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CASE STUDY

Usefulness of transthoracic ultrasonography to diagnose pneumothorax after peroral endoscopic myotomy: a case report

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Abstract The treatment of esophageal achalasia using peroral endoscopic myotomy (POEM) is a standard technique that is less invasive than other techniques. There have been no previous reports of using transthoracic ultrasonography to detect complications with POEM.

We report the case of a 29-year-old male patient with esophageal achalasia who underwent POEM. The procedure was repeatedly interrupted due to hypercapnia and hemodynamic instability. Even after a peritoneal puncture to release abdominal distention, improvement of his respiratory condition was limited. The patient emerged promptly from general anesthesia but developed tachypnea. Using transthoracic ultrasonography we diagnosed left pneumothorax. He was admitted to the intensive care unit, and the trachea was extubated without any invasive intervention 6 hours later.

We treated a patient who required mechanical ventilation due to hypercapnic respiratory failure after undergoing POEM and found that transthoracic ultrasonography may be useful to detect pneumothorax in such cases.

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Key words: Achalasia; Per-oral endoscopic myotomy; Hypercapnia; Pneumothorax; Transthoracic ultrasonography.

Introduction

Achalasia is an esophageal disorder characterized by a lack of peristalsis, incomplete lower esophageal sphincter relaxation, and increased tone[1]. Peroral endoscopic myotomy (POEM) is the first-line therapy for all types of achalasia because the efficiency of POEM is equivalent to that of laparoscopic Heller myotomy with fewer complications and shorter recovery times[2-4]. However, perioperative complications associated with gas insufflation, such as pneumothorax, pneumomediastinum, and subcutaneous emphysemas have been reported[5].

We treated a patient who required mechanical ventilation due to hypercapnic respiratory failure after undergoing POEM and found that transthoracic ultrasonography may be useful to detect pneumothorax in such cases.

Case Report

We have obtained written informed consent from the patient to publish this case report.

A 29-year-old man (height 175 cm, body weight 78 kg) diagnosed with esophageal achalasia without any particular medical history or abnormal laboratory findings underwent POEM. Anesthesia was induced and maintained with propofol, ketamine, remifentanil, and rocuronium bromide. The following variables were monitored continuously during anesthesia: electrocardiogram, peripheral oxygen saturation (SpO_2), end-tidal concentration of carbon dioxide ($EtCO_2$), indirect blood pressure, body temperature (esophagus), bispectral index, and urinary output. The trachea was intubated under cricoid pressure to prevent aspiration. Just after the induction of anesthesia, blood pressure (BP) was 125/62 mmHg, and the heart rate (HR) was 65

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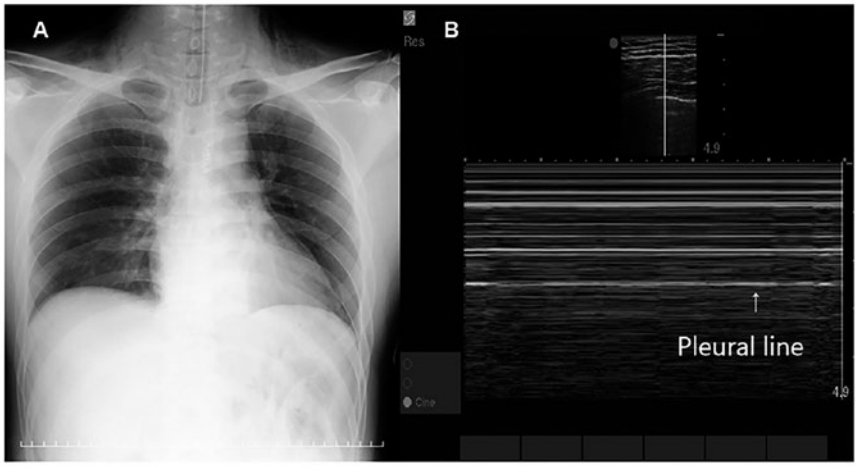

Fig1. Chest X-ray film and lung ultrasound image at the end of surgery. A: Chest X-ray film showed mediastinal emphysema and subcutaneous emphysema. B: Thoracic ultrasonography showed pneumothorax findings in left lung that the sliding sign and seashore sign disappeared, and stratosphere sign appeared in M mode.

beats per minute (bpm). Volume control ventilation was initiated with F_IO_2 0.4, tidal volume (V_T) of 500 mL at 12 breaths per minute (bpm), and positive end expiratory pressure of 5 cmH_2O. After CO_2 insufflation was initiated at a flow rate of 1.2 L/min, peak inspiratory pressure (PIP) gradually increased from 12 to 20 cmH_2O. Mechanical ventilation was changed to pressure control ventilation mode and adjusted to maintain V_T 6–7 mL/kg and $EtCO_2$ between 35 and 40 mmHg. However, in accordance with the increasing $EtCO_2$ >50 mmHg, HR and BP gradually increased (>100 bpm and >160/90 mmHg, respectively). Intermittent administration of diltiazem was required to control his hemodynamics. To maintain normocapnia, it was necessary to increase PIP and respiratory rate (RR) from 15 to 22 cmH_2O and from 12 to 17 bpm, respectively. However, it was difficult to maintain V_T and $EtCO_2$ within the normal range. The procedure was repeatedly interrupted due to hypercapnia and hemodynamic instability, therefore an attending anesthesiologist asked the surgeons to puncture the peritoneum to release the abdominal distension. The peritoneal puncture visually improved the abdominal distension. However, the improvement in ventilation following the peritoneal puncture was limited and high PIP (20 cmH_2O) was required to maintain V_T >6 mL/kg. $EtCO_2$ remained between 45 and 50 mmHg despite the peritoneal puncture. The procedure did succeed in improving the patient's hemodynamics (HR <80 bpm, BP <150/80 mmHg) and the surgery could be continued. The duration of surgery was 1 hour 54 minutes.

After the surgery, the patient emerged promptly from general anesthesia. However, he developed tachypnea (RR >30 bpm) even after the administration of sugammadex (train-of-four count 100%) for complete reversal of neuromuscular blockage. Arterial blood gas analysis revealed respiratory acidosis (pH 7.27; $PaCO_2$, 62.5 mmHg). We ordered chest radiography to confirm the presence of respiratory complications, but this revealed only pneumomediastinum and subcutaneous emphysema(Figure 1A). Next, transthoracic ultrasonography of the left anterior chest wall was conducted and revealed the absence of lung sliding, lung pulse, B-line and seashore sign and the existence of a stratosphere sign (Figure 1B). The ultrasonographic image of the lateral chest showed a normal appearance.

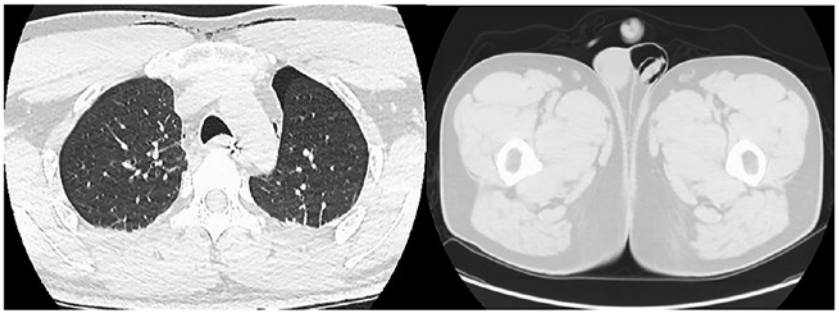

Fig2. CT image before entering the ICU. There are mediastinal emphysema, pneumothorax, subcutaneous and scrotal emphysema.

Therefore, the patient was sedated again with propofol and transferred to the intensive care unit (ICU), with extubation postponed until his respiratory pattern and $PaCO_2$ returned to normal by the spontaneous absorption of CO_2. Before admission to the ICU, computed tomography (CT) was performed and revealed pneumothorax, pneumomediastinum, pneumoperitoneum with free air, subcutaneous emphysema, and scrotal emphysema (Figure 2). The trachea was extubated 6 h after his admission to the ICU without any invasive interventions having been necessary, and the patient was discharged from the ICU the following day.

Discussion

This case represents two issues of clinical importance. First, a patient with achalasia undergoing POEM required mechanical ventilation due to postoperative hypercapnia with pneumothorax, pneumomediastinum, subcutaneous emphysema, and scrotal emphysema. Second, transthoracic ultrasonography was helpful to confirm these respiratory complications.

Respiratory complications associated with esophageal and gastric insufflation of CO_2 should be looked out for during POEM, even though POEM seems less invasive than other procedures. Pannu et al[6] reported that the findings from CT esophagrams on post-procedure day 1 showed a high incidence of CO_2 insufflation-related complications, including pneumomediastinum (85.7%), pneumoperitoneum (66.7%), subcutaneous emphysema (52.4%), and pleural effusion (46.4%). Other findings included retroperitoneal air (38.1%), pneumothorax (19%), atelectasis (14.3%), intramural air in the esophagus and/or stomach (13.1%), pericardial effusion (2.4%), and pneumopericardium (2.4%)[6]. Although most of these findings are mild and may not require intervention, the more serious complication, pneumopericardium, was also reported[7]. Banks-Venegoni et al reported that CO_2 insufflation during POEM caused pneumopericardium and resulted in cardiopulmonary arrest[7]. This complication cannot be corrected by peritoneal puncture[8]. In the present case, even after peritoneal puncture, PIP did not drastically change. This phenomenon might provide telling clues about pneumothorax or accidental cardiopulmonary complications during POEM.

The present case also showed extensive subcutaneous emphysema during POEM even after repeated interruptions followed by a peritoneal puncture to improve his condition. The continuous absorption of CO_2 from the pneumoperitoneum and subcutaneous emphysema were considered to be the source of his prolonged hypercapnia. It has been reported that adverse complications, such as pneumoperitoneum, pneumothorax, pneumomediastinum, subcutaneous emphysema, or a combination of these, can all be resolved without any therapeutic in-

tervention[9]. However, the development of subcutaneous emphysema and its involvement in upper airway obstruction after CO_2 insufflation have been reported[10]. Careful evaluation is essential if extensive subcutaneous emphysema is detected following CO_2 insufflation. In such cases, tracheal extubation should be delayed until spontaneous resolution of the hypercapnia and subcutaneous emphysema has occurred.

Transthoracic ultrasonography may be useful to detect pneumothorax associated with POEM. We were able to diagnose pneumothorax that could not be diagnosed by chest radiography before performing computed tomography. A meta-analysis has been carried out that supports the use of transthoracic ultrasonography[11]. Ding et al[11] compared chest radiography with transthoracic ultrasonography for the diagnosis of pneumothorax and showed that the latter, although more dependent on the operator's skill, had higher sensitivity and similar specificity compared with those of the former. In addition, ultrasonography may be also useful for identifying pneumomediastinum[12]. Transthoracic ultrasonography is useful for detecting pneumothorax even under positive pressure breathing. Ueda et al reported two cases of intraoperative pneumothorax in which transthoracic ultrasound was used as the initial imaging modality and contributed to correct diagnosis and timely treatment[13]. The advantage of ultrasound systems is that they are easy to swiftly bring to the patient, and examination can be started promptly and non-invasively. In the future, the role of transthoracic ultrasonography as point-of-care ultrasound during POEM should be increasingly considered.

In conclusion, we treated a patient undergoing POEM who required mechanical ventilation due to postoperative hypercapnia with pneumothorax, pneumomediastinum, subcutaneous emphysema, and scrotal emphysema and found that transthoracic ultrasonography may be useful to detect pneumothorax.

Declarations

Ethics approval and consent to participate

Not applicable.

Consent for publication

A written informed consent was obtained from the patient for the publication of this case report.

Availability of data and material

Please contact the author for data requests.

Conflicts of interest

The authors declare that they have no conflict of interest.

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