

Pneumothorax: from definition to diagnosis and treatment

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Abstract: Pneumothorax is an urgent situation that has to be treated immediately upon diagnosis. Pneumothorax is divided to primary and secondary. A primary pneumothorax is considered the one that occurs without an apparent cause and in the absence of significant lung disease. On the other hand secondary pneumothorax occurs in the presence of existing lung pathology. There is the case where an amount of air in the chest increases markedly and a one-way valve is formed leading to a tension pneumothorax. Unless reversed by effective treatment, this situation can progress and cause death. Pneumothorax can be caused by physical trauma to the chest or as a complication of medical or surgical intervention (biopsy). Symptoms typically include chest pain and shortness of breath. Diagnosis of a pneumothorax requires a chest X-ray or computed tomography (CT) scan. Small spontaneous pneumothoraces typically resolve without treatment and require only monitoring. In our current special issue we will present the definition, diagnosis and treatment of pneumothorax from different experts in the field, different countries and present different methods of treatment.

Keywords: Pneumothorax; medical thoracoscopy; spontaneous; secondary

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Primary spontaneous

Spontaneous pneumothoraces are divided into two types: primary, which occurs in the absence of known lung disease, and secondary, which occurs in someone with underlying lung disease. Until now the cause of primary spontaneous pneumothorax (PSP) has not been identified, however; several risk factors have been identified such as; smoking, male sex, and a family history of pneumothorax. Several underlying mechanisms have been observed and are discussed below. Moreover; a PSP tends to occur in a young adult without underlying lung problems. Symptoms such as, chest pain and sometimes mild breathlessness are usually

observed. There are several cases where a PSP is a threat for a patient’s life, however; several patients may wait several days before seeking medical attention. It has been observed that it is rare for PSPs to cause tension pneumothoraces.

Secondary spontaneous

Secondary spontaneous pneumothorax occurs due to underlying chest diseases. Most commonly they are observed in patients with chronic obstructive pulmonary disease (COPD), which accounts for approximately 70% of cases. Other known lung diseases that may increase the incidence for pneumothorax are; tuberculosis, necrotizing

pneumonia, pneumocystis carini, lung cancer, sarcoma involving the lung, sarcoidosis, endometriosis, cystic fibrosis, acute severe asthma, idiopathic pulmonary fibrosis, Rheumatoid arthritis, ankylosing spondylitis, polymyositis and dermatomyositis, systemic sclerosis, Marfan's syndrome and Ehlers-Danlos syndrome, histiocytosis X and lymphangiomyomatosis (LAM). Secondary spontaneous pneumothoraces (SSPs), by definition, occurs in individuals with significant underlying lung disease. The following symptoms are usually observed; hypoxemia and hypercapnia in more severe cases. The sudden onset of breathlessness in patients with known underlying lung diseases such as; COPD, cystic fibrosis, or other serious lung diseases should therefore prompt investigations to identify the possibility of a pneumothorax.

Traumatic pneumothorax

Traumatic pneumothorax occurs when the chest wall is pierced, such as when a stab wound or gunshot wound allows air to enter the pleural space. Traumatic pneumothoraces have been found to occur in up to half of all cases of chest trauma, with only rib fractures being more common in this group. The pneumothorax can be occult in half of these cases, but may enlarge—particularly if mechanical ventilation is required. This type of pneumothorax has also been observed to patients already receiving mechanical ventilation for some other reason.

Mechanism

The thoracic cavity contains the lungs, heart, and numerous major blood vessels. On each side of the cavity, a pleural membrane covers the surface of lung (visceral pleura) and also lines the inside of the chest wall (parietal pleura). Between the two layers there is a small amount of lubricating serous fluid. The lungs are fully inflated within the cavity because the pressure inside the airways is higher than the pressure inside the pleural space. Pneumothorax can only develop if air is allowed to enter, through damage to the chest wall or damage to the lung itself, or occasionally because microorganisms in the pleural space produce gas.

Treatment

The treatment of pneumothorax depends on a number of factors, and may vary from discharge with early follow-up to immediate needle decompression or insertion of a chest

tube. Treatment also depends on the physician that is going to handle the patient; pulmonary physicians usually perform medical thoracoscopy (minimally invasive) one port, while thoracic surgeons use a surgery suite and two ports. In some cases patient preference is requested.

In traumatic pneumothorax, chest tubes are usually inserted and these patients are handled by thoracic surgeons as other chest organs might be affected. If mechanical ventilation is required, the risk of tension pneumothorax is greatly increased and the insertion of a chest tube is mandatory. Any open chest wound should be covered with an airtight seal, as it carries a high risk of leading to tension pneumothorax.

Tension pneumothorax is usually treated with urgent needle decompression. There are several cases where “silent lung” is observed and needle decompression may be required before transport to the hospital upon the site of the accident, and can be performed by an emergency medical technician or other trained professional. The needle or cannula is left in place until a chest tube can be inserted. If tension pneumothorax leads to cardiac arrest, needle decompression is performed as part of resuscitation as it may restore cardiac output.

Conservative

Small spontaneous pneumothoraces do not always require treatment, as they are unlikely to proceed to respiratory failure or tension pneumothorax, and generally resolve spontaneously. A case by case evaluation is needed and careful follow up of these patients. This approach is most appropriate if the estimated size of the pneumothorax is small (defined as <50% of the volume of the hemithorax), there is no breathlessness, and there is no underlying lung disease. A 24-hour observation is optional for these patients or clear instructions are given to return to hospital if there are worsening symptoms. Follow up as outpatients require repeated X-rays to confirm improvement. Secondary pneumothoraces are only treated conservatively if the size is very small (1 cm or less air rim) and there are limited symptoms. Oxygen given at a high flow rate may accelerate resorption as much as fourfold.

Aspiration

In view of a large PSP (>50%), or in a PSP associated with breathlessness, guidelines recommend that reducing the size by aspiration is equally effective as the insertion

of a chest tube. In order to perform this procedure administration of local anesthetic is necessary and inserting a needle connected to a three-way tap; up to 2.5 liters of air (in adults). Upon follow up if there has been significant reduction in the size of the pneumothorax on subsequent X-ray, the remainder of the treatment can be conservative. It has been observed that when compared to tube drainage, first-line aspiration in PSP reduces the number of people requiring hospital admission significantly, without increasing the risk of complications. The same technique could be also considered in secondary pneumothorax of moderate size (air rim 1-2 cm) without breathlessness, however; ongoing observation in hospital is required even after a successful procedure.

Chest tube

A chest tube (or intercostal drain) is the most definitive initial treatment of a pneumothorax. Chest tube is typically inserted in an area under the axilla (armpit) called the “safe triangle”, where damage to internal organs can be avoided. Local anesthetic is applied. Usually there are two types of tubes used. In spontaneous pneumothorax, small-bore (smaller than 14 F, 4.7 mm diameter) tubes may be inserted by the Seldinger technique. Larger tubes do not have an advantage. It has been observed that for traumatic pneumothorax, larger tubes (28 F, 9.3 mm) are used.

Chest tubes are required in PSPs that have not responded to needle aspiration, in large SSPs (>50%), and in cases of tension pneumothorax. The method indicates that they are connected to a one-way valve system that allows air to escape, but not to re-enter, the chest. Several times it includes a bottle with water that functions like a water seal, or a Heimlich valve. Moreover; they are not usually connected to a negative pressure circuit, due to the fact that this would result in rapid re-expansion of the lung and a risk of pulmonary edema. The tube is left in place until no air is seen to escape from it for a period of time (no more than 2 days), and X-rays confirm re-expansion of the lung. If after 2-4 days there is still evidence of an air leak, various options are available. If air leak persists then, surgery may be required, especially in SSP.

Chest tubes are also used as first-line treatment when pneumothorax occurs in people with AIDS, usually due to underlying pneumocystis pneumonia (PCP), due to the fact that this condition is associated with prolonged air leakage. Furthermore, when bilateral pneumothorax occurs common in people with PCP, surgery is often required.

Pleurodesis and surgery

Pleurodesis is considered the final solution it is a procedure that permanently obliterates the pleural space and attaches the lung to the chest wall. The surgical thoracotomy with identification of any source of air leakage and stapling of blebs—followed by pleurectomy of the outer pleural layer and pleural abrasion of the inner layer is considered most effective. During the healing process, the lung adheres to the chest wall, effectively obliterating the pleural space. Recurrence rates are approximately 1%. Post-thoracotomy pain is usually observed.

A less invasive approach is thoracoscopy, usually in the form of a procedure called video-assisted thoracoscopic surgery (VATS). The results of VATS are considered less effective than thoracotomy, however; smaller scars in the skin. VATS offers a shorter in-hospital stays, less need for postoperative pain control, and a reduced risk of lung problems after surgery. VATS may also be used to achieve chemical pleurodesis; this involves insufflation of talc. Insufflation of talc induces an inflammation of the pleura surfaces. If a chest tube is already in place, various agents may be instilled through the tube to achieve chemical pleurodesis, such as talc, tetracycline, minocycline or doxycycline. Results of chemical pleurodesis tend to be worse than when using surgical approaches, talc pleurodesis has been found to have the best results.

Aftercare

If pneumothorax occurs in a smoker, it may be advisable for someone to remain off work for up to a week after a spontaneous pneumothorax (1-10). For those who have undergone pleurodesis it may take up to two to three weeks off work to recover. Air travel is discouraged for up to seven days after complete resolution of a pneumothorax if recurrence does not occur. Underwater diving is considered unsafe after an episode of pneumothorax unless a preventative procedure has been performed (11-20). Currently professional guidelines suggest that pleurectomy should be performed on both lungs and that lung function tests and CT scan normalize before diving is resumed. Aircraft pilots may also require assessment for surgery (12,21-28).

Summary

In conclusion, treatment depends on the training of the pulmonary physician who handles such a patient, if the

medical thoracoscopy can be applied then it could be the first option. In the case where medical thoracoscopy is available or medical thoracoscopy has not provided previously a solution for a patient then a thoracic surgeon or an experienced general surgeon should take over to provide a solution for the patient.

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