Eur Respir Rev 2010; 19: 117, 217–219
DOI: 10.1183/09059180.00005310

REVIEW: ENDOSCOPY

Spontaneous pneumothorax: epidemiology, pathophysiology and cause

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ABSTRACT: Spontaneous pneumothorax represents a common clinical problem. An overview of relevant and updated information on epidemiology, pathophysiology and cause(s) of spontaneous (primary and secondary) pneumothorax is described.

KEYWORDS: Epidemiology, pathogenesis, pneumothorax

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Received:
May 25 2010
Accepted:
May 26 2010

PROVENANCE
Publication of this peer-reviewed article was supported by GlaxoSmithKline, Belgium (principal sponsor, *European Respiratory Review* issue 117).

Pneumothorax is defined as the presence of air in the pleural space. Although intrapleural pressures are negative throughout most of the respiratory cycle [1], air does not enter into the pleural space because the sum of all the partial pressures of gases in the capillary blood averages only 93.9 kPa (706 mmHg). Hence, net movement of gases from the capillary blood into the pleural space would require pleural pressures lower than -54 mmHg (*i.e.* lower than -36 cmH_2O), which hardly ever occur in normal circumstances [2]. Hence, if air is present in the pleural space, one of three events must have occurred: 1) communication between alveolar spaces and pleura; 2) direct or indirect communication between the atmosphere and the pleural space; or 3) presence of gas-producing organisms in the pleural space. From a clinical standpoint, pneumothorax is classified as spontaneous (no obvious precipitating factor present) and nonspontaneous (table 1) [2, 3]. Primary spontaneous pneumothorax (PSP) is defined as the spontaneously occurring presence of air in the pleural space in patients without clinically apparent underlying lung disease.

PRIMARY SPONTANEOUS PNEUMOTHORAX

PSP has an incidence of 7.4 to 18 cases (age-adjusted incidence) per 100,000 population each year in males, and 1.2 to 6 cases per 100,000 population each year in females [4, 5]. PSP typically occurs in tall, thin subjects. Other risk factors are male sex and cigarette smoking. Contrary to popular belief, PSP typically occurs at rest; avoiding exercise, therefore, should not be recommended to prevent recurrences [6]. Precipitating factors may be atmospheric pressure changes (which may account for the often observed clustering of PSP) [7] and exposure to loud music [8]. Almost all patients with PSP report a sudden ipsilateral chest pain, which usually spontaneously resolves within 24 h [2]. Dyspnoea may be present but is usually mild. Physical examination can be normal in small pneumothoraces. In larger pneumothoraces, breath sounds and tactile fremitus are typically decreased or absent, and percussion is hyper-resonant. Rapidly evolving hypotension, tachypnea, tachycardia and cyanosis should raise the suspicion of tension pneumothorax, which is, however, extremely rare in PSP.

Diagnosis can be confirmed in the majority of cases on an upright posteroanterior (PA) chest radiograph, which also allows an estimation of the pneumothorax size with good accuracy [9]. In cases with a small PSP, computed tomography (CT) may be necessary to diagnose the presence of pleural air. Routine expiratory chest radiographs are useless [10]. It is important to realise that a contralateral shift of the trachea and mediastinum is a completely normal phenomenon in spontaneous pneumothorax, and not at all suggestive for tension pneumothorax; this observation should therefore in no way influence treatment strategies [1].

PATHOGENESIS

The exact pathogenesis of the spontaneous occurrence of a communication between the alveolar spaces and the pleura remains unknown. Most authors believe that spontaneous rupture of a subpleural bleb, or of a bulla, is always the cause of PSP [11], but alternative explanations are available [12, 13]. Although the majority of PSP patients, including children [14], present blebs or bullae [15–18], it is unclear how often these lesions actually are the site of air leakage [19–21]. Only a minority of blebs are actually ruptured at the time

European Respiratory Review
Print ISSN 0905-9180
Online ISSN 1600-0617

TABLE 1 Clinical classification of pneumothorax

Spontaneous
Primary: no apparent underlying lung disease
Secondary: clinically apparent underlying disease (*e.g.* chronic obstructive pulmonary disease and cystic fibrosis)
Catamenial: in conjunction with menstruation
(Neonatal)
Traumatic
Iatrogenic: secondary to transthoracic and transbronchial biopsy, central venous catheterisation, pleural biopsy and thoracentesis
Non-iatrogenic: secondary to blunt or penetrating chest injury

of thoracoscopy or surgery, whereas often other lesions are present (''pleural porosity'' [19–21]: areas of disrupted mesothelial cells at the visceral pleura, replaced by an inflammatory elastofibrotic layer with increased porosity, allowing air leakage into the pleural space). The latter phenomenon may explain the high recurrence rates of up to 20% of bullectomy alone (without associated pleurodesis) as therapy [22–25]. The development of blebs, bullae and areas of pleural porosity may be linked to a variety of factors, including distal airway inflammation [21–26], hereditary predisposition [27], anatomical abnormalities of the bronchial tree [28], ectomorphic physiognomy with more negative intrapleural pressures [29] and apical ischaemia [30] at the apices [31], low body mass index and caloric restriction [15, 32], and abnormal connective tissue [33, 34]. The role of increased plasma aluminium concentrations in the pathogenesis of PSP remains unresolved [35, 36].

These lesions may, therefore, predispose to PSP when combined with (largely unknown) precipitating factors; blebs and bullae indeed also occur in up to 15% of normal subjects [15–17]. New techniques such as fluorescein-enhanced autofluorescence thoracoscopy [37] or infrared thoracoscopy [38] may shed more light on this issue, and may be helpful in the detection of the culprit areas during thoracoscopy or surgery. It should be clear, however, that every therapeutic intervention with the purpose to prevent recurrences of PSP should include a pleurodesis technique, with or without an intervention at the level of the lung parenchyma [39].

SECONDARY SPONTANEOUS PNEUMOTHORAX

A multitude of respiratory disorders have been described as a cause of spontaneous pneumothorax. The most frequent underlying disorders are chronic obstructive pulmonary disease with emphysema, cystic fibrosis, tuberculosis, lung cancer and HIV-associated *Pneumocystis carinii* pneumonia, followed by more rare but ''typical'' disorders, such as lymphangioleiomyomatosis and histiocytosis X (table 2). Because lung function in these patients is already compromised, secondary spontaneous pneumothorax (SSP) often presents as a potentially life-threatening disease, requiring immediate action, in contrast with PSP, which is more of a nuisance than a dangerous condition. The general incidence is almost similar to that of PSP. Depending upon the underlying disease, the peak incidence of SSP can occur later in life, *e.g.* 60–65 yrs of age in the emphysema population [2].

In SSP, dyspnoea is the most prominent clinical feature; chest pain, cyanosis, hypoxaemia and hypercapnia, sometimes

TABLE 2 Frequent and/or typical causes of secondary spontaneous pneumothorax

Airway disease
Emphysema
Cystic fibrosis
Severe asthma
Infectious lung disease
Pneumocystis carinii pneumonia
Tuberculosis
Necrotising pneumonia
Interstitial lung disease
Idiopathic pulmonary fibrosis
Sarcoidosis
Histiocytosis X
Lymphangioleiomyomatosis
Connective tissue disease
Rheumatoid arthritis, scleroderma and ankylosing spondylitis
Marfan's syndrome
Ehlers Danlos syndrome
Malignant disease
Lung cancer
Sarcoma

resulting in acute respiratory failure, can also be present. Diagnosis is confirmed on a PA chest radiograph; in bullous emphysema, the differential diagnosis with a giant bulla can be difficult, necessitating CT confirmation [40]. As in PSP, air may enter the pleural space through various mechanisms: direct alveolar rupture (as in emphysema or necrotic pneumonia), *via* the lung interstitium, or backwards *via* the bronchovascular bundle and mediastinal pleura (pneumomediastinum). Recurrence rates usually are higher when compared to those for PSP, ranging up to 80% of cases, as is observed in cystic fibrosis [41].

STATEMENT OF INTEREST

None declared.

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