JACC: CASE REPORTS VOL. 30, NO. 2, 2025

ISCHEMIC HEART DISEASE

CLINICAL CASE

Stellate Ganglion Block and Bilateral Sympathectomy for Recurrent Coronary Vasospasm Secondary to Severe Eosinophilic Asthma

Kai Yi Wu, MD,[a] Ruochen Mao, MD,[a] Craig Butler, MD, MS,[a] Pishoy Gouda, MBBCH BAO, MS,[a] Naji Alhulaimi, MBBS,[a] Rohan Parab, MD,[b] Bryan James Dicken, MD, MS,[c] Sayra Khandekar, MD,[a] Michelle Graham, MD,[a] Kevin R. Bainey, MD, MS[a]

ABSTRACT

A 42-year-old man experienced recurrent coronary artery spasm (CAS) secondary to eosinophilic asthma despite being on multiple medications. He underwent a successful unilateral stellate ganglion block followed by bilateral thoracoscopic sympathectomy, with no subsequent recurrence of CAS. These invasive therapies offer a potential treatment option for refractory CAS. (JACC Case Rep. 2025;30:102813) © 2025 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 42-year-old man with known recurrent coronary artery spasm (CAS) and eosinophilic asthma presented with vague central chest tightness. In the week before his hospital presentation, he experienced progressive shortness of breath and wheezing caused by COVID-19 infection, resulting in excessive salbutamol use.

TAKE-HOME MESSAGES

- The autonomic nervous system plays an important role in the pathogenesis of CAS.
- Asthma is associated with CAS secondary to mechanisms related to vasomotor tone and bronchodilator use, which augments sympathetic activity.
- Stellate ganglion block and bilateral thoracoscopic sympathectomy offer potential treatment options for refractory CAS.

On route to the emergency department, he was started on ipratropium bromide, albuterol, dexamethasone, and aspirin by the paramedics. In the emergency department, his blood pressure was 113/71 mm Hg, his heart rate was 97 beats/min, his respiratory rate was 24 breaths/min, his oxygen saturation of 89% on room air increased to 98% on high-flow oxygen, and his temperature of was 36.4 °C. He was euvolemic and had an unremarkable cardiac examination. His respiratory examination found mild bilateral wheezing and increased work of breathing.

From the [a]Division of Cardiology, Mazankowski Alberta Heart Institute, University of Alberta, Edmonton, Alberta; [b]Department of Radiology and Diagnostic Imaging, University of Alberta, Edmonton, Alberta; and the [c]Department of Surgery, Stollery Children's Hospital, University of Alberta, Edmonton, Alberta.

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 July 5, 2024; revised manuscript received September 17, 2024, accepted October 9, 2024.

ISSN 2666-0849 https://doi.org/10.1016/j.jaccas.2024.102813

ABBREVIATIONS AND ACRONYMS

ACS = acute coronary syndrome

CAS = coronary artery spasm

CCB = calcium-channel blocker

DES = drug-eluting stent

ECG = electrocardiogram

hs-cTnT = high-sensitivity cardiac troponin T

IgE = immunoglobulin E

MINOCA = myocardial infarction with no obstructive coronary disease

STEMI = ST-segment elevation myocardial infarction

VSMC = vascular smooth muscle cell

PAST MEDICAL HISTORY

He had poorly controlled eosinophilic asthma, nasal polyps, esophagitis, mild non-occlusive coronary artery disease, dyslipidemia, and hypertension, and he was an ex-smoker (10 pack-year history). He had multiple emergency visits and hospital admissions, with 6 invasive coronary angiograms for acute coronary syndrome (ACS) secondary to CAS in the preceding 2 years, which were associated with asthma exacerbations (Table 1). During his earlier admissions to a peripheral hospital, he received a diagnosis of type 1 myocardial infarction instead of CAS, and he underwent percutaneous coronary intervention and received a right coronary artery drug-eluting stent (DES) and a distal left anterior descending artery DES. Furthermore, his previous ST-segment elevation myocardial infarction (STEMI) presentation was complicated by ventricular fibrillation requiring defibrillation.

At the time of his current presentation, he was taking isosorbide mononitrate (120 mg orally daily), amlodipine (10 mg orally daily), and diltiazem extended-release (480 mg orally daily) for control of his CAS. Other medications included oral aspirin and atorvastatin, along with montelukast, mometasone, tiotropium bromide inhaler, salbutamol inhaler, and fluticasone propionate/salmeterol inhaler. He had previously received benralizumab but discontinued its use several months ago because of perceived inefficacy and insurance coverage limitations.

DIFFERENTIAL DIAGNOSIS

The differential diagnosis for his chest pain includes: plaque rupture or erosion with an occlusive thrombus, CAS, coronary microvascular dysfunction, nonatherosclerotic coronary dissection, coronary embolism, and oxygen supply-demand imbalance.

INVESTIGATIONS

His electrocardiogram (ECG) was consistent with an inferior STEMI (Figure 1A). His laboratory investigations demonstrated high-sensitivity cardiac troponin T (hs-cTnT) levels of 16 and 23 ng/L (overall 99th percentile upper reference limit: ≤14 ng/L on the Roche hs-cTnT assay), an N-terminal pro-B-type natriuretic peptide level of 67 ng/L (normal <125 ng/L), a white blood cell count of 11.1 $\times 10^9$/L (normal: 4-11 $\times 10^9$/L), and a C-reactive protein value of 2.7 mg/L (normal: <8 mg/L). His serum eosinophil count was 0.2 $\times 10^9$/L (normal: 0-0.7 $\times 10^9$/L), but previously it was as high as 2.2 $\times 10^9$/L before treatment with benralizumab. He had an elevated immunoglobulin E (IgE) value of 183 kU/L (normal <120 kU/L), negative *Aspergillus fumigatus* IgE, negative schistosomiasis serology, and negative anti-neutrophil cytoplasmic antibody.

MANAGEMENT

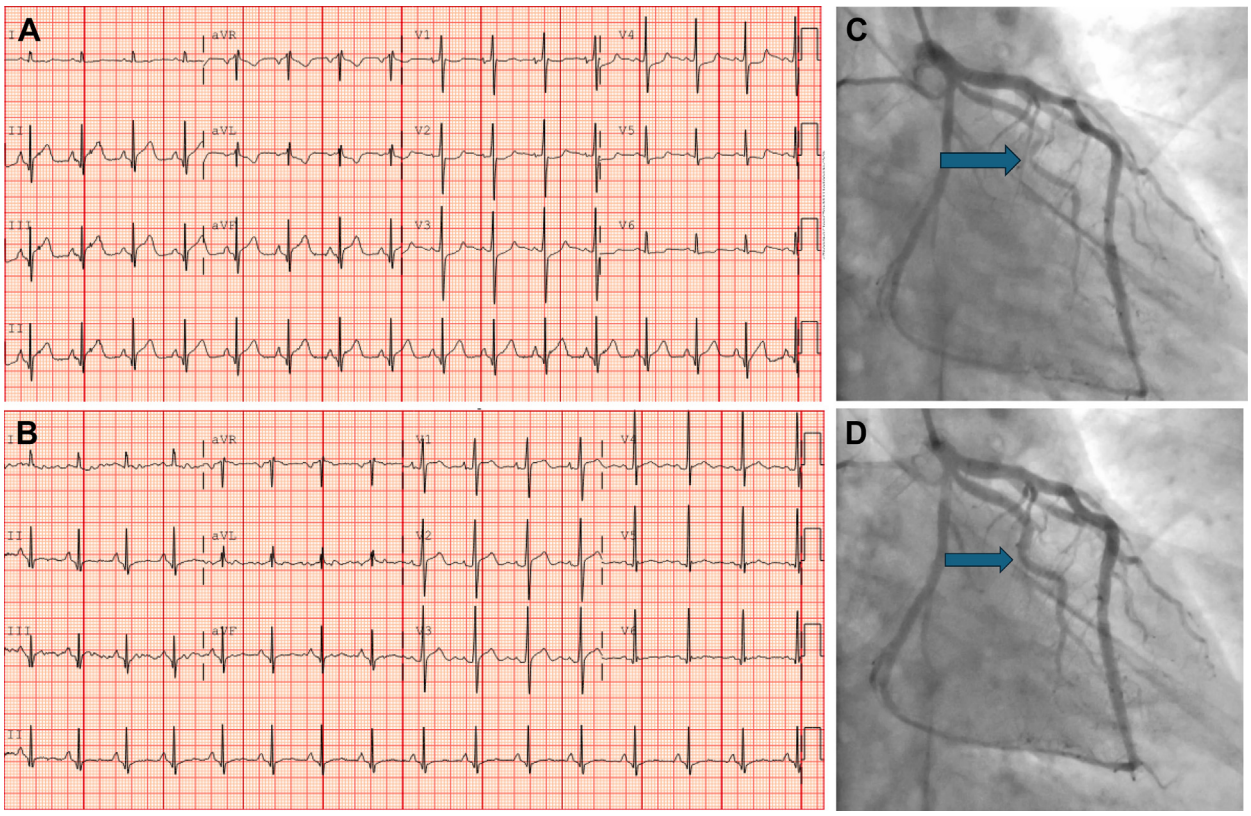
He was started on an intravenous heparin infusion and was promptly transferred to the cardiac catheterization laboratory. He was found to have a patent right coronary artery stent but a 90% narrowing of a

TABLE 1 Summary of Previous Hospital Visits for Chest Pain and Coronary Artery Spasm

Type of Hospital Visit	Cardiac Diagnosis	Angiography Performed	Angiogram Findings/Interventions	Days From Current Admission
Hospital admission	Inferior STEMI	Yes	Diffuse severe narrowing of the RCA resulting in DES insertion from proximal to distal RCA	727
Hospital admission	NSTEMI	Yes	RCA stents patent, query coronary artery spasm	724
ED visit with discharge	Chest pain	No	–	730
ED visit with discharge	Chest pain	No	–	696
Hospital admission	NSTEMI	Yes	Nitrate-responsive diffuse LAD spasm	677
Hospital admission	Anterolateral STEMI	Yes	Significant distal LAD narrowing not responsive to intracoronary nitroglycerin DES insertion to the distal LAD	530
Continuation of previous admission	NSTEMI	Yes	Persistent chest pain with new mid-LCx narrowing responsive to intracoronary nitroglycerin	524
ED visit with discharge	Chest pain	No	–	459
ED visit with discharge	Chest pain	No	–	160
Hospital admission	Inferior STEMI	Yes	Diffuse coronary spasm responsive to intracoronary nitroglycerin	143
Current hospital admission	Inferior STEMI	Yes	Severe ramus intermedius narrowing responsive to intracoronary nitroglycerin	–

DES = drug-eluting stent; ED = emergency department; LAD = left anterior descending (artery); LCx = left circumflex artery; NSTEMI = non-ST-segment elevation myocardial infarction; RCA = right coronary artery; STEMI = ST-segment elevation myocardial infarction.

FIGURE 1 **Initial Electrocardiogram and Coronary Angiograms**



(A) The patient's electrocardiogram on presentation in the emergency department shows an inferoposterior ST-segment elevation myocardial infarction. (B) There is resolution of his ST-segment changes after administration of intracoronary nitroglycerin. Corresponding coronary angiograms showing severe ramus intermedius narrowing (blue arrow) (C) before and (D) after intracoronary nitroglycerin administration.

large ramus intermedius feeding the lateral and inferior wall. He was treated with 400 μg of intracoronary nitroglycerin (**Figures 1B to 1D**, Videos 1A and 1B) which completely resolved his coronary spasm. His symptoms and ECG findings resolved as well. His echocardiogram showed preserved biventricular size and function without regional wall motion abnormalities.

He was started on a budesonide-formoterol inhaler, and his home mometasone nasal spray, montelukast, and tiotropium were continued. His salbutamol was discontinued given the presumed provocation of his CAS. His aspirin was discontinued in favor of clopidogrel (75 mg daily), and his isosorbide mononitrate and diltiazem doses were increased to 240 mg orally daily and 720 mg orally daily, respectively. The decision not to use corticosteroids was based on the patient's recent STEMI event, as well as the low eosinophil count and normal C-reactive protein levels, which diminish the likelihood of eosinophilic inflammation as the cause of CAS. Because of the frequency and severity of his asthma and CAS (along with the failure of medical therapy), he underwent a successful ultrasound-guided left stellate ganglion block as a trial before surgical sympathectomy, with 10 mL of 0.5% bupivacaine and 1 mL of dexamethasone (4 mg) instilled at the anterior aspect of the longus colli muscle and between the longus colli muscle and the carotid artery below the level of the carotid tubercle. He was discharged from the hospital with plans for outpatient surgical sympathectomy.

Over the course of the next 2 months, the patient was admitted twice to the pulmonary medicine service for severe asthma exacerbation, *without* recurrence of CAS. Given his response to the stellate ganglion blockade (temporary fix), he underwent bilateral thoracoscopic sympathectomy to include

levels T2 to T4. Intraoperatively he demonstrated transient tachycardia on ablation of the left sympathetic chain that resolved immediately following ablation of the right T3 and T4 trunks. He had an unremarkable postoperative course and was discharged from the hospital the following day. He was restarted on benralizumab for asthma control. His isosorbide mononitrate, diltiazem, and amlodipine continued at the same doses, with plans to taper toward discontinuation.

DISCUSSION

CAS is a potential cause of myocardial infarction with nonobstructive coronary disease (MINOCA), which occurs in approximately 5% to 6% of patients with acute infarction who are referred for coronary angiography.[1] The appearance of CAS may be mistaken for plaque rupture on coronary angiography, thus resulting in unnecessary coronary stenting. The exact prevalence of CAS is not known, but in 1 study, 46% of patients with a diagnosis of MINOCA who were undergoing provocation testing had CAS.[2] Moreover, the presence of MINOCA is associated with adverse outcomes during the acute setting and long term.[3] Refractory CAS occurs in 10% to 15% of cases and is defined as recurrent CAS despite a combination of 2 standard drugs (either 2 calcium-channel blockers [CCBs] or a CCB and a long-acting nitrate).

CAS can occur in response to a particular trigger or spontaneously.[1] The mechanism is poorly understood, but classically CAS is thought to be caused by the interaction among endothelial dysfunction, smooth muscle cell hyperreactivity, and 1 or more vasomotor stimuli.[4] The autonomic nervous system is an important stimulus because both increased sympathetic tone and increased parasympathetic tone can trigger CAS. Acetylcholine can cause vasoconstriction in the context of vascular smooth muscle cell (VSMC) hyperreactivity,[4] and norepinephrine can trigger vasoconstriction in the VSMCs through stimulation of the α-adrenergic receptors.[4] CAS induces pain and myocardial ischemia, leading to the release of adenosine. This release stimulates the transient receptor potential vanilloid-1 receptors, triggering activation of the cardiac sympathetic afferent reflex and ultimately leading to heightened sympathetic tone.[5] CAS also induces remodeling of the stellate ganglion, with resulting autonomic remodeling and increased sympathetic tone, thereby worsening CAS.[5] Although this is common, a single case report demonstrated improvement in diffuse CAS through intracoronary epinephrine. This improvement is thought to be linked to the predominance of β_2-adrenergic receptors in smaller coronary arteries.[6] Autonomic modulation addresses the foregoing sympathetic mechanisms through blocking the release of norepinephrine, decreasing myocardial oxygen demand through lowering heart rate and systolic blood pressure, and relieving pain by partially blocking the sensory nerve pathway.[7]

CAS in patients with eosinophilic asthma may be caused by infiltration of eosinophils and mast cells in the coronary artery adventitia, resulting in reduced responsiveness to traditional CAS treatments.[8] This patient's CAS may have been caused by various factors, such as endothelial dysfunction, hyperreactive VSMCs, and excessive sympathetic stimulation from salbutamol use, chest pain, and asthma exacerbation. The impact of eosinophilic coronary infiltration on his current symptoms is uncertain, as his serum eosinophil counts were normal, likely due to benralizumab's residual effect. His COVID-19 infection was a trigger for his asthma exacerbation, but COVID-19 may cause coronary endothelial dysfunction, resulting in coronary vasoconstriction.[9]

Considering the patient's poorly controlled asthma with frequent exacerbations correlating to his CAS, along with the severity of his CAS episodes resulting in ACS and cardiac arrest, autonomic modulation was explored as a potential solution to reduce the occurrence and intensity of future CAS presentations. Stellate ganglion block and subsequent surgical sympathectomy successfully prevented recurrence of CAS, thus highlighting the effectiveness of autonomic modulation in treating CAS in the context of poorly controlled asthma and COVID-19 infection. Previous studies used stellate ganglion block[5] and surgical sympathectomy,[10,11] with favorable outcomes, in the treatment of refractory CAS. Using stellate ganglion block as the primary approach can assist in differentiating individuals who exhibit a response from those who do not respond to more permanent autonomic modulation.[12]

FOLLOW-UP

He was assessed 1 month after his procedure in the general cardiology clinic and did not have further episodes of chest discomfort. In the subsequent 4 months, he experienced 3 additional episodes of asthma exacerbation, leading to respiratory failure and emergency department visits, *but without a recurrence of CAS*. He is working with his outpatient respirologist on further optimization of his asthma, including consideration to switch to alternative biologic agents.

CONCLUSIONS

We report the use of a stellate ganglion block as a temporizing measure in bridging to bilateral thoracoscopic sympathectomy for the treatment of severe and recurrent CAS. In these refractory cases, we believe that the described approach provides a safe and reasonable treatment option for patients with recurrent ischemia.

FUNDING SUPPORT AND AUTHOR DISCLOSURES

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

ADDRESS FOR CORRESPONDENCE: Dr Kevin R. Bainey, Division of Cardiology, Mazankowski Alberta Heart Institute, University of Alberta, 2C2 WMHSC 8440 112th Street, Edmonton, Alberta T6G 2B7, Canada. E-mail: kevin.bainey@albertahealthservices.ca.

REFERENCES

1. Tamis-Holland JE, Jneid H, Reynolds HR, et al. Contemporary diagnosis and management of patients with myocardial infarction in the absence of obstructive coronary artery disease: a scientific statement from the American Heart Association. *Circulation*. 2019;139(18):E891–E908.

2. Montone RA, Niccoli G, Fracassi F, et al. Patients with acute myocardial infarction and non-obstructive coronary arteries: safety and prognostic relevance of invasive coronary provocative tests. *Eur Heart J*. 2018;39(2):91–98.

3. Bainey KR, Welsh RC, Alemayehu W, et al. Population-level incidence and outcomes of myocardial infarction with non-obstructive coronary arteries (MINOCA): insights from the Alberta Contemporary Acute Coronary Syndrome Patients Invasive Treatment Strategies (COAPT) study. *Int J Cardiol*. 2018;264:12–17.

4. Lanza GA, Careri G, Crea F. Mechanisms of coronary artery spasm. *Circulation*. 2011;124(16):1774–1782.

5. Malik V, Chew DP, Vaile J, Sanders P. Sympathetic denervation abolishes recurrent ventricular fibrillation and intractable coronary spasm: autonomic dysfunction: a shared mechanism? *JACC Clin Electrophysiol*. 2024;10(5):1017–1020.

6. Malik V, Safaa A, Clugston R, et al. How should I treat this unusual anterolateral ST-elevation myocardial infarction with recurrent ventricular fibrillation and cardiac arrest? *EuroIntervention*. 2016;12(7):928–932.

7. Hokimoto S, Kaikita K, Yasuda S, Tsujita K, Ishihara M, Matoba T, et al. JCS/CVIT/JCC 2023 guideline focused update on diagnosis and treatment of vasospastic angina (coronary spastic angina) and coronary microvascular dysfunction. *Circ J*. 2023;87(6):879–936.

8. Backhouse B, Scully T, Rajakariar K, Jin D, Chandrasekhar J, Freeman M. Coronary artery vasospasm in patients with eosinophilia. *JACC Case Rep*. 2023;19:101932.

9. Giustino G, Pinney SP, Lala A, et al. Coronavirus and cardiovascular disease, myocardial injury, and arrhythmia: JACC focus seminar. *J Am Coll Cardiol*. 2020;76(17):2011–2023.

10. Cardona-Guarache R, Pozen J, Jahangiri A, et al. Thoracic sympathectomy for severe refractory multivessel coronary artery spasm. *Am J Cardiol*. 2016;117(1):159–161.

11. Abbate A, Hamza M, Cassano AD, et al. Sympathectomy as a treatment for refractory coronary artery spasm. *Int J Cardiol*. 2012;161(1):e7e9.

12. Malik V, Shivkumar K. Stellate ganglion blockade for the management of ventricular arrhythmia storm. *Eur Heart J*. 2024;45(10):834–836.

KEY WORDS acute coronary syndrome, myocardial infarction, myocardial ischemia

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