Chapter

138 Pneumothorax

ANITA SHARMA

INTRICACIES OF PNEUMOTHORAX

A pneumothorax is defined as the presence of air between visceral and parietal pleura that leads to lung collapse. The term was used in the doctoral thesis of the French physician Itard in 1803, although the presence of an abnormal collection of air and fluid within the chest might have been inferred as early as the fifth century BC by physicians in ancient Greece who practiced the so-called Hippocratic succussion of the chest[1].

PATHOPHYSIOLOGY OF PNEUMOTHORAX

In normal people, because of the inherent tendencies of the lungs to collapse and the chest wall to expand, the pleural space has a negative pressure compared with atmospheric pressure. Since the alveolar pressure is always greater than the pleural pressure (due to elastic recoil of the lung), a communication between an alveolus and the pleural space results in airflow down the pressure gradient until equilibrium occurs or until the communication is sealed[2]. As the pneumothorax enlarges, the lung becomes smaller. The main physiologic consequence of this process is a decrease in the vital capacity and the partial pressure of oxygen. Young and otherwise healthy patients can tolerate these changes fairly well, with minimal changes in vital signs and symptoms, but those with underlying lung disease may have respiratory distress. Decrease in vital capacity may lead to respiratory insufficiency with alveolar hypoventilation and respiratory acidosis. Most patient with a pneumothorax have a reduced arterial PO_2 and an increase in alveolar-arterial oxygen tension difference[3].

Classification

It is usually classified on the basis of its cause. Trauma (iatrogenic or accidental) is a common cause of pneumothorax. When pneumothorax occurs without preceding trauma, it is classified as spontaneous pneumothorax, either primary (without clinically or radiographically apparent lung or chest wall disease), or secondary (when such disease is present)[4].

Incidence: The incidence of pneumothorax is probably underestimated, since patients with a small spontaneous pneumothorax may not seek medical attention. In one study, diagnosis of pneumothorax was made in 318 patients between 1950 and 1974. The age-adjusted annual incidence of primary pneumothorax was 7.4 per 100,000 men and 1.2 per 100,000 women. The annual incidence of secondary pneumothorax was 6.3 per 100,000 men and 2.0 per 100,000 women[5]. In a large study , spontaneous pneumothorax occurred in 723 (60.3%) of 1,199 cases; of these, 218 were primary and 505 were secondary. Traumatic pneumothorax occurred in 403 (33.6%) patients, 73 (18.1%) of whom had iatrogenic pneumothorax[6].

PRIMARY SPONTANEOUS PNEUMOTHORAX (PSP)

Etiology: It occurs in patients without a precipitating event or underlying lung disease, most of these patients have a variety of emphysematous lesions detected by computed tomography of the chest or during thoracoscopic surgery [7].

These subpleural emphysematous blebs are usually located in the apex of the lung[8]. There is strong association between smoking and the development of a PSP.

The occurrence of a spontaneous pneumothorax is related to the level of cigarette smoking[9].

Patients with PSP tend to be younger, taller and thinner than control persons[10]. An increased length of the chest may contribute to the formation of the subpleural blebs. Because pleural pressure falls about 0.20 cm of H_2O per cm vertical height, pleural pressure will be more negative at the apex of the lung in taller than in shorter people: accordingly the alveoli at their lung apex are subjected to greater mean distended pressure over an extended period. This could lead to the formation of the subpleural blebs in those tall people who are genetically predisposed to bleb formation.

SECONDARY SPONTANEOUS PNEUMOTHORAX (SSP)

Although almost every lung disease can result in SSP, chronic obstructive pulmonary disease is the most common cause[11] (Table 1). The incidence of SSP increases with age.

Table 1: Causes of secondary spontaneous pneumothorax according to frequency

Airway disease
Chronic obstructive pulmonary disease
Cystic fibrosis
Status asthmaticus
Infectious lung disease
Pneumocystis carinii pneumonia
Necrotizing pneumonias
Interstitial lung disease
Sarcoidosis
Idiopathic pulmonary fibrosis
Pulmonary Langerhans cell histiocytosis
Lymphangioleiomyomatosis
Tuberous sclerosis
Connective tissue disease
Ankylosing spondylitis, Polymyositis, Dermatomyositis, Scleroderma
Marfan's syndrome, Ehlers-Danlos syndrome
Cancer
Sarcoma
Lung cancer
Miscellaneous
Catamenial pneumothorax
Pneumothorax ex vacuo
Aerosolized pentamidine isethionate (NebuPent, Pentacarinat, Pentam) therapy

Etiologic factors: Chronic obstructive pulmonary disease (COPD) is the most common underlying disease in patients with SSP, although almost any lung disease can lead to SSP[12]. In the last few years, one of the diseases most commonly associated with SSP has been the acquired immunodeficiency syndrome(AIDS) – associated *Pneumocystis carinii* infection.

Iatrogenic Pneumothorax: Transthoracic needle aspiration or biopsy is the leading cause of iatrogenic pneumothorax (Table 2). The overall incidence is about 20%, and risk increases with deeper insertions, multiple passes, and smaller lesions, in addition to the presence of underlying obstructive lung disease[13,14].

Table 2: Causes of iatrogenic pneumothorax according to frequency

Transthoracic needle aspiration or biopsy
Thoracentesis
Closed pleural biopsy
Transbronchial biopsy
Subclavian or jugular vein catheterization
Mechanical ventilation
Cardiopulmonary resuscitation
Nasogastric tube placement
Tracheostomy
Liver biopsy

Tension Pneumothorax: A tension pneumothorax developes when the intrapleural pressure exceeds the atmospheric pressure throughout expiration and often during inspiration as well. Most patients who develop a tension pneumothorax are receiving positive pressure to their airways—either during mechanical ventilation or during resuscitation—for a tension pneumothorax to develop in a spontaneously breathing person; some type of one-way valve mechanism must be present. Hypoxia results as the collapsed lung on the affected side and the compressed lung on the contralateral side compromise effective gas exchange. This hypoxia and decreased venous return caused by compression of the relatively thin walls of the atria impair cardiac function. The decrease in cardiac output results in hypotension and, ultimately, in hemodynamic collapse and death to the patient, if untreated.

Clinical Manifestations of Pneumothorax: It has got a wide spectrum of clinical presentations, asymptomatic patients to a critically sick condition—depending on the degree of lung collapse and underlying lung pathology. In general, the clinical symptoms associated with SSP are more severe than are those associated with PSP. Like chest pain, dyspnea, respiratory distress, unilateral decreased/ absent breath sounds, hyper-resonance on percussion, tachycardia, pulsus paradoxus, tracheal deviation and hypotension.

Tension pneumothorax should also be suspected in any patient undergoing cardiopulmonary resuscitation

in whom ventilation is difficult. Tension pneumothorax should also be suspected in any patient who deteriorates suddenly who already has a pneumothorax, or who has undergone a procedure known to cause a pneumothorax.

Diagnosis:

Chest radiograph (confirms pneumothorax)

- A linear shadow of visceral pleura with lack of lung markings peripheral to the shadow may be observed, indicating collapsed lung.
- In supine patients, deep sulcus sign with radiolucency along costophrenic sulcus may help to identify occult pneumothorax.
- Mediastinal shift toward the contralateral lung may also be apparent.
- Small pleural effusions are commonly present, and increase in size if the pneumothorax does not re-expand.

CT scan is not recommended for routine use

Methods to estimate the fractional size of pneumothorax are controversial:

- There are currently two methods described in adults:If lateral edge of lung is > 2cms from thoracic cage, then this implies pneumothorax is at least 50%, and hence large in size.
- Calculate the ratio of the transverse radius of the pneumothorax (cubed) to the transverse radius of the hemithorax (cubed). To express the pneumothorax size as a percentage, multiply the fractional size by 100.

Treatment

The therapeutic approach to pneumothorax depends on its type, size, and clinical presentation; the number of prior episodes; co-morbid diseases; and underlying lung pathology. An important factor for appropriate treatment is the amount of lung collapse Although there are no evidence-based medical standards of practice for treatment of pneumothorax, the American College of Chest Physicians and the British Thoracic Society have both published guidelines based on expert consensus[15,16]. The ultimate goal is to decrease the likelihood of recurrence after an initial episode of pneumothorax.

Primary Spontaneous Pneumothorax

A treatment algorithm for primary spontaneous pneumothorax is shown in Fig. 1. Small pneumothorax usually does not require intervention unless there is an ongoing air leak; short-term observation is usually sufficient. No further management or follow-up is required if the chest X-ray film reveals a stable or smaller pneumothorax in 24 hours. High-flow oxygen should be given when possible, it acts by decreasing the amount of nitrogen in the blood and creating a nitrogen gradient between the air in the pleural cavity and the pleural capillaries that results in gas resorption. It should be noted that the effect is modest (about 1 to 2% of the volume in the chest in 24 hours).

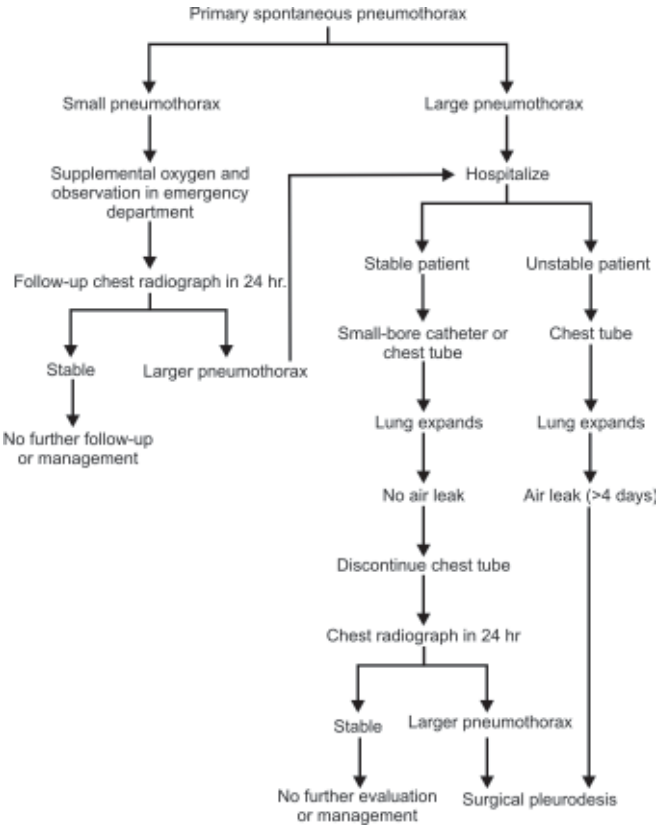

Fig. 1: Treatment of primary spontaneous pneumothorax

Patients with a large pneumothorax, regardless of clinical stability, usually require placement of small-bore catheters or standard chest tubes. Drainage with or without suction should continue until the lung expands and the air leak resolves. Most of these patients should be hospitalized. In those who expand the lung without an air leak, the chest tube can be removed quickly. Most experts do not recommend pleurodesis for the initial episode in stable patients. If an air leak persists for more than 4 days, surgical pleurodesis is warranted. Some form of pleurodesis should be considered if there is recurrence.

Secondary Spontaneous Pneumothorax

In contrast to a small PSP, a small secondary spontaneous pneumothorax is a cause for hospitalization. The threshold for chest tube placement is lower in SSP and depends on the severity of underlying lung disease and on clinical stability (Fig. 2). Large pneumothoraces should be drained with a chest tube. Many patients with SSP should undergo surgical pleurodesis to prevent another episode, which could be fatal. Indications for surgical intervention include bilateral spontaneous pneumothorax, second ipsilateral pneumothorax, first contralateral pneumothorax, persistent (>4 days) air leak in spite of continuous tube drainage, and high-risk professions (e.g., pilots and deep-sea divers).

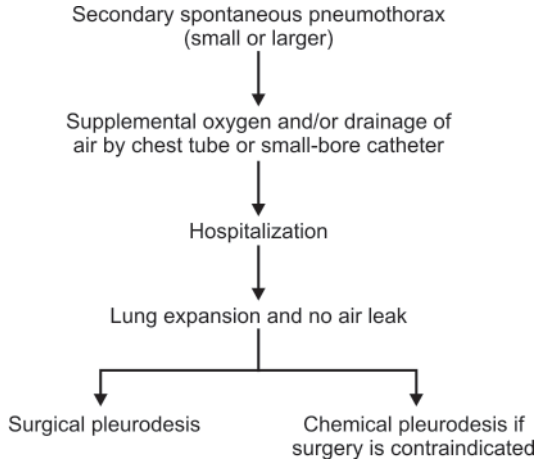

Fig. 2: Treatment of secondary spontaneous pneumothorax

Chemical pleurodesis may be an alternative for patients in whom surgery is contraindicated. Commonly used chemical agents are talc slurry, doxycycline, and bleomycin sulfate (Blenoxane). Talc slurry is found to be the most effective, but there have been reports of acute respiratory distress syndrome after its instillation into the pleural space.

Iatrogenic Pneumothorax

Treatment of iatrogenic pneumothorax is usually simple, and therapy to prevent future occurrence is not needed. Simple aspiration of air with a small-bore catheter and oxygen supplementation are sufficient. However, in the setting of mechanical ventilation, the risk of tension pneumothorax is high and chest tube drainage is necessary[17].

Tension Pneumothorax

Treatment of tension pneumothorax should commence immediately after diagnosis, without waiting for further consultation and/or evaluation. If a tension pneumothorax is suspected, immediately administer 100% oxygen, and evaluate the patient for evidence of respiratory compromise, hemodynamic instability, or clinical deterioration. Place large-bore catheters, because hemothorax can be associated with pneumothorax. Immediately perform needle thoracostomy or chest tube placement if the clinical condition warrants such action. Once a needle thoracostomy has been performed, chest tube insertion must follow. The process of lung re-expansion and healing is not immediate and may be complicated by pulmonary edema. A chest tube is, therefore, usually left in place for at least 3 days unless the clinical condition warrants a longer placement.

Special Considerations

Special treatment may be needed for patients who deep-sea dive, pilot aircraft, or have HIV infection. Types of pneumothorax that call for particular consideration include catamenial pneumothorax, pneumothorax ex vacuo, and familial spontaneous pneumothorax.

Conclusion

Pneumothorax can occur in a variety of clinical settings. Categorizing a pneumothorax as primary or secondary, as well as determining its size, is a rational approach to treatment. Small primary spontaneous pneumothoraces often require no intervention, while a secondary spontaneous pneumothorax almost always requires drainage because of the high risk of complications for the patient.

In an emergency situation, one should believe more on eyes than ears, and treat the patient, not the chest X-ray.

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