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Bidirectional ventricular tachycardia induced by caffeine poisoning

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ABSTRACT

Bidirectional ventricular tachycardia (BVT) is a tachyarrhythmia characterized by 180-degree beat-to-beat alteration in the QRS axis. BVT is traditionally known as an electrocardiography (ECG) finding pathognomonic of digitalis poisoning and a hallmark of catecholamine-induced ventricular tachycardia. Apart from digitalis poisoning, aconitine poisoning is the only reported cause of poisoning-related BVT, and no report of caffeine-poisoning-related BVT is as yet available. A-27-year-old woman was transported to hospital with cardiac arrest from ventricular fibrillation after taking a massive dose of a caffeine-containing supplement (corresponding to 6 g of caffeine) 6 h before presentation. Return of spontaneous circulation (ROSC) was achieved by defibrillation. She developed BVT after ROSC. Hemodialysis was performed to remove the causative drug from the blood, with subsequent resolution of BVT and hemodynamic stabilization. At presentation, she had a blood caffeine concentration of 232 μg/mL. A suggested mechanism of development of BVT is that increased intracellular calcium concentration causes delayed afterdepolarization, which induces alternate occurrence of triggered activities within different His-Purkinje fibers, and thereby produces characteristic ECG findings. Caffeine acts on the ryanodine receptor to promote calcium release from the sarcoplasmic reticulum, and thus can induce BVT via the same mechanism. Caffeine poisoning can be treated by dialysis. In cases of BVT induced by caffeine poisoning, hemodynamic stabilization can be achieved by emergency dialysis.

1. Introduction

Caffeine poisoning is a known cause of fatal arrhythmias, including ventricular fibrillation (VF). Nevertheless, caffeine is easily available in over-the-counter (OTC) products and dietary supplements.

Bidirectional ventricular tachycardia (BVT) is a tachyarrhythmia characterized by a 180-degree beat-to-beat QRS axis alteration, a traditionally recognized electrocardiography (ECG) finding pathognomonic of digitalis poisoning [1]. Reported causes of BVT include catecholaminergic polymorphic ventricular tachycardia (CPVT), Anderson–Tawil syndrome, fulminant myocarditis, myocardial infarction, and familial hypokalemic periodic quadriplegia [2-5]. Aconitine poisoning is the only reported cause of poisoning-related BVT [6,7], and there has been no report of caffeine-poisoning-related BVT.

We describe a case of BVT as a manifestation of caffeine poisoning in a patient who survived cardiac arrest.

2. Case presentation

A 27-year-old woman was transported to our hospital after surviving cardiopulmonary arrest due to VF. She had a history of depression and was prescribed Vegetamin® (chlorpromazine + promethazine + phenobarbital), imipramine, and nitrazepam as regular oral medications. She had no history of heart disease or arrhythmia.

She told her mother that she ingested caffeine tablets and she felt nauseous and had vomited. 6 h elapsed, then she fainted and seized, and then emergency medical services (EMS) were called. ECG at EMS contact showed VF (Fig. 1). Return of spontaneous circulation was achieved by resuscitation with sternal compression and automated external defibrillation; the patient was transported to our hospital. Her family reported a caffeine overdose.

At presentation, Glasgow Coma Scale score was 3 (E1, V1, M1), blood pressure 113/49 mm Hg, heart rate 151 bpm (irregular), respiratory rate 18 breaths/min, and SpO_2 100% (FiO_2 1.0). Pupils were 5 mm in diameter, round, and reactive to light. Tracheal intubation was performed for post-resuscitation systemic management. Her initial ECG showed narrow QRS tachycardia and ventricular extrasystoles and BVT (Fig. 2).

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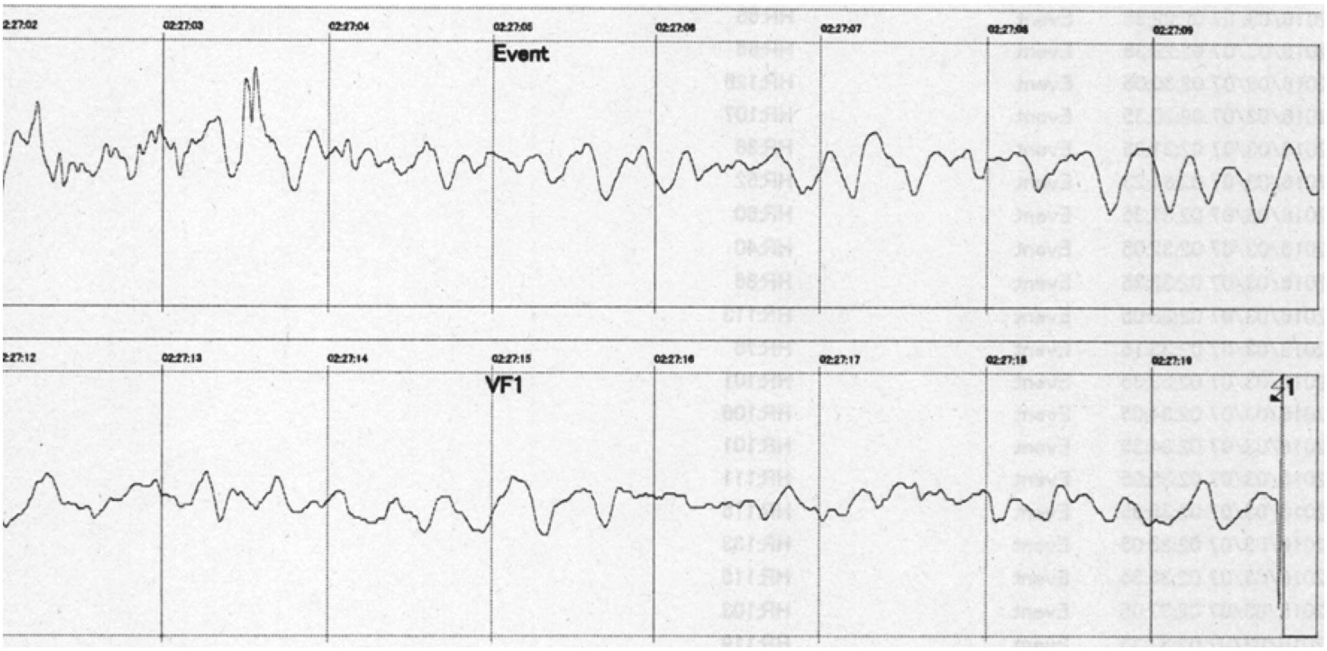

Fig. 1. Electrocardiogram at the time of emergency medical service contact, showing ventricular fibrillation.

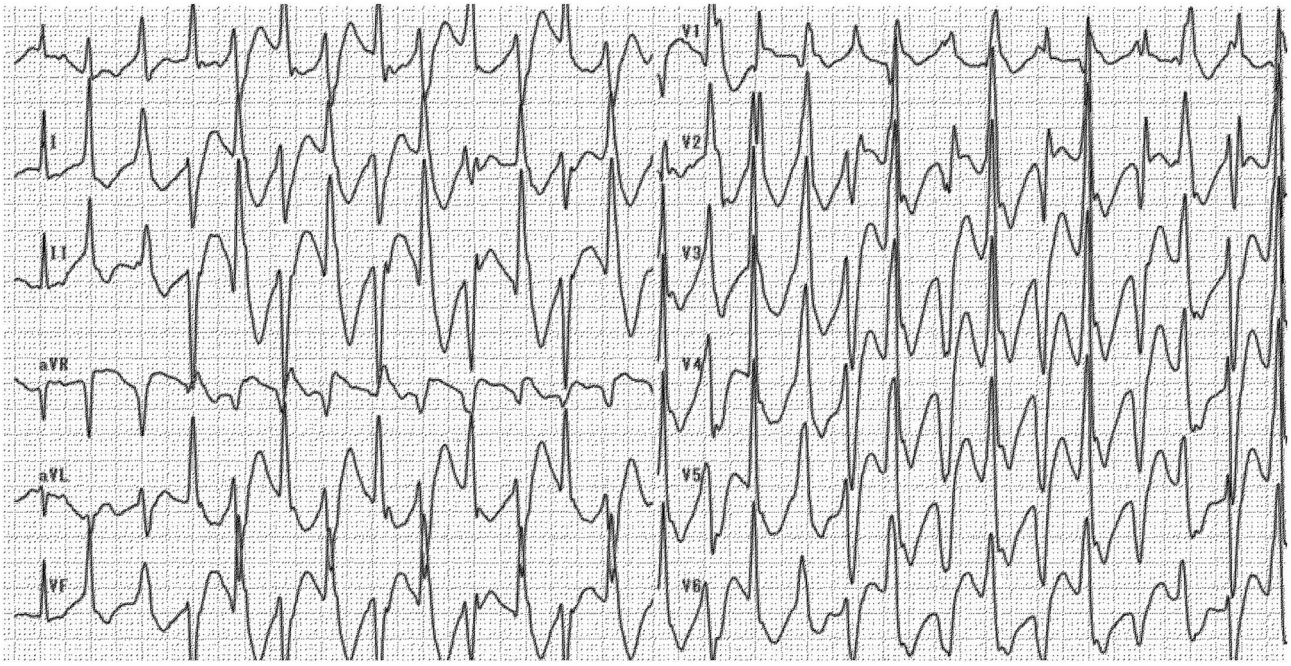

Fig. 2. Bidirectional ventricular tachycardia.

Blood analysis revealed hypokalemia (2.1 mEq/L) and marked lactic acidemia (Lactate level was 19 mmol/L). Qualitative troponin test was negative. Echocardiography showed no organic cardiac abnormality; coronary angiography revealed no coronary artery disease. To treat the continuous BVT, we administered 1 mg of IV propranolol and activated charcoal soon after arriving at our hospital. As this did not control the arrhythmia, hemodialysis was performed. Within 30 min of initiation of dialysis, BVT resolved and she was hemodynamically stable during the entire dialysis run. On hospital day 2, she regained consciousness and was extubated. She then admitted to ingesting an overdose of a caffeine-containing supplement (Estalon Moca® which is contained caffeine and trace Vitamins, corresponding to 6 g caffeine), purchased online, in a suicide attempt.

At presentation, blood caffeine concentration was 232 μg/mL, far above the lethal concentration [8]. "By GC/MS analysis, blood concentrations of her regular medications which may affect the cardiovascular system (Vegetamin®, imipramine) were under

detecting sensitivity, so we determined their levels were low enough to have negligible cardiovascular effect.

Therefore, we concluded that the cardiac arrest and BVT observed in the present patient were induced by caffeine poisoning.

3. Discussion

Caffeine is a xanthine derivative structurally similar to theophylline. The estimated toxic dose is 1–3 g and lethal dose is ≥5 g. It is an easily available OTC product; our patient ingested 6 g. The molecular weight is 194, distribution volume 0.6, and protein binding rate 36%, and caffeine poisoning can be effectively treated with hemodialysis [8-10]. "According to a report, the average blood concentration of caffeine is around 1.96–5.95 μg/mL (Cmax) after ingesting two cups of standard coffee (caffeine content of around 160 mg) [11].

Cardiotoxicity is the most fatal toxic effect. Extrasystoles are the most commonly observed caffeine-related arrhythmia, including supraventricular and ventricular arrhythmias, multifocal extrasystoles, and VF. No characteristic ECG findings of caffeine-related arrhythmias have been reported and no report of caffeine poisoning-related BVT is available.

BVT is a hallmark of CPVT, a hereditary arrhythmic disease that causes fatal arrhythmias, including VF, from exercise-induced catecholamine stimulation or other triggers, and is a known cause of sudden death in children. CPVT results from mutations of the ryanodine receptor (RyR2) gene expressed in cardiac muscle; increased calcium release from mutant RyR2 receptors with increased intracellular calcium causes arrhythmia. BVT is thought to develop from increased intracellular calcium leading to delayed afterdepolarization, which induces distinctive arrhythmias characterized by alternate occurrence of electrical activities within different His-Purkinje fibers with resulting alternate changes in the electrical axis [12].

Caffeine acts as an RyR2 receptor agonist, promoting calcium release from the sarcoplasmic reticulum, thereby increasing intracellular calcium concentration [13]. Caffeine stimulates the beta-1 and beta-2 adrenergic receptors to promote catecholamine release which triggers arrhythmia in CPVT patients. Thus, caffeine could likely induce BVT.

In the present case, drug involvement was suspected because of BVT. We then learned that the patient had ingested caffeine, so we performed emergency hemodialysis. BVT subsequently resolved with hemodynamic stabilization. Thus, the BVT observed in our patient may have been induced by elevated caffeine concentration.

VF is a well-known complication of caffeine poisoning. Because BVT is likely to progress to VF, the BVT in our patient was possibly a precursor state of VF.

Common treatments for BVT include carvedilol, verapamil, and flecainide [14]. In poisoning-related BVT, priority should be given to treatment of poisoning. Caffeine can be readily removed from blood by hemodialysis. Awareness of BVT resulting from caffeine poisoning will facilitate early introduction of hemodialysis as a treatment option.

4. Conclusion

Caffeine poisoning can cause BVT. Thus, physicians should consider caffeine poisoning as a differential diagnosis of BVT.

Conflicts of interest

None.

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