

Clinical reports

Anesthesia for laparoscopic cholecystectomy in an elderly patient with emphysematous bullae—combined general and epidural anesthesia with spontaneous respiration and abdominal wall-lift method

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Introduction

Laparoscopic cholecystectomy is rapidly gaining popularity with surgeons and patients, but as the popularity of this technique increases and the selection of patients widens to older and sicker people, careful considerations in anesthetic management are required. We recently experienced a case of laparoscopic cholecystectomy with emphysematous bullae. To avoid the risk of barotrauma, we adopted an abdominal wall-lift method without peritoneal insufflation, and maintained anesthesia with spontaneous respiration.

Case report

An 81-year-old female, weighing 42 kg and 146 cm tall, was admitted with cholecystolithiasis and was scheduled for laparoscopic cholecystectomy. She had a 5-year history of pulmonary emphysema and emphysematous bullae. Her chest X-ray and computed tomography (CT) showed multiple bullae in the left lung field. It was also noted that one giant bulla in the left lower lobe had advanced in size over the last 5 years. The spirometric measurements were as follows: vital capacity was 2.22 l (111%) and forced expiratory volume in the 1st second was 1.66 l (74%). Analysis of arterial blood gases while breathing room air revealed a pH of 7.43, P_{aCO_2} of 41.9 mmHg, and P_{aO_2} of 74.9 mmHg.

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From these preoperative examinations, we judged that the patient should be able to tolerate general anesthesia, but an accidental rupture of bullae and concurrent pneumothorax were concerns. We could not neglect the hazard of pulmonary barotrauma in the presence of bullae, particularly if high positive airway pressure is required to provide adequate ventilation of the lungs during a pneumoperitoneum with carbon dioxide. We held a conference with surgeons and planned to perform a laparoscopic cholecystectomy without pneumoperitoneum according to the abdominal wall-lift method reported by Nagai et al. [1]. We also planned to maintain airway pressure as low as possible.

Preoperative medication consisted of atropine 0.3 mg and hydroxyzine 25 mg. Upon arrival in the operating room, her blood pressure (BP) was 120/70 mmHg and heart rate (HR) was 62 beats·min⁻¹. The left radial artery was cannulated for continuous blood pressure monitoring and blood sampling. An epidural catheter was inserted at the T8–9 intervertebral space, and 6 ml of 2% lidocaine was given. Fifteen minutes later, analgesia from T3 to T12 was confirmed by the pinprick method. Dopamine was continuously administered in addition to rapid infusion of lactated Ringer's solution (approximately 500 ml in 30 min) to counter the decrease in blood pressure. Pure oxygen was given through a face mask. After midazolam 1 mg was given intravenously, isoflurane was administered with its concentration raised step by step. No assist ventilation was attempted throughout the procedure. Two milliliters of 4% lidocaine was injected into the trachea through the cricothyroid ligament to achieve surface anesthesia of the trachea. Inhalation of 1.5% isoflurane in oxygen was continued for another 5 min and endotracheal intubation was performed without a muscle relaxant. Anesthesia was maintained with 1.0%–1.5% isoflurane in oxygen and intermittent epidural administration of 2% lidocaine. Spontaneous respiration was reserved.

The patient's respiratory rate was 20–25 times per minute and respiration was regular and stable. The patient's hemoglobin oxygen saturation was maintained around 99%. Analysis of arterial blood gases while breathing 100% oxygen revealed a pH of 7.39, $Paco_2$ of 46.9 mmHg, and Pao_2 of 367 mmHg.

Two wires were placed through the skin, one in the upper portion of the umbilicus and the other in the midclavicular line at the right costal margin. Cholecystectomy was done in the same way with the peritoneal insufflation method. When the visibility of the operative field was not obtained sufficiently and the surgeons asked that the abdominal muscles be relaxed more, 3 ml of 2% lidocaine was administered intermittently into the epidural space. Good visibility of the operative field was obtained immediately with the procedure. During the operation, it was necessary to increase the dose of lidocaine twice. The operation was performed within 1 h 25 min. Isoflurane was discontinued at the end of the operation and 30 min later the patient responded well to our verbal commands. Analysis of arterial bloodgases revealed a pH of 7.39, $Paco_2$ of 43.2 mmHg, and Pao_2 of 424 mmHg. Then, the endotracheal tube was extubated. The patient's postoperative course was uneventful.

Discussion

Barotrauma is an inclusive term that may be classified as pulmonary interstitial emphysema, pneumomediastinum, subcutaneous emphysema, and pneumothorax [2]. When pneumothorax occurs, failure to recognize it and to provide prompt treatment may cause be fatal [3]. Peak airway pressure is most frequently cited as the main risk factor that contributes to barotrauma [2,4].

An application of high pressure to the airway results in overdistention of the alveoli with subsequent leakage of gas into the surrounding tissues producing pulmonary interstitial emphysema. A perivascular spread of the small bubbles of gas to the hilum induces pneumomediastinum. Finally, the gas may pass through a tear of the mediastinal pleura into the pleural space, thus causing a pneumothorax [4,5]. A secondary cause of pneumothorax can occur by distal spread of the pulmonary interstitial emphysema to the surface of the lung where subpleural blebs or bullae exist. These blebs or bullae are apt to rupture and connect the peripheral airway to the pleural space [4,5]. In a patient with emphysematous bullae who requires positive pressure ventilation, both of these mechanisms can occur and the risk of pneumothorax is high [6].

The benefits of laparoscopic cholecystectomy, as opposed to the traditional open technique, include: (1)

small incision, (2) less postoperative pain, and (3) less postoperative bed rest [7]. This technique is gaining popularity recently on account of these benefits. Generally, laparoscopic procedures are associated with the peritoneal insufflation of carbon dioxide. Absorption of carbon dioxide through the peritoneum causes hypercarbia, which must be managed by increasing minute ventilation [8]. The pneumoperitoneum also alters pulmonary mechanics. Respiratory impedance measurements have shown a marked elevation of the diaphragm [9]. Once the pneumoperitoneum is established, increased airway pressures are necessary to compensate for the fall in lung-thorax compliance resulting from the restriction of diaphragmatic movements [10]. Here precautions against barotrauma are critical.

Therefore, we reserved spontaneous respiration and tried to minimize the peak airway pressure, but when a patient is anesthetized under spontaneous respiration and the laparoscopic procedures are associated with the pneumoperitoneum method, there is a high incidence of hypercarbia [11]. If an assist ventilation has to be applied to compensate for the rise in carbon dioxide tension, it should increase airway pressures as mentioned before. These problems may be resolved by adopting the abdominal wall-lift method [1]. Since this method requires no peritoneal insufflation, carbon dioxide absorption may be excluded and the restriction of diaphragmatic movement is expected to be less compared with the pneumoperitoneum method. Therefore, the risk of hypercarbia can be avoided even under spontaneous respiration. Another advantage of the abdominal wall-lift method is that pneumothorax induced by the existence of a congenital defect of the diaphragm can be avoided [12].

Another problem associated with the anesthetic management is how to assure the visibility of the operative field. The patient's abdominal muscles need to be completely relaxed to obtain a good exposure of the operative field, but the need to reserve spontaneous respiration limits the use of muscle relaxants. In our case, the administration of regional anesthetics to the epidural space provided a satisfactory operative field. We believe that epidural anesthesia is effective enough to achieve relaxation of the abdominal muscles, though it may be difficult in obese or sinewy patients.

In summary, we have described a case of anesthesia for laparoscopic cholecystectomy in an elderly patient with emphysema and multiple bullae. In managing this patient with a high risk of pulmonary complications, special precautions against barotrauma were taken. First, we adopted the abdominal wall-lift method as a laparoscopic technique. Secondly, we maintained anesthesia with spontaneous respiration to minimize the peak airway pressure. Thirdly, we achieved abdominal muscle relaxation by the intermittent epidural

injection of regional anesthetics, and barotrauma was prevented.

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