JACC: CASE REPORTS VOL. 3, NO. 4, 2021

MINI-FOCUS ISSUE: CORONARY ARTERY DISEASE

BEGINNER

CASE REPORT: CLINICAL CASE

Pathological Q-Waves With Coronary Artery Spasm

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ABSTRACT

This case highlights the diagnostic challenge associated with myocarditis, especially when accompanied by coronary spasm. Any coronary spasm with hemodynamic instability and/or an inexplicable widespread electrocardiogram should alert the clinician to the possibility of fulminant myocarditis and the necessity of endomyocardial biopsy for treatment decisions. (**Level of Difficulty: Beginner.**) (J Am Coll Cardiol Case Rep 2021;3:555–60) © 2021 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 71-year-old woman presented to the emergency department with a 1-day history of chest pain and exertional dyspnea. Although she currently smoked, there was no current or past use of cocaine or other stimulants. She had not developed respiratory or gastrointestinal infection, or a distinct viral prodrome within the week before admission. She was afebrile. Her blood pressure was 95/42 mm Hg, and her heart rate was 87 beats/min. Her physical examination revealed signs of fluid overload, including high jugular venous pressure and edema, but no murmur, galloping, or rubbing was heard on auscultation.

LEARNING OBJECTIVES

- To recognize coronary vasospasm as a prodromal sign in acute myocarditis.
- To make an early diagnosis of fulminant myocarditis concomitant with coronary vasospasm.
- To identify the clinical significance of low QRS voltage in differentiating acute myocarditis from myocardial infarction in the presence of pathologic Q-waves.

PAST MEDICAL HISTORY

The patient had a history of hypertension, but no significant history of heart disease.

DIFFERENTIAL DIAGNOSIS

Taking into consideration the presentation of chest pain complicated by exertional dyspnea, the initial differential diagnosis included acute coronary syndrome, acute decompensated heart failure, acute myocarditis and/or pericarditis, stress-induced cardiomyopathy, acute aortic dissection, and pulmonary embolism.

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The authors attest they are in compliance with human studies committees and animal welfare regulations of the authors' institutions and Food and Drug Administration guidelines, including patient consent where appropriate. For more information, visit the Author Center.

Manuscript received August 14, 2020; revised manuscript received October 15, 2020, accepted November 2, 2020.

ISSN 2666-0849 https://doi.org/10.1016/j.jaccas.2020.11.033

ABBREVIATIONS AND ACRONYMS

CMR = cardiovascular magnetic resonance

ECG = electrocardiography

IABP = intra-aortic balloon pump

INVESTIGATIONS

Laboratory examinations revealed a troponin level of 12,683 pg/ml (normal range: ≤15.6 pg/ml), a brain natriuretic peptide level of 487 pg/ml (normal range: ≤18.4 pg/ml), and a C-reactive protein level of 3.00 mg/dl (normal range: ≤0.14 mg/dl). Electrocardiography (ECG) (**Figure 1A**) demonstrated Q-waves in the inferior and anterior precordial leads, along with a low QRS voltage and wide QRS complex. There was coved-type ST-segment elevation in leads V_1 and V_2, and an upward concave shape of the ST-segment with QRS notching in the inferior leads, with ST-segment depression in the lateral leads (i.e., reciprocal change). PR-segment depression in the inferior leads was observed. Echocardiography revealed diffuse hypokinesis, excluding the basal inferolateral segments of the left ventricle. There was no evidence of increased wall thickness, intracardiac thrombi, or pericardial effusion (**Figure 2**, Videos 1 and 2). Coronary angiography confirmed normal coronary arteries, whereas the provocative test with intracoronary injections of ergometrine at 3-min intervals in each coronary artery (20 to 40 to 60 μg) induced a >90% constrictor response in both the proximal right coronary artery and the mid-left anterior descending artery, accompanied by chest discomfort, which strongly suggested myocardial infarction secondary to multivessel coronary spasm (**Figure 1B**).

MANAGEMENT

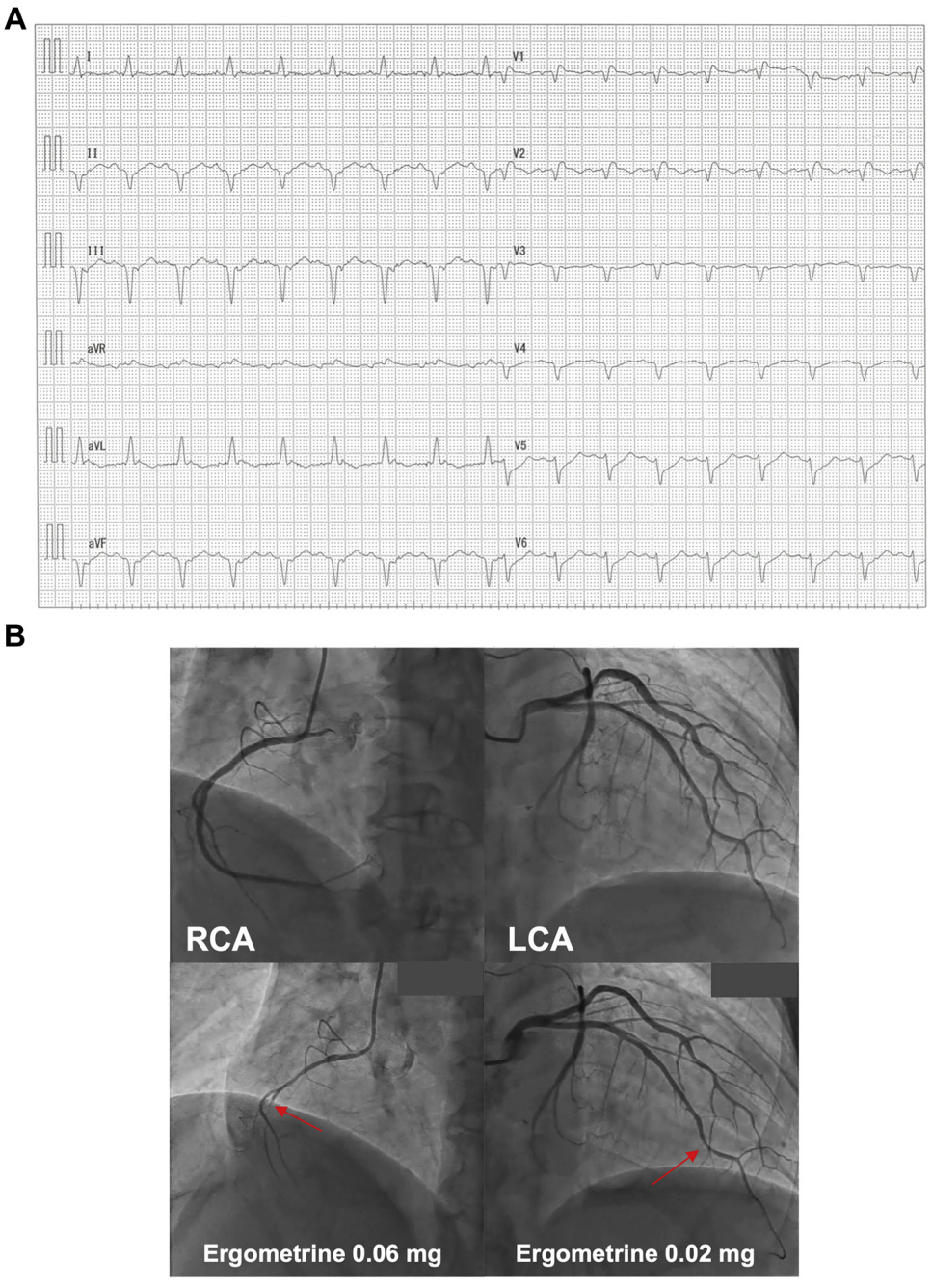
On day 2, ECG demonstrated frequent, consecutive premature ventricular contractions, and sustained ventricular tachycardia developed. An intra-aortic balloon pump (IABP) was placed due to cardiogenic shock complicated by recurrent ventricular tachycardia. Biopsy samples were obtained from the mid-right ventricular septum. Histological samples exhibited intense lymphocytic infiltrates, myocyte necrosis, and prominent multinucleated giant cells consistent with myocarditis, thus confirming the diagnosis of giant cell myocarditis (**Figure 3**). The patient was treated using pulsed intravenous methylprednisolone, followed by combined treatment with cyclosporine and prednisolone. However, clinical deterioration progressed, with refractory ventricular tachycardias and cardiogenic shock, which ultimately required simultaneous percutaneous venoarterial extracorporeal membrane oxygenation and left ventricular decompression therapy with the Impella pump (Abiomed, Danvers, Massachusetts).

DISCUSSION

Acute myocarditis presents similarly to myocardial infarction with chest pain, high cardiac biomarkers, and ECG abnormalities. To our knowledge, this is the first report to describe several features of ECG changes mimicking myocardial infarction, severe multivessel coronary spasm, and regional wall motion abnormalities without an increase in wall thickness in the acute setting of giant cell myocarditis. However, superimposed coronary vasospasm, in addition to regional wall motion abnormalities, may lead to an erroneous diagnosis of myocardial infarction. This case highlights the diagnostic challenge associated with myocarditis, especially when accompanied by coronary spasm.

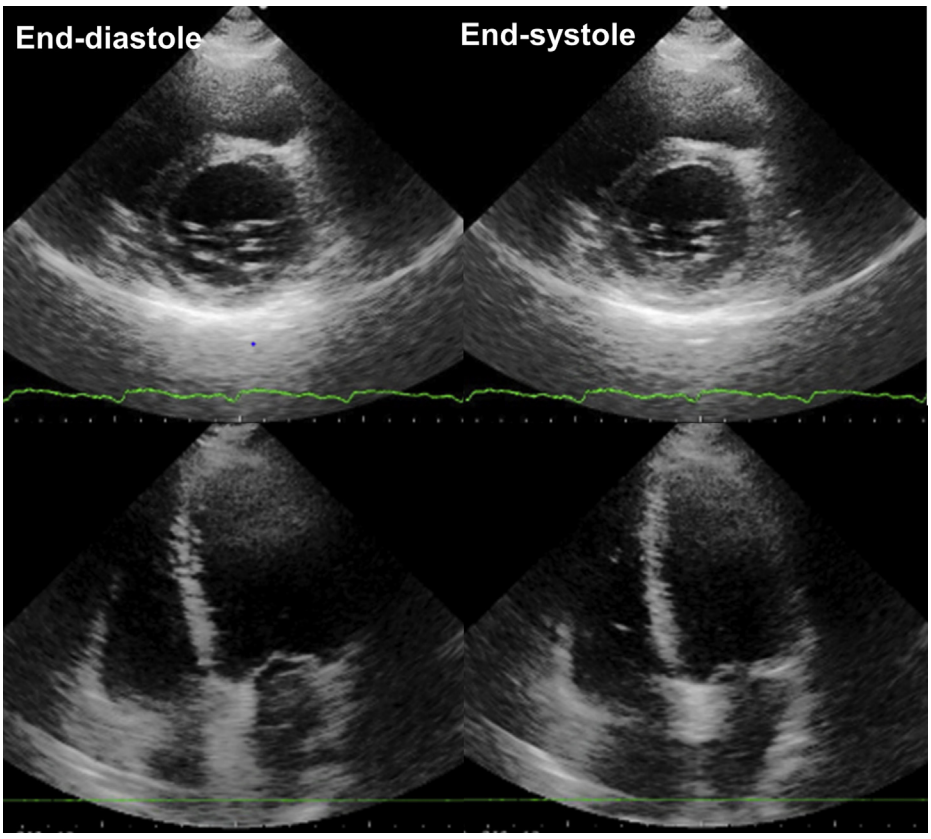
Yilmaz et al. (1) demonstrated that coronary vasospasm was induced in 39 of 55 (70.9%) clinically stable patients with chest pain and suspected acute myocarditis using intracoronary acetylcholine testing. Coronary vasospasm may be 1 of the main reasons for atypical chest pain in patients with myocarditis, whereas other causes, such as pericarditis, cannot be excluded and must be kept in mind. The pathogenesis of coronary vasospasm is likely multifactorial and heterogeneous. In a study by Klein et al. (2), a correlation was noted between the number of lymphocytes in the myocardium and epicardial coronary vasospasm in response to acetylcholine, which suggested that coronary vasospasm was associated with the severity of inflammation in the heart. Inflammatory responses via the release of cytokines and chemokines could cause endothelial dysfunction through reduction of vascular nitric oxide bioavailability and increases in oxidative stress (3). In addition, the occurrence of coronary vasospasm in patients with myocarditis might be related to vasoactive substances, such as endothelin-1 and thromboxane A2 (4,5). In the study by Kuhl et al. (6), the persistence of virus genomes was closely associated with ergonovine-induced coronary vasospasm even in the absence of histological features of active myocarditis. Thus, another underlying cause of vasospasm in patients with myocarditis might be related to the presence of infection itself. Myocardial inflammation or virus persistence, or both, induce coronary endothelial dysfunction and may cause coronary vascular smooth muscle hyper-reactivity,

FIGURE 1 Electrocardiogram and Coronary Angiography at the Time of Initial Admission to the Emergency Department



(A) An electrocardiogram shows Q-waves in the inferior and anterior precordial leads, along with a low QRS voltage in the precordial leads and a wide QRS complex of 150 ms. There is a coved-type ST-segment elevation in leads V_1 and V_2 and an upward concave shape of the ST-segment with QRS notching in the inferior leads and ST-segment depression in the lateral leads. PR-segment depression in the inferior leads is observed. Sweep speed, 25 mm/s, 10 mm/mV. **(B)** Coronary angiography demonstrated normal coronary arteries, whereas a provocative test with ergometrine induced total occlusion of the proximal right coronary artery (RCA) and a 90% constrictor response in the mid-left anterior descending artery accompanied by chest discomfort **(arrows)**. LCA = left coronary artery.

FIGURE 2 Transthoracic Echocardiography

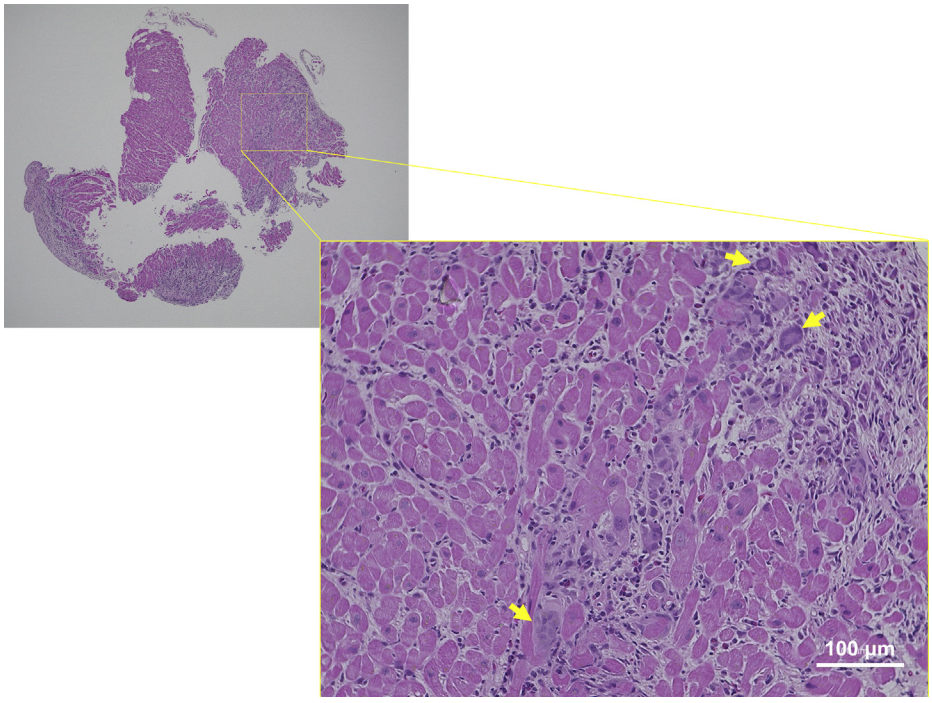


Echocardiography revealed diffuse hypokinesis, excluding the basal inferolateral segments of the left ventricle. No evidence of increased wall thickness, intracardiac thrombi, or pericardial effusion was observed.

facilitating the development of coronary vasospasm. Moreover, regional wall motion abnormalities associated with myocarditis are most likely due to localized inflammation or ischemia caused by coronary spasm. Thus, in cases with coronary spasm complicated by cardiogenic shock, the early recognition of fulminant myocarditis secondary to giant cell myocarditis is clinically imperative due to different clinical management requirements. On hospital day 2, endocardial biopsy was performed during IABP placement to confirm giant cell or eosinophilic myocarditis. However, standard histological preparation for light microscopy requires paraffin wax embedding, sectioning, and staining, which may further delay the diagnosis.

Advanced cardiac imaging modalities, such as cardiovascular magnetic resonance (CMR), can help confirm the diagnosis of myocarditis; however, CMR is contraindicated in patients with unstable hemodynamics. ECG patterns of acute myocarditis are diverse and the sensitivity of ECG for diagnosing acute myocarditis is low, being estimated at 47% (7). However, ECG is an appropriate screening test and a valuable diagnostic tool in differentiating between acute myocarditis and myocardial infarction in hemodynamically unstable patients. In this clinical scenario, the patient did not exhibit further evolution of ECG changes indicative of myocardial ischemia despite recurrent and intractable ventricular arrhythmias. These clues further underscored the clinical importance of serial ECG for differentiating between myocarditis and myocardial infarction. The low QRS voltage was attributed to myocardial edema in addition to changes associated with pericardial effusions and other extracardiac influences. Although the aVR lead receives less attention in clinical evaluation, aVR placement is oriented to examine the right upper side of the heart and can reflect changes in the right ventricular outflow tract and the basal portion of the septum (8). Therefore, low QRS voltage

FIGURE 3 Hematoxylin and Eosin-Stained Myocardial Tissue Samples



Histological samples exhibited marked lymphocytic infiltrates, myocyte necrosis, and prominent multinucleated giant cells consistent with giant cell myocarditis **(arrows)**.

in lead aVR and in the precordial leads suggests diffuse myocardial edema, including the apical region positioned opposite to lead aVR, which permits a possible differential diagnosis based on ECG criteria. In the presence of pathologic Q-waves, low QRS voltage may be clinically important in differentiating acute myocarditis from myocardial infarction.

FOLLOW-UP

Although maximum supportive therapy was provided and initial improvement in her cardiac function was observed, the patient died from invasive fungal infection 1 month following admission.

CONCLUSIONS

Any coronary spasm with hemodynamic instability and/or inexplicable widespread ECG should alert the clinician to the possibility of fulminant myocarditis and the necessity of endomyocardial biopsy for treatment decisions.

ACKNOWLEDGMENT The authors thank Susan M. Miller, MD, MPH, at the Houston Methodist Hospital for reviewing the manuscript and editorial assistance.

FUNDING SUPPORT AND AUTHOR DISCLOSURES

The authors have reported that they have no relationships relevant to the contents of this paper to disclose.

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JACC: CASE REPORTS, VOL. 3, NO. 4, 2021
APRIL 2021:555–60

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KEY WORDS giant cell myocarditis, electrocardiogram, myocardial infarction, multivessel coronary spasm

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