УДК [61+615.1] (06)
ББК 5+52.81
А 43
ISBN 978-985-21-1865-1

K.D.S.T. Jayawardana, S.V. Daluwathumulla Gamage

NEW DIAGNOSTIC METHODS OF MICROVASCULAR ANGINA

Tutor: senior lecturer A.S. Aliakseyeva
Department of Outpatient Therapy
Belarusian State Medical University, Minsk

К.Д.С.Т. Джаявардана, С.В. Далуватхумулла Гамаге

НОВЫЕ МЕТОДЫ ДИАГНОСТИКИ МИКРОВАСКУЛЯРНОЙ СТЕНОКАРДИИ

Научный руководитель: ст. преп. Е.С. Алексеева
Кафедра поликлинической терапии
Белорусский государственный медицинский университет, г. Минск

Резюме. Микрососудистая стенокардия (МВА) – все более распознаваемое клиническое состояние, характеризующееся ишемическими симптомами, несмотря на отсутствие значительной обструкции коронарных артерий. Традиционные методы диагностики часто не выявляют МВА, что приводит к гиподиагностике и неправильному лечению. Однако достижения в области диагностических инструментов, включая инвазивные и неинвазивные методы, значительно улучшили обнаружение и понимание МВА. В этом обзоре рассматриваются новые диагностические методы и их влияние на выявление и лечение МВА.

Ключевые слова: микрососудистая стенокардия, коронарная микрососудистая дисфункция, тестирование коронарной функции, инвазивные методы, неинвазивные методы.

Resume. Microvascular angina (MVA) is an increasingly recognized clinical condition characterized by ischemic symptoms despite the absence of significant coronary artery obstruction. Traditional diagnostic methods often failed to identify MVA, leading to underdiagnosis and mismanagement. However, advancements in diagnostic tools, including invasive and noninvasive techniques have significantly improved the detection and understanding of MVA. This review explores emerging diagnostic methods and their impact on the identification and management of MVA.

Keywords: microvascular angina, Coronary microvascular dysfunction, Coronary function testing, Invasive methods, Noninvasive methods.

Relevance. Microvascular angina (MVA) is a form of chest pain that occurs in the absence of significant coronary artery blockages, making its diagnosis and management particularly challenging. Unlike traditional forms of angina, which are typically caused by obstructive coronary artery disease, microvascular angina arises from dysfunction within the smaller blood vessels of the heart–known as the coronary microcirculation. These microvessels play a crucial role in regulating blood flow to the heart muscle, and when impaired, they can lead to reduced oxygen supply and the characteristic symptoms of angina, even when larger coronary arteries remain unaffected.

Aim: this literature review aims to evaluate and compare emerging diagnostic methods for MVA, emphasizing their effectiveness, accuracy, limitations and clinical applicability.

Objectives:

1. To analyze the pathophysiology and clinical presentation of MVA.
2. Explore the latest advancements in diagnostic modalities, including CMR, PET, and coronary function testing.

УДК [61+615.1] (06)
ББК 5+52.81
А 43
ISBN 978-985-21-1865-1

3. Discuss the advantages and limitations of each technique.

Results and their discussion. Anatomy and Physiology of Coronary Microcirculation: The coronary microcirculation is composed of three anatomical compartments, each contributing differently to vascular resistance. Large epicardial arteries (>500 μm) act primarily as conduits, offering minimal resistance (~5%). Prearterioles (100–500 μm) contribute moderately (~20%) by maintaining perfusion pressure, while the small intramyocardial arterioles and capillaries are the principal regulators of flow, accounting for approximately 75% of vascular resistance. Under normal physiological conditions, these vessels dilate in response to metabolic demand, allowing a substantial increase in blood flow during stress.

Pathophysiology of CMD: CMD is broadly classified into *functional* and *structural endotypes*. Functional CMD arises from endothelial dysfunction, impaired nitric oxide bioavailability, or dysregulated smooth muscle tone, leading to poor vessel relaxation. Structural CMD is associated with vessel wall remodeling, fibrosis, hypertrophy, inflammation, or microembolization that physically impairs perfusion.

Unlike obstructive coronary artery disease (CAD), CMD does not involve large-vessel stenosis. Instead, several mechanisms contribute to microvascular impairment:

- Endothelial dysfunction causes imbalance between vasodilators (e.g., nitric oxide) and vasoconstrictors (e.g., endothelin).
- Vascular remodeling results in capillary rarefaction and stiffening, reducing flow capacity.
- Inflammation promotes oxidative stress and further endothelial injury.
- Autonomic nervous system abnormalities may lead to inappropriate vasoconstriction during stress.

Clinical Presentation and Risk Factors: Patients with CMD often present with microvascular angina (MVA)–a form of angina not attributable to obstructive CAD. Symptoms include exertional or rest chest pain, pressure, or dyspnea, and may extend to the jaw or back. Unlike classic angina, symptoms often persist longer and are less responsive to nitrates.

Risk factors for CMD include:

- Traditional cardiovascular risks: smoking, age, hypertension, diabetes, hyperlipidemia
- Systemic inflammatory disorders: lupus, rheumatoid arthritis
- Psychosocial stress: emotional and mental health disturbances can exacerbate vasomotor dysfunction

Diagnostic Evaluation: As the coronary microcirculation is not visible on standard angiography, functional assessment is essential.

Coronary Flow Reserve (CFR): CFR evaluates the heart's ability to increase blood flow in response to stress. A CFR ≤2.0–2.5 suggests CMD. It can be measured using:

- Doppler method – A Doppler guidewire measures peak flow velocity during rest and hyperemia.
- Thermodilution – A saline bolus is injected, and mean transit times at rest and hyperemia are used to calculate flow reserve.

УДК [61+615.1] (06)
ББК 5+52.81
А 43
ISBN 978-985-21-1865-1

Microvascular Resistance (MR): MR assesses resistance within the small coronary vessels:

- Hyperemic Microvascular Resistance (hMR) – Calculated using Doppler flow and distal coronary pressure.
- Index of Microvascular Resistance (IMR) – Derived from thermodilution measurements.
- Absolute Resistance (Rmicro) – Evaluated using continuous thermodilution.

An IMR >25 or hMR >2.5 indicates structural CMD.

Acetylcholine Testing: This test distinguishes between healthy and dysfunctional endothelium. Acetylcholine normally causes vasodilation via nitric oxide stimulation, but in CMD, it may provoke vasoconstriction. Stepwise or bolus administration is used to assess for epicardial or microvascular spasm.

Non-Invasive Imaging Modalities: Several imaging techniques provide additional diagnostic support:

- Positron Emission Tomography (PET) – Gold standard for assessing myocardial perfusion and CFR.
- Cardiac Magnetic Resonance (CMR) – Useful for flow reserve and structural evaluation, without radiation.
- Transthoracic Doppler Echocardiography (TTDE) and CT Perfusion (CTP) – Offer cost-effective, accessible alternatives.

Non-Invasive Diagnostic Methods: Includes PET, CMR, TTDE, and CTP. Each method provides insights into myocardial perfusion and flow reserve. PET is the gold standard; others offer advantages like no radiation or affordability, below we have presented a table with this information (table .1)

Diagnostic Criteria for CMD and Microvascular Angina

According to COVADIS Criteria, CMD diagnosis requires:

1. Symptoms of myocardial ischaemia - Effort and/or rest angina or angina equivalents (i.e., breathlessness)

2. Absence of obstructive epicardial CAD - (<50% stenosis or FFR < 0.80) assessed on either CT coronary angiogram or invasive coronary angiography

3. Objective evidence of myocardial ischaemia - e.g., ischemic ECG changes during an episode of chest pain, stress-induced chest pain and/or ischemic ECG changes in the presence or absence of transient/reversible abnormal myocardial perfusion and/or wall motion abnormality

4. Evidence of impaired coronary microvascular function - e.g., impaired coronary flow reserve (cut-off values between ≤2.0 and ≤2.5), microvascular spasm (reproduction of symptoms, ischemic ECG shifts but no epicardial spasm during Ach testing), abnormal coronary microvascular resistance indices (e.g., IMR > 25), coronary slow flow (TIMI frame count > 25).

Diagnosis of microvascular angina is only confirmed if all four criteria are met. Diagnosis of microvascularangina is suspected if patient fulfils criteria 1 and 2 but only criterion 3 or 4 alone.

УДК [61+615.1] (06)
ББК 5+52.81
А 43
ISBN 978-985-21-1865-1

Tbl. 1. Non-invasive methods of diagnosing MVA and their characteristics

Modality	**Procedure**	**Pharmacologic Agents**	**Key Benefits**	**Limitations**
Echocardiography	Doppler ultrasound of blood flow in the left anterior descending artery during rest and stress	Adenosine, Dipyridamole, Regadenoson	- Widely accessible and cost-effective - No radiation exposure	- Highly dependent on operator and patient - Evaluates only endothelium-independent function - Not suitable for patients with asthma or heart block - Only assesses LAD region
Cardiac PET	Stress and rest myocardial perfusion imaging using dynamic techniques	Adenosine, Regadenoson, Dipyridamole	- Most accurate non-invasive tool for CMD - Can measure total myocardial blood flow quantitatively	- Involves radiation - Lower spatial resolution - Expensive and not widely available - Not ideal for certain patient groups
Cardiac MRI	Quantitative or semi-quantitative imaging of perfusion at rest and stress	Adenosine, Regadenoson	- No radiation - Assesses entire heart perfusion - High spatial detail improves diagnostic accuracy	- Not yet fully validated for stress perfusion - Contraindicated in some patients (e.g., with metal implants or kidney issues) - Can be affected by imaging artefacts - High cost and limited access

Conclusions. The evolution of diagnostic tools has transformed the detection and management of microvascular angina, allowing for earlier and more accurate diagnoses. The increased prevalence of diagnosed MVA cases underscores the importance of integrating these advanced techniques into routine cardiology practice. Future research should focus on optimizing these methods and developing standardized diagnostic protocols to ensure consistent and effective patient care.

Literature

1. 2024 ESC Guidelines for the management of chronic coronary syndromes: Developed by the task force for the management of chronic coronary syndromes of the European Society of Cardiology (ESC) Endorsed by the European Association for Cardio-Thoracic Surgery (EACTS), European Heart Journal, Volume 45, Issue 36, 21 September 2024, Pages 3415–3537

2. Taqueti, V.R. & Di Carli, M.F., 2021. Coronary microvascular disease pathogenic mechanisms and therapeutic options: JACC state-of-the-art review. Journal of the American Heart Association, 10(23), p.e021032. doi:10.1161/JAHA.121.021032

3. Abramik J, Mariathas M, Felekos I. Coronary Microvascular Dysfunction and Vasospastic Angina-Pathophysiology, Diagnosis and Management Strategies. J Clin Med. 2025 Feb 10;14(4):1128. doi: 10.3390/jcm14041128. PMID: 40004660; PMCID: PMC11856034.

4. Spione F, Arevalos V, Gabani R, Sabaté M, Brugaletta S. Coronary Microvascular Angina: A State-of-the-Art Review. Front Cardiovasc Med. 2022 Mar 30;9:800918. doi: 10.3389/fcvm.2022.800918. PMID: 35433857; PMCID: PMC9005807.

5. Lanza GA, De Vita A, Kaski JC. 'Primary' Microvascular Angina: Clinical Characteristics, Pathogenesis and Management. Interv Cardiol. 2018 Sep;13(3):108-111. doi: 10.15420/icr.2018.15.2. PMID: 30443265; PMCID: PMC6234490.