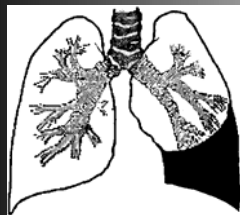


# International Pleural Newsletter



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## FLYING AND DIVING AFTER PNEUMOTHORAX

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Two activities one really would not wish to be involved in whilst sustaining a pneumothorax are flying and diving! Even allowing for the usual pressurization of an aircraft cabin, the volume of trapped gas in the thoracic cavity increases by over one third at cruising height, with potentially catastrophic effects for pneumothorax. Gas in the lungs of a diver will be compressed during descent and expand again during ascent. At 33 feet under the sea surface, lung gas reduces its volume by half and by two thirds at twice that depth – this means that as a diver surfaces, expanding gas trapped within the thorax could cause a fatal tension pneumothorax.

So what should we advise our patients who wish to fly or dive after suffering from a pneumothorax?

**FLYING:** When medical advice lacks a good evidence base, a consensus view tends to emerge. In the case of flying after pneumothorax, common advice is that six weeks should elapse before undertaking a flight. There is no evidence to support this advice and probably what really matters is that a flight should be avoided until there is radiographic proof of complete re-expansion of the lung.

It is wise to note whether the patient had a primary or secondary pneumothorax and also how it was treated, as recurrence rates will vary considerably. The Aerospace Medical Association Guidelines advise a two to three week wait after successful drainage of a pneumothorax, whilst the British Thoracic Society's Air Travel Working Party recommends that seven days should elapse between radiographic resolution of pneumothorax and a flight, although a period of two weeks is sensible after a traumatic pneumothorax<sup>1</sup>. However, alarmingly, they go on to warn of the potentially serious consequences of sustaining a pneumothorax during a flight and suggest that alternative forms of transport should be considered for up to one year – especially for those with co-existing lung disease<sup>2</sup>! With the

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increasing use of early thoracoscopic surgical repair of pneumothoraces patients should be fit to fly as soon as they have recovered from surgery.

**DIVING:** Sustaining a pneumothorax implies that there is, potentially, an anatomical abnormality within the lung where air may become trapped – so-called “emphysema-like changes”<sup>3</sup>. This means that a diver’s lungs may be unable to vent expanding gases during ascent, risking pneumothorax with potentially serious consequences. A traumatic pneumothorax may also cause underlying lung damage severe enough to cause air trapping and each case will need individual assessment. Iatrogenic pneumothoraces, however, caused by procedures such as subclavian line insertion should not be a contraindication to diving, but lung surgery is a contraindication because of the necessary distortion of lung architecture, which may also result in gas trapping. The lowest recurrence rates for pneumothorax occur after thoracotomy with pleural abrasion or pleurectomy so that this rather than thoracoscopic repair<sup>4</sup> is the best treatment for pneumothorax sufferers who wish to dive<sup>5</sup>. Finally, it is reassuring to know that the available diving mortality statistics from the United States do not report a single death attributable to tension pneumothorax or arterial gas embolism following a pneumothorax or previous thoracic surgery<sup>6</sup>.

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## CHEST TUBES FOR PNEUMOTHORAX: DOES SIZE MATTER?

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Chest tubes are utilized for drainage of both spontaneous and traumatic (iatrogenic and non-iatrogenic) pneumothoraces. The appropriate setting to use a chest tube or to

proceed with less invasive options, including aspiration or simple observation, is the subject of several recent guidelines<sup>1,2</sup>, a review<sup>3</sup>, and a meta-analysis<sup>4</sup>. When chest tube placement is chosen, appropriate size selection is a must.

The myriad of chest tube manufactures and widely varying chest tube sizes complicate tube selection<sup>5</sup>.



Knowledge of air and liquid flow rates accommodated by a tube is key. Up to 20% of non-iatrogenic traumatic pneumothoraces have an accompanying hemothorax<sup>3</sup>. Hemothorax may also accompany an iatrogenic traumatic or spontaneous pneumothorax; therefore the clinician must always consider the need for air and blood drainage. If air and substantial blood must be drained, larger bore (28–36F) tubes are selected<sup>6</sup>. However, accommodating airflow remains the focal issue for most pneumothoraces. The Fanning equation determines the flow of moist gas (turbulent flow characteristics) through a tube ( $v = \pi^2 r^5 P / fl$ ;  $v$  is flow,  $r$  is radius,  $P$  is pressure,  $f$  is the friction factor and  $l$  is length). The chest tube bore (internal diameter) is the critical determinant of airflow followed by the tube’s length.

The rate of pleural air accumulation (and possibly blood) must also be considered<sup>3,5</sup>. Air leaks ranging from <1L/minute to as large as 16L/minute occur in patients with bronchopleural fistulas due to chest trauma, thoracotomy, and acute respiratory distress syndrome. Air leaks may be larger in mechanically ventilated patients including in patients with bronchopleural fistulas from postoperative pneumonectomy stump dehiscence. Patients with spontaneous pneumothoraces and iatrogenic traumatic pneumothoraces requiring mechanical ventilation are at risk for large air leaks. Inappropriate selection of an inadequate chest tube bore in the setting of rapid air accumulation can precipitate a tension pneumothorax.

What are the airflow rates of commonly available smaller bore chest tubes available in the United States? Catheters assessed at -20cmH<sub>2</sub>O pressure have widely varying flow rates<sup>5</sup>. Lowest mean flow rates are found with thoracentesis catheters (with side ports) utilized as pneumothorax catheters [(Arrow thoracentesis kit, Arrow International, Reading PA, 8.0F by 12cm, 3.4L/min) (Argyle Safety Thoracentesis, Sherwood Medical, 8.0F, 10cm length, 2.6L/min)]. Arrow drainage catheters (14F, 23 cm length, pigtail or straight) have significantly greater mean flow rates (both 16.8L/min) compared with the 14F (29cm length, 12.8L/min) and 16F (41cm length, 14.8L/min) Cook devices (Cook; Bloomington, IN). Once a chest tube is placed, it may be connected to a pleural drainage unit. Pleural drainage units (PDU) must also be considered as potential impediments to air flow and knowledge of their flow rates is

equally important. Of recently tested PDU available in the United States, the Argyle Aqua-Seal (Sherwood Medical, Tullamore, Ireland) has the highest mean flow rate at -20cmH<sub>2</sub>O pressure (41.1L/min) with the Argyle Sentinel Seal having the lowest rate (10.8L/min).

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consideration of surgical intervention should be made as the likelihood of non-resolution of the air leak is greater.

Surgical options for the management of pneumothorax include open thoracotomy or video assisted thoracoscopy with chemical or abrasive pleurodesis, or partial or total pleurectomy. Pleurectomy is associated with a lower rate of recurrence of pneumothorax, but makes any future procedure more difficult<sup>5</sup>.

Pneumothorax management may need to take into account disease specific factors. For example, in cystic fibrosis the median survival following pneumothorax is 30 months. This reflects the severity of disease at the time of this complication rather than mortality from the pneumothorax itself<sup>6</sup>. In this group, the reported recurrence rate is 50% without surgical intervention and thus the recommended therapy is early intervention provided the patient is considered fit enough.

Patients who undergo lung transplantation for pLAM have higher rates of surgical complications, most often related to previous pleural procedures<sup>3</sup>. Pleurodesis and/or pleurectomy makes lung transplantation more technically demanding, but in the absence of an impact on survival, is not considered an absolute contraindication. There is potential to increase the time taken to explant the native lungs which may lead to a longer cold ischemic time, but can be avoided with careful co-ordination and planning. Increased blood loss can be minimized by having a greater time to perform the recipient pneumonectomy and thus is usually manageable<sup>3</sup>.

In conclusion, pneumothorax in patients being considered for lung transplantation should be managed as per standard guidelines. Prior pleural procedures are not a contraindication to lung transplantation but accurate, detailed knowledge of the prior surgery allows appropriate logistical planning when suitable donor organs become available.

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## Management of Pneumothorax in Potential Candidates for Lung Transplantation

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Lung transplantation is now an accepted therapy for a wide range of end stage pulmonary diseases. The underlying lung disease, or its evaluation (eg lung biopsy) or treatment, may lead to pleural reaction with concern that this may increase the risk of subsequent transplant surgery. Neither pleurodesis<sup>1</sup>, nor lung volume reduction surgery<sup>2</sup> have been shown to increase the mortality of subsequent lung transplantation. In cystic fibrosis and pulmonary lymphangiomyomatosis (pLAM) however, there are uncontrolled case series reporting increased surgical complications secondary to pleural disease<sup>2,3</sup>.

Conditions such as cystic fibrosis and COPD and rarer diseases (eg pLAM and histiocytosis X) may be complicated by spontaneous pneumothorax with prolonged air leak. Clinicians may be faced with the dilemma of how to proceed because of concern of increasing the risk of subsequent lung transplantation. Generally we believe the management of pneumothorax in the setting of underlying parenchymal disease is not dissimilar to that in patients without lung disease<sup>4</sup>. The major differences being that aspiration is appropriate only for small pneumothoraces and earlier

# CATAMENIAL PNEUMOTHORAX: REVIEW AND UPDATE

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Catamenial pneumothorax (CP), first described in 1958<sup>1</sup>, is an incompletely understood entity characterized by repeated pneumothoraces temporally associated with menses. Over 200 cases have been described<sup>2</sup> but the true incidence is unknown<sup>3</sup>. Diagnosis is established by clinical history. Any unexplained pneumothorax occurring within the first few days of the onset of menses, or, rarely, immediately preceding menstruation should raise clinical suspicion. Commonly, CP occurs sporadically rather than with each cycle underscoring the need for a detailed history. Overwhelming, most episodes of CP are right-sided but bilateral pneumothoraces have been described.

**Pathophysiology:** The pathophysiology of CP is not entirely delineated but functioning endometrial tissue within the thorax and loss of diaphragmatic integrity likely play central roles. The implantation theory postulates that viable endometrial tissue migrates into the thorax via retrograde menstruation. Desquamation of endometrial tissue on the visceral pleura causes small air leaks and subsequent pneumothorax. However, endometrial tissue is not universally found in the thorax. Additionally, how endometrial tissue gains access to the thorax remains unclear. Diaphragmatic integrity may be compromised either by endometrial implants on the peritoneal surface of the diaphragm or by congenital or acquired defects. The incidence of diaphragmatic defects visualized during thoracoscopy varies<sup>4</sup>.

Another hypothesis suggests that the extrusion of the cervical plug during menstruation allows an open connection between the abdominal cavity and the ambient air. This air may cross the diaphragm leading to pneumothorax. Others postulate that CP is best explained by the coelomic metaplasia theory<sup>5</sup> which suggests that tissue of coelomic origin, such as the pleura, has the potential to develop foci of endometriosis upon stimulation by metaplasia-inducing substances such as estrogens and substances released by degenerating endometrium.

**Treatment:** The acute management of patients presenting with CP is similar to that of any patient with pneumothorax. Although the pneumothorax will often spontaneously resolve following menstruation, tube thoracostomy is indicated for large or symptomatic pneumothoraces.

Both medical and surgical therapies are potentially beneficial and are often needed in conjunction. Medical therapy is often centered on hormonal alteration with the

goal of suppressing the growth of thoracic endometrial implants. Therapeutic options include oral contraceptive pills, danazol, progestational agents, and gonadotropin-releasing hormone (GnRH) analogues. Hormonal therapy alone is inadequate in most patients.

Recurrent pneumothoraces necessitate inspection of the pleural space for endometrial implants and diaphragmatic defects. Pleurodesis without visual inspection of the diaphragm and pleural space should be avoided. Video-assisted thoracoscopic surgery or thoracotomy should be performed at the onset of menstrual flow to maximize visualization of endometrial implants. Visualized diaphragmatic defects should be surgically repaired; mesh covering may be helpful<sup>6</sup>. Post-operative hormonal therapy may decrease the risk of recurrences. Total abdominal hysterectomy and bilateral oophorectomy is suggested as an alternative to long-term hormonal therapy but need to be considered in light of the patient's wishes for fertility.

**Summary:** CP should be suspected in any ovulating female who presents with a unexplained pneumothorax. To establish the diagnosis the timing of the pneumothorax relative to menstruation must be explored. Hormonal therapy in conjunction with surgical inspection of the pleural space and repair of diaphragmatic defects is typically necessary. Post-operative hormonal therapy may decrease recurrence.

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**If you have any comment on the Newsletter or any interesting cases of pleural disease, contact:**

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# “ATLAS THORACOSCOPICON” THE FIRST THORACOSCOPIIC ATLAS

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Felice Cova (fig 1), called the Paganini of the thoracoscope because of his dexterity and speed in performing Jacobaeus’ operation, was born in Milan, Italy in 1877. In 1924 he was appointed head of the Female Division at the Vittorio Emanuele III Sanatorium in Garbagnate, near Milan.

He became famous throughout Europe for his book “Atlas Thoracoscopicon” (fig 2)<sup>1</sup> published in 1928. This Atlas is an outstanding work in the thoracoscopic field in that it opens the period of larger applications of the method. It became a regular reference source and was subsequently constantly cited in relevant literature, such as in the British Medical Journal and in the articles by Brauer and Jaquerod.

The book had a preface by H.C. Jacobaeus who wrote “*In thoracoscopy ...it is necessary that the method be applied with perfect technique, which is by itself very difficult and can be*



Fig 1. Felice Cova

*acquainted only after a long time of exercise and experience ... It is very fatiguing and requires a hard loss of time to him who will devote himself to study the method, the learning without sufficient publications and without explanation of the images that can be observed during thoracoscopies. This book is of the most high value for the practical way in which it has been written, and of higher value it is still for the fine trichromies and their instructive descriptions, finer and more complete than any I have ever seen in preceding publications of other authors”.* Jacobaeus clearly wanted to highlight the original character of the Atlas in which pictures were the most important aspect.

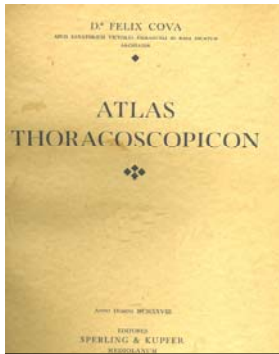


Fig 2. Atlas Thoracoscopicon

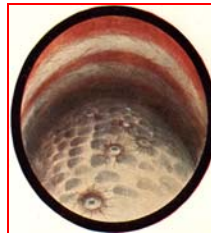
Also the author in his preface says “*Among the causes hindering the spreading of this ... means of diagnosis (thoracoscopy), one is the lack of ... familiarity in reading the report (in the sense of being able to interpret the endoscopic pictures), as only can be obtained after a good number of thoracoscopies ... To help the physicians, who initiate their thoracoscopic experience, it has been thought to assemble in collection a certain number of thoracoscopic figures, printed in trichromatic tables”.*

In the Atlas there are 50 beautiful colored plates: three on normal anatomy of the pleural cavity; 38 on main thoracoscopic pictures, and nine dedicated to the technique of Jacobaeus’ operation. In these figures the principal macroscopic alterations are displayed in logical continuity, allowing, even to the untrained eye, an orientation to the recognition of the lesions. Each plate has a clear explanation in three languages, Italian, German and English, once again underlining the international intent of the author.

Fig 3. “*Acute pleuritis in plaques*” described by the author as “*the inflamed pleura loses transparency, becomes velvet-like ... and around the plaque the vessels become swollen, turgid ...*”.



Fig 4. “*Metastatic carcinomatous nodes on the visceral pleura*”. The authors described “*six nodes umbilicated, crater-shaped, whitish, elevated and jutting out ... They are metastatic nodes of a carcinoma from the head of the pancreas*”.



By 1927, Cova had already published another exhaustive book entitled “Toracosopia – Operazione Di Jacobaeus”<sup>2</sup>, but the Atlas remains a “diagnostic pinnacle” in thoracoscopy<sup>3</sup>, still useful today. Cova died in 1935, aged 58, after a short illness.

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