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CASE REPORT
Coronary heart disease

Dizziness in an avid cyclist: an unusual presentation of a common problem

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Background Presyncope and syncope are common presentations with a wide range of differential diagnoses; when it occurs primarily on exertion, a cardiovascular cause is more likely. Structural abnormalities and primary rhythm disturbances are the usual culprits in these patients.

Case summary A 75-year-old gentleman presented with a history of progressive exertional presyncope. His investigations demonstrated normal cardiac structure, function, and rhythm. He underwent an exercise stress test, which demonstrated a significant reduction in peak blood pressure with equivocal electrocardiogram changes and absence of ischaemic symptoms. In view of his age and gender, a computerized tomography coronary angiogram (CTCA) was organized to exclude obstructive coronary artery disease (CAD). Intriguingly, the CTCA demonstrated a severe proximal left anterior descending (LAD) artery stenosis. This stenosis was confirmed to be functionally significant using invasive coronary physiology and was treated with percutaneous coronary intervention. At follow-up, there was no recurrence of exertional presyncope and the patient was continuing to return to his baseline function.

Conclusion Presyncope and/or syncope as the sole manifestation of obstructive CAD, in the presence of normal ventricular function and valves, has rarely been reported. Myocardial ischaemia-mediated presyncope and/or syncope may be secondary to numerous mechanisms, which are described in this case report. Revascularization of the functionally significant proximal LAD stenosis resulted in cessation of exertional presyncope in our patient. The long-term outcome of revascularization in patients with presyncope and syncope needs to be further investigated.

Keywords Presyncope • Obstructive coronary artery disease • Coronary physiology assessment • Case report

ESC Curriculum 3.3 Chronic coronary syndrome • 3.1 Coronary artery disease • 3.4 Coronary angiography

Learning points

- Functionally significant proximal or multi-vessel coronary artery disease (CAD) can, in rare circumstances, present with exertional (pre)syncope in the absence of ischaemic symptoms and, therefore, should form part of the (pre)syncope workup in selected patients.
- There are disparate mechanisms that lead to myocardial ischaemia-mediated (pre)syncope. Revascularization of functionally significant CAD may lead to amelioration of the mechanistic milieu leading to (pre)syncope and may improve long-term outcomes.

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Introduction

Presyncope and syncope are common clinical presentations with a wide list of differential diagnoses, with disparate pathophysiology and prognosis. A fall in systemic blood pressure, resulting in attenuation of cerebral blood flow, is the final step in the chain of events resulting in presyncope and subsequent syncope. Exertional symptoms tend to suggest an underlying cardiac aetiology. The prevalence of cardiac syncope increases with age, with <5% of patients under the age of 40 years having an underlying cardiac aetiology; this goes up to 30% in patients above 60 years of age, with near equal number of patients suffering from structural heart disease, such as aortic stenosis, and dysrhythmias, such as high degree atrioventricular (AV) block.[1] Therefore, the first line of investigations in patients with exertional presyncope and syncope includes rhythm monitoring and cardiac imaging.

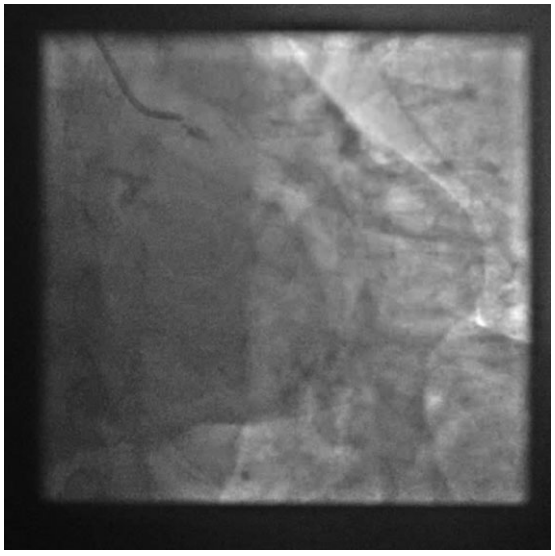
Timeline

Visit #1	**Referral for exertional presyncope during vigorous exertion only**
Electrocardiogram (ECG)	Sinus rhythm with no atrioventricular (AV) block
Laboratory blood test results	Normal full blood count and biochemistry
24-h ambulatory ECG	Sinus rhythm throughout with good heart rate variability and no AV block
Visit #2	**Exertional presyncope getting progressively worse and impeding his quality of life**
Exercise treadmill test	9 min and 19 s of Bruce protocol [metabolic equivalents (METS) 11.1] 97% target heart rate achieved <1 mm ST elevation in V1 and 1 mm inferolateral upsloping ST depression during exertion. No chest pain or dyspnoea *Blood pressure drop during peak exercise (Δ −16 mmHg) and 2 min into recovery (Δ −52 mmHg)*
Transthoracic echocardiogram	Normal biventricular systolic function and valvular function
Computed tomography coronary angiogram	Severe partially calcified plaque in the proximal left anterior descending (LAD) artery (70–99% stenosis)
Invasive coronary angiogram	Moderate–severe proximal LAD stenosis. LAD pressure-wire assessment: Pd/Pa 0.92 and fractional flow reserve (FFR) 0.71. Percutaneous coronary intervention (PCI) to proximal LAD with one drug-eluting stent Post-PCI LAD Pd/Pa 0.96 and FFR 0.90
Visit #3	**Exercise capacity back to baseline and cessation of exertional presyncope**
Exercise treadmill test	9 min and 19 s of Bruce protocol (METS 11.1) 103% target heart rate achieved No ischaemic ECG changes *No blood pressure drop during exercise and 2 min into recovery*

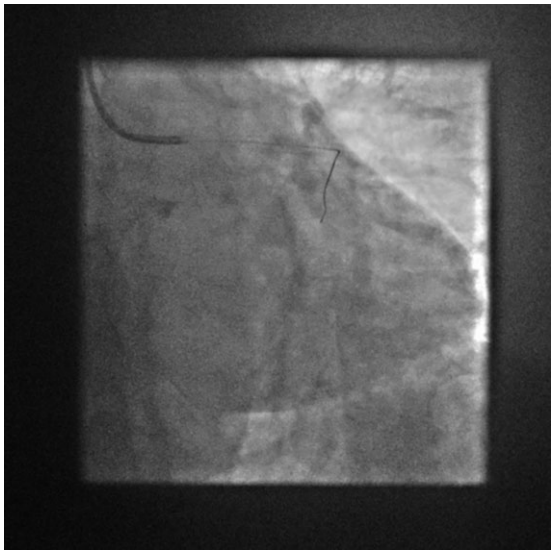
Case presentation

A 75-year-old gentleman with a background of prostate cancer (treated with prostatectomy 8 years ago) was referred to the Cardiology services due to presyncopal symptoms during vigorous exertion. He did not have any traditional cardiovascular risk factors, apart from his gender and age. He denied any family history of premature coronary artery disease (CAD) and was not taking any regular medications. Prior to his presentation, he was an avid cyclist and used to cycle 14 km every day without any limiting symptoms. Over time, he started noticing presyncopal symptoms predictably beyond a certain distance, which would ameliorate within minutes of resting. He vehemently denied any history of chest pain, dyspnoea, or palpitations. His cardiac and systemic examinations were normal, specifically, he had normal heart sounds with no murmurs. His jugular venous pressure was normal and there was no evidence of peripheral oedema. Given his age, his absence of chest pain and dyspnoea, and his normal cardiac examination, the initial set of investigations focused on excluding a primary arrhythmic abnormality. His electrocardiogram (ECG) demonstrated sinus rhythm with normal PR, QRS, and QTc intervals. His 24-h ambulatory ECG showed sinus rhythm with adequate heart rate variability (61–112 beats per minute) and no evidence of AV block.

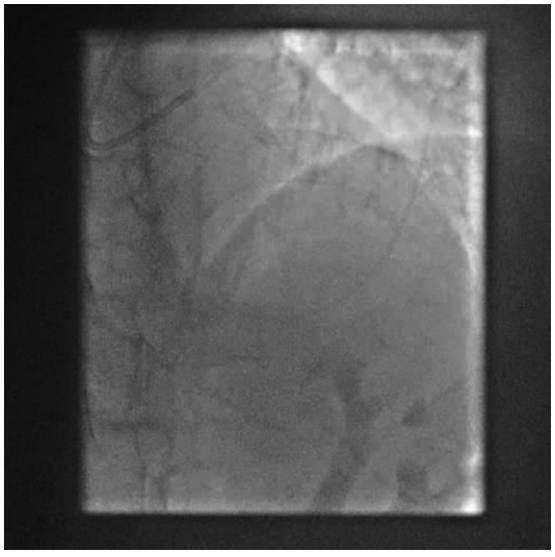
During his next clinic appointment, his symptoms of exertional presyncope had progressed significantly and he was now limiting his level of activity to avoid presyncopal episodes. He continued to deny symptoms of chest pain or dyspnoea. He underwent a transthoracic echocardiogram, which demonstrated normal biventricular systolic function and valves (*Videos 1–3*, Supplementary material online, *Videos S1–S3*). In view of worsening symptoms and normal initial set of investigations, an exercise stress test was organized to exclude exertion-related dysrhythmias. He was able to exercise for over 9 min of the Bruce protocol, achieving metabolic equivalents of 11.1. During his exercise stress test, he denied any chest pain or dyspnoea. He developed 1 mm upsloping inferolateral ST depression and <1 mm ST elevation in V1 during peak exercise (Stage 4 Bruce protocol) (*Figure 1A*). Interestingly, a significant drop in blood pressure was observed both during peak exercise (Δ -16 mmHg) and 2 min into recovery (Δ -52 mmHg). In view of the patient's age and the reduction in blood pressure during peak exertion, we organized a computed tomography coronary angiogram (CTCA) to exclude obstructive proximal CAD. A CTCA, as opposed to an invasive coronary angiogram, was organized as obstructive CAD was thought to be an



Video 1 Caudal view demonstrating severe proximal LAD stenosis.



Video 3 Post-PCI caudal view demonstrating good stent result in the proximal LAD.



Video 2 Post-PCI cranial view demonstrating good stent result in the proximal LAD.

unlikely cause of his presentation in the absence of ischaemic symptoms and equivocal exercise ECG changes. Intriguingly, the CTCA demonstrated a severe focal lesion in the proximal LAD (*Figure 2*).

This was followed up with a prompt invasive coronary angiogram, which confirmed a functionally significant proximal LAD stenosis [fractional flow reserve (FFR) 0.71] (*Figure 3A and B*; *Videos 1–3*, Supplementary material online, *Videos S1–S3*). The ensuing myocardial ischaemia was felt to be the mechanism driving the patient's exercise-induced hypotension and his symptoms of exertional presyncope. Given the proximal nature of this functionally significant stenosis, it also potentially had prognostic implications. Therefore, after discussion with the patient, his CAD was treated by percutaneous coronary intervention (PCI) with intravascular ultrasound guidance using a single drug-eluting stent. Post-PCI invasive physiological assessment demonstrated FFR of 0.90 (*Figure 3C and D*; *Videos 1–3*, Supplementary material online, *Videos S1–S3*). This represents a desirable physiological result, as post-PCI FFR ≥0.90 leads to best outcomes post-revascularization.[2] During his 3-month follow-up, his symptoms of exertional presyncope had abated and he was returning back to his baseline level of function. His repeat exercise stress test did not demonstrate any ischaemic ECG changes (*Figure 1B*) and there was no reduction in blood pressure during peak exertion.

Discussion

Exertional presyncope or syncope are indicators of malignant underlying aetiology, which, when presenting at an older age, prompts assessment for obstructive valvular disease or primary rhythm disturbance. Therefore, the first line of investigation in elderly patients with exertional presyncope or syncope includes a 12-lead ECG, 24-h ambulatory ECG and an echocardiogram.[3] Both the European Society of Cardiology (ESC) and American College of Cardiology/American Heart Association/Heart Rhythm Society (ACC/AHA/HRS) guidelines recommend an exercise stress test in selected patients with exertional presyncope and/or syncope, with the aim of assessing for exercise-induced dysrhythmias.[3,4] However, exertional presyncope and/or syncope can, on rare occasions, be the sole manifestation of functionally significant CAD. Exertional syncope is one of the common features of 'cardiac syncope' and there is some evidence supporting an association between cardiac syncope and obstructive CAD.[3,5–7] However, there are currently no prospective studies that

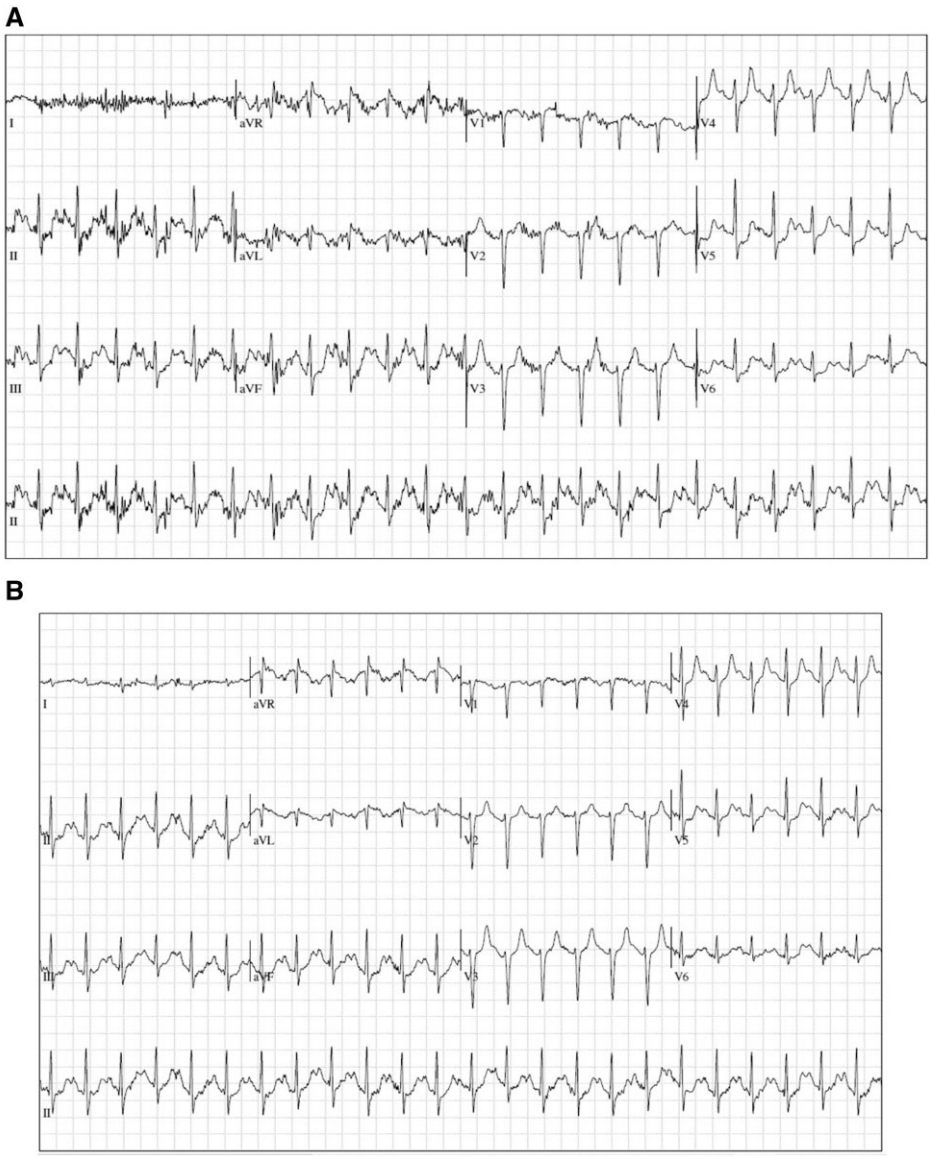


Figure 1 This figure demonstrates the exercise stress test electrocardiogram traces during peak exertion pre-percutaneous coronary intervention (*A*) and post-percutaneous coronary intervention (*B*).

have demonstrated a causal link between these two entities. Myocardial ischaemia, secondary to functionally significant proximal coronary artery stenosis or multivessel CAD, may lead to exertional syncope through a variety of mechanisms; these include (i) depressed cardiac output as a result of ischaemia-mediated left ventricular (LV) systolic dysfunction (this was the mechanism in our case), (ii) ventricular tachyarrhythmias, (iii) sinoatrial or AV block, and (iv) triggering the Bezold–Jarisch reflex (limited to inferior wall ischaemia), which may lead to severe bradycardia and hypotension. Myocardial ischaemia-mediated LV systolic dysfunction represents an earlier stage of the ischaemic cascade and ought to be more sensitive than ischaemic ECG changes or symptoms of chest pain. This would usually manifest as regional wall motion abnormalities on stress imaging and would only be clinically apparent if the degree of LV dysfunction, during exertion, is severe, as would be the case with left main or proximal LAD disease.

Previous studies have demonstrated a high prevalence of CAD in patients presenting with 'cardiac syncope'.[5] It is also recognized that 'cardiac syncope' is associated with a significantly heightened risk of fatal and non-fatal cardiovascular events.[6] Furthermore, in a cohort of patients with obstructive CAD and normal LV function, syncope was found to be an independent predictor of sudden cardiac death.[7] However, despite a strong association between obstructive CAD and cardiac syncope, PCI in patients with syncope did not lead to a reduction in syncope-related readmission rates in an elderly population.[8] However, the retrospective registry analysis that led to this conclusion had significant flaws, on top of the inherent drawbacks of a non-randomized, non-controlled, retrospective analysis. These

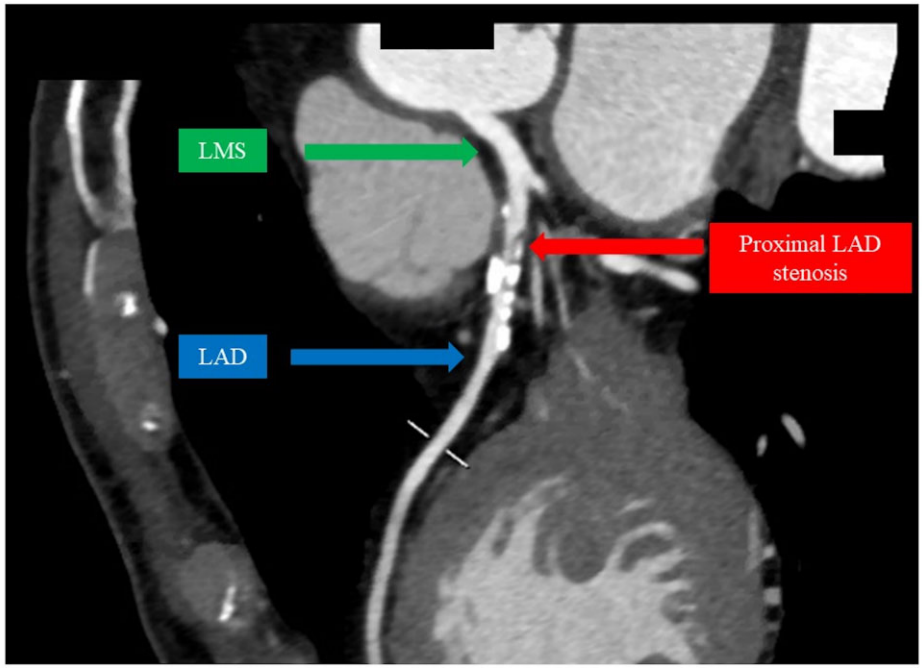


Figure 2 This figure demonstrates a computed tomography coronary angiography image of severely stenosed proximal left anterior descending artery.

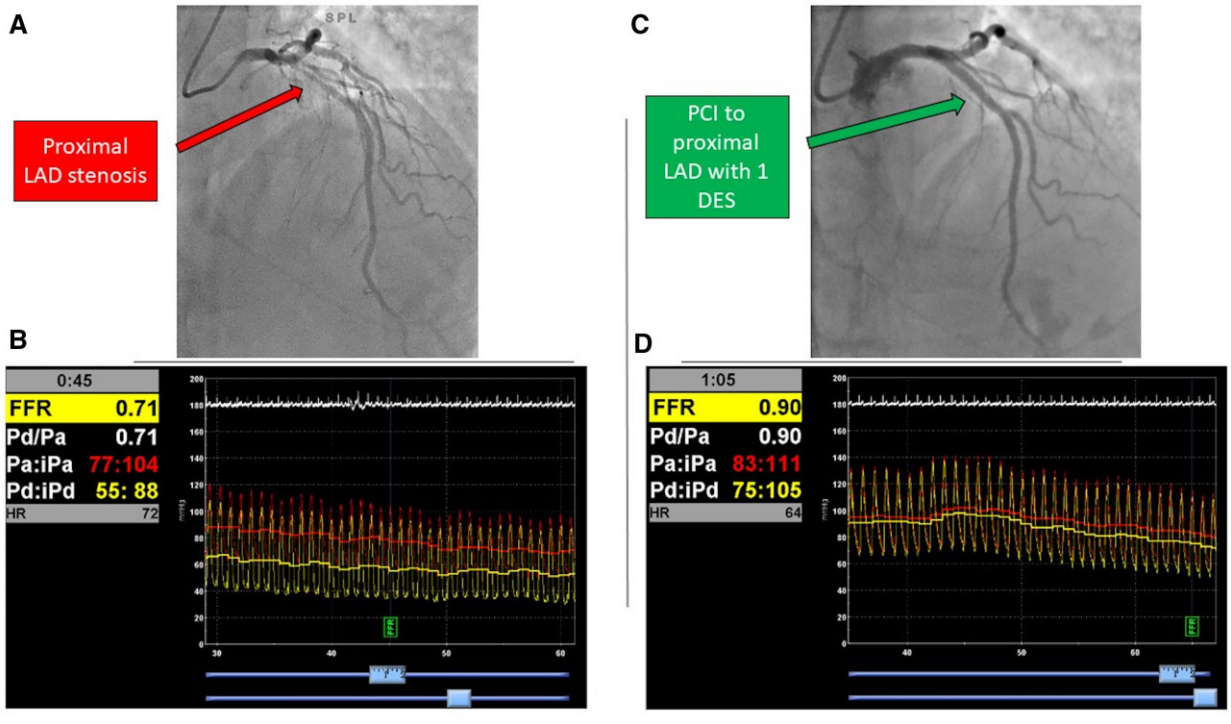


Figure 3 (*A*) Invasive coronary angiography cine image of a severely stenosed proximal left anterior descending artery. (*B*) Invasive coronary physiology assessment demonstrating pre-intervention fractional flow reserve of 0.71 in the left anterior descending artery. (*C*) Invasive coronary angiography cine image post-percutaneous coronary intervention with one drug-eluting stent. (*D*) Invasive coronary physiology assessment demonstrating post-intervention fractional flow reserve of 0.90 in the left anterior descending artery.

flaws included (i) not characterizing the diagnosis of syncope any further (i.e. there was no distinction between cardiac and non-cardiac syncope), (ii) only 2.5% of patients with syncope underwent coronary angiography and there was no mention of any other indications for coronary angiography in these patients, and (iii) the reasons for why clinicians offered PCI to certain patients and optimal medical therapy alone to others was not stipulated. Furthermore, syncope in the elderly population may have a multifactorial aetiology; therefore, mitigating for one pathophysiology may not be enough to prevent syncopal episodes. Therefore, although this study has been cited by international guidelines when describing the equipoise in treatment options for patients with obstructive CAD and syncope, the significant limitations of this study make it inappropriate to base contemporary clinical decisions on.

An exercise treadmill test was utilized as the second line investigation in this case, in concordance with the ESC guidelines in patients with exertional (pre)syncope.[3] This test allows for the assessment of exercise-induced myocardial ischaemia, as well as other mechanisms that may lead to exertional presyncope, such as chronotropic incompetence and high degree AV blocks during exertion. However, exercise treadmill testing has got its limitations, such as its reliance on reaching an adequate workload and heart rate because of the late occurrence of ECG changes in the ischaemic cascade.[9] Different stress imaging modalities could also have been utilized, such as exercise stress echocardiogram, which can detect wall motion abnormalities that occur earlier in the ischaemic cascade.

Exertional presyncope or syncope as the sole manifestation of obstructive CAD is a rare finding. This case report highlights the importance of multi-modality assessment in patients with progressively worsening symptoms but negative initial investigation results. Our patient reported amelioration of his exertional symptoms and has since returned to his high level of baseline function. Longitudinal studies are required to illustrate whether revascularization in this patient cohort results in reduced hospitalizations and improved outcomes in the long-term.

Lead author biography

Dr Aish Sinha is a Cardiology Registrar at St. Thomas' Hospital, London and a Clinical Research Fellow at King's College London. His research interests include coronary physiology assessment and coronary microvascular disease.

Supplementary material

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

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

Consent: The authors confirm that written consent for the 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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