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ISCHEMIC HEART DISEASE

CASE REPORT: CLINICAL CASE

Coronary Vasospasm Presenting in a Catastrophic Way

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ABSTRACT

Coronary artery vasospasm is an under-recognized yet fatal condition that can manifest as sudden cardiac arrest. A 51-year-old man presented with out-of-hospital cardiac arrest due to ventricular fibrillation during exercise. Coronary angiogram showed severe disease at ostial left main coronary artery and left anterior descending artery (LAD), that was not present anymore on repeated angiography and intravascular ultrasound assessment. Cardiac magnetic resonance demonstrated evidence of prior myocardial infarction in the LAD territory. Acetylcholine challenge test was performed that induced severe left main coronary artery and LAD spasm. Coronary artery vasospasm has contributed to a significant proportion of patients presenting with coronary artery disease. Establishing the correct diagnosis is detrimental to future management of patients. This case highlighted a multimodality approach in the diagnosis of coronary vasospasm. (JACC Case Rep. 2024;29:102554) © 2024 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/).

HISTORY OF PRESENTATION

A 51-year-old Asian man presented with out-of-hospital cardiac arrest while cycling. Initial rhythm revealed ventricular fibrillation. Defibrillation was given 2 times with return of spontaneous circulation. He denied any preceding symptoms before the event. He was admitted to the intensive care unit for targeted temperature management.

TAKE-HOME MESSAGES

- Malignant arrhythmia with sudden cardiac death, driven primarily by ischemia, is an uncommon yet fatal presentation of coronary vasospasm.
- A multimodality investigative approach is required to establish the correct diagnosis, that is detrimental to future management of the patient.

PAST MEDICAL HISTORY

He had good past medical health without any family history of sudden cardiac death.

DIFFERENTIAL DIAGNOSIS

The differential diagnoses of his arrhythmic cardiac arrest included myocardial ischemia, other nonischemic phenotypes of cardiomyopathy, myocarditis, metabolic disturbances, primary arrhythmia syndrome, and early repolarization syndrome.

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ABBREVIATIONS AND ACRONYMS

CCB = calcium channel blocker

ECG = electrocardiogram

ICD = implantable cardioverter-defibrillator

IVUS = intravascular ultrasound

LAD = left anterior descending artery

LMCA = left main coronary artery

INVESTIGATIONS

His electrolytes level including sodium, potassium, calcium, and magnesium were normal. There was a nonspecific rise of high sensitivity troponin T level from 79 to 431 ng/L. Electrocardiogram (ECG) was unremarkable, and there were no ST-segment changes suggestive of active ischemia (**Figure 1**). Echocardiography was unrevealing with no obvious structural abnormalities. The left and right ventricular sizes and function were normal. Urgent diagnostic coronary angiogram was performed, showing severe ostial left main coronary artery (LMCA) disease with pressure dampening during engagement of diagnostic catheter. There was also diffuse disease over the left anterior descending artery (LAD) (**Figures 2A and 2B**, Video 1). Myocardial infarction due to severe LMCA and LAD disease was suspected, and the patient was treated with aspirin, clopidogrel, and low-molecular-weight heparin. The patient remained chest pain free during coronary angiogram and subsequent hospital stay.

Percutaneous coronary intervention was arranged 3 days later after the index coronary angiogram. Intravascular nitroglycerin was given after engagement with a Launcher EBU 3.5 guide catheter (Medtronic). However, repeated coronary angiography with intravascular ultrasound assessment showed normal LMCA with mild LAD disease only (**Figures 3A to 3D**, Video 2). There was no evidence of recent plaque rupture or erosion. Urgent cardiac magnetic resonance was performed to look for potential substrates for the arrhythmia, which showed subendocardial delayed enhancement in the mid to apical septal walls and in the cardiac apex, involving 75% of the wall thickness (**Figures 4A and 4B**). The findings were highly compatible with recent myocardial infarction with ischemia-driven ventricular arrhythmia, that was suspected to be caused by LMCA and LAD vasospasm primarily.

MANAGEMENT

Calcium channel blocker (CCB) was prescribed empirically for suspected coronary vasospasm. Implantable cardioverter-defibrillator (ICD) was implanted prior to discharge for secondary prevention of sudden arrhythmic death.

VISUAL SUMMARY

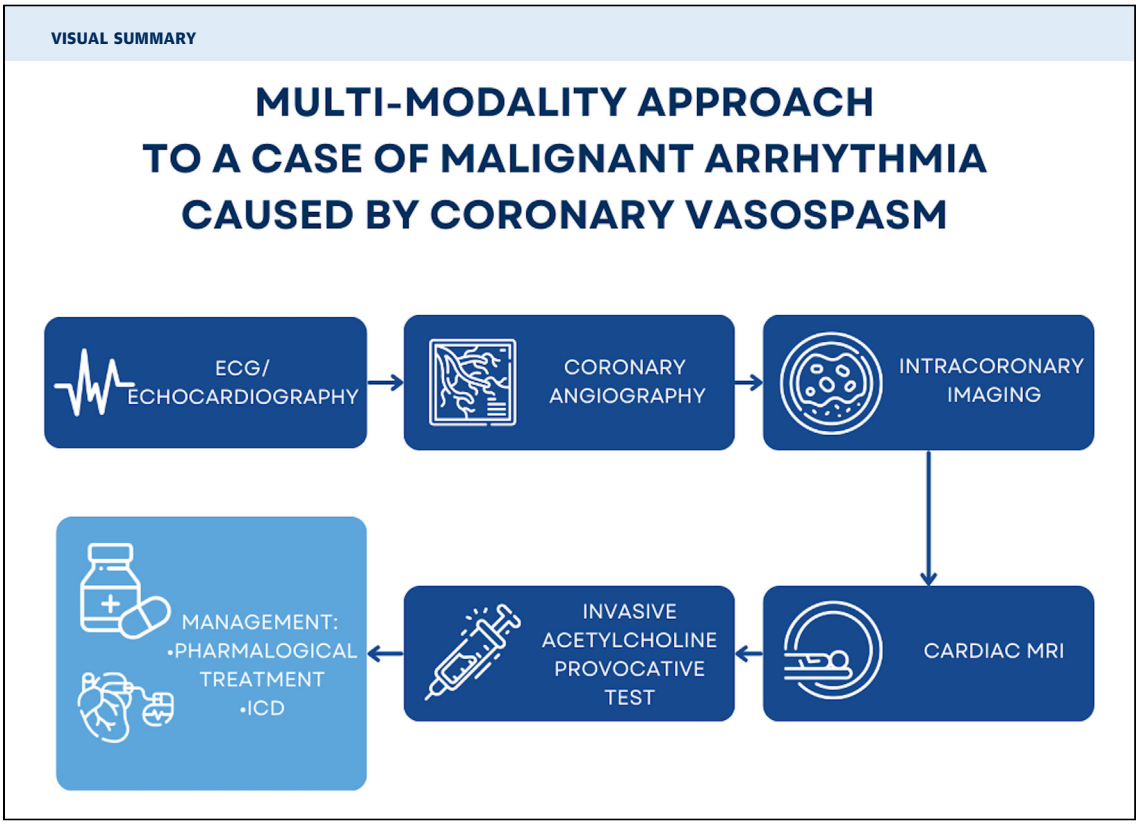
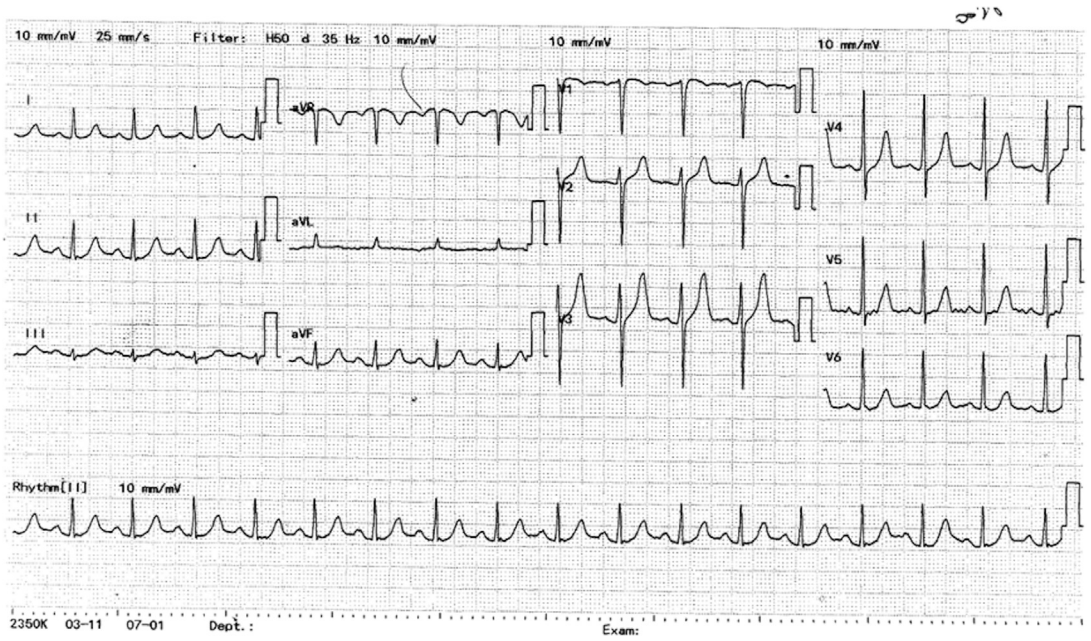


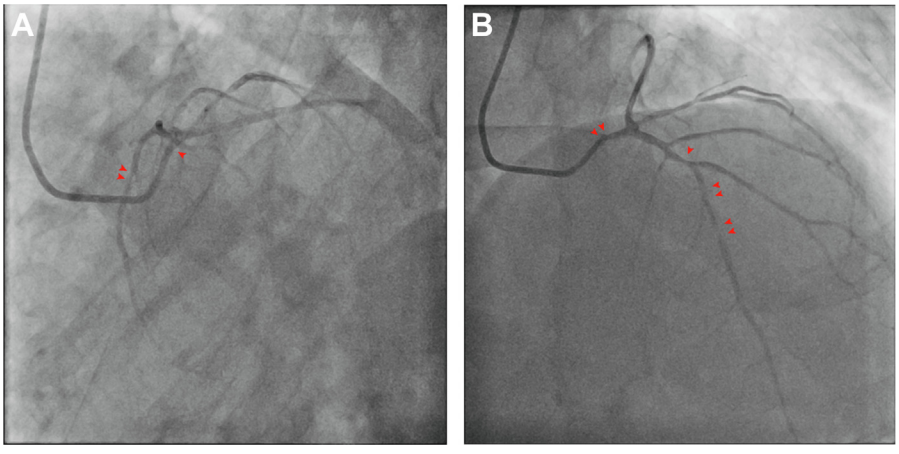
FIGURE 1 Electrocardiogram on Hospital Admission Showed Sinus Tachycardia Without Obvious Ischemic ST-Segment Changes



OUTCOME AND FOLLOW-UP

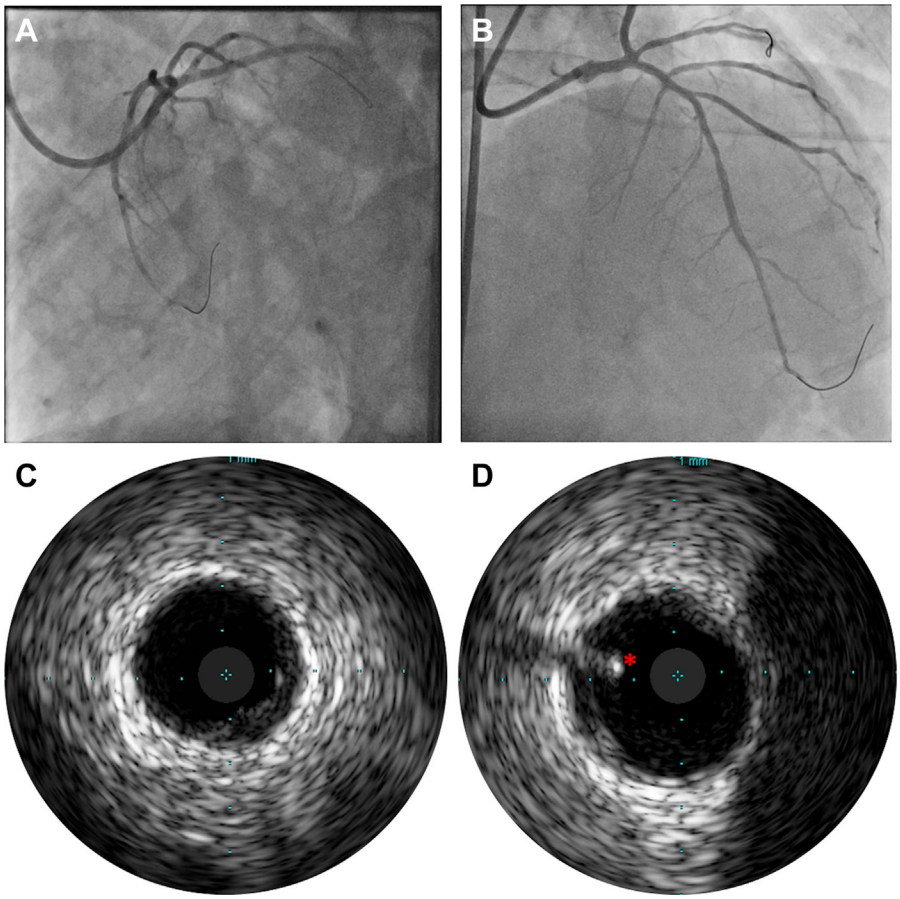
The patient was subsequently referred to another tertiary center for acetylcholine challenge test. On testing, there was pressure dampening on catheter engagement of the LMCA. He developed chest pain with worsening ST-segment elevation on ECG on incremental intracoronary injection of acetylcholine (**Figures 5A to 5F**, Videos 3 to 5). Symptoms and coronary spasm resolved after intracoronary

FIGURE 2 Initial Diagnostic Cardiac Catheterization



(A) Left anterior oblique caudal view showed left main and left anterior descending artery severe stenosis (arrowheads). (B) Right anterior oblique cranial view showed diffuse left anterior descending artery stenosis (arrowheads).

FIGURE 3 Repeated Coronary Angiography and Intravascular Ultrasound



(A) Left anterior oblique caudal view showed normal left main and mild left anterior descending artery disease. (B) Right anterior oblique cranial view showed mild left anterior descending artery disease. Minimal disease was shown on intravascular ultrasound in the (C) proximal part of left anterior descending artery and (D) left main (asterisk shows the wire artifact).

administration of 200 μg nitroglycerin, together with resolution of ST-segment changes on ECG (**Figures 5G and 5H**, Video 6). The diagnosis of epicardial coronary vasospasm was confirmed.

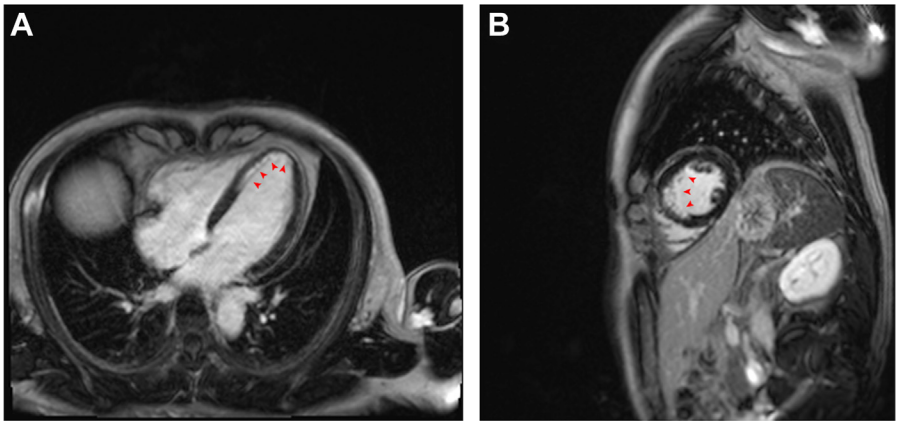
The patient remained symptom free with CCB, and there was no recurrent ventricular arrhythmia detected on ICD interrogation on follow-up.

DISCUSSION

Coronary artery spasm is an under-recognized cause of sudden cardiac death. The pathologic condition was first described in 1959 by Prinzemetal et al[1] as abnormal dynamic constriction of an epicardial coronary artery. It is defined as transient total or subtotal coronary artery occlusion (>90%) associated with angina symptoms, together with ischemic ECG changes, either occurring spontaneously or in response to a provocative stimulus.[2] We reported a case of coronary vasospasm presenting in an unusual but fatal way as ventricular arrhythmia and sudden cardiac death.

In the present case, intracoronary nitroglycerin was not given in the index diagnostic coronary angiogram for fear of LMCA injury given the severe pressure dampening on catheter engagement. Nitroglycerin was given prior to the repeated coronary angiogram and intravascular ultrasound (IVUS), which likely resolved the coronary vasospasm, and hence explained the discrepancy in angiographic findings in the 2 sets of coronary angiograms. The absence of thrombus, recent plaque rupture, or erosion on IVUS assessment rendered atherothrombosis the less likely cause of myocardial infarction.

FIGURE 4 **Delayed Enhancement of Cardiac Magnetic Resonance After Administration of Gadolinium-Based Contrast**



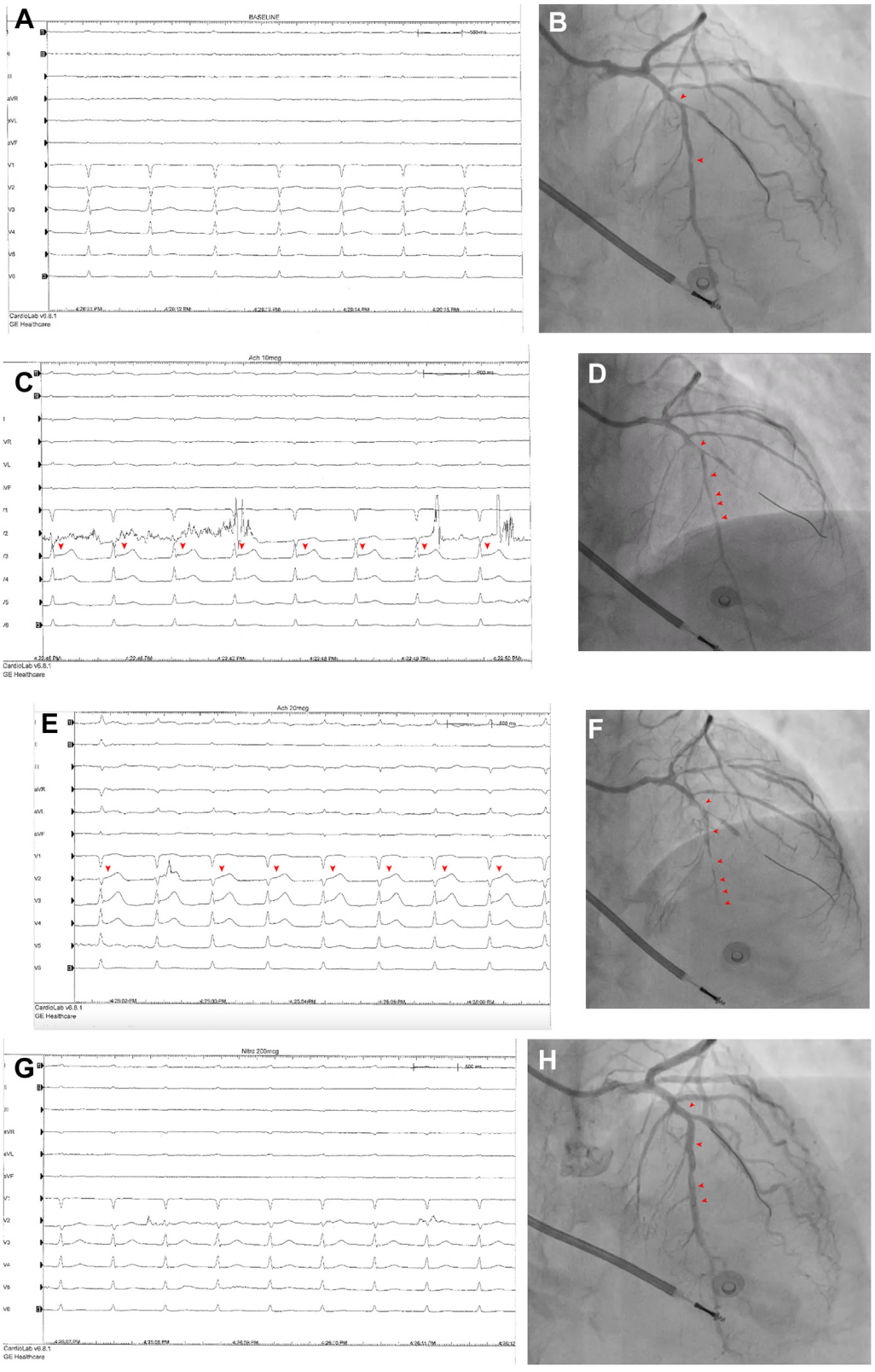
(A) Four-chamber view showed subendocardial delayed enhancement involving mid to apical septal wall, involving ~75% of wall thickness (arrowheads). (B) Short-axis view at midlevel showed subendocardial delayed enhancement involving anteroseptal wall (arrowheads).

Coronary artery spasm is a well-known cause of myocardial infarction with nonobstructive coronary arteries. Diagnosis can be made in patients with nitrate-responsive chest pain, transient ST-segment changes on ECG at the time of chest pain episodes, and angiographic evidence of coronary artery spasm. In a meta-analysis of 24 studies investigating the presence of coronary vasospasm, which composed over 6,500 patients with suspected coronary artery disease and normal or nonobstructive coronary arteries on coronary angiograms, the prevalence of epicardial coronary vasospasm was reported to be 40%.[3]

Provocation test remains the gold standard for diagnosis of coronary artery spasm. In the present case, because the diagnosis was not confirmed during a spontaneous episode, provocation test was required. Common agents used for spasm provocation testing include acetylcholine and ergonovine. A positive response to spasm provocation testing is defined as transient occlusion with more than 90% narrowing of a coronary artery with signs and symptoms of myocardial ischemia. During provocation testing, the present patient experienced chest pain with ST-segment elevation after injection of intracoronary acetylcholine injection with 90% of LMCA and LAD obstruction, indicating a positive result. Resolution of symptoms and ECG changes with nitroglycerin were also diagnostic of coronary vasospasm. Concerns regarding safety of provocation testing are also one of the reasons why it is not routinely performed. A recent meta-analysis, which included 16 studies with over 12,000 patients who underwent intracoronary acetylcholine provocation test, showed that the incidence of major complications was 0.5% without any reports of death,[4] indicating that it is a safe procedure.

Mainstay of treatment of coronary artery spasm includes CCBs. CCBs are proven to be useful in alleviating angina symptoms and adverse cardiac events. Long-acting nitrates are used in addition to CCBs to improve angina symptoms. Sudden cardiac death resulting from ventricular arrhythmias remains a rare yet severe complication in patients with coronary artery spasm. ICD implantation remains controversial, and there are no consistent guidelines for ICD recommendations in patients for primary or secondary prevention of sudden cardiac death. Arrhythmic risks for coronary spasm include history of out-of-hospital cardiac arrest, proximal epicardial coronary artery spasm, obstructive coronary artery disease, ST-segment elevation during angina, multivessel spasm, smoking, and beta-blocker use.[5] At present, no randomized trials compared ICD implantation and medical therapy with medical therapy alone in patients with coronary artery spasm. According to the 2022 European Society of Cardiology Guidelines,[6] it is a Class IIa recommendation for patients experiencing sudden cardiac arrest due to coronary artery spasm to have ICD implantation. In a Japan registry which included 35 patients with coronary artery spasm who experienced ventricular arrhythmia with out-of-hospital cardiac arrest, 14 of them had an ICD

FIGURE 5 **Intracoronary Acetylcholine Provocation Test**



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implantation along with medical treatment. Among those 14 patients with ICD, 2 patients had experienced ventricular fibrillation and appropriate ICD shocks.[7] Because this patient was young and had experienced prior cardiac arrest, we decided for ICD implantation for secondary prevention after thorough discussion with the patient.

CONCLUSIONS

The present case highlighted a comprehensive approach comprising the use of multidisciplinary investigative modalities to ascertain the correct diagnosis, that carried crucial implication in future management and prognosis of the patient.

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KEY WORDS cardiac magnetic resonance, coronary angiography, ventricular fibrillation

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

FIGURE 5 Continued

(A) Baseline electrocardiogram (ECG). (B) Baseline coronary angiography showed mild focal coronary spasm at mid and distal left anterior descending artery (LAD) (arrowheads). (C) ECG showed ST-segment elevation at V_3 to V_5 after injection of 10 μg of acetylcholine (arrowheads). (D) Corresponding angiogram showed diffuse left main (LM) and LAD spasm (arrowheads). (E) ECG showed more extensive ST-segment elevation at V_2 to V_5 after injection of 20 μg of acetylcholine (arrowheads). (F) Corresponding angiogram showed worsening of LM and LAD spasm with string sign (arrowheads). (G) Resolution of ST-segment changes after injection of 200 μg of nitroglycerin. (H) Corresponding angiogram showed resolution of LM and LAD spasm (arrowheads).