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CASE REPORT
Coronary heart disease

The role of computed tomography coronary angiography in multi-vessel coronary vasospasm: a case report

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Background Coronary vasospasm can present like an acute coronary syndrome (ACS) with an intense vasoconstriction resulting in total or near-total occlusion of one or more of the coronary vessels. Definitive diagnosis can be made by intracoronary provocation testing.

Case summary A 37-year-old Caucasian male and smoker was admitted with chest pain. Highly sensitive troponin-I was positive at 63 ng/L (99th percentile upper reference limit, <15 ng/L) with a repeat value of 45 ng/L three and a half hours later which was of clinical significance. Serial electrocardiography (ECG) showed no ischaemic changes. Coronary angiography revealed several distal and side branch stenoses; however, angiographic appearances were atypical of coronary plaque. A differential diagnosis of spontaneous coronary artery dissection was suspected although the patient was pain free during the procedure. Computed tomography coronary angiography (CTCA) demonstrated normal coronary arteries, confirmed on repeat invasive coronary angiography. Cold pressor testing was unsuccessful in reproducing vasospasm. Acute coronary syndrome treatment was discontinued, he received smoking cessation advice and Amlodipine 5 mg daily was started. He has experienced no further episodes of cardiac chest pain on follow-up consultation 7 months later.

Discussion This is an unusual case of persistent, extensive coronary vasospasm in a patient without ongoing chest pain or ischaemic ECG changes. Intracoronary nitrates are usually effective at relieving coronary spasm. Cold pressor testing has poor sensitivity for diagnosing vasospasm when compared to intracoronary provocation testing using either acetylcholine or ergonovine. Multi-slice CTCA may help to discriminate coronary plaque from coronary vasospasm when there is diagnostic uncertainty.

Keywords Case report • Coronary vasospasm • Acute coronary syndrome • Coronary angiography • Spontaneous coronary artery dissection • Computed tomography angiography • Multislice computed tomography

Learning points

- Extensive, severe coronary vasospasm can present like an acute coronary syndrome and persistent spasm can exist without ongoing chest pain or electrocardiography changes.
- Multi-slice computed tomography coronary angiography may help to discriminate coronary plaque from vasospasm, thus preventing unnecessary, invasive treatment when there is diagnostic uncertainty.
- Intracoronary nitrates are highly effective at relieving coronary vasospasm. Cold pressor testing is poorly sensitive for confirming a diagnosis of vasospasm when compared with pharmacological intracoronary provocation using either acetylcholine or ergonovine.

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Introduction

Coronary vasospasm mimics acute coronary syndromes (ACS) in its presentation with chest pain, ischaemic electrocardiography (ECG) changes and elevated cardiac biomarkers.[1] Initially described by Prinzmetal *et al.* in patients with normal or near-normal coronary arteries on invasive coronary angiography; it is characterized by an intense vasoconstriction resulting in total or near-total occlusion of one or more of the coronary vessels.[2,3] Its pathophysiology is multifactorial relating to endothelial dysfunction and low-grade inflammation, occurring more frequently in smokers and at sites of significant coronary atherosclerosis.[4,5] Definitive diagnosis can be made by intra-coronary provocation testing.[6] We describe an unusual case of persistent, extensive coronary vasospasm without ongoing chest pain or ECG changes.

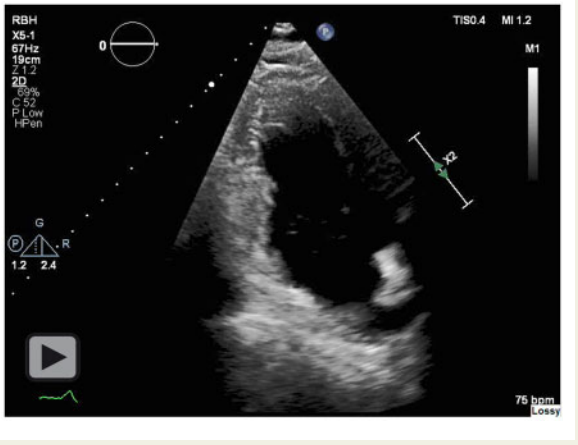
Timeline

Date	Event
22nd December 2019	Admitted with troponin positive chest pain and normal electrocardiography findings.
23rd December 2019	Coronary angiography demonstrates multi-vessel stenoses—appearances are atypical of coronary plaque.
24th December 2019	Computed tomography coronary angiography reveals normal coronary arteries—confirmed on repeat invasive coronary angiography. Patient remains pain free and is discharged from hospital.
July 2020	No further episodes of cardiac chest pain on follow-up teleconsultation.

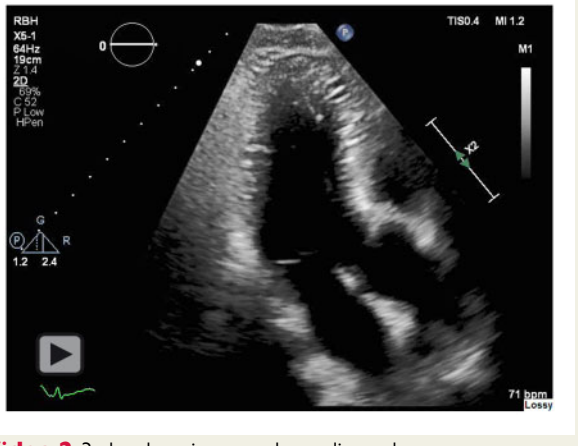
Case presentation

A 37-year-old Caucasian male presented to the Emergency Department with chest pain. He described awaking with central chest tightness radiating to both arms lasting 20 min. The chest pain was associated with diaphoresis and resolved spontaneously. He smoked 10–15 cigarettes a day and had previously used anabolic steroids some 10–12 years ago, although denied any current drug use. His past medical history included a respiratory arrest following anaphylaxis to NSAIDs, asthma, and pulmonary sarcoidosis.

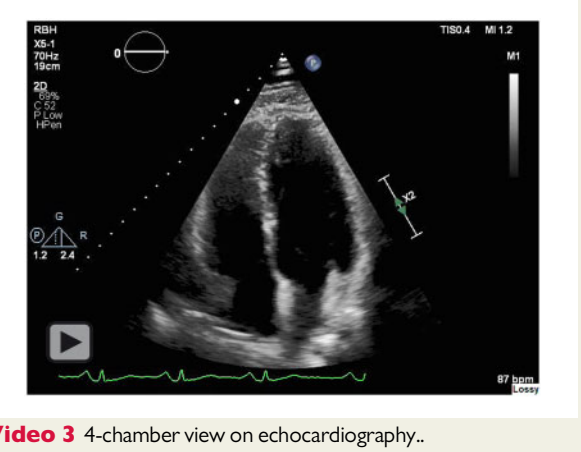
On examination, his body habitus was of muscular build; cardiac auscultation revealed no murmurs and there were no signs of heart failure. Serial ECGs during his hospital admission showed normal sinus rhythm with no dynamic or ischaemic changes (*Figure 1*). Full blood count and renal function were normal. High-sensitivity troponin-I was positive at 63 ng/L (99th percentile upper reference limit, <15 ng/L) with a repeat value of 45 ng/L approximately three and a half hours later. Serum cholesterol levels were elevated with a total cholesterol of 5.4 mmol/L, LDL 3.1 mmol/L, and triglycerides 2.9 mmol/L. He was treated as an ACS with dual anti-platelets, statin, and B-blocker therapy.



Video 1 2-chamber view on echocardiography.



Video 2 3-chamber view on echocardiography.



Video 3 4-chamber view on echocardiography..

Echocardiogram showed normal biventricular function with no obvious regional wall motion abnormalities (*Videos 1–3*). Coronary angiography was performed approximately 24 h following admission to the hospital, during which time the patient remained free of chest pain. Severe stenoses were observed at the ostium of a diagonal branch of the left anterior descending artery (LAD), proximal diagonal vessel, proximal intermediate artery, non-dominant circumflex (LCx), distal right coronary artery, and posterior descending artery (*Figure 2A,B*). There was also a moderate lesion in the mid-LAD at the bifurcation with the diagonal vessel (Supplementary material online, *Videos S1* and *S2*). No ischaemic ECG changes were seen during coronary angiography.

Angiographic appearances were atypical of coronary plaque and computed tomography coronary angiography (CTCA) was performed to exclude a differential diagnosis of spontaneous coronary artery dissection (SCAD). This demonstrated normal coronary arteries (*Figure 3A–C*) and repeat invasive coronary angiography confirmed resolution of the severe coronary vasospasm seen previously (Supplementary material online, *Videos S3* and *S4*). Cold pressor testing during coronary angiography was unsuccessful in reproducing vasospasm.

A drug screen was not performed at this stage as the patient had denied the recent use of illicit drugs and more than 48 h had passed from the time of presentation to the CT findings. Anti-platelet and statin treatment were discontinued; he was commenced on Amlodipine 5 mg daily and received smoking cessation advice prior to discharge from the hospital. At cardiology clinic follow-up, 7 months later, he has experienced no further episodes of cardiac chest pain.

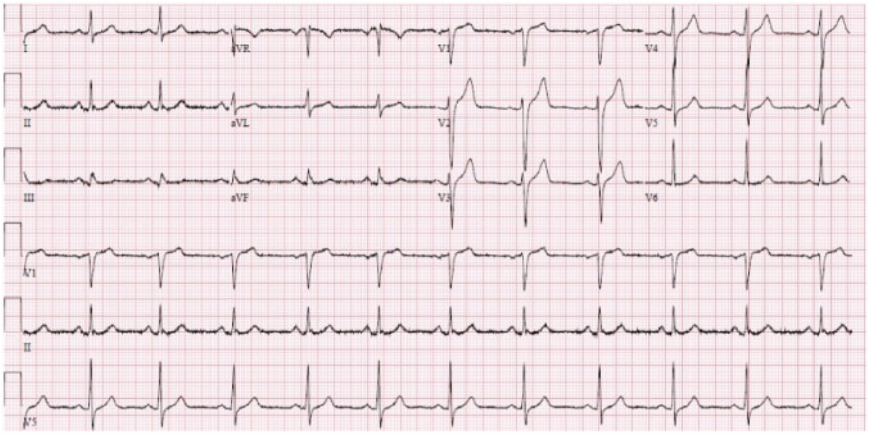


Figure 1 Electrocardiography on admission showing no ischaemic changes.

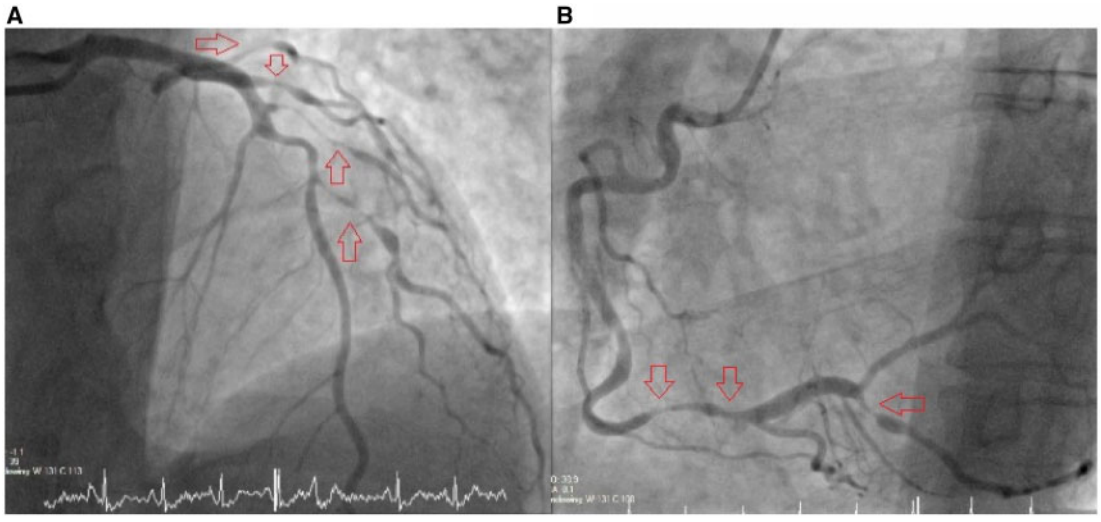


Figure 2 (*A*, *B*) Severe multi-vessel stenosis (indicated by red arrows) seen on invasive coronary angiography.

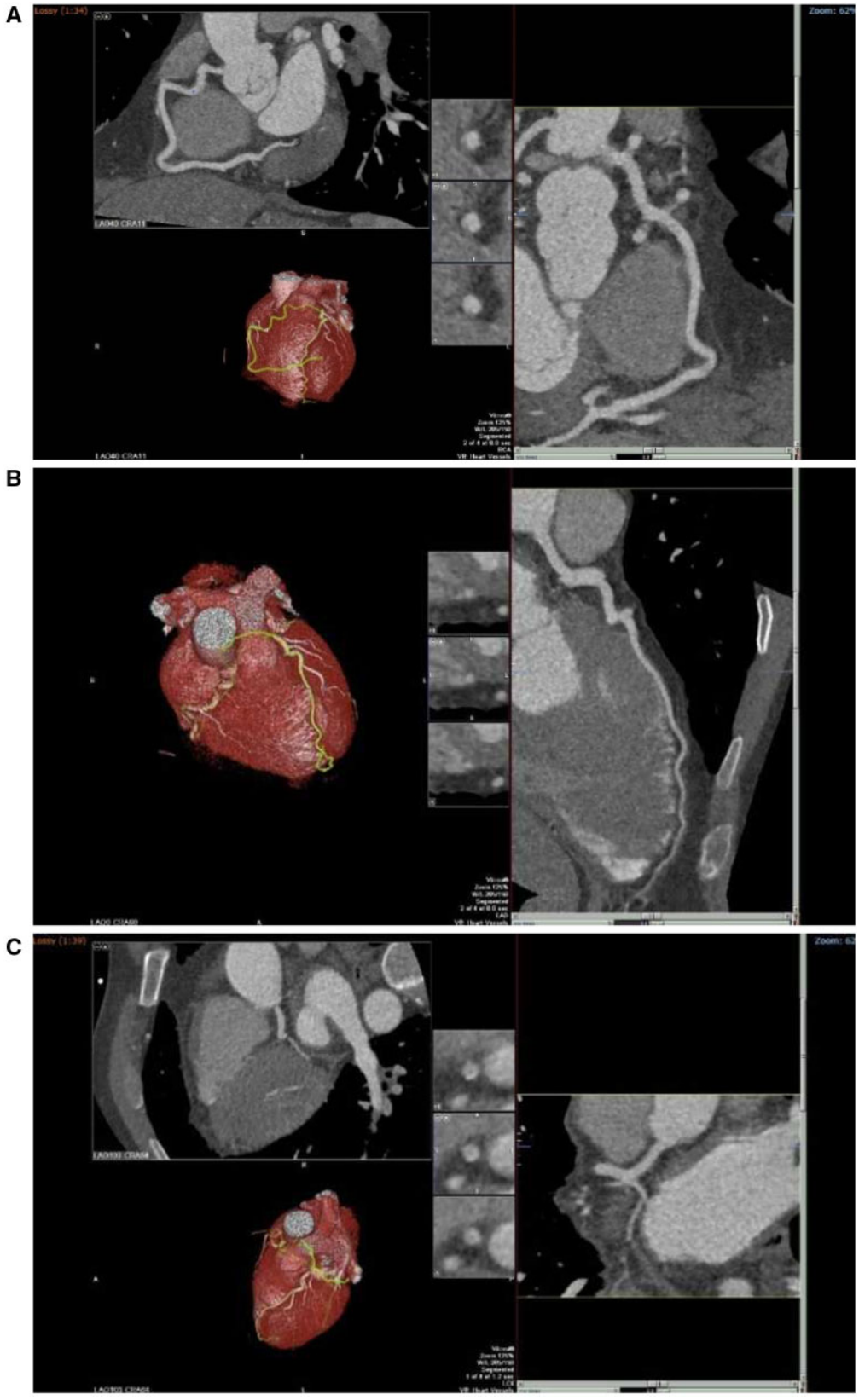


Figure 3 (*A–C*) Three-dimensional reconstruction using computed tomography coronary angiography showing normal coronary arteries.

Table 1 Drug therapy for the treatment of coronary vasospasm

Drug class	Examples and effective dosages	Mechanism of action
Calcium channel blockers	• Amlodipine 10 mg • Verapamil 240 mg SR • Diltiazem 90 mg b.i.d. Diltiazem 120–360 mg o.d.	• Vascular smooth muscle relaxation • Reduced oxygen demand
Long-acting nitrates	• Isosorbide mononitrate XL 30 mg	• Epicardial vasodilation • Reduced oxygen demand
Other vasodilators	• Nicorandil 10–20 mg b.i.d.	• Nitrate and K^+ channel activation • Microvascular dilatory effect
ACE inhibitors/ARBs	• Ramipril 2.5–10 mg	• Improved coronary flow reserve • Reduced cardiac workload • Small vessel remodelling
Statins	• Rosuvastatin 10–20 mg	• Improved coronary endothelial function • Reduced vascular inflammation

Discussion

The case presented differs from the majority of published literature on coronary vasospasm due to the absence of chest pain and ECG changes at the time of invasive coronary angiography. Mohammed *et al.*[7] reported a case of coronary vasospasm in a patient presenting with ST elevation on ECG and no chest pain. Coronary angiography showed no evidence of coronary vasospasm although provocation testing was not undertaken to confirm the diagnosis. Another study described an asymptomatic patient with an absence of ECG changes and a near-total occlusion of the atrioventricular groove branch of the circumflex artery on coronary angiography, which was relieved by intracoronary nitroglycerine (NTG).[8]

In our case, widespread severe coronary vasospasm was initially not suspected in a young male patient with few risk factors for coronary artery disease. A variation of >20% in high-sensitivity cardiac troponin is a predictor for adverse cardiac outcomes in ACS, thereby mandating the need for invasive coronary angiography.[9] Intracoronary nitrates are almost always effective in relieving coronary vasospasm but were not administered on this occasion due to the low clinical suspicion.[10] Although uncommon, type 3 SCAD may present with similar angiographic appearances to coronary atherosclerosis.[11]

Cardiac magnetic resonance imaging is limited in its role in diagnosing SCAD or transient coronary vasospasm associated with small-sized infarcts and preserved left ventricular systolic function.[12] Computed tomography coronary angiography has an emerging role for discriminating between coronary plaque, SCAD, and vasospasm due to its high plaque detectability and negative predictive value.[13–16]

The diagnosis of coronary vasospasm is suggested by a typical history of short-lasting angina attacks at rest, responding promptly to sublingual nitrates. Documentation of transient ST elevation (>1 mm) can confirm a diagnosis although in certain cases provocation testing may be required.[6] Cold pressor testing is comparatively less sensitive in diagnosing vasospasm when compared to pharmacological methods using either ergonovine (ER) or acetylcholine (Ach). In a study of 34 patients, ER testing induced angina and ST elevation in 100% and 94% of cases, respectively, whereas cold pressor testing was sensitive in only 15% and 9% of cases.[17] Neither ER nor Ach was used in this case due to a lack of familiarity of their use within our department.

Intracoronary imaging tools (IVUS and OCT) may have some benefit in confirming coronary vasospasm although again, clinical

Table 2 Common and less commonly associated medications and drugs which may exacerbate coronary vasospasm

	Common
1.	Sumatriptan
2.	Cocaine, amphetamines, ecstasy
3.	Butane, toluene, glue inhalation
4.	Cigarette smoking, nicotine
5.	Alcohol
6.	Acetylcholine
7.	Ergonovine
8.	α-Blockers, β-blockers
9.	Diclofenac, NSAIDs, Aspirin
	Uncommon
1.	Marijuana, heroin, khat (herbal ecstasy)
2.	Anaesthetic agents e.g. propofol
3.	Thyroxine
4.	5-Fluorouracil
6.	Chemotherapeutic agents e.g. Capecitabine
7.	Allopurinol
8.	Bromocriptine
9.	Amoxicillin

utility in severe cases is limited if the probe cannot traverse the lesion.[18] As the differential included SCAD, it was not felt safe to use these invasive imaging techniques when an alternative safer investigation, CTCA, was available.

The management of coronary vasospasm involves modification of risk factors for coronary atherosclerosis and the use of vasodilator therapy, ACE inhibitors, and statins (*Table 1*).[19] Calcium channel antagonists are effective in preventing coronary vasospasm in 90% of patients, while the addition of long-acting nitrates is helpful in controlling symptoms and those intolerant to calcium channel blockers.[6] Drugs that may exacerbate coronary vasospasm should be avoided (*Table 2*).[20] In severe refractory cases, percutaneous coronary intervention may be considered alongside other coronary vasodilator agents such as Nicorandil.[6]

Lead author biography

Dr James Tomlinson is a Cardiology Registrar working at The Royal Bournemouth Hospital in Dorset, United Kingdom. He is in his first year of Cardiology specialty training following achievement of the Membership of the Royal College of Physicians (UK) diploma and completion of Core Medical Training. His previous experience as a Cardiology Clinical Fellow in Bristol, UK has resulted in some early interest in the field of cardiac electrophysiology.

Supplementary material

Supplementary material is available at *European Heart Journal - Case Reports* online.

Slide sets: A fully edited slide set detailing these cases and suitable for local presentation is available online as Supplementary data.

Consent The authors confirm that written consent for submission and publication of this case report including images and associated text has been obtained from the patient in line with COPE guidance.

Conflict of interest: None declared.

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