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# Cases of Pneumothorax and Severe Subcutaneous Emphysema During Laparoscopic Surgery

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Laparoscopic surgery can cause various perioperative complications unassociated with conventional open surgery. We describe complications caused by laparoscopic surgery in 2 patients. Patient1 was a 52-year-old woman who underwent a laparoscopic cholecystectomy for gallstones and cholecystitis. The percutaneous oxygen saturation and blood pressure decreased 20 minutes after the onset of pneumoperitoneum. A chest film confirmed a right-sided pneumothorax. Her respiratory status improved after placement of a drain in the thoracic cavity. Anatomical weakness of the diaphragm was suspected to have caused the pneumothorax. Patient 2 was an 86-year-old woman who underwent a laparoscopic nephrectomy via a retroperitoneal approach for cancer of the right kidney. After the induction of pneumoperitoneum, the end-tidal partial pressure of carbon dioxide ($PETCO_2$) rapidly increased and did not improve, even after altering the ventilation conditions. Subcutaneous emphysema developed and gradually extended from both thighs to the neck. After surgery, the patient received artificial ventilation through an endotracheal tube until the resolution of subcutaneous emphysema. Laparoscopic surgery can cause various complications, such as pneumothorax and subcutaneous emphysema, and result in ventilatory impairment. Patients who undergo laparoscopic surgery should be carefully monitored during the perioperative period to ensure early detection of potential complications.

**Key words**: laparoscopic surgery, pneumothorax, subcutaneous emphysema, perioperative complications, hypercapnia

## Introduction

Laparoscopic surgery is less invasive than open surgery and is now becoming the procedure of choice for cholecystectomy and nephrectomy. However, various perioperative complications can be caused by surgery under pneumoperitoneum[1)~3)]. The main complications of pneumoperitoneum with carbon dioxide include hypercapnia[4)5)], subcutaneous emphysema[4)~6)], mediastinal emphysema[7)], and pneumothorax[7)8)], leading to ventilatory impairment in some patients. We describe our experience with patients in whom pneumothorax and severe subcutaneous emphysema developed during laparoscopic surgery.

## Case Reports

### Patient 1

A 52-year-old woman was obese, with a body-mass index of 30.7. The height was 152 cm, and the body weight was 71 kg. She underwent a laparoscopic cholecystectomy for gallstones and cholecystitis. On admission, the percutaneous oxygen saturation ($SpO_2$) was low (88%), but rapidly rose to 99% after oxygen inhalation. The patient received epidural and general anesthesia. After the induction of anesthesia, there was no difference in breath sounds between the right and left lungs. Arterial-

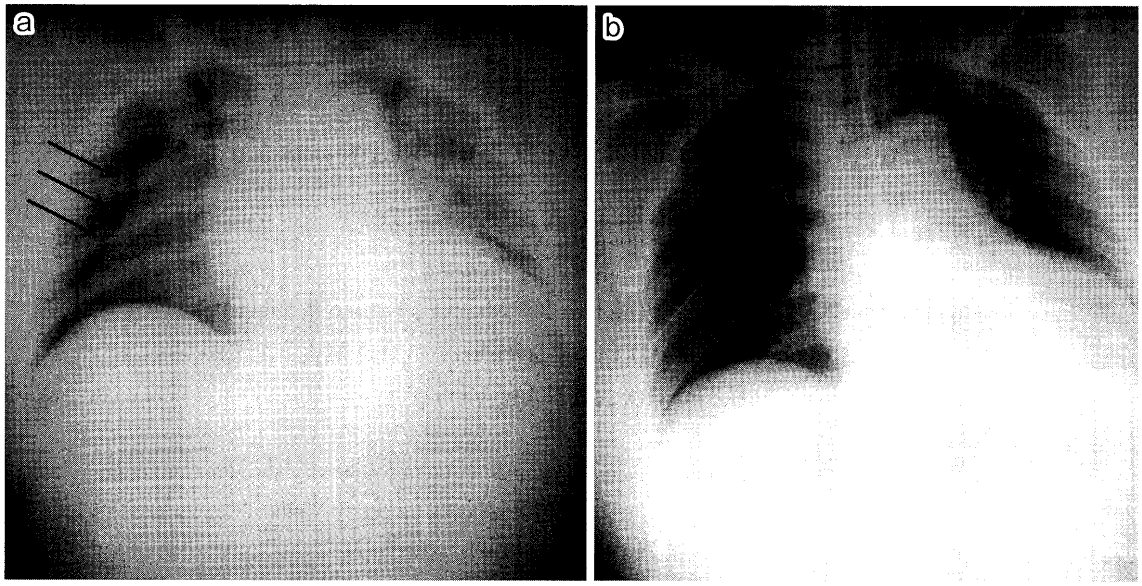


**Fig. 1**
a : A plain chest radiograph, showing pneumothorax (arrow).
b : A plain chest radiograph after placement of a drain in the thoracic cavity, showing that the right lung was inflated and improved.

blood gas analysis revealed no accumulation of carbon dioxide. After about 20 minutes of pneumoperitoneum at a pressure of 10 mm Hg, $SpO_2$ started to decrease ($SpO_2$, 90%) and did not improve even after inhalation of 100% oxygen. Breath sounds over the right lung were diminished. Arterial-blood gas analysis showed hypoxemia ($PaO_2$, 72 mm Hg) and hypercapnia ($PaCO_2$, 68 mm Hg). Bronchoscopy was performed. There were no problems with the lumen or site of the endotracheal tube. The surgical procedure was temporarily discontinued, and chest radiography was performed. The examination confirmed a right pneumothorax (Fig. 1a). A drain was placed in the thoracic cavity. Immediately thereafter, exhaled air was passed. Arterial-blood gas analysis showed a $PaO_2$ of 144 mm Hg and a $PaCO_2$ of 40 mm Hg during inhalation of 100% oxygen. Exhaled air was passed from the drain placed in the thoracic cavity during pneumoperitoneum. After pneumoperitoneum, however, exhaled air was not passed. After the completion of surgery, spontaneous respiration was resumed. A chest film showed dilatation of the right lung (Fig. 1b). After confirming the normal results of arterial-blood gas analysis ($PaO_2$, 266 mm Hg and $PaCO_2$, 44 mm Hg during inhalation of 50% oxygen), the endotracheal tube was removed. The patient recovered uneventfully. On the second hospital day, the drain was removed from the thoracic cavity. The patient was discharged on the eighth hospital day, without any deterioration in respiratory status.

**Patient 2**

An 82-year-old woman underwent a laparoscopic nephrectomy via a retroperitoneal approach for cancer of the right kidney. The height was 137 cm, the body weight was 42 kg, and the body-mass index was 22.7. Before surgery, she had anemia (hemoglobin level, 8.9 g/dl) and was positive for irregular antibodies. Plain radiography of the chest and abdomen revealed scoliosis. The patient received epidural and general anesthesia. Three trocars were inserted to perform laparoscopic surgery: the first was placed two fingerbreadths above the right iliac spine in the midaxillary line, the second at the 12th right inferior costal margin in the posterior axillary line, and the third at the right umbilical region in the midclavicular line. Pneumoperitoneum was induced at a pressure of 8 to 10 mm Hg. The end-tidal carbon dioxide pressure ($PETCO_2$) before pneumoperitoneum was 32 mm Hg. Immediately af-

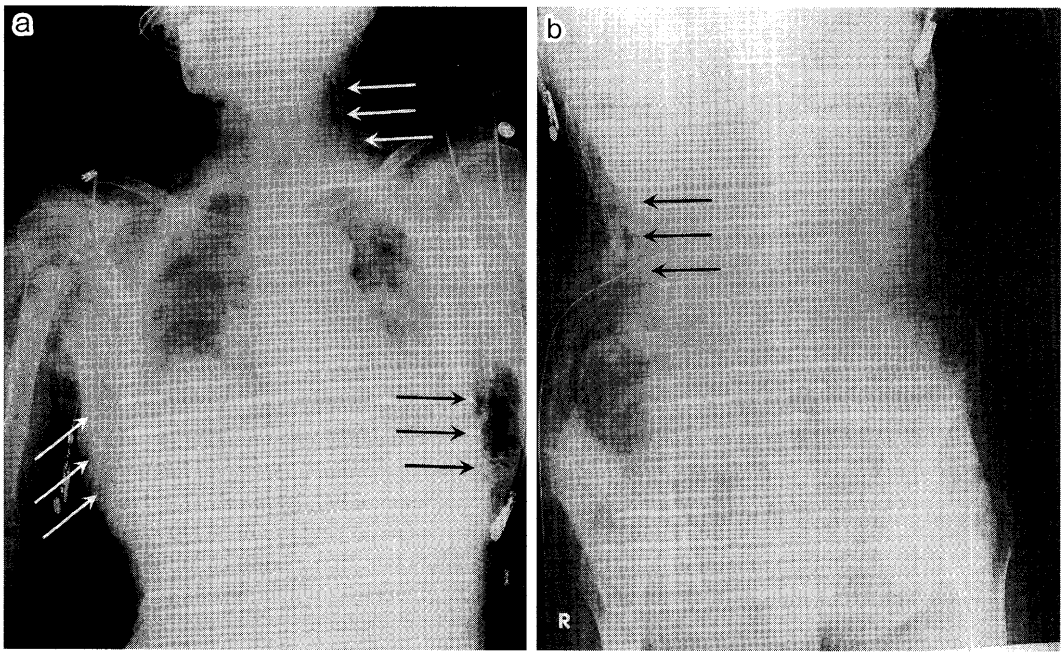


**Fig. 2**
a : A plain chest radiograph, showing subcutaneous emphysema (arrow).
b : A plain abdominal radiograph, showing subcutaneous emphysema (arrow).

ter pneumoperitoneum, however, $PETCO_2$ rose from 60 to 69 mm Hg. The ventilation volume and frequency increased, but $PETCO_2$ did not improve. Arterial-blood gas analysis performed 45 minutes after pneumoperitoneum showed that the $PaCO_2$ had increased to 68 mm Hg. Bronchoscopy was performed to confirm airway problems, such as displacement of the endotracheal tube caused by elevation of the diaphragm. However, no abnormalities were apparent. The $PETCO_2$ was 57 mm Hg. There was no distinct evidence of subcutaneous emphysema. As insufflation was increased to secure an adequate working space, subcutaneous emphysema developed and gradually spread. Five hours after pneumoperitoneum, open surgery was needed to achieve hemostasis. After pneumoperitoneum, the $PETCO_2$ improved rapidly and $PaCO_2$ decreased to 32 mm Hg. The hemoglobin level decreased to 5.6 g/dl, and the blood pressure decreased slightly. Blood transfusion and administration of a catecholamine preparation were thus started. The blood pressure returned to normal. The hemoglobin level increased to 7.0 g/dl. After surgery, the patient was transferred to the intensive care unit and underwent radiography of the chest and abdomen. Radiography of the chest and abdomen (Fig. 2a and 2b) showed that subcutaneous emphysema extended from both thighs to the neck. After the completion of surgery, mechanical ventilation was continued through the endotracheal tube. On postoperative day 2, subcutaneous emphysema resolved, and the tracheal tube was removed. The patient recovered uneventfully.

## Discussion

Laparoscopic surgery is less invasive than open surgery and has several advantages, such as ease of postoperative pain management, a shorter hospital stay, and a less conspicuous surgical scar[2]. However, complications that do not occur with open surgery may develop because carbon dioxide is used to secure an adequate field of vision. Most complications during laparoscopic surgery with pneumoperitoneum are caused by increased intra-abdominal pressure and the effects of hypercapnia on the respiratory and circulatory systems[1)~9)]. The incidence of pneumothorax has been reported to be only 0.3% to 0.5%[9]. Pneumothorax can be caused by a number of factors, including the presence of pulmonary cysts before surgery, pulmonary overinflation during anesthesia, and tissue damage due to surgical

procedures[7][8]. However, Patient 1 had no exhaled air from the drain placed in the thoracic cavity after pneumoperitoneum. The patient was considered to have no lung injury and therefore had none of these risk factors. Carbon dioxide insufflated into the abdominal cavity to induce pneumoperitoneum probably entered the thoracic cavity through fragile parts of the diaphragm, resulting in pneumothorax[9]. General anesthesia is associated with a low incidence of pneumothorax. However, the development of pneumothorax during pneumoperitoneum-induced elevation of the diaphragm with decreased tidal volume can lead to marked ventilatory impairment. Therefore, early detection and early treatment of pneumoperitoneum-induced pneumothorax are essential. Patients' conditions should be carefully monitored by pulse oximetry, capnography, and assessment of breath sounds.

In patients in whom $PETCO_2$ rises rapidly and does not improve even after increasing minute ventilation, similar to Patient 2, carbon dioxide may be absorbed from subcutaneous emphysema, thereby increasing $PETCO_2$[4)~6)]. This is attributed to the fact that carbon dioxide leaks into subcutaneous tissues more easily enters the bloodstream than carbon dioxide absorbed from the peritoneum[4)~6)]. Acute subcutaneous emphysema may have been caused by displacement of a trocar due to forceps application. Insufflated carbon dioxide might have been pumped directly into subcutaneous tissue through the tip of a trocar or might have entered from the insertion site in the peritoneum via the trocar and forceps, rapidly causing subcutaneous emphysema. Carbon dioxide may have been continuously insufflated into the site of subcutaneous emphysema, which then rapidly spread. Extension of subcutaneous emphysema to the neck, such as in our patient, is associated with a risk of airway obstruction. Close coordination with the operator is thus essential, including the withdrawal of pneumoperitoneum. Because respiratory status may deteriorate after surgery, caution is required.

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# 腹腔鏡下手術中に気胸および著明な皮下気腫を来たした症例

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腹腔鏡下手術は，従来の開腹術にはみられない多彩な周術期合併症を引き起こす可能性がある．今回，鏡視下手術中経験した合併症を紹介する．（症例1）52歳女性．胆石・胆嚢炎に対し腹腔鏡下胆嚢摘出術が施行された．気腹20分後に経皮酸素飽和度が低下し血圧も低下した．胸部X線撮影で右気胸が確認された．胸腔ドレーンを挿入し呼吸状態は改善された．気胸の原因として，横隔膜の脆弱性が疑われた．（症例2）86歳女性．腹腔鏡下後腹膜到達法（retroperitoneal approach）で右腎癌に対して右腎臓摘出術が施行された．気腹後から呼気終末二酸化炭素分圧（$PETCO_2$）が急に上昇し換気条件を変更しても改善されなかった．皮下気腫を認め，徐々に広範となった．両側大腿部から頸部まで進展したため，手術後も皮下気腫が改善するまで気管内挿管下呼吸管理を行った．腹腔鏡下手術中は気胸，皮下気腫などの合併症が起こり換気障害を来たすことがあるので，早期発見につとめ，周術期も注意深く観察する必要がある．