Acute tracheal tear – A potential cause of spontaneous pneumomediastinum in patients with COVID-19

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Abstract

Spontaneous pneumomediastinum following prolonged periods of severe coughing should raise the suspicion of tracheal rupture in COVID-19 patients.

Introduction

Spontaneous pneumomediastinum (SP) is defined as free air in the mediastinum without an obvious cause. SP is a rare and usually benign self-limiting condition with only a few cases reported in the literature. There have however been a small number of cases recently reported on SP in coronavirus disease 2019 (COVID-19) patients. Authors suggest that the development of SP is a poor prognostic sign and an indicator of worsening disease [1]. We describe three patients with an acute tracheal tear who developed SP prior to initiation mechanical ventilation.

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Case Report

Case #1

A 66-year-old male with no past medical history or smoking history, a body mass index (BMI) of 27 (kg/m^2), was admitted with severe cough and shortness of breath, known to be COVID-19 positive. Prior to admission, he had been symptomatic with ten days of coughing, breathlessness and fevers. The patient was started on high flow nasal cannula (HFNC) oxygen therapy, received dexamethasone and tocilizumab, and admitted to the intensive care unit (ICU) for ongoing monitoring. Computerized tomographic pulmonary angiogram (CTPA) performed on admission demonstrated a small pneumomediastinum tracking from the right anterior heart border, surrounding the aortic arch and right paratracheal region. At this time no tracheal defect was seen. Computerized tomographic (CT) thoracic scan two days later, demonstrated significant free air surrounding the tracheal wall and in the soft tissues with a small defect noted within the right posterior tracheal wall. This was reported as suggesting a spontaneous tracheal defect or tear and noted to be in the absence of a history of penetrating trauma. The patient developed hiccups raising the possibility of diaphragmatic phrenic nerve irritation and soon after required intubation and mechanical ventilation. Post intubation, the patient developed increasing subcutaneous emphysema spreading into the orbits and left skull convexity, worsening pneumomediastinum and pneumoperitoneum that was not responsive to drainage. Bronchoscopy was performed which confirmed a tracheal tear in the lower 1/3 of the membranous trachea extending to the origin of the carina. Given the patient's status, it was viewed that the best approach to the tear, would be to manage it conservatively. Microbiologist advice was solicited to maximize antimicrobial therapy. The patient was paralyzed, and the endotracheal tube was advanced to the carina. Repeat bronchoscopies demonstrated the tear to be healing. However, the patient subsequently died of multiorgan failure.

Case #2

A 61-year-old male with a medical history of relapsing gastric lymphoma and a BMI of 27 (kg/m^2), maintained on rituximab therapy was admitted to the hospital with 16 days of fever and cough after being noted positive for COVID-19. He tolerated oxygen via a face mask for ten days before desaturating and requiring transfer to ICU for HFNC oxygen therapy. CTPA performed on admission demonstrated extensive pneumomediastinum with

extension of free air into the subcutaneous tissues of the base of the neck. Within 24 hours, the patient deteriorated requiring intubation. Post-intubation, he developed worsening subcutaneous emphysema in the left neck fascia, lateral chest wall and supraclavicular fossae. Repeat CT thorax demonstrated significant interval worsening of the pneumomediastinum and neck subcutaneous emphysema. Bronchoscopy was performed which demonstrated a 4mm tear posteriorly at the level of the carina below the endotracheal tube with evidence of granulation tissue formation. Microbiologist advice was solicited due to the concern of mediastinitis. Unfortunately, the patient developed multiorgan failure and died secondary to worsening respiratory failure and sepsis.

Case #3

A 70-year-old male with a medical history of hypertension and a BMI of 31 (kg/m^2), had been unwell for 7 days prior to being found hypoxic, confused and with a continuous cough. He was admitted directly to ICU for HFNC oxygen therapy. Admission CTPA demonstrated a large and extensive pneumomediastinum extending from the diaphragmatic hiatus into the neck which appeared to exert a small degree of mass effect on the surrounding lung. Within twenty-four hours, he deteriorated rapidly and required intubation. Post-intubation chest radiology demonstrated new subcutaneous emphysema in the left supraclavicular fossa and in the soft tissues of the thorax. Bronchoscopy was performed which demonstrated two tracheal tears 4cm apart: a tear posteriorly 5mm long and a tear anteriorly 4mm long. Following surgical, microbiological and intensive care consultation, both tears were managed conservatively. The SP and subcutaneous emphysema both significantly improved. However, the patient deteriorated and died as a consequence of multiorgan failure.

Discussion

Spontaneous pneumomediastinum (SP) is a rare condition often occurring in the setting of trauma, surgery or mechanical ventilation. During the initial Severe Acute Respiratory Syndrome (SARS) outbreak in 2004, which was secondary to a coronavirus (SARS-CoV) infection, SP was noted in 11.6% of patients unrelated to assisted mechanical ventilation [2]. It is not known if any of these patients had SP associated with a tracheal tear. The incidence of SP in patients with severe COVID-19 infection is not known.

The pathophysiology of SP is based on free air from alveolar rupture, in the setting of high intra-alveolar pressure. This may result in air dissecting the bronchovascular sheath into the mediastinum [1,2]. The air may continue to dissect through fascial planes into the neck, or abdomen resulting in extensive subcutaneous emphysema, known as Hamman's crunch [3]. With COVID-19, the increase in intra-alveolar pressure from coughing, straining or mechanical ventilation, could damage the already weakened alveoli leading to pneumomediastinum. If mediastinal pressures continue to increase, air can escape from the mediastinal pleura into the pleural space producing a pneumothorax [1].

Similarly, the pathophysiology of a spontaneous tracheal tear is related to the development of a sudden rise in intra-tracheal pressure secondary to severe coughing with an already weakened membranous trachea [4]. Our findings support the concept that the development of pneumomediastinum and subcutaneous emphysema, following prolonged periods of severe coughing, in patients with COVID-19, should raise the suspicion of tracheal rupture.

None of our patients developed a pneumothorax prior to or after mechanical ventilation. Pneumothorax is rare in the context of tracheal tears but not uncommon in mechanically ventilated patients due to barotrauma and volutrauma [1]. It is hypothesized that because the tears were healing or protected by the endotracheal tube, these patients were not at greater risk of developing pneumothoraces than other COVID-19 patients treated in our department. Had the tears been in the bronchi, though rare, this would allow for communication into the pleural space, thus putting the patients at increased risk for developing pneumothoraces [5]. Additionally, though none of our patients had a history of underlying lung disease, all three had a BMI over 25 (kg/m^2) which represents an independent risk factor for pulmonary complications, including alveolar damage, pulmonary oedema and thrombi [1].

Research undertaken in 2004 on SARS-CoV and again in 2020 on COVID-19, found patients developed SP at day 19.6+/- 4.6 from the onset of COVID-19 symptoms [1,2]. Our patients presented with SP at day 7, day 13, and day 26 of symptoms. It is noteworthy, Patient 3 who developed SP on day 7, had two tracheal tears. We suspect Patient 3 experienced shearing forces and deceleration from violent movements such as bending back and forth associated with coughing, resulting in two tracheal tears occurring opposite to one another in a linear plane.

When there is a suspicion of tracheal tear, bronchoscopy is a diagnostic tool which allows confirmation and direct visualization of the tear. Treatment options include conservative management, tracheal stents or surgical repair. In patients who have significant comorbidities, who are deemed unfit for surgical intervention, conservative management is the mainstay of treatment [6].

Our experience suggests that acute tracheal tear is associated with poor prognosis when it occurs in patients with severe COVID-19 infection. We recommend that all patients who are positive for COVID-19, who show signs of SP, should undergo urgent bronchoscopy to exclude a tracheal tear. Early diagnosis is essential to permit multidisciplinary team discussion to define appropriate therapeutic strategies.

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