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EDITORIAL COMMENT

The "Evolving" Role of Intravascular Imaging in Myocardial Infarction With Nonobstructive Coronary Arteries*

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First reported more than 80 years ago, myocardial infarction with non-obstructive coronary arteries (MINOCA) is an increasingly recognized diagnosis occurring in 5% to 15% of patients who present with acute myocardial infarction (MI).[1] Up to one-third of patients who present with ST-segment elevation on electrocardiography (ECG) will have a diagnosis of MINOCA. The diagnostic criteria for MINOCA include a clinical presentation of ischemia with either symptoms or signs that could include ECG changes or wall motion abnormalities on imaging, elevated cardiac enzymes, and either normal coronary arteries or minimally obstructive disease with no stenosis ≥50% visually apparent on coronary angiography.[2,3] The increasing use of high-sensitivity troponin assays is responsible for this not-too-infrequent diagnosis. There are numerous etiologies of MINOCA classified according to the underlying pathology, including both epicardial and microvascular etiologies. Epicardial causes include both plaque erosion and plaque rupture with myocardial necrosis mediated by thrombosis and thromboembolism. Additional epicardial causes include spontaneous coronary artery dissection and epicardial vasospasm which may not be apparent on coronary angiography. Microvascular etiologies of MINOCA include microvascular spasm, which accounts for about 25% of MINOCA cases and is due to an exaggerated response to vasoconstrictors. Takotsubo cardiomyopathy is thought to be due in part to ischemia caused by microvascular spasm and can mimic the presentation of MINOCA. Myocarditis resulting in myocardial edema and compression of the microvascular circulation is considered by some as an extrinsic cause of MINOCA. Potential noncardiac disorders that need to be excluded in workup of MINOCA include myocardial injury, pulmonary embolism, sepsis, and cardiac contusion.

In the early years of coronary angiography, patients with MI with no obstructive coronary disease were labeled as having a false-positive MI with the implication that no further evaluation was warranted. Now, with a multitude of potential etiologies, the concept of a false positive MI is no longer valid, and making the diagnosis has become more complex and is often not pursued. Although MINOCA was initially thought to be associated with a better prognosis than for patients with MI and obstructive coronary artery disease, recent studies have shown similar long-term outcomes with treatment and prognosis influenced by the primary etiology.[4]

In this issue of *JACC: Case Reports,* Franzino et al[5] report the case of a 45-year-old woman who presented with chest pain without changes on 12-lead ECG. In the setting of rising cardiac biomarkers and transthoracic echocardiography that revealed inferior wall hypokinesis, the patient was taken urgently to the cardiac catheterization laboratory. Coronary angiography revealed no evidence of obstructive coronary artery disease, so the presumptive diagnosis was MINOCA. Subsequent cardiac magnetic resonance imaging revealed an inferior wall ischemic pattern, and subsequent ECG demonstrated evolving

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inferior T-wave changes. Cardiac catheterization was repeated and revealed significant luminal narrowing of the mid-to-distal right coronary artery not responsive to intracoronary nitroglycerin. Intravascular ultrasound (IVUS) revealed diffuse intramural hematoma without evidence of atherosclerotic disease. Multiple stents were placed, with resolution of the luminal narrowing observed with both angiography and IVUS.

Intracoronary hematoma is a rare cause of MINOCA. Although it occurs more commonly after percutaneous coronary intervention, it can occur spontaneously, and, unlike intimal dissection associated with coronary artery disease, the dissection occurs in the media or between the media and adventitia with no evidence of intimal dissection or obstructive disease, prompting this discussion regarding the importance of advanced imaging as performed in this case.

Although long considered to be the criterion standard for the determination of coronary atherosclerotic disease, coronary angiography with lesion severity determined by visual estimation is limited by intra- and interobserver variability.[6] In the VANQWISH (Veterans Affairs Non-Q Wave Infarctions Strategies In-Hospital) trial, coronary angiography failed to identify a culprit lesion in 39% of patients presenting with a non-Q-wave MI. A single identifiable culprit lesion was identified in fewer than 50% of patients.[7]

In patients with MINOCA, IVUS has been shown to identify the culprit lesion in up to 38% of patients.[8] Although not as readily available, optical coherence tomography (OCT), with its superior image resolution, has had a higher diagnostic yield in the identification of lesions responsible for a MINOCA presentation. In a prospective study of 145 women with a diagnosis of MINOCA, OCT identified a definite or possible culprit lesion in 46% of patients with plaque rupture, intraplaque cavity, or layered plaque that was not seen on angiography.[9] In that study, the severity of the angiographic stenosis did not predict the culprit lesion. Using visual interpretation, sites rated 53.8% of the angiograms to be normal with no stenosis >10%, whereas the angiographic core laboratory labeled only 3.4% to be normal. In a second study, OCT identified the culprit lesion in 80% of patients with wall motion abnormalities corresponding to the ECG changes.[10] Furthermore, that study demonstrated that the earlier the intravascular imaging, the higher the diagnostic yield.

Current recommendations support the use of multimodality imaging in the assessment of patients with MINOCA.[2] Cardiac magnetic resonance is important to assess for ischemia to direct further investigation and treatment, as was done in the present case, and is considered to be the preferred noninvasive investigation owing to its ability to accurately detect common causes.[11,12] Intravascular imaging is important to help in the identification of a culprit lesion. As to which comes first, it should be directed by the clinical presentation and the suspicion of the underlying etiology.

The present report nicely demonstrates the evolving nature of a spontaneous coronary artery hematoma, which although rare, is one the many etiologies of MINOCA. Whether IVUS or OCT at the time of the initial angiography would have made an earlier diagnosis possible remains unknown, but the case does present a compelling argument for intravascular imaging at the time of the initial cardiac catheterization in the patient with a confirmed MI and a nondiagnostic angiogram. Importantly, the case highlights the need for persistence in the evaluation of the MINOCA patient so as to direct appropriate care.

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