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Noncardiogenic Pulmonary Edema and Venous Air Embolus as Complications of Operative Hysteroscopy

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A 37-year-old patient undergoing operative hysteroscopy developed noncardiogenic pulmonary edema after fluid absorption of 6 L of Ringer's lactate distension solution. No electrolyte or neurologic sequelae were associated with this fluid absorption. A subsequent 35-year-old patient having similar surgery in which a device was used to control intrauterine pressure and fluid absorption, developed a venous air embolus. The use of Ringer's lactate solution reduces the consequences associated with fluid absorption but it is not without risks. A device to limit intrauterine pressure and fluid absorption does not eliminate other risks.

Keywords: Hysteroscopy, operative; fluid absorption venous air embolus; intrauterine pressure; pulmonary edema; gynecologic procedures.

Introduction

Operative hysteroscopy has been utilized for several decades both to diagnose and treat a number of intrauterine pathologies. Although it is typically perceived to be a very safe procedure, hysteroscopy entails specific risks of which anesthesiologists should be aware. The most common identified risks continue to be trauma to the cervix, uterine perforation, bleeding, and postoperative infection. In addition, air embolism and severe fluid overload continue to be potentially devastating complications of hysteroscopy. Many of these complications have been reported in the gynecologic literature, but to date have not been published in the anesthesia journals. To alert anesthesiologists to the potential for certain serious intraoperative complications, we describe clinical manifestations and treatment of two patients seen in our ambulatory surgery center.

Case Reports

Case 1: Noncardiogenic Pulmonary Edema

A 37-year-old, 60-kg patient with a medical history of menorrhagia and submucosal fibroids was scheduled for operative hysteroscopy and myomectomy. Past medical history other than menorrhagia and physical examination were unremarkable. Preoperative laboratory values included a hematocrit (Hct) of 37%

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and platelet count of 369,000 mm^3. Preoperative vital signs included blood pressure of 96 mmHg systolic, 73 mmHg diastolic, heart rate of 73 bpm, and oxygen saturation (SpO_2) of 98%.

General anesthesia was induced with propofol and a Laryngeal Mask Airway (LMA North America, Inc., San Diego, CA) was inserted. Anesthesia was maintained with a combination of propofol, alfentanil, and nitrous oxide. Hysteroscopy revealed two 3-cm pedunculated fibroids. Hysteroscopic resection of the fibroids was begun using the Versapoint bipolar vaporization system (Ethicon US, Summerville, NJ) and lactated Ringer's (LR) crystalloid solution for the distention medium. The LR irrigation was pressurized to improve visibility. Approximately one half hour into the procedure, the patient began having decreased SpO_2 to 85% (on 40% inspired oxygen). The patient then received succinylcholine, the trachea was intubated, and mechanical ventilation was started. After endotracheal intubation and mechanical ventilation with 100% oxygen, SpO_2 improved to 100%. Surgery continued because the patient was otherwise tolerating the procedure and the surgeons expressed a strong desire to avoid an open abdominal operation. Shortly thereafter, peak inspiratory pressures increased to 50 cm H_2O, tachycardia ensued, and facial and upper body edema became apparent. A radial arterial catheter was placed. During the course of events, it was noted that a total of 18 L of distention medium had been used, with 12 L of LR returned. The decision was then made that the patient's respiratory status was compromised and that no more fluid could be tolerated. Consequently, the procedure was discontinued after 6 L of LR was absorbed in addition to 1.1 L of intravenous (IV) LR. At the end of the procedure, laboratory findings were significant for Hct of 26.7, platelet count of 215, serum sodium of 137, potassium of 4.3, and chloride of 111. Furosemide 20 mg was administered and the patient was taken to the intensive care unit (ICU). Admission work-up in the ICU was significant for arterial blood gas analysis (ABG) showing a pH of 7.23, pCO_2 of 70 mmHg, pO_2 of 476 mmHg (FIO_2 of 1.0), and HCO_3 of 30. Chest radiography was consistent with pulmonary edema. Repeat electrolytes 2 hours later showed a sodium of 138, potassium of 4.1, chloride of 105, glucose of 102, blood urea nitrogen (BUN) of 9, creatinine of 0.6, Hct of 31.4, and platelet count of 239,000 mm^3. Partial thromboplastin time (PTT) was 30.8 and international normalized ratio (INR) at that time was 1.4. The patient continued brisk diuresis in the ICU, and her trachea was extubated 6 hours after the operation. Electrolyte panel the next morning showed serum sodium of 136, with the rest of the panel within normal limits. Complete blood count (CBC) was significant for a Hct of 29.1 and platelet count of 198,000 mm^3. Chest radiography showed improvement of pulmonary edema. The patient was transferred to the medical floor, and repeat blood levels taken on the afternoon of postoperative day 1 continued to be unremarkable. The patient was discharged home the evening of postoperative day 1 without any further events.

Case 2: Venous Air Embolus

The second patient was a 35-year-old, 58-kg, ASA status II female scheduled for operative hysteroscopic myomectomy and exploratory laparotomy to evaluate and treat fibroids and a history of dysmenorrhea and metorrhagia. She had mild reactive airway disease, which was treated with occasional use of albuterol. The patient's surgical history consisted of previous laparoscopy and myomectomy with general anesthesia. A peripheral IV catheter was started and ASA standard monitors were attached to the patient. An epidural catheter was placed within the L_3–L_4 interspace for treatment of postoperative pain. After negative reaction to a test dose of 1.5% lidocaine with epinephrine, induction of general anesthesia was performed with propofol 100 mg, fentanyl 150 μg, and vecuronium 6 mg. Direct laryngoscopy and endotracheal intubation were performed. Anesthesia was maintained with a combination of propofol, alfentanil, and nitrous oxide. Cefazolin was administered IV without incident, and 2% lidocaine was injected in 5-mL aliquots into the epidural space. The hysteroscopy portion of the case began with the infusion of LR solution into the uterus. An intrauterine installation infusion device (Gynecare Veristat fluid management system, Ethicon US) was used to maintain intrauterine pressures and a continuous record of fluid balance. This device was implemented because of the adverse event reported in Case 1 above. After 45 minutes of hysteroscopy, a sudden decrease in the patient's $ETCO_2$ from 34 mmHg to 22 mmHg occurred. The patient's mean arterial pressure (MAP) decreased from 105 mmHg to 60 mmHg immediately afterwards. On auscultation of the chest, the patient was found to have a new 3/6 churning, mill wheel type murmur. An arterial blood sample was drawn shortly after the initial incident (and at which time $ETCO_2$ was 22 mmHg) showed a pH 7.34, pCO_2 43 mmHg, and pO_2 233 mmHg. Oxygen saturation remained at 100% and all other vital signs remained stable and within normal limits. Treatment for a presumed venous air embolus was initiated following the precipitous decrease in $ETCO_2$. Nitrous oxide was discontinued and FIO_2 was increased to 100%. The surgeons immediately stopped the hysteroscopy and evacuated the uterus of pressurized fluid and air. The total amount of fluid absorption was 2.2 L. Because of the patient's rapid return to her baseline status, a central venous catheter was not placed for aspiration of entrained air bubbles. A subsequent ABG 1 hour later showed pH 7.39, pCO_2 40 mmHg, and pO_2 443mmHg, with an $ETCO_2$ 45 to 50mmHg. The remaining portions of the scheduled surgery were cancelled, and the patient awakened without incident. All vital signs remained normal and an initial neurologic assessment revealed no deficiencies. The patient was admitted to the general ward for observation overnight and discharged home the next day without evidence of cardiopulmonary or neurologic injury.

Discussion

It has been well documented that hysteroscopic procedures entail a risk of fluid absorption, which can result in

complications such as pulmonary or cerebral edema, congestive heart failure, electrolyte disturbances, and coagulation abnormalities. The absorption may occur through a variety of mechanisms, including 1) directly into open vascular structures during surgical resection, 2) absorption across the walls of the endometrium, and 3) *via* the fallopian tubes and absorption from the peritoneum.[1,2] Additionally, increased distention pressure, surgical resection of fibroids, length of the procedure, and a more vascular endothelium result in a greater risk of vascular absorption.[3] Initially, electrocautery instruments used for hysteroscopy required the use of nonionic solutions for the distention medium. Case reports have documented the absorption of dextrose,[4,5] glycine,[6] sterile water,[7] or Dextran-70,[8] with the above-named resulting complications. Uterotubal and transendometrial passage of irrigating fluid occurs frequently with fluid pressures commonly used for endometrial surgery.[9] Our literature search found a case report of LR absorption during laparoscopy,[10] but was unable to find a case of fluid absorption of LR/nonionic solutions for hysteroscopy. Infusion pumps for the distending medium recently have gained favor in some hospitals.[11] These infusion devices aim at keeping the installation of fluid below intrauterine pressure, thus decreasing the rate of fluid absorption. Some surgeons feel that visibility during hysteroscopy is impaired when continuous flow infusion pumps decrease pressure in the intrauterine cavity. Recently, a new bipolar system has allowed for the use of ionic distention solutions.[12] Our case report suggests that isotonic distension medium such as LR still has the potential for rapid absorption and resulting pulmonary edema, but it has a reduced risk of producing electrolyte abnormalities (*e.g.,* hyponatremia) that have been reported after use of nonionic distension mediums. Regardless, hysteroscopic procedures continue to require meticulous calculation of fluid status. A device for maintaining intrauterine pressures was used for the second case when venous air embolus occurred. During this case, total fluid absorption was kept to 2.2 L but there was still a significant complication of venous air embolus. It is impossible to compare the total absorption of fluid between the two cases because the first case of pulmonary edema was a more extensive surgical procedure. It should be noted that maintaining intrauterine pressures near the MAP is not sufficient to prevent venous air embolus. Gas embolus can be related to many types of surgical procedures but is usually associated with open venous structures above the level of the heart and subsequent entrainment of air. These conditions usually exist when the surgical site is above the level of the heart. During hysteroscopy, fluid is instilled under pressure to improve surgical exposure. This system does not exclude air, and bubbles are commonly visualized in the uterus during hysteroscopy, which can potentially enter open venous structures during surgical hysteroscopy. Venous air embolus during hysteroscopy is likely a rare event and has seldom been reported in the anesthesia literature,[13-15] yet it is commonly a fatal event[16] when it does occur. Devices used to control intrauterine pressure may decrease the amount of fluid absorption but do not eliminate the risk of venous air embolus.

Summary

Hysteroscopic procedures continue to require meticulous calculation of fluid status, which may be facilitated by the use of controlled intrauterine infusion pumps. Ringer's lactate solution has been a significant improvement over previous irrigation solutions that contained glycine or dextran. Moreover, LR may prevent many of the complications (such as hyponatremia) caused by glycine and dextran solutions, but accurate calculation of absorbed fluid is still required. Venous air embolus is a potentially lethal complication of hysteroscopy that has seldom been reported in the literature. Controlled intrauterine infusion devices that maintain a lower infusion pressure and help decrease fluid absorption do not prevent venous air embolus.

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