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Extensive Subcutaneous Emphysema and Ventilatory Failure during Gynecologic Laparoscopic Surgery: A Case Report

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Abstract

Subcutaneous emphysema (SCE) is a relatively common complication of laparoscopic surgery; however, extensive cases associated with ventilatory failure are rare. We report a case of massive SCE with ventilatory compromise during laparoscopic total hysterectomy. A 50-year-old woman underwent laparoscopic total hysterectomy for uterine fibroids associated with menorrhagia. Shortly after the vaginal incision, a sudden increase in end-tidal CO_2 levels and ventilatory failure occurred. Extensive SCE was subsequently observed, with emphysema extending from the neck to the thighs. The patient's respiratory status stabilized after reducing insufflation pressure and increasing both tidal volume and respiratory rate. A postoperative chest X-ray showed no evidence of pneumothorax or mediastinal emphysema. She was safely extubated, monitored in the general ward, and discharged on postoperative day four. Possible contributing factors include tissue fragility and surgical technique. Early recognition and prompt intervention, through close communication with the anesthesiologists and operating room staff, are essential in managing such complications.

Keywords

Subcutaneous Emphysema, Ventilatory Failure, Laparoscopic Surgery, Gynecology

1. Introduction

In recent years, laparoscopic and robot-assisted surgeries have become increasingly

common as minimally invasive procedures in gynecology [1] [2]. Subcutaneous emphysema (SCE) is a known complication of laparoscopic surgery, with reported incidence rates ranging from 2.3% to 56%, depending on the diagnostic modality, such as palpation, chest X-ray, or computed tomography [3] [4].

Most cases of SCE are subclinical; however, when emphysema extends to the neck, pharyngeal involvement may lead to airway obstruction [5]. In some instances, extubation can be difficult or even life-threatening [3] [6].

Here, we present a rare case of extensive SCE accompanied by ventilatory failure during a laparoscopic total hysterectomy. Early detection and close collaboration with anesthesiologists and the operating room staff are essential for the effective management of such intraoperative complications.

2. Case Report

A 50-year-old woman (Gravida 1, Para 1) was referred to the Central Japan International Medical Center for the management of uterine fibroids associated with menorrhagia. She was otherwise healthy and not taking any medications. Pelvic magnetic resonance imaging revealed an approximately 5-cm intramural myoma (**Figure 1**), and a laparoscopic total hysterectomy was scheduled. Preoperative evaluations, including laboratory tests and cardiopulmonary assessments, were unremarkable. Her American Society of Anesthesiologists Physical Status was classified as Grade I. Her body mass index (BMI) was 18 (weight: 48 kg; height: 162 cm).

Figure 1. Pelvic magnetic resonance imaging showing an approximately 5-cm intramuscular fibroid.

An initial 5-mm trocar was inserted through the umbilicus, and the peritoneal cavity was insufflated with carbon dioxide (CO_2) to a pressure of 10 mmHg using the Endoflator 50® (Karl Storz Inc., Germany). The authors have used the conventional insufflator for gynecological laparoscopic surgery. Three additional 5-mm trocars were placed: one in the lower midline and two in the lateral abdominal regions. After that, the patient was placed in the lithotomy position with a 15˚ Trendelen-

burg tilt. The patient underwent a laparoscopic total hysterectomy with bilateral salpingectomy (Figure 2). The total operative time was 1 hour and 46 minutes, with an insufflation time of 1 hour and 38 minutes. The amount of bleeding was small.

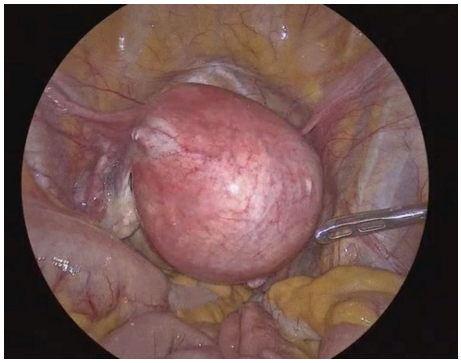

Figure 2. Intraoperative findings: fist-sized uterus with uterine fibroid.

The intraoperative course of end-tidal CO_2 ($EtCO_2$) and tidal volume is summarized in Figure 3. Eighty-five minutes after the start of surgery, during the vaginal incision, the anesthesiologist noted a sudden increase in $EtCO_2$ from 40 mmHg to 60 mmHg, accompanied by signs of ventilatory compromise. In response, the insufflation pressure was reduced from 10 mmHg to 5 - 6 mmHg. Based on these findings, SCE was strongly suspected. Intraoperative palpation confirmed the presence of SCE, primarily in the abdominal region, with extension to the neck and thighs. The insufflation system used in this case could not record the total volume of CO_2 insufflated during surgery. Before and after the $EtCO_2$ spike, the patient's respiratory condition stabilized after the ventilatory rate was increased from 10 per minute to 14 per minute, followed by an increase in tidal volume from 500 mL to 620 mL. This allowed the insufflation pressure to be cautiously raised back to 8 mmHg, and the procedure was continued without further complications. The intra-operative arterial blood gases were not measured. Continuous capnography monitoring was used alone. The patient's condition was no different from that after laparoscopic surgery under general anesthesia.

Upon completion of the operation, chest and abdominal radiographs were obtained. Both the chest (Figure 4(a)) and abdominal (Figure 4(b)) X-rays revealed subcutaneous emphysema extending from the abdomen to the neck, thighs, and buttocks (Figure 5). However, there were no signs of airway narrowing or obstruction, and the patient was extubated safely. The patient remained hemodynamically and respiratory stable under close monitoring in the operating room and was subsequently transferred to the general ward for further observation. In the ward, the patient was monitored using percutaneous arterial oxygen saturation, blood pressure, and an electrocardiogram. No abnormalities were noted in the vital signs.

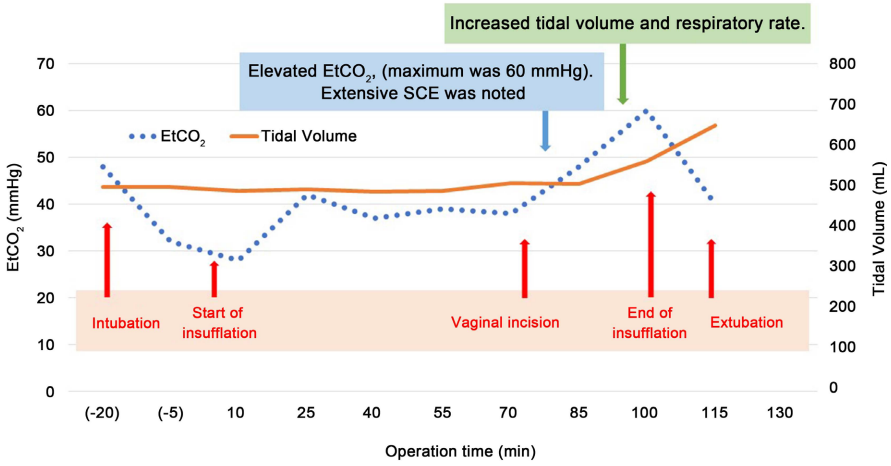

Figure 3. Intraoperative time course. The maximum $EtCO_2$ reached 60 mmHg.

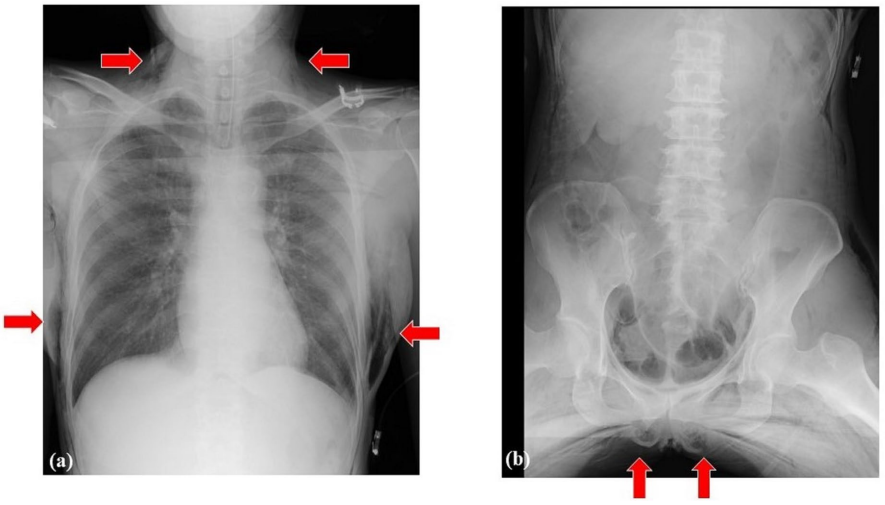

Figure 4. Chest and abdominal X-rays showing subcutaneous emphysema extending beyond the abdomen to the neck, thighs, and buttocks (arrows).

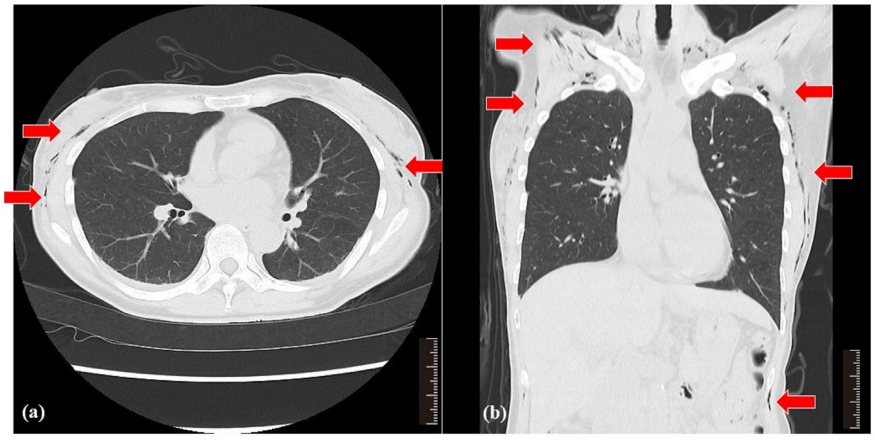

Figure 5. Chest computed tomography on postoperative day 1 showed persistent subcutaneous emphysema extending from the neck to the chest, without evidence of mediastinal emphysema.

On postoperative day 1, whole-body computed tomography revealed persistent, extensive subcutaneous emphysema; however, there were no signs of mediastinal emphysema or pneumothorax (**Figure 6**). On postoperative day 4, physical examination showed marked improvement in the SCE, and the patient was discharged home in stable condition. Her postoperative course was uneventful.

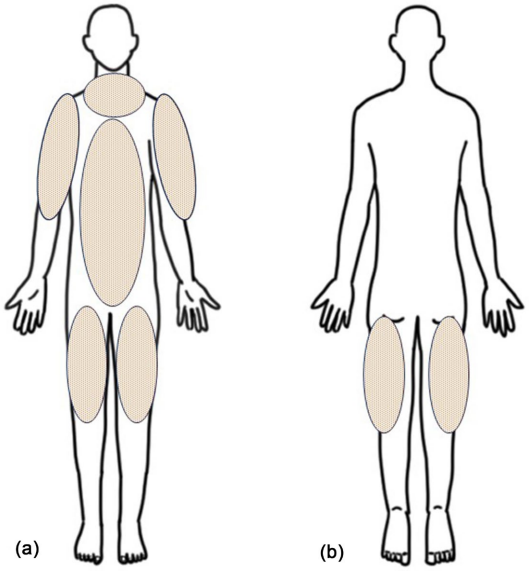

Figure 6. Schematic illustration of the SCE distribution: (a) Anterior view; (b) Posterior view. The affected areas are shown in light yellow.

3. Discussion

The risk factors for SCE include older age, low BMI, and a history of corticosteroid use—all of which are associated with tissue fragility [5] [7] [8]. Surgical factors such as prolonged operative time (>200 minutes), elevated pneumoperitoneum pressure (>15 mmHg), the use of multiple trocars (>6), and larger trocar diameters (>10 mm) have also been implicated [5] [8].

In the present case, although both the duration of surgery and insufflation pressure remained within standard limits, the patient's thin body habitus and relatively advanced age may have contributed to increased tissue fragility. Furthermore, the use of sharp dissection through subcutaneous tissues and blunt dissection of the rectus sheath may have facilitated the spread of insufflated gas along tissue planes. Similar mechanisms have been reported in cases involving peritoneal dissection during endometriosis surgery [9].

In addition to the above risk factors, the total amount of CO_2 insufflated into the abdominal cavity is also associated with the development of SCE [10]-[12]. Leakage of insufflated CO_2 into subcutaneous tissues can lead to SCE. When CO_2-related SCE becomes extensive, systemic CO_2 absorption increases, resulting in elevated $EtCO_2$ levels [12]. The vaginal incision likely increased CO2 insufflation and led to SCE. Furthermore, the SCE may have worsened, causing a decrease in intra-abdominal CO_2 pressure and necessitating an increase in CO_2 insufflation, which

could further exacerbate the patient's respiratory condition. Management includes hyperventilation, reduction of insufflation pressure, and close intraoperative monitoring of arterial CO_2 levels [12]. In surgeries lasting approximately 90 minutes, as in the present case, continuous arterial blood gas monitoring may not be necessary. However, intraoperative capnography remains essential for the early detection of SCE.

Regarding the insufflation system, a conventional device was used in this case. In contrast, the AirSeal® system (ConMed, NY) is a valve-free insufflation system that continuously monitors CO_2 flow, enabling a more stable pneumoperitoneum. The use of AirSeal® has been reported to reduce CO_2 consumption and shorten operative time [13]. However, because high-flow insufflation may occur through the side port of the trocar, CO_2 can potentially diffuse into the subcutaneous soft tissues if the trocar is not properly positioned [14]. Although the use of AirSeal theoretically reduces the risk of SCE, there have been reports of increased SCE that may be related to trocar slippage. Although the use of AirSeal® is reported to shorten surgery time [14], the laparoscopic surgery for benign gynecological diseases like the present case generally does not take that long, so the authors have used the conventional insufflator instead of AirSeal® for gynecological laparoscopic surgery in our hospital. In contrast, conventional trocar systems, such as the one used in this case, insufflate CO_2 through the end hole of the trocar.

Although most cases of SCE are clinically mild and often go unnoticed, there have been reports of severe cases associated with failure to extubate and life-threatening complications [3] [6]. Fortunately, these conditions typically resolve spontaneously within 2 to 3 days.

During surgery, it can be challenging for surgeons to promptly recognize changes in the surrounding tissues, as their attention is primarily focused on the surgical field. However, as demonstrated in the present case, when the anesthesiologist reported a sudden increase in $EtCO_2$, SCE was promptly suspected. Additionally, early detection can result from input provided by surgical assistants or observations from operating room staff regarding abnormalities in pneumoperitoneum pressure or monitoring equipment. Like the patient in this case, even patients who do not have many of the risk factors for SCE listed above may still have the possibility of SCE, so it is important to pay close attention to the patient's condition during surgery. We believe that early detection and effective management of such complications require close and proactive communication among all members of the operating room team and vigilance toward changes outside the immediate surgical field [5] [8].

4. Conclusion

Subcutaneous emphysema (SCE) is a recognized complication of laparoscopic surgery and is typically mild. However, extensive SCE leading to ventilatory compromise is rare. We described a case of intraoperative extensive SCE resulting in ventilatory failure. Prompt recognition and timely intervention—facilitated by ef-

fective communication among the operating room staff—ensured successful patient management. This case underscores the importance of maintaining vigilance for uncommon but potentially serious complications during laparoscopic procedures.

Acknowledgements

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Consent

Verbal consent was obtained from the patient before writing this case report.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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Abbreviations

SCE	Subcutaneous emphysema
BMI	Body mass index
$EtCO_2$	End-tidal CO_2