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CASE REPORT

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Syncope with QT-interval prolongation and T-wave inversion in anterior and inferior leads: Foreboder of a life-threatening condition?

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Abstract

Even though patients with pulmonary embolism usually present with respiratory distress and tachycardia, the patient presented with syncope only. Typical ECG changes associated with PE include right axis deviation, right bundle-branch block, S1Q3T3 pattern, arrhythmia, nonspecific ST-segment changes, QR pattern in lead V1, Brugada ECG pattern, and T-wave inversions in the precordial leads. However, his electrocardiogram showed QT-interval prolongation and simultaneous T-wave inversions in the inferior and anterior leads. This ECG pattern is crucial for diagnosing PE. The patient underwent computed tomography-pulmonary angiography, which revealed pulmonary embolism. At the same time, these ECG changes should be differentiated from those of long QT syndrome, myocardial ischemia, Takotsubo cardiomyopathy, post-pacing T-wave memory, hypertrophic cardiomyopathy, and subarachnoid hemorrhage.

KEYWORDS
pulmonary embolism, QT-interval prolongation, T-wave inversions

1 | CASE

A 60-year-old patient with syncope for 1 day presented to the emergency department of the First Affiliated Hospital of USTC. He had a history of hypertension for 6 months, which was well-controlled on medication. There was no family history of sudden cardiac death. Physical examination revealed a heart rate of 62 beats/min and a blood pressure of 117/74 mmHg. All vital signs were within the normal limits. An electrocardiogram (ECG) on admission is shown in Figure 1. Laboratory results (hemogram, renal and hepatic function tests, and troponin I, antineutrophil cytoplasmic antibody, antiphospholipid antibody, serum sodium, potassium, magnesium, and calcium levels) were all within normal limits. However, D-dimer levels were significantly elevated to 5.07 mg/L (reference value, <0.5 mg/L).

There were no signs of peripheral edema or neurological dysfunction. Echocardiography revealed right ventricular enlargement (44 mm) with mild pulmonary hypertension (systolic pulmonary artery pressure, 46 mmHg). Venous Doppler ultrasonography was negative for deep venous thrombosis. His peripheral oxygen saturation fluctuated between 95 and 96% on room air. The patient underwent computed tomography-pulmonary angiography, which revealed pulmonary embolism (PE) (Figure 2). He was anticoagulated with low-molecular-weight heparin and warfarin for 7 days. Repeat ECG showed that the QT interval had shortened to 432 ms (Figure 3). The patient recovered favorably, and was discharged from the hospital.

Several typical ECG changes are associated with PE, including P pulmonale, right axis deviation, S1S2S3 pattern, low voltage, clockwise rotation, right bundle-branch block, S1Q3T3 pattern, arrhythmia, nonspecific ST-segment changes, QR pattern in lead V1,

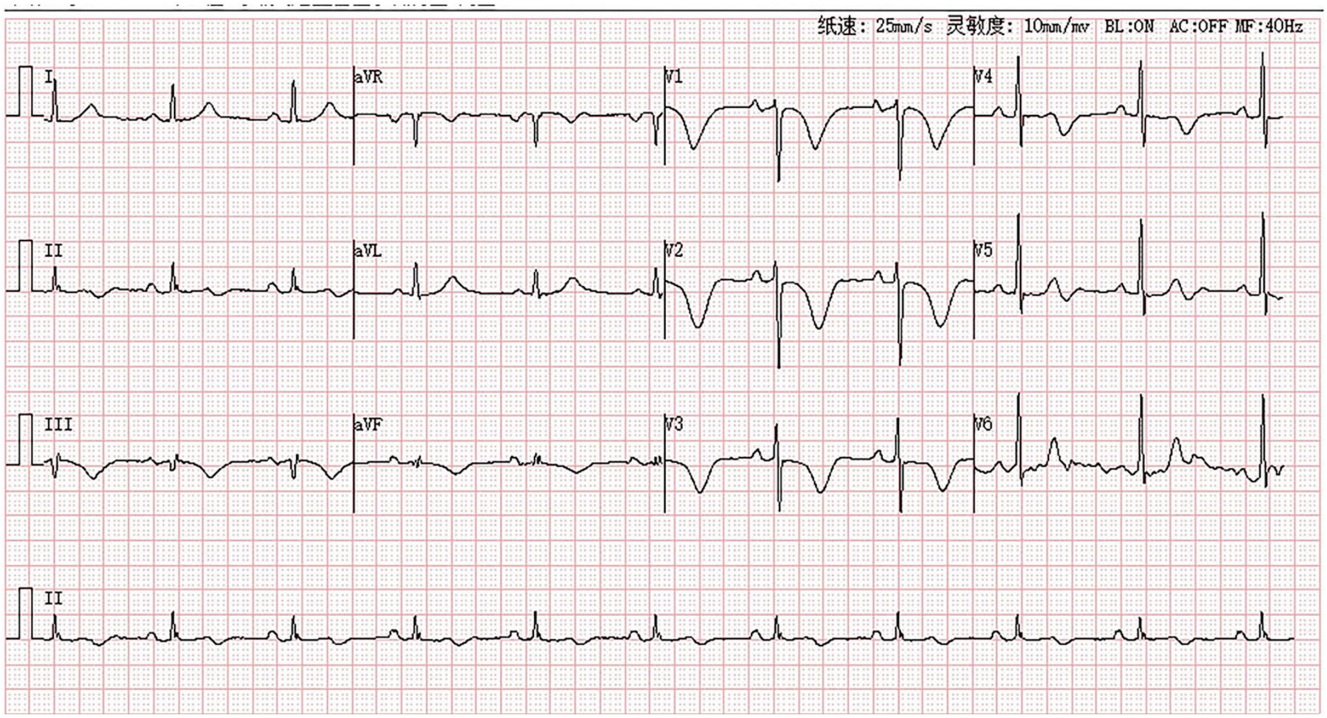

FIGURE 1 Findings of electrocardiogram (ECG) performed at admission. Initial ECG revealed sinus rhythm, S1Q3T3 pattern, QT-interval prolongation to 508 ms, heart rate-corrected QT-interval prolongation to 516 ms, and T-wave inversion in leads II, III, aVF, and V1–V4

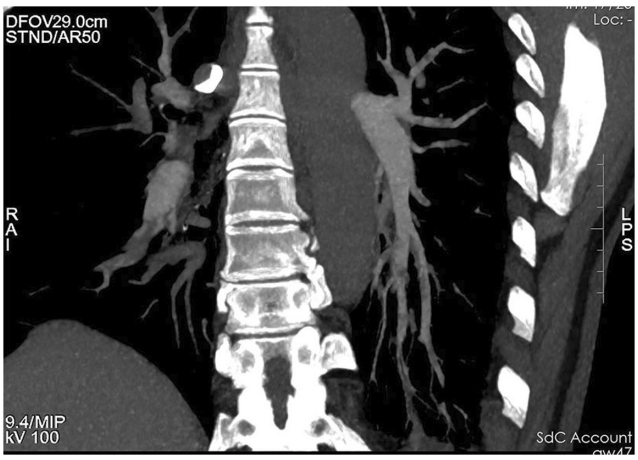

FIGURE 2 Computed tomography-pulmonary angiography: Pulmonary embolism

Brugada ECG pattern, and T-wave inversions in the precordial leads. (Ullman et al., 2001; Zhai & He, 2021) In addition, global T-wave inversion with QT-interval prolongation associated with acute PE has been described in an isolated case report. (Lui, 1993) Similarly, Zhao et al. reported QT-interval prolongation and T-wave inversion in a patient with PE. (Zhao et al., 2015) In the present case, this patient's ECG exhibited QT-interval prolongation with T-wave inversion in anterior and inferior leads that, together with computed tomography-pulmonary angiography findings, strongly suggested PE. T-wave inversion in the right precordial leads should prompt consideration of right ventricular overload. T-wave inversion and QT prolongation might be catecholamine-mediated or due to histamine-induced myocardial ischemia. (Lui, 1993) However, many clinicians maybe unaware of this ECG pattern caused by PE. It is essential to consider PE if QT prolongation and T-wave inversion in the anterior and inferior leads are observed. Yamagami et al. did a follow-up ECGs in a patient with pulmonary embolism. In the follow-up ECGs, the QT-interval prolongation gradually resolved in 3 days, and the inverted T waves in leads V1-V4 remained for several weeks.5 However, the electrophysiological mechanisms of these findings in patients with acute pulmonary embolism are unclear and warrant further studies. (Yamagami et al., 2014; Punukollu et al., 2004)

Causes of QT-interval prolongation and T-wave inversion on ECG should be carefully investigated. Sudden syncope and QT prolongation on ECG is also associated with long QT syndrome (LQTS), and patients maybe misdiagnosed with LQTS if pertinent investigations are not performed. LQTS is an inherited primary arrhythmia syndrome that may present with malignant arrhythmia, torsade de pointes, syncope, and sudden death. Furthermore, the causes of QT prolongation include electrolyte disturbances, PE, and usage of class I and class III antiarrhythmic drugs, macrolide antibiotics, arsenic trioxide, antimalarial drugs, antipsychotic drugs, pentamidine, and methadone. On the basis of the patient's family and past medical history, and normal serum electrolyte levels, these causes of QT prolongation were ruled out.

Negative T waves often occur in patients with acute coronary syndrome (e.g., Wellens' syndrome) but are also found in PE, Takotsubo cardiomyopathy (TCM), hypertrophic cardiomyopathy (HCM), and subarachnoid hemorrhage and after pacemaker

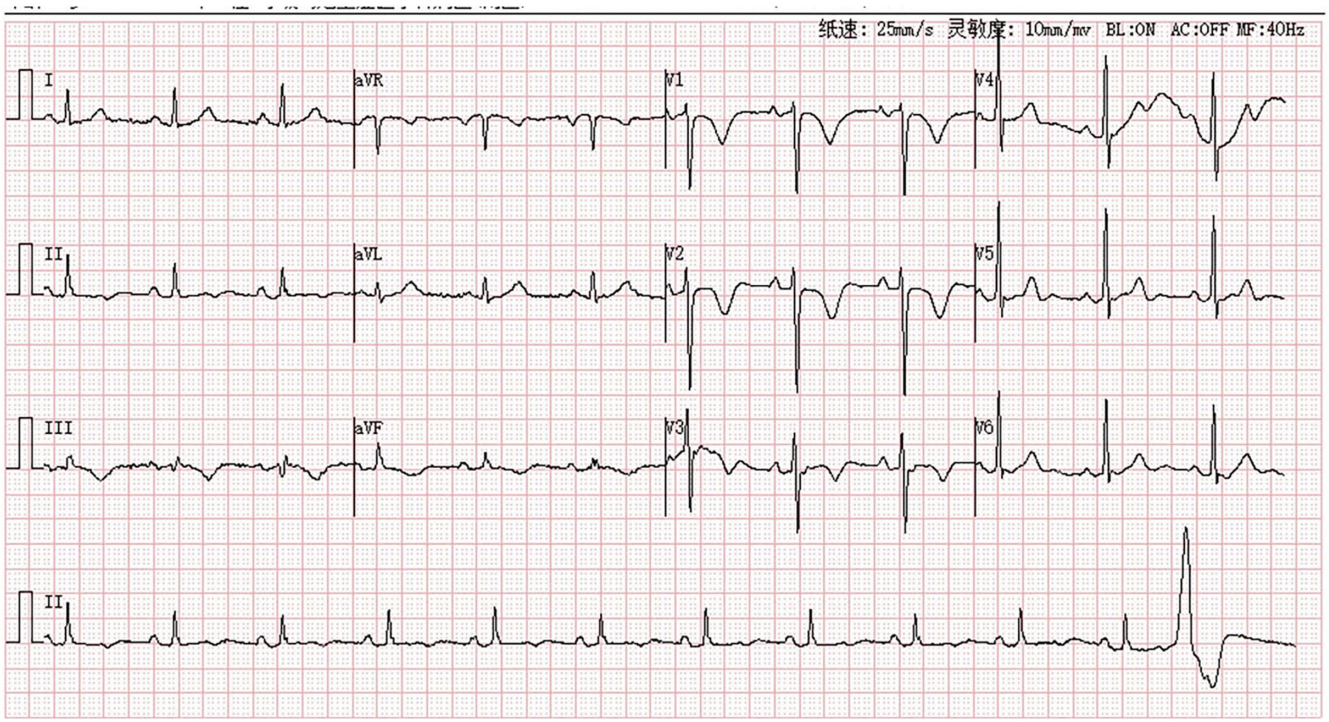

FIGURE 3 Findings of electrocardiogram (ECG) performed at discharge ECG showed that the QT interval had shortened to 432 ms

implantation (post-pacing inverted T-waves or cardiac memory). Establishing the definitive diagnosis is essential for selecting an appropriate treatment strategy for improving outcomes. Wellens' syndrome is a pattern of inverted T waves in leads I, aVL, and V2–V5 on ECG due to critical stenosis of the proximal left anterior descending coronary artery.(Zhao et al., 2017) However, negative T waves in both leads III and V1 can help diagnose PE with 97% specificity and 90% sensitivity. These characteristics of T-wave inversions can help differentiate ischemia from PE.

Distinguishing between PE and TCM as the cause of T-wave inversions can be challenging. ECG manifestations of TCM can be separated into four stages: (1) ST-segment elevation after the onset of symptom, (2) initial T-wave inversions after resolution of ST-segment elevation, (3) transient improvement in T-wave inversions, and (4) deeper T-wave inversions that might last for months. (Kosuge & Kimura, 2014) In TCM, T-wave inversions commonly appear after the resolution of initial ST-segment elevation. Negative T waves on ECG persist for a long time during the entire course of TCM. Kosuge et al. pointed out that a positive T wave in lead aVR and no T-wave inversion in lead V1 helped identify TCM with 97% specificity and 95% sensitivity. (Kosuge et al., 2012) This ECG criteria can easily and accurately differentiate PE from TCM.

One of the differential diagnoses in the present patient was hypertrophic cardiomyopathy (HCM). HCM is diagnosed if left ventricular wall thickness on echocardiography is 15 mm or greater. T-wave inversions in the lateral leads are associated with underlying HCM, (Lee et al., 2021) which were absent in our patient. Together with the physical examination and related auxiliary investigation findings, we ruled out subarachnoid hemorrhage and post-pacing T-wave memory as causes of inverted T-waves.

Finally, clinicians should keep in mind that syncope maybe the only symptom of PE and that PE maybe present even without cardiorespiratory symptoms, thromboembolic risk factors, desaturation on pulse oximetry, or peripheral edema. QT-interval prolongation and simultaneous T-wave inversions in the inferior and anterior leads are underrecognized but crucial clues for physicians for diagnosing PE.

AUTHOR CONTRIBUTION

Jing Wang and Xue-Qi Li contributed significantly to data collection and manuscript preparation. Jing-Xiu Li and Min Gao performed the analysis with discussion. All authors agree on the order in which their names will be listed in the manuscript.

CONFLICT OF INTEREST

Founders did not play any role in this study design, data collection, analysis, the decision to publish, or preparation of the manuscript.

DATA AVAILABILITY STATEMENT

Data sharing does not apply to this article as no datasets were generated or analyzed during the current study.

ETHICAL APPROVAL

We identify that the ethics committee of Dancheng County Central Hospital has approved the case and that this case conforms to recognized standards, the Declaration of Helsinki.

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