Fluid management in hysteroscopy*

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Abstract

Nowadays many hysteroscopic procedures can be done in the outpatient or office setting. With the introduction of tissue removal systems with a smaller diameter than a resectoscope, operative hysteroscopy is well tolerated and preferred by patients in the office setting. These procedures can be done with normal saline with seemingly limited risk of complications. However, as more operative hysteroscopic procedures are done outside the OR facility with limited surveillance of the patient, one should always be aware of the risks. Fortunately, potential life-threatening complications especially those related to fluid overload are hardly being reported anymore. However, if unnoticed, these complications can still occur.

This review gives an overview of the potential (life-threatening) risks and how, based on guidelines, fluid deficit should be monitored during operative hysteroscopic surgery. The use of an automated fluid management system makes monitoring easier and should be considered a standard of care in operative hysteroscopy in both in- and outpatient setting.

Keywords: **Fluid management, fluid overload, management, risk reduction.**

Introduction

Both diagnostic and increasingly therapeutic hysteroscopic procedures are progressively performed in an outpatient or office setting. This is due to the fact that over the last decades diameters of hysteroscopes as well as therapeutic instruments has decreased to an extend that is well tolerated by the patient in an office setting. Furthermore, the introduction of tissue removal systems has decreased operative risks (Noventa et al., 2015) and therefore office hysteroscopy seems to be easy and nearly complication free. Nevertheless, past has shown that severe complications can occur, especially in patients with unnoticed fluid overload. As office hysteroscopy will become more and more the standard for diagnostic as well as therapeutic procedures, this article describes the added value of fluid management in hysteroscopy.

Guidelines

In 2016 British and European Societies for Gynaecological Endoscopy (BSGE/ESGE) published a guideline on management of fluid distention media in operative hysteroscopy. (Umranikar et al., 2016) This guideline together with the guideline of the American Association of Gynecologic Laparoscopists (AAGL) (AAGL, 2013) can be considered as the backbone of guidelines on fluid management. There is no reason to believe that the advice in these guidelines regarding fluid management will be different around the globe. Therefore, in the absence of national guidelines, these guidelines could/should be taken into account in the development of local protocols on fluid management.

Review of literature

A repeated literature search was done on the combination of MeSH (Medical subject Headings) and relevant index terms as was used in the BSGE/

ESGE guideline on management of fluid distension media in operative surgery (Umranikar et al., 2016) in order to identify additional evidence on this guideline. The used MeSH or index terms were: “operative hysteroscopy”, “TCRE”, “hysteroscopy” AND “glycine”, “resectoscope”, “hysteroscopy” AND “fluid overload”, “hysteroscopy” AND “management”. The search was limited to humans and articles in the English language. The search was done from 2015 until 01-06-2023. The additional 18 papers included the BSGE/ESGE guideline and the practical guideline of the Society of Obstetricians and Gynaecologists of Canada (Laberge et al., 2015), besides book chapters, review articles and a case report (Lee et al., 2020). There was one retrospective comparative study comparing volumetric and biochemical assessment of intravasation which showed that there was significant differences and poor agreement between volumetric and biochemically assessed intravasation (Haude et al., 2020). A prospective single centre trial showed that spinal anaesthesia is associated with less glycine absorption, less thoracic fluid load, better control of haemodynamics and better patient satisfaction in operative hysteroscopy (Moharram et al., 2017).

History

Since the first described hysteroscopy in 1869 (Tarneja and Duggal, 2002) it took forty-five years before Heinenberg in 1914 introduced the first irrigation system to distend the uterine cavity (Manchanda et al., 2022). In the 1930s it became clear that an intrauterine pressure of a least 25-30 mmHg was needed for adequate visualisation and the intraperitoneal spill over the fallopian tubes occurred at a pressure > 55mmHg (Manchanda et al., 2022; Schroeder, 1934). Decades followed in which one gained more understanding in intrauterine pressure, ways to rinse the uterine cavity and maintain intrauterine vision. A manometer to measure intrauterine pressure was first described in the early 1960s (Manchanda et al., 2022; Gribb, 1960).

The infusion of high-viscosity media in the 1970s made it possible to have a better visualisation of the uterine cavity as these liquids did not mix with blood, and only slowly flowed over the fallopian tubes. Hysteroscopy was mainly performed for diagnostic reasons in those days.

In the late 1970s and early 1980s different techniques were described to remove or destroy intrauterine pathology, such as Nd:YAG laser and the first use of a resectoscope (Manchanda et al., 2022; Neuwirth, 1978). As for the use of monopolar radiofrequency electrical circuits, which was used in the first resectoscopes, an electrolyte free distension media was necessary. As sterile water led to haemolysis, hypotonic media such as glucose, sorbitol or glycine were used (AAGL, 2013). When absorbed in a certain volume, patients could suffer from nausea, vomiting, neurological symptoms including muscular twitching, grand-mal seizure and coma. As it was first described in urological use of a resectoscope this phenomenon was also known as TURP (Transurethral resection of the prostate) syndrome (Arieff, 1987).

It became apparent that there was a need to calculate fluid deficit, because manual calculation was either inaccurate as well as determined afterwards (AAGL, 2013). In the 1990s the first more or less closed loop systems were developed in which the inflow channel was connected to a pump for continuous intrauterine pressure and the outflow was connected to a collecting jar. However, the fluid deficit was not calculated automatically. At the end of the 1990s the Dolphin® fluid delivery system (Gyrus ACMI Inc. Maple Grove, MN, USA) was one of the first to have an alarm activated when a fluid deficit of 1000 mL was reached (Corson, 1997).

It is only since the last decade and a half that we have fluid delivery systems which are able to display real time fluid deficit (Manchanda et al., 2022).

Alongside the development of better fluid delivery systems, the operative instruments which were used in hysteroscopy also changed. Where procedures under general anaesthesia and after blind cervical dilatation with a monopolar resectoscope with an outer diameter of 26-27 Fr (8.7-9.0mm) were once first choice of treatment in case of intrauterine pathology. Bipolar resectoscopes were introduced reducing the complications of fluid overload as these could be used with isotonic normal saline. The development of smaller diameter hysteroscopes and instruments over the last two decades, together with a new (vaginoscopic) approach of the uterine cavity, made it possible to perform more complex procedures in a less complex (outpatient or office) setting (Bettocchi and Selvaggi, 1997; di Spiezio Sardo, 2020; Papalampros et al., 2009).

Types of distending media

In order to visualise the uterine cavity, one needs to distend the cavity. Different distending media have been used, which can be divided in three groups carbon dioxide, high-viscosity media and low-viscosity media. Due to the risks of complications as described below, currently only low-viscosity media are used. From these, isotonic media are the safest to use (Umranikar et al., 2016).

Carbon Dioxide

Carbon dioxide was first described in the 1920s (Manchanda et al., 2022). Because catastrophic cardiorespiratory collapse can occur if in therapeutic hysteroscopy large volumes of CO_2 reaches the systemic circulation, CO_2 should only be used in diagnostic hysteroscopy only with a low-pressure hysteroscopic insufflator (AAGL, 2013; Umranikar et al., 2016). As carbon dioxide is only used for diagnostic reasons, its use and management of complications is outside the scope of this article.

High-Viscosity Distending Media

Although high-viscosity distending media, such as dextran 70 (32% dextran 70 in 10% dextrose) have the advantage of preserving a better view as they are insoluble with blood, the high risk of adverse outcome even with small fluid deficits, makes these media nearly unsuitable for operative hysteroscopic procedures and should therefore be avoided, as there are safer media available (AAGL, 2013).

Low-Viscosity Distending Media

In the past commingle of blood with low-viscosity distending media was a challenge to overcome. The introduction of hysteroscopes with an outflow channel made it possible to rinse the uterine cavity and made a safer low-viscosity distending media could be used instead of high-viscosity distending media (Manchanda et al., 2022).

There are different low-viscosity distending media which vary in osmolarity (iso- or hypotonic) and presence or absence of electrolytes. In order to use a monopolar radiofrequency (RF) electosurgery device an electrolyte free solution is needed. Except from Mannitol all electrolyte free solutions are hypotonic (AAGL, 2013).

The development of bipolar electrical instruments and later tissue removal systems made it possible to perform operative procedures with isotonic electrolyte-containing media such as normal saline and Ringer's lactate (AAGL, 2013).

The absorption of large amounts of distending media may lead to fluid overload, which depending on the media used (hypo- or isotonic) will sooner or later lead to major complications.

Fluid overload

Fluid overload has been defined by the BSGE/ESGE as a fluid deficit more than 1000 mL in healthy women when using a hypotonic solution and more than 2500 mL in healthy women using normal saline, an isotonic solution (Umranikar et al., 2016). However in elderly women and those who have cardiovascular or renal diseases a threshold of 750 mL (for hypotonic) and 1000 mL for isotonic solutions is recommended (Table 1) (AAGL, 2013; Umranikar et al., 2016).

Absorption of distending media is inevitable, nevertheless understanding the mechanisms which lead to fluid absorption is a minimal requirement for all of us who perform hysteroscopic surgery.

First of all, there is retrograde passage of fluid over the fallopian tubes. The risk of leakage over the fallopian tubes increases when the intrauterine pressure exceeds 70-75mmHg (Umranikar et al., 2016; Hasham et al., 1992), but it may already occur when intrauterine pressure exceeds 55 mmHg (Manchanda et al., 2022).

The second mechanism is absorption through the endometrium itself. If the mean arterial pressure (MAP) is exceeded by the intrauterine pressure, absorption of fluid into the systemic circulation will occur. To prevent this, one can quickly estimate the maximum intrauterine pressure by calculating the MAP = diastolic pressure + 1/3 (difference between systolic and diastolic pressure) (DeMers and Wachs, 2023). Another risk of absorption through the endometrium is in case of a large uterine cavity, as one needs more fluid to distend and in general a higher pressure to achieve adequate visualisation (Umranikar et al., 2016).

Finally, absorption takes place through open vessels during surgery. Where in general a polypectomy has one vascular pedicle with a small number of open vessels, a myomectomy or a thermal resection of the endometrium will lead to multiple open vessels (Umranikar et al., 2016).

Table I. — BSGE/ESGE Guideline recommendations on maximum fluid overload.

	Maximum fluid overload	
Patient	Hypotonic media	Isotonic media
Healthy of reproductive age	1000 mL	2500 mL
Elderly women	750 mL	1500 mL
With cardiovascular diseases		
With renal disease		
With multiple co-morbidity		
Adapted from the BSGE/ESGE guideline (Umranikar et al., 2016).		

The use of a hypotonic electrolyte free solution, such as Glycine 1.5% (200 mOsm/L) of sorbitol 3% (165 mOsm/L), which are needed for monopolar electrosurgery, have the disadvantage of creating electrolyte disturbances. Headache, nausea, vomiting and muscle weakness occur when the sodium levels drop below 125 mmol/l. If not recognised further fluid loss will lead to brain oedema and increased intracranial pressure, brain stem herniation, coma and even death (Istre et al., 1994; Baggish et al., 1993). In contrast to men and postmenopausal women, premenopausal women have a 25 times higher risk to develop permanent brain damage because female sex hormones inhibit Na+/K+-ATPase pump which helps the brain to compensate in case of an osmotic imbalance (Ayus et al., 1997).

With the introduction of bipolar electrosurgery an electrolyte containing isotonic solution as normal saline the risks of complications due to fluid overload decreases, however if absorbed in large amounts electrolyte disturbances such as hyperchloremic acidosis (Schäfer et al., 2005) as well as pulmonary oedema (Grove et al., 2004) can still occur.

Therefore, careful monitoring of the fluid loss has been advocated ever since the first guidelines in hysteroscopy were published (AAGL, 2013; Umranikar et al., 2016; Loffer et al., 2000) Nevertheless, if not carefully monitored, major complications could result from fluid overload (Lee et al., 2020). Not only should we monitor fluid loss carefully, but an automated real time calculation is needed. This is because, as Boyd and Stanley had shown, many non-automated factors can and will contribute to an incorrect fluid loss (Boyd and Stanley, 2000). For example, 3-litre fluid bags were on average 2.8% overfilled, estimated fluid in remaining bags was miscalculated by 4-50%, collection of fluid by 10-39% and remaining fluid on the operating floor was over- or underestimated by 56-67%. This makes manual calculating fluid loss nearly impossible (Boyd and Stanley, 2000).

Incidence of fluid overload

The incidence of fluid overload is related to the type of surgery performed. In a prospective multicentre study by Jansen et al, 11,085 diagnostic and 2,515 operative procedures were reviewed. Fluid overload which was defined as a loss of > 1500 mL was only seen in operative procedures in 5 cases (0.2%) and never in diagnostic procedures. Four of these five cases were during myomectomy (Jansen et al., 2000). Another multicentre survey in 21,676 operative hysteroscopies fluid overload syndrome was recorded in 13 patients (0.06%). Ten patients had a myomectomy and three an endometrial ablation (Aydeniz et al., 2002).

Based on these studies in operative hysteroscopy the incidence of fluid overload is approximately 0.1-0.2% in which myomectomy and endometrial ablation have the highest risks and this incidence is very low in polypectomy (Aydeniz et al., 2002; Jansen et al., 2000). It is so far unknown if tissue removal with a tissue removal system will increase or decrease these risks, but the use of these instruments seems relatively safe (Noventa et al., 2015). Furthermore, increased use of normal saline has probably reduced the incidence of fluid overload. Besides that, the risk of fluid overload in diagnostic procedures is nearly non existing. Nevertheless, if unrecognised fluid overload can lead to severe outcomes (Arieff, 1987; Baggish et al., 1993; Ayus et al., 1997; Schäfer et al., 2005; Grove et al., 2004; Lee et al., 2020).

Prevention of fluid overload

As prevention is better than cure, the preoperative administration of GnRH agonists in premenopausal women before hysteroscopic resection of myoma, Intracervical injection with dilute Vasopressin and maintaining the intrauterine pressure as low as possible are recommended approaches to reduce risk of fluid overload (Umranikar et al., 2016). In many cases an intrauterine pressure of 60-70 mmHg will be sufficient.

Fluid management system

All current fluid management systems are closed systems. This means that they have an automated pump to control intrauterine pressure and a collection system which measures the returned amount of fluid (Manchanda et al., 2022). The displayed fluid deficit is calculated by the difference between inflow and collected outflow. Even in closed systems there is possibility of overestimating fluid loss, because there can be fluid loss in blankets or on the floor, which falsely increase the calculated loss. This may result in premature abortion and incomplete resection during surgery (Marshburn et al., 2021). Conversely, if the procedure is continued after an alarm the loss might be underestimated by the team (Boyd and Stanley, 2000).

A fluid-collection drape with a reservoir can be applied underneath the bottom of the patient, preventing leakage in blankets or alongside regular drapes on the floor (Marshburn et al., 2021). In office setting a fluid-collection drape can easily be positioned in the proper way as the patient is awake and can lift her bottom herself.

The first automated closed systems which displayed fluid deficit and equipped with an alarm system was the Hysteroflow II® (Olympus Winter & Ibe GmbH, Hamburg, Germany), (Olympus - Hysteroflow II n.d.) introduced in 2013, followed by Aquilex® (WOM, Berlin, Germany) in 2014 which calculated fluid deficit volume. (Hologic - Aquilex n.d.) The first fluid management system with a user friendly touchscreen and which calculated fluid deficit based on a weight difference was Hysterolux® (Medtronic INC, Minneapolis, MN, USA) introduced in 2018. (Medtronics - Hysterolux n.d.) Another worldwide used "smart" pump is the Hysteromat E.A.S.I® (Karl Storz Endoscopy GmbH, Tuttlingen, Germany). (Karl Storz - Hysteromat n.d.) The latest development in fluid management system is Fluent® (Hologic Inc., Marlborough, MA, USA.) which was introduced in 2020. (Hologic - Fluent n.d.) Compared to its predecessor (Hologic - Aquilex n.d.) the Fluent® is easier to set-up and is therefore very suitable in office setting use. Furthermore, Fluent® has a peristaltic in- and outflow, this reduces the amount of fluid which is used during the procedure and leads to more stable and better vision even at low intrauterine pressures (Figure 1).

Figure 1

If there is no possibility to use a modern automated pump in therapeutic procedures, fluid deficit should be measured at a minimum of a 10 minutes interval (Umranikar et al., 2016). As the use of a fluid management system is costly and also produces waste, a fluid management system it is not always needed in every procedure. As in diagnostic settings fluid overload is very low, (Jansen et al., 2000) a diagnostic hysteroscopy can be performed with normal saline in a pressure bag. The same applies for the removal of small polyps with forceps and scissors or with a manual tissue removal system (e.g. MyoSure Manual®, Hologic Inc., Marlborough, MA, USA). If a 1L normal saline bag, which in the majority of cases is sufficient in diagnostic and small operative procedures, is used in all procedure without the use of a fluid management system, a fluid overload of > 1500mL is impossible. By doing so a hysteroscopy without the use of a fluid management system is safe in all patients including those with renal impairment or cardiovascular diseases (Umranikar et al., 2016).

Conclusion

In the last two decades there has been a major improvement in hysteroscopic surgery. The use of bipolar electrical current made it possible to use normal saline and reducing the risks of electrolyse disturbances caused by hypotonic solutions which were used before. Reducing the diameter of hysteroscopes, vaginoscopic approach and the introduction of small diameter instruments lead to a shift from the operating room (OR) to an outpatient or office setting for not only diagnostic but also operative hysteroscopy. Moving from the OR towards an outpatient or office setting reduces costs, shorten hospital stay. It is efficient, well accepted by patients and often preferred over a hysteroscopy in the OR (Ma et al., 2017). Although the complication rates are considered as negligible by some (Ma et al., 2017) there is still a risk of fluid overload. Although the risks of complications due to fluid overload maybe smaller than reported before, the consequences if it happened can be devastating.

In aviation we expect that aircraft personnel will take all safety measurements prescribed in order to prevent accidents to happen. In 2022 the risk of an individual person to die on a flight was 0.11/million flights. (IATA n.d.) Bearing these figures in mind, may our patients expect from us to measure fluid loss, as we expect from the aircraft personnel on safety issues in aviation? There is no excuse not to use a fluid management system or measure fluid loss manually every 10 minutes in operative hysteroscopic surgery, if we cannot end the procedure within the use of 1L of normal saline as guidelines advise (AAGL, 2013; Umranikar et al., 2016)

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