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## Life-threatening pneumothorax of the ventilated lung during thoracoscopic pleurectomy

**Purpose:** To report the case of a patient who underwent right thoracoscopic pleurectomy with lung exclusion and developed contralateral (left) pneumothorax with resulting life-threatening alteration of the respiratory and cardiovascular functions.

**Clinical features:** A 28-yr-old male was admitted to the intensive care unit for a well tolerated, second episode of spontaneous right pneumothorax and scheduled for right thoracoscopic pleurectomy. Anesthesia was induced and maintained with sufentanil and propofol. A double lumen endotracheal tube (ETT) was inserted, its correct positioning checked clinically and by fiberoptic bronchoscopy and the patient was placed in the left decubitus position. Approximately one hour into the procedure, during the second period of right pulmonary exclusion, SpO<sub>2</sub> values decreased within two minutes to 78%. End tidal capnography (EtCO<sub>2</sub>) values decreased to 6–8 mmHg within seconds and peak airway pressure increased to values between 50 and 60 cm H<sub>2</sub>O. Severe cyanosis, sinus bradycardia and arterial hypotension developed. The surgical procedure was stopped, propofol administration discontinued, bipulmonary ventilation reinstated and the patient placed in the supine position which restored hemodynamic and respiratory function. Inspection and auscultation were consistent with tension left pneumothorax which was evacuated.

**Conclusion:** Pneumothorax of the ventilated lung during one lung ventilation for thoracoscopic procedures must be diagnosed quickly. Reinstitution of bipulmonary ventilation should probably be the first therapeutic attitude.

**Objectif:** Citer le cas d'un patient qui a subi une pleurectomie thoracoscopique droite, associée à un isolement pulmonaire, et chez qui s'est développé un pneumothorax contralatéral (gauche) entraînant une modification grave des fonctions respiratoire et cardiovasculaire.

**Éléments cliniques :** Un homme de 28 ans a été admis à l'unité des soins intensifs pour un second épisode de pneumothorax spontané droit bien toléré pour lequel on a planifié une pleurectomie thoraco-

scopique droite. L'anesthésie a été induite et maintenue avec du sufentanil et du propofol. Un tube endotrachéal (TET) à double lumière a été inséré, sa position vérifiée cliniquement et par fibroscopie bronchique et le patient a été placé en décubitus gauche. Une heure environ après le début de l'intervention, pendant la seconde période de l'isolement pulmonaire droit, les valeurs de la SpO<sub>2</sub> ont baissé à 78 % en deux minutes. La capnographie de fin d'expiration (EtCO<sub>2</sub>) a chuté à 6–8 mmHg en quelques secondes et la pression maximale du conduit aérien a augmenté jusqu'à des valeurs entre 50 et 60 cm de H<sub>2</sub>O. Une cyanose sévère, une bradycardie sinusale et une hypotension artérielle se sont développées. L'intervention chirurgicale a été stoppée, l'administration de propofol interrompue, la ventilation bipulmonaire réinstaurée et le patient placé en décubitus dorsal, ce qui a rétabli la fonction hémodynamique et respiratoire. L'inspection et l'auscultation étaient caractéristiques d'un pneumothorax sous tension gauche qui a été évacué.

**Conclusion :** Le pneumothorax du poumon ventilé pendant la ventilation à un seul poumon, lors d'une intervention thoracoscopique, doit être diagnostiqué rapidement. La réintroduction de la ventilation bipulmonaire doit probablement être la première intervention thérapeutique.

**P**NEUMOTHORAX as a consequence of barotrauma is a relatively rare event during anesthesia accounting for approximately 3% of anesthetic complications.<sup>1</sup> Bilateral pneumothorax is even less frequent during anesthesia but, if not diagnosed rapidly, can be life-threatening. The recent development of thoracoscopy as a diagnostic and therapeutic procedure for thoracic surgery has added new challenges to anesthesiologists because the surgical field cannot be inspected easily.

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We report the case of a patient who, during right lung exclusion for a thoroscopic procedure, developed hypoxemia, increased airway pressure, decreased end-tidal CO<sub>2</sub> (EtCO<sub>2</sub>) concentrations, sinus bradycardia and arterial hypotension.

#### Case report

A 28-yr-old male weighing 53 kg for a height of 172 cm was admitted to the intensive care unit (ICU) for a well tolerated, second episode of spontaneous right pneumothorax. The patient had right chest tube thoracostomy without complications and thoroscopic pleurectomy was decided. Except for the two episodes of pneumothorax the patient's medical history was irrelevant.

After premedication with 100 mg hydroxyzine *po*, placement of the venous line and the usual monitoring, anesthesia was induced with sufentanil and propofol. Tracheal intubation was facilitated with rocuronium bromide. Anesthesia was maintained with propofol and sufentanil titrated to the hemodynamic reactions to noxious stimuli. After placement of a double lumen endotracheal tube (ETT) (Carlens, Size 39, Mallinckrodt®, les Ulis, France), mechanical ventilation was initiated with a tidal volume of 600 ml and a respiratory rate of 13 breaths·min<sup>-1</sup>. The inspired oxygen fraction was set to 1. Correct positioning of the double lumen ETT was verified clinically and by fiberoptic bronchoscopy. The patient was placed in the left decubitus position and correct positioning of the double lumen ETT tube checked again, both clinically and by fiberoptic bronchoscopy. Peak airway pressures value, as displayed by the anesthesia machine (Mönnal A®, Taema®, Antony, France), were 25 cm H<sub>2</sub>O.

The right chest tube was withdrawn and the thoroscopic procedure started. Exclusion of the right lung was uneventful and there was no increase in peak airway pressure. Oxygen saturation (SpO<sub>2</sub>) measured by pulse oxymetry (Oxycapno 1000®, Nellcor®, Jouy-en-Josas, France) decreased progressively from 100% to 90% after 30 min of right pulmonary exclusion. Bipulmonary ventilation was reinstated for several minutes and SpO<sub>2</sub> values increased to 98%. The right lung was again excluded and peak airway pressure values increased to 30 cm H<sub>2</sub>O.

Approximately one hour into the procedure, SpO<sub>2</sub> values decreased within two minutes to 78%. EtCO<sub>2</sub> decreased to 6–8 mmHg within seconds and peak airway pressures between 50 and 60 cm H<sub>2</sub>O were observed while the patient was still on controlled ventilation. Manual ventilation was instituted and increased airway pressure was confirmed. The patient became severely cyanotic, heart rate decreased to 50 beats·min<sup>-1</sup> (sinus bradycardia) and blood pressure could not be

measured (Collin PressMate®, Baxter, Maurepas, France). Carotid artery pulse pressure was barely perceived. The surgical procedure was stopped, propofol administration discontinued and bipulmonary ventilation reinstated. The correct position of the double lumen ETT was checked by fiberoptic bronchoscopy. The patient was placed in the supine position and right chest tube thoracostomy performed followed by closure of the surgical incision. SpO<sub>2</sub> increased to 100%, heart rate and blood pressure values became normal and EtCO<sub>2</sub> increased to 39 mmHg. Upon inspection, the patient presented a major distension of the left hemithorax and lung auscultation was consistent with the diagnosis of left pneumothorax. Left chest tube thoracostomy confirmed the left tension pneumothorax. The double lumen ETT was replaced with a single lumen ETT. Lung auscultation revealed bilateral symmetric breath sounds.

The surgical procedure was cancelled and the patient transferred to the ICU intubated and ventilated mechanically. His postoperative course was uneventful. The trachea was extubated two hours after his arrival to the ICU. The patient left the ICU on the following morning and the hospital on the 5<sup>th</sup> postoperative day without sequelae. Long-term follow-up of the patient could not be performed.

#### Discussion

Spontaneous pneumothorax is observed most frequently in patients during their second and third decade of life.<sup>2</sup> Recurrent episodes of spontaneous pneumothorax are treated surgically in 30 to 40% of cases.<sup>3</sup> Historically, the surgical procedure used the axillary thoracotomy approach.

The development of thoracoscopy has profoundly changed the therapeutic strategy for these patients.<sup>3–5</sup> Treatment of recurrent pneumothorax is one of the main indications of thoracoscopy<sup>5</sup> because it provides a complete view of the thoracic cavity, of the lung together with the visceral and parietal pleura<sup>2,6</sup> and allows several surgical procedures such as mechanical or chemical pleurodesis.<sup>2</sup> However, thoracoscopy requires the exclusion of the lung and one lung ventilation.

Hypoxemia occurring after institution of one lung ventilation is not uncommon and is the expected consequence of persistent perfusion of the excluded lung.<sup>7,8</sup> The first episode of hypoxemia in this case report is consistent with this mechanism. In contrast, the second episode of hypoxemia occurred rapidly, coincided with increased peak airway pressure, decreased EtCO<sub>2</sub> and impaired cardiovascular performance. Several clinical situations could have resulted in similar clinical signs:

Incorrect positioning of the double lumen could have explained several clinical signs but fiberoptic bronchoscopy eliminated this diagnosis.

Anesthesia machine malfunction could not explain the clinical signs since increased airway pressure persisted during manual ventilation.

Systemic gaseous embolism has been reported during mechanical ventilation in adults and could have explained most of the clinical signs (hypoxemia, decreased EtCO<sub>2</sub>, bradycardia and arterial hypotension) but not the increased peak airway pressure.

A hemorrhagic complication, difficult to diagnose because of the thoracoscopic procedure, could have mimicked the decreased EtCO<sub>2</sub>, the hemodynamic instability but not the increased airway pressure in the absence of major intraalveolar hemorrhage.

Tension pneumothorax of the ventilated lung could explain all the clinical signs observed.

The main causes of pneumothorax during anesthesia are regional blocks (40% of reported cases), airway instrumentation (19%), barotrauma (16%) and placement of central venous lines (7%).<sup>1,7</sup> The most probable cause of pneumothorax in this case is barotrauma which occurred despite airway pressures below 40 cm H<sub>2</sub>O, as displayed by the anesthesia machine. Occurrence of a pneumothorax on the ventilated lung, and particularly of a tension pneumothorax, can be life-threatening if not rapidly diagnosed. Immediate reinstitution of double lung ventilation was life-saving for the patient and should probably represent the first therapeutic attitude.

It is difficult to incriminate the thoracoscopy technique per se as the cause of barotrauma although it cannot be formally excluded. Complications of thoracoscopy have been reported in a cohort of 1337 patients in which the authors reported one death (0.07%) and 56 non-lethal complications (4.26%). Several other large thoracoscopy series did not report pneumothorax of the ventilated lung during one lung ventilation as a complication of the thoracoscopic procedure.<sup>3,4,6,7,9-14</sup> The thoracoscopic procedure, because of its lack of direct vision of the surgical field, certainly increases the diagnostic difficulties.

Anesthesiologists should be aware that a pneumothorax of the ventilated lung during lung exclusion can occur, as reported previously.<sup>15-17</sup> Thoracoscopy, by obscuring the surgical field and the mediastinum can make the diagnosis of this life-threatening complication more difficult. Barotrauma, which is probably the most frequent cause of pneumothorax during anesthesia, could be prevented by the use of pressure-limited ventilation with permissive hypercapnia.

In conclusion, we present the case of a patient who developed a life-threatening pneumothorax of the

ventilated lung during one-lung ventilation for therapeutic thoracoscopy of a recurrent pneumothorax. The clinical signs developed quickly and the diagnosis was obscured by the lack of access to the surgical field. Reinstitution of bipulmonary ventilation was probably life-saving in this case.

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