

Coronary Microvascular Dysfunction in Patients with No Obstructive Artery Disease

Daelman Genom*

Department of Paediatrics, Monash University, Melbourne, Victoria, Australia

Introduction

Coronary Microvascular Dysfunction (CMD) in patients without obstructive Coronary Artery Disease (CAD) has emerged as a critical area of study, challenging the traditional belief that significant myocardial ischemia only arises from large-vessel atherosclerosis. This condition, frequently underrecognized, especially in women, involves functional abnormalities in the coronary microcirculation rather than visible blockages in the epicardial arteries. Many patients, particularly postmenopausal women, present with angina-like chest pain despite having "normal" coronary angiograms, leading to misdiagnosis, delayed treatment and compromised quality of life. As awareness grows about CMD's clinical significance and its contribution to long-term adverse cardiac events, the need for more accurate diagnostic tools and tailored therapies becomes imperative. This introduction underscores the urgency of redefining how clinicians perceive, diagnose and manage ischemic symptoms in patients whose coronary arteries appear structurally intact on conventional imaging [1].

Description

CMD refers to the dysfunction of the smaller vessels within the heart's vascular system arterioles and capillaries that play a crucial role in regulating myocardial perfusion. These microvessels cannot be visualized by standard angiography, which leads to the underdiagnosis of patients suffering from ischemic symptoms in the absence of large-vessel stenosis. Physiologically, CMD may manifest as impaired vasodilation, increased vasoconstriction, or both, due to endothelial dysfunction, smooth muscle cell irregularities, or abnormal autonomic regulation. The reduced Coronary Flow Reserve (CFR) and microvascular spasm contribute to myocardial ischemia, even when epicardial arteries remain patent. Clinical studies, particularly the landmark WISE (Women's Ischemia Syndrome Evaluation) project, have shown that CMD is a prevalent and persistent issue among women with chest pain and no obstructive CAD. This population remains at increased risk for Heart Failure with preserved Ejection Fraction (HFpEF), hospitalization and major adverse cardiac events.

Diagnostic methods such as invasive Coronary Reactivity Testing (CRT), Positron Emission Tomography (PET), Cardiac Magnetic Resonance Imaging (CMR) and transthoracic Doppler echocardiography are employed to detect microvascular abnormalities. These tests assess endothelial and non-endothelial responses to vasodilators like acetylcholine and adenosine, helping quantify CFR and identify abnormalities in microvascular responsiveness. Pathophysiological contributors to CMD include metabolic syndrome, insulin resistance, systemic inflammation, oxidative stress and autonomic imbalance.

***Address for Correspondence:** Daelman Genom, Department of Paediatrics, Monash University, Melbourne, Victoria, Australia, E-mail: Daelman@Genom.au

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Management of CMD is multifaceted and largely empirical, with a focus on symptom relief and risk factor modification.

Pharmacologic interventions include beta-blockers, ACE inhibitors, statins, calcium channel blockers and, less commonly, long-acting nitrates. Lifestyle interventions such as stress management, cardiac rehabilitation and regular aerobic exercise also play a critical role. Yet, the absence of evidence-based guidelines for CMD poses a barrier to standardized care, making patient-centered approaches essential. Furthermore, CMD is being increasingly linked with non-ischemic cardiovascular syndromes, including HFpEF and Takotsubo cardiomyopathy, suggesting that it may be a systemic microvascular disorder with broad clinical ramifications beyond ischemic heart disease alone [2].

Conclusion

In conclusion, Coronary Microvascular Dysfunction represents a significant yet often overlooked form of ischemic heart disease in patients lacking visible epicardial artery obstruction. Its presence correlates with poor cardiovascular outcomes, ongoing anginal symptoms and heightened healthcare utilization. As such, CMD challenges the conventional diagnostic paradigm and necessitates a shift toward incorporating microvascular evaluation into routine clinical practice, especially in symptomatic women with non-obstructive CAD. Early identification through advanced imaging and targeted testing, combined with comprehensive pharmacological and lifestyle-based management strategies, is essential for improving outcomes in this high-risk patient population. By recognizing CMD as a discrete pathological entity, clinicians can more effectively tailor interventions, reduce symptom burden and mitigate long-term cardiovascular risks.

Acknowledgement

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Conflict of Interest

None.

References

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