

## Case Report

# Ball Valve Effect as a Cause of Acute Respiratory Failure during Palliative Chemotherapy for Small Cell Lung Cancer

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## Keywords

- Small cell lung cancer
- Ball-valve effect
- Acute respiratory failure
- Chemotherapy

## Abstract

Ball valve effect is an unusual albeit life threatening phenomenon resulting in tension pneumothorax in extreme cases. We report a case of a patient with extensive stage small cell lung cancer who developed type 1 respiratory failure, during his first cycle of palliative chemotherapy. A Computed Tomography Pulmonary Angiogram (CTPA) did not show any evidence of pulmonary emboli but showed significant narrowing of the right main bronchus causing 'ball valve' effect with hyperinflation of right lung and compression of the left lung. A ball valve effect (BVE) is a partial obstruction which causes an inflow of air during the inspiration phase of breathing and, on the other hand, as expiration begins, prevents outflow. Despite is rare, it is important to consider ball-valve effect among differential diagnosis for patients with lung cancer presenting with acute respiratory failure as this is a reversible cause. Delay or failure to diagnose it can lead to tension pneumothorax and cardiac arrest.

## ABBREVIATIONS

CT: Computer Tomography; SCLC: Small Cell Lung Cancer; ECOG: Eastern Cooperative Oncology Group; PS: Performance Status; AUC: Area Under the Curve; ABG: Arterial Blood Gas analysis; SatO<sub>2</sub>: Saturation of peripheral Oxygen; ICU: Intensive Care Unit; NIV: Non-Invasive Ventilation; CTPA: Computed Tomography Pulmonary Angiogram; VAC: Cyclophosphamide, doxorubicin and Vincristine; BVE: Ball Valve Effect; VTE: Venous Thromboembolic Events; ARF: Acute Respiratory Failure; HCC: Hepatocellular Carcinoma

## INTRODUCTION

Thoracic malignancies can invade the mediastinum and can also lead to respiratory failure by obstructing the patency of main bronchi. We report a case of a patient with extensive stage small cell lung cancer who developed type 1 respiratory failure, due to a ball valve effect, during his first cycle of palliative chemotherapy.

## CASE PRESENTATION

A 61 years old heavy-smoker lady was admitted to a nearby

District General Hospital for gradual deterioration of clinical conditions and worsening shortness of breath. An abnormal chest radiograph led to Computer Tomography (CT) scan of chest and abdomen, which revealed a multilobar mass on the right hilum invading the mediastinum, with mediastinal and supraclavicular fossa lymph nodes, pericardial effusion and left adrenal gland metastasis. Radiological staging was T4N3M1b.

Endobronchial biopsy, showed malignant cells with features consistent with Small Cell Lung Cancer (SCLC). She was transferred to the Christie to start urgent chemotherapy. The patient had no comorbidities and her Eastern Cooperative Oncology Group (ECOG) Performance status (PS) was 1.

She was started on first-line palliative chemotherapy with carboplatin/etoposide (carboplatin area under the curve (AUC) 6 IV on day 1 and etoposide 120 mg/m<sup>2</sup> IV on days 1-3 given every 21 days). On cycle 1 day 2, a few hours after starting the etoposide infusion, her dyspnoea suddenly deteriorated and saturation of peripheral oxygen (SatO<sub>2</sub>) in room air dropped to 85%. An arterial blood gas analysis (ABG) showed a type 1 respiratory failure, with a SatO<sub>2</sub> of 85% in room air, pO<sub>2</sub> 7.03 kPa

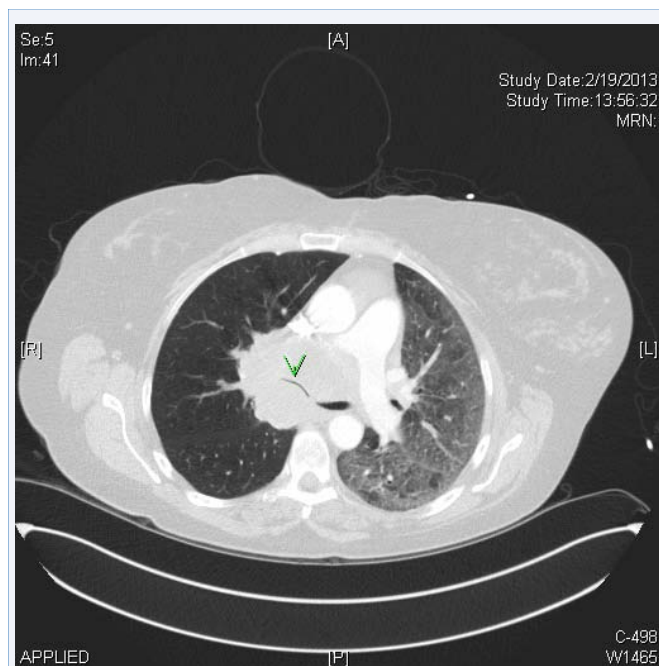
(normal range 9.98-13.30),  $pCO_2$  3.90 kPa (normal range 4.66-5.99), pH 7.46 (normal range 7.35-7.45),  $HCO_3$  21 mmol/l (normal range 21.0-28.0), BE -3.2 mmol/l (normal range -2/+3). She was started on high flow oxygen ( $FiO_2$ : 40%), intravenous steroids and diuretics with initial improvement on the repeated ABG ( $SatO_2$  95.5%;  $PaO_2$  13.95 kPa;  $PaCO_2$  4.53 kPa) but subsequent deterioration ( $SatO_2$  90%,  $pO_2$  7.49,  $pCO_2$  4.11, pH 7.47,  $HCO_3$  22.7, SE -1.2 mmol/l) so she was transferred to Intensive Care Unit (ICU) to start non-invasive ventilation (NIV).

A Computed Tomography Pulmonary Angiogram (CTPA) did not show any evidence of pulmonary emboli but showed significant narrowing of the right main bronchus causing 'ball valve' effect with hyperinflation of right lung and compression of the left lung (Figure 1). She was promptly transferred to the thoracic surgical ward and an endobronchial stent was inserted on right main bronchus which completely restored the bronchus patency. The patient experienced an immediate symptomatic relief and improvement of her oxygen saturation. She was then discharged home the following day and was able to complete her planned course of chemotherapy as an outpatient.

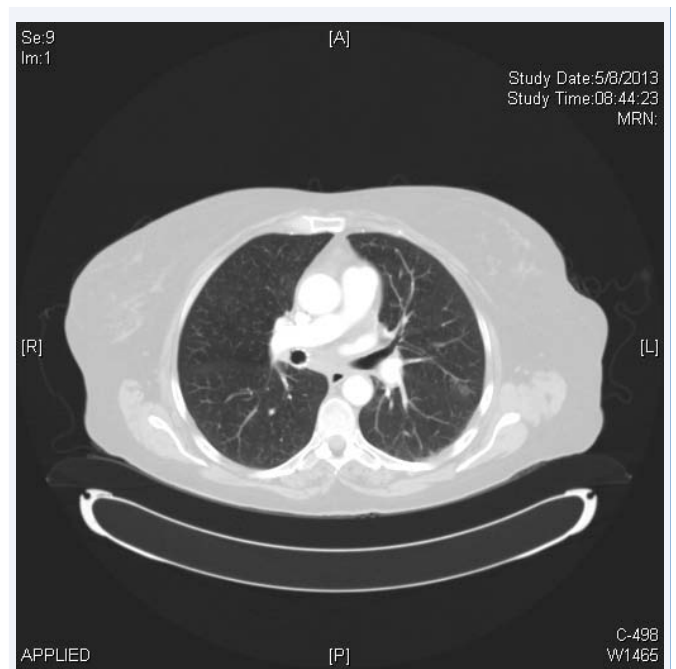
Restaging CT scan after 4 cycles of chemotherapy demonstrated a partial response according to RECIST criteria with the stent on right main bronchus still in situ (Figure 2). She went on to receive palliative chest irradiation and prophylactic cranial irradiation. Unfortunately her disease progressed 2 months later and was treated with second-line chemotherapy with cyclophosphamide, doxorubicin and vincristine (VAC) and died 8 months after her diagnosis.

## DISCUSSION

Small Cell Lung Cancer represents 15 % of all lung cancer diagnoses [1]. The standard of care for patient with extensive



**Figure 1** CT scan of the chest showing obstruction of right main bronchus causing ball valve effect.



**Figure 2** CT scan after 4 cycles of chemotherapy showing partial response to treatment and right main bronchus stent in situ.

stage SCLC is 4-6 cycles of platinum and etoposide chemotherapy [1]. Response rate from first-line chemotherapy range between 70-80% but unfortunately all patients will progress and die of their disease. The prognosis of extensive disease is poor with a median survival of 8-10 months and a 2-year survival rate of 10%. Patients responding to chemotherapy will experience prompt improvement of symptoms and general conditions. Unfortunately patients not responding to treatment will deteriorate very quickly, not uncommonly developing respiratory failure. For this reason, it is very important to identify non-responders from other potentially reversible causes which could lead to acute respiratory failure during chemotherapy.

A Ball Valve Effect (BVE) is a partial obstruction which causes an inflow of air during the inspiration phase of breathing and, on the other hand, as expiration begins, prevents outflow. This condition will then lead to hyperinflated lung distal to the level of the obstruction, with a concomitant compression of the structures surrounding the lung itself (oesophagus, mediastinum, bronchial tree, contralateral lung etc). The most common and severe complication of a BVE is pneumothorax, which, if left untreated, could lead to cardio respiratory compromise and collapse [2].

This is, to our knowledge, the first case reported in the literature where the BVE was caused by small cell lung cancer. Ball valve effect obstruction has been observed in gastrointestinal bezoars [3] and gastric polyp [4]. Foucher et al described the case of a 65 years old man who was affected by SCLC and developed a ball-valve obstruction of the airways caused by a blood clot [5]. Different malignancies have been reported in association with BE. Two cases of ball valve syndrome caused by gastric cancer have been reported. This phenomenon is relatively rare and it is reported in association with 3.6% of all gastric tumors [6,7]. As described by Kanda et al, metastatic hepatocellular carcinoma

(HCC), can also cause ball valve effect in cases of metastasis to the heart [8]. The incidence of cardiac metastases in patients with HCC is around 10% whilst intra-atrial and intraventricular metastases are only 1-4%.

## CONCLUSION

Acute respiratory failure (ARF) is a very frequent cause for admission of a cancer patient to ICU [9] and pulmonary embolism is one of the commonest causes of ARF. The incidence of Venous Thromboembolic Events (VTE) in patient affected by lung cancer is 3% in the first year from diagnosis [10]. Cancer patients who are receiving chemotherapy have a 7-fold risk of developing VTE as compared with those without cancer [11]. Prompt diagnosis of pulmonary embolism is crucial. Currently, CTPA is the gold standard to rule out pulmonary embolism [12]. As in this case, it can also give information about the main vessels and mediastinal structures. Despite being rare, we believe it is important to consider BVE among differential diagnosis for patients with lung cancer presenting with acute respiratory failure as this is a reversible cause. Delay or failure to diagnose it can lead to tension pneumothorax and cardiopulmonary arrest.

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