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CASE REPORT
Arrhythmias/Electrophysiology

Coronary vasospasm-induced polymorphic ventricular tachycardia: a case report and literature review

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Introduction Coronary vasospasm is an uncommon but important cause of myocardial ischaemia and ventricular arrhythmias.

Case presentation In this report, we present a striking example of vasospasm manifesting as ST-segment elevation and ventricular tachycardia on Holter monitoring. Later, spasm occurred during a procainamide challenge performed for suspected Brugada syndrome. The patient underwent implantable cardioverter-defibrillator insertion and was successfully treated with oral calcium channel blocker.

Discussion We review contemporary data regarding management and outcomes in coronary vasospasm and discuss the use of implantable defibrillator therapy in patients who have sustained a significant arrhythmic event.

Keywords Coronary vasospasm • Procainamide • ST-segment elevation • Case report

Learning points

- Coronary vasospasm is an important cause of myocardial ischaemia that manifests with electrocardiographic ST-segment changes and can be complicated by ventricular arrhythmias.
- Medical therapy with calcium channel blockade remains the cornerstone of management, while patient values and prognostic risk assessment are helpful in evaluating candidacy for an implantable cardioverter-defibrillator following a serious arrhythmic event.

Introduction

Vasospastic angina (VSA) was first described by Prinzmetal *et al.*[1] as a variant form of angina in which transient myocardial ischaemia occurred due to coronary artery spasm. Afflicted individuals present with chest pain and ST-segment deviation, frequently complicated by ventricular arrhythmias.[2–4]

Several triggers for coronary vasospasm have been identified, with reports implicating sodium channel blockade as a potential precipitant.[5,6] After survival of the index arrhythmic event, in addition to risk factor modification and medical therapy, question frequently arises regarding the value of implanting an implantable cardioverter-defibrillator (ICD) for secondary prevention. We report a striking example of vasospasm occurring during non-invasive cardiac monitoring, then later in the setting of intravenous procainamide.

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Timeline

Day (setting)	Events
1 (Device clinic)	Patient presents with 5-day history of intermittent chest pain
	Episodes of ventricular high rates detected on single chamber permanent pacemaker corresponding to recalled symptoms
4 (Hospital inpatient)	Patient returns after 48-h Holter monitor demonstrates transient progressive ST-segment elevation degenerating into polymorphic ventricular tachycardia
	Exercise stress test performed that was symptom and electrically negative for cardiac ischaemia
	10 mg/kg procainamide challenge performed develops ST-segment elevation in recovery period with chest pain
	Urgent coronary angiography performed: shows non-flow-limiting coronary artery disease
6 (Hospital inpatient)	Uptitrated on high-dose diltiazem with no recurrence of arrhythmia or pain
	Undergoes upgrade of permanent pacemaker to implantable cardioverter-defibrillator
34 (Device clinic)	Tolerating medication well with normal repeat Holter monitor and no device-detected events

Case presentation

A 56-year-old man, who had a dual-chamber permanent pacemaker (Medtronic) implanted 9 years earlier for cardioinhibitory vasovagal syncope verified by tilt-table test, presented to the pacemaker clinic with intermittent chest pain for 5 days prior. His past medical history was significant for hypertension, type 2 diabetes mellitus, and asthma; medications included ramipril 5 mg daily, metoprolol 25 mg b.i.d., metformin 500 mg b.i.d, and infrequent use of a salbutamol inhaler. On physical examination, blood pressure was 134/72 mmHg and heart rate was 66 beats/min. His jugular venous pressure was normal and chest clear, with no peripheral oedema. Cardiac auscultation revealed normal first and second heart sounds with no extra heart sounds or murmurs. Device interrogation showed multiple episodes of irregular high ventricular rates, which had never been detected on prior routine device evaluations. As no electrograms were stored by the device for these episodes, an urgent Holter monitor was arranged. During the monitoring period, the patient reported intermittent chest pressure at rest that correlated with progressive ST-segment elevation leading to episodes of self-terminating polymorphic ventricular tachycardia (*Figure 1*). These findings raised suspicion for the possibility of cardiac ischaemia or Brugada syndrome.

The patient was then brought to the hospital for an exercise stress test using a standard Bruce protocol, which did not demonstrate any symptoms or electrical changes suggestive of cardiac ischaemia at target heart rate. A procainamide infusion of 10 mg/kg infusion over 30 min was performed, which did not show any ST-segment changes or arrhythmias during drug administration to suggest Brugada syndrome. However, in the post-infusion monitoring period he developed chest pain with ST-segment elevation (*Figure 2*). Urgent coronary angiography demonstrated diffuse, non-flow-limiting coronary artery disease in the right coronary artery (Supplementary material online, *Videos*). The most likely diagnosis was coronary artery vasospasm. The patient was treated with oral calcium channel blockade (diltiazem extended-release 240 mg daily), enteric-coated aspirin 81 mg daily, and the cessation of metoprolol. After extensive discussion among multiple care providers and the patient, his dual-chamber pacemaker was upgraded to an ICD. This decision was based upon his high-risk presentation with recurrent polymorphic ventricular tachycardia as well as his risk of sudden cardiac death if vasospasm was not adequately controlled with medical therapy. He had no recurrence of chest discomfort, ischaemic electrocardiogram changes, or arrhythmias in subsequent follow-up of 6 months. In addition, he underwent Holter monitoring 4 weeks after the initiation of calcium channel blockade, and no further arrhythmia was identified clinically or on his ICD.

Discussion

Multiple pathophysiologic mechanisms for VSA have been proposed, including vagal withdrawal, endothelial cell dysfunction with subsequent reduction in nitric oxide, and focal vessel wall hyperplasia[7]. The role of sodium channel inhibition in the induction of coronary spasm has been postulated. Goda *et al.*[5] documented VSA induced by the Class IC antiarrhythmic medication pilsicainide; the patient had developed chest pain while taking oral flecainide; chest pain and ST-segment elevation were noted and coronary spasm on right coronary angiography was documented during pilsicainide infusion. Chinusi *et al.*[6] reported a case of oral Class IC antiarrhythmic drug use triggering VSA in a patient with Brugada syndrome. The mechanism of sodium channel inhibition inducing vasospasm has not been elucidated, although it may be related to local action on the vascular endothelial wall in susceptible individuals. To our knowledge, there has been no previous report of procainamide precipitating VSA. The temporal association between procainamide infusion and vasospasm episode is suggestive of a causal relationship, although it is possible that these occurred together by chance. In keeping with contemporary practice recommendations[8], provocative testing was not performed since the patient had not failed medical therapy or experienced sudden cardiac arrest.

Calcium channel blockers remain the mainstay for treating VSA, with a documented reduction in angina episodes and major cardiovascular adverse events[9]. Nitrates are also frequently used as an adjunctive anti-anginal agent in VSA, although a recent large observational study found no incremental benefit to the combination of diltiazem and nitrate therapy over diltiazem monotherapy.[10] Long-term prognosis on chronic medical therapy is excellent, with a 5-year free survival free from major cardiovascular events and death of 91%

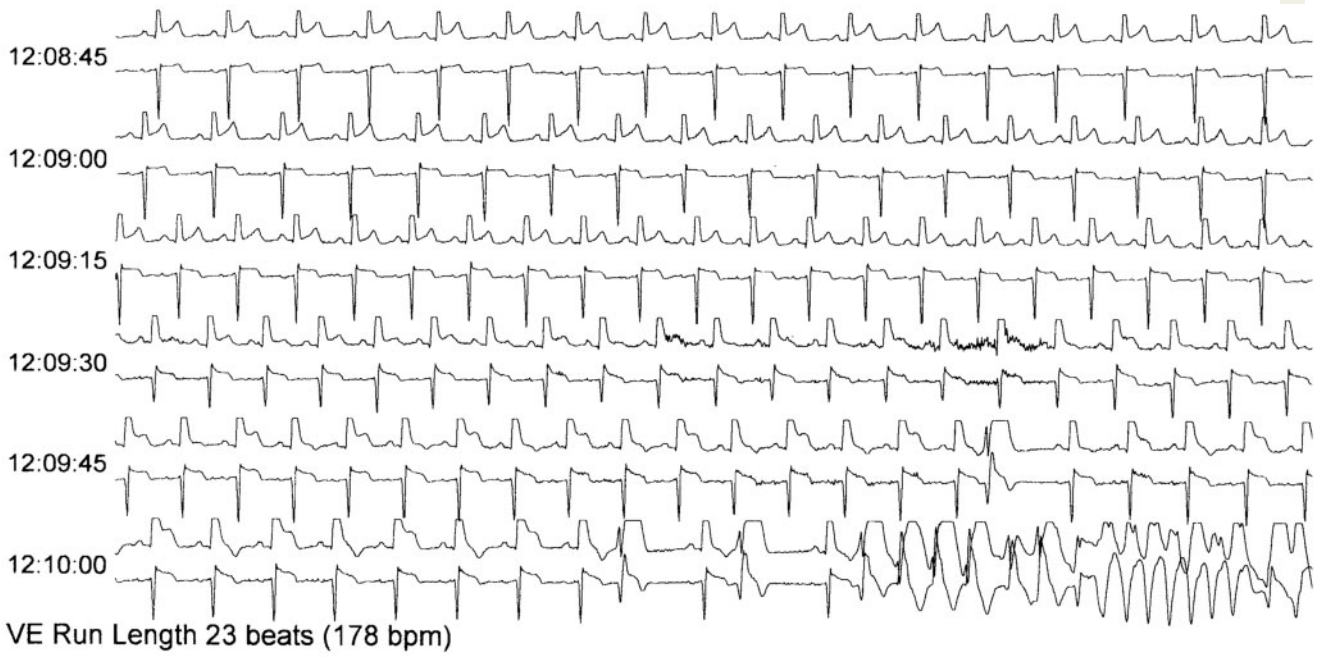

Figure 1 Holter monitor tracing demonstrating progressive ST-segment elevation with onset of polymorphic ventricular tachycardia.

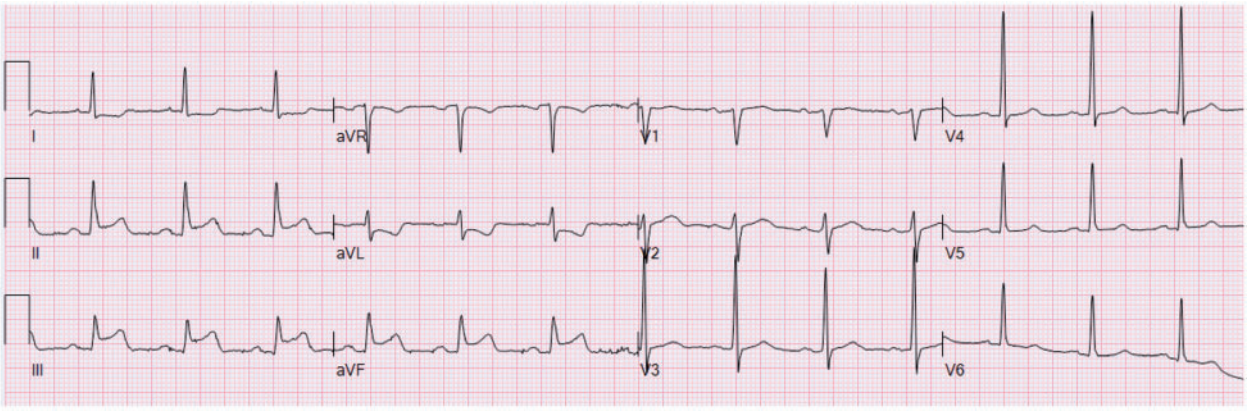

Figure 2 Electrocardiogram performed following procainamide drug infusion, demonstrating inferior ST-segment elevation with reciprocal changes in lateral leads.

and 98%, respectively. Medication adherence is felt to be critical to sustain clinical quiescence, which can be a challenge in younger populations, and adverse events have been linked to abrupt medication withdrawal.[11,12] Risk stratification is important to identify high-risk patients such that despite medical therapy silent or manifest anginal symptoms can still occur with a risk of malignant arrhythmia.[2] A risk prediction score has been developed by the Japanese Coronary Spasm Association[4] that includes: out of hospital cardiac arrest (4 points), smoking history, documented angina, significant coronary stenosis, or multi-vessel spasm (2 points each), ST-segment elevation or spasm while on beta blocker therapy (1 point each). Patients who score ≥6 are at the highest risk, with a predicted risk of major adverse cardiac events of 13%. It is important to recognize that this score was developed and validated in an East Asian population and to date its applicability to other ethnicities is not known. Patients with VSA who initially present as an acute coronary syndrome may also represent a group at higher risk for recurrent infarction.[13]

The arrhythmic risk of coronary vasospasm is variable, ranging from 2% to 17%; it is likely also heterogeneous based on baseline-risk profiles.[4,14] In patients with VSA who are deemed high risk, especially those who survived cardiac arrest, ICD use remains debatable. Contemporary guidelines on ICD therapy do not specifically address

recommendations for secondary prevention after life-threatening ventricular arrhythmias due to vasospasm, beyond advising against ICD implantation when a reversible cause is identified and treated.[15–17] Most patients with documented VSA and cardiac arrest are young, and there are significant implications to an implantable device that commits them to multiple procedures for lead and generator revisions over a lifetime. It has been noted that most adverse events tend to recur within the first 3 months, which has led to a proposed 'hot phase' where spasm events tend to cluster into episodes within several weeks, punctuated by long asymptomatic periods.[18–20] This disease course may be an appealing indication for a wearable external defibrillator, albeit access to this technology remains limited in many countries. If an implantable defibrillator is deemed appropriate based on clinical circumstances, a subcutaneous ICD may be preferred for a young patient who is not anticipated to require pacing therapies. As subcutaneous ICDs are completely extravascular, they avoid transvenous lead complications inherent to traditional ICDs.[21]

Long-term data are limited on outcomes following the implantation of a defibrillator in VSA patients who survived cardiac arrest. Meisel *et al.*[22] reported arrhythmia recurrence in eight patients refractory to medical therapy who survived the index arrhythmic event and subsequently had an ICD implanted. Median time to recurrence was 15 months. Matsue *et al.*[11] also documented arrhythmia recurrence in 5 of 23 patients followed for almost 3 years with a time to event of approximately 1 year, although with a broad range (50–600 days). These reports highlight the difficulty in predicting risk of recurrent arrhythmia in patients with VSA and further underscore the high recurrence rate of potentially lethal arrhythmias in a high-risk population. The decision to implant an ICD in patients who have experienced a significant ventricular arrhythmia should be individualized, incorporating known risk factors for future adverse events and patient preferences.

Supplementary material

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

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Consent: The author/s confirm that written consent for submission and publication of this case report including image(s) and associated text has been obtained from the patient in line with COPE guidance.

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