OPEN ACCESS Freely available online

Journal of Clinical & Experimental Cardiology

Opinion Article

Microvascular Turbulence Index: A Novel Predictor of Subclinical Cardiac Dysfunction in Normotensive Individuals

Avenor Lysanthir*

Department of Cardiology, The University of Queensland, Brisbane, Australia

DESCRIPTION

Subclinical cardiac dysfunction represents a critical yet often undetected phase in the progression of cardiovascular disease, particularly among individuals who do not exhibit traditional risk factors such as hypertension or diabetes. In recent years, attention has increasingly shifted toward the role of coronary microcirculation in the early pathogenesis of cardiac abnormalities. While macrovascular pathology has been extensively studied, microvascular flow dynamics remain less understood despite their fundamental role in myocardial perfusion. A growing body of theoretical and experimental insights suggests that disturbances at the microvascular level may precede overt clinical manifestations. Within this context, the concept of the Microvascular Turbulence Index (MTI) emerges as a novel and potentially transformative parameter for identifying early cardiac dysfunction in normotensive individuals.

Microvascular turbulence refers to the disruption of normal laminar blood flow within the small vessels of the coronary circulation. Under physiological conditions, blood flow through these vessels is smooth and streamlined, ensuring efficient oxygen delivery and metabolic exchange. However, subtle endothelial dysfunction, localized inflammation, or alterations in vascular tone can lead to irregular flow patterns characterized by eddies and vortices. These disturbances may not significantly alter systemic hemodynamic parameters such as blood pressure, yet they can compromise myocardial oxygenation and initiate a cascade of pathological changes. The MTI is conceptualized as a quantitative measure of these flow irregularities, integrating variables such as flow velocity variance, shear stress gradients, and temporal fluctuations in perfusion.

The physiological basis for MTI is rooted in the sensitivity of the endothelium to mechanical forces. Endothelial cells respond dynamically to shear stress, modulating the release of vasoactive substances including nitric oxide, endothelin, and prostacyclin. In the presence of turbulent flow, these signaling pathways become dysregulated, leading to impaired vasodilation and increased oxidative stress. Over time, such alterations may contribute to structural remodeling of the microvasculature, including basement membrane thickening and capillary rarefaction. Importantly, these changes can occur independently of systemic hypertension, highlighting the limitations of conventional diagnostic approaches that rely primarily on blood pressure measurements. The clinical implications of MTI are significant, particularly in the realm of preventive cardiology. Early identification of individuals with elevated MTI could enable timely intervention before the onset of irreversible myocardial damage. For instance, patients with increased microvascular turbulence may benefit from targeted therapies aimed at improving endothelial function, such as lifestyle modifications, antioxidant supplementation, or pharmacological agents that enhance nitric oxide bioavailability. Furthermore, MTI could serve as a valuable tool for risk stratification, complementing existing biomarkers and imaging techniques to provide a more comprehensive assessment of cardiovascular health.

Advances in imaging technology offer promising avenues for the practical implementation of MTI. High-resolution Doppler echocardiography, combined with sophisticated computational algorithms, can potentially capture the nuanced flow patterns within coronary microvessels. Similarly, cardiac magnetic resonance imaging with phase-contrast techniques may provide detailed insights into microvascular perfusion dynamics. The integration of artificial intelligence and machine learning could further enhance the accuracy and reproducibility of MTI measurements, enabling real-time analysis and personalized risk profiling. Wearable devices equipped with advanced sensors may also play a role in continuous monitoring, although such applications remain speculative at present. Despite its potential, the concept of MTI requires rigorous validation through clinical research. Large-scale prospective studies are necessary to establish normative values, assess reproducibility, and determine its predictive power for adverse cardiovascular outcomes. Additionally, the relationship between MTI and other markers of

Correspondence to: Avenor Lysanthir, Department of Cardiology, The University of Queensland, Brisbane, Australia, E-mail: avenor.lysanthir@cardio-research.uq.au

Received: 02-Jan-2026, Manuscript No. JCEC-26-41101; **Editor assigned:** 05-Jan-2026, PreQC No. JCEC-26-41101 (PQ); **Reviewed:** 19-Jan-2026, QC No. JCEC-26-41101; **Revised:** 26-Jan-2026, Manuscript No. JCEC-26-41101 (R); **Published:** 02-Feb-2026, DOI: 10.35248/2155-9880.26.17.993

Citation: Lysanthir A (2026). Microvascular Turbulence Index: A Novel Predictor of Subclinical Cardiac Dysfunction in Normotensive Individuals. J Clin Exp Cardiolog. 17:993.

endothelial dysfunction, such as flow-mediated dilation and circulating biomarkers, warrants further investigation. Ethical considerations, including the implications of early diagnosis in asymptomatic individuals, must also be carefully addressed.

Another important dimension of MTI lies in its potential to bridge the gap between experimental cardiology and clinical practice. By providing a measurable link between microvascular physiology and clinical outcomes, MTI could facilitate the translation of basic research findings into actionable diagnostic strategies. This aligns with the broader trend toward precision medicine, where individualized assessments guide tailored interventions. In this context, MTI may not only serve as a diagnostic tool but also as a marker for monitoring therapeutic response, enabling clinicians to evaluate the effectiveness of interventions in real time.

CONCLUSION

The Microvascular turbulence index represents a compelling new paradigm in the detection of subclinical cardiac dysfunction. By focusing on the often-overlooked domain of coronary microcirculation, it offers a window into the earliest stages of cardiovascular disease, particularly in individuals who appear healthy by conventional standards. Although still in the conceptual phase, MTI holds the promise of enhancing diagnostic precision, guiding preventive strategies, and ultimately improving cardiovascular outcomes. Continued research and technological innovation will determine its place in the future landscape of cardiology, but its foundational premise underscores a critical shift toward recognizing the importance of microvascular health in maintaining overall cardiac function.