

MINI-FOCUS ISSUE: IMAGING

BEGINNER

CASE REPORT: CLINICAL CASE

A Challenging and Unexpected Case of MINOCA Using Multimodality Imaging



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ABSTRACT

We describe a challenging case of a patient with MINOCA due to isolated right ventricular myocardial infarction with microvascular obstruction identified on cardiac magnetic resonance imaging. This case highlights that even a comprehensive, guideline-based assessment of these patients can initially fail to detect the underlying pathology. (**Level of Difficulty: Beginner.**) (J Am Coll Cardiol Case Rep 2020;2:1564-9) © 2020 The Authors. Published by Elsevier on behalf of the American College of Cardiology Foundation. This is an open access article under the CC BY-NC-ND license (<http://creativecommons.org/licenses/by-nc-nd/4.0/>).

A 66-year-old man developed sudden-onset severe central chest and epigastric pain at rest. The electrocardiogram (ECG) performed by the paramedics showed ST-segment elevation in V₁ to V₅ and II, III, and aVF (**Figure 1**). His observations revealed hypertension (180/100 mm Hg) and a heart rate of 60 beats/min. On arrival, he had ongoing chest pain, was diaphoretic and clammy, and appeared acutely unwell. The rest of the cardiorespiratory examination was unremarkable. There was no history of a recent viral illness.

PAST MEDICAL HISTORY

The patient had a history of Miller Fisher syndrome, hypertension, and dyslipidemia.

DIFFERENTIAL DIAGNOSIS

Given the findings of severe central chest pain and ST-segment elevation, the most likely differential

LEARNING OBJECTIVES

- To recognize that, in patients presenting with myocardial infarction with nonobstructive coronary arteries, an exhaustive search for the underlying cause should be undertaken, as per the 2019 AHA Scientific Statement.
- To recognize that early CMR is a key investigation in patients with MINOCA.
- To be aware that RV microvascular obstruction is a rare complication of RV myocardial infarction and can be misinterpreted as normal myocardium.
- To recognize that repeat CMR examination in the chronic phase can be helpful in selected high-risk patients in whom initial diagnostic tests have been unsatisfactory.
- To recognize that comprehensive intracoronary imaging is recommended in cases of suspected MINOCA.

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diagnosis was ST-segment elevation myocardial infarction (STEMI). Other important differentials considered were myocarditis, pericarditis, pulmonary embolus, and bowel ischemia.

INVESTIGATIONS

Initial high-sensitivity troponin T level was 50 ng/l, which peaked at 1,229 ng/l (normal range <14 ng/l). C-reactive protein (CRP) was <5 mg/l (normal range <6.0 mg/l). The only other abnormality on blood tests was a metabolic acidosis, with a venous lactate of 6.0 mmol/l (normal range 0.5 to 2.2 mmol/l).

MANAGEMENT

Immediate coronary angiography showed an unobstructed left main stem with mild to moderate plaque disease in the left anterior descending (LAD) artery, first diagonal, and left circumflex arteries. The right coronary artery only demonstrated mild plaque disease (Figure 2, Videos 1, 2, 3, 4, 5, and 6). Given the high index of clinical suspicion of a myocardial infarction (MI), detailed review of the angiographic images was performed, which did not suggest an ostial occlusion of a branch coronary artery. In addition, based on the predominantly anterolateral ECG changes at presentation, optical coherence tomography (OCT) was performed in the LAD, circumflex, or first obtuse marginal arteries, and this confirmed that

there was no intravascular evidence of a ruptured plaque or coronary dissection. Left ventricular (LV) ventriculogram was normal.

The patient was returned to the coronary care unit with a working diagnosis of MI with nonobstructive coronary arteries (MINOCA). Dual antiplatelet therapy and standard secondary prevention was started pending further investigations.

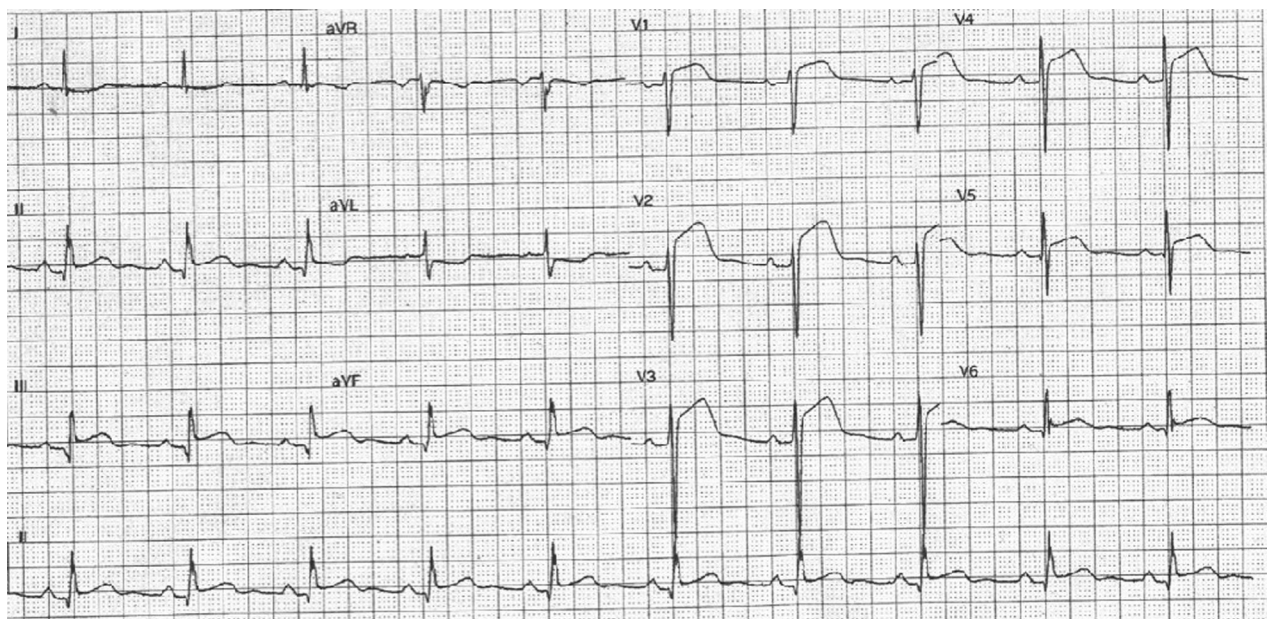
Bedside echocardiography showed mildly impaired right ventricular (RV) systolic function with severe hypokinesia of the RV free wall and mild right atrial enlargement. LV function was normal, with no regional wall motion abnormality and no significant valvular abnormality. Computed tomography (CT) pulmonary angiography (CTPA) results were normal.

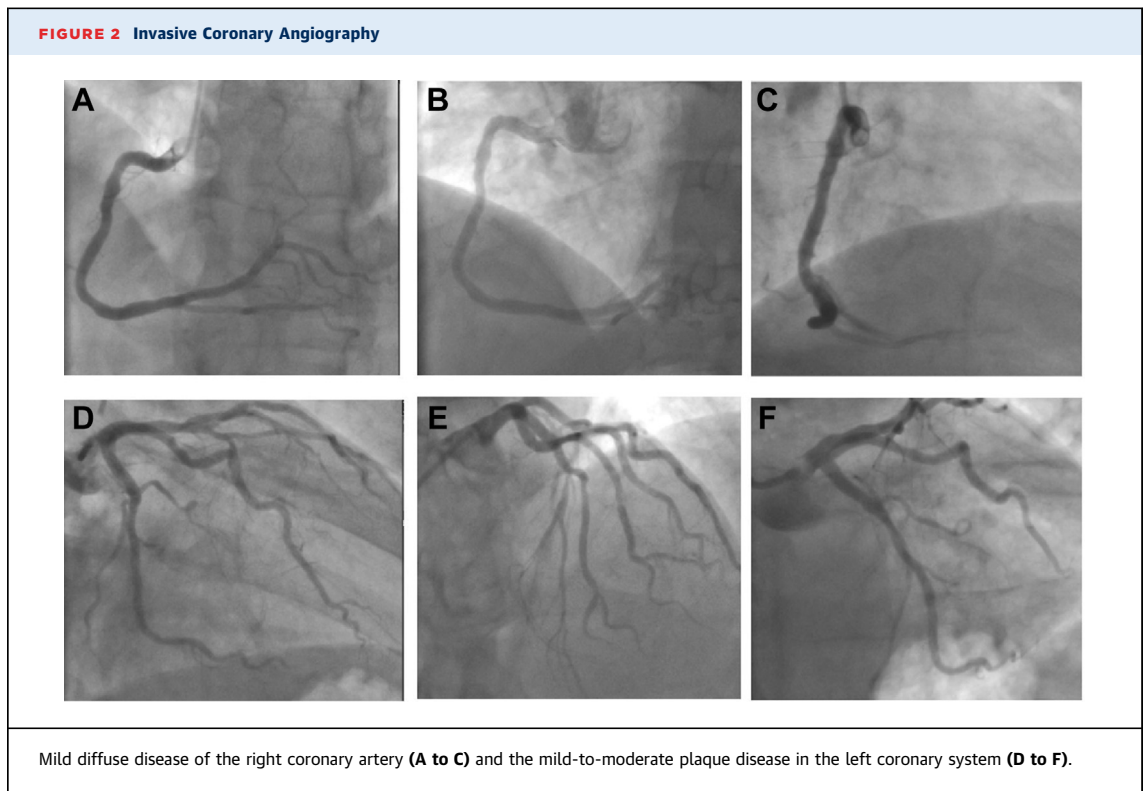
Cardiac magnetic resonance (CMR) was performed 1 day following the presentation (Figure 3). This revealed normal LV systolic function with no regional wall abnormalities. However, there was marked systolic flattening of the interventricular septum, and the RV was mildly dilated with impaired ejection fraction (EF) (49%) and severe hypokinesia/akinesia of the mid to apical RV free wall. T2-short tau inversion recovery (STIR) imaging was normal, and there was no late gadolinium enhancement (LGE) to suggest any acute edema or acute MI. In addition, the

ABBREVIATIONS AND ACRONYMS

- CMR** = cardiac magnetic resonance
- CTPA** = computed tomography pulmonary angiogram
- CRP** = C-reactive protein
- ECG** = electrocardiogram
- LAD** = left anterior descending
- LGE** = late gadolinium enhancement
- MINOCA** = myocardial infarction with nonobstructive coronary arteries
- MVO** = microvascular obstruction
- OCT** = optical coherence tomography
- RV** = right ventricle

FIGURE 1 12-Lead Electrocardiogram on Admission





pericardium appeared normal, and there was no evidence of pericardial effusion.

A working diagnosis of RV predominant myopericarditis was made, and the patient was started on anti-inflammatory medication, analgesia, and was advised to abstain from strenuous exercise for 6 months.

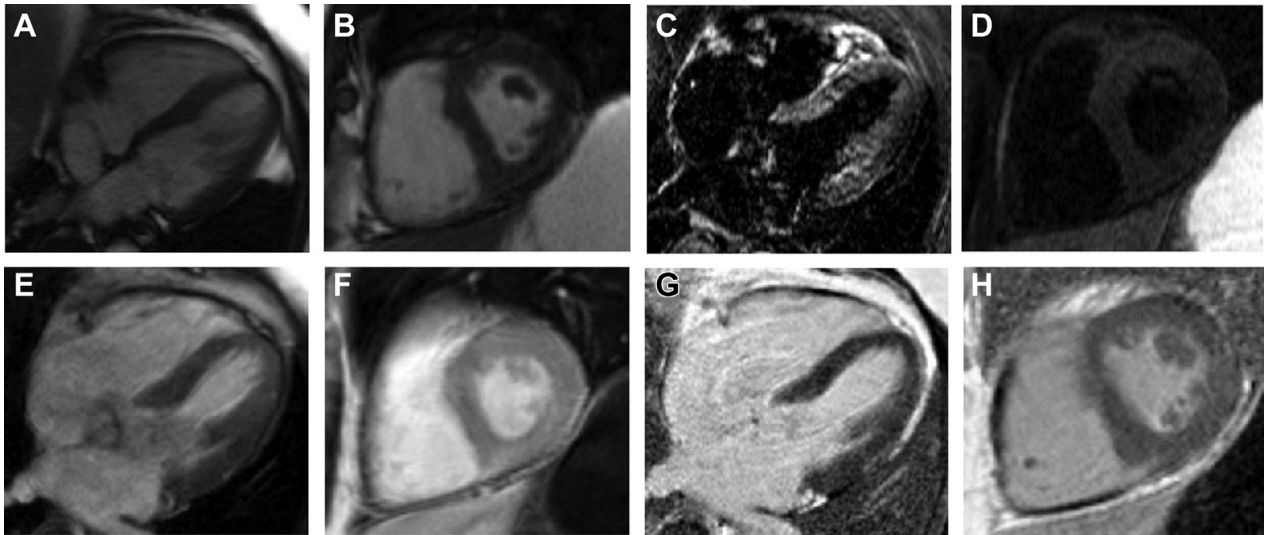
Repeat CMR was performed at 6 weeks as part of a local research study (Figure 4). The RV remained impaired with the previously described regional wall motion abnormalities. However, the LGE images now clearly showed transmural late enhancement of the basal to mid-right ventricular free wall and part of the diaphragmatic wall, consistent with RV infarction.

Review of the initial CMR (Figure 3) demonstrated very low signal throughout the RV free wall on the early post-contrast images, consistent with extensive microvascular obstruction (MVO) (Figure 5). This had been incorrectly interpreted as normal myocardium, given the signal characteristics and the challenge of the thin-walled RV free wall, the absence of normal reference myocardium within the same segment, and the rarity of RV MVO.

DISCUSSION

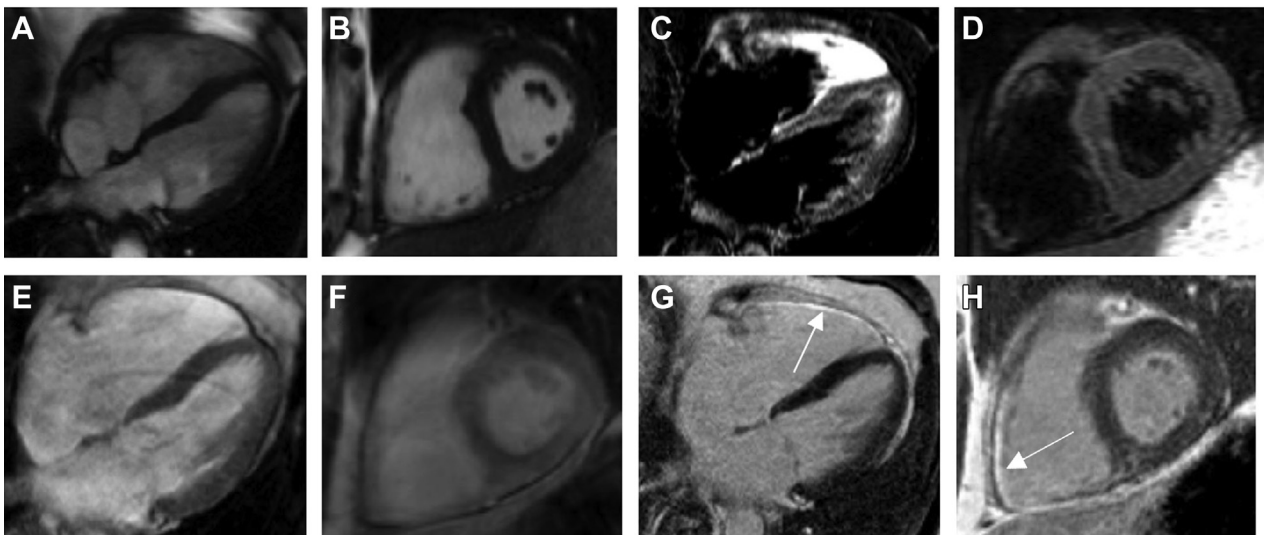
Myocardial infarction with nonobstructive coronary arteries is relatively common, affecting up to 6% of patients with acute MI (1). A 2019 AHA scientific statement (2) sought to clarify some of the confusion around the diagnostic term “MINOCA.” It is made clear that MINOCA is a descriptive working diagnosis in patients with presumed ischemic etiology to their presentation. Diagnosis requires a rise or fall in cardiac troponin (usually defined as a 20% change) with 1 value >99th centile; corroborative evidence of infarction: for example, symptoms consistent with myocardial ischemia; the absence of obstructive coronary artery disease on angiography (no stenosis $\geq 50\%$ in any major epicardial vessel); and the absence of any alternate diagnosis for the clinical presentation (such as sepsis, pulmonary embolism, or myocarditis). They advocate a traffic-light approach to comprehensively assess these patients. Suggested steps include detailed review of the angiogram in light of further clinical information, imaging with echo and/or CMR, intravascular coronary imaging,

FIGURE 3 Cardiac Magnetic Resonance at Presentation

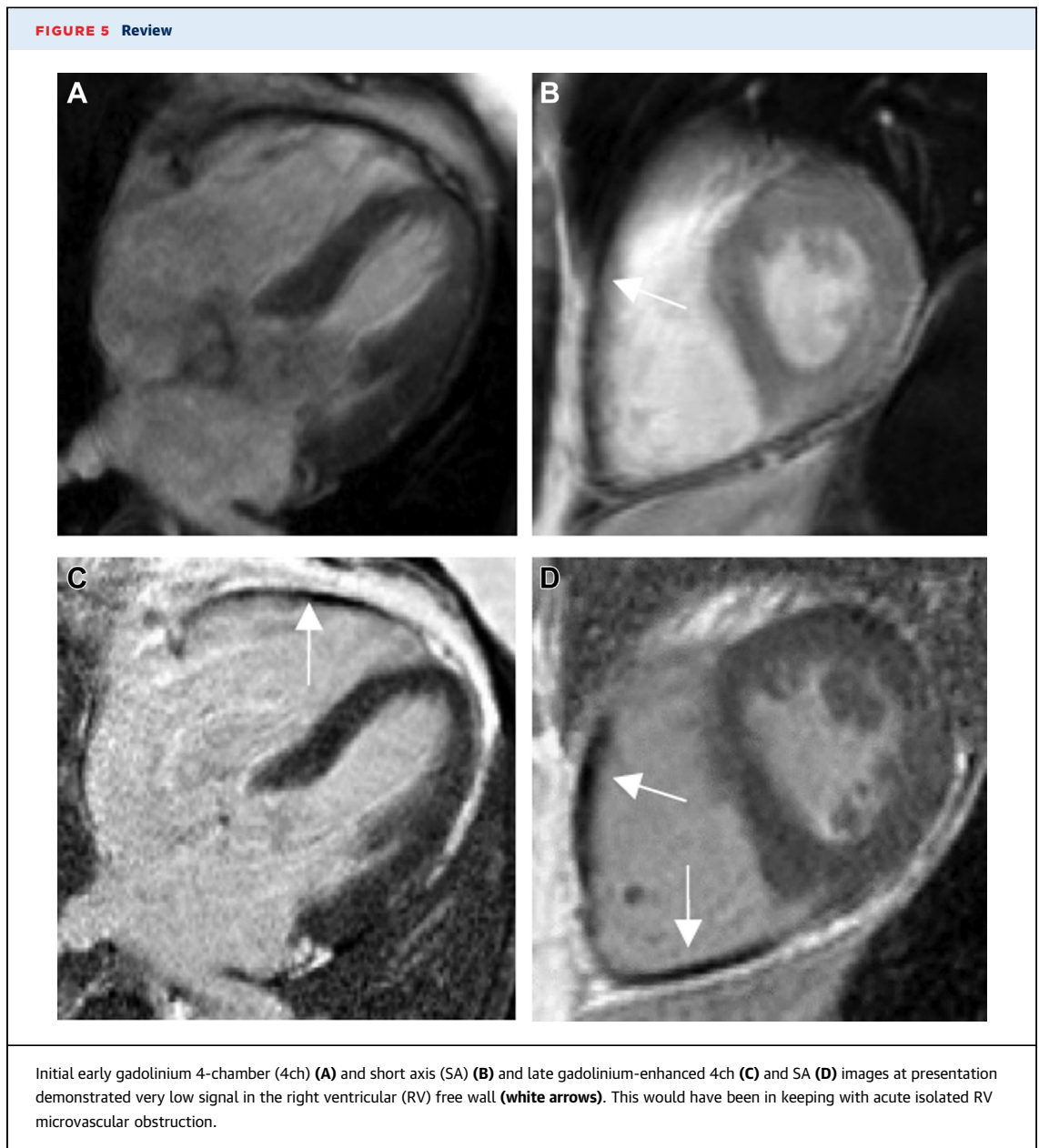


Four-chamber (4ch) cine image (A) demonstrating a mildly dilated right ventricle (RV). Short axis view in end systole (B) demonstrating flattened septum consistent with RV pressure overload; 4ch and mid ventricular short axis (SA) T2-short tau inversion recovery (STIR) images (C and D) showing no myocardial edema. Early gadolinium 4ch long axis (E) and mid-SA (F) images. Late gadolinium 4ch long axis (G) and SA (H) images.

FIGURE 4 Cardiac Magnetic Resonance at 6-Week Follow-Up



Four-chamber (4ch) cine image (A) and mid-ventricular SA view in end systole (B) demonstrating ongoing mildly dilated right ventricle (RV) but now reduced septal flattening; 4ch and mid-SA T2-STIR images (C, D) showing no myocardial edema. Early gadolinium 4ch long axis (E) and mid-SA (F) showing relatively increased signal in the RV free wall, compared with the previous scan, in keeping with resolution of acute microvascular obstruction and some perfusion of contrast into the RV free wall. Late gadolinium 4ch long axis (G) and SA (H) now showing very high signal in the RV free wall in keeping with established RV myocardial infarction (white arrows).



and coronary functional assessment. Furthermore, a recent consensus statement advocates comprehensive intracoronary imaging in cases of suspected MINOCA, and this case strengthens this recommendation, as imaging of the RCA was overlooked but may have provided an acute diagnosis (3).

CMR is recommended as a key investigation in the diagnostic work-up of patients with MINOCA and can make a diagnosis in approximately 3 of 4 patients (4). CMR is a noninvasive imaging modality used to investigate cardiac anatomy, function, and tissue characterization. CMR can facilitate identification of cardiomyopathies—such as myocarditis, pericarditis,

acute MI, and Takotsubo—in patients presenting with MINOCA. CMR performed within 2 weeks of presentation can increase the diagnostic yield from ~70% to ~84% (5). LGE can detect as little as 1g of infarcted myocardium (6).

We report a rare case of isolated RV MI with MVO. Despite following established recommendations, the diagnosis still took 6 weeks to be confirmed, highlighting the unique intellectual challenges in this cohort of patients.

Although there are sparse reports of RV MVO in the literature (7,8) there is not a published case report to our knowledge of isolated RV MVO.

MVO is seen following coronary reperfusion in patients who have had significant periods of ischemia. Its appearances on CMR are caused by the inability of gadolinium contrast material to pass through the myocardial microvasculature, as reperfused myocytes become edematous because of osmotic overload and occlude the capillaries (9). This leads to a focal, well-defined area of absent signal within an area of high-signal infarction or acute ischemia (8). Myocardium with microvascular obstruction is less likely to regain function and leads to ventricular wall scarring and remodeling when compared with patients who have no microvascular obstruction (10). The presence of microvascular obstruction is associated with higher rates of cardiovascular events in the first 2 years following an MI and a poorer prognosis.

FOLLOW-UP

Our final diagnosis was a transmural, nonviable, RV MI. The patient was contacted to explain the diagnosis and was restarted on aspirin 75 mg, clopidogrel 75 mg, and appropriate secondary prevention.

The presumed culprit lesion was an ostial RV branch occlusion, which could not be identified on angiography. Subsequent ECGs (Supplemental Figures 1 and 2) demonstrated findings consistent with a transmural infarction.

The role of antiplatelet therapy in MINOCA is controversial. In our case, we thought that the most likely underlying pathophysiology was an ostial plaque rupture event, and so we decided to treat the patient as a nonreperfused STEMI, as per the 2017 ESC guidelines (11).

CONCLUSIONS

This is the first reported case of isolated RV infarction with MVO and highlights the value of CMR in patients with MINOCA.

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KEY WORDS cardiac magnetic resonance, coronary angiography, myocardial infarction, right ventricle

APPENDIX For supplemental videos and figures, please see the online version of this paper.