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Case report

Pneumomediastinum that progression to tension pneumoperitoneum after bronchioloalveolar lavage: A case report

Pien-Lung Po [a], Hsueh-Fen Bai [a,*], Chia-Heng Lin [a], Chen-Chun Lin [a,b]

[a] Division of Chest Medicine, Department of Internal Medicine, Shin-Kong Wu Ho-Su Memorial Hospital, Taipei, Taiwan, ROC
[b] Fu-Jen Catholic University School of Medicine, Taipei, Taiwan, ROC

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ABSTRACT

Background: Pneumomediastinum is an abnormal accumulation of air within the mediastinum. Herein, we report a rare case in which a patient initially developed pneumomediastinum and extensive subcutaneous emphysema after bronchoscopic bronchioloalveolar lavage (BAL). The condition then progressed to abdominal compartment syndrome leading to death.

Case presentation: An 80-year-old man with acute respiratory failure caused by severe pneumonia and septic shock, was admitted to our intensive care unit. Bronchoscopic BAL was performed for microbiological specimen collection. The patient developed subcutaneous emphysema after the procedure, and pneumomediastinum was identified on subsequent chest radiography. The patient initially received supportive care. However, he experienced persistent hypotension, which did not respond to vigorous fluid replacement and high dose vasopressor treatment. Physical examination revealed distended, tense abdomen with diffuse tympanic sound upon percussion. Computer tomography scan showed extensive subcutaneous emphysema, massive air accumulation in the retroperitoneal cavity, near total collapse of the inferior vena cava, and left sided shifting of intra-abdominal organs. The impression was tension pneumoperitoneum with abdominal compartment syndrome. The patient eventually died of refractory hypotension.

Conclusions: Iatrogenic injury is a rare condition. The common complications include hypoxia, bleeding, infection, arrhythmia, subcutaneous emphysema, and pneumomediastinum, and these can be managed conservatively. However, more complex and life-threatening conditions can be caused by tracheal perforation or alveolar rupture, and can lead to pneumothorax, pneumoperitoneum, or even abdominal compartment syndrome. A high level of suspicion is needed for early detection, and immediate decompression is required to prevent death.

1. Introduction

Abnormal accumulation of air within the human body can result in problems ranging from less severe conditions including subcutaneous emphysema to more serious ones such as pneumothorax, pneumomediastinum, and pneumoperitoneum. These can be caused by trauma or other complications leading to air leaking from the lungs or airways into the human cavity.

Subcutaneous emphysema, is a condition in which air is trapped in the subcutaneous layer of the skin, and is often managed conservatively. It indicates an unidentified source of air leak, which may further develop to air extravasation into other body cavities [1].

Pneumomediastinum is the accumulation of air or gas in the mediastinum. It is commonly attributed to high alveolar pressure with rupture or tracheobronchial perforation caused by performing medical procedures on the tracheobronchial tract [2]. Similar to subcutaneous emphysema, it is usually self-limiting and non-fatal. However, in patients on mechanical ventilation, without timely assessment and early intervention, it may lead to respiratory and cardiovascular compromise and even death. Conservative management for pneumomediastinum is typically acceptable in clinical practice. However, some patients require aggressive treatments [3]. Ventilation support with low positive end-expiratory pressure (PEEP) is recommended to prevent further deterioration [4].

Compared with subcutaneous emphysema, small amount of pneumothorax may resolve spontaneously without further intensive

* Corresponding author. Division of Chest Medicine, Department of Internal Medicine, Shin-Kong Wu Ho-Su Memorial Hospital 95, Wen-Chang Rd, Shih-Lin, Taipei 111, Taiwan.
E-mail addresses: tinmyozaw@gmail.com, icejack.strike@msa.hinet.net (H.-F. Bai).

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management. However, tension pneumothorax is a more life-threatening condition resulting in cardiopulmonary compromise. Although it rarely occurs, increasing intra-thoracic pressure with barotraumas after airway procedures, including flexible bronchoscopy, contributes to the development of pneumothorax or pneumomediastinum [5,6].

In pneumoperitoneum, gastrointestinal perforation caused by esophagogastroduodenoscopy or colonoscopy is the most common etiology. Nevertheless, airway management procedures, including nasopharyngeal catheter oxygen delivery [7], may cause iatrogenic gastric injury and subsequently air collection in the abdomen. Patients with pneumoperitoneum managed with mechanical ventilation, develop abdominal compartment syndrome, which is treated with decompressive laparotomy [8].

Herein, we describe a rare case in which the patient initially developed extensive subcutaneous emphysema and pneumomediastinum after bronchoscopic bronchioloalveolar lavage (BAL). Then, tension pneumoperitoneum progressed to severe abdominal compartment syndrome leading to death.

1.1. Case report

An 80-year-old man had a medical history of heart failure, ventricular tachycardia after dual chamber implantable cardioverter-defibrillator implantation, paroxysmal atrial fibrillation, chronic kidney disease, stage 3b, type 2 diabetes mellitus and hypertension. He was admitted to the regular ward initially diagnosed with acute exacerbation of heart failure, lung edema, and secondary pulmonary infection.

His physical examination findings upon admission were as follows: high blood pressure (141/131 mmHg); normal body temperature (38.2 °C); irregular heart rate (100 beats/min) without murmur; and respiratory rate (30 cycles/min) and presence of lung crackles.

Table 1 depicts the initial laboratory data upon admission. The complete blood cell count and serum chemistry findings were as follows: leukocytosis (white blood cell count: 17.7 × 10^3, segmented neutrophil: 92.0%), anemia (hemoglobin level: 11.1 g/dL), impaired renal function (creatinine level, 4.50 mg/dL, estimated glomerular filtration rate, 13.01 mL/min, with baseline creatinine, level ranging from 1.8 to 2.5 mg/dL 6 months prior) and elevated C-reactive protein (CRP 23.39 mg/dL). Chest radiography revealed right lung opacities.

The patient was initially ventilated with an oxygen mask at 6–10 L/min. However, it was advanced to Venturi Mask 50% at 12 L/min. Empiric antibiotic treatment and inotropic agent with dopamine were administered at the ward. Intravenous diuretics (bumetanide) were prescribed for heart failure with lung congestion. The patient initially received hemodialysis via the femoral double-lumen catheter. However, he removed the catheter by himself causing massive bleeding and subsequent respiratory distress. Then, he was transferred to the intensive care unit and was intubated for mechanical ventilation.

After he was transferred to the intensive care unit, chest radiography revealed diffused opacities in the right lung, with high oxygen demand (FiO2: 60%–80%, PEEP: 6–8 cmH2O, PC above PEEP: 16 cmH2O, and SpO2: 95%–98%). A permanent catheter was inserted via the right subclavian vein and flexible bronchoscopic BAL (OLYMPUS EVIS LUCERA 260) was then performed for microbiological specimen collection. However, the patient developed subcutaneous emphysema and chest radiography revealed pneumomediastinum without evident pneumothorax (Fig. 1). Iatrogenic injury caused by endotracheal tube insertion, permanent catheter deployment, and BAL was suspected. However, the injury became more apparent, and a causal correlation between subcutaneous emphysema and pneumomediastinum was observed after BAL, which was considered the main cause. Other risk factors that contributed to respiratory tract fragility might include profound infection and inflammation of the respiratory tract and intensive mechanic ventilation.

The patient then received high-frequency ventilator setting (FiO2: 90%, PEEP: 10 cmH2O, PC above PEEP: 16 cmH2O, and SpO2: 98%–100%). However, he presented with persistent hypotension, which did not respond to vigorous fluid replacement and high-dose vasopressor treatment. Physical examination revealed distended, tense abdomen with diffuse tympanic sound upon percussion. Subcutaneous emphysema remained unrelieved after intra-pleural pigtail drainage. Next, computer tomography scan was performed, and results showed extensive subcutaneous emphysema, massive accumulation of air in the retroperitoneal cavity, near total collapse of the inferior vena cava (Fig. 2), and left-sided shifting of intra-abdominal organs (Fig. 3). The impression was tension pneumoperitoneum with abdominal compartment syndrome. However, the patient eventually died of refractory hypotension, which was attributed to total collapse of the inferior vena cava leading to cardiopulmonary compromise.

Table 1
Laboratory data upon admission.

Serum chemistry profile	Results	Reference range
BUN level (mg/dL)	50	7–25
Creatinine level (mg/dL)	4.50	0.5–1.3
Sodium level (mEq/L)	140	133–145
Potassium level (mEq/L)	3.4	3.3–5.1
CRP level (mg/dL)	23.39	0–1
CBC		
White blood cell count (10^3/μL)	17.7	3.8–10
Hemoglobin level (g/dL)	11.1	11–16
Segmented neutrophil (%)	92.0	37–75

Abbreviation: BUN, blood urea nitrogen; CRP, C-reactive protein level; CBC, complete blood count.

2. Discussion

Abnormal accumulation of air in the human skin layers or body cavities can be associated with spontaneous, surgical, traumatic, or infectious etiologies. Several medical procedures performed in the intensive care unit in daily medical practice lead to catastrophic events such

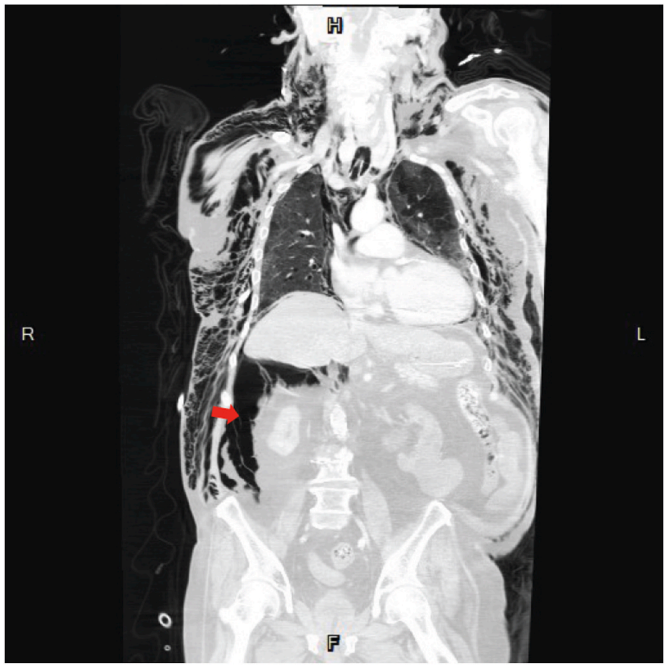

Fig. 1. Extensive subcutaneous emphysema and pneumomediastinum
Small arrow: continue diaphragm sign
Large arrow: ginkgo leaf sign.

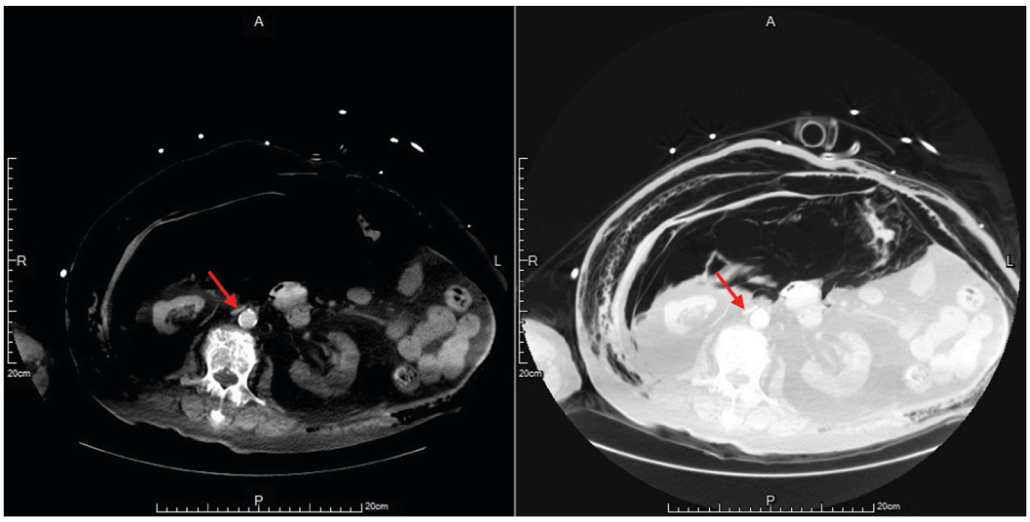

Fig. 2. Small arrow: near total collapse of the inferior vena cava.

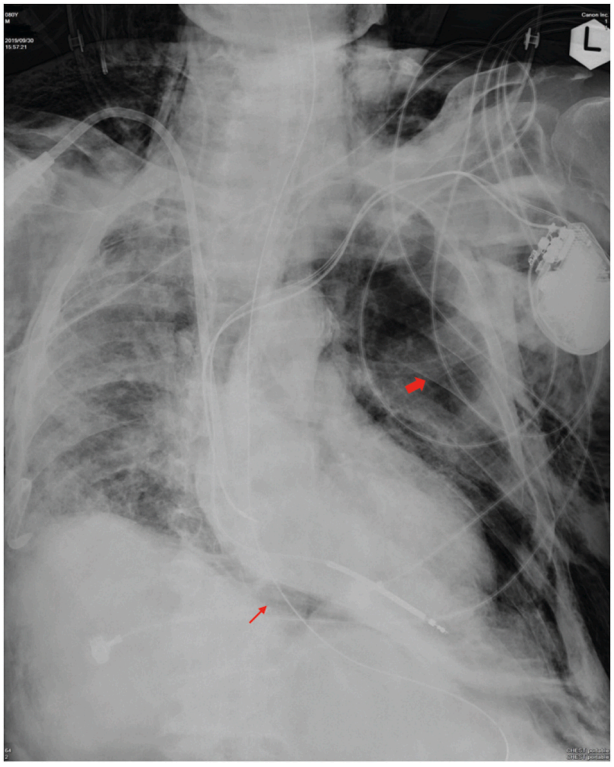

Fig. 3. Large arrow: pneumoperitoneum with left-sided shifting of intra-abdominal organs.

as iatrogenic air way injury caused by mal-manipulation of mechanical ventilator, traumatic intubation, over inflation of endotracheal tube cuffs, central venous access procedures, or even nasogastric tube placement [1]. Previous studies have reported the occurrence of esophageal or gastrointestinal perforation correlated with laryngoscopy, colonoscopy, and other endoscopic procedures for esophageal or gastrointestinal management.

BAL is a useful procedure for diagnosis and microbiological specimen collection with a relatively low risk. In a retrospective review conducted in 2008, the clinical records of 23,862 patients were assessed. Result showed that the rate of severe complications was 0.637%, and the mortality rate was 0.013% [9]. Geraci, G., et al. [10] performed a retrospective review of 107969 bronchoscopy procedures conducted from 1974 to 2006 and showed that the incidence of non-life-threating complications is low.

The complications associated with BAL include hypoxia, bronchospasm, hemoptysis, bleeding, cardiac arrhythmia, and infection [11]. Other serious complications are tracheal perforation, esophagotracheal fistula [9], and bronchopleural fistula [12]. The most common iatrogenic complications attributed to BAL are subcutaneous emphysema, pneumothorax, and pneumomediastinum [5,6,9,10,13–18]. Generally, accumulation of air is confined to the thorax and mediastinum. However, expansion of air into the peritoneal cavity, which might be caused by diaphragmatic injury, has also been recorded [19]. The etiologies of pneumoperitoneum were perforation of a hollow organ induced by trauma [20] or iatrogenic causes, such as complications of mechanic ventilation [21], endoscopic procedure [8], and surgery [22].

Herein, we described an 80-year-old man with heart failure who presented with acute pulmonary edema and suspect secondary lung infection. The patient developed extensive subcutaneous emphysema, pneumomediastinum, and tension pneumoperitoneum that progressed to abdominal compartment syndrome after BAL for microbiological specimen collection. Clinical examination showed extensive crepitus over the neck, shoulder, and trunk. Tense abdomen with diffuse tympanic percussion were also observed, which may indicate pneumoperitoneum. Abdominal compartment syndrome, which is commonly evaluated by measuring bladder pressure via a three-way Foley tube, was suspected. Hence, computer tomography scan was performed, and results showed massive accumulation of air in the retroperitoneal cavity, near total collapse of the inferior vena cava, and left-sided shifting of intra-abdominal organs. However, the exact point of air leak could not be identified. In our patient, the potential risks, which could be attributed to the occurrence of pneumomediastinum and pneumoperitoneum, might be fragility of the tracheobronchial tract caused by previous inflammation and pneumonia [3]. A series of mal-manipulation associated with endotracheal tube deployment, permanent catheter insertion, and BAL might be the major cause.

As shown in our case, this severe morbidity is rare. In the WEB database, a case report revealed a similar condition in which the patient experienced pneumomediastinum, pneumopericardium, pneumoperitoneum, interstitial lung emphysema, and subcutaneous emphysema [23]. In our case, abdominal compartment syndrome was highly suspected due to near total collapse of the inferior vena cava and left-sided shifting of intra-abdominal organs. This resulted in cardiopulmonary compromise, refractory hypotension and mortality. Based on this unique course and presentation, caution should be observed during

bronchoscopic BAL in the intensive care unit.

3. Conclusion

Endotracheal tube deployment, mechanic ventilation support and endoscopic airway management are used for diagnosis and treatment in modern medical practice. Iatrogenic injury is a rare condition. The common complications include hypoxia, bleeding, infection, arrhythmia, subcutaneous emphysema and pneumomediastinum, and these can be managed conservatively. However, more complex and life-threatening conditions can be caused by tracheal perforation or alveolar rupture and can lead to pneumothorax, pneumoperitoneum or even abdominal compartment syndrome. A high level of suspicion is needed for early detection, and immediate decompression is required to prevent death.

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Declaration of competing interest

The authors report no conflicts of interest. The authors alone are responsible for the content presented in this paper.

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References

[1] K. Kukuruza, A. Aboeed, Subcutaneous emphysema, in: StatPearls, 2020. Treasure Island (FL).
[2] S. Moreira-Silva, et al., Subcutaneous emphysema and pneumomediastinum as rare complications of transbronchial biopsy, BMJ Case Rep. (2016), 2016.
[3] M. Edwards, A.J. Ramappa, An uncommon cause of spontaneous pneumomediastinum and subcutaneous emphysema, Eur J Case Rep Intern Med 4 (4) (2017), 000549.
[4] S.L. Sathiyaseelan, N. Senthil, P. Varadaraj, Case of pneumomediastinum due to alveolar rupture following endotracheal intubation, BMJ Case Rep. 2018 (2018).
[5] M. Ok, V. Winograd Gomez, M. Mahmoud, Flexible bronchoscopy complicated by pneumomediastinum and subcutaneous emphysema, Paediatr. Anaesth. 29 (10) (2019) 1070–1071.
[6] M. Goicoechea Irigaray, I. Rodriguez Alvarado, M.T. Gomez Hernandez, Pneumomediastinum and subcutaneous emphysema after flexible bronchoscopy, Arch. Bronconeumol. 55 (6) (2019) 328.
[7] K. El-Kersh, H. Karnib, Tension pneumoperitoneum associated with nasopharyngeal catheter oxygen delivery during bronchoscopy, Am. J. Respir. Crit. Care Med. 196 (6) (2017) 785–786.
[8] M. Cadena, et al., Tension pneumoperitoneum: case report of a rare form OF acute abdominal compartment syndrome, Int J Surg Case Rep 55 (2019) 112–116.
[9] F. Jin, et al., Severe complications of bronchoscopy, Respiration 76 (4) (2008) 429–433.
[10] G. Geraci, et al., [Complication of flexible fiberoptic bronchoscopy. Literature review], Ann. Ital. Chir. 78 (3) (2007) 183–192.
[11] R.M. Schnabel, et al., Clinical course and complications following diagnostic bronchoalveolar lavage in critically ill mechanically ventilated patients, BMC Pulm. Med. 15 (2015) 107.
[12] S. Singh, et al., Bronchopleural fistula secondary to bronchoalveolar lavage-induced pneumothorax: a rare complication, Lung India 37 (2) (2020) 185–186.
[13] M. Baldi, et al., Pneumothorax after a bronchoalveolar lavage, J Bronchology Interv Pulmonol 25 (4) (2018) e45–e46.
[14] Y. Eguchi, et al., Latrogenic mediastinal emphysema and subcutaneous emphysema induced by bronchoscopic examination, Indian J. Chest Dis. Allied Sci. 58 (3) (2016) 185–187.
[15] S. Patolia, et al., Bilateral pneumothorax after bronchoscopy without biopsy–A rare complication: case presentation and literature review, J Bronchology Interv Pulmonol 19 (1) (2012) 57–60.
[16] T.T. Nicholson, G.M. Mutlu, Pneumothorax following bronchoalveolar Lavage for the Diagnosis of non-tuberculous mycobacterial infection. An <<atypical>> complication of bronchoscopy? Arch. Bronconeumol. 52 (5) (2016) 278–279.
[17] A. Jeyabalan, A.R. Medford, Post-bronchoalveolar lavage pneumothorax, QJM 106 (5) (2013) 479–480.
[18] H.J. Ahn, et al., Whole-lung lavage complicated with pneumothorax: a case report, Korean J Anesthesiol 70 (4) (2017) 462–466.
[19] K. Fujiwara, et al., Massive intraperitoneal free air induced by pneumothorax and pneumomediastinum, Int J Surg Case Rep 49 (2018) 78–80.
[20] A.C. Alder, J.L. Hunt, E.R. Thal, Abdominal compartment syndrome associated with tension pneumoperitoneum in an elderly trauma patient, J. Trauma 64 (1) (2008) 211–212.
[21] E. Garcia-Santos, et al., Abdominal compartment syndrome by tension pneumoperitoneum secondary to barotrauma. Presentation case], Cir. Cir. 83 (5) (2015) 429–432.
[22] S. Ersryd, et al., Editor's choice - abdominal compartment syndrome after surgery for abdominal aortic aneurysm: subgroups, risk factors, and outcome, Eur. J. Vasc. Endovasc. Surg. 58 (5) (2019) 671–679.
[23] G.E. Abraham, B.H. Sumrall, M.R. Bowling, The air apparent: a rare complication during flexible bronchoscopy, Am. J. Med. Sci. 341 (3) (2011) 243–245.