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Pneumomediastinum Following Endotracheal Intubation

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Clinical Research

Scholarship in Medicine Proposal

By checking this box, I indicate that my mentor has read and reviewed my draft proposal prior to submission

Abstract

EP, an 81-year-old female with a history of multiple metastases presented to the Emergency Department (ED) for shortness of breath. She developed respiratory failure requiring endotracheal intubation. She was successfully intubated, treated with etomidate, succinylcholine, propofol, fentanyl, and admitted to the Intensive Care Unit (ICU). A follow up chest CT at 2 hours demonstrated an incidental finding of pneumomediastinum.

Key Words: Pneumomediastinum, mediastinal emphysema, air in mediastinum

Introduction/Literature Review

Pneumomediastinum is a relatively uncommon phenomena presenting as air in the mediastinum. Clinical presentations can include, but are not limited to, dyspnea, chest pain, or dysphagia. The physiology of pneumomediastinum is appreciated by an abnormal increase of pressure within the mediastinum. In order for air to travel to mediastinum, the pressure gradient must be low, relative to surrounding organs.¹ Suspicions of this process arise with clinical symptoms as described above. Confirmation of pneumomediastinum requires a diagnostic chest radiograph or computed tomography scan. X-rays alone may not be enough as an additional CT may be necessary to identify small amounts of pneumomediastinum.² Radiographic findings include elevation of the thymus in the pediatric population, ring sign (air surrounding the pulmonary arteries), double bronchial wall, or air adjacent to the spine.

Pneumomediastinum may arise spontaneously or secondary to trauma, disease, recreational drugs or intubation.⁵ Of the two, secondary pneumomediastinum is more prevalent.⁶ In the emergency department, endotracheal intubation is often performed to improve oxygenation, ventilation, and to protect the airway. It is thought that trauma due to intubation may be a possible cause as well as predisposing factors such as esophageal rupture or concomitant infection.⁷ Rupture may be complicated by reinsertion of a dislodged tracheostomy or multiple endotracheal intubation attempts.^{2,8} Rarely, acute pneumonia can lead to alveolar rupture causing pneumomediastinum if the pneumonia is not treated.⁹ Pneumomediastinum has been shown to exacerbate acute asthma attacks and decompression therapy of pneumomediastinum may relieve the exacerbation.¹⁰ Data and complications regarding secondary pneumomediastinum are limited in the published literature, but a case shows a delay in treatment may worsen prognosis.¹¹ Outcomes are typically favorable when treated appropriately with rest and treating the

underlying cause, as the disease is often self-limiting. In a study measuring reoccurrence spontaneous pneumomediastinum, 1 out of 18 patients had recurrent spontaneous pneumomediastinum when treating the underlying cause.⁴

Clinical Questions

Can endotracheal intubation lead to pneumomediastinum, a rare but life-threatening complication? Are interventions needed for resolution of pneumomediastinum?

Case Description/Summary

History and Presentation

EP, an 81-year-old female with past medical history of metastatic cancer and hiatal hernia presented to the emergency department for altered mental status, and dyspnea. Physical examination demonstrated EP was unable to be fully assessed due to altered mental status, but she was able to open eyes to stimuli. She had symmetric breath sounds without wheezes, rales or rhonchi, regular rate rhythm with S1 and S2, and warm, dry skin. Laboratory studies included a leukocytosis with a WBC count of 17.9k/mm³, calcium 8.4 mg/dL, glucose 400 mg/dL, albumin 3.2 g/dL and negative troponins. Chest radiography prior to intubation was remarkable for a large hiatal hernia. She had presented to the ED one day prior to this current visit for hypoglycemia and was subsequently discharged home following treatment. She had a past medical history of hyperglycemia secondary to steroids; metastatic cancer in her brain, pancreatic tail, kidney, and peritoneum; lumpectomy for invasive ductal carcinoma of the breast in 2015. One year ago, the patient's family members began noticing back pain, memory, and balance impairment with slowly deteriorating functional status. She was scheduled to have her

pancreatic mass biopsied a day after her current ED visit. In the ED, mental status worsened, and she developed respiratory failure requiring intubation.

Diagnostic Focus and Assessment

(What were the steps that led toward the diagnosis? What was the thought process? What were the test results?)

Before any intubation attempts, etomidate 10 mg and succinylcholine 40 mg were administered. Cricoid pressure was utilized. Video laryngoscopy failed on the first attempt to visualize the vocal cords as there was difficulty securing the epiglottis. On second attempt, another dose of succinylcholine 40 mg was administered. Direct visualization with a Miller blade allowed for successful visualization of the vocal cords and a 7.0 cuffed endotracheal tube was placed 23 cm to the dental ridge. However, the patient vomited and potentially aspirated gastric contents. 2 hours post-intubation, chest CT scan confirmed a large amount of air in the upper mediastinum, more in the left aspect but no air in the lower mediastinum (figure 1). CT neck the following day showed resolution of subcutaneous emphysema and no evidence of tracheal or esophageal injury. The following night, patient self-extubated but SpO₂ remained in 90s so reintubation was not required. A Gastrografin swallow the morning after found no extravasation.

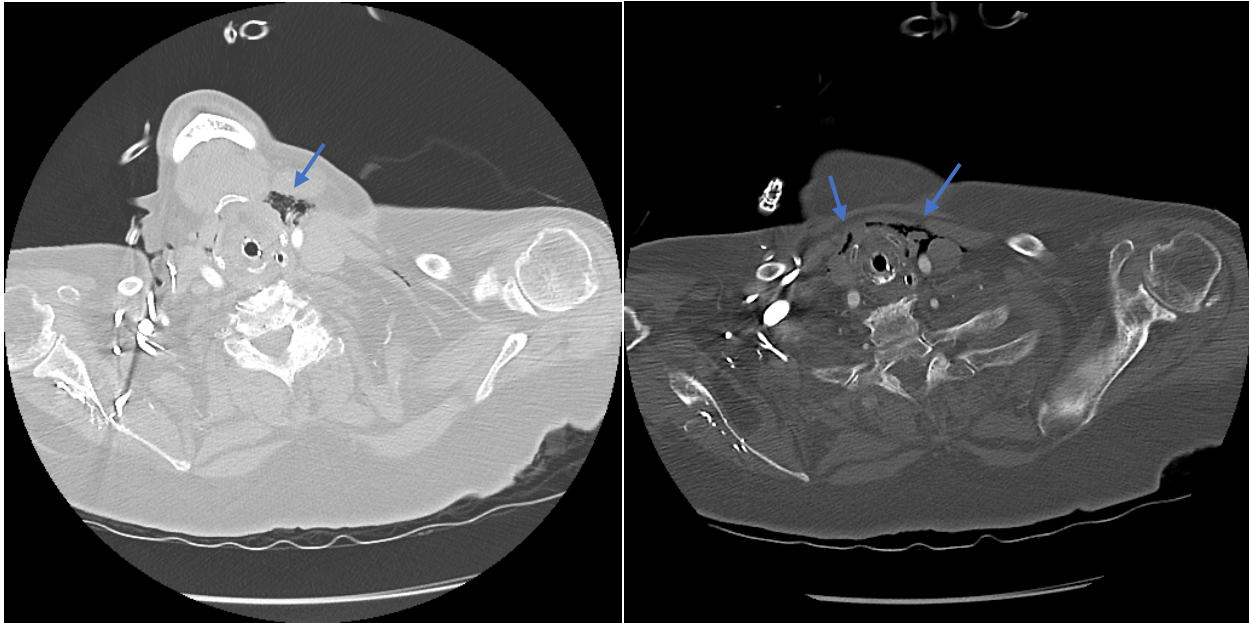


Figure 1a (left) and Figure 1b (right): Arrows pointing to areas of hyperlucency adjacent to trachea on non-contrast CT indicate pneumomediastinum

Therapeutic Focus and Assessment

Cardiothoracic surgery and ENT were consulted for potential surgical interventions, but both felt medical management was superior. ENT recommended a Gastrografin swallow study following spontaneous resolution to rule out further injuries; results were insignificant. EP was managed post extubation with oxygen and a spontaneous resolution followed.

Follow-up and Outcome

Ultimately, the patient was hospitalized in the ICU for 8 days before being discharged to home hospice for multiple metastases. She was treated for hypoglycemia and altered mental status while admitted to inpatient service. 45 days after hospitalization, EP expired due to complications of previous conditions.

Analysis of Diagnostic Assessment/Therapeutic Interventions

Compared to direct laryngoscopy, video laryngoscopy is associated with fewer intubation attempts required for successful intubation and fewer complications such as aerodigestive trauma, hypoxemia, death, etc. Thus, it is the preferred method of intubation.¹⁸ During the first attempt, video laryngoscopy failed to secure an airway for EP and a Miller blade was used to secure the glottis on the second attempt. Video laryngoscopy and the Miller blade have shown best outcomes for visualization of the glottis when compared to the other airway devices.²⁰

A follow up chest CT was taken 2 hours post-intubation. For pneumomediastinum, CXR has a 52% sensitivity and 100% specificity while chest CT has a 50% sensitivity, 90%. Despite having similar efficacies, CT allows for greater visualization and localization. In this case, the known failed intubation attempts prompted the decision to order a chest CT because of increased risk for pneumomediastinum. Moreover, increased mediastinal air on initial CT has a direct correlation with mortality. The added benefit of CT also helps to rule out concomitant pneumopericardium or pneumothorax, which can be life-threatening.^{12, 13}

Gastrografin swallow was done shortly thereafter to rule out any signs of active aerodigestive perforation. Water soluble agents, such as Gastrografin, are used because of their quick absorption compared to barium. The benefit of potential perforation identification outweighs the rare risk of necrotizing pneumonitis secondary to Gastrografin.¹⁵

Discussion and Connection to Literature

Pneumomediastinum is defined as air in the mediastinum and has been studied as early as 1827. Underlying pathophysiology for primary pneumomediastinum involves increased alveolar pressure resulting in air leakage into mediastinum. Secondary pneumomediastinum can stem

from iatrogenic causes, such as intubation, toxin/drug ingestion, or pre-existing pulmonary pathologies. Mechanism of injury for EP most likely involves direct perforation of the trachea or esophagus resulting in leakage of air or from increased intrathoracic pressure. Negative past medical history of drug abuse rules out the likely possibility of drug-related complications, but no drug screen was collected in the ED. The most common symptoms include neck/chest pain, odynophagia, and dyspnea. Additionally, there are several cases studying iatrogenic pneumomediastinum; failed intubation attempts are the most common complication of airway management.¹⁶ Multiple attempts (>2) are heavily associated with complications and mortality.¹⁷ The incidence of complications between first and second attempts increases by 42% and by 10% between second and third attempts.¹⁹ The increase in risk with failed attempts elucidates the importance of maximizing chances of successful intubation.

Pneumomediastinum most commonly self-resolves without surgical management when placed on oxygen, rest, and analgesic medications.¹⁴ Prognosis is good with spontaneous resolution as air is usually absorbed into surrounding tissues over time.⁵ EP did not have any prior existing airway disease facilitating timely recovery without intervention despite acute hypoxic respiratory failure and self-extubation 2 days post-intubation. A multidisciplinary effort between critical care, ENT, and cardiothoracic surgery prevented unnecessary interventions and allowed for enabled recovery.

Conclusion

Pneumomediastinum secondary to intubation is a rare phenomenon that could be caused by tracheobronchial injury. It carries a good prognosis with multidisciplinary medical management. Chest CT is the test of choice when assessing for severity of pneumomediastinum. Other investigative studies can help rule out concerning pathologies.

Patient Perspective

Patient is deceased. Consent was obtained on the date of the ED visit, which includes consent for photography

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