Myocardial Infarction with Non-Obstructive Coronary Arteries: MINOCA

A Changing Philosophy

Non-obstructive CAD is not a false positive. It’s not benign.
Normal coronary angiogram. A smooth patent covedable left main, LAD, and circumflex projected from the screen. Next to these innocent-appearing vessels was a distinctly sinister IVUS study from the same angiogram demonstrating plaque rupture and ulceration.

The finding of angiographically smooth coronary arteries does not preclude an aetiologic role of thrombotic disease in MINOCA.

What we can see is only 5% of the total coronary tree.

What you see...
Non-obstructive Coronary Arteries

What you don’t see...
? Coronary Microvascular Dysfunction
Mechanisms for ischemic heart disease in women.
*Plaque disruption denotes plaque rupture or plaque erosion

MINOCA ‘ Five Ws and One H ’

The What, When, Who, Why, How and Where of Myocardial Infarction With Non-Obstructive Coronary Arteries (MINOCA)
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MINOCA Etiology

Underlying pathophysiological mechanisms of MINOCA

**Coronary causes**
1. Vasospastic Angina (epicardial artery spasm)
2. Coronary Microvascular Disorders
   i. Coronary slow flow
   ii. Microvascular angina
   iii. Microvascular spasm
3. Coronary Plaque Disruption
4. Spontaneous coronary thrombosis/embolism
5. Missed Obstructive CAD

**Non-Coronary causes**

**Myocardial Disorders**
1. Myocarditis
2. Takotsubo cardiomyopathy
3. Other cardiomyopathies (DCM, HCM)

**Non Cardiac Disorders**
1. Pulmonary embolism
2. Renal impairment
3. Stroke
4. Sepsis

The diagnosis of MINOCA is made immediately upon coronary angiography in a patient presenting with features consistent with an AMI, as detailed by the following criteria:

1. Universal AMI criteria

2. Non-obstructive coronary arteries on angiography, defined as no coronary artery stenosis \( \geq 50\% \) in any potential IRA

3. No clinically overt specific cause for the acute presentation
A potential problem with current AMI criteria is their central focus upon troponins, since clinicians encounter elevated troponins in clinical scenarios other than AMI.
MINOCA: A case study of a 55-year-old woman with an anterior STEMI presentation.
MINOCA should be considered as a ‘working diagnosis’, analogous to heart failure, and thus prompts further evaluation regarding its underlying mechanism(s).

Current US guidelines do not address MINOCA.
What is new in 2017 STEMI Guidelines

2017 NEW / REVISED CONCEPTS

MINOC A AND QUALITY INDICATORS:
• New chapters dedicated to these topics.

STRATEGY SELECTION AND TIME DELAYS:
• Clear definition of first medical contact (FMC).
• Definition of “time 0” to choose reperfusion strategy (i.e. the strategy clock starts at the time of “STEMI diagnosis”).
• Selection of PCI over fibrinolysis; when anticipated delay from “STEMI diagnosis” to wire crossing is ≤120 min.
• Maximum delay time from “STEMI diagnosis” to bolus of fibrinolysis agent is set in 10 min.
• “Door-to-Ballon” term eliminated from guidelines.

TIME LIMITS FOR ROUTINE OPENING OF AN IRA:
• 0–12h (Class I); 12–48h (Class IIa); >48h (Class III).

ELECTROCARDIOGRAM AT PRESENTATION:
• Left and right bundle branch block considered equal for recommending urgent angiography if ischemic symptoms.

TIME TO ANGIOGRAPHY AFTER FIBRINOLYSIS:
• Timeframe is set in 2–24h after successful fibrinolysis.

PATIENTS TAKING ANTICOAGULANTS:
• Acute and chronic management presented.
Diagnostic test flow chart in MINOCA.

**SUSPECTED STEMI**

**ACUTE INVESTIGATION**

- Coronary stenosis >50%
  - Treat as STEMI
- No coronary stenosis >50%
  - Urgent angiography + Fulfillment universal AMI criteria
- Acute LV wall motion assessment (angiogram / echo)

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**SUSPECTED DIAGNOSIS AND FURTHER DIAGNOSTIC TESTS**

**Non-invasive**
- TTE Echo (pericardial effusion)
- CMR (myocarditis, pericarditis)
- TTE Echo (Regional wall motion abnormalities, embolic source)
- TOE/Bubble Contrast Echo (Patient foramen ovale, atrial septal defect)
- TTE Echo CMR (Takotsubo, others)
- D-dimer (Pulmonary embolism)
- CT scan (Pulmonary embolism)
- Endomyocardial biopsy (myocarditis)
- IVUS/OCT (plaque disruption/dissection)
- Ergonovine/Ach test³ (spasm)
- Pressure/Doppler test (microvascular dysfunction)

**Invasive**
- Pulmonary Embolism
- Oxygen supply/demand imbalance- Type 2 MI
- Blood tests, Extracardiac investigation

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*Figure 7* Diagnostic test flow chart in MINOCA. CMR = Cardiac Magnetic Resonance; IVUS = Intravascular Ultrasound; LV = Left Ventricle; MINOCA = Myocardial Infarction with Non-Obstructed Coronary Arteries; OCT = Optical Coherence Tomography; STEMI = ST-segment elevation myocardial infarction; TOE = Trans-Oesophageal Echocardiography; TTE = Transthoracic Echocardiography. Takotsubo syndrome cannot be diagnosed with certainty in the acute phase as the definition requires follow-up imaging to document recovery of left ventricular function. IVUS and OCT frequently show more abnormalities than may be appreciated on angiography. They also increase sensitivity for detection of intracoronary imaging. It is appropriate to carry out this imaging at the time of the acute cardiac catheterization, after diagnostic angiography. Patients should be made aware of the additional information the test can provide and the small increase in risk associated with intracoronary imaging.

1. Provocative testing for coronary artery spasm might be considered in selected patients with a recent AMI with suspected vasospastic angina. Provocative manoeuvres have to be always performed by operators with experience and not necessarily in the acute phase of STEMI.

2. Clinically suspected myocarditis by ESC Task Force criteria: No angiographic stenosis >50%, plus non-ischemic pattern on CMR. Define myocarditis by ESC Task Force criteria: No angiographic stenosis >50%, plus endomyocardial biopsy confirmation (histology, immunohistochemistry, polymerase-chain reaction based techniques to search for genome of infectious agents, mainly viruses).
MINOCA: A case study of a 55-year-old woman with an anterior STEMI presentation.

JACC: Cardiovascular Imaging
January 2017
DOI: 10.1016/j.jcmg.2016.11.010
Myocardial Infarction With Nonobstructed Coronary Arteries
Impact of CMR Early After Presentation

CMR imaging is a key investigation in identifying the underlying cause.
Coronary angiography portraying subtle lesion (arrow) involving the mid LAD.

Cardiac MRI revealing LGE of the mid to distal anteroseptal wall (arrows). Still frames from horizontal long axis (top row) and short axis (bottom row) are consistent with mid to distal LAD infarction.


Cardiac magnetic resonance (CMR) imaging findings in patients with MINOCA.

Bar graph of published studies showing the diagnostic significance of CMR imaging in MINOCA patients. Data presented as percentage (%).
Management

A fundamental consideration is identifying the underlying cause of this heterogeneous syndrome because that will determine appropriate therapy.

MINOCA: is not a benign condition?

All-Cause Mortality in Patients With MINOCA or MI-CAD

<table>
<thead>
<tr>
<th>Comparative Studies</th>
<th>MI-CAD</th>
<th>MINOCA</th>
<th>OR (95% CI)</th>
<th>P Value</th>
<th>All MINOCA Studies</th>
</tr>
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<tbody>
<tr>
<td>In-hospital Mortality</td>
<td>% (95% CI)</td>
<td>% (95% CI)</td>
<td></td>
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<tr>
<td>3.2% (1.8%, 4.6%)</td>
<td>1.1% (-0.1%, 2.2%)</td>
<td>0.37 (0.2–0.67)</td>
<td>P=0.001</td>
<td>(0.5%, 1.3%)</td>
<td></td>
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<tr>
<td>6.7% (4.3%, 9.0%)</td>
<td>3.5% (2.2%, 4.7%)</td>
<td>0.59 (0.41–0.83)</td>
<td>P=0.003</td>
<td>(2.6%, 6.9%)</td>
<td></td>
</tr>
</tbody>
</table>

Data presented as percentage (%) and 95% confidence intervals (%) with odds ratio (OR) and P values. MI-CAD indicates myocardial infarction with coronary artery disease; and MINOCA, myocardial infarction with nonobstructive coronary arteries.

*Circulation 2015;131(10):861–870*
In-hospital and 12-month all cause mortality comparison for patients with myocardial infarction with nonobstructive coronary arteries (MINOCA) and those with myocardial infarction and obstructive coronary artery disease (MICAD).

**Guarded Prognosis**

Although the outcome of MINOCA strongly depends on the underlying cause, its overall prognosis is serious, with a 1 year mortality of about 3.5%.

Hence patients with MINOCA should receive the same clinical attention as AMI patients who have single- or double-vessel disease and not merely dismissed as having an insignificant clinical condition.

*This is crucial since many patients, particularly those with angiographically normal coronary arteries, are often labelled as ‘non-cardiac’, therefore missing the chance for appropriate treatment. And this group of patients characterizes substantially worse outcome than previously it was believed.*
Circulation. 2017;135:1481–1489

Clinical Perspective

What Is New?

- This is the first study evaluating secondary prevention treatments in a large group of patients with myocardial infarction with nonobstructive coronary arteries.
- Patients treated with statins and renin-angiotensin system blockers had a significantly 2.3% and 18% lower risk of a major adverse cardiac event during follow-up.
- In contrast, there were no significant reductions in risk of major adverse cardiac events after treatment with β-blockers and dual antiplatelet therapy.

What Are the Clinical Implications?

- The results indicate that long-term treatment with statins and renin-angiotensin system blockers may be beneficial in patients with myocardial infarction with nonobstructive coronary arteries.
- Treatment with β-blockers and dual antiplatelet therapy seem less likely to reduce the risk of new cardiovascular events in patients with myocardial infarction with nonobstructive coronary arteries.

Survival curves for treated and untreated in the 1:1 propensity score-matched populations.
MINOCA occurs dominantly in women
MINOCA is not a false positive MI
Additional diagnostics should be used (IVUS, MRI, OCT, CTA)
Differential can include plaque rupture, plaque erosion, coronary dissection, Takotsubo cardiomyopathy, vasospasm, pro-thrombotic disorder, myocarditis)
RAS blocker and high intensity statin therapy makes sense