146

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Case report

Spontaneous tension pneumothorax during laparoscopic cholecystectomy secondary to congenital diaphragm defects

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Abstract

A 67-year-old woman with chronic cholecystitis was scheduled to have laparoscopic cholecystectomy under general anesthesia. About 5~10 min after the CO_2 intraperitoneal insufflation, the peak airway pressure gradually increased from 15 cmH_2O to 27 cmH_2O, the end-tidal CO_2($EtCO_2$) from 32 mmHg to 56 mmHg. The SpO_2 decreased from 100% to 96%, and blood pressure from 135/80 mmHg to 80/52 mmHg. A right side tension pneumothorax was confirmed and a drainage tube was placed in the right pleural cavity. As the continuous gas leakage from the drainage tube was noted, even as ventilation was withheld, the diaphragm was carefully examined and a porous diaphragm was found. These defects were then patched with biomedical materials. The operation was finished uneventfully. It was concluded that in a patient with a tension pneumothorax during laparoscopic surgery, a diaphragm defect should be taken into consideration.

Keywords: pneumothorax; diaphragm defect

INTRODUCTION

The first laparoscopic cholecystectomy was performed in France in 1987[1]. Laparoscopic surgery has become a popular surgical procedure in China. Many laparoscopic surgeries are performed in our hospital, such as inguinal herniorrhaphy, splenectomy, colectomy, nephrectomy, adrenalectomy, pulmonary lobectomy, and most commonly, cholecystectomy.

The benefits from laparoscopic surgery are that it is less invasive, there is reduced postoperative pain, and an earlier recovery[2]. The particular concerns related to laparoscopic surgery,mainly from CO_2 pneumoperitoneum, are increased airway pressure, hypercarbia, subcutaneous emphysema, gas embolism and profound hemodynamic changes[2-4]. Pneumothorax is one of the possible complications associated with laparoscopic surgery. Intra-operatively the pneumothorax may be caused by rupture of pulmonary bullae as the CO_2 pneumoperitoneum increases the peak airway pressure. Surgical trauma and congenital diaphragm disease induced pneumothorax have also been reported[5-9].

We report a case of tension pneumothorax during laparoscopic cholecystectomy due to the patient's congenital diaphragmatic defect.

CASE REPORT

A 67-year-old woman with chronic cholecystitis was scheduled to have laparoscopic cholecystectomy under general anesthesia. She had no history of trauma or any pulmonary disease. Preoperative evaluation was unremarkable. On admission into the operation room, the patient was monitored with ECG, noninvasive blood pressure and pulse oximeter. The anesthesia was induced by 4.0 mg of midazolam and 20 mg of etomidate. Muscles were paralyzed by 50 mg of atracurium. Fentanyl 0.2 mg was used to blunt the cardiovascular response to tracheal intubation. An ID 7.0 mm tube was placed into the trachea to a depth of 21 cm from the front teeth. Pure oxygen was used to mechanically ventilate the lungs. The SpO_2 increased from 96% baseline with room air to 100% with pure oxygen. The tidal volume was set at about 7 ml/kg, respiratory rate 12 bpm, and an I:E ratio of 1:2. The

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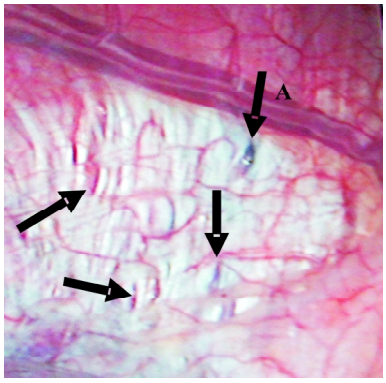
patient was positioned supine with about 15 degree head up and 15 degree left side rotation after anesthesia induction. The peak airway pressure, which was 15 cmH_2O before the pneumoperitoneum, gradually increased to 27 cm H_2O in about 5~10 min as the CO_2 was insufflated. The $EtCO_2$ also increased from 32 mmHg to 56 mmHg, and the SpO_2 decreased from 100% to 96%. Blood pressure, which was automatically measured at 3 min intervals, decreased from 135/80 mmHg to 80/52 mmHg. It was noticed that the right thoracic wall was elevated and the breath sounds on the right side of the lung disappeared. A tension pneumothorax was suspected and a chest X-ray confirmed the diagnosis. A thoracic surgeon was consulted and a drainage tube was placed at mid-clavicle line between 2nd and 3rd intercostal space to evacuate the gas in the right pleural cavity. Both the SpO_2 and the blood pressure returned to normal values.

The operation continued. Continuous gas leakage from the pleural drainage tube was then noted, even when the lungs were not ventilated. This phenomenon suggested that the gas in the right pleural cavity was not from the ruptured pulmonary bullae, but from the pneumoperitonium. As the CO_2 pneumoperitorium was discontinued, the gas leakage from the drainage tube also gradually disappeared. When the lungs were manually ventilated again, only a small amount of gas leakage was initially observed. The diaphragm was thereafter carefully observed and four to five defects at the right side(porous diaphragm) in an area of 5 cm × 7 cm were found(***Fig. 1***). The deflation and inflation processes of the right lung could be observed via these defects. The diaphragm tissue around the defects was not injured and the defects were judged as being congenital. It was finally decided that the congenital defect be patched with a bio-absorbable synthetic nonwoven polyglycolic acid fabric (Neoveil, Gunze, Japan) and medical glue(***Fig. 2***). At the usual pneumoperitonium pressure of 15 mmHg CO_2, there was no further gas leakage from the thoracic drainage tube. The operation was completed uneventfully.



Note the smaller defects nearby(arrows)

Fig. 1 Laparoscopic image of right diaphragmatic defect (arrow A)

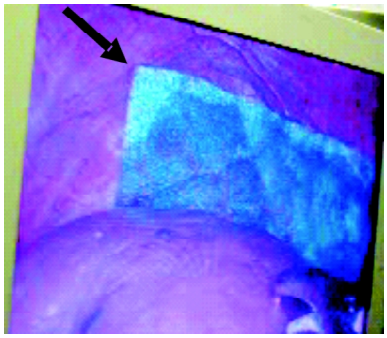


Fig. 2 The diaphragm defects were patched with a bioabsorbable synthetic nonwoven polyglycolic acid fabric(arrow) and medical glue

DISCUSSION

Patients are at risk of lung injury in the perioperative period. Anesthetic management can cause, exacerbate or ameliorate these injuries[3-6]. In this case, the tension pneumothorax was observed. The gas leakage from the drainage tube continued even after the ventilation was temporarily stopped. This phenomenon suggested the gas in the right pleural cavity was not from ruptured pulmonary bullae but from the pneumoperitonium. Measuring the CO_2 concentration in the gas leaked from pleural drainage tube by capnography is helpful in finding the source of the pneumthorax. A CO_2 concentration similar to the end-tidal level suggests the pneumothorax is caused by ruptured pulmonary bullae. If the CO_2 is much higher than the corresponding end-tidal value then the CO_2 originated from the pneumoperitomium. In the former case, the flow of fresh gas in the anesthesia circuit would need to be increased.

Pneumothorax has been reported in almost all kinds of laparoscopic surgery[3-8]. Explanations for the development of a pneumothorax during laparoscopic surgery varied greatly. A direct surgical injury to the diaphragm, malposition of the CO_2 pneumoperitonium needle leading to subcutaneous emphysema diffusing into the pleural cavity, anatomical communications around the aorta or esophagus, and the presence of a pleuroperitoneal canal closed by loose adhesions opened on institution of the pneumoperitoneum, have all been proposed[10]. Two reports have been found in the literature proposing that the pneumothorax occurring during laparoscopic surgery was due to a congenital diaphragmatic defect[11-12].

Embryologically the diaphragm originates from septum transversum, mesoesophagus, and pleuroperitoneal membrane and the abdominal wall. Congenital diaphragm hernias are occasionally reported, although diaphragmatic defects are rare. Clinically a

diaphragmatic defect is postulated to be related to "porous diaphragm syndromes", pneumothorax during menses, and to pleural effusion in cirrhotic patient without cardiac disease[13-17]. Seldom is a diaphragm defect confirmed. In our case, a pneumothorax was noticed first, a diaphragm problem was then suspected, and finally diaphragm defects were detected. The defects were right-sided as is usually reported. Surgical correction of diaphragm defect is recommended[18,19], although there is a report of the spontaneous resolution of pneumothorax occurring during laparoscopic cholecystectomy[20]. The diaphragm defects were patched successfully in our case, and gas leakage stopped soon after the patch. The right pleural drainage tube was pulled out 2 days later and the patient recovered well. Pneumothorax is rare but can be a severe complication of laparoscopic surgery. Some authors recommend the simultaneous monitoring of airway pressures, dynamic compliance, and particularly, $EtCO_2$ for an immediate diagnosis and prompt treatment of pneumothorax[21].

As a summary, a diaphragm defect is rare, but may be lethal if it goes unrecognized during surgery. In a patient who develops a tension pneumothorax during laparoscopic surgery, a diaphragm defect should be taken into consideration.

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