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Case Report

Dramatic complication of pneumothorax treatment requiring lifesaving open-heart surgery ☆

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ABSTRACT

Pneumothorax is an extremely common entity that is typically readily diagnosed and treated. Standard treatment for a small pneumothorax in an otherwise healthy patient is oxygen and observation. For many cases of pneumothorax (those that are larger, more symptomatic, occur in patients with underlying lung disease, or occur in patients who live far from an emergency facility), treatment includes needle aspiration or chest tube placement. We report the clinical presentation and imaging appearance of a 47-year-old female who had a trocar traverse the heart during pleural chest tube placement. Based on this case, policies in the emergency department were reviewed and quality measures were improved.

Introduction

A pneumothorax occurs when air leaks into the space between lung and chest wall (the pleural space). It has many potential causes, some of which include trauma, medical instrumentation, and underlying pulmonary disease such as chronic obstructive pulmonary disease or pneumonia. It may also be idiopathic. Some risk factors include smoking, mechanical ventilation, and history of prior pneumothorax. Common symptoms include acute chest pain and shortness of breath. Treatment involves oxygen and observation for minor cases and needle and chest tube placement for more severe cases.

Case report

A 47-year-old obese female, height 168 cm, weight 108 kg, body mass index 40, with multiple medical problems presented to the Emergency Department (ED) with spontaneous chest pain and rapidly progressive dyspnea. There was no history of trauma. The initial chest x-ray was negative (Fig. 1). Because of progressive symptoms, the patient was intubated. A subsequent chest radiograph following intubation demonstrated a large tension pneumothorax (Fig. 2). This case was pre-COVID-19 pandemic; thus, the virus could not account for the diagnosis of pneumothorax. Initial pneumothorax may have been the

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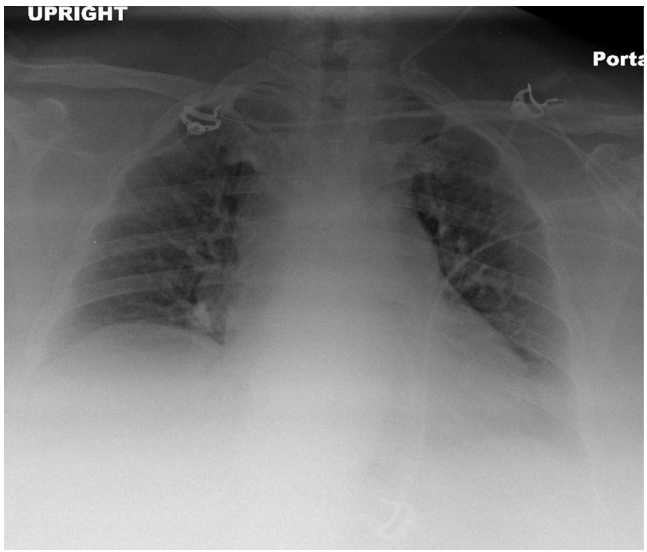

Fig. 1 – Initial anteroposterior chest x-ray shows no infiltrate and no definite pneumothorax.

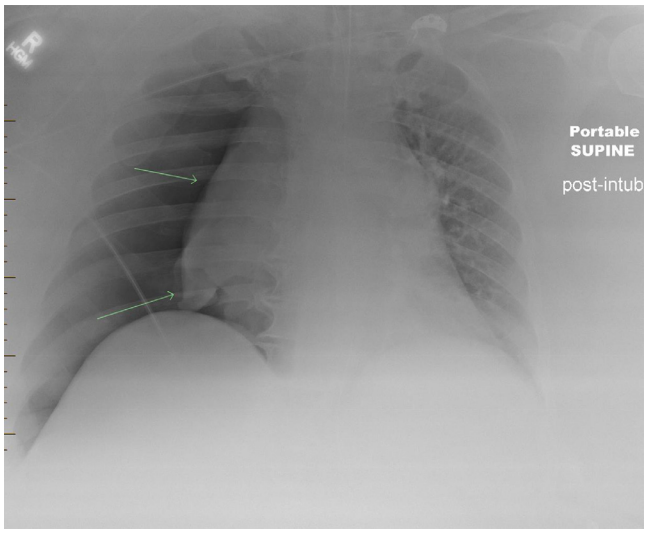

Fig. 2 – Chest x-ray after intubation demonstrates a large tension pneumothorax.

result of mild emphysema and small apical blebs (not shown). It is possible that the mechanical ventilation caused the pneumothorax, and it is likely that the barotrauma from the ventilation made the pneumothorax much larger and visible on radiograph.

Chest tube was deemed necessary. A 24 French chest tube and trocar was inserted via the right chest wall. The tube placement inadvertently included the trocar along with the catheter. The trocar traversed the heart and extended into the contralateral left lung (Fig. 3). This was detected with post procedure chest radiograph. The trocar was removed, but the catheter was temporarily left in the heart near the pulmonary outflow tract. Both interventional radiology and cardiothoracic surgery were immediately consulted. The patient was

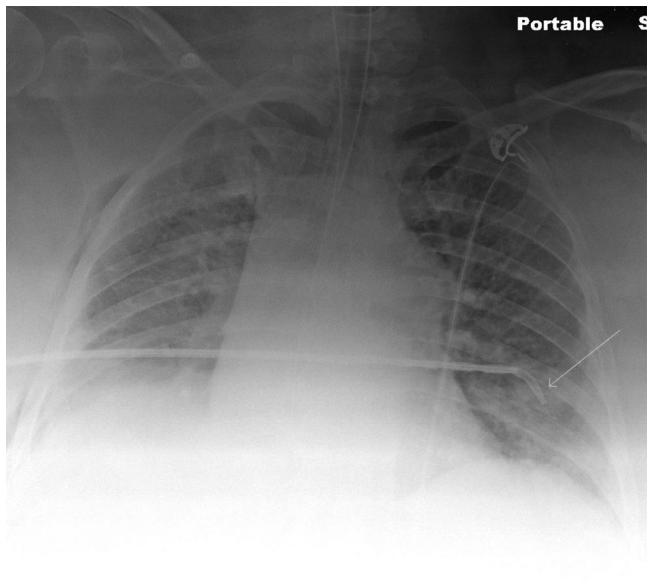

Fig. 3 – Chest x-ray after chest tube placement shows both chest tube and trocar traversing the heart.

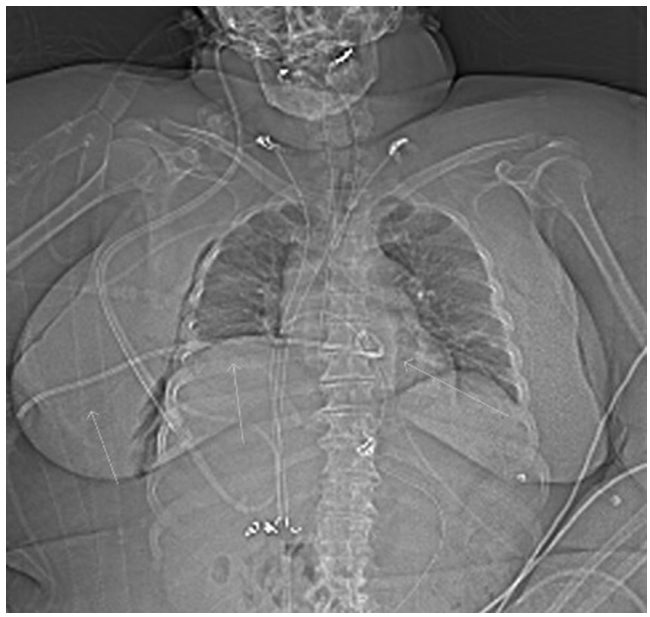

Fig. 4 – Chest CT scout film after removal of trocar demonstrates chest tube within the heart near the pulmonary outflow tract.

diagnosed with inadvertent placement of the trocar along with the chest tube, both traversing the right lung, the heart, and the left lung, with the tube ultimately lodging in the heart (Figs. 4-6). Emergent thoracotomy for direct visualization of chest tube removal and surgical exploration of cardiac and pulmonary trauma was performed on the same day. The device was safely removed. Surgical exploration revealed that the catheter had predominantly traversed fibrous cardiac tissue. Mild hemorrhage was detected in both lungs. The

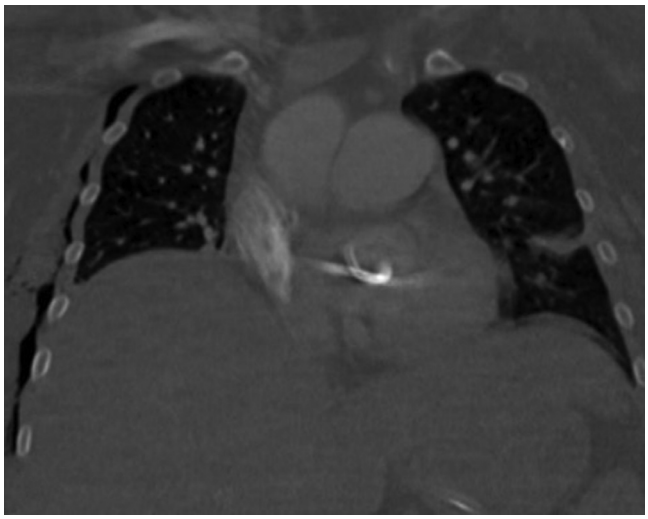

Fig. 5 – Chest CT coronal image demonstrates chest tube within the heart.

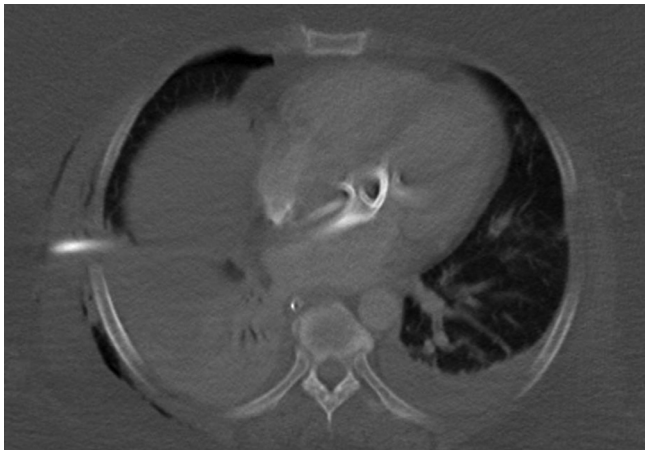

Fig. 6 – Chest CT axial image with bone window shows catheter traversing the interatrial septum and terminating just anterior to the left atrium

patient had a prolonged hospitalization but was ultimately discharged in good health.

Discussion

The word pneumothorax comes the Greek "pneumo" meaning air and "thorax" meaning chest. The term's first use is credited to the French physician Itard, a student of Laennec [1]. In the normal state, the lungs are fully inflated because the pressure inside the airways is greater than the pressure inside the pleural space. In the pathologic state, air enters the pleural space, the pleural pressure increases, and the lung contracts.

Pneumothorax can be divided, by etiology, into spontaneous or traumatic. Spontaneous pneumothorax is further divided into primary (those occurring in patients with normal lungs) and secondary (those occurring in patients with underlying lung pathology). Causes of traumatic pneumothorax include gunshot wound, motor vehicle accident, subclavian catheter placement, needle aspiration, lung biopsy, and mechanical ventilation [2].

Patients with primary pneumothorax are at a low risk for developing the serious complication of tension. Patients with secondary pneumothorax are at a higher risk for tension, since their lung disease often leads to one-way valve mechanics and air trapping. Tension compromises respiratory and cardiac function and can be fatal if left untreated.

The symptoms of pneumothorax typically include chest pain, shortness of breath, and, when secondary, hypoxemia and hypercapnia. Five percent of patients have no symptoms. Spontaneous pneumothorax usually occurs at rest. Patients with secondary pneumothorax are often more symptomatic than the pneumothorax size on plain film might suggest. Up to 50% of pneumothorax can be missed on the initial chest radiograph after trauma [3].

The American College of Chest Physicians (ACCP) defines a small pneumothorax as one having an apical length of less than 3 cm. The British Thoracic Society (BTS) defines a small pneumothorax as one having a "chest wall to outer lung edge" measuring less than 2 cm (while more than 2 cm is large). PSP (primary spontaneous) may be observed if the patient has no symptoms and the pneumothorax is of small size. If intervention is needed, the BTS recommends simple aspiration as a therapeutic option, whereas the ACCP recommends only the use of an indwelling chest tube. For refractory cases, both advise surgery or pleurodesis. The ACCP does not recommend computerized tomography (CT) for evaluation of pneumothorax, but the BTS does, especially for estimating volume and to exclude other entities. Clinical assessment is probably the most important determinate of treatment, even more so than size [4].

Oxygen therapy is useful. With high flow oxygen, nitrogen disappears from the pleural cavity, leaving only oxygen, which is then absorbed faster from the pleural cavity and into the veins. The BTS advises high flow oxygen (10 L/min) in symptomatic patients, with note to take caution of over-oxygenation in chronic obstructive pulmonary disease, patients. Oxygen at a high flow rate may hasten resorption by as much as 4 times.

The decision to admit and place a chest tube is based on pneumothorax size, extent of symptoms, primary versus secondary, and distance from the treatment center.

Regarding the chest tube, it is advisable to avoid thick tubes, as there is no evidence that thicker tubes offer superior results. The efficacy of suction is not well verified and adds the potential downside of re-expansion pulmonary edema. Risk factors for re-expansion pulmonary edema include patient age less than 40, pneumothorax more than 3 days old, large pneumothorax size, significant negative pressure, and rapid lung re-expansion. Aspiration (where a needle is temporarily inserted, air is aspirated, and the needle is then removed) has a 55% success rate. Up to 25% of chest tube placements have complications. This is usually because of an inability to place the tube or an incorrect tube placement and happens more frequently with less experienced clinicians [5].

There are 3 techniques most commonly used to place a chest tube. The standard technique employs a blunt dissection to access the pleural space. The Seldinger technique uses serial dilatation over a guide wire; after introduction of an introducer needle into the pleural space, a guidewire is inserted through an introducer needle, then dilators are employed, and a chest tube is placed. The third technique includes the use of a trocar. After penetrating the pleural space, the trocar, and drain together are advanced toward the apex by using force.

A proceduralist can confirm that a drain is in the pleural cavity if the chest drain fogs up, a fluid level in the chest drain internal pipe swings, the prime fluid level bubbles when the patient coughs, or the pleural fluid drains from the chest [6].

Mechanical ventilation greatly increases the risk of tension. If mechanical ventilation is planned, chest tubes are often placed even for small pneumothorax.

In our case, the patient's body habitus and underlying lung disease made initial detection of the pneumothorax difficult. The patient was intubated for symptomatic shortness of breath, mechanical ventilation was started, and the subsequent chest radiograph detected a pneumothorax. It is possible that the pneumothorax developed after mechanical ventilation began. Subsequently, the chest tube and trocar were placed, and the trocar and catheter inadvertently lodged into the heart near the pulmonary outflow tract. Anatomically, the trocar passed through the ipsilateral skin, subcutaneous fat, intercostal muscle, parietal pleura, pleural space, visceral pleura, lung parenchyma, inner visceral pleura, inner pleural space, and inner parietal pleura. Then, it continued through the pericardium, the myocardium, out the contralateral side of the pericardium, and the contralateral parietal pleura, pleural space, visceral pleura, and lung. It seems that the device fortuitously predominantly traversed thick fibrous tissue within the heart, preventing sudden exsanguination and death. The thoracic surgeon elected to take the patient to the operating room immediately to safely remove the device under direct open inspection, and to control life-threatening hemorrhage, should it occur. The thoracotomy went well and resulted in no further complications. The patient remained an inpatient for an extended period of time but was ultimately discharged in good condition. Consequently, policies regarding chest tube placement training and supervision were reviewed and improved.

Patient Consent

Patient consent for publication of this case was obtained.

Supplementary Material

Supplementary material associated with this article can be found, in the online version, at doi:10.1016/j.radcr.2020.12.034.

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