Case Report / Olgu Sunumu

A Case of Pneumomediastinum Due to Positive End-Expiratory Pressure

Yüksek Pozitif Ekspiryum Sonu Basıncı Nedeniyle Oluşan Pnömomediyastinum Olgusu

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Abstract

A 26-year-old female patient, who presented to the emergency department with chronic renal failure, general condition disturbance and dyspnea, was intubated due to low oxygen saturation. The results of the blood biochemical test were normal except for low saturation. Our case did not have any coronary artery disease or obstructive pulmonary disease. While she was undergoing the positive end-expiratory pressure (PEEP) treatment in the intensive care unit, the patient was detected to have right heart failure on her echocardiogram examination and pneumomediastinum was found on her direct radiography examination and on chest x-ray and computed tomography (CT) on the 2nd day of her hospitalization. The development of pneumomediastinum associated with PEEP for low saturation appears to be a rare phenomenon. In accompany with the findings of the case, the examination data and the literature information were prepared as a case report.

Key words
Pneumomediastinum, positive end-expiratory pressure, computed tomography

Özet

Kronik böbrek yetmezliği, genel durum bozukluğu ve solunum sıkıntısı ile acil servise başvuran 26 yaşındaki kadın hasta satürasyon problemi nedeniyle entübe edildi. Satürasyon düşüklüğü dışında genel kan biyokimyasında belirgin patoloji ayırt edilmedi. Olguda koroner arter hastalığı ya da kronik obstruktif akciğer hastalığı yoktu. Yoğun bakımda, pozitif ekspiryum sonu basınç (PEEP) tedavisi altındayken, ekokardiyografi (EKO) tetkikinde olgunun sağ kalp yetmezliği olduğu ve direkt grafi tetkikinde, yatışının 2. gününde akciğer grafisinde ve bilgisayarlı tomografi (BT) tetkikinde pnömomediyastinum tespit edildi. Düşük saturasyon için yapılan pozitif expirium sonu basınç (PEEP) tedavisi altında iken pnömomediastinum gelişmesi nadir bir durumdur. Olgunun bulguları eşliğinde tetkik verileri ve literatür bilgisi olgu sunumu olarak hazırlandı.

Anahtar kelimeler
Pnömomediyastinum, pozitif ekspiryum sonu basınç, bilgisayarlı tomografi

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Introduction

The presence of free air in the pleural cavity of the thorax is called pneumothorax, whereas the presence of air in the mediastinal cavity is called pneumomediastinum. Air often passes to the mediastinum after pneumothorax through adjacency. However, isolated pneumomediastinum may also be followed by some conditions such as diastolic dysfunction of the heart. In pneumomediastinum, the

heart, the trachea and the neck passages remain under compression by free air. It is the heart among the organs in the mediastinum which is most seriously affected by compression (1).

Case Report

A 26-year-old female patient whose detailed anamnesis could not be obtained and who was known to be a patient with chronic renal failure (CRF) was hospitalized in the intensive care unit due to her need for dialysis and poor general condition. Right heart-based increased cardiothoracic ratio was striking on the direct anterior and posterior chest radiograph taken during her hospitalization. Severe tricuspid regurgitation and the hypertrophic heart image were verified by the echocardiograpic findings. The patient, whose dyspnea became obvious during dialysis and who was then intubated, was connected to a mechanical ventilator in the pressure-synchronized intermittent mandatory ventilation (P-SIMV) mode, with FiO_2, respiration number, peak airway pressure, and positive end-expiratory pressure (PEEP) being 50%, 12, 15 cmH_2O and 5 cmH_2O, respectively. The patient, who underwent dialysis every day as she had no urine output, was followed as being hypertensive (around 170/90 mmHg), having atrial fibrillation (90-100 beats/min), being anemic (Hb: 7.4 and Hct: 29.3%), and having high values of urea and creatinine in terms of the biochemical parameters (urea: 87 and Cre: 6.4). Cardiology consultation was asked. Considering diastolic dysfunction, a calcium antagonist was started and atrial fibrillation (AF) was treated. On the 3rd day of her hospitalization, the peak airway pressure had to be raised up to 20 cmH_2O and the PEEP value up to 12 cmH_2O by tittering according to the daily arterial blood gas values. The O_2 saturations, arterial blood gas values and clinical status of the patient improved (pH: 7.28, PO_2: 89 and PCO_2: 52) until the 5th day of her hospitalization. While she was under 12 cmH_2O of PEEP treatment with the same parameters on the 5th day, it was observed that dyspnea, a fall in O_2 saturation, worsening of the blood gas values (pH: 7.04, PO_2: 54 and PCO_2: 64), hypotension (around 85/55 mmHg) and tachycardia (130 beats/min) developed. Pneumomediastinum was detected to be present on the direct chest radiograph taken. The patient was evaluated by means of thoracic computed tomography. On CT, free air densities were observed around the heart, in the trachea, on the anterior and posterior thyroid, and in the cutaneous and subcutaneous regions towards the arm on the right-hand side. The findings were accompanied by minimal pneumothorax in the apical region of the left lung. In addition, there were increases in the reticular density in the basal segments of both lungs both on the chest radiography and during the thoracic CT examination. The opinion of a thoracic surgeon was obtained, and it was recommended to follow pneumomediastinum and the clinical picture it would cause.

Following the decreased PEEP (decreased to 8 cmH_2O), an increase in pneumomediastinum was detected during the control CT examination the next day. On the same day, the surgical tracheostomy was opened and the air in the mediastinum was released by thoracic surgery. Nevertheless, the patient, whose hemodynamics were impaired and the general state did not improve, became exitus on the 7th day of her hospitalization in the intensive care unit. Consent was obtained from the relatives of the patient for the scientific presentation.

Discussion

Abnormalities of myocardial relaxation and an increase in resistance to ventricular filling result in diastolic heart dysfunction. Although the development of pneumomediastinum in acute diastolic dysfunction cannot be fully explained, the use of high PEEP may further impair the ventricular filling of the heart, in which diastolic dysfunction has developed. Mechanical ventilation, and particularly the use of PEEP, may result in the development of pneumothorax, subcutaneous emphysema, and pneumomediastinum.

In this case report, we aimed to discuss the approach to the patient who had acute fatal diastolic heart failure and in whom pneumomediastinum developed after the use of PEEP.

Pneumomediastinum and increases in the reticular density were observed on the 4th day chest radiograph (Figure 1). The air density around the heart was striking on the chest radiograph obtained the next day (on the 5th day) (Figure 2). An increase in the heart size (Figure 3), pneumothorax (Figure 4) and free air adjacent to the thyroid and in the subcutaneous area (Figure 5) were detected during the CT examination on the same day. During the follow-up, it was observed that the free air around the heart increased (Figures 6, 7).

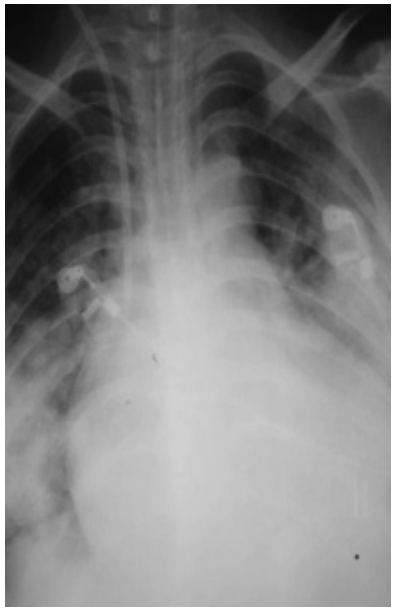

Figure 1. The chest radiograph of the case at arrival (first PA lung X ray)

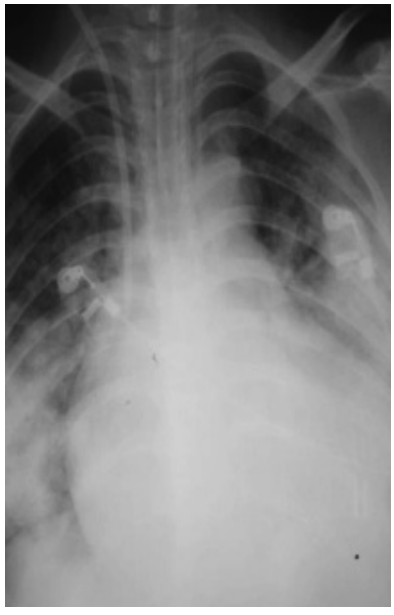

Figure 2. Pneumomediastinum (arrow)

Figure 3. An increase in the heart size in the computed tomography examination

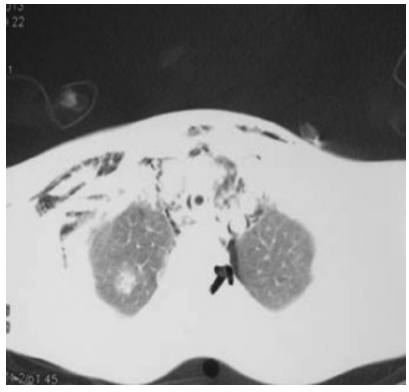

Figure 4. Minimal pneumothorax in the left lung

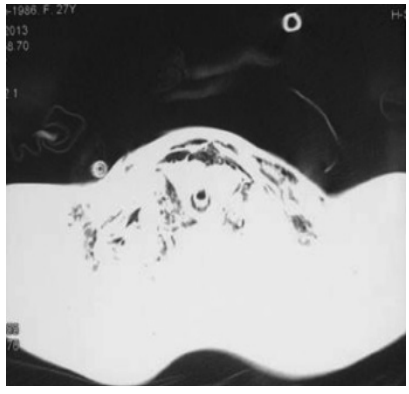

Figure 5. Subcutaneous emphysema

The physiological abnormalities in the myocardial relaxation or anatomic abnormalities enhancing the resistance to ventricular filling appear with diastolic dysfunction. Myocardial ischemia and hypertrophy are examples of these physiological abnormalities. They occur with insufficient relaxation and inactivation of myocardial cells. These situations rapidly lead to pulmonary edema and advanced ischemic heart disease. Regarding the anatomic abnormalities, diastolic dysfunction in heart failure may develop with hypertrophy or tamponade on the ventricular wall, pericardial effusion, constriction, and right ventricular overload (1). Diastolic dysfunction is diagnosed on the basis of:

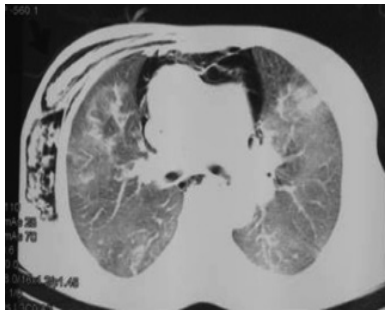

Figure 6. Free air around the heart

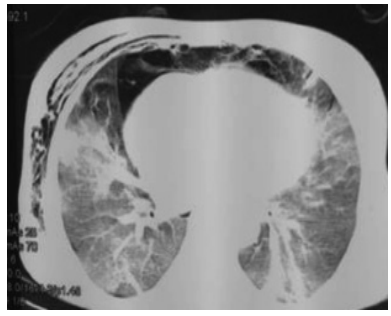

Figure 7. Pneumomediastinum on computed tomography

1) The presence of findings of heart failure,

2) Normal or slightly reduced left ventricle ejection fraction,

3) An increase in diastolic filling pressure (2,3).

Diastolic heart failure may be diagnosed with echocardiography (4). How isolated pneumomediastinum causes has not been explained yet. A narrowed or plugged airway, a closed glottis or blunt chest trauma might cause it. Moreover, the causes may also include sinus fracture, dental extraction, perforation of a whole organ, or alveolar rupture (3).

Ring-around-the-artery sign, tubular artery sign, double bronchial wall sign, continuous diaphragm sign and extrapleural sign are among the radiological signs which help with the diagnosis of pneumopericardium and pneumomediastinum. CT and digital radiography may help with diagnosis (4). The pulmonary barotrauma associated with mechanical ventilation, like the use of PEEP in particular, may result in pneumothorax, subcutaneous emphysema, and then, pneumomediastinum. The maximum level of PEEP and the duration of its application determine the form of the complication (5).

Our case did not have any coronary artery disease or obstructive pulmonary disease. The only reason for the right ventricular overload was stated to be pulmonary embolism in a case report by Rigatelli (5). In a case report by Zkidkov (6), PEEP was applied at the 7 cm H_2O level of pressure to a fifteen-year-old patient with respiratory distress syndrome too, and then, interstitial emphysema, pneumomediastinum and bilateral pneumothorax developed.

On the contrary, the use of PEEP leads to wide pneumomediastinum, thereby, rapidly reducing the diastolic filling and developing active diastolic relaxation, as we encounter in constrictive pericarditis. In conclusion, the equalization of the right chamber pressures was demonstrated with catheterization, and a typical dip-plateau and increased diastolic filling pressure were shown. Right heart failure might develop in rapidly changing hemodynamic environments. Pneumomediastinum after PEEP leads to acute diastolic dysfunction (5).

Conclusion

The coexistence of the development of pneumomediastinum following PEEP and right heart failure was striking in our case. The case, from whom no response could be received to treatment, was presented in accompany with the radiological findings and the literature. When applying mechanical ventilation to patients with right heart failure, the patient's clinical follow-up and lung mechanics should be monitored closely; a chest radiograph should absolutely be taken; one should be alert to the risk of the development of pneumomediastinum; and in the event of any suspicion, the diagnosis should be confirmed by thoracic CT.

Informed Consent: Consent form was filled out by all participants, Concept: Özlem Kocatürk, Özüm Tunçyürek, Design: Özlem Kocatürk, Özüm Tunçyürek, Data Collection or Processing: Özlem Kocatürk, Fatma Bayrak, Emine Meltem Bulut, Analysis or Interpretation: Özlem Kocatürk, Özüm Tunçyürek, Literature Search: Özlem Kocatürk, Özüm Tunçyürek, Neslihan Karataş, Writing: Özlem Kocatürk, Özüm Tunçyürek, Peer-review: Externally peer-reviewed, Conflict of Interest: No conflict of interest was declared by the authors, Financial Disclosure: The authors declared that this study has received no financial support.

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