Case report: Tension pneumomediastinum from opioid inhalation

Rahul V. Nene, MD PhD\textsuperscript{a,}\textsuperscript{*}, Adam T. Hryniewicki, MD\textsuperscript{a}, Elizabeth Roderick, MD\textsuperscript{b}, Scott Chicotka, MD\textsuperscript{b}, Moises Hernandez Vazquez, MD\textsuperscript{b}, Patricia A. Thistlewaite, MD, PhD\textsuperscript{b}, Christanne Coffey, MD\textsuperscript{a}, Mazen F. Odish, MD\textsuperscript{c}
\textsuperscript{a}Department of Emergency Medicine, University of California San Diego, San Diego, CA, USA
\textsuperscript{b}Department of Surgery, Division of Cardiovascular and Thoracic Surgery, University of California San Diego, San Diego, California, USA
\textsuperscript{c}Department of Medicine, Division of Pulmonary, Critical Care, and Sleep Medicine, University of California San Diego, San Diego, CA, USA

Abstract

Pneumomediastinum is a rare complication of substance use, likely due to a Valsalva maneuver after drug inhalation. There are no previously documented associations between pneumomediastinum and opioid use. A 30-year-old man with a history of recent heroin and fentanyl inhalation presented to the emergency department in respiratory distress requiring intubation. His course was complicated by pneumomediastinum which subsequently developed tension physiology. He required emergent surgical decompression with a “blowhole incision” to his anterior chest. Although a rare complication of polysubstance use, pneumomediastinum can progress to tension physiology, requiring prompt diagnosis and management.

1. Introduction

Emergency department visits related to substance use disorder are becoming increasingly common [1], and emergency physicians should be prepared for the myriad ways these patients can present. Spontaneous pneumomediastinum (SPM) is a rare complication of substance use, and patients typically present with chest pain, shortness of breath, sore throat, and neck pain [2]. SPM usually has a benign course and self-resolves without intervention. However, rarely, SPM can progress to tension physiology, especially in patients requiring positive pressure ventilation. We present a case of tension pneumomediastinum associated with opioid inhalation and describe the medical and surgical management of such cases.
2. Case report

A 30-year-old incarcerated man with a history of polysubstance abuse presented with shortness of breath. He admitted to smoking fentanyl and heroin a few hours prior to arrival. His symptoms began the morning of presentation, including fatigue, malaise, and nausea. On arrival, the patient was afebrile, with a blood pressure of 105/97 mmHg, heart rate of 120 beats per minute, respiratory rate of 36 per minute, and initial oxygen saturation of 81% on room air, with improvement to 98% on 15 l nonrebreather facemask. He was toxic appearing. Bilateral rhonchi and crepitus along the anterior chest wall were noted on initial lung exam. The rest of his physical exam was unremarkable.

Chest x-ray was notable for pneumomediastinum with no evidence of pneumothorax (Fig. 1). The patient’s mental status and respiratory status worsened, requiring emergent intubation. Enhanced computed tomography (CT) scan of the chest confirmed extensive pneumomediastinum (Fig. 2). Thirty minutes later, the patient became more unstable and required vasopressor support, concerning for developing tension physiology. Repeat exam now showed the chest wall crepitus expanded to cover his entire anterior chest wall, neck, and lower face. The cardiothoracic surgery service was consulted for emergent surgical decompression of his pneumomediastinum, and a “blowhole incision” was performed at bedside. A 4-cm incision was made below the right clavicle and the incision depth was carried to the pectoralis major fascia, but did not enter muscle. A vacuum-assisted wound device (Wound vac: 3 M-KCI, San Antonio, TX) was placed within the defect, covered with an occlusive dressing, and suction begun at −125 mmHg (Fig. 3). His crepitus resolved over the next several hours, with x-ray resolution of his pneumomediastinum after 2 days. The patient was discharged on hospital day 21 neurologically intact.

3. Discussion

3.1. Pathophysiology

Pulmonary barotrauma is defined as alveolar damage secondary to positive pressure within the bronchial tree, leading to the accumulation of air in extra-alveolar areas, with the most common clinical manifestations being pneumothorax, pneumomediastinum, and subcutaneous emphysema [3]. In our case, we suspect that glottic closure immediately following deep inspiration from inhaled drug use created high positive pressure within the tracheobronchial tree, leading to alveolar rupture and tracking of air into the mediastinum, a phenomenon called the Macklin effect [4].

Inhalation or insufflation of multiple substances have been identified as risk factors in the development of SPM, including cocaine, marijuana, 3,4-Methyl enedioxy methamphetamine (MDMA), and nitrous oxide [5–8]. Case reports on SPM associated with methamphetamine, ketamine, mephedrone, hookah, and vaping have also been reported [9–12]. To our knowledge there are no previous case reports of heroin or other opioid inhalation or insufflation leading to SPM.
3.2. Medical management

SPM is typically a benign disease requiring only conservative management, including observation, bedrest, analgesics, and cough suppressants [2]. There is insufficient evidence to recommend the routine use of prophylactic antibiotics or administration of 100% oxygen. However, patients with pneumomediastinum receiving mechanical ventilation are at risk for further worsening barotrauma. Ventilator settings should be titrated to minimize respiratory rate, plateau pressure, and peak inspiratory pressures. This can be accomplished by reducing positive end-expiratory pressure (PEEP) and tidal volume (TV). For patients with persistent pneumomediastinum, extracorporeal membrane oxygenation (ECMO) may provide additional support [13,14].

3.3. Surgical management

Severe pneumomediastinum may result in tension physiology similar to cardiac tamponade. The increase in mediastinal pressure compromises venous return to the heart, leading to cardiovascular collapse [15]. This rare complication has no well-established treatment modality, however multiple surgical approaches have been historically described, such as decompressive sternotomy [16] and chest tube placement directly within the mediastinum [17]. Our cardiothoracic surgeons chose a less invasive procedure, utilizing a modified “blowhole incision” with negative pressure wound therapy (NPWT), which was also effective at resolving the patient’s extensive subcutaneous emphysema (Figs. 3 and 4). Although the incision does not directly violate the mediastinum, the connection between the tissue planes and the application of the NPWT is effective in draining the mediastinal air [18].

4. Why should an emergency physician be aware of this?

Patients with polysubstance abuse frequently visit emergency departments and can present with various vague complaints. Emergency physicians should be aware of the association between drug ingestion and thoracic barotrauma, as well as its management. In severe cases requiring intubation, emergency physicians should understand initial ventilator management strategies. They should also be aware that pneumomediastinum can progress to tension physiology, requiring emergent decompression.

Financial support

Mazen Odish is currently receiving a grant (T32GM121318) from National Institutes of General Medical Sciences, National Institute of Health.

References

[1]. QuickStats. Number of emergency department visits for substance abuse or dependence per 10,000 persons aged ≥18 years, by age group — United States, 2008–2009 and 2016–2017. MMWR Morb Mortal Wkly Rep. Dec. 2019;68(50): 1171. 10.15585/mmwr.mm6850a7. [PubMed: 31856150]

[2]. Takada K, et al. Management of spontaneous pneumomediastinum based on clinical experience of 25 cases. Respir Med. Sep. 2008;102(9):1329–34. 10.1016/j.rmed.2008.03.023. [PubMed: 18585025]
[3]. Gotway MB, et al. Thoracic complications of illicit drug use: an organ system approach. RadioGraphics. Oct. 2002;22(suppl_1):S119–35. 10.1148/radiographics.22.suppl_1.g02oc01s119. [PubMed: 12376606]

[4]. Macklin CC. Transport of air along sheaths of pulmonic blood vessels from alveoli to mediastinum. Arch Intern Med. Nov. 1939;64(5):913. 10.1001/archinte.1939.00190050019003.

[5]. Costeira De FS, Vieira F, Gomes FM, Leite C. Pneumomediastinum and subcutaneous emphysema: complication of cocaine use. BMJ Case Rep. Oct. 2019;12(10). 10.1136/bcr-2019-229205.

[6]. Weiss ZF, Gore S, Foderaro A. Pneumomediastinum in marijuana users: a retrospective review of 14 cases. BMJ Open Respir Res. 2019;6(1):e000391. 10.1136/bmjrresp-2018-000391.

[7]. Obiechina NE, Jayakumar A, Khan Y, Bass J. Bilateral pneumothorax, surgical emphysema and pneumomediastinum in a young male patient following MDMA intake. BMJ Case Rep. Apr. 2018;2018. 10.1136/bcr-2017-223103.

[8]. Tavare AN, Li D, Hare SS, Creer DD. Pneumomediastinum and pneumorrhachis from recreational nitrous oxide inhalation: no laughing matter. Thorax. 2018;73(2): 195–6. 10.1136/thoraxjnl-2017-210291. [PubMed: 28743767]

[9]. Chen G-A, Yang C-C. Late diagnosis of methamphetamine inhalation related pneumothorax, pneumomediastinum and diffuse subcutaneous emphysema: a case report. J Acute Med. Mar. 2018;8(1):30–3. 10.6705/jacme.201803_8(1).0005. [PubMed: 32995199]

[10]. Williams J, Hsu E, Flamer-Caldera A, Ferrabolli YJ. The special K constellation, a rare presentation of ketamine use: a case report. Cureus. May 2019;11(5):e4766. 10.7759/cureus.4766. [PubMed: 31363447]

[11]. Graham R, Bowen N, Singh J. Mephedrone inhalation causes pneumomediastinum. BMJ Case Rep. Mar. 2014;2014. 10.1136/bcr-2014-203704.

[12]. Alaska YA. Spontaneous pneumomediastinum secondary to hookah smoking. Am J Case Rep. May 2019;20:651–4. 10.12659/AJCR.915118. [PubMed: 31056536]

[13]. Daoud O, et al. Extracorporeal membrane oxygenation in 5 patients with bronchial fistula with severe acute lung injury. Ann Thorac Surg. Jul. 2011;92(1):327–30. 10.1016/j.athoracsur.2011.01.060. [PubMed: 21718865]

[14]. Odish MF, et al. Treatment of bronchopleural and alveolopleural fistulas in acute respiratory distress syndrome with extracorporeal membrane oxygenation, a case series and literature review. Crit Care Explor. May 2021;3(5):e0393. 10.1097/CCE.0000000000000393. [PubMed: 34036268]

[15]. Beg MH, Reyazuddin, Ansari MM. Traumatic tension pneumomediastinum mimicking cardiac tamponade. Thorax. Jul. 1988;43(7):576–7. 10.1136/thx.43.7.576. [PubMed: 3212757]

[16]. Jennings S, Peeceeyen S, Horton M. Tension pneumomediastinum after blunt chest trauma. ANZ J Surg. Jan. 2015;85(1–2):90–1. 10.1111/ans.12378. [PubMed: 24172602]

[17]. Campisi A, Poletti V, Ciarrocchi AP, Salvi M, Stella F. Tension pneumomediastinum in patients with COVID-19. Thorax. Dec. 2020;75(12):1130–1. 10.1136/thoraxjnl-2020-215012. [PubMed: 32747475]

[18]. Son BS, Lee S, Cho WH, Hwang JJ, Kim KD, Kim DH. Modified blowhole skin incision using negative pressure wound therapy in the treatment of ventilator-related severe subcutaneous emphysema. Interact Cardiovasc Thorac Surg. Dec. 2014;19(6):904–7. 10.1093/icvts/ivu287. [PubMed: 25164135]
Fig. 1.
Chest x-rays during hospitalization. A. Initial chest x-ray at presentation, demonstrating air within the mediastinum (arrow). B. Chest x-ray post intubation, 3 h after arrival. C. X-ray during tension physiology, demonstrating extensive subcutaneous air (star), 4 h after arrival. D. X-ray following blowhole incision and resolution of pneumomediastinum and subcutaneous air, hospital day 3.
Fig. 2.
Enhanced computed tomography during hospitalization demonstrating pneumomediastinum, extensive subcutaneous emphysema, and eventual resolution. A: coronal section, hospital day 1. B: transverse section, hospital day 1. C: coronal section, hospital day 4, D: transverse section, hospital day 4. Arrows: mediastinal air. Star: lung consolidation, likely from a combination of atelectasis, aspiration and pneumonia.
Fig. 3.
Application of negative pressure wound therapy. A: A 4 cm incision is made on the anterior chest below the clavicle. B: Blunt dissection is carried down to maximize egress of the subcutaneous emphysema. C: Black wound vacuum sponge is placed in the wound bed. D: Negative suction pump is connected.
Fig. 4.
Blowhole Incision on Anterior Chest with a Negative Pressure Wound Vacuum. Chest tattoo blurred for patient confidentiality.