Case Report

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

Sumit Sharma [1] , Shrinuvasan.S*[1], Jothibasu .T[1] , Chidambaram.R[1]

Department(s) and institution(s)

[1]Department Of Radiology , Sri Lakshmi Narayana Institute of Medical Sciences, Agaram Village, Affiliated to Bharath University, Chennai, Puducherry- 605502, India.

Corresponding author *

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

Spontaneous
Primary: no apparent underlying lung disease
Secondary: clinically apparent underlying disease (*e.g.* chronic obstructive pulmonary disease and cystic fibrosis)
Catamenial: in conjunction with menstruation
(Neonatal)
Traumatic
Iatrogenic: secondary to transthoracic and transbronchial biopsy, central venous catheterisation, pleural biopsy and Thoracentesis
Non-iatrogenic: secondary to blunt or penetrating chest injury

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.[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.[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.[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

www.ijbamr.com P ISSN: 2250-284X , E ISSN : 2250-2858

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

.

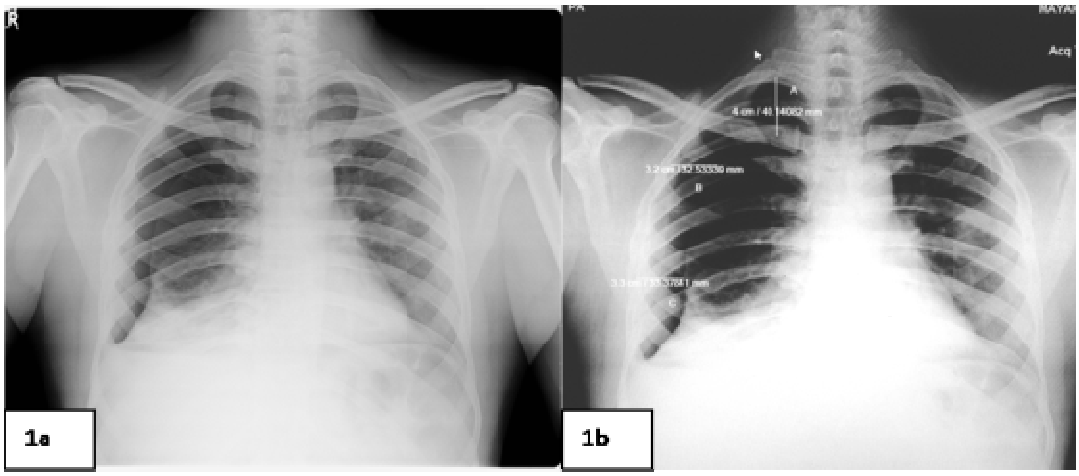

Figure 1: Frontal Chest radiograph shows **(a)** a pencil thin white line along the lateral margin of the right lung associated with absent lung markings beyond it. Reduction in lung volume on the right side is noted with mild ipsilateral pleural effusion and diaphragmatic tenting. Slight ipsilateral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

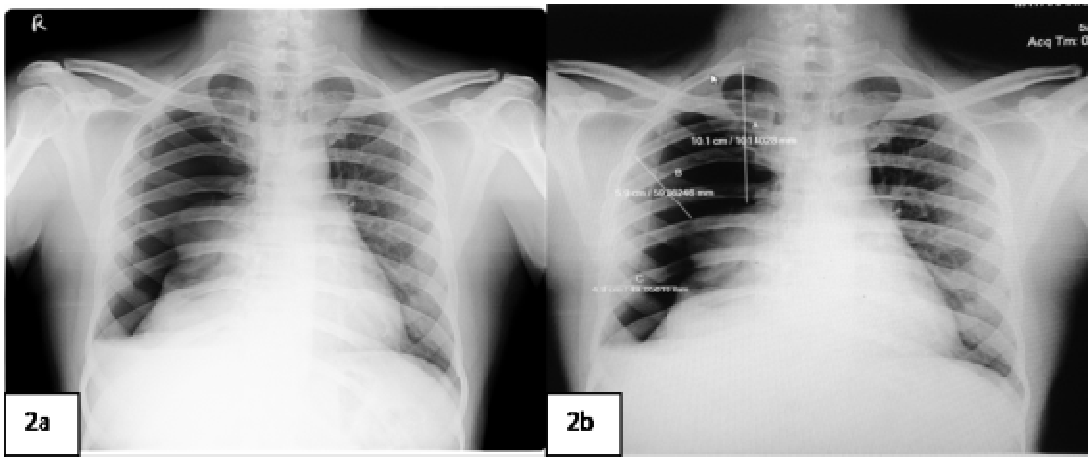

Figure 2: A Frontal Chest radiograph taken twelve hours later shows **(a)** the progressive nature of spontaneous pneumothorax with complete collapse of the right lung and ipsilateral costophrenic angle pleural

www.ijbamr.com P ISSN: 2250-284X , E ISSN : 2250-2858

effusion noted and **(b)** AID measuring 6.9 cm with pneumothorax size estimating to 65 % requiring immediate intervention with thoracostomy tube insertion.

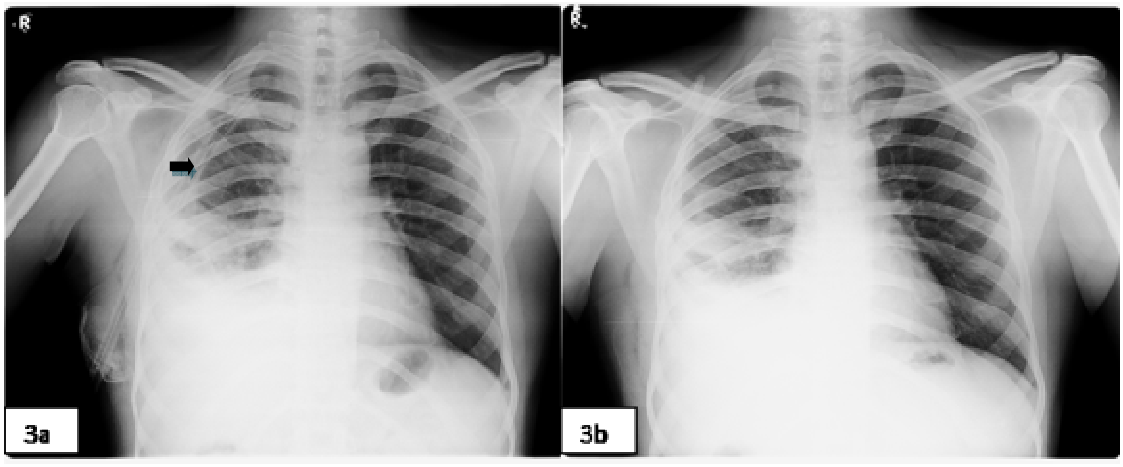

Figure 3: Another PA chest radiograph taken four hours post thoracostomy tube insertion shows **(a)** complete resolution of the pneumothorax with tube in situ **(arrow)** and re-expansion of the collapsed segments and subsequent relief of symptoms. A subcutaneous emphysema is also noted and **(b)**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

www.ijbamr.com P ISSN: 2250-284X , E ISSN : 2250-2858

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.[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.[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.[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.[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

1) Eledrisi MS, Alshanti MS, Shah MF, Brolosy B, Jaha N (May 2006). "Overview of the diagnosis and management of diabetic ketoacidosis". American Journal of the Medical Sciences. 331 (5): 243–51. doi:10.1097/00000441-200605000-00002. PMID 16702793
2) Joint British Diabetes Societies Inpatient Care Group (September 2013). "The Management of Diabetic Ketoacidosis in Adults" (pdf). p. 8. Retrieved 14 August 2015.
3) L. S. Weathers, W. G. Brooks, and T. J. DeClue, “Spontaneous pneumomediastinum in a patient with diabetic ketoacidosis: a potentially hidden complication,” Southern Medical Journal, vol. 88, no. 4, pp. 483–484, 1995.
4) Noppen M, Schramel F Pneumothorax. Eur Respir Mon 2002; 22: 279–296.Google Scholar
5) Baumann MH, Noppen M Pneumothorax. Respirology 2004; 9: 157–164.CrossRefMedlineGoogle Scholar
6) Melton LJ, Hepper NGG, Offord KP . Incidence of spontaneous pneumothorax in Olmsted County, Minnesota: 1050–74. Am Rev Respir Dis 1979; 120: 1379–1382. MedlineGoogle Scholar
7) Light RW Management of spontaneous pneumothorax. Am Rev Respir Dis 1993; 148: 245–248.CrossRefMedlineGoogle Scholar
8) González-Clemente JM, Navarro MP, Muñoz A, Gomis R. Isolated pneumothorax as a complication of diabetic ketoacidosis. Med Clin (Barc). Med Clin (Barc) 1993 May;101(1):37-8

9) Kitabchi AE, Umpierrez GE, Miles JM, Fisher JN (July 2009). "Hyperglycemic crises in adult patients with diabetes". Diabetes Care. 32 (7): 1335–43. doi:10.2337/dc09-9032. PMC 2699725 . PMID 19564476

10) Dunger DB, Sperling MA, Acerini CL, et al. (February 2004). "European Society for Paediatric Endocrinology/Lawson Wilkins Pediatric Endocrine Society consensus statement on diabetic ketoacidosis in children and adolescents". Pediatrics. 113 (2): e133–40.doi:10.1542/peds.113.2.e133. PMID 14754983

11) Drolet S, Gagné J-P, Langis P. Spontaneous pneumorrhachis associated with pneumomediastin in a patient with diabetic ketoacidosis: an exceptional manifestation of a benign disease. Canadian Journal of Surgery. 2007;50(3):225-226

12) Toomey FB, Chinnock RF Subcutaneous emphysema, pneumomediastinum, and pneumothorax in diabetic ketoacidosis.Radiology. 1975 Sep;116(3):543-5

13) MacDuff A, Arnold A, Harvey J, BTS Pleural Disease Guideline Group (December 2010). "Management of spontaneous pneumothorax: British Thoracic Society pleural disease guideline 2010". Thorax. 65 (8): ii18–ii31.doi:10.1136/thx.2010.136986. PMID 20696690

14) Lee C, Revell M, Porter K, Steyn R, Faculty of Pre-Hospital Care (March 2007). "The prehospital management of chest injuries: a consensus statement. Faculty of Pre-hospital Care, Royal College of Surgeons of Edinburgh". Emergency Medicine Journal. 24 (3): 220–4.

15) Leigh-Smith S, Harris T (January 2005)."Tension pneumothorax—time for a re-think?". Emergency Medicine Journal. 22 (1): 8–16. doi:10.1136/emj.2003.010421.PMC 1726546. PMID 15611534

16) Lee C, Revell M, Porter K, Steyn R, Faculty of Pre-Hospital Care (March 2007). "The prehospital management of chest injuries: a consensus statement. Faculty of Pre-hospital Care, Royal College of Surgeons of Edinburgh". Emergency Medicine Journal. 24 (3): 220–4