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CASE REPORT

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Lung ultrasound diagnosis of pulmonary edema resulting from excessive fluid absorption during hysteroscopic myomectomy: a case report

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Abstract

Background Hysteroscopic surgery is a safe procedure used for diagnosing and treating intrauterine lesions, with a low rate of intraoperative complications. However, it is important to be cautious as fluid overload can still occur when performing any hysteroscopic surgical technique.

Case Presentation In this case report, we present a unique instance where lung ultrasound was utilized to diagnose pulmonary edema in a patient following a hysteroscopic myomectomy procedure. The development of pulmonary edema was attributed to the excessive absorption of fluid during the surgical intervention. By employing lung ultrasound as a diagnostic tool, we were able to promptly identify and address the pulmonary edema. As a result, the patient received timely treatment with no complications. This case highlights the importance of utilizing advanced imaging techniques, such as lung ultrasound, in the perioperative management of patients undergoing hysteroscopic procedures.

Conclusions This case report underscores the significance of early detection and intervention in preventing complications associated with fluid overload during hysteroscopic myomectomy procedures.

Keywords Hysteroscopy, Intraoperative complications, Pulmonary edema, Ultrasonography, Extravascular lung water, Early diagnosis

Background

Hysteroscopic surgery is a commonly performed minimally invasive procedure in gynecology, offering advantages such as reduced invasiveness and quicker recovery times compared to traditional laparotomy [1]. During this procedure, a uterine distension medium is utilized to expand the uterus and clear debris, allowing for optimum visualization of the endometrial cavity. However, there is a potential complication known as Operative Hysteroscopy Intravascular Absorption (OHIA) syndrome, which can occur due to excessive fluid overload from the intravasation of the distension medium [2]. Reports are available of gynecologists using higher distension pressures (40–60 mm Hg) which results in rapid absorption of the irrigation fluid [3]. Other factors contributing to the risk are a high volume of irrigation fluid, the extent of the transaction of vascular beds, duration of the procedure, and surgical expertise [4]. Although OHIA

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syndrome is considered a rare complication in hysteroscopic surgery, it is crucial not to overlook the potential risks [5]. This syndrome can lead to serious consequences such as hyponatremia, volume overload, hypo-osmolality, hypothermia, pulmonary edema, cerebral edema, or heart failure, which can be fatal [6]. Early detection and intervention are important for positive outcomes in cases of OHIA syndrome; however, detection may be difficult or nearly impossible while the patient is under general anesthesia and cannot complain of symptoms [7]. Recent advancements in medical technology have introduced the use of ultrasound for studying lung diseases, with results comparable to chest computer tomography (CT) [8]. In this case report, we present a patient who underwent hysteroscopic surgery and experienced pulmonary complications due to fluid overload. Fortunately, the patient's condition was promptly identified through lung ultrasound, allowing for timely intervention and successful treatment without any complications.

This case report has obtained the written informed consent for publication from the patient.

Case report

A 55-year-old woman, standing at 155 cm tall and weighing 65 kg, was scheduled for a hysteroscopic resection of uterine myomectomy. The patient presented at the hospital with postmenopausal vaginal bleeding. An abdominal ultrasound revealed a solid mass in the uterus, indicating a submucosal fibroid located on the anterior wall of the uterine cavity, measuring 4.5×3.8 cm. The preoperative diagnosis was postmenopausal bleeding, submucosal uterine leiomyoma? She had a history of untreated hypertension and a long-standing smoking habit. Prior to the operation, there were no abnormal findings in her physical examination or laboratory tests, and both her electrocardiogram (ECG) and chest X-ray results were normal.

Upon arrival in the operating room, the patient was lithotomic position, and intravenous lactated Ringers solution was administered. Her preoperative blood pressure was 175/98 mmHg, heart rate was 75 beats/min, and SpO2 was 96%. The patient was lithotomic position and scanned along the intercostal space using the Sonosite M-Turbo ultrasound diagnostic instrument with an L38xi probe (10-5 MHz). Utilizing the recommended techniques outlined in the 2012 Pulmonary Ultrasound Guidelines [9], a lung ultrasound was conducted and documented (Fig. 1a). General anesthesia was induced using etomidate and sufentanil, and a $4^{\#}$ laryngeal mask airway was inserted. Controlled ventilation was initiated, with respiratory parameters adjusted using an oxygen-air mixture. The ventilation parameters employed during the procedure involved the use of the Drager Fabius Tiro anesthesia machine in volume controlled ventilation (VCV) mode. The respiratory parameters were set as follows: tidal volume (VT) at 440 mL, inspiratory time to expiratory time ratio (TI: TE) at 1:2, positive end-expiratory pressure (PEEP) at 0 cmH_2O, fresh air flow rate at 2 L/min, and fraction of inspired oxygen (FiO_2) at 40%. Following the induction of anesthesia, the patient's blood pressure ranged from 135–145/72–83 mmHg, the heart rate was recorded at 64 beats per minute, and the peripheral oxygen saturation remained consistently between 99% and 100%. Anesthesia was maintained with

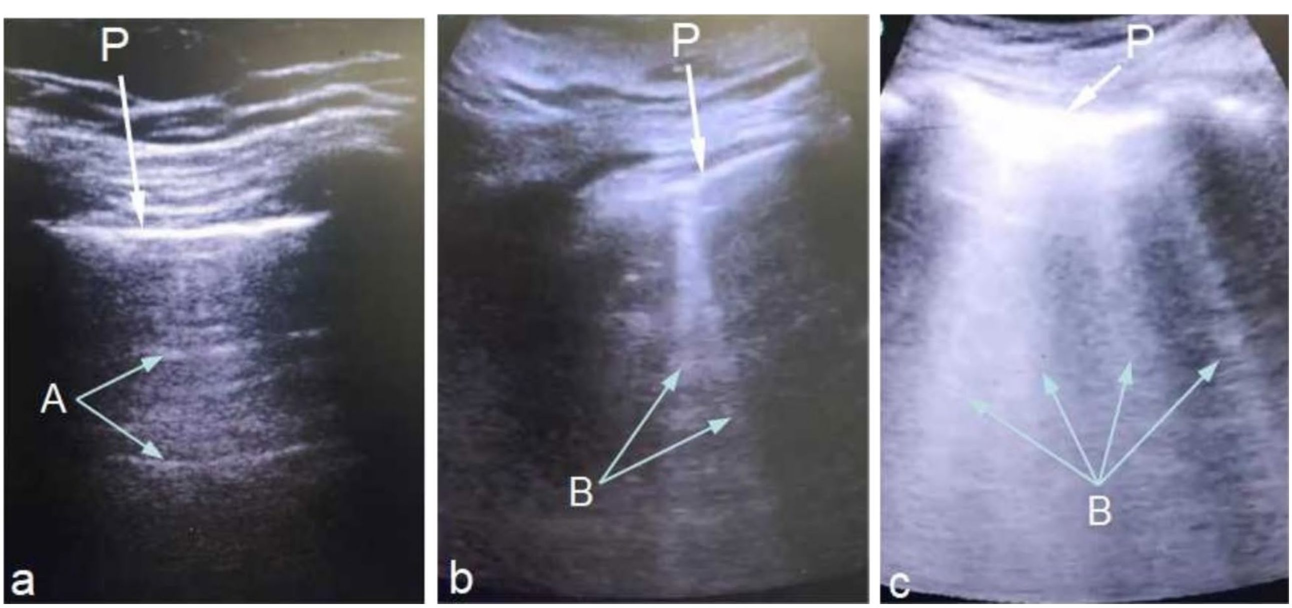

Fig. 1 The lung ultrasound results of the patient. P: pleural line; A: A-lines; B: B-lines. **(a)**: before the operation, the patient's lung ultrasound was normal. **(b)**: the first examination during the operation, the B-lines were found. **(c)**: the second examination during the operation, there were diffuse B-lines

continuous infusion of propofol and remifentanil. The target controlled infusion (TCI) method was employed for the continuous delivery of anesthesia, ensuring propofol was maintained at a concentration of 3 μg/ml and remifentanil at 4 ng/ml. Throughout the operation, the dosage of anesthesia drugs is carefully adjusted by monitoring the patient's vital signs in order to maintain the appropriate depth of anesthesia.

The uterine dilation medium used was 0.9% normal saline (NS), with a uterine dilation pressure of 100 mmHg. Thirty minutes post-operation, 10 mg of furosemide was administered prophylactically. Arterial blood gas (ABG) analysis showed normal results, with no significant hemodynamic changes observed. However, the patient's SpO_2 decreased from 99 to 95% ten minutes later, with no audible wet rales. At this time, there was no obvious hemodynamic change was observed, but B-lines were detected in both lungs via ultrasound (Fig. 1b). ABG analysis was conducted with the suspection that liquid overload had occurred. Three minutes later, $P_{ET}CO_2$ dropped from 34mmHg to 29mmHg and ABG analysis revealed a decrease in PO_2 to 72mmHg (Table 1, 2nd). Bilateral rales were heard upon lung auscultation, especially in the right lung.

The surgical procedure was temporarily halted, FiO_2 was increased to 100% and an additional 20 mg of furosemide was administered. The left radial artery was catheterized for continuous pressure monitoring. Blood pressure was carefully maintained within the range of 105–120/61–73 mmHg, while the heart rate remained steady at approximately 90 bpm. Five minutes later, electrocardiography on the monitor showed ST depression in leads II, III and a pulmonary ultrasound revealed the presence of diffuse B-lines in both lungs (Fig. 1c). Based on the clinical scenario, a diagnosis of OHIA syndrome was made.

Subsequent ABG analysis indicated a return of PO_2 levels to 128 mmHg, however, hemoglobin levels had decreased to 108 g/l and serum potassium had dropped to 3.0 mmol/l (Table 1, 3rd). To address the low potassium levels, 10 ml of 10% potassium chloride was administered slowly via intravenous pump.

Following a thorough assessment of hemostasis by the surgeon, the decision was made to conclude the operation. The patient regained consciousness and began breathing autonomously without any discomfort after 15 min. The laryngeal mask was removed, and oxygen was administered via a mask while the patient was closely monitored in the operation room. With potassium supplementation, the T wave abnormalities on the electrocardiogram gradually resolved. However, a subsequent ABG analysis revealed a decrease in PO_2 levels to 68 mmHg, prompting the patient to be transferred to the Post-Anesthesia Care Unit (PACU) for further management.

During the procedure, a total of 5000 mL of irrigation fluid was input, with 4000 mL output. The total intraoperative intravenous fluid volume administered was 300 mL, while urine output amounted to 1000 mL, and blood loss was estimated at 30 mL.

The patient in the PACU received oxygen therapy via a mask. During monitoring, blood pressure fluctuated between 128–139/74–80 mmHg, and heart rate ranged from 81 to 88 bpm. The ABG levels were rechecked twice, with normal PO_2 levels and no apparent abnormalities noted (Table 1, 5th and 6th). Subsequently, the patient was transferred back to the ward. In the PACU, the patient's urine output is 500 mL.

A chest X-ray performed on the second postoperative day revealed multiple spots and hyperemia shadows in the right lung (Fig. 2b). Despite these findings, the patient did not exhibit respiratory distress, chest tightness, wheezing, shortness of breath, or any other symptoms. A follow-up chest X-ray three days later showed no abnormalities (Fig. 2c). Ultimately, the patient was discharged from the hospital following a successful recovery.

Discussion

OHIA syndrome was initially described in 1993 [10] and to date, fewer than 30 cases have been reported worldwide [11]. The appearance of OHIA syndrome is attributed to increased fluid absorption, which is influenced by various factors such as the duration of surgery, flushing fluid pressure, tumor size and depth, and the presence of false passages or cervical tears [12]. Rapid absorption of

Table 1 The ABG analysis results of the patient

	Ph	PO_2 (mmHg)	PCO_2 (mmHg)	Hb (g/l)	Hct	Na^+(mmol/l)	K^+(mmol/l)
1^{st}	7.37	214	43	124	36	135	3.3
2^{nd}	7.35	72	45	119	34	137	3.3
3^{rd}	7.33	128	46	108	29	137	3.0
4^{th}	7.39	68	36	131	39	137	3.8
5^{th}	7.34	161	41	137	40	138	3.4
6^{th}	7.34	183	45	138	40	138	3.3

There were obviously decreased with PO_2 in the 2^{nd} and 4^{th}. The Hb and the serum potassium dropped in the 3rd. There were no obvious changes of serum sodium in all the ABG analysis

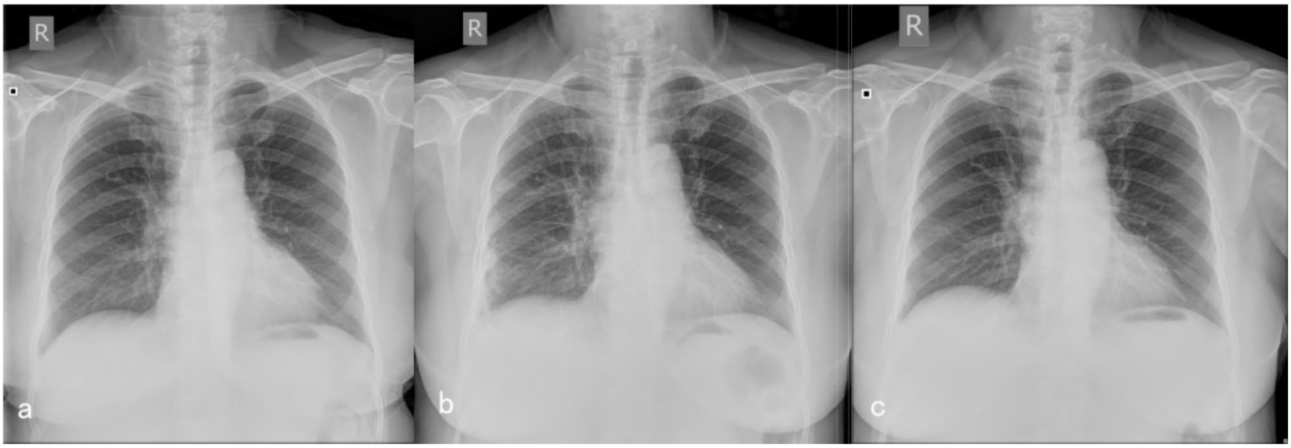

Fig. 2 The chest X-ray results of the patient. **(a)**: preoperative. **(b)**: the second day after operation. **(c)**: before discharge. There were no image abnormal in both Fig. 2. **(a)** and Fig. 2. **(c)**. Figure 2. **(b)** showed multiple spots and hyperemia shadows in the right lung. Regretfully, since the high blood pressure of the patient after surgery, we failed to transfer the patient for chest X-ray examination in time and the patient's lungs did not show typical signs of pulmonary edema

all types of fluid media can lead to systemic circulation dilation, resulting in complications such as pulmonary edema and heart failure [13]. In comparison to hypotonic electrolyte-free solutions, isotonic electrolyte solutions are safer dilution fluids. They help minimize the risk of hyponatremia, which can lead to severe brain edema [14]. However, it does not eliminate the risk of congestive cardiac failure and pulmonary edema resulting from excessive fluid absorption. Severe pulmonary edema can lead to systemic tissue edema, throat edema, heart failure, brain edema, and more [1].

In our case, the patient underwent a hysteroscopic myomectomy with NS used as the irrigation medium, and developed hypoxemia and hypokalemia. She also exhibited signs suggestive of pulmonary edema caused by excessive fluid overload, such as a decrease in SpO_2, $P_{ET}CO_2$, and PO_2 levels. Actually, there was a drop in blood pressure of patient since the OHIA syndrome happend. Blood pressure results from the product of the volume of blood ejected by the heart into the arteries (namely, cardiac output) and systemic vascular resistance [15]. During surgery, the patients may experience fluid overload due to fluid absorption, leading to an increase in cardiac afterload and the potential development of heart failure as a consequence of untreated hypertension. Post-anesthesia, peripheral vessels were in a relaxed state with insufficient vascular tension. Cardiac dysfunction resulting in decreased cardiac output, low vascular tone, and increased volume all contribute to a decrease in pressure.

Early diagnosis and treatment of fluid overload can reduce hospitalization rates and slow the progression of heart failure. However, as previously mentioned, early detection of symptoms may be challenging or nearly impossible while the patient is under general anesthesia and unable to communicate any discomfort. According to the guidelines, in order to prevent complications resulting from fluid overload, it is recommended that the surgical team maintain a running balance every 10 min and at the end of each use of the fluid bag [13]. However, accurate fluid monitoring can be challenging in open systems where fluid can escape through various channels, making monitoring inaccurate or impossible.

Real-time monitoring of oxygenation status and electrolytes can be achieved through ABG analysis, although this method is time-consuming and invasive. It is important to note that the risk of fluid absorption cannot be solely judged by the plasma sodium ion content when NS used as the irrigation medium. Hemoglobin levels may decrease due to the dilution of NS, and plasma potassium and calcium ions can also be used as observation indexes. In our case, we observed that the sodium ion content in the plasma did not show any significant fluctuations following the administration of NS. But this did lead to the development of hypoxemia, hypokalemia, and dilutional anemia.

It is important to note that we utilized ultrasound to monitor the patient's lung in our case. At the first decrease in oxygen saturation (from 99 to 95%), we detected the B-lines through pulmonary ultrasound when there was no obvious hemodynamic change was observed. We strongly suspect that there has been a liquid overload at this time. To further support this diagnosis, we have conducted an ABG analysis. Pulmonary ultrasound plays a vital role in detecting early signs of pulmonary edema resulting from fluid overload. This early identification is essential for ensuring prompt and precise treatment.

For many years, ultrasound technology was considered ineffective for imaging the lungs due to the scattering of sound waves by air, hindering accurate transmission.

However, the discovery of B-lines has revolutionized the use of ultrasound for monitoring and diagnosing pulmonary edema. Recent advancements in lung ultrasound technology have revealed that diffuse white lung is an early ultrasonic characteristic of acute pulmonary edema. Real-time monitoring of B-lines can guide fluid resuscitation treatment for critically ill patients [16]. Studies have shown a strong correlation between B-lines artifacts and increased extravascular lung water (EVLW), a clinical indicator of pulmonary edema. Lung ultrasound has demonstrated high accuracy in comparison to CT [8] scans and PiCCO monitoring [17]. B-lines can even be detected in the early stages of pulmonary edema before functional injury occurs [18]. Additionally, the correlation between the number of B-lines, and clinical pulmonary edema is well-established, with quantitative algorithms based on B-line counts expected to provide a valuable clinical tool for evaluating pulmonary edema [19].

Lung ultrasonography is highly accurate and radiation-free, making it a preferable option over chest X-rays or CT scans for daily patient management [20]. It aids in the diagnosis and monitoring of pulmonary diseases in diverse clinical scenarios. In our case, we were unable to promptly transfer a patient for a chest X-ray examination in the surgery, however, lung ultrasound has played a crucial role in our ability to detect pulmonary lesions early on. The arterial gas analysis and SpO_2 levels revealed a problem with oxygen exchange, which correlated with the elevated B-lines identified through lung ultrasonography. This result further supports the diagnostic value of pulmonary ultrasound in detecting pulmonary edema in hysteroscopic surgery, even in the absence of pulmonary rales and other clinical symptoms.

Early diagnosis is crucial for effective clinical treatment, while early intervention plays a key role in determining clinical prognosis. Treatment typically involves fluid restriction, diuretics, and close monitoring. The treatment approach depends on the symptoms and severity of the condition. If the patient presents volume overload, the focus of treatment will be on optimising respiratory status through measures such as supplemental oxygen, non-invasive positive pressure ventilation or intubation, as necessary. Additionally, correction of hypervolemia will be achieved by using a loop diuretic. On the other hand, in this case, despite adequate airway and respiratory support being achieved, IV fluids prompted congestion, which improved after negative fluid balance.

In the particular case, we encountered challenges in accurately measuring fluid deficit within an open system. For women with known cardiovascular disease, adapting to sudden significant increases in intravascular fluid can be difficult, increasing the likelihood of complications even at lower levels of fluid deficiency [21]. During surgery, the patient may experience fluid overload, increased cardiac afterload, and the potential for heart failure as a result of untreated hypertension. To address these concerns, we implemented strategies to manage fluid levels during the perioperative period. By restricting intravenous fluids and administering diuretics, we were able to reduce the risk of fluid overload and buy time for subsequent treatments. In our clinical practice, we have observed the benefits of administering furosemide preventively within 30 min of surgery while this method falls under empirical administration and has not been compared to other approaches, there are similar recommendations in the existing literature [11]. By administering preventive medication, we have seen a reduction in clinical symptoms and an improvement in the overall surgical process. In the meantime, it is better to stop the procedure before a potential life-threatening for the patient.

Conclusions

This case highlights a very common surgery and its rare complications, and early identification and management are crucial for successful treatment. The use of isotonic fluids during operative hysteroscopy is preferred to prevent complications such as hyponatremia and cerebral edema. However, excessive absorption of distending fluid can still lead to serious issues like pulmonary edema and cardiac overload. Pulmonary ultrasound can aid in the early detection of pulmonary edema and provide valuable insights into fluid overload. These tools are essential for timely diagnosis of fluid overload and for implementing an intervention treatment plan before clinical symptoms manifest. Eternal vigilance to the complications, quick response, and time management is the key to safely cruise through this serious complication.

Abbreviations

OHIA	Operative Hysteroscopy Intravascular Absorption
CT	Computer tomography
ECG	Electrocardiogram
PEEP	Positive end-expiratory pressure
VCV	Volume controlled ventilation
FiO_2	Fraction of inspired oxygen
TCI	Target controlled infusion
NS	0.9% normal saline
ABG	Arterial blood gas
PACU	Post-Anesthesia Care Unit
TURP	Transurethral resection of the prostate
EVLW	Extravascular lung water
BSGE/ESGE	British Society for Gynaecological Endoscopy/European Society for Gynaecological Endoscopy

Supplementary Information

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Supplementary Material 1

Supplementary Material 2

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Not applicable.

Author contributions
Heng Dai made major contributions to the writing of the manuscript, which involved creating and organizing charts and graphs. Lin Gan and Jing Li diligently collected and organized the clinical data of the patient. Jin Yu, the anesthesiologist of the patient, played a crucial role in the diagnosis and treatment process, providing valuable analytical insights. Xiaofeng Lei, as the corresponding author of this article, meticulously analyzed and interpreted the data. All authors have thoroughly reviewed and approved the final manuscript.

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Data availability
Data is provided within the manuscript or supplementary information files.

Declarations

Ethics approval and consent to participate
This case report was approved by the Ethics Committee of Chongqing Health Center for Women and Children [(2023) Lunshen (Ke) No. 050].

Consent for publication
Informed consent for publication was obtained from the patient.

Competing interests
The authors declare no competing interests.

Clinical trial number
Not applicable.

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All of the material is owned by the authors and/or no permissions are required.

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