

Pneumothorax: an up to date “introduction”

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Abstract: The pneumothorax is an abnormal collection of air or gas in the pleural space that separates the lung from the chest wall. Like pleural effusion where a large abnormal concentration of fluid (>100 mL) is liquid buildup in that space, pneumothorax may interfere with normal breathing. A medical term that it is used is the collapsed lung, although that term may also refer to atelectasis. There are two major types of pneumothorax; there is one that occurs without an apparent cause and in the absence of significant lung disease, while the so called; “secondary” pneumothorax occurs in the presence of existing lung pathology. In a minority of cases, the amount of air in the chest increases markedly when a one-way valve is formed by an area of damaged tissue, leading to a third type of pneumothorax, called “tensioned”.

Keywords: Pneumothorax; traumatic pneumothorax; spontaneous pneumothorax; iatrogenic pneumothorax

Submitted Jan 14, 2015. Accepted for publication Jan 28, 2015.

doi: 10.3978/j.issn.2305-5839.2015.03.23

View this article at: <http://dx.doi.org/10.3978/j.issn.2305-5839.2015.03.23>

The term ‘Pneumothorax’ signifies the presence of air in the chest, and specifically within the pleural space. It is a fairly common condition that may be encountered by physicians in several clinical specialties. Its etiology is diverse, and the spectrum of its severity may range from the self-limiting to the life-threatening. Its presence is usually confirmed by radiological imaging, but its detection requires an awareness of the circumstances that may lead to its formation, and a corresponding degree of clinical suspicion. ‘Pneumothorax’ is a composite word of Greek origin [from πνεῦμα (pneuma) = air + θώραξ (thorax) = chest]. It was first used by the French physician Jean Marc Gaspard Itard [1774-1838], who was a student of Rene Laennec. His thesis on this condition, entitled ‘Dissertation sur le pneumo-thorax ou

les congestions gazeuses qui déforment dans la poitrine’, was published in 1803 (1); Laennec himself described pneumothorax in more detailed clinical and anatomical terms in 1819 (2). In the 19th century most cases were secondary to tuberculosis, though some had been observed in otherwise healthy persons. Kjaergaard in 1932 provided the first modern description of primary spontaneous pneumothorax in young people (3).

There is no specific mention of pneumothorax in the Hippocratic corpus. However, as commented by the authors of a modern classic textbook (4), this condition might have been inferred as early as the 5th century BC by physicians in ancient Greece who practised the so-called ‘Hippocratic succussion’: shaking the patient produced a splashing sound

which could be heard over the chest or abdominal wall, and was interpreted as due to the presence of air and fluid within a body cavity (e.g., hydropneumothorax). This is indirect evidence that the phenomenon may have been suspected even in antiquity. The two major forms of pneumothorax are spontaneous and traumatic. Spontaneous pneumothorax occurs without history of trauma, in people with or without underlying respiratory disease, and is further classified as primary or secondary. Primary spontaneous pneumothorax occurs in young, fit and healthy persons without known lung disease, while secondary spontaneous pneumothorax is a complication of underlying lung pathology (e.g., chronic obstructive pulmonary disease, cystic fibrosis, interstitial lung disease, etc.). The consequences of a pneumothorax are significantly greater in patients with pre-existing lung disease, and the management is potentially more difficult (5). Spontaneous pneumothorax is a significant global health problem. One study from Olmsted County, Minnesota, USA, reported an age-adjusted incidence of primary spontaneous pneumothorax of 7.4/100,000/year for males and 1.2/100,000/year for females. For secondary spontaneous pneumothorax, the incidence was 6.3 and 2.0/100,000/year for males and females, respectively. The ratio of male-to-female incidence was 6.2:1 for primary and 3.2:1 for secondary spontaneous pneumothorax (6). Combined hospital admission rates for primary and secondary spontaneous pneumothorax in the United Kingdom have been reported as 16.7/100,000 for men and 5.8/100,000 for women, with corresponding annual mortality rates of 1.26/million and 0.62/million between 1991 and 1995 (7).

Traumatic pneumothorax results from direct or indirect injury to the chest, and is further subclassified as iatrogenic (the most common type today) or noniatrogenic. The latter may be due to penetrating or non-penetrating wounds (from road traffic accidents, gunfire, broken ribs that puncture the lung etc.). An early description of traumatic pneumothorax secondary to rib fractures is given by the Turkish surgeon Şerafeddin Sabuncuoğlu [1385-1468] in his textbook *Imperial Surgery*, in which he also recommends a method of simple aspiration by 'mihceme', a form of 'cupping therapy' (8). Iatrogenic pneumothorax is caused if the pleura is breached in the course of a medical procedure, either deliberately or inadvertently. In the former instance air is introduced in the pleural cavity to facilitate inspection of the pleural surfaces during thoracoscopy or video-assisted thoracic surgery, and is drained at the completion of the procedure, with no ill effects for the patient. In

the latter air enters the pleural cavity accidentally during procedures such as subclavian vein cannulation, pleural aspiration and biopsy, transthoracic or transbronchial lung biopsy etc. Pneumothorax may also occur as a form of barotrauma, that is, lung injury caused by application of positive airway pressure during mechanical ventilation. The frequency of iatrogenic pneumothorax appears to be increasing, in parallel with the expansion of the number and indications of invasive procedures and the use of invasive ventilation. When it occurs as an accidental complication of a medical procedure, pneumothorax may become an issue of medicolegal significance, especially if it goes unnoticed.

Pneumothorax may be entirely asymptomatic, and may be picked up only incidentally on chest films. More commonly it causes a varying combination of chest pain, dyspnea, cough, or other symptoms, depending on the cause and general circumstances of each individual case. In general, symptoms are more severe in secondary than in primary spontaneous pneumothorax, and most patients with secondary spontaneous pneumothorax experience breathlessness that is out of proportion to the size of the pneumothorax (5). Its extreme form is tension pneumothorax, in which intrapleural pressure exceeds atmospheric pressure throughout the respiratory cycle. The ever-rising pressure in the pleural space compromises respiratory and cardiac function leading to progressive hemodynamic instability which may even result to death if it is not urgently diagnosed and managed. These issues are dealt with in detail in subsequent chapters of the book.

As already stated, the diagnosis of pneumothorax is confirmed by imaging techniques, which also provide information about its size and any other associated lung pathology. However, clinical evaluation of each individual patient (which includes an assessment of the pathophysiological burden imposed by the pneumothorax) is probably the most important determining factor of the management strategy, regardless of size (5). In the history of medicine artificial induction of pneumothorax has also been used therapeutically in the management of cavitating tuberculosis before the advent of specific antituberculous chemotherapy. Following chance observations of symptomatic improvement of tuberculosis after spontaneous pneumothorax (9), Carlo Forlanini of Pavia created the first artificial pneumothorax in 1888 by filling the pleural cavity with nitrogen, and over the next 18 years he published successive results on 25 treated cases (10-25). Quite independently, John Benjamin Murphy of the Cook County Infirmary in Chicago observed that unilateral pneumothorax



Figure 1 Apparatus for induction of artificial pneumothorax, Birmingham, England, 1920-1940. Available online: <http://www.sciencemuseum.org.uk/broughttolife/objects/display.aspx?id=5956>

resulting from chest injuries sustained in the American Civil War very rarely caused breathing difficulties. In 1898, he published descriptions of pneumothorax produced by trocar, and was probably the first to use the new X-ray technique to dose the size of the lung collapse (9). The use of ‘artificial pneumothorax’ and other forms of ‘collapse therapy’ in the management of tuberculosis continued until the 1950’s, when antituberculous pharmaceutical treatment became widespread (26-35). The fact that lots of patients survived for 50 or 60 years after the application of such ‘collapse therapy’ is strong testimony of its effectiveness. This method is nowadays of historical importance only, and the equipment employed for the instillation of gas into the pleura and creation of artificial pneumothorax can only be found in museums of medical history (*Figure 1*) (36-54). It is of amusing interest to note that in at least one country (Greece) artificial pneumothorax (as well as pneumoperitoneum) is still included in the official list of medical procedures that are reimbursed by state health insurance, though I must confess I never attempted to test the validity of this claim! I would like to close this brief introduction with a personal anecdote, a tribute to one of my mentors, the late Spiros Makris, first professor of anesthesiology in the Aristotle University of Thessaloniki, Greece. A few months before his untimely death in 1978, he had given a lecture at a students’ congress entitled ‘The crucifixion and resurrection of Jesus Christ in the light of science’. As a member of the organizing committee I had the honor of chairing that particular session. He described in gruesome detail the mechanism of death by crucifixion (a slow progressive asphyxiation caused by the inability of the ribcage to

expand, fixed as it was by the body weight dragged down against the nails), and added that, even if Jesus Christ had not already died from cardiorespiratory exhaustion, he was most certainly killed by the coup de grace delivered in his side by the Roman soldier’s spear, which must have caused a fatal pneumothorax.

Acknowledgements

Disclosure: The authors declare no conflict of interest.

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Cite this article as: Papagiannis A, Lazaridis G, Zarogoulidis K, Papaiwannou A, Karavergou A, Lampaki S, Baka S, Mpoukovinas I, Karavasilis V, Kioumis I, Pitsiou G, Katsikogiannis N, Tsakiridis K, Rapti A, Trakada G, Karapantzos I, Karapantzou C, Zissimopoulos A, Zarogoulidis P. Pneumothorax: an up to date "introduction". *Ann Transl Med* 2015;3(4):53. doi: 10.3978/j.issn.2305-5839.2015.03.23