Case Report

Radiographic spectrum of a medical emergency- spontaneous pneumothorax as a rare complication of diabetic ketoacidosis

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Abstract

Diabetic ketoacidosis (DKA) is a possible cause of fatality in patients affected by diabetes mellitus, especially by type 1 DM. DKA develops as an aftermath of insulin shortage wherein the body responds by switching to metabolizing fatty acids and producing acidic ketone bodies that lead to the development of most of the symptoms and the lethal complications. One of such complications, which is rarely encountered is the spontaneous pneumothorax. We report here a rare case of a medical emergency in a 37-year-old male patient, who is a known case of DKA further complicated by the onset of spontaneous pneumothorax, and present the progressive radiographic spectrum of the findings.

Keywords: DKA, Spontaneous pneumothorax, radiographic spectrum, medical emergency.

Introduction

DKA was first described in 1886. Until the introduction of insulin therapy in the 1920s, it was almost universally fatal.[1] DKA is a medical emergency, and without treatment, it can lead to death. It now carries a mortality of less than 1% with adequate and timely treatment.[2]

Pneumomediastinum is a rare comorbidity of DKA. Other reported pneumo-complications in patients with DKA are pneumothorax [3], pneumopericardium and pneumorrhachis. Pneumothorax is defined as the abnormal presence of air in the pleural space. Due to the negative intrapleural pressures throughout most of the respiratory cycle, air does not enter into the pleural cavity because the total partial pressures of gases in the capillary blood averages to only 93.9 kPa (706 mmHg). Therefore, net diffusion of gases from the capillary blood into the pleural cavity would require pleural pressures less than -54 mmHg, which can only happen in abnormal circumstances. Hence, if air is present in the pleural space, one of three events must have occurred:

1) communication between alveolar spaces and pleura;
2) direct or indirect communication between the atmosphere and the pleural space; or
3) presence of gas-producing organisms in the pleural space.

From a clinical standpoint, pneumothorax is classified as spontaneous (idiopathic), non-spontaneous and traumatic. (Table 1) [4,5]
Table 1: Clinical classification of Pneumothorax

<table>
<thead>
<tr>
<th>Spontaneous</th>
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<tr>
<td>Primary: no apparent underlying lung disease</td>
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<td>Secondary: clinically apparent underlying disease (e.g. chronic obstructive pulmonary disease and cystic fibrosis)</td>
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<td>Catamenial: in conjunction with menstruation (Neonatal)</td>
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<tr>
<td>Traumatic</td>
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<tr>
<td>Iatrogenic: secondary to transthoracic and transbronchial biopsy, central venous catheterisation, pleural biopsy and Thoracentesis</td>
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<tr>
<td>Non-iatrogenic: secondary to blunt or penetrating chest injury</td>
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Primary spontaneous pneumothorax (PSP) is defined as the spontaneously occurring presence of air in the pleural space in patients without clinically apparent underlying lung disease. PSP has an incidence of 7.4 to 18 cases (age-adjusted incidence) per 100,000 population each year in males, and 1.2 to 6 cases per 100,000 population each year in females.\(^\text{[6]}\) PSP typically occurs in tall slender individuals. The exact pathogenesis of the spontaneous occurrence of a communication between the alveolar spaces and the pleura remains unknown. It is believed that spontaneous rupture of a subpleural bleb, or of a bulla, is always the cause of PSP.\(^\text{[7]}\)

Secondary spontaneous pneumothorax comprises of multiple respiratory conditions. The most frequent being a COPD with emphysema, tuberculosis, cystic fibrosis, lung cancer and HIV-associated PCP, followed by rare disorders like LAM and histiocytosis X. Secondary spontaneous pneumothorax (SSP) often presents as a potentially life-threatening disease in such conditions, requiring immediate action.

Isolated pneumothorax as a complication of diabetic ketoacidosis is a rare presentation.\(^\text{[8]}\) We report here a rare medical emergency in a 37-year-old male patient, who is a known case of diabetic ketoacidosis, presenting with complaints of a dyspnoea, shortness of breath, chest pain and fatigue further complicated by the presence of spontaneous pneumothorax and lay forth the radiological findings that help in a reliable diagnosis and in meting out prompt life-saving treatment.

**Case report**

A 37-year-old male patient of DKA, presented with complaints of dyspnoea, shortness of breath, chest pain and fatigue and with serum bicarbonate level of 9 mmol/l and pH value of 6.5.

A diagnostic posteroanterior radiograph (Fig 1) was taken and found to have a white margin of visceral pleura separated from the parietal pleura extending along the lateral margin of the right lung. An absence of lung markings beyond the visceral pleural margin was noted. The average interpleural distance (AID) was found to be 3.5 cms giving an estimate of pneumothorax size as 35 %. Partial atelectasis of the right lung was also noted associated with mild crowding of ribs and slight ipsilateral tracheal deviation. Pleural effusion was
noted in the right basal zone. The left hemithorax appeared normal. The patient was discharged against medical advice due to non-compliance. But only to return with a worsened condition after a period of twelve hours. On a subsequent radiograph taken (Fig 2), the AID was found to be 6.9 cm with pneumothorax size estimate of 65%, showing confirmed signs of a progressive pneumothorax with a complete atelectasis of the right lung.

Another radiograph, taken four hours post tube thoracostomy (Fig 3) shows signs of complete resolution of the pneumothorax and re-expansion of the collapsed upper and middle lobes associated with relief of the symptoms.

Figure 1: Frontal Chest radiograph shows (a) a pencil thin white line along the lateral margin of the right lung associated with absent lung markings beyond it. Reduction in lung volume on the right side is noted with mild ipsilateral pleural effusion and diaphragmatic tenting. Slight ipsilateral tracheal deviation also noted. (b) AID measures 3.5 cm with pneumothorax size estimating to 35%.

Figure 2: A Frontal Chest radiograph taken twelve hours later shows (a) the progressive nature of spontaneous pneumothorax with complete collapse of the right lung and ipsilateral costophrenic angle pleural
effusion noted and (b) AID measuring 6.9 cm with pneumothorax size estimating to 65 % requiring immediate intervention with thoracostomy tube insertion.

Figure 3: Another PA chest radiograph taken four hours post thoracostomy tube insertion shows (a) complete resolution of the pneumothorax with tube in situ (arrow) and re-expansion of the collapsed segments and subsequent relief of symptoms. A subcutaneous emphysema is also noted and (b) persisting right lower zone pleural effusion.

Discussion

DKA may be the first symptom of previously undiagnosed diabetes, but it may also occur in people known to have diabetes as a result of a variety of causes, such as intercurrent illness or poor compliance with insulin therapy. Vomiting, dehydration, deep gasping breathing, confusion and occasionally coma are typical symptoms. DKA is diagnosed with blood and urine tests; it is distinguished from other, rarer forms of ketoacidosis by the presence of high blood sugar levels.

The American Diabetes Association (ADA) categorizes DKA in adults into one of three stages of severity:

1. Mild: Blood pH mildly decreased to between 7.25 and 7.30 (normal 7.35–7.45); serum bicarbonate decreased to 15–18 mmol/l (normal above 20); the person is alert
2. Moderate: pH 7.00–7.25, bicarbonate 10–15, mild drowsiness may be present
3. Severe: pH below 7.00, bicarbonate below 10, stupor or coma may occur

Treatment involves intravenous fluids to correct dehydration, insulin to suppress the production of ketone bodies, treatment for any underlying causes such as infections, and close observation to prevent and identify complications.[9][10]

In DKA, the high pressure caused by vomiting efforts and Kussmaul's respiration, leads to a hyperpnoea phenomenon secondary to metabolic acidosis. This can lead to unusual air tracking in compartments other than the mediastinum; pneumothorax, pneumoperitoneum and pneumoretroperitoneum have been reported.[11]

The presentation may vary from no symptoms to severe dyspnea with hypotension and tachycardia. In patients who have a tension pneumothorax, there may be a presentation of distended neck veins and tracheal deviation, cardiac arrest and most lethally death. The diagnosis of a pneumothorax on chest radiograph is
easily appreciated. Typically they demonstrate visible visceral pleural thin, sharp white line with no lung markings seen peripherally to this line. The peripheral space is radiolucent compared to the adjacent lung. The lung may completely collapse. The mediastinum does not shift contralaterally from the pneumothorax unless a tension pneumothorax is present. Subcutaneous emphysema and pneumomediastinum and pneumothorax may also coexist together rarely in DKA.\textsuperscript{[12]}

In our study, DKA was found to be of the moderate severity as per ADA and subsequently presented with spontaneous progressive pneumothorax which is a rare association and complication, treated with tube thoracostomy. The treatment of pneumothorax depends on a number of factors, and may vary from discharge with an early follow-up to immediate needle decompression or insertion of a chest tube. Treatment is determined by the severity of symptoms and indicators of acute illness, the presence of underlying lung disease, the estimated size of the pneumothorax on X-ray, and - in some instances - on the personal preference of the person involved.\textsuperscript{[13]} In traumatic pneumothorax, chest tubes are usually inserted. Any open chest wound should be covered with an airtight seal, as it carries a high risk of leading to tension pneumothorax. Ideally, a dressing called the "Asherman seal" should be utilized, as it appears to be more effective than a standard "three-sided" dressing. The Asherman seal is a specially designed device that adheres to the chest wall and, through a valve-like mechanism, allows air to escape but not to enter the chest.\textsuperscript{[14]}

Tension pneumothorax is usually treated with urgent needle decompression. The needle or cannula is left in place until a chest tube can be inserted.\textsuperscript{[15][16]}

**Conclusion**

Spontaneous pneumothorax complicating diabetic ketoacidosis is a rare life-threatening condition. A detailed radiographical interpretation in an emergency setup plays a pivotal role in the early accurate diagnosis of the overlapping conditions and its complications for developing an effective life-saving management protocol and its timely implementation.

**References**


