

Sudden Cardiac Death and Short QT Syndrome

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Introduction

The evaluation of patients recovered from sudden death (SD) is based on diagnostic investigation aiming to identify structural heart diseases or exclusion of noncardiac diseases and metabolic disorders. After exclusion of these pathologies, one is faced with sudden cardiac death (SCD) without structural heart disease, in which electrical and latent heart diseases account for up to 56% of cases, while the remaining is considered idiopathic disease¹. This latter group has been gradually reduced due to the increasing characterization of molecular mechanisms that generate potentially lethal arrhythmias. We report the case of a young patient recovered from SCD, with no apparent structural heart disease, probably due to electrical heart disease associated with occult anomalous bundle and both diagnoses being possible according to the available means in clinical practice.

Case Report

Male patient, Caucasian, 23 years old, single, printing technician, referred with a three-month history of intense palpitations and loss of consciousness during a soccer match. According to the reports of witnesses, the patient was taken to the nearest Basic Health Unit (BHU), a five-minute trajectory, as he was unconscious and unresponsive to stimuli and cardiopulmonary arrest (CPA) in asystole was verified by the physician present at the BHU. Cardiopulmonary resuscitation was initiated, with total CPR time of 25 minutes. The patient was then taken to the local ICU, where he was treated with induced hypothermia (32-34°C) for 24 h. There was complete neurological recovery and he was discharged in five days.

The patient reported having palpitations triggered by great exertion lasting 30-40 minutes, with no associated symptoms, which improved with rest since the age of 14 years. He reported two episodes of loss of consciousness: at 18, while swimming, he had palpitations, no other associated symptoms; right after leaving the pool, he lost

consciousness, with rapid recovery and no mental confusion or sphincter release; at 19, while playing soccer, he had an episode of syncope with the same characteristics.

He had no other known diseases or history of SD in the family. He denied alcoholism, smoking, use of illicit drugs or medications. On physical examination, no abnormalities were observed, especially in the cardiovascular system. He was admitted for investigation and the following test results were obtained:

- **Electrocardiogram (ECG):** Sinus rhythm, 55 bpm, PR interval: 130 ms, QRS: 60 ms, QTc: 349 ms (maximum slope method and Framingham formula), J-point to T-wave-peak interval: 220 ms (Figure 1).

- **Stress test:** Treadmill Ramp Protocol (4.5km/h to 9 km/h/ 6% to 16%); 15.7 MET. Maximum HR: 200 bpm. No arrhythmias. Pre-stress HR and QTc intervals, peak and recovery, respectively: 94 bpm, 431 ms, 200 bpm, 422 ms, 130 bpm, 404 ms.

- **Holter:** Sinus rhythm. Mean HR: 79 bpm, minimum, 53 bpm (sleep) and maximum of 179 bpm (watching a game). Normal RR range. Two isolated ventricular extrasystoles. Rare atrial extrasystoles.

- **Echocardiogram:** Cardiac chambers of normal dimensions; ejection fraction of 77%, preserved segmental motility.

- **Cardiac MRI:** Ejection fraction: 67% (left ventricle) and 60% (right ventricle). Morphologically normal heart. Absence of regional alterations in contractility. No areas of delayed myocardial enhancement after paramagnetic contrast.

- **Cardiac catheterization:** Coronary arteries with normal origin and trajectory and free of obstructive lesions.

- **Electrophysiological study:** normal AH and HV intervals (AH = 70 ms; HV = 38 ms)

Atrial stimulation: ventricular activation through AV node; Normal Wenckebach point (350 ms). Atrioventricular induction by orthodromic reentrant tachycardia (AVT) with retrograde atrial activation starting earlier in the distal coronary sinus electrogram (accessory pathway with exclusively retrograde conduction in the lateral portion of the mitral annulus) (Figure 1).

Ventricular stimulation: eccentric retrograde atrial activation, starting earlier in the distal coronary sinus electrogram (Figure 1).

Radiofrequency ablation performed via accessory pathway. QTc interval measurements (Bazett's formula): 338 msec (pre-ablation), 388 ms (post-ablation) and 342 ms after isoproterenol (3 mcg/kg/min).

Keywords

Death, sudden; short QT syndrome; concealed accessory atrioventricular pathway.

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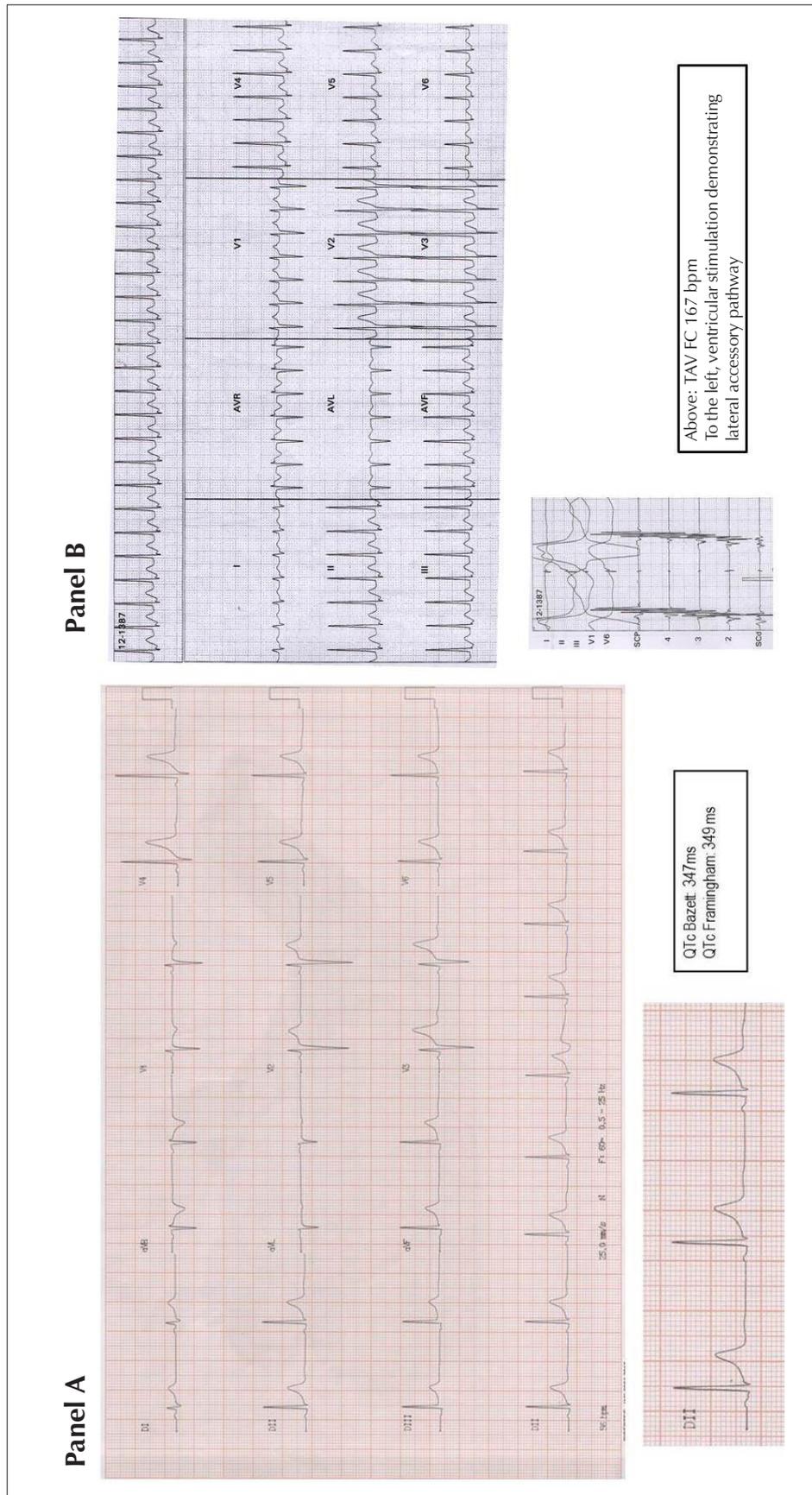


Figure 1 – Panel A: Electrocardiogram obtained on admission. Sinus rhythm (SR), bradycardia with 55 bpm, PR interval = 130 ms, QRS = 60 ms and QTc = 349 ms. inferior early repolarization. Below, detail of elongated DII and QTc intervals calculated by the formulas of Bazett and Framingham. Panel B: Electrocardiogram obtained during electrophysiological study. Atrioventricular reentry tachycardia with HR = 167 bpm. Below: Ventricular stimulation showing left lateral accessory pathway. PCS: proximal coronary sinus. DCS: distal coronary sinus.

Case Report

Programmed ventricular stimulation (after ablation of the accessory pathway): right ventricular stimulation (apex) protocols with basic cycles of 600, 500 and 430 ms and up to 3 extra-stimuli (minimal coupling interval: 200 ms) with no induction of ventricular tachyarrhythmia. Ventricular refractory period < 200 ms.

A Cardioverter Defibrillator (ICD) was implanted, considering a documented episode of SCD in a patient with short QTc. To date (nine months of follow-up), the patient has shown no new events.

Discussion

Sudden cardiac death in patients without structural heart disease constitutes a big challenge in clinical practice. In recent decades, new knowledge has been added to this subject, allowing the identification of the underlying cause in many cases. It is essential to recognize the situations and characteristics that predispose to SCD and once overt structural cardiovascular diseases are excluded, electrical heart disease and latent structural causes should be investigated. It is estimated that up to 10% of survivors of SCD have electrical heart disease².

The present case report has, according to standard criteria, high probability of falling into the diagnosis of short QT syndrome (SQTS). This entity was characterized in 2000³ as an autosomal dominant hereditary disorder of electrical channels, which typically displays abnormally short QT-intervals and propensity to develop potentially lethal ventricular arrhythmias⁴. Five genes encoding the normal or abnormal functioning of potassium ion channels (KCNH2, KCNQ1, KCNJ2) and calcium (CACNA1C, CACNB2b) involved in the generation of the action potential have been described to date⁵.

The ECG is the main diagnostic tool; however, the appropriate QTc cutoff is controversial. The prevalence of short QTc pattern in the general population has been evaluated in several studies and there is an intersection between the values found in the general population and in patients with SQTS⁶. Thus, diagnostic criteria have been suggested in order to increase the accuracy of disease recognition⁷, considering ECG, medical history, family history and genotype (Table 1). The patient described in this case report scored 4 points, indicating high probability according to the points related to QTc (< 350 ms) and SCD. In 33% of cases, the initial presentation is the SCD and 80% of patients have a personal or family history of SCD⁸.

Holter monitoring is useful in the prognostic evaluation, due to the documentation of ventricular tachycardia and atrial fibrillation (AF). The role of the EPS in risk stratification still requires further investigation and short refractory periods during programmed stimulation indicate the vulnerability in presenting polymorphic VT/ spontaneous VF. In the follow-up of SQTS patients, polymorphic VT/VF were induced in only 60%⁹.

The treatment mainstay is the ICD, based on a high percentage of cases showing SCD, even if empirically. In the longitudinal follow-up study of 53 patients, Giustetto et al. found an annual recurrence rate of 4.9% of arrhythmic events.

Table 1 – Diagnostic criteria proposed by Giustetto et al. (ref. 7)

Criteria	Points
QTC	
< 370	1
< 350	2
< 330	3
Point J- T-wave peak Interval < 120 ms	1
Clinical History	
History of cardiac sudden death	2
Documented polymorphic VT or VF	2
Unexplained Syncope	1
Atrial fibrillation	1
Family History	
First or second-degree relative with high probability of SQTS	2
First or second-degree relative with negative autopsy for SCD	1
Sudden infant death syndrome (SIDS)	1
Genotype	
Positive genotype	2
Culprit gene mutation of undetermined significance	1

≥ 4 points: high probability; 3 points: intermediate probability; ≤ 2 points: low probability. A minimum of 1 point must be obtained in the ECG criterion. Clinical history: points only for 1 of the 3 first characteristics. Family history: points can only be obtained once in this section.

Furthermore, administration of hydroquinidine showed to be effective to increase the QTc interval and prevent VF. It is also worth mentioning that the presence of early repolarization in patients with SQTS is more prevalent in the general population and shows higher risk of arrhythmic events¹⁰.

The diagnosis of an associated left lateral occult accessory pathway has never been described previously in association with SQTS and there is no description in the literature of SCD by AVT mediated by an accessory pathway of retrograde conduction only, due to the consequent impossibility of producing pre-excited AF. It is noteworthy that patients with SQTS have a high incidence of AF, not detected in this patient. However, it should be considered that in this particular case, the accessory pathway-mediated tachycardia in adrenergic situation may have contributed to the occurrence of SCD.

The increase in HR can promote reduction in ventricular refractory period, enabling the emergence of potentially lethal arrhythmia. The shortening of QT interval by adrenergic stimulation, altering the autonomic balance, has also been described in the literature, in this case probably due to release of catecholamines during exertion. Another possibility is that the accessory pathway is just a physiopathological detail, coincident, but not contributing to the SCD. Moreover, the patient remained asymptomatic after ablation, a fact that sets the AVT as the most likely mechanism responsible for the palpitations.

Thus, the case reported here is unique considering the likely association of SQTs with early repolarization pattern and left lateral occult accessory pathway. It should also be noted that the appropriate assessment of ventricular repolarization is of utmost importance for the diagnosis of abnormal repolarization syndromes.

Author contributions

Conception and design of the research: Cury-Pavão MLR, Schmidt A; Acquisition of data: Cury-Pavão MLR, Ono VC, Arfelli E; Writing of the manuscript: Cury-Pavão MLR; Analysis and interpretation of the data: Arfelli E, Schmidt A; Critical revision of the manuscript for intellectual content: Simões MV, Marin-Neto JA, Schmidt A.

Potential Conflict of Interest

No potential conflict of interest relevant to this article was reported.

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Study Association

This study is not associated with any thesis or dissertation work.

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