

## Anesthetic management for repair of adult Bochdalek hernia by laparoscopic surgery

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### Abstract

This report describes anesthetic management of a case (a 64-year-old man) who was originally diagnosed as paraesophageal hernia before surgery and later diagnosed as Bochdalek hernia during laparoscopic surgery. Anesthesia was started with oxygen, nitrous oxide, and sevoflurane, and respiration was managed using controlled mechanical ventilation. Although left pneumothorax was noticed during laparoscopic surgery (aeroperitonia pressure: 10 cmH<sub>2</sub>O), the surgery was performed using the same anesthesia procedure, because hardly any changes were observed on the monitor and vital signs were stable. The surgery was completed without incident. However, postoperative chest X-rays revealed the residual large pneumothorax. A chest drain tube was inserted immediately, after which the pneumothorax was improved. Pneumothorax is considered to be inevitable in cases of laparoscopic repair of Bochdalek hernia. To prevent exacerbation of pneumothorax, anesthetic management should consist of discontinuing the use of nitrous oxide and lowering the aeroperitonia pressure concomitantly with the use of positive airway pressure.

**Key words** Adult Bochdalek hernia · Laparoscopic surgery · Pneumothorax

### Introduction

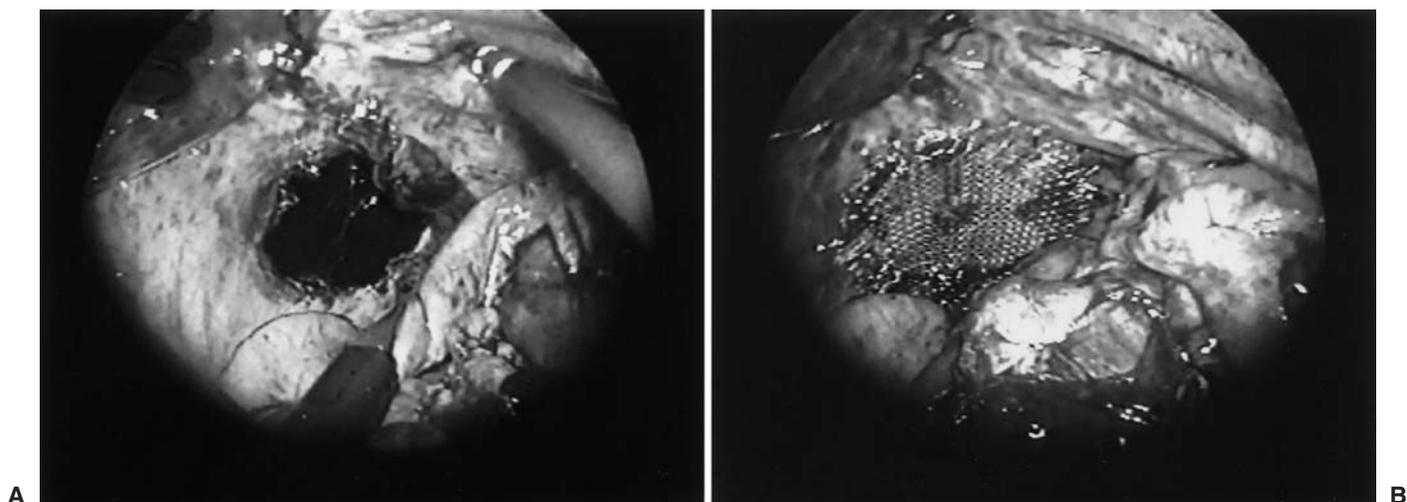
We experienced a case of managing anesthesia for laparoscopic repair of Bochdalek hernia in an adult. The patient was originally diagnosed as paraesophageal hernia before surgery, but was later determined during surgery to present with Bochdalek hernia. We describe problems in terms of anesthetic management during laparoscopic repair of Bochdalek hernia.

### Case report

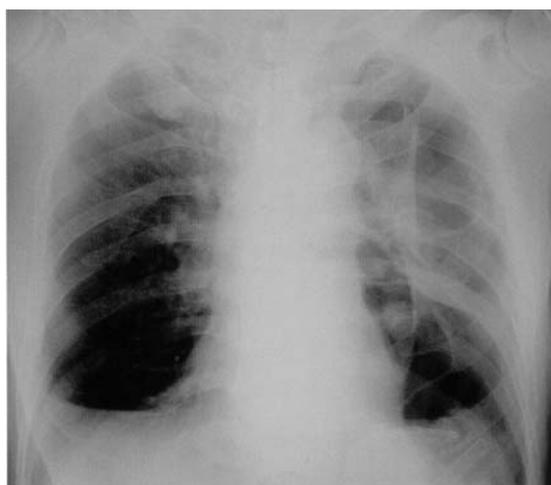
A 64-year-old man (height 168 cm, weight 65 kg) was scheduled to undergo surgery using the Nissen procedure (laparoscopic reconstructive hernia surgery). The patient was originally diagnosed as paraesophageal hernia before surgery. The patient had previously undergone removal of the left inferior lobe of the lung for treatment of pulmonary squamous cell carcinoma 4 years before.

At arrival in the operating room, the patient's blood pressure was 154/63 mmHg, his pulse rate was 57 beats/min, and pulse oximetry (SpO<sub>2</sub>) on room air was 98%. Following insertion of an epidural catheter (T9–T10), 3 ml 1% lidocaine was injected through the catheter. Then, anesthesia was induced intravenously with 2 mg/kg propofol and 7 mg vecuronium. There were no differences in lung sounds between the lungs following intubation, and listening was satisfactory. Anesthesia was maintained with 3% sevoflurane in 50% nitrous oxide and 50% oxygen with controlled mechanical ventilation (CMV: tidal volume = 600 ml, respiration rate = 15/min).

Aeroperitonia began after 5 min into the surgical procedure, and the aeroperitonia pressure reached 10 cmH<sub>2</sub>O. The surgeon noticed the presence of the hilum of a hernia posterolateral to the left diaphragm soon after aeroperitonia. During the procedure, the surgeon stated that the lung was visible. Ventilation was switched to manual ventilation to prevent lung collapse. After confirming that ventilation was adequate and both lung sounds and movement of the diaphragm were satisfactory, the patient was returned to CMV. The surgery was subsequently continued using the same anesthetic procedure. There was no rise in airway pressure following resumption of surgery, and also no decreases in SpO<sub>2</sub> were observed. A defect foramen (approximately 3 × 4 cm in size) was observed posterolateral to the left diaphragm when the deviated stomach was



**Fig. 1.** **A** Photograph shows a defect foramen (approximately  $3 \times 4$  cm) observed posterolateral in the left diaphragm. **B** The defect foramen is reinforced with mesh



**Fig. 2.** Chest X-ray showing left pneumothorax

returned to the abdominal cavity during laparoscopy (Fig. 1A). The defect foramen was reinforced with mesh (Fig. 1B), and the aeroperitonium was discontinued before completing the procedure.

Following completion of surgery, 1 mg atropine sulfate and 2 mg neostigmine were given by intravenous injection to antagonize the muscle relaxants after the patient had returned to spontaneous respiration. Because  $Sp_{O_2}$  subsequently decreased from 100% to 94%–95%, a chest X-ray was taken under administration of 100% oxygen. The chest X-ray revealed left pneumothorax (percentage of lung collapse approximately 45%) (Fig. 2).

A chest drain tube was inserted immediately, after which the pneumothorax improved with adequate deaeration. The patient's vital signs stabilized and the results of arterial blood gas analyses ( $F_{I_{O_2}}$ : 1.0) consisted of pH 7.436,  $Pa_{O_2}$  230 mmHg,  $Pa_{CO_2}$  45.6 mmHg, and  $Sa_{O_2}$  99.5%. Tidal volume was roughly 650 ml (10 ml/kg), respiration pattern was normal, and respiration rate was 14–15/min. The patient was then extubated as swallowing and coughing reflexes were observed, and the patient responded when called by name and opened his eyes. This case was diagnosed as Bochdalek hernia because a defect foramen was observed posterolateral to the left diaphragm and there was no hernial sac observed.

## Discussion

The incidence of adult Bochdalek hernia is extremely rare in comparison with that during infancy [1]. It is considered to be caused by an abnormality that occurs during fetal development (defective fusion of the pleuroperitoneal membrane) [2]. In this case, the left posterolateral portion of the diaphragm and partial layer of the pleura were thought to have been congenitally defective.

In cases of the adult-type disorder, the condition is considered to be induced by an elevation of intraperitoneal pressure [3]. This case had a history of surgery for treatment of lung cancer. However, it is unlikely that the previous surgery was the cause of this condition, because a considerably long period of time had elapsed before the primary complaint appeared.

Recently, adult Bochdalek hernia has sporadically been reported to be treated surgically using an endoscopic procedure such as thoracoscopy or laparoscopy. As the frequency of the presence of a hernial sac is low in cases of adult Bochdalek hernia [4,5], it has been reported that laparoscopic procedures by aeroperitonitis are associated with a high risk of causing tension pneumothorax and should therefore be avoided [6].

Because the case reported here was diagnosed as paraesophageal hernia before surgery, a laparoscopic procedure was selected using aeroperitonitis. However, it is thought that the chest cavity and abdominal cavity were in direct communication based on findings obtained during surgery. If aeroperitonitis is performed while in this condition, the gas used for aeroperitonitis (carbon dioxide) ends up entering the chest cavity and causing pneumothorax (capnothorax). The occurrence of pneumothorax is frequently noticed during laparoscopic procedures by a rise in airway pressure and a decrease in  $S_{pO_2}$ . In such cases, pneumothorax is improved rapidly by discontinuing the aeroperitonitis and ventilating with 100% oxygen [7,8].

In general, pneumothorax that has occurred during aeroperitonitis can be handled by discontinuing aeroperitonitis and lowering aeroperitonitis pressure in combination with PEEP. In this case, however, even though pneumothorax occurred during aeroperitonitis, hardly any changes were observed on the monitor and the patient's vital signs remained stable. Consequently, we did not change the anesthetic procedures. In terms of respiratory management, positive end-expiratory pressure (PEEP) was not used. This is thought to have maintained a suitable degree of lung collapse and facilitated the surgical procedure.

Tension pneumothorax fortunately did not occur in this case. A possible reason for this is that the hernia foramen was too large for it to function as a check valve. However, according to the chest X-ray taken immediately after surgery (see Fig. 2), there was increased transparency of the left lung field, and the collapsed left

lung had contracted so as to be facing toward the hilum of the lung. On the basis of these findings, there was also the possibility that tension pneumothorax was beginning to occur.

Cases of diaphragmatic hernia in adults consist almost entirely of paraesophageal hernia, and because their clinical symptoms are similar, it is difficult to diagnose Bochdalek hernia before surgery. In the case of a diagnosis of paraesophageal hernia before surgery, and a laparoscopic procedure performed by aeroperitonitis, it is essential to collaborate with the surgeon in confirming the location of the hernial foramen. In anatomical terms, the Bochdalek foramen is present posterolateral to the left diaphragm in nearly all cases. In cases in which the hernial foramen is not a paraesophageal hiatus, but rather located posterolateral to the left diaphragm, Bochdalek hernia should be suspected, and it should be also considered that the procedure be changed to a thoracoscopic procedure.

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