Disease

Inflammation plays a central role in the initiation, progression, and complications of coronary artery disease. [redacted] These events contribute to the formation of atherosclerotic plaques and influence their stability (81).

Role of Inflammation in Atherosclerosis

Inflammation is a fundamental mechanism underlying the development of atherosclerosis and is present throughout every stage of the disease process. [redacted] These inflammatory cells migrate into the intima and initiate a cascade of immune reactions that contribute to plaque development (35).

Inflammatory Cells in Coronary Artery Disease

Inflammatory cells are essential mediators of atherosclerotic plaque development and progression. [redacted]

[redacted]

T lymphocytes regulate immune responses by secreting cytokines that influence macrophage activity and vascular inflammation (32).

Cytokines and Inflammatory Mediators

Cytokines and inflammatory mediators are signaling molecules that regulate immune responses and coordinate inflammatory activity within atherosclerotic plaques. [redacted]

- Matrix metalloproteinases (MMPs)

Inflammation and Plaque Vulnerability

Plaque vulnerability refers to the tendency of an atherosclerotic plaque to rupture or erode and subsequently trigger thrombus formation. [redacted]

Persistent inflammation weakens the structural

integrity of the plaque by promoting degradation of collagen and other extracellular matrix components (85).

Platelets in Coronary Artery Disease

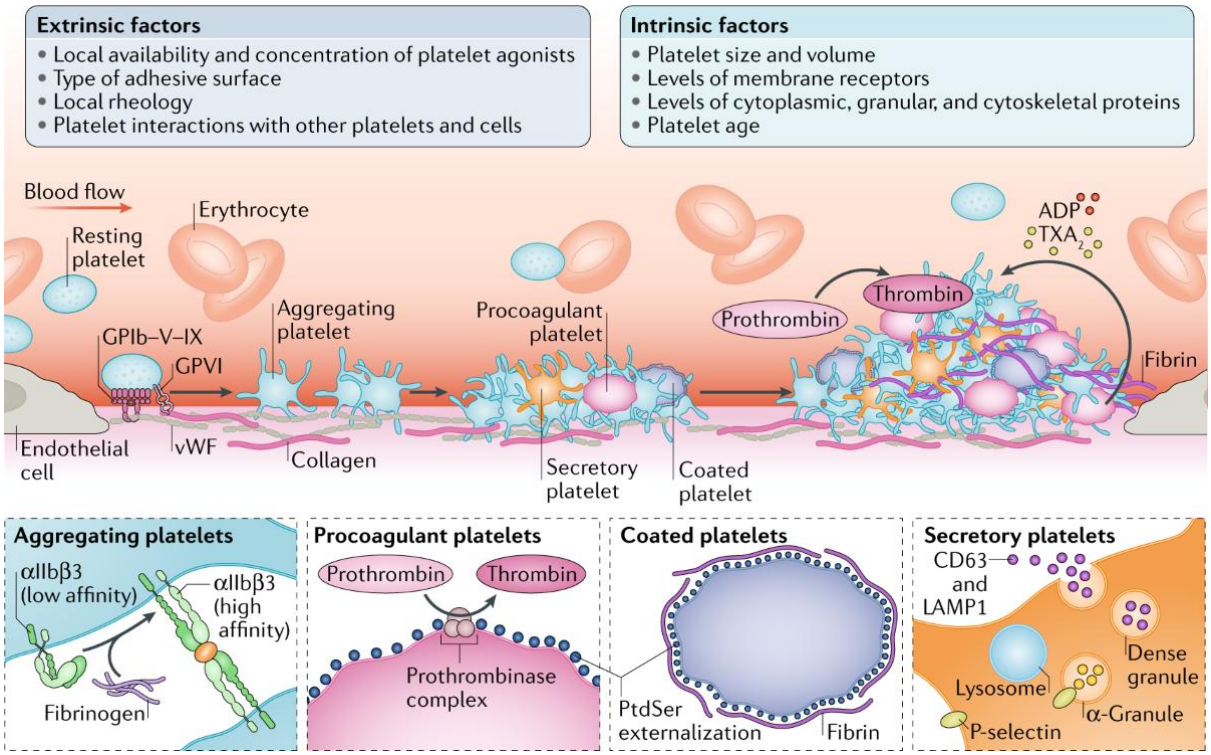


Figure 10: Platelet Biology

Platelets are small, anucleate blood components derived from megakaryocytes in the bone marrow and play a crucial role in hemostasis and thrombosis. [redacted] Consequently, platelet activity is closely associated with the severity of coronary artery disease and adverse cardiovascular outcomes (88).

Platelet Structure and Physiology

Platelets are small disc-shaped cellular fragments produced from the cytoplasm of bone marrow megakaryocytes. [redacted]

[redacted]

Alpha granules contain growth factors, coagulation proteins, and adhesion molecules, whereas dense granules contain adenosine diphosphate, calcium, serotonin, and other substances involved in platelet activation (39).

Platelet Activation

Platelet activation is a critical event in the pathogenesis of coronary artery disease and its thrombotic complications. [redacted]

- Shear stress

Platelet Aggregation

Platelet aggregation refers to the process by which activated platelets adhere to one another and form platelet plugs. [redacted]

[redacted]

- Coagulation pathway activation

Platelet-Mediated Inflammation

Platelets are increasingly recognized as important mediators of inflammation in addition to their traditional role in thrombosis. [redacted]

- Enhancement of oxidative stress
- Facilitation of plaque progression

Role of Platelets in Atherothrombosis

Atherothrombosis is the process by which thrombosis develops on a disrupted atherosclerotic plaque. [redacted] The resulting thrombus may partially or completely obstruct coronary blood flow (94).

Platelets in Acute Coronary Syndromes

Platelets are the principal cellular mediators responsible for the development of acute coronary syndromes. [redacted] Increased platelet reactivity has been associated with recurrent ischemic events, stent thrombosis, and adverse cardiovascular outcomes (95).

Hematological Biomarkers in Coronary Artery Disease

Hematological biomarkers have emerged as valuable tools in the evaluation, risk stratification, and prognostic assessment of patients with coronary artery disease. [redacted] Since coronary artery disease is increasingly recognized as a chronic inflammatory and thrombotic disorder, hematological parameters reflecting these processes have gained considerable clinical significance (2).

Complete Blood Count Derived Biomarkers

The complete blood count is one of the most frequently performed laboratory investigations in clinical medicine and provides a wealth of information beyond the diagnosis of hematological disorders. [redacted]

[redacted]Numerous studies have demonstrated significant associations between these biomarkers and coronary artery disease severity, plaque burden, and cardiovascular outcomes (99).

Role of Platelet-Based Biomarkers

Platelet-based biomarkers have gained considerable importance in coronary artery disease because platelets play a central role in atherosclerosis, inflammation, thrombosis, and acute coronary events (100). [redacted]Therefore, platelet-related parameters may serve as indirect indicators of thrombotic activity within the cardiovascular system (88).

Role of Inflammatory Biomarkers

Inflammatory biomarkers play a crucial role in understanding the pathophysiology of coronary artery disease because inflammation is involved throughout every stage of atherosclerosis (101). [redacted]

Many inflammatory markers have been shown to correlate with coronary artery disease severity and prognosis (102).

Mean Platelet Volume

Mean Platelet Volume (MPV) is one of the most widely studied platelet indices in cardiovascular medicine and has emerged as an important biomarker reflecting platelet size, function, and activity (103). [redacted]

[redacted]Numerous studies have demonstrated relationships between elevated MPV and acute coronary syndromes, restenosis, stroke, peripheral arterial disease, and coronary artery disease severity (103).

Definition and Measurement

Mean Platelet Volume is a quantitative measure of the average size of circulating platelets and is routinely reported as part of an automated complete blood count. [redacted]Under normal conditions, MPV typically ranges between approximately 7 and 12 femtoliters, although reference ranges may vary among laboratories (104).

Determinants of Mean Platelet Volume

Mean Platelet Volume is influenced by multiple physiological and pathological factors that affect platelet production, maturation, activation, and destruction. [redacted]These newly formed platelets contain greater amounts of granules, enzymes, and prothrombotic substances, leading to elevated MPV values (105).

Biological Significance of Mean Platelet Volume

The biological significance of Mean Platelet Volume lies in its close relationship with platelet function and thrombogenic potential. [redacted]

[redacted]Upon activation, these substances are released into the circulation and contribute to thrombosis, inflammation, and vascular remodeling (106).

Mean Platelet Volume as a Marker of Platelet Activity

Mean Platelet Volume is widely regarded as an indirect marker of platelet activity because platelet size is closely associated with platelet function. [redacted]

Consequently, elevated MPV is often considered a marker of heightened platelet activation (108).

Factors Affecting Mean Platelet Volume

Several physiological, pathological, and technical factors can influence MPV values. [redacted]Additionally, laboratory variables can influence measured values independently of biological changes (107).

Mean Platelet Volume in Cardiovascular Diseases

[redacted]

Mean Platelet Volume and Coronary Artery Disease Severity

The relationship between Mean Platelet Volume and coronary artery disease severity has been the subject of extensive investigation. [redacted]These mechanisms may explain the observed association between elevated MPV and greater angiographic disease burden (25).

Platelet-to-Lymphocyte Ratio

Platelet-to-Lymphocyte Ratio (PLR) is a novel hematological biomarker derived from routine complete blood count parameters and has gained increasing attention in cardiovascular medicine. [redacted] Consequently, an increased PLR may indicate a more active atherothrombotic state and a greater burden of coronary artery disease (9).

Definition and Calculation

Platelet-to-Lymphocyte Ratio is a hematological parameter calculated by dividing the absolute platelet count by the absolute lymphocyte count obtained from a complete blood count. [redacted] Higher values generally indicate increased platelet activity, reduced lymphocyte-mediated immune regulation, or a combination of both (7).

Biological Basis of Platelet-to-Lymphocyte Ratio

The biological basis of Platelet-to-Lymphocyte Ratio lies in its ability to reflect two important processes involved in coronary artery disease: thrombosis and inflammation. [redacted]

The combined effect of elevated platelet counts and reduced lymphocyte counts results in an increased PLR (9).

Platelet Component and Thrombotic Activity

The platelet component of PLR reflects the thrombotic aspect of coronary artery disease.

Activated platelets release substances such as thromboxane A_2, adenosine diphosphate, serotonin, and growth factors that promote vascular inflammation and thrombosis (39).

Lymphocyte Component and Inflammatory Response

The lymphocyte component of PLR reflects immune regulation and inflammatory status.

Lower lymphocyte counts have been associated with adverse cardiovascular outcomes and increased mortality (111).

Platelet-to-Lymphocyte Ratio as an Inflammatory Marker

Platelet-to-Lymphocyte Ratio is increasingly recognized as a useful inflammatory marker because it reflects both platelet-mediated thrombosis and lymphocyte-mediated immune responses.

Platelet-to-Lymphocyte Ratio in Cardiovascular Diseases

Elevated PLR has been reported in a variety of cardiovascular disorders and is increasingly recognized as a marker of disease severity and prognosis.

Platelet-to-Lymphocyte Ratio and Coronary Artery Disease Severity

The association between Platelet-to-Lymphocyte Ratio and coronary artery disease severity has been extensively investigated in recent years. [redacted]

These changes contribute to higher PLR values and may explain the observed relationship between PLR and angiographic disease burden (9).

Relationship Between Mean Platelet Volume, Platelet-to-Lymphocyte Ratio and Coronary Artery Disease Severity

Mean Platelet Volume (MPV) and Platelet-to-Lymphocyte Ratio (PLR) have emerged as important hematological biomarkers in the assessment of coronary artery disease severity. [redacted] Their widespread availability and low cost make them attractive tools for cardiovascular risk stratification (112).

Pathophysiological Basis

The association between MPV, PLR, and coronary artery disease severity is rooted in the pathophysiological processes underlying atherosclerosis and atherothrombosis. [redacted] Simultaneously, elevated PLR

reflects increased platelet activity combined with reduced lymphocyte counts, indicating heightened inflammation and physiological stress (107).

Platelet Activation and Coronary Atherosclerotic Burden

Platelet activation is a critical contributor to the development and progression of coronary atherosclerosis. [redacted] Consequently, elevated MPV values often indicate heightened platelet reactivity (103).

Inflammation and Coronary Atherosclerotic Burden

Inflammation is a fundamental driver of atherosclerosis and significantly influences coronary artery disease severity. [redacted] Consequently, a high PLR may indicate a more active inflammatory state and greater atherosclerotic burden (7).

Association with Angiographic Severity

[redacted]

Prognostic Significance in Coronary Artery Disease

The prognostic significance of MPV and PLR has been increasingly recognized in patients with coronary artery disease. [redacted]

[redacted]

These biomarkers may therefore help identify patients at increased risk of future cardiovascular complications (55).

Clinical Utility of Mean Platelet Volume and Platelet-to-Lymphocyte Ratio

Mean Platelet Volume (MPV) and Platelet-to-Lymphocyte Ratio (PLR) have emerged as valuable hematological biomarkers in cardiovascular medicine because they reflect two fundamental mechanisms involved in coronary artery disease: platelet activation and inflammation (9). [redacted]

Risk Stratification

Risk stratification is an essential component of coronary artery disease management and involves identifying patients who are at increased risk of adverse cardiovascular events. [redacted]

Patients with increased values of these biomarkers frequently exhibit more active atherosclerotic disease and greater susceptibility to adverse cardiovascular outcomes (5).

Prediction of Coronary Artery Disease Severity

[redacted]

Utility in Routine Clinical Practice

The utility of MPV and PLR in routine clinical practice is largely attributable to their simplicity, accessibility, and cost-effectiveness. [redacted]

[redacted]Their widespread availability makes them particularly attractive in resource-limited settings where advanced diagnostic techniques may not be readily accessible (114).

Advantages of MPV and PLR

The growing popularity of MPV and PLR as cardiovascular biomarkers is largely due to their numerous practical and clinical advantages. [redacted]This dual relevance enhances their potential clinical applicability in cardiovascular medicine (2).

Limitations of MPV and PLR

Despite their potential clinical utility, MPV and PLR possess several limitations that should be considered when interpreting results. [redacted]Inflammatory disorders, infections, hematological diseases, malignancies, autoimmune conditions, and certain medications may influence biomarker values and confound interpretation (7).

Rationale and Need for the Present Study

Coronary artery disease (CAD) is one of the leading causes of morbidity and mortality worldwide and continues to impose a substantial burden on healthcare systems. [redacted]

Research Studies

[redacted] **(2026)** evaluated the prognostic significance of mean platelet volume in patients with coronary heart disease across multiple prospective studies. [redacted] Overall, the findings reinforce the concept that platelet size and activation contribute significantly to CAD progression and severity (55).

[redacted] **(2025)** explored the relationship between hematological parameters and coronary angiographic findings in patients undergoing coronary angiography. [redacted] The study strengthens the evidence linking routine blood parameters with angiographic disease severity (56).

[redacted] **(2025)** assessed the efficiency of platelet-to-lymphocyte ratio in predicting major adverse cardiovascular events following percutaneous coronary intervention in acute coronary syndrome patients. [redacted] This study provides robust evidence for incorporating PLR into clinical risk stratification models (115).

[redacted] **(2025)** evaluated the prognostic value of the platelet-to-lymphocyte ratio in patients with asymptomatic coronary artery disease. [redacted]

[redacted]The authors conclude that PLR is a sensitive, cost-effective prognostic biomarker that may aid early risk stratification and preventive decision-making in CAD (57).

[redacted] **(2025)** assessed the association between platelet-to-lymphocyte ratio and long-term cardiovascular outcomes in hypertensive individuals. [redacted]This study strengthens the evidence supporting PLR as a valuable biomarker for cardiovascular risk prediction and disease progression (110).

[redacted] **(2024)** investigated the clinical significance of mean platelet volume and the mean platelet volume-to-lymphocyte ratio in patients presenting with acute coronary syndrome. [redacted]This study contributes valuable clinical evidence linking hematological parameters with acute CAD severity (114).

[redacted] **(2024)** examined the association between mean platelet volume and in-hospital outcomes in patients with ST-segment elevation myocardial infarction undergoing primary percutaneous coronary intervention. [redacted]This study reinforces the relevance of MPV in predicting both angiographic severity and short-term clinical outcomes in acute, high-risk CAD settings (6).

[redacted] **(2023)** explored emerging biomarkers of platelet activation and their role in the pathogenesis of atherosclerosis. [redacted]This article provides strong theoretical support for studies evaluating MPV and PLR as markers of disease burden and prognosis (88).

[redacted] **(2023)** evaluated the prognostic significance of platelet indices, platelet-to-lymphocyte ratio, and neutrophil-to-lymphocyte ratio in patients with coronary artery disease. [redacted]This study strengthens the

evidence linking inflammatory hematological markers with angiographic and clinical severity of CAD (112).

(2022) discussed platelet physiology and the pathological roles of platelets in thrombosis and coronary artery disease. This review offers mechanistic justification for the use of MPV in cardiovascular risk assessment and supports its role as a surrogate marker of disease severity in coronary artery disease (39).

2019) focused on the prognostic value of mean platelet volume in coronary artery disease and acute coronary syndromes. This review reinforces the conceptual framework supporting MPV as a biomarker for CAD severity and risk stratification (109).

(2019) investigated the relationship between mean platelet volume and coronary plaque vulnerability in patients with non-ST-elevation acute coronary syndrome. This work offers strong mechanistic and clinical support for MPV as a marker of high-risk coronary lesions (116).

(2019) examined the platelet-to-lymphocyte ratio as an inflammatory marker across various systemic diseases.

[redacted]This article provides important mechanistic insight supporting the use of PLR in CAD severity assessment (7).

[redacted] **(2016)** assessed the clinical usefulness of inflammatory and platelet-related biomarkers in patients presenting with acute coronary syndromes. [redacted]The authors concluded that MPV and PLR represent simple, cost-effective tools that can complement existing risk assessment strategies in ACS patients (98).

[redacted] **(2014)** investigated the role of mean platelet volume in patients diagnosed with acute coronary syndromes, focusing on its diagnostic and prognostic significance. [redacted]This study reinforces the relevance of MPV as a simple and accessible biomarker reflecting the severity and activity of acute coronary syndromes (117).

[redacted] **(2014)** examined the association between platelet-to-lymphocyte ratio and the severity of coronary artery disease. [redacted]

[redacted]

These findings strongly support the role of PLR as a marker of CAD severity and reinforce its relevance in cardiovascular risk stratification (9).

[redacted] **(2014)** explored the evolving understanding of platelets as active immune and inflammatory cells rather than passive participants in hemostasis alone. [redacted]

This article provides essential mechanistic insight underpinning the use of MPV and PLR in assessing CAD severity and prognosis (118).

[redacted] **(2013)** investigated the association between mean platelet volume and the extent of coronary artery disease in patients undergoing coronary angiography. [redacted]

This study provides direct evidence linking MPV with angiographic severity and supports its use as a simple and accessible marker of CAD extent (66).

[redacted] **(2013)** evaluated the relationship between mean platelet volume and the severity of coronary artery disease using objective scoring systems. [redacted] This study remains a key reference supporting the association between MPV and CAD severity (8).

[redacted] **(2009)** examined the relationship between mean platelet volume and the extent of coronary artery disease. [redacted] Due to its prospective design and large sample size, this study is considered a cornerstone reference supporting the association between MPV and CAD severity (119).

[redacted] **(2009)** evaluated the association between mean platelet volume and cardiovascular risk across multiple studies. [redacted] This study offers strong aggregated evidence supporting the clinical relevance of MPV in predicting CAD severity and adverse cardiovascular outcomes (120).

[redacted] **(2003)** described the central role of platelets in the pathophysiology of acute coronary syndromes. [redacted]

[redacted]It offers essential background supporting the clinical use of platelet indices in assessing disease activity and severity in coronary artery disease (121).

MATERIALS AND METHODS

MATERIALS AND METHODS

Source of Data:

Study Design:

Study Period: .

Sample Size:

Sampling Technique:

Inclusion Criteria:

The study included:

Exclusion Criteria

The study excluded:

- Patients unable to provide consent

[redacted]

Study Protocol: [redacted]

- **Biochemical and Hematological Parameters:** [redacted]
- **Coronary Angiography:** [redacted]

[redacted]

Data Collection Procedure: [redacted]

Data Processing and Statistical Analysis: [redacted]

Anticipated Adverse Events: [redacted]

Investigations Conducted:

The following investigations were performed:

[redacted]

[redacted]

Cost of Investigations: [redacted]

Budget Analysis:

Budget: Nil

INCOME DETAILS	ACTUAL	BUDGETED
—	—	—

EXPENSE DETAILS	ACTUAL	BUDGETED
—	—	—

Data Analysis Table:

Sl. No	IP/OP No	Independent Variable 1	Independent Variable 2	Dependent/Independent Variable

RESULTS

RESULTS

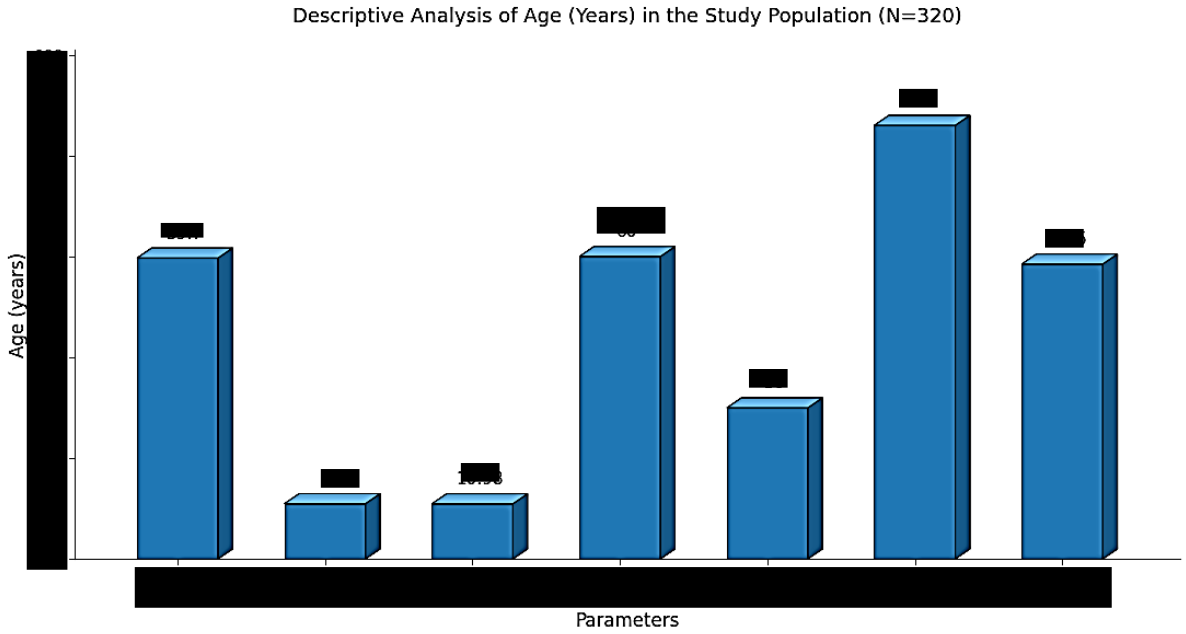
Statistical Methods

Descriptive analysis was carried out using mean and standard deviation (SD) for normally distributed quantitative variables and median with interquartile range (IQR) for non-normally distributed quantitative variables. [redacted]

Table 1: Descriptive Analysis of Age (Years) in the Study Population (N=320)

Parameter	Mean ± SD	Median	Minimum	Maximum	95% C.I	
					Lower	Upper
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]

Graph 1: Descriptive Analysis of Age (Years) in the Study Population (N=320)

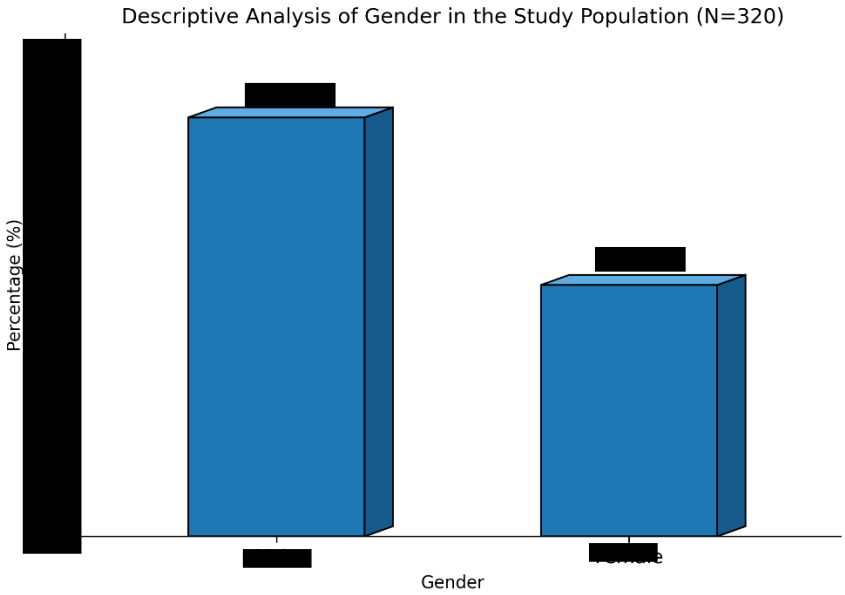


In the present study, the mean age of the study population was [redacted] years. [redacted]

Table 2: Descriptive Analysis of Gender in the Study Population (N=320)

Gender	Frequency	Percentages
[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]

Graph 2: Descriptive Analysis of Gender in the Study Population (N=320)



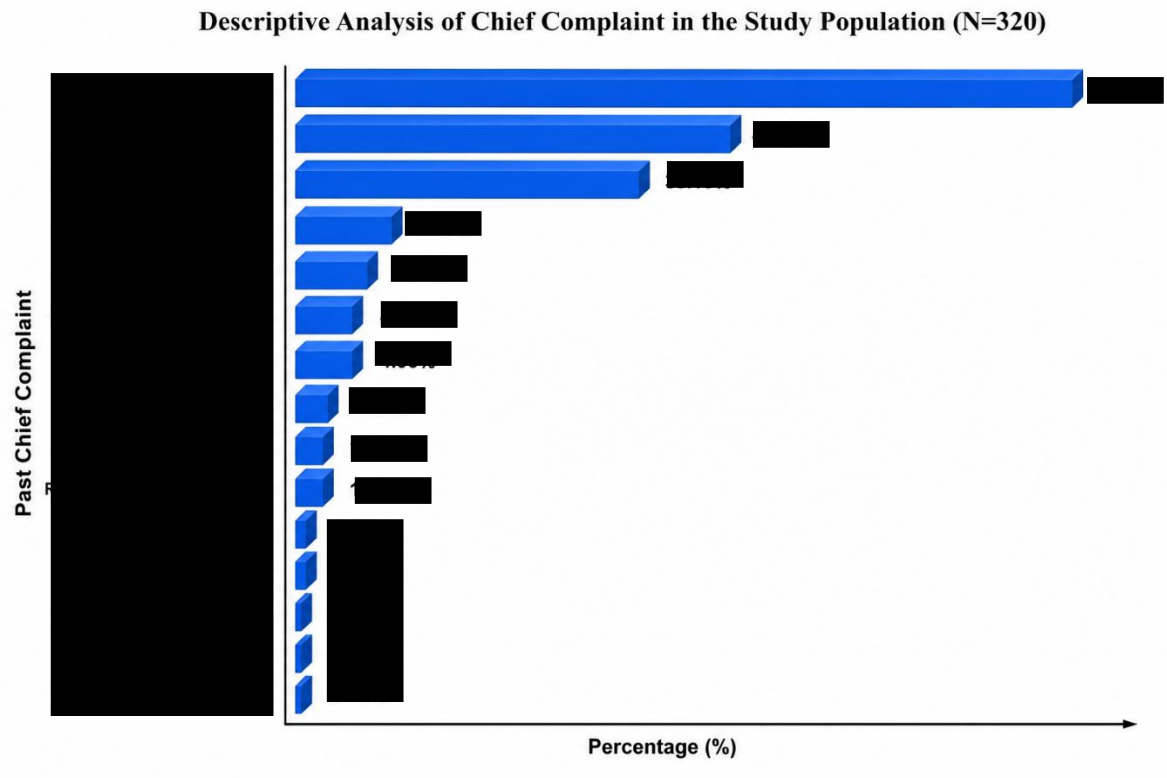
[redacted]

[redacted]Thus, males constituted the majority of the study population, while females accounted for [redacted]

Table 3: Descriptive Analysis of Chief Complaint in the Study Population (N=320)

Past Chief Complaint	Frequency	Percentages
[redacted]	[redacted]	[redacted]

Graph 3: Descriptive Analysis of Chief Complaint in the Study Population (N=320)



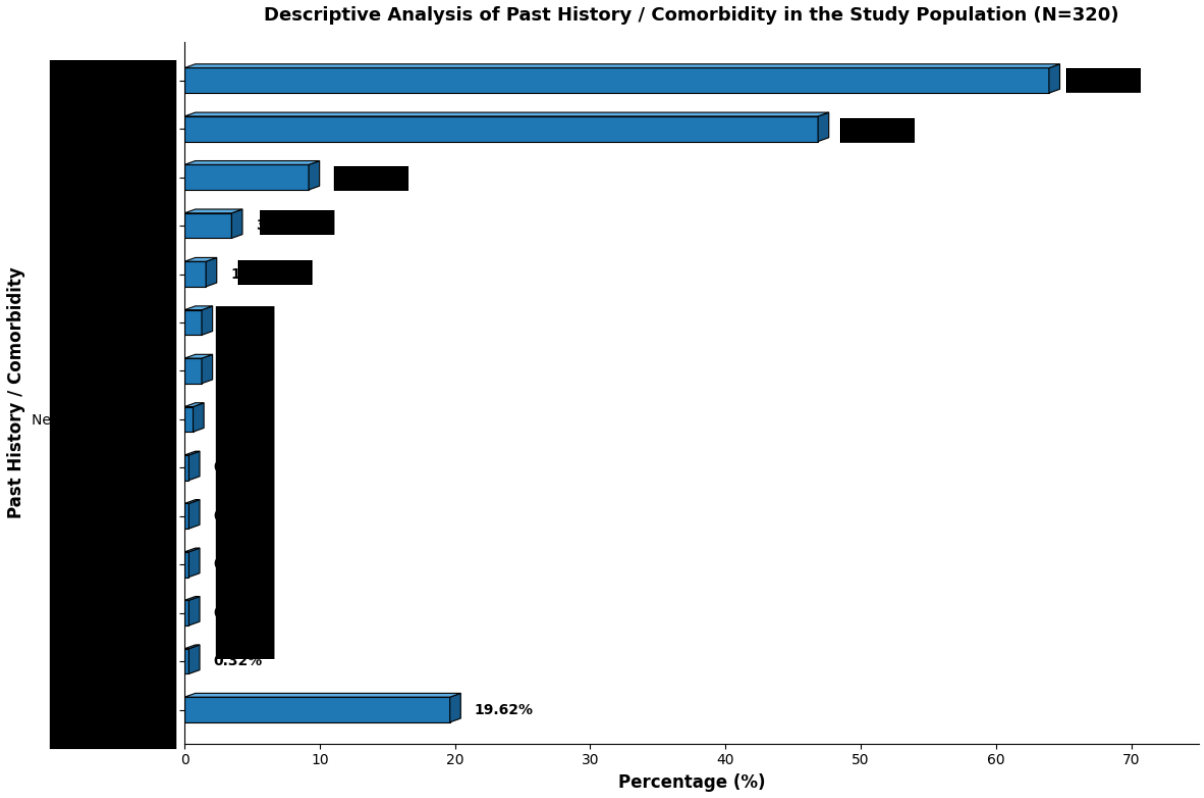
In the present study, the most common chief complaint was chest pain, reported by [redacted] ([redacted]) participants. [redacted]

[redacted] Vomiting, throat pain, and swelling of legs were each reported by [redacted] ([redacted]) participant.

Table 4 Descriptive Analysis of Past History / Comorbidity in the Study Population (N=320)

Past history / Comorbidity	Frequency	Percentages
[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]

Graph 4 Descriptive Analysis of Past History / Comorbidity in the Study Population (N=320)



In the present study, hypertension was the most common comorbidity and was present in [redacted] ([redacted]) participants. [redacted]

Table 5: Descriptive Analysis of Laboratory Data in the Study Population (N=320)

Parameter	Mean ± SD	Median	Minimum	Maximum	95% C.I	
					Lower	Upper

In the present study, the mean pulse rate was [redacted], with a median of [redacted], minimum value of [redacted], maximum value of [redacted], and a [redacted] confidence interval (CI) ranging from [redacted].

[redacted]

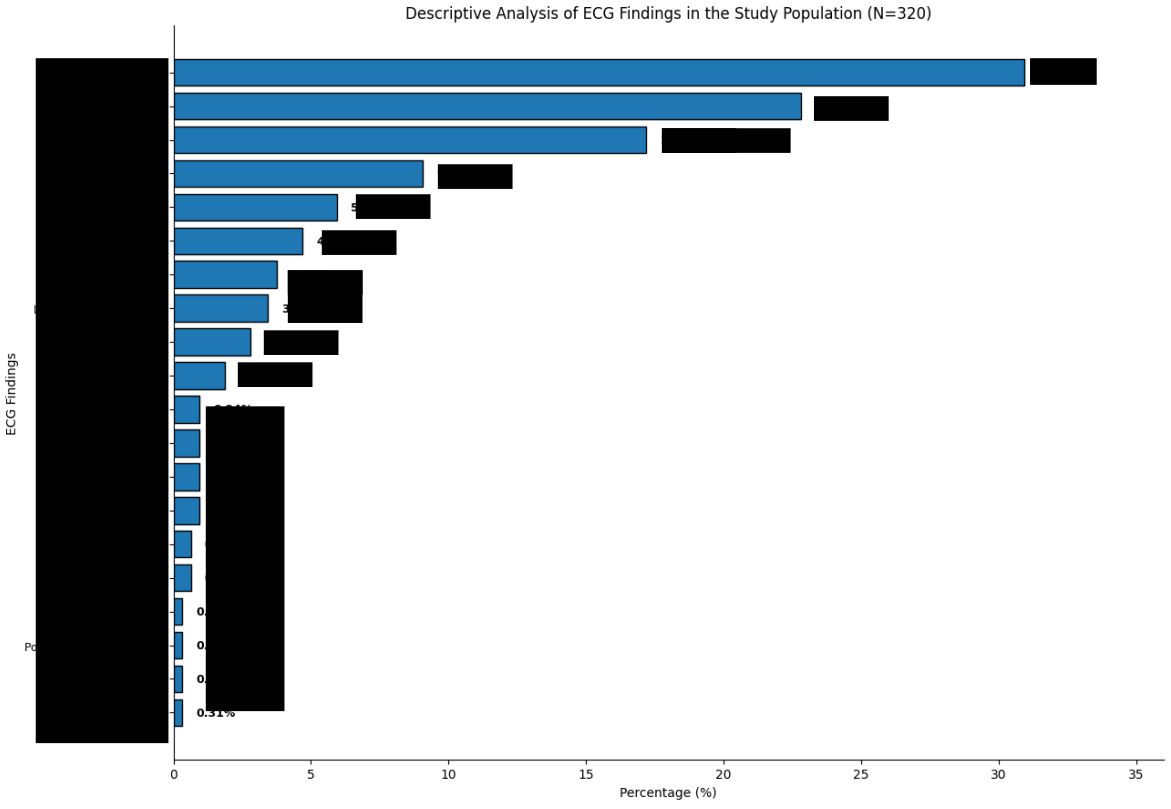
[redacted]

[redacted]

Table 6: Descriptive Analysis of ECG Findings in the Study Population (N=320)

ECG finding	Frequency	Percentages
[redacted]	[redacted]	[redacted]

Graph 5: Descriptive Analysis of ECG Findings in the Study Population (N=320)



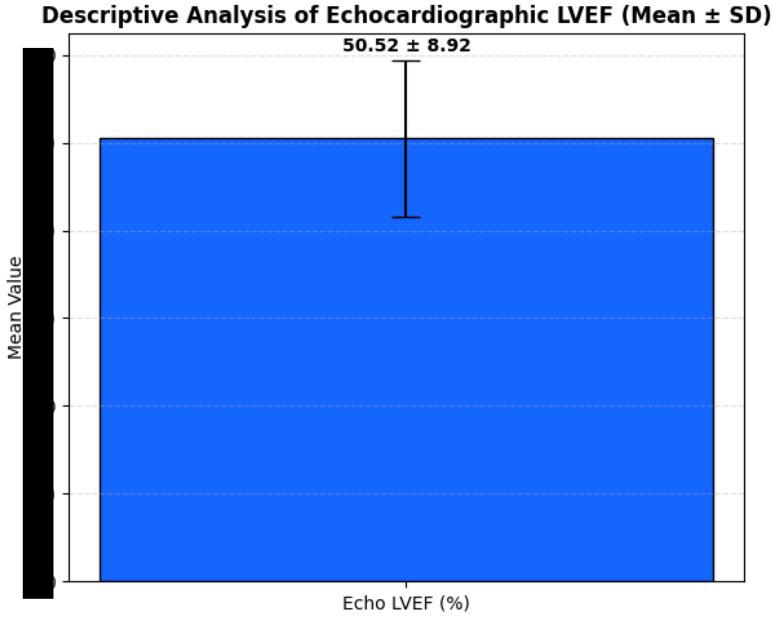
In the present study, normal sinus rhythm (NSR) was observed in [redacted] ([redacted]) participants. [redacted]

Sinus bradycardia, poor R-wave progression, Wolff–Parkinson–White (WPW) syndrome, and anteroseptal wall myocardial infarction (ASWMI) were each observed in [redacted] ([redacted]) participant.

Table 7: Descriptive Analysis of Echocardiographic Left Ventricular Ejection Fraction (LVEF) in the Study Population (N=320)

Parameter	Mean ± SD	Median	Minimum	Maximum	95% C.I	
					Lower	Upper
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]

Graph 6: Descriptive Analysis of Echocardiographic Left Ventricular Ejection Fraction (LVEF) in the Study Population (N=320)

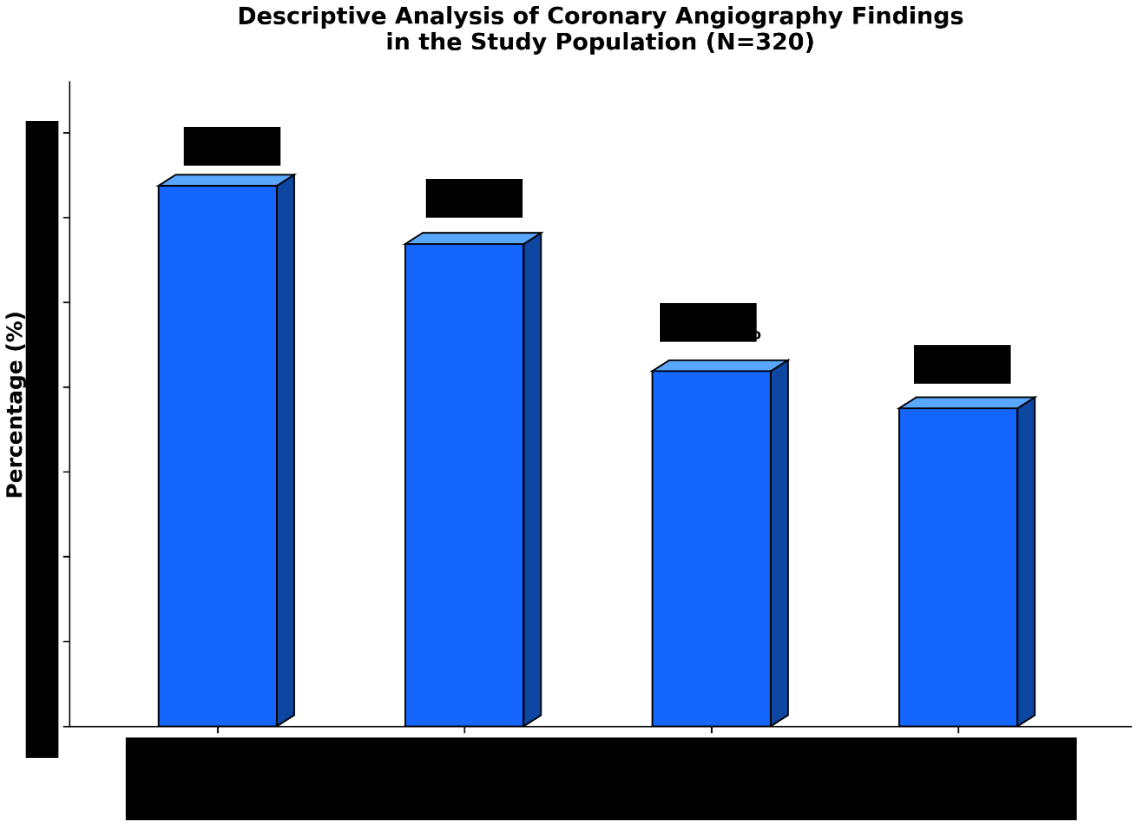


In the present study, the mean echocardiographic left ventricular ejection fraction (LVEF) was [redacted].

Table 8: Descriptive Analysis of Coronary Angiography Findings in the Study Population (N=320)

Coronary Angiography	Frequency	Percentages
[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]

Graph 8: Descriptive Analysis of Coronary Angiography Findings in the Study Population (N=320)

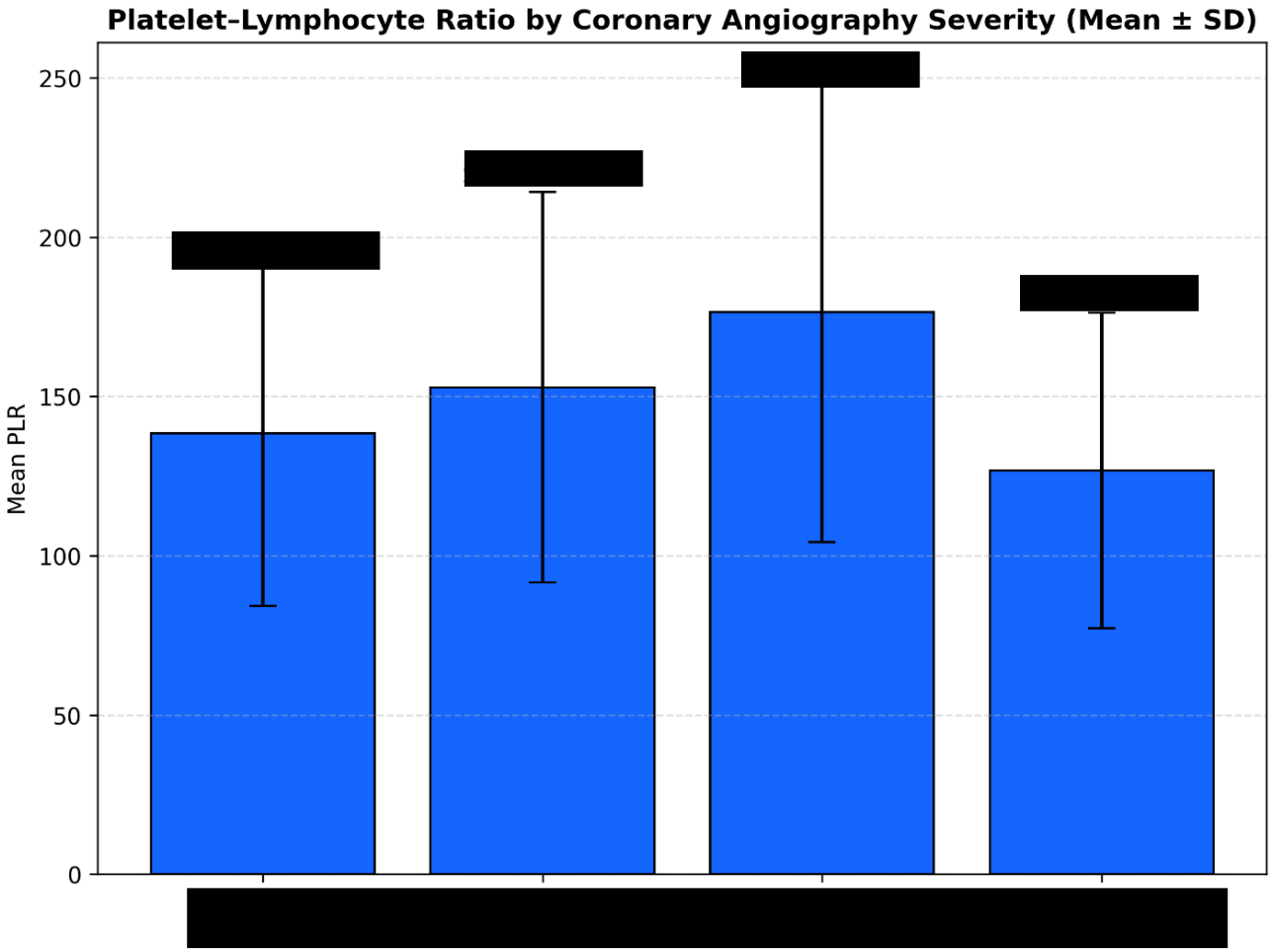


In the present study, Single Vessel Disease (SVD) was observed in 102 (31.87%) participants. [redacted] Normal epicardial coronaries were found in [redacted] participants.

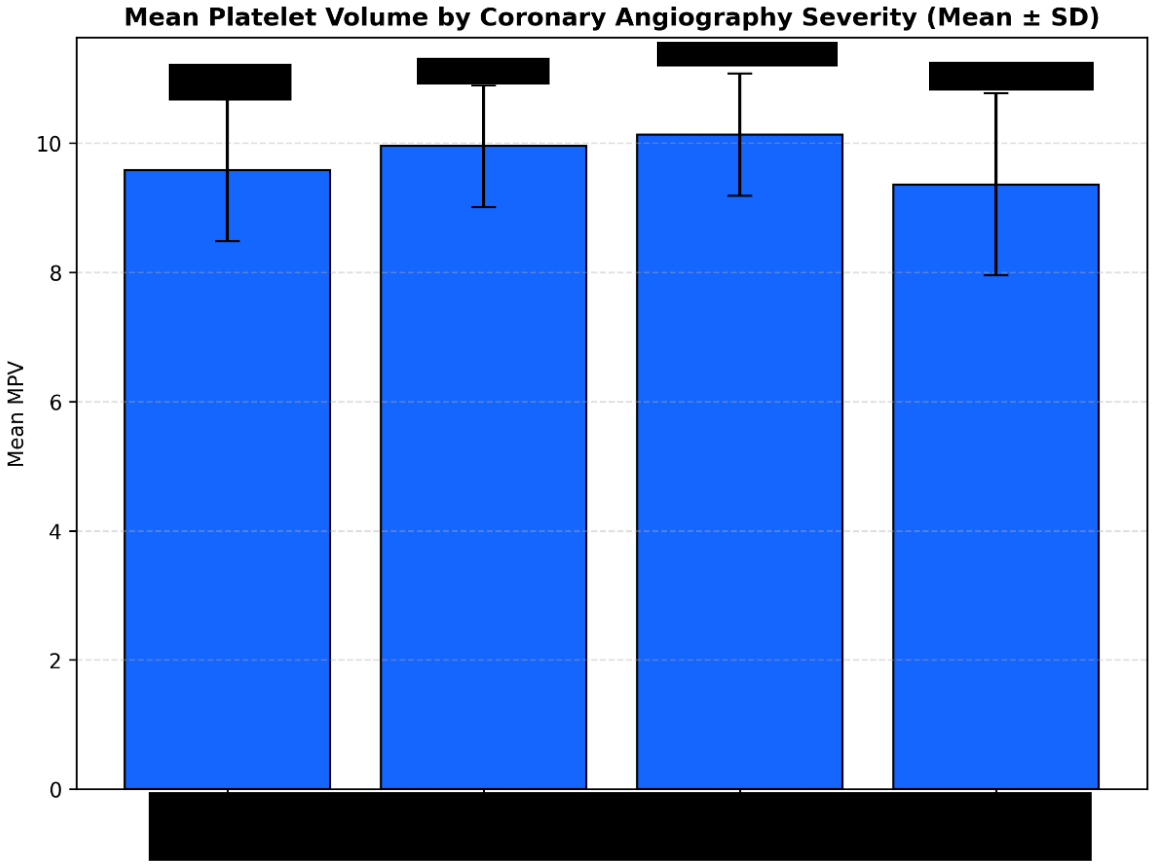
Table 9: Association of Platelet–Lymphocyte Ratio and Mean Platelet Volume with Severity of Coronary Artery Disease on Coronary Angiography (N=320)

Parameter	Coronary Angiography				P Value
	Single Vessel Disease	Double Vessel Disease	Triple Vessel Disease	Normal Epicardial Coronaries	
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]

Graph 9 A: Association of Platelet–Lymphocyte Ratio and Mean Platelet Volume with Severity of Coronary Artery Disease on Coronary Angiography (N=320)



Graph 9 B: Association of Platelet–Lymphocyte Ratio and Mean Platelet Volume with Severity of Coronary Artery Disease on Coronary Angiography (N=320)



In the present study, the mean Platelet–Lymphocyte Ratio (PLR) was [redacted] in participants with Single Vessel Disease, [redacted] in participants with Double Vessel [redacted]

DISCUSSION

DISCUSSION

The present study was undertaken to evaluate the association between Mean Platelet Volume (MPV), Platelet-to-Lymphocyte Ratio (PLR), and the severity of Coronary Artery Disease (CAD) in patients admitted with suspected coronary artery disease and undergoing invasive coronary angiography. [redacted]

[redacted]

[redacted]

Age

[redacted]

(2019) also demonstrated that patients with CAD and acute coronary syndromes generally belonged to older age groups, further emphasizing the contribution of advancing age to coronary atherosclerosis and adverse cardiovascular outcomes (109).

Gender

[redacted]

(2019) similarly reported that men represented the majority of patients with CAD undergoing clinical evaluation (109).

Chief Complaint in the Study Population

[redacted]

(2022), which

highlights that CAD presentations may vary from typical angina to atypical symptoms (2,20,128,129).

Past History / Comorbidity in the Study Population

[redacted] Less frequent comorbidities included old CVA/CVA [redacted] ([redacted]), bronchial asthma [redacted] ([redacted]), COPD [redacted] ([redacted]), thyroid disorders [redacted] ([redacted]), nephrotic syndrome [redacted] ([redacted]), and CLD, PVD, HOCM, HBsAg positivity, and seizure disorder each in [redacted] ([redacted]) participant.

Laboratory Parameters

[redacted]

[redacted]Therefore, the present table should be discussed as showing a laboratory profile suggestive of inflammatory and platelet activation status in suspected CAD patients.

Descriptive Analysis of ECG Findings in the Study Population

In the present study, normal sinus rhythm (NSR) was the most common ECG finding, observed in [redacted] ([redacted]) participants. [redacted]

(2024), who discussed coronary angiographic evaluation in patients with suspected CAD (58,67).

Echocardiographic Left Ventricular Ejection Fraction (LVEF) in the Study Population

[redacted] (2024) also described coronary angiography as an essential investigation for comprehensive assessment of patients with suspected coronary artery disease.

Coronary Angiography Findings in the Study Population

In the present study, Single Vessel Disease (SVD) was the most common angiographic finding and was observed in [redacted] ([redacted]) participants. [redacted] (2024) reported that increasing coronary disease complexity and multivessel involvement are associated with poorer cardiovascular outcomes (68,133).

Platelet–Lymphocyte Ratio and Mean Platelet Volume with Severity of Coronary Artery Disease

In the present study, platelet–lymphocyte ratio showed a progressive rise with increasing angiographic severity of coronary artery disease. [redacted] (2019) also emphasized the prognostic relevance of mean platelet volume in coronary artery disease severity and risk stratification.

Strengths of the Study

1. The study directly evaluated the association between Mean Platelet Volume (MPV), Platelet-to-Lymphocyte Ratio (PLR), and coronary artery disease severity, which was the primary objective of the research.

[redacted]

10. The study contributes to the growing body of evidence regarding the role of inflammation and platelet activation in the pathogenesis and progression of coronary artery disease.

Limitations of the Study

1. The study was conducted at a single tertiary care centre, which may limit the generalizability of the findings to other populations.

[redacted]

9. Being a hospital-based study, the possibility of selection bias cannot be completely excluded.

CONCLUSION

CONCLUSION

The present study was conducted to evaluate the association between Mean Platelet Volume (MPV), Platelet-to-Lymphocyte Ratio (PLR), and the severity of coronary artery disease in patients admitted with suspected coronary artery disease and undergoing invasive coronary angiography. [redacted]

The progressive increase in both MPV and PLR with increasing vessel involvement suggests that these hematological indices may serve as practical tools for risk stratification and assessment of coronary artery disease burden in clinical practice.

SUMMARY

SUMMARY

The present study, titled “Mean Platelet Volume and Platelet-to-Lymphocyte Ratio as Indicators of Coronary Artery Disease Severity: A One-Year Observational Study” was conducted to evaluate the association between Mean Platelet Volume (MPV), Platelet-to-Lymphocyte Ratio (PLR), and the severity of coronary artery disease (CAD) in patients undergoing invasive coronary angiography. [redacted]

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BIBLIOGRAPHY

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132. Shalev A, Nakazato R, Arsanjani R, Nakanishi R, Park HB, Otaki Y, et al. SYNTAX score derived from coronary CT angiography for prediction of complex percutaneous coronary interventions. Acad Radiol. 2016;23(11):1384-1392. doi:10.1016/j.acra.2016.07.003.

ANNEXURES

ANNEXURES-I

ANNEXURES-II

MASTERCHART