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Diaphragmatic Herniation with Pneumothorax Due to Barotrauma-Lessons to Learn: A Case Report

Jiao Ran[1], Peng Ji[2*]

[1]*Department of Anesthesiology, West China Hospital, Sichuan University, Chengdu, China*

[2]*Department of Critical Care Medicine, West China Hospital, Sichuan University, Chengdu, China*

Corresponding Author: **Peng Ji**

Address: Department of Critical Care Medicine, West China Hospital, Sichuan University, Chengdu, No. 37, Guoxue Alley, Chengdu 610041, Sichuan, China; Email: drpengji@wchscu.cn

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Abstract

Diaphragmatic hernia is usually congenital or follows thoracoabdominal injury. Diaphragmatic hernia combined with pneumothorax is a rare combination in the clinical setting, where pneumothorax is usually secondary to hollow viscera perforation in the long-term complications of diaphragmatic herniation or rupture of ectopic endometrium over the diaphragm during menstruation. Unlike the aforementioned conditions, we describe a 67-year-old man with chronic diaphragmatic hernia who suffered from pneumothorax and pneumoperitoneum secondary to pulmonary bulla by barotrauma during mechanical ventilation. Computed tomography showed scattered free gas in the thoracic and abdominal cavities, while there was no tenderness and rebound tenderness. The patient was managed conservatively with low PEEP and a lung-protective mechanical ventilation strategy. Finally, the oxygenation index gradually rose from 58 to 107. Unfortunately, in light of the patient's poor clinical status and significant comorbidities, the patient passed away peacefully 3 weeks after hospital admission. Diaphragmatic hernia combined with pneumothorax should be differentiated from tension pneumothorax. Whether to intubate chest drainage depends on the cause of pneumothorax and pneumoperitoneum, as well as the risks and benefits of chest drainage. Additionally, mechanical ventilation should be applied cautiously, and respiratory parameters should be adjusted reasonably in patients at high risk of pneumothorax.

Keywords

Diaphragmatic Herniation, Pneumothorax, Pneumoperitoneum, Mechanical Ventilation, Barotrauma

Introduction

Diaphragmatic hernia is usually congenital or follows thoracoabdominal injury [1,2]. Diaphragmatic hernia combined with pneumothorax is rare in the clinical setting. Pneumothorax is usually secondary to hollow viscera perforation. Some patients have a history of diaphragmatic trauma or congenital diaphragmatic herniation, while others suffer from recurrent spontaneous pneumothorax during their menstrual periods [3,4]. We present a case of pneumothorax resulting from ventilator-associated barotrauma after traumatic diaphragmatic herniation. We have learned valuable lessons from this case.

Case Description

A 67-year-old man presented to the hospital with a fever and cough for the past 20 days, with a history of chronic bronchitis, emphysema, and chronic renal

failure. In daily activities, the patient could tolerate walking and had no symptoms such as chest tightness or dyspnea. The patient had a smoking history of more than 30 years but had quit smoking over 10 years ago. Additionally, the patient suffered from a traumatic diaphragmatic hernia in a car accident 26 years ago and did not receive surgical treatment. On physical examination, the breath sounds in the right lung were significantly weaker, with a few wheezes in the left lung. Chest computed tomography (CT) revealed ground-glass opacity, reticular and strip shadows, pulmonary consolidation, elevated right diaphragm, and partial atelectasis in the right lung (**Fig-1**). As the lung infection worsened and the oxygenation index decreased, the patient received invasive mechanical ventilation.

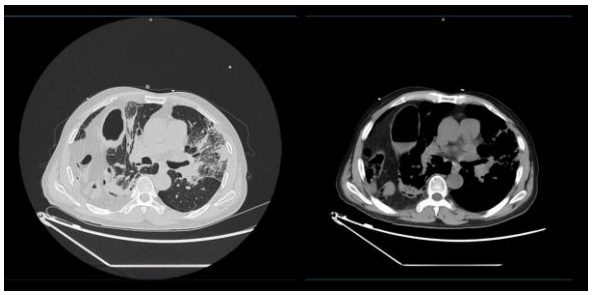

Fig-1:

Chest Computed Tomography (CT) Revealed Ground-Glass Opacity, Reticular and Strip Shadows, Pulmonary Consolidation and Diaphragmatic Herniation at Admission

Unfortunately, hypoxemia occurred on the fourth day of mechanical ventilation, with saturation of pulse oxygen (SPO_2) fluctuating between 68% and 75%. His abdomen was distended with tympany, but there was no tenderness or rebound tenderness. An urgent bedside chest and abdomen X-ray indicated pneumothorax and pneumoperitoneum equivocally (**Fig-2**). Taking the above into account, positive end-expiratory pressure (PEEP) was decreased from 8 cmH_2O to 5 cmH_2O, and the fraction of inspired oxygen (FiO_2) was increased to 100%. Meanwhile, spontaneous respiration was interrupted via deep sedation, strong analgesia, and muscle relaxant. Finally, SPO_2 slowly increased to 93%. The patient then received another chest and abdomen CT, which demonstrated scattered free gas in the thoracic and abdominal cavities (**Fig-3**).

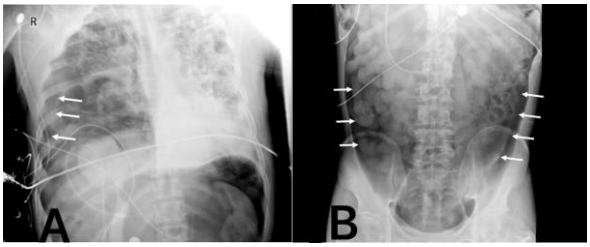

Fig-2:

X-ray indicates Pneumothorax (A) and Pneumoperitoneum (B) (white arrows) equivocally

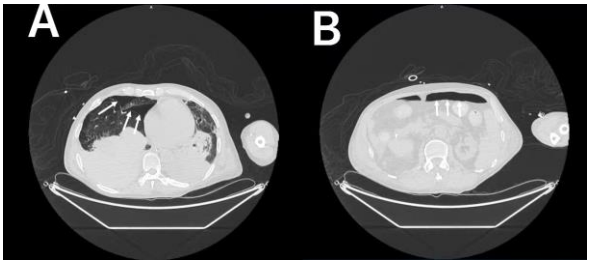

Fig-3:

Chest and Abdominal CT demonstrates that there is scatter free gas in Thoracic (A) and Abdominal (B) Cavity (white arrows)

Pneumothorax may be caused by barotrauma during mechanical ventilation. Owing to gas diffusing into the abdominal cavity via the defective diaphragm and gas being absorbed by the peritoneum, the compression on the lung and abdominal organs was significantly relieved. Finally, SPO_2 and the oxygenation index gradually rose (**Table-1**). Unfortunately, the patient experienced septic shock and remained unresponsive throughout the ICU stay. The patient expired peacefully 3 weeks after hospital admission.

Discussion

Diaphragmatic hernia combined with pneumothorax is very rare in clinical practice. Pneumothorax is

Table-1: Arterial Blood Gas

Time	pH	PO_2 (mmHg)	PCO_2 (mmHg)	SO_2 (%)	FiO_2 (%)	P/F
Before pneumothorax	7.31	100	45.8	98.9	70	143
Day of pneumothorax	7.32	58.2	55.9	87.4	100	58
One day after pneumothorax	7.35	107.6	51.5	98.6	100	107

PO2: Partial Pressure of Oxygen; PCO2: Partial Pressure of Carbon Dioxide; SO2: Saturation Oxygen; Fio2: Fraction of Inspired Oxygen; P/F: Oxygenation Index

usually secondary to hollow viscera perforation. Some patients are admitted to the hospital for tension pneumothorax, viscerothorax, and fecopneumothorax after occult traumatic diaphragmatic injury, often complicated by sepsis and poor prognosis [5-7]. Others suffer from recurrent spontaneous pneumothorax during their menstrual periods due to the rupture of ectopic endometrium over the diaphragm, resulting in diaphragmatic hernia and pneumothorax [8,9].

It is even rarer for pneumothorax to result from ventilator-associated barotrauma in a patient with a history of a traffic accident with associated traumatic diaphragmatic hernia 26 years ago. The CT also indicated diaphragmatic hernia and peripheral pulmonary bullae. The oxygen index decreased suddenly during invasive mechanical ventilation, and the X-ray showed pneumothorax and pneumoperitoneum. However, there was no tenderness or rebound tenderness, and there were numerous bullae. Therefore, we believe that the gas in the thoracic and abdominal cavities resulted from the lung via cracked bullae and diaphragmatic hernia. Compared with the previous CT, the tissue herniated into the thoracic cavity decreased after pneumothorax. We argued in a multidisciplinary discussion that chest drainage was not optimal. Interestingly, SPO_2 gradually rose the next day after pneumothorax. We might call this phenomenon "self-regulation between diaphragmatic hernia and pneumothorax." Vermillion et al. suggested that chest drainage could relieve tension physiology in diaphragmatic hernia with fecopneumothorax [6,7], but the situation in this patient was different, and chest drainage might aggravate tension physiology.

Diaphragmatic hernia combined with tension viscerothorax should be differentiated from tension pneumothorax. Although tension pneumothorax is fatal, chest drainage may lead to catastrophic cavitary organ perforation when viscerothorax occurs [7,10]. When diaphragmatic hernia is combined with tension viscerothorax, nasogastric tube decompression could relieve compression [11]. However, it is usually difficult to insert the nasogastric tube, and in such situations, we should not repeatedly try and must be alert to the risk of cardiac arrest.

Certainly, pneumothorax in this patient also needs to be differentiated from pleural residual space. There may be pleural residual space in patients who have an old diaphragmatic hernia after abdominal contents return to the abdominal cavity while the lung is atelectatic. Nevertheless, since pneumothorax and pneumoperitoneum coexisted in this patient, we still think that pneumothorax occurred [7].

We should learn from this case that mechanical ventilation should be applied cautiously, and respiratory parameters should be adjusted reasonably in patients at high risk of pneumothorax. Once mechanical ventilation is applied, patient-ventilator synchrony should be monitored to avoid high peak airway pressure. This patient received PEEP of 14 cmH_2O to expand the lung due to extensive lung consolidation in the early treatment period, which may have promoted pneumothorax. Fortunately, pneumothorax did not lead to catastrophic consequences due to the combined diaphragmatic hernia. There are some shortcomings in this case. Considering that high PEEP may aggravate pneumothorax, we reduced PEEP to 6 cmH_2O in the later period. We should monitor transpulmonary pressure dynamically, which could inflate the lung to the maximum extent while avoiding aggravating pneumothorax.

Above all, patients with pulmonary bullae should receive a lung-protective ventilation strategy. It is important to integrate history with physical examination in the differential diagnosis of patients with simultaneous pneumothorax and pneumoperitoneum. Lastly, whether to intubate chest drainage depends on the cause of pneumothorax and pneumoperitoneum, and the risks and benefits of chest drainage.

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Declaration of Conflicting Interests

The authors declare that there is no conflict of interest.

Written Informed Consent

Written informed consent was obtained from the patient's legally authorized representative for anonymized information to be published in this article.

Ethics Approval

Our institution waived the need for ethics approval for the collection, analysis, and publication of anonymized case reports.

Reference

[1] Hanna WC, Ferri LE, Fata P, Razek T, Mulder DS. The current status of traumatic diaphragmatic injury: lessons learned from 105 patients over 13 years. Ann Thorac Surg. 2008 Mar;85(3):1044-48. [**PMID**: 18291194]

[2] Perrone G, Giuffrida M, Annicchiarico A, Bonati E, Del Rio P, Testini M, Catena F. Complicated Diaphragmatic Hernia in Emergency Surgery: Systematic Review of the Literature. World J Surg. 2020 Dec;44(12):4012-31. [**PMID**: 32783122]

[3] Masahata K, Usui N, Nagata K, Terui K, Hayakawa M, Amari S, Masumoto K, Okazaki T, Inamura N, Urushihara N, Toyoshima K, Uchida K, Furukawa T, Okawada M, Yokoi A, Okuyama H, Taguchi T. Risk factors for pneumothorax associated with isolated congenital diaphragmatic hernia: results of a Japanese multicenter study. Pediatr Surg Int. 2020 Jun;36(6):669-77. [**PMID**: 32346849]

[4] Cremonini C, Lewis MR, Jakob D, Benjamin ER, Chiarugi M, Demetriades D. Diagnosing penetrating diaphragmatic injuries: CT scan is valuable but not reliable. Injury. 2022 Jan;53(1):116-21. [**PMID**: 34607700]

[5] Chern TY, Kwok A, Putnis S. A case of tension faecopneumothorax after delayed diagnosis of traumatic diaphragmatic hernia. Surg Case Rep. 2018 Apr 20;4(1):37. [**PMID**: 29679240]

[6] Vermillion JM, Wilson EB, Smith RW. Traumatic diaphragmatic hernia presenting as a tension fecopneumothorax. Hernia. 2001 Sep;5(3):158-60. [**PMID**: 11759804]

[7] McMahon KR, Lee M, Beal E, Merritt RE. Diaphragmatic Hernia Perforation Leading to Fecopneumothorax. Ann Thorac Surg. 2020 Apr;109(4):e251-53. [**PMID**: 31473180]

[8] Arakawa S, Matsudaira H, Noda Y, Yamashita M, Hirano J, Ogawa M, Ohtsuka T. Catamenial pneumothorax with partial liver herniation due to diaphragmatic laceration: a case report and literature review. J Cardiothorac Surg. 2021 Mar 17;16(1):23. [**PMID**: 33731157]

[9] Ciriaco P, Muriana P, Carretta A, Ottolina J, Candiani M, Negri G. Catamenial Pneumothorax as the First Expression of Thoracic Endometriosis Syndrome and Pelvic Endometriosis. J Clin Med. 2022 Feb 23;11(5):1200. [**PMID**: 35268286]

[10] Al Skaini MS, Sardar A, Haroon H, Al Ghamdi SM, Homran A, Rabie ME. Traumatic diaphragmatic hernia: delayed presentation with tension viscerothorax--lessons to learn. Ann R Coll Surg Engl. 2013 Mar;95(2):e27-29. [**PMID**: 23484976]

[11] Song IH. Tension gastrothorax in late-onset congenital diaphragmatic hernia, a rare but life-threatening condition: A case report. Medicine (Baltimore). 2021 Feb 19;100(7):e24815. [**PMID**: 33607846]