Usefulness of electrocardiographic and radiographic changes in the diagnosis of acute pulmonary embolism

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Learning Point for Clinicians

The utility of electrocardiography (ECG) and chest radiography in the diagnosis of pulmonary embolism is often limited by their low sensitivity and specificity. However, the presence of multiple electrocardiographic signs of right ventricular (RV) overload and the Westermark sign (oligemia) in chest radiography suggests a high probability and severity of pulmonary embolism.

Case report

A 75-year-old woman with a history of hypertension experienced general malaise and weakness for 1 day. Rapidly progressive shortness of breath was noticed thereafter and an ambulance was called by her family. On the way to the hospital, a sudden loss of consciousness was noted, and cardiopulmonary resuscitation was performed by emergency medical technicians for cardiac arrest. At emergency department arrival, cardiopulmonary resuscitation was continued, and spontaneous circulation was gained 12 min after onset of cardiopulmonary arrest. Physically, neither respiratory wheezes nor cardiac murmurs were heard. The post-resuscitation blood pressure was 122/96 mmHg, heart rate 118/min, body temperature 36.8°C and Glasgow coma scale E1M1V1. Vasopressor and inotropic agents were administered for sustained hypotension after resuscitation. The arterial partial pressure of oxygen was 56 mmHg with 100% inspired oxygen. The white blood cell count was mildly increased (12 250 cells/µl) and the metabolic profile showed elevated levels of aspartate aminotransferase (169 U/l), alanine aminotransferase (180 U/l), blood glucose (422 mg/dl) and troponin-I (2.02 ng/ml).

The 12-lead ECG (Figure 1a) revealed sinus tachycardia (139 per min), a RV strain pattern (ST-T changes in V1–V4), complete right bundle branch block (RBBB) and an S1Q3T3 pattern (an S-wave in lead I, Q-wave in lead III and inverted T-wave in lead III). The chest radiography (Figure 1b) showed a focal oligemia at right middle lung field and the artificial teeth found in the larynx were removed immediately. The brain computed tomography (CT) did not show any intracranial insult. The contrast-enhanced chest CT (Figure 1c) showed filling defects within bilateral inferior pulmonary arteries, indicating acute pulmonary embolism. She received anticoagulant therapy with heparin. Due to intractable shock and arterial oxygen...
desaturation after resuscitation, she underwent emergent pulmonary artery surgical embolectomy and extracorporeal membrane oxygenation support was continued for 3 days. No deep vein thrombosis of the lower extremities was discovered by duplex ultrasound scan. The post-operative course was complicated with ventilator-associated pneumonia and acute kidney injury, and she was discharged 1 month later with mild neurological deficits.
Discussion

Massive pulmonary embolism which was characterized by hemodynamic instability carried a mortality rate, especially in patients requiring cardiopulmonary resuscitation. The early diagnosis, which depended on histories, physical findings and basic tests, including ECG and chest radiography, was crucial to initiate definitive therapy rapidly and improve the outcome. Although the cardinal symptoms of which were sudden onset dyspnea, chest pain and fainting were helpful in making a clinical diagnosis, the reported specificity was only 40%. Therefore, the characteristic electrocardiographic and radiographic findings were emphasized in the integral assessment of pulmonary embolism before a definitive diagnostic test.

Pulmonary embolism caused occlusion of pulmonary artery with acute RV pressure overload and about one half of patients had relevant ECG changes. The principal findings were an S1Q3T3 pattern, RBBB and T-wave inversion in V1–V4; and separately, the reported rates were only 10–20%. Previous studies had shown that single ECG abnormality suggesting RV overload had limited diagnostic value in patients with suspected pulmonary embolism. On the other hand, the presence of multiple ECG changes would give a high diagnostic accuracy which was implied by the positive relationship between ‘ECG score’ and the severity of pulmonary embolism.

The majority of patients with acute pulmonary embolism had abnormal results for chest radiography, and the most common abnormalities were cardiac enlargement, elevated hemidiaphragm and pleural effusion, which were not specific for pulmonary embolism. Theoretically, oligemia (the Westermark sign), a prominent central pulmonary artery (the Fleishner sign) and a well-defined pleural-based area of consolidation with a convex apex toward hilum (the Hampton hump sign) were specific radiographic changes for pulmonary embolism. Among these classic signs, previous studies demonstrated that the Westermark sign was a highly specific chest radiographic finding while the study results of other signs were inconsistent.

In this case, a prompt diagnosis of acute massive pulmonary embolism was made by a compatible history in combination with multiple ECG signs of RV overload and the Westermark sign in chest radiography. In spite of the low prevalence of a typical presentation, clinicians should be familiar with these findings to reduce time to diagnosis and improve outcome in patients with pulmonary embolism.

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References


