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## Case Report

# An Unusual Case of Cardiogenic Shock: Coronary Artery Vasospasms

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## Abstract

Coronary artery vasospasms may occur in one or multiple coronary arteries, typically causing transient chest pain or angina. Although rare, it can lead to lethal cardiac arrhythmias, cardiac arrest, or cardiogenic shock and is often misdiagnosed. We report a case of a young man with an atypical presentation of generalized coronary vasospasm leading to cardiac arrest and subsequent cardiogenic shock. The patient required support with veno-arterial extracorporeal membrane oxygenation and Impella. We discuss the risk factors, diagnosis, and treatment of this rare condition.

**Keywords:** cardiogenic shock, coronary vasospasm, cardiac arrest, Impella, extracorporeal membrane oxygenation

## Background

Coronary artery vasospasms, or Prinzmetal's angina, are vasospasms in one or more of the coronary arteries leading to angina. The disease is uncommon and often misdiagnosed, resulting in significant morbidity and mortality.<sup>1</sup> Patients commonly present with recurrent chest pain or angina with corresponding transient changes in the electrocardiogram (ECG); however, they may present with acute coronary syndrome (with or without ST changes), arrhythmias, cardiac arrest, or cardiogenic shock. Risk factors include smoking, diabetes mellitus, and younger age. Vasospasms typically present in males, with a higher incidence in the Japanese population.<sup>1,2</sup> The causes include endothelial dysfunction, autonomic and sympathetic tone imbalance, allergic reaction, and oxidative stress, as well as some genetic factors. Diagnosis of coronary artery vasospasms on coronary angiograms can be difficult, as it may include epicardial and microvascular spasms and involve atypical presentation involving multiple vessels. The only definitive testing is provocative testing with intracoronary methylergonovine or

acetylcholine administration during coronary angiography.<sup>2</sup> Upon diagnosis, patients are treated with medical therapy, including nitrates and calcium channel blockers.

Coronary artery vasospasms have been noted to cause cardiac arrest; however, it is rare for vasospasms to lead to cardiogenic shock where the patient requires support with extracorporeal membrane oxygenation (ECMO). Recognizing vasospasms is difficult; thus, clinicians must thoroughly assess patients presenting with cardiac arrest and cardiogenic shock and include coronary vasospasms in the differential diagnoses. If identified early, appropriate treatment can be applied to reduce the risk of permanent damage or further cardiac arrests.

## Case Report

### *Patient History and Presentation*

The patient was a 34-year-old African-American male with a history of hypertension, hyperlipidemia, chronic kidney disease, and obesity; he had no history of drug use. The patient

was found unresponsive in his home after consuming alcohol; bystander cardiopulmonary resuscitation (CPR) was performed. Emergency medical services arrived, and the patient was found to be in ventricular fibrillation. He was defibrillated four times while receiving CPR for ten minutes before achieving a return of spontaneous circulation. He was taken via ambulance to the nearest hospital.

After arrival at the hospital, the patient was assessed (Table 1) and displayed signs of cardiogenic shock. His initial echocardiogram revealed a severely reduced left ventricular systolic function with a moderately reduced right ventricular function. No valvular abnormalities were noted. An electrocardiogram revealed sinus tachycardia with no ST changes (Figure 1). His initial laboratory assessments showed evidence of end-organ dysfunction and transaminitis (Table 1), and he was oliguric. Therefore, he was started on continuous renal replacement therapy. A urine drug screen was negative.

Table 1. Initial patient assessment. The patient's vital signs upon arrival at the hospital and initial laboratory assessments are presented.

Vital Signs upon Initial Hospital Arrival	
Heart rate (beats per minute)	113
Blood pressure (mm Hg)	122/66
Mean arterial pressure (mm Hg)	89
Initial Laboratory Assessments	
Alanine aminotransferase (units/L)	12347
Aspartate aminotransferase (units/L)	19341
Creatinine (mg/dL)	4.32
Lactic acid (mmol/L)	5.8

*Diagnosis and Intervention*

The patient was taken to the cardiac catheterization laboratory and underwent a coronary angiogram and right heart catheterization. A coronary angiogram was interpreted as multivessel coronary artery disease with a 99% left main stenosis, small left anterior descending artery, small left circumflex artery, and 70% proximal right coronary artery stenosis (Figure 2). Right heart catheterization revealed a right atrial pressure of 24 mm Hg, pulmonary artery pressure of 45/28 mm Hg with a mean pressure of 35 mm Hg, pulmonary capillary wedge pressure of 30 mm Hg, Fick cardiac output of 5.1 L/min, and Fick cardiac index of 1.8 L/min/m<sup>2</sup>. An Impella CP was placed, and he was transferred to our facility for consideration of coronary artery bypass grafting.

Despite Impella CP placement, the patient arrived at our facility showing signs of cardiogenic shock. His filling pressures remained significantly elevated, and his cardiac output remained low. Pulmonary artery catheter tracings and arterial line tracings showed decreased pulsatility; his lactic acid level remained elevated. In addition, the patient was noted to have ST-segment elevations in the inferior and septal leads (Figure 3). After a multidisciplinary discussion, he was taken to the cardiac catheterization laboratory and underwent placement of veno-arterial ECMO. A pulmonary angiogram was negative for a pulmonary embolus. During a coronary angiogram, intracoronary nitroglycerin was used to evaluate the coronary arteries better. The angiogram revealed that the patient did not have severe triple vessel disease but was having severe coronary vasospasms (Figure 4). After arrival at the intensive care unit, the patient was started on nitroglycerin and nicardipine drips, which resolved all ST elevations.

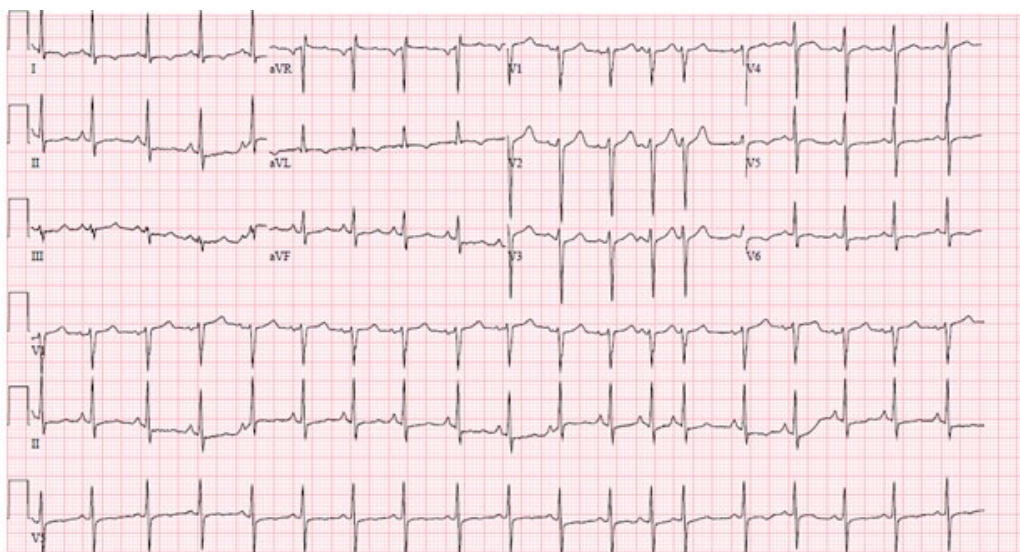


Figure 1. Initial electrocardiogram. The patient's initial electrocardiogram revealed sinus tachycardia with no ST changes.

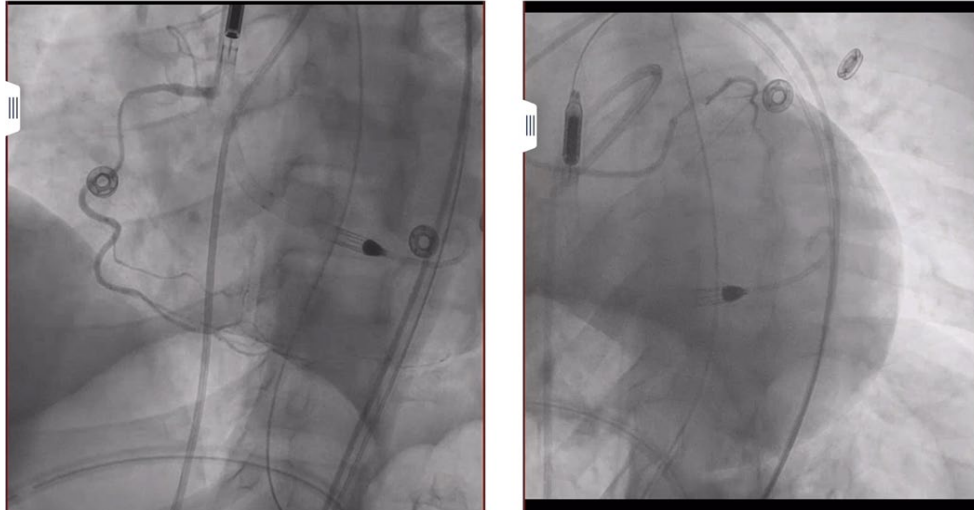


Figure 2. Initial coronary angiogram. The patient's initial coronary angiogram was interpreted as multivessel coronary artery disease.

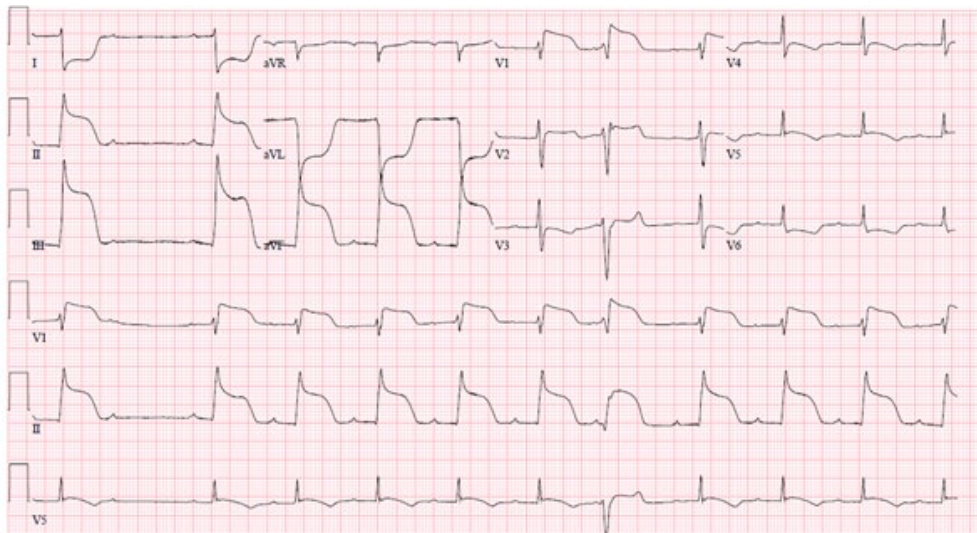


Figure 3. Electrocardiogram after arriving at our facility. The patient's electrocardiogram showed ST-segment elevations in the inferior and septal leads.

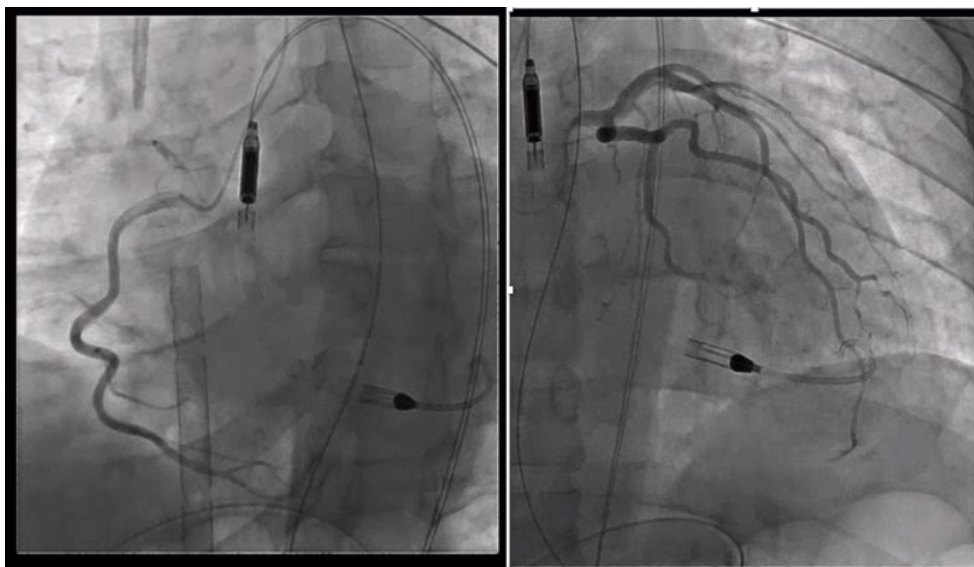


Figure 4. Coronary angiogram after nitroglycerin administration. Nitroglycerin was used to evaluate the coronary arteries during an angiogram, which revealed that the patient was having severe coronary vasospasms.

## Outcome

His status continued to improve, and he had no further ST elevations. He was decannulated from ECMO three days later, and the Impella CP was removed five days later. The patient had no neurological deficits at discharge, and both right ventricular and left ventricular systolic functions were normal. He also had full renal recovery without the need for dialysis. He was discharged on amlodipine and isosorbide mononitrate.

## Comment

Coronary artery vasospasms are typically diagnosed because of angina symptoms at rest with transient ST elevation on the electrocardiogram. This patient's presentation with cardiac arrest and subsequent cardiogenic shock is unique. To our knowledge, he had never had prior chest pain or signs of vasospastic angina. In addition, the severity of these vasospasms is uncommon. We have only found limited case reports showing cardiogenic shock in multivessel coronary vasospasms and only one case using ECMO support.<sup>3-6</sup>

Typically, coronary artery vasospasms are suspected after the patient presents with chest pain and coronary angiography reveals normal coronaries. Studies have shown that up to 40% of patients with stable angina have normal coronaries on angiograms. The diagnostic workup should include provocation testing, which remains the only definite testing for coronary vasospasm.<sup>7</sup> Although it typically presents in middle-aged men with a history of smoking and diabetes mellitus and often involves transient changes in the ECG, its presentation may be atypical, presenting as a generalized coronary vasospasm leading to cardiogenic shock and a delayed diagnosis, as in our patient. As the patient developed refractory cardiogenic shock requiring both ECMO and Impella support (ie, ECMELLA), the initial coronary angiography did not include provocation testing, per the current guidelines. However, upon transfer to our large-volume center, the second coronary angiography included intracoronary nitroglycerin administration, which identified the atypical presentation of the generalized severe coronary vasospasm, after which the coronary vasospasms resolved.<sup>8-11</sup> Despite the lack of mention in the 2021 guidelines for percutaneous coronary intervention from the American College of Cardiology, American Heart Association, and Society for Cardiovascular and Angiography Intervention, the administration of intracoronary nitroglycerin can avoid potential misdiagnosis of severe coronary atherosclerotic disease versus vasospasms.<sup>7</sup>

This case demonstrates the importance of a thorough diagnostic evaluation of a patient presenting with refractory cardiogenic shock, which may include provocative testing in coronary angiography to rule out coronary vasospasm. Despite the advancements in the understanding and management of coronary vasospasms, the condition requires greater awareness and further research to optimize diagnostic

and therapeutic strategies. The decision to use intracoronary nitroglycerin to evaluate the coronaries further while providing this patient with mechanical circulatory support for cardiogenic shock was vital in the successful treatment outcome.

## Waived Consent and HIPAA Statement

*In accordance with the Health Insurance Portability and Accountability Act (HIPAA) and institutional review board guidelines, our case report adheres strictly to patient confidentiality and privacy standards. In this case report, all patient data has been de-identified and presented in a manner that precludes the possibility of patient identification. Given that the patient has signed a HIPAA agreement upon admission and the non-identifiable nature of the data, specific informed consent for this report was deemed unnecessary and thus waived. This approach is consistent with the ethical standards for case reporting and aligns with the Committee on Publication Ethics guidelines.*

## Disclosures

Amanda Bergeron is a speaker for Abiomed (Danvers, MA).

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