CASE REPORT

ECG phasic voltage changes associated with spontaneous pneumothorax in a patient with vanishing lung syndrome

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SUMMARY

Alternating or phasic ECG voltage changes are most commonly associated with intrinsic myocardial electrophysiological perturbations or mechanical oscillation within a pericardial effusion. Rare descriptions of electrical alternation have been reported with pneumothorax. We present a case of a 53-year-old woman with vanishing lung syndrome who presented with spontaneous left pneumothorax and phasic ECG voltage changes that resolved after re-expansion of the lung.

BACKGROUND

Chest pain and shortness of breath are common clinical symptoms, and the differential diagnosis spans multiple organ systems that require a thorough evaluation to rule out life-threatening aetiologies. ECG, imaging and serological studies are often obtained to distinguish between these diagnoses. Pneumothorax has been sporadically reported in the literature with associated ECG changes including axis deviation, right bundle branch block, T wave inversion, ST segment elevations and electrical alternans.[1–7] We present a case of a spontaneous pneumothorax with phasic voltage alterations. For patients with acute chest symptoms, clinicians must entertain the possibility of a primary pulmonary condition even in the setting of acute ECG abnormalities.

CASE PRESENTATION

A 53-year-old woman with a medical history of hypertension presented with sudden onset of mid-sternal chest pain and shortness of breath. The patient described the pain as intermittent, sharp, pleuritic, worse with exertion, and she denied radiation elsewhere. She denied any nausea, vomiting, abdominal pain, cough, diaphoresis or fever. There was no history of chest trauma. The patient had no history of lung disease, but she smoked 1/3 pack per day cigarettes for 20 years.

Vital signs were significant for a heart rate of 126 bpm, blood pressure 168/108 mm Hg, respiratory rate of 24 breaths/min, temperature 36.6°C and an oxygen saturation of 90–92% on room air. The patient was observed to be in mild distress. Head, eyes, nose, throat and neck examinations were unremarkable. Trachea was midline and there was no stridor. Breath sounds were quiet but clear bilaterally with good air entry. No wheezing or rales were appreciated. No retractions were visualised. Auscultation of the heart revealed normal heart sounds without murmur, but with a regular, tachycardic rate. No jugular venous distention was appreciated. The patient had reproducible pain with tenderness to palpation over the mid-sternum. The abdomen was soft and non-tender. The extremities were well perfused with strong pulses and no oedema.

INVESTIGATIONS

A bedside ultrasound was performed that showed normal ventricular contractility with no pericardial effusion. No lung sliding was visualised on the

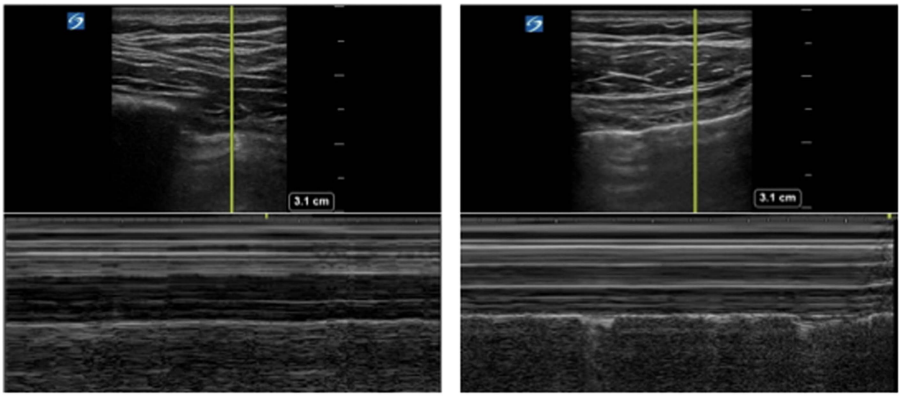

Figure 1 Ultrasound M-mode showing seashore sign associated with the right lung versus stratosphere sign associated with the left lung indicating pneumothorax. Seashore sign refers to horizontal waves produced by the motionless chest above a granular pattern produced by sliding lung tissue. These are separated by the hyperechoic pleural interface. Stratosphere sign refers to parallel linear horizontal lines above and below the parietal pleural line without a suggestion of movement.

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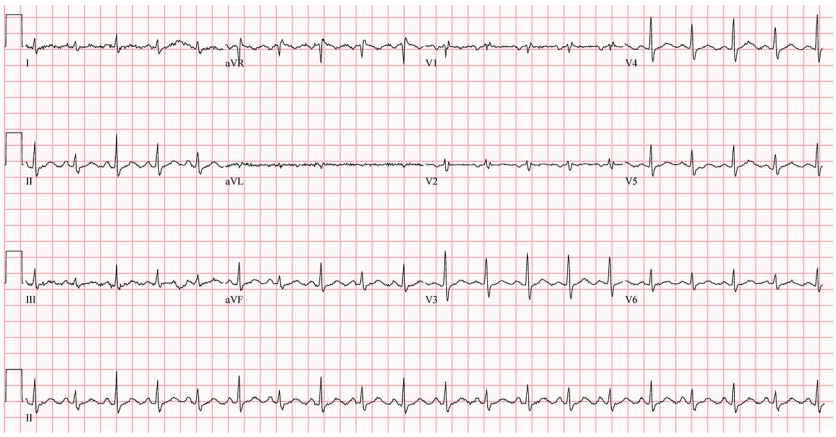

Figure 2 ECG with a rate of 116 bpm, PR 128 ms, QRS 78 ms, QT 326 ms, illustrating alternating QRS amplitudes in precordial and limb leads, and lower frequency modulation possibly due to respirations.

patient's left compared with the right side (figure 1). ECG showed sinus tachycardia with phasic variation of the QRS complex amplitude in all leads and generally mild decreased voltage (figure 2). There were no acute ST or T segment abnormalities or bundle branch block. A portable anteroposterior chest radiograph was consistent with large left pneumothorax and associated collapsed left lung, and slight mediastinal shift (figure 3).

DIFFERENTIAL DIAGNOSIS

The differential diagnosis for this patient with acute chest pain and dyspnoea was broad, but rapidly narrowed after initial emergent investigations described above. QRS alternans on ECG raised concern for pericardial effusion and tamponade, but bedside ultrasound demonstrated no pericardial effusion. Furthermore, the patient had no history of heart disease and was not taking digoxin or other medicines to suggest an electrophysiological cause of alternans. Bedside ultrasound suggested left side pneumothorax and this was confirmed with a portable chest X-ray. It became evident that spontaneous pneumothorax was the cause of the patient's symptoms, and they improved with treatment.

TREATMENT

The patient was immediately placed on 6 L oxygen by nasal cannula. A size 8 Fr pigtail catheter was placed in the left chest with local anaesthesia in the emergency department (ED). No rush of air was detected through the catheter on entry, and it was placed to suction via a pleurovac device. The patient experienced immediate symptomatic improvement. After hospital admission, poor lung expansion on day 2 prompted cardiothoracic surgery consultation and CT of the chest (figure 4). Extensive large bullae were consistent with giant bullous emphysema, also known as vanishing lung syndrome. The patient underwent video-assisted thoracic surgery with talc pleurodesis, wedge resection and bullectomy. Repeat imaging showed resolution of the pneumothorax and the patient was discharged home after several days of recovery. Follow-up telemetry showed resolution of previously observed phasic QRS complex changes (figure 5), and no further 12 lead ECG was recorded.

OUTCOME AND FOLLOW-UP

Follow-up with the patient 3 months later showed complete resolution of the patient's symptoms. No recurrence of bullae or pneumothorax was reported and clinical as well as functional improvement can be expected for at least 5 years following surgery.[8]

DISCUSSION

In an era when chest radiographs are generally widely available and readily obtainable, pneumothorax can usually be easily differentiated from other cardiopulomonary causes of acute dyspnoea. However, unusual ECG presentations in patients with pneumothorax may result in a delay of definitive treatment or even misdiagnosis. There have been a few reports of these phenomena including multiple instances in which patients with

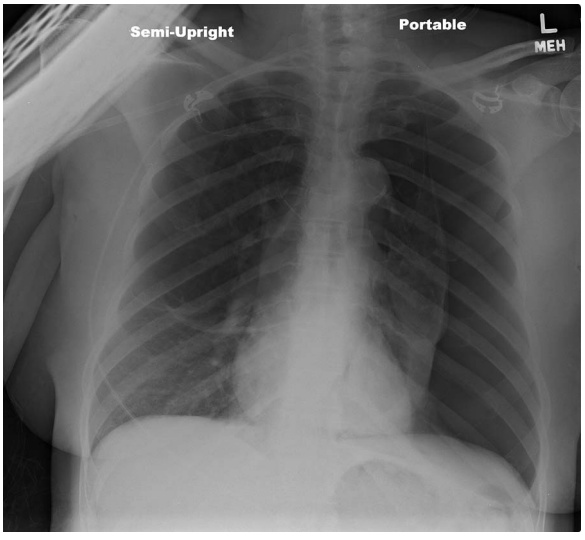

Figure 3 Chest radiology showing large left pneumothorax and right mediastinal shift.

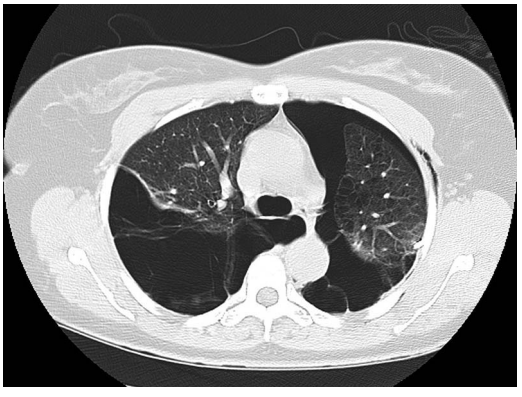

Figure 4 Chest CT scan showing extensive bilateral bullae after chest tube placement, but prior to surgery.

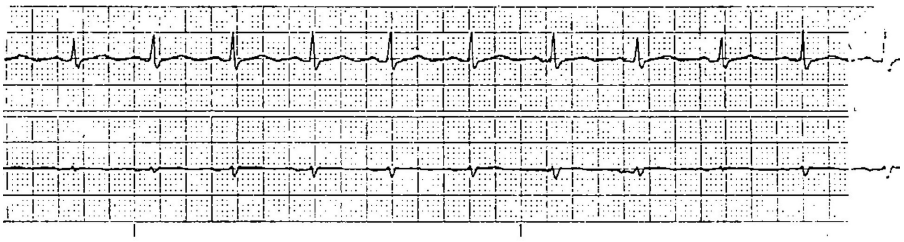

Figure 5 Rhythm strip recorded after resolution of the spontaneous pneumothorax. No follow-up ECG was available at this point in time.

pneumothoraces also presented with ST elevations suggestive of a primary cardiological event.[4 7] Conversely, some ECG findings such as signs of right heart strain may point to the possibility of acute pulmonary disease. The differential diagnosis of electrical alternans is predominantly associated with cardiac aetiologies such as pericardial effusion, aortic regurgitation, cardiomegaly, left ventricular dysfunction and digoxin toxicity. There are few reports of pulmonary causes of electrical alternans.[1 2]

We present a case of spontaneous left pneumothorax that demonstrated phasic ECG variation including variable electrical alternans with decreased amplitude throughout the ECG. The mechanism of QRS amplitude variation in this condition has previously been attributed to possible changes in cardiac volume and anatomy with respiration.[1] A patient may experience mediastinal shift corresponding with respirations due to a large pneumothorax. This could cause oscillation of the heart and alternans as well as overlying phasic modulation at the rate of respirations. The resulting tachycardia, low voltage amplitudes and phasic voltage variations may be similar to what is often reported in patients with pericardial effusions and cardiac tamponade. However, alternans in the setting of pericardial effusion is generally not modulated by respirations. Electrical alternans is neither sensitive nor specific for cardiac tamponade.[9] Clinicians should be aware that these changes can be present with pneumothoraces, and may be more common than reported.

Bedside ultrasound has become an important modality for rapid diagnosis in the ED. In cases of pleuritic chest pain, ultrasound use in the ED has been shown to be highly sensitive and specific in identifying pneumothorax.[10] Even in a case such as this where large emphysematous bullae can obscure the diagnosis, we were able to identify correctly pneumothorax on ultrasound. Unfortunately, a lung point was not visualised on examination. The lung point is a pathognomonic sign of pneumothorax where lung and air are visualised in the same view. This sign has been shown to approximate the size of pnuemothorax by ultrasound.[11] Employing ultrasound in the ED is a valuable diagnostic tool for a variety of cardiopulmonary diseases.

As demonstrated in this case, multiple modalities are available to diagnose spontaneous pneumothorax including the physical examination with auscultation and percussion, bedside ultrasound, chest radiography, CT imaging, etc. In this case, the patient had severe but previously undiagnosed underlying bullous emphysema with associated quiet lung sounds. This magnifies the risk of cardiorespiratory collapse from pneumothorax given the pneumothorax is superimposed on chronically compromised pulmonary function. Furthermore, it can increase the challenge of diagnosis. Repeat lung auscultation examination after knowledge of the diagnosis but prior to decompression remained symmetric in this patient. Both bedside ultrasounds with absence of lung sliding and portable chest radiography were diagnostic. This case demonstrates the utility of using bedside ultrasound as an initial test to differentiate chest pain and shortness of breath. Nevertheless, phasic variation or alternation of QRS amplitude in a patient with chest symptoms should raise awareness of the possibility of spontaneous pneumothorax as well as commonly associated conditions. This finding should hasten definitive studies including chest radiography or bedside ultrasound and appropriate emergent treatment.

Learning points

- ECG changes can be seen in a variety of non-cardiac conditions.
- Pneumothorax can present with a variety of ECG abnormalities including electrical alternans, tachycardia and low voltages on ECG.
- Bedside ultrasound can be useful to clarify rapidly the presence of pericardial effusion or pneumothorax in the presence of electrical alternans.
- Clinicians must consider the possibility of a pulmonary condition such as spontaneous pneumothorax in patients who present with acute chest symptoms and demonstrate ECG findings suggestive of a cardiac event such as ST elevation or electrical alternans.

Contributors JF and KAM both cared for the patient described, reviewed the relevant literature, collected images, and drafted the final manuscript. JF obtained patient consent for case report publication.

Competing interests None.

Patient consent Obtained.

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