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Case Report

Utility of cardiac magnetic resonance in the diagnosis of suspected "MINOCA": a case series and literature review ☆

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ABSTRACT

Myocardial infarction with nonobstructive coronary artery (MINOCA) is a common condition in clinical practice with multiple specific causes, such as plaque rupture, plaque erosion, and epicardial coronary vasospasm. There must be an ischemic mechanism responsible for the myocyte injury and an exclusion of nonischemic mechanisms that can mimic myocardial infarction, and then a diagnosis of MINOCA can be made. Cardiac magnetic resonance (CMR) plays an essential role in the diagnosis and differential diagnosis of MINOCA, which can not only exclude myocarditis, Takotsubo syndrome, and cardiomyopathies, but also provide imaging confirmation of acute myocardial infarction. In this study, we presented 2 typical cases with the clinical presentation of acute myocardial infarction but normal or nonobstructive epicardial coronary arteries. Further CMR examinations showed different patterns of late gadolinium enhancement (LGE) in these 2 cases, one case with subendocardial LGE of the anterolateral wall and the other one with subepicardial LGE of the lateral wall, which indicated 2 different mechanisms for the myocyte injury. Subsequently, these 2 patients received different treatment regimens and were discharged with improved symptoms. In conclusion, CMR should be a mandatory test in patients with suspected MINOCA, because it can not only make a clear diagnosis, but also play an important role in guiding clinical decision-making.

Introduction

Myocardial infarction with nonobstructive coronary artery (MINOCA) is a not uncommon condition with multiple specific causes, such as plaque rupture, plaque erosion, and epicardial coronary vasospasm [1]. In the 2018 fourth universal definition of myocardial infarction and 2019 American Heart Association (AHA) scientific statement, they definitely proposed that, for the diagnosis of MINOCA, there must be an ischemic mechanism responsible for the myocyte injury and an exclusion of nonischemic mechanisms that can mimic myocardial infarction (eg, myocarditis). Cardiac magnetic resonance (CMR) is recommended as a key diagnostic tool in MINOCA patients,

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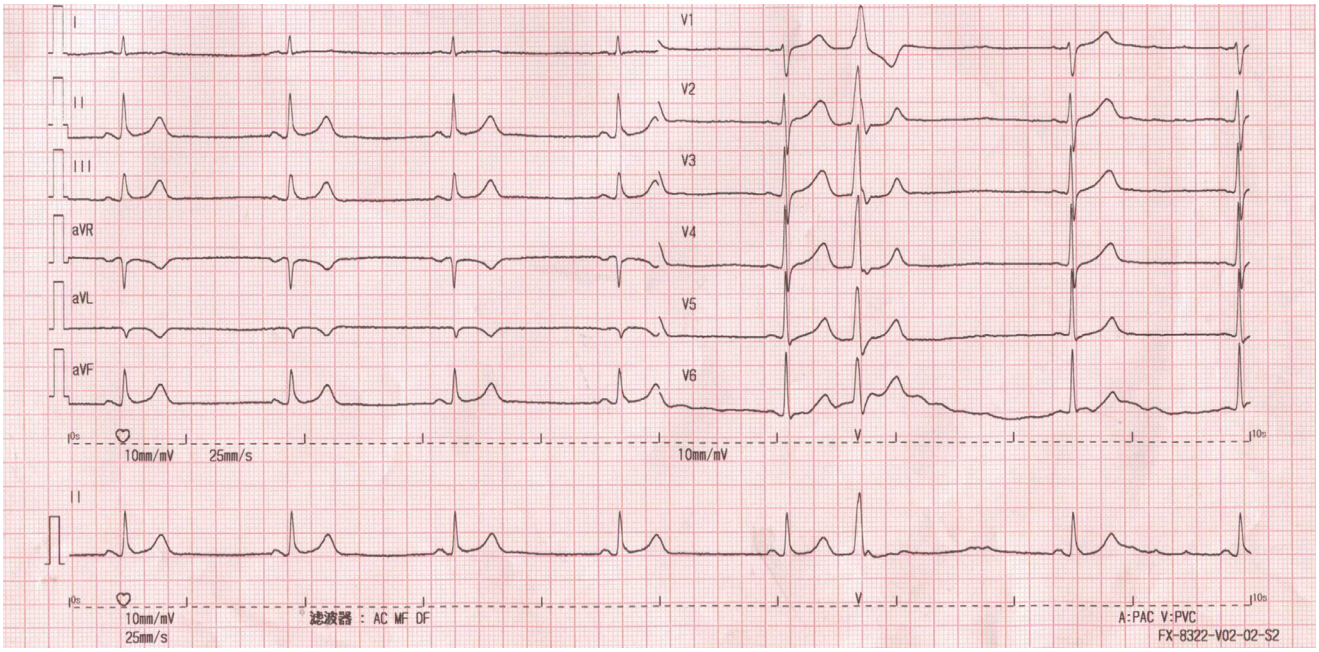

Fig. 1 – Electrocardiography (ECG) at admission. ECG showed abnormal Q wave and inverted T wave in aVL lead, sinus bradycardia and ventricular premature beat.

which can not only exclude myocarditis, takotsubo syndrome and cardiomyopathies, but also provide imaging confirmation of acute myocardial infarction (AMI) [1,2]. Therefore, in this study, we aimed to underline the updated diagnostic criteria for MINOCA and emphasize the role of CMR in the diagnosis of MINOCA through 2 typical cases.

Case presentation

Case 1

A 63-year-old man with hyperlipidemia and 80-pack-year smoking history presented with chest pain lasting an hour with associated sweating which was relieved with oral antianginals. He experienced similar symptoms in the early hours of the morning which resolved spontaneously after 10 minutes. For further diagnosis and treatment, the patient came to the emergency department of our hospital. Electrocardiography (ECG) showed abnormal Q wave and inverted T wave in aVL lead, sinus bradycardia, and ventricular premature beat (Fig. 1). Cardiac troponin I (cTnI) was elevated (3.160 ng/mL; normal value: <0.02 ng/mL). Echocardiography demonstrated hypokinesis of the left ventricular lateral wall and a left ventricular ejection fraction of 53%. According to the clinical symptoms and relevant examinations mentioned above, the initial diagnosis was likely to be AMI. Thus, coronary angiography (CAG) was performed to detect the culprit coronary artery that may account for the symptoms of the patient. However, CAG revealed no significant stenosis (<50%) of the epicardial coronary arteries (Fig. 2, Supplementary material, Video S1-S3). Further investigation, CMR, was recommended to detect probable underlying causes. CMR showed subendocardial myocardial edema and late gadolinium enhancement (LGE) in the anterolateral wall of basal and mid-ventricular segments of left ventricle, which conformed to the ischemia pattern of LGE according to the Fourth universal definition of myocardial infarction [2] and indicated AMI (Fig. 3, Supplementary material, Video S4). Therefore, put all these information together, the patient was finally diagnosed with CMR confirmed MINOCA according to the AHA scientific statement [1]. Subsequently, the patient was initiated on dual antiplatelet therapy with a proton pump inhibitor, and secondary prevention including beta-blockers, ACE-inhibitors, long-acting nitrates, and statins. The cTnI levels of the patient gradually decreased during his hospitalization, and the patient was discharged with improved symptoms.

Case 2

A 44-year-old man had a history of hypertension and hyperlipidemia for 3 years, and had no history of diabetes and smoking. The patient admitted to the emergency department of our hospital due to sudden chest pain for 5 hours. ECG showed ST segments slightly elevated (0.1-0.2 mV) in I, aVL and V4-V6 leads (Fig. 4). Echocardiography demonstrated hypokinesis of inferolateral wall of the left ventricle and a left ventricular ejection fraction of 56%. Cardiac troponin I (cTnI) was elevated (5.820 ng/mL; normal value: <0.02 ng/mL). AMI was considered and CAG was performed immediately. However, CAG showed normal epicardial coronary arteries (Fig. 5, Supplementary material, Video S5-S7). The diagnosis of suspected MINOCA was made immediately upon CAG in this patient, and the patient was subsequently transferred to the coronary care unit for further treatment. CMR examination was recom-

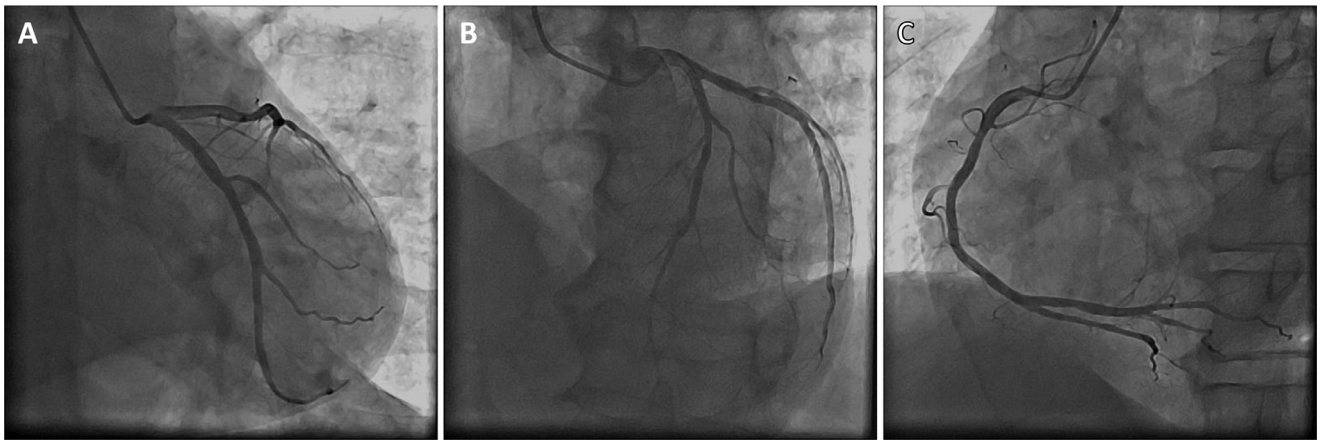

Fig. 2 – Coronary angiography (CAG) images. CAG showed no significant stenosis (<50%) in three major epicardial coronary arteries.

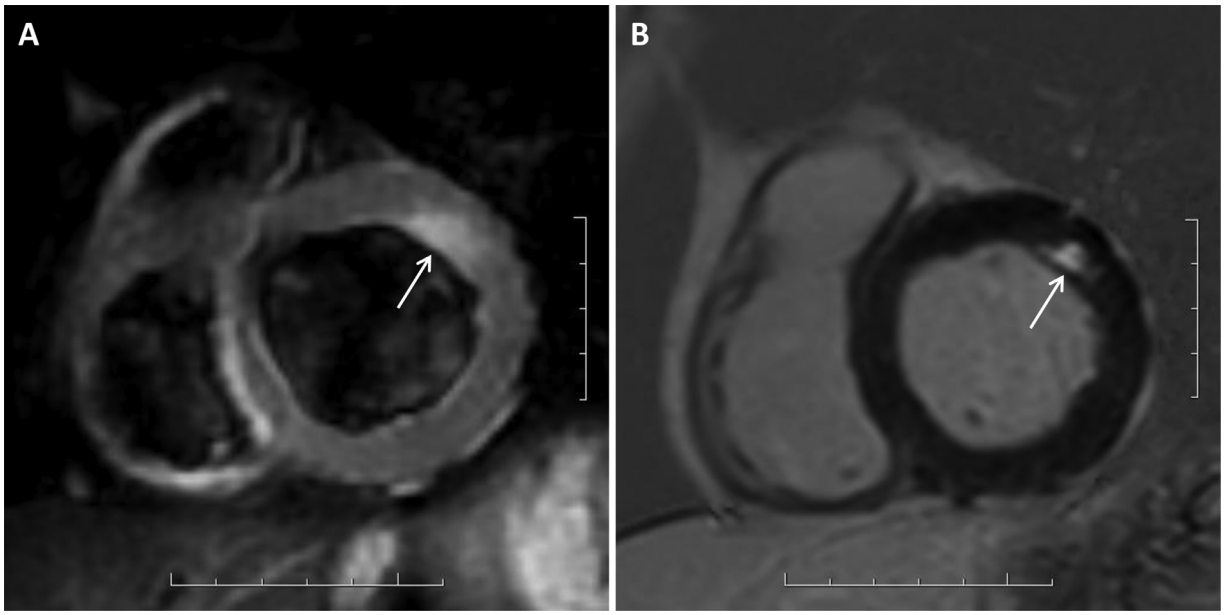

Fig. 3 – Cardiac magnetic resonance (CMR) images. CMR showed patchy subendocardial myocardial edema (A, T2-weighted fat suppression) and late gadolinium enhancement (LGE) (B) in the anterolateral wall of basal and mid-ventricular segments of left ventricle.

mended to exclude other specific alternative diagnosis for the clinical presentation. CMR showed left ventricular lateral wall edema and subepicardial enhancement, which conformed to the nonischemia pattern of LGE according to the Fourth universal definition of myocardial infarction [2] and indicated acute myocarditis (Fig. 6, Supplementary material, Video S8). Further inquiry of medical history revealed that the patient had a history of fever 3 days ago. Therefore, put all these information together, the patient was finally diagnosed with acute myocarditis [3]. Then the patient received symptomatic relief and supportive treatments, including myocardial protection, blood pressure and heart rate control, and lipid-lowering therapy. The cTnI levels of the patient gradually decreased during his hospitalization, and the patient was discharged with improved symptoms. One month later, the patient had no obvious discomfort. ECG reexamination showed no abnormality (Supplementary material, Fig. S1) and echocardiography reexamination showed improved cardiac function.

Discussion

In this study, we presented 2 typical cases with the clinical presentation of AMI but normal or nonobstructive epicardial coronary arteries. Further CMR examinations showed different patterns of LGE in these 2 cases, one case with subendocardial LGE of the anterolateral wall and the other one with

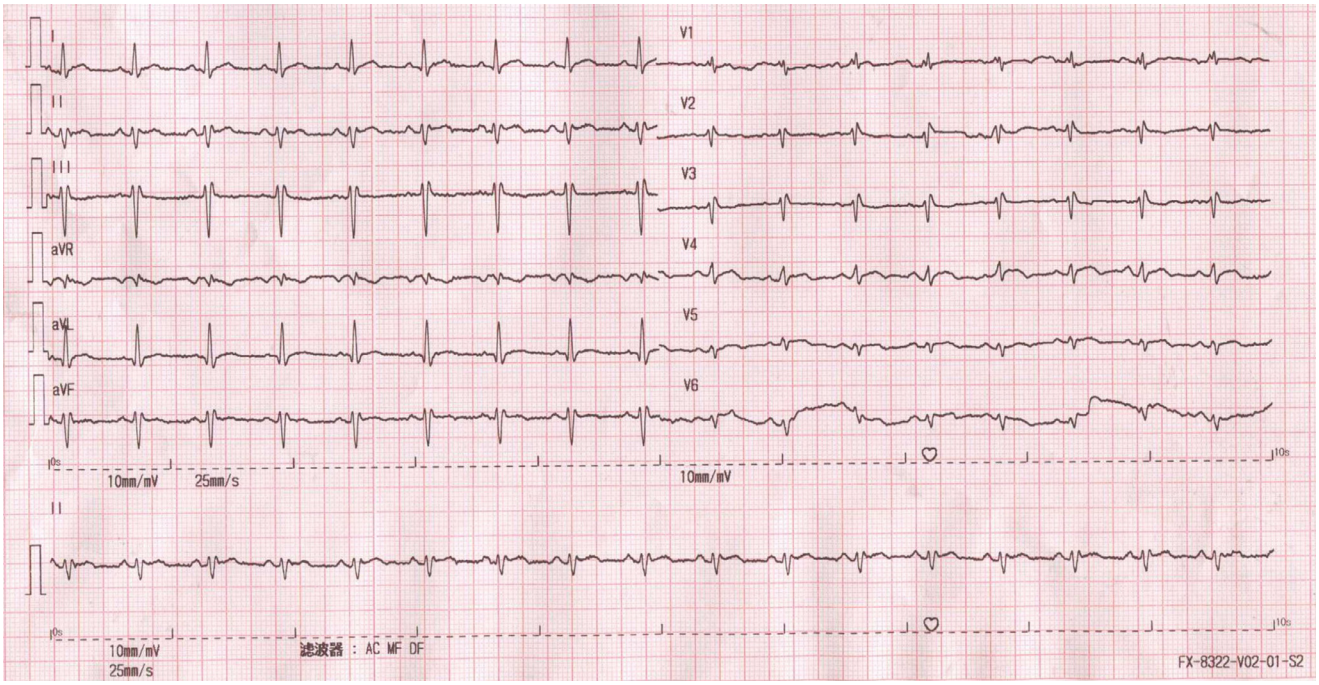

Fig. 4 – Electrocardiography (ECG) at admission. ECG showed ST segments slightly elevated (0.1-0.2 mV) in I, aVL and V4-V6 leads.

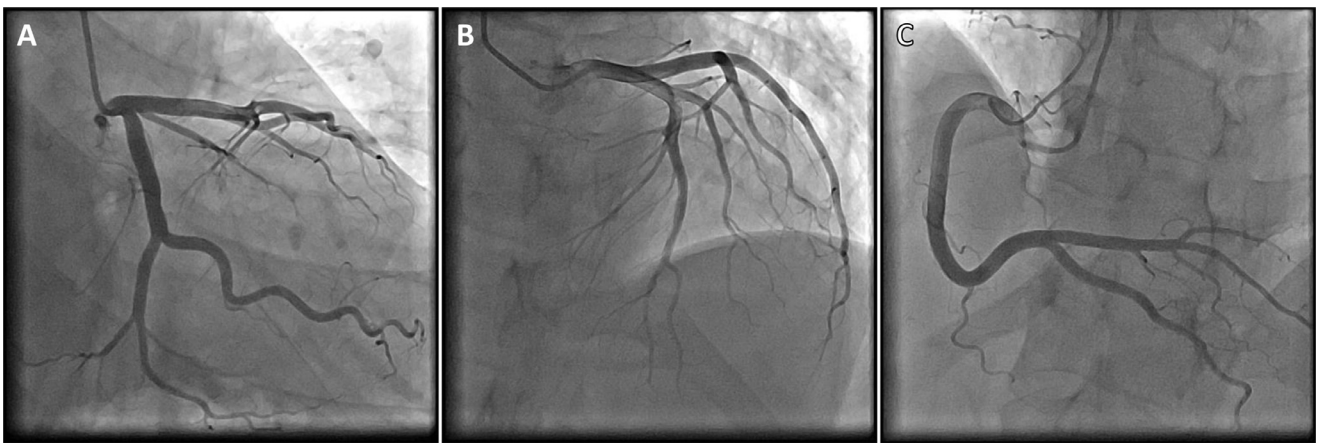

Fig. 5 – Coronary angiography (CAG) images. CAG showed normal epicardial coronary arteries.

subepicardial LGE of the lateral wall, which indicated 2 different mechanisms for the myocyte injury. Just as what mentioned before, for the diagnosis of MINOCA, there must be an ischemic mechanism responsible for the myocyte injury (*Case 1*) and an exclusion of nonischemic mechanism that can mimic myocardial infarction (*Case 2*). Therefore, through these 2 typical cases, we can better understand the updated diagnostic criteria for MINOCA and the role of CMR in the diagnosis of suspected MINOCA.

The updated definition of MINOCA

In 2017, the European Society of Cardiology (ESC) working group developed the first international position article on MINOCA [4]. However, in this position paper, the elevated troponin levels can result from either ischemic or nonischemic mechanisms. Given this limitation of the troponin bioassay, the 2018 fourth universal definition of myocardial infarction redefined the concept of myocardial injury and distinguished it from myocardial infarction [2]. The key difference between these 2 entities is whether there is evidence of acute myocardial ischemia. With this revised concept of AMI, the 2019 AHA scientific statement stated that the term MINOCA should be reserved for patients in whom there is an ischemic basis for their clinical presentation, and it is imperative to exclude clinically subtle nonischemic mechanisms of myocardial injury that can mimic myocardial infarction (eg, myocarditis), then a diagnosis of MINOCA can be made [1].

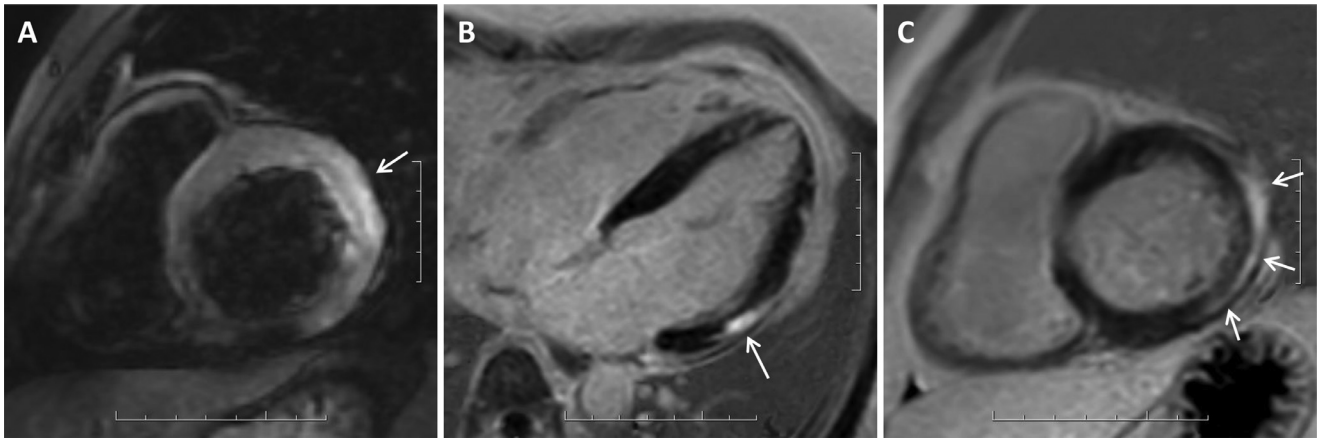

Fig. 6 – Cardiac magnetic resonance (CMR) images. CMR showed myocardial edema (A, T2-weighted fat suppression) and subepicardial enhancement (B and C) in the lateral wall of left ventricle.

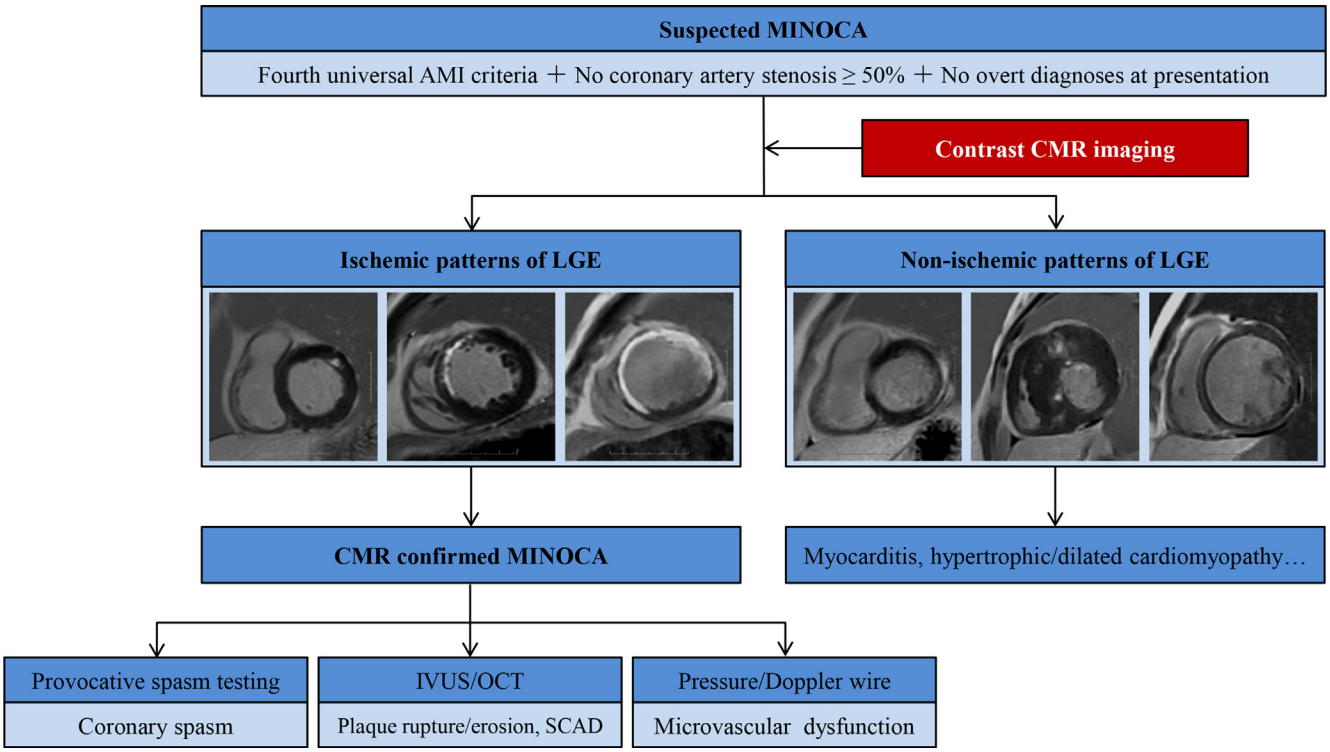

Fig. 7 – Graphic scheme for the management of patient with suspected MINOCA. AMI, acute myocardial infarction; CMR, cardiac magnetic resonance; LGE, late gadolinium enhancement; IVUS, intravascular ultrasound; OCT, optical coherence tomography; SCAD, spontaneous coronary artery dissection.

Diagnostic value of CMR in MINOCA

CMR is a "one-stop" examination method integrating cardiac structure, function, and tissue characteristics, especially LGE imaging technique, which plays an essential role in the diagnosis and differential diagnosis of MINOCA. The leading differential diagnosis is myocarditis, accounting for 33% of patients with presentation of AMI and nonobstructive coronary artery [5]. Acute myocarditis typically presents with hyperemia, edema, and necrosis of the myocardium and is characterized by high T2 signal and subepicardial LGE on CMR imaging [6]. This pattern of LGE is typically distinct from ischemic lesions, which invariably include subendocardial layers, whereas myocarditis typically excludes those zones, just as shown in case 2. Other differential diagnoses commonly include takotsubo syndrome, hypertrophic, and dilated cardiomyopathies, which can be easily distinguished from myocardial infarction by CMR depending on the cardiac structure, contractile function and the presence or pattern of LGE [5]. Therefore, as for those patients with presentation of AMI and

nonobstructive coronary artery, namely suspected MINOCA, further CMR examination is very necessary, which can not only make a clear diagnosis, but also play an important role in guiding clinical decision-making (Fig. 7).

However, it is important to note that although CMR can confirm the diagnosis of MINOCA (as shown in case 1), additional coronary vascular imaging, such as intravascular ultrasound and optical coherence tomography (OCT), and coronary functional assessment may further elucidate the mechanism of MINOCA, including atherosclerotic plaque rupture, plaque erosion, spontaneous coronary artery dissection, and coronary vasospasm (Fig. 7) [1,7].

Acknowledgments

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Patient consent statement

The written informed consents for publication of the cases were obtained from the patients.

Supplementary materials

Supplementary material associated with this article can be found, in the online version, at doi:10.1016/j.radcr.2022.06.101.

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