Pneumothorax and insertion of a chest drain

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Abstract

A pneumothorax occurs when the visceral or parietal pleurae are breached and air enters the pleural space. This leads to loss of the negative intrapleural pressure and lung collapse. Pneumothoraces are classified according to the aetiology as spontaneous (which may be primary or secondary depending on the underlying pathology) or traumatic. Further descriptive terms such as tension, open or sucking describe features of the pneumothorax that may guide management.

A chest X-ray is essential in the diagnosis and management of any pneumothorax, with the strict exception of tension pneumothoraces. These are clinical emergencies that should be diagnosed clinically and decompressed immediately with needle thoracocentesis without delay for imaging. Chest drains are the definitive management for complex pneumothoraces and are indicated when aspiration is unsuccessful in controlling symptoms in a simple pneumothorax. A thoracic surgical opinion should be sought if there is persistent air leak from the drain or the lung fails to re-expand after 3 days.

Chest drains (also known as intercostal drains, pleural drains or tube thoracostomy) may be used to drain air, blood, fluid or pus from the pleural space. Although insertion of a chest drain is a common procedure, the risk of injury or death may be up to 2% and has been the subject of a National Patient Safety Agency (NPSA) Rapid Response Report. Proper attention should be paid therefore to patient preparation, which should include full consent, asepsis, appropriate patient positioning, and application of NPSA and British Thoracic Society recommendations. Ultrasound guidance is recommended for effusions, but is not required for pneumothoraces. The procedure is usually performed under local anaesthesia in the 'safe triangle' of the lateral chest wall using a Seldinger technique or blunt dissection. Following insertion, careful attention must also be paid to the management of the chest drain.

Keywords Chest drain; chest surgery; effusion; empyema; pleura; pleurectomy; pneumothorax; thoracocentesis; trauma; video-assisted thoracic surgery

Anatomy

The visceral pleura is a very thin membrane that is tightly adherent to the outer surface of the lung. It is continuous at the hilum of the lung with the parietal pleura, which covers the internal aspect of each hemithorax (mediastinum, diaphragm, chest wall and apex of the chest). A closed potential space exists between the two pleurae filled with a film of fluid secreted by the mesothelial lining of the pleural surfaces. A near constant negative intrapleural pressure (−0.5 kPa) in this space results from the elastic recoil of the lungs away from the chest wall, preventing lung collapse.

Pathophysiology

A pneumothorax occurs when *either* the visceral or parietal pleura are breached. This allows air to enter the pleural space, leading to loss of the negative intrapleural pressure and lung collapse. It is important to remember that breach of the parietal pleura can occur along the chest wall (such as in an open injury) or along the mediastinum (e.g. with a ruptured oesophagus).

A simple pneumothorax is a catch-all term for any non-tensioning, non-traumatic pneumothorax. These are the most common type and usually occur when air from the lung enters the pleural space via a ruptured bleb or bulla. The intrapleural pressure usually remains negative relative to the atmosphere. As the lung collapses, the air leak may seal itself spontaneously, in which case treatment may not be necessary. There is no loss of function of any other intrathoracic organs other than the affected lung.

A tension pneumothorax occurs if air continues to enter the pleural space with each breath despite complete collapse of the lung. This one-way valve effect causes increasingly positive intrapleural pressure leading to deviation of the mediastinum away from the pneumothorax. It is this 'tension' on the great vessels that impairs venous return and causes the haemodynamic instability that gives the condition its name. Untreated, death results from a combination of absence of ventilation of either lung, and electromechanical dissociation of the heart.

An open (sucking) pneumothorax due to chest trauma is also life-threatening. It occurs where there is a defect in the chest wall larger than two-thirds of the diameter of the trachea. As a result, movement of air in and out of the thorax during respiration occurs preferentially through the wound rather than the airways, and the pleural space rather than the lung parenchyma is aerated.

Aetiology

Primary spontaneous pneumothorax (PSP) occurs in the absence of known or suspected underlying lung disease. Patients are typically tall, young (20–30 years old) male smokers. Incidence is 18–20 per 100,000 males per annum and 1.2–6/100,000 in women. PSPs are caused by rupture of subpleural blebs (air-filled spaces between the lung parenchyma and the visceral pleura). The lungs are normal with the exception of these blebs, which are most commonly located at the apices of the lung or along the fissures. PSP is slightly more common on the right side.

Secondary spontaneous pneumothorax (SSP) occurs due to overt underlying lung disease, most commonly emphysematous conditions such as chronic obstructive airways disease. Other causes include asthma, respiratory infections (both acute and chronic), interstitial lung diseases, and connective tissue disorders. There is

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a significantly higher morbidity and mortality associated with SSP. Pneumothorax is very rarely the first manifestation of a thoracic malignancy.

Catamenial pneumothorax is a type of SSP that was once considered a rare curiosity, but may in fact account for between 3 and 6% of spontaneous pneumothoraces in women. It implies the development of an SSP related to menstruation. In patients with a history of pelvic endometriosis, endometrial tissue is thought to traverse diaphragmatic defects or embolize, leaving thoracic deposits. These can cause recurrent pneumothoraces that typically occur 72 hours from the onset of menstruation. Another mechanism is migration from air from the Fallopian tubes via the peritoneal cavity and into the pleural space through small diaphragmatic defects.

Traumatic pneumothorax may be iatrogenic (e.g. following central line insertion, percutaneous lung biopsy, and pleural aspiration) or due to blunt or penetrating trauma. The presence of surgical emphysema or multiple rib fractures in the trauma patient should raise a strong index of suspicion for pneumothorax or lung injury. Other causes include rupture of the intrathoracic oesophagus due to a forceful vomit against a closed glottis (Boerhaave's syndrome) or iatrogenic perforation at endoscopy.

Diagnosis

The most common presenting symptoms for any pneumothorax are pleuritic pain and dyspnoea. The severity of symptoms does not necessarily correlate with the size of the pneumothorax. A large pneumothorax may be associated with reduced chest wall movement, resonance to percussion, reduced or absent tactile fremitus, and absent or reduced breath sounds on the affected side. Tracheal deviation away from the side of the pneumothorax, raised jugular venous pressure or engorged neck veins with haemodynamic compromise suggest tension pneumothorax. Clinical examination may be normal for a small pneumothorax.

An erect posteroanterior radiograph of the chest in inspiration is usually sufficient to diagnose and estimate the size of a pneumothorax. Occasionally diagnosis is more difficult as illustrated by the radiograph in Figure 1. A CT scan of the chest may be considered the gold standard and is helpful when the diagnosis is in doubt such as cases where extensive surgical emphysema or giant bullae are present. It is also useful in diagnosis of complications of pneumothorax such as empyema and haemothorax.

Management

A tension pneumothorax is a medical emergency and, if suspected clinically should be treated with *immediate* needle thoracocentesis with a wide bore venflon in the second intercostal space in the mid-clavicular line. The needle stylet should be left in place as the chest wall will otherwise kink the cannula and impede decompression. Classically, 'you should never see an X-ray of a tension' as decompression should not be delayed for radiography. Definitive treatment is by insertion of a chest drain.

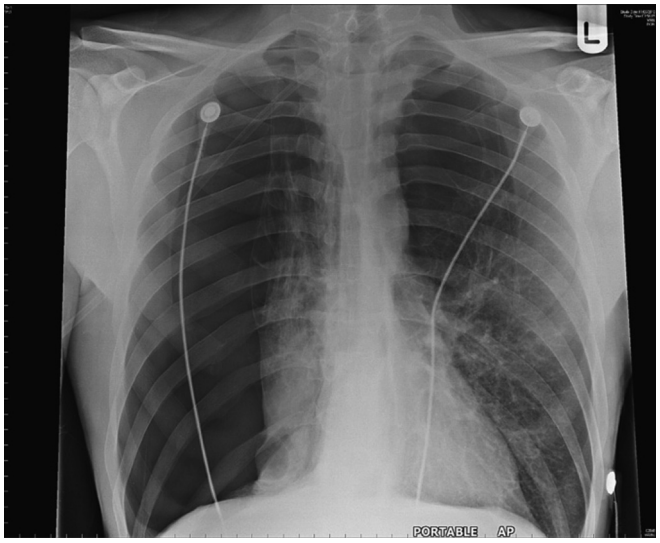

Figure 1 A chest radiograph in a patient with a right-sided pneumothorax and a large emphysematous bulla on the left. There are lung markings visible peripherally in relation to the bulla that are not present on the side of the pneumothorax.

Open pneumothorax requires immediate treatment to provide closure of the wound with a makeshift one-way flutter valve. This is usually made of a square, airtight dressing material taped on three sides, with one edge of the square free. Definitive treatment usually requires surgical assessment, although if this is delayed in any way, a chest drain can temporize.

Spontaneous pneumothorax management is determined primarily by the severity of symptoms, although the extent of lung collapse and underlying cause should also be considered. A visible rim of air 2 cm from the chest wall (at the level of the hilum in the UK, rather than apex to cupola as in US guidelines) equates to 50% loss of lung volume. British guidelines dictate that observation is appropriate first-line treatment for small (<2 cm), closed, mildly symptomatic spontaneous pneumothoraces. For secondary pneumothoraces, due to the potential for deterioration, this should be in hospital over 24 hours. Small primary pneumothoraces can be seen in outpatient clinics with advice to return if symptoms deteriorate. Needle aspiration of up to 2.5 L is also advocated as first-line treatment prior to chest drain insertion for small (1–2 cm) SSP or any size PSP, as resolution and recurrence rates are similar. It is less successful in secondary pneumothorax. Aspiration should typically only be performed on a single occasion, escalating the treatment strategy to small bore chest drainage if this fails. The chest drain is connected to an underwater seal drainage system and does not require suction for the first 48 hours. Where air leak continues beyond this time, high-volume, low-pressure (−10 kPa to −20 kPa) suction may be applied to promote visceral and parietal apposition and pleurodesis.

The opinion of a thoracic surgeon should be sought if there is a persistent air leak from the drain or if the lung fails to re-expand after 3 days. Open thoracotomy or video-assisted thoracic surgery allow closure of air leaks, as well as achieving pleural symphysis with either a parietal pleurectomy, pleural abrasion or surgical talc pleurodesis; instillation of talc via a