

Review

Complications When Infusing Massive Distending Medium in Hysteroscopic Surgery: A Review of Preventions and Cures for Operative Hysteroscopy Intravascular Absorption Syndrome (OHIA)

Xia Cao¹, Xu Ding^{1,*}

¹Department of Anesthesiology, Fuxing Hospital, Capital Medical University, 100038 Beijing, China

*Correspondence: dingxudoctor@sina.com (Xu Ding)

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Abstract

Objectives: Hysteroscopic surgery, as a minimally invasive gynecological diagnosis and treatment technique, has advantages including less trauma, quick recovery, and short hospital stay that are very common in clinical practice; however, certain problems remain. Using large amounts of distending medium can induce a series of body changes such as diluent hyponatremia, pulmonary edema and hypothermia. According to the 2021 Chinese Expert Consensus on anesthesia management for hysteroscopic diagnosis and treatment, the most common complication of hysteroscopic surgery was uterine perforation (0.12%), followed by operative hysteroscopy intravascular absorption syndrome (OHIA) (0.06%), intraoperative bleeding (0.03%), air embolism syndrome (0.03%), bladder or bowel injury (0.02%), and endometritis (0.01%). The incidence of uterine perforation and endovascular absorption syndrome was higher than others. With advances in both medical technology and devices, the incidence of uterine perforation has gradually decreased. Severe adhesions, multiple endometrial polyps, large uterine fibroids, etc., increase the difficulty of surgery, thus increasing operation time and the amount of fluid perfusion during surgery. OHIA has become the most important concern of clinicians during hysteroscopic surgery. At present, the prevention and treatment of OHIA remains to be further studied; accordingly, this article seeks to provide a review of current treatment modalities of OHIA during hysteroscopic surgery. **Mechanism:** Medline, Web of Science, and Ovid databases were searched using the following terms: distending medium, operative hysteroscopy, intravascular absorption syndrome; complications of hysteroscopic surgery. **Findings in Brief:** Shortening the operation time, reducing the volume of distending medium, decreasing infusion pressure, and using a bipolar scope can reduce the occurrence of OHIA during hysteroscopic surgery. **Conclusions:** Effective means of controlling and limiting OHIA during hysteroscopic surgery include: exploring the appropriate temperature of perfusion fluid; mastering the advanced monitoring methods; promoting the advanced surgical energy and perfusion system; and improving the surgical team's understanding, diagnosis and treatment level of hysteroscopic surgical complications for the safety of perioperative patients' vital signs.

Keywords: hysteroscopy; distending medium; OHIA; dilution hyponatremia

1. Background

Hysteroscopic surgery is widely used in clinical practice owing to its advantages such as minimized trauma and improved postoperative recovery. Specific distending medium was used to irrigate the uterine cavity during the operation to form a clear operative field. However, certain problems persist with hysteroscopic surgery. There are numerous types of hysteroscopic surgery, including hysteroscopic endometrial polypectomy, hysteroscopic intrauterine adhesion surgery, and hysteroscopic myomectomy. While most hysteroscopic procedures are very safe, a small number, such as severe endometrial adhesions and uterine fibroids, cause serious complications due to prolonged operation time or a large amount of uterine perfusion fluid, etc. Garry *et al.* [1] suggested that a large amount of distending medium in hysteroscopic surgery enters the patient's circulatory system in two ways: absorption in the uterine venous sinus and absorption in the fallopian tube and peritoneal membrane. Marco *et al.* [2] demonstrated

that absorption of large amounts of distending medium can cause diluent hyponatremia and operative hysteroscopy intravascular absorption syndrome (OHIA), which can lead to pulmonary edema, brain edema, heart failure and other complications.

However, James *et al.* [3] showed that hysteroscopic surgery can help patients with uterine problems, even if it carries some risks. In total, the advantages of hysteroscopic surgery outweigh the disadvantages. Accordingly, reducing the risk of OHIA in patients is worth pursuing. A study by Liao *et al.* [4] showed that correct diagnosis and treatment play an important role in reducing serious outcomes such as cardiopulmonary complications.

2. Occurrence and Related Complications of OHIA during Hysteroscopic Surgery

The unipolar energy system is still used for hysteroscopic surgery in certain hospitals. The bulging medium used during surgery is a non-electrolyte solution. The risk



of perioperative diluent hyponatremia increases with the duration of the operation. Haruko Okazaki *et al.* [5] demonstrated that patients undergoing hysteroscopic surgery developed severe hyponatremia, brain edema, and postoperative epilepsy during the operation. Studies have shown that these complications are due to the continuous absorption of distending medium by open blood vessels in the uterus during hysteroscopic surgery. As a result, a large amount of hypotonic perfusion fluid is absorbed. This results in fluid volume overload, diluent hyponatremia, and continuous decrease of plasma colloid osmotic pressure, which, in turn, lead to circulatory dysfunction such as acute pulmonary edema and a series of nervous system dysfunctions such as convulsions and coma [6–8]. Garry *et al.* [9] suggest that after a large amount of absorption into the body during hysteroscopic surgery, the concentration of sodium ions in the extracellular fluid and the extracellular osmotic pressure can both be reduced. Cells pump intracellular sodium out of the cell through Na^+/K^+ -ATPase on the membrane surface to compensate for extracellular low sodium.

Furthermore, Askin *et al.* [10] showed that the concentration of sodium ions in extracellular fluid and osmotic pressure decreased due to the massive absorption of perfusion fluid during hysteroscopic surgery; tissue cells, in turn, pump intracellular sodium ions out of the cell through the Na^+/K^+ -ATPase on the membrane surface to compensate for the decrease of osmotic pressure of extracellular fluid, thus alleviating the swelling of cells. When the compensatory capacity of the body is exceeded, it leads to hyponatremia, which can have a severe impact on the body.

Acute hyponatremia [11] can cause central neuropathy, which can lead to epilepsy and encephalopathy. In addition, there are symptomatic cases starting 24 hours after surgery, when the patient has usually been discharged from the hospital [12]; the potential for risk in here is self-evident.

With the development of technology, the use of bipolar energy system for hysteroscopic surgery and the use of saline for distending medium can reduce the risk of non-electrolytes entering the body during surgery and causing diluent hyponatremia. However, prolonged operation time and increased fluid intake during operation may bring about hypervolemia [13], leading to OHIA during hysteroscopic surgery. OHIA refers to a series of complications caused by fluid overload due to hysteroscopic surgery, such as pulmonary edema and heart failure. Ming-Tse Wang *et al.* [14] demonstrated that although many rules of hysteroscopic surgery have been formulated and followed, the incidence of increased circulating blood volume caused by hemodilution still exists in hysteroscopic surgery. Excessive fluid intake during surgery can cause fluid overload in the body. It has been reported that even if bipolar electrodes are used to reduce the intrauterine pressure as much as possible, OHIA may still occur during hysteroscopic surgery [15].

The influence of dilatant fluid temperature on body temperature during hysteroscopic surgery is also an important area of concern. Body temperature is a key indicator of the human body, and body temperature regulation is one of the body's primary regulatory mechanisms. Numerous factors cause perianesthesia hypothermia, including the influence of anesthetic drugs on thermoregulation, the excessively low ambient temperature in the operating room. Perioperative hypothermia can lead to surgical site infection, increased intraoperative bleeding, adverse cardiac events, postoperative shivering, and prolonged hospital stay. Bay *et al.* [16] studied body temperature, oxygen consumption and cardiac output of 24 patients with postoperative shivering and those without shivering 20 minutes following the operation. They found that postoperative shivering increased the body's oxygen consumption, leading to an increased probability of myocardial ischemia and myocardial infarction in elderly and other high-risk patients. Through multivariate analysis of 100 patients, Frank *et al.* [17] associated perioperative hypothermia with myocardial complications. The study showed that patients with hypothermia had an increased probability of myocardial ischemia and ventricular arrhythmias. Evidently, hypothermia is associated with the development of heart disease.

Hypothermia can also affect a patient's ability to clot blood and increase the risk of bleeding. Schmied *et al.* [18] studied the amount of blood loss during hip surgery in 60 patients under normal temperature and mild hypothermia. The study found that core cold temperatures of just 1.6 °C increased blood loss by 500 mL (30%) and significantly increased the risk of allogeneic blood transfusion. At the same time, hypothermia can increase the risk of postoperative infection by inducing thermoregulation of vasoconstriction [19] and reducing the body's immune function [20], thus increasing the risk of postoperative infection.

Hypothermia can also cause a delay in waking up. Sessler *et al.* [21] showed that enzymes regulating organ functions and metabolizing drugs are highly sensitive to temperature. Low temperature can alter the pharmacodynamics of many drugs, especially volatile anesthetics. Haier T *et al.* [22] compared the effects of normal temperature and mild low temperature on vecuronium and recovery time. They found that hypothermia can prolong the action time of muscle relaxants. Likewise, Bansinath *et al.* [23] compared dogs' personality and cardiovascular responses at different temperatures and showed that hypothermia can reduce the clearance rate of drugs.

3. Prevention of Distending Medium into Blood during Hysteroscopic Surgery

3.1 The Selection of Bulge Medium

In hysteroscopic surgery, distending medium is a necessary condition to ensure good display of uterine cavity; some researchers have reduced the occurrence of pulmonary edema by changing the type of distending medium.

Carbon dioxide, dexanhydride-70, glycine, sorbitol, mannitol, normal saline and lactate Ringer's solution are used in clinical practice, but they all entail certain problems [15]. Studies have shown that the use of normal saline can reduce the occurrence of dilution hyponatremia, but hypervolemic blood is still inevitable [15]. The randomized controlled study of Darwish *et al.* [24] showed that the application of bipolar energy system with electrolyte dilator can significantly reduce the dilator absorption and the reduction of blood sodium level compared with the use of non-electrolyte dilator. In addition, compared with the unipolar energy system [25], the bipolar energy system has the advantages of rapid blood coagulation and reduced bleeding, and can provide a better field of vision for the hand surgeon. Further, it can shorten the operation time and reduce the suction of perfusion fluid. For these reasons, a bipolar energy system with electrolyte perfusion fluid is recommended for hysteroscopic surgery.

3.2 The Choice of Uterine Pressure

Clinicians use various methods to improve the factors that may cause OHIA during hysteroscopic surgery. It is necessary to reduce intrauterine pressure as much as possible to reduce the absorption in the blood vessels and the abdominal cavity [14]. In 2012, Chinese Code for Diagnosis and Treatment of Gynecological Hysteroscopy recommended the use of hysteroscopic perfusion system; the perfusion pressure was set at 80–100 mmHg (1 mmHg = 0.133 kPa or \leq the patient's mean arterial pressure). Hsieh *et al.* [26] showed that acute pulmonary edema was caused by excessive perfusion pressure.

3.3 Uptake of Distending Medium

It has been reported that the difference between the amount of fluid entering and leaving the uterine cavity should be comprehensively assessed during surgery. When the difference is greater than 1500 mL or the serum sodium is less than 120 mL, the operation should be stopped in time [27,28]. It has also been pointed out that clinicians should use isotonic distending medium and bipolar systems during hysteroscopic surgery. Especially in instances when the net irrigation amounts >3000 mL and the total irrigation amounts >8000 mL, surgery should be postponed [14]. USA Practice Guidelines for the Management of Hysteroscopic Distending Media states that if young patients have no complications, the maximum absorption volume of hypertonic perfusion fluid should be less than 500 mL, or less than 300 mL for elderly patients or patients with cardiopulmonary insufficiency [29].

3.4 Operation Time

A study on the relationship between types of hysteroscopic fibroids and medium intake showed that the duration of surgical operation is correlated with medium intake [30], indicating that operative time is also an important fac-

tor causing OHIA during surgery. Therefore, shortening the operation time can reduce the probability of OHIA.

4. Treatment of Complications of Distending Medium Entering Blood during Hysteroscopic Surgery

4.1 Actively Treat Hyponatremia

Hyponatremia caused by hysteroscopic surgery is hyponatremia of hypotonic and hypervolemic type. Treatment depends on the degree of decrease in the patient's serum sodium. According to the 2014 Clinical Practice Guideline on Diagnosis and Treatment of Hyponatremia, moderate to severe hyponatremia (serum sodium concentration <135 mmol/L,) should be actively treated and sodium supplementation should be given according to the blood sodium situation.

4.2 Actively Treat Pulmonary Edema

Clinical treatment of pulmonary edema is generally based on the goal of the treatment, e.g., to maintain the airway patency, limit fluid intake, dehydration, or diuresis. When pulmonary edema occurs during hysteroscopic surgery, diuretics are often used to give the patient diuretic dehydration. Sethi *et al.* [31] reported a case of pulmonary edema that indicated the importance of fluid volume control. Yaprak *et al.* [32] treated a patient with pulmonary edema after hysteroscopic surgery with diuretics 24 hours after the patient returned to normal and was discharged from hospital. The current treatment of pulmonary edema in hysteroscopic surgery is later than that of increased airway pressure, decreased blood oxygen saturation, and lung auscultation of wet sound. If an increase in lung water content can be expected early, early treatment may be more beneficial to the patient's recovery.

4.3 Management of Hypothermia

At present, there is increased awareness of the harm of hypothermia in clinical practice, and there are many thermal measures for perioperative patients, such as skin warmth, air heating, resistance heating, and heat radiator [33]. However, for hysteroscopic surgery, in addition to the above thermal measures, the temperature of dilatant solution is also worth considering. Sessler [21] showed that it was impossible to warm the patient by heating the infusion of fluids; at ambient temperatures, however, each liter of fluid lowers the average adult's body temperature by about 0.25 °C. When a large amount of liquid input is required (i.e., several liters per hour) and heating the air alone proves insufficient to keep warm, the injected liquid should be heated. Therefore, adequate thermal insulation for patients in hysteroscopic surgery is vital. To date, most studies on the temperature of dilatant solution used by hysteroscopy have focused on postoperative pain, patient satisfaction, blood loss and intraoperative clarity of hysteroscopy [33,34]. Although these studies do not show the

effect of distending medium on body temperature, we do know that distending medium is safe to reach these temperatures during hysteroscopic surgery. At present, iThermometer monitoring has been gradually applied to monitor the core temperature of patients in clinical operations. Body temperature monitoring can provide a real-time guide on the effect of warming for patients, thereby reducing perioperative chills, affecting the recovery time and postoperative satisfaction of patients.

In sum, for hysteroscopic surgery, it is necessary to shorten the operation time, reduce the volume of distending medium, decrease infusion pressure, carefully monitor the pulmonary water content, prevent perioperative hypothermia, and exercise close monitoring by an anesthesiologist. Nevertheless, certain complications of hysteroscopic surgery remain difficult to avoid.

It is of utmost importance to prevent complications of hysteroscopic surgery. When complications arise, the first choice is to stop the operation and manage according to different situations (e.g., sodium supplementation in severe hyponatremia). Pulmonary edema should be fully diuretic to promote water excretion. At the same time, fluid insulation measures and perioperative insulation may be used to warm the patient.

5. Conclusions

It is imperative to determine and develop ways of offsetting the deleterious effects of OHIA during surgery. Proven methods include warming the distending medium, using as low pressure as possible, shortening the operating time, using narrow hysteroscopes that have lower flow, and using bipolar hysteroscopes, if possible. At the same time, it is crucial to explore the appropriate temperature of perfusion fluid, master advanced monitoring methods, popularize advanced surgical energy and perfusion systems, and improve the surgical team's understanding as well as diagnosis and treatment of complications in hysteroscopic surgery.

Author Contributions

XC—extraction, drafting, design, revision manuscript; XD—extraction manuscript. All authors read and approved the final manuscript.

Ethics Approval and Consent to Participate

Not applicable.

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Conflict of Interest

The authors declare no conflicts of interest.

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