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Chapter

Operative Hysteroscopy Complications

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Abstract

Operative hysteroscopy is a minimally invasive gynaecological procedure and is considered the gold standard for the treatment of intracavitary uterine pathology. Over the last decades, with the development of new surgical instruments, the popularity of this technique has increased with gynaecologists across the world. However, this minimally invasive technique can be associated with rare but serious complications that can lead to severe morbidity and, if not treated adequately in some cases, ultimately lead to mortality. Any gynaecologist using this procedure should not only train in the operative technique but should also acquire knowledge on what type of complications may arise whilst performing an operative hysteroscopy. The following chapter explores the diagnosis of complications associated with the operative hysteroscopy and management options.

Keywords: operative hysteroscopy, complications, uterine perforation, false passage, bleeding, fluid overload, local anaesthetic systemic toxicity, gas embolism, postoperative hematometra, postablation tubal sterilization syndrome

1. Introduction

The first reported hysteroscopy was performed in 1869 by Pantaleoni [1], making it one of the oldest reported endoscopic procedures. Hysteroscopy has greatly evolved since its primordial times and is now considered the gold standard procedure for the investigation of intrauterine pathology and subsequent treatment [2].

With the miniaturization of operative scopes and introduction of new surgical instruments, the outpatient operative hysteroscope is fast surpassing traditional in-patient hysteroscopy performed in an operating theatre [3]. This is due to the fact that office hysteroscopy offers several advantages, including shorter operating times, quicker postoperative recovery, not requiring hospital admission, no risks associated with general anaesthesia and its low cost when compared to inpatient hysteroscopy [4].

Complications during operative hysteroscopy are rare events. In a national multicentre survey in the Netherlands that analysed the complication rate in 13,600 hysteroscopic procedures (11,085 diagnostic and 2515 operative), it was reported that operative hysteroscopies had a significantly higher complications rate in relation to diagnostic procedures (i.e. 0.95% vs. 0.13%). Jansen et al. also found that more than half of the complications were entry related and that certain operative procedures carried a higher complication rate, which they associated with complexity of the
technique used. Intrauterine adhesiolysis, for example, presented the highest complication rate (4.5%), with patients undergoing this procedure having a 12-fold higher complication rate when compared to those having a polypectomy [5]. In another large multicentre study in Germany that included 21,676 operative hysteroscopies, the overall complication rate was 0.22% [5]. In this study, the most common complication was uterine perforations (0.12%), followed by fluid overload (0.06%), bleeding (0.03%), bladder or bowel injury related to uterine perforation (0.02%) and infection (0.01%) [6].

Hysteroscopy in any setting is a safe procedure and surgical complication rates seem to be the same for office hysteroscopy and inpatient hysteroscopy [4]. As this technique moves into an office setting with more operative procedures being performed as an outpatient procedure, it is important to improve the training presently offered. It is imperative that training not only focus on technical skills, but also offers guidance on early diagnosis of complications and prompt management as some of these potential life-threatening complications were traditionally identified by the anaesthesiologist in a theatre setting. It is also important to further research on complications in operative hysteroscopy as the majority of knowledge presently available derives from case studies reporting on adverse outcomes.

Most complications associated with operative hysteroscopy arise during the surgery and need to be carefully discussed with the patient when explaining the procedure and surgical risks involved. However, some complications may only emerge after the procedure and are sometimes forgotten when obtaining an informed consent. It is important that these late complications also be included in the initial discussion with the patient as they may have important implications on future health issues.

2. Intraoperative complications

2.1 Vasovagal

Vasovagal reactions are a potential complication when performing hysteroscopies in an outpatient setting with incidence rates in published reports varying between 0.17% and 2.83% [7–9]. In a prospective observational study that included 2079 outpatient hysteroscopies, Agostini et al. reported that nulliparous and postmenopausal women had a higher risk of a vasovagal reaction, corresponding to 40% and 33.3% of cases, respectively. The risk is also higher when using larger diameter scopes required for operative hysteroscopy (2.83%).

These reactions are often associated with severe pain, which trigger a physiological response mediated by the parasympathetic nervous system, characterized by bradycardia and hypotension. Triggers during hysteroscopy usually include manipulation of the uterine cervix (e.g. dilatation and entry with hysteroscope) and uterine distention, but may also be triggered by severe anxiety associated with the procedure [10, 11]. If these are not managed in a timely manner, they can lead to vasovagal syncope, also known as neurocardiogenic syncope. Vasovagal syncope is usually preceded by prodromal symptoms that may include diaphoresis, nausea and pallor.

Management in a vasovagal reaction includes immediate removal of the stimulus, mainly by extraction of the scope, positioning the patient in reverse Trendelenburg and assessment of vitals, including blood pressure, pulse, respiratory rate and oxygen saturation. Most cases recover spontaneously within minutes. If bradycardia is persistent, an IV line should be sited and intravenous fluids started, oxygen given and
local resuscitation team called [12]. If further deterioration occurs, consideration can be given to the administration of atropine.

2.2 Cervical trauma

Cervical lacerations occur when significant traction is used on handling surgical instruments applied to the cervix. In a study that included 797 operative hysteroscopes, Bigatti et al. report an incidence rate of 0.9% [13]. This type of trauma occurs mainly during the dilation of the cervix and is more frequent in women with cervical stenosis [14]. Risk factors for cervical stenosis include postmenopausal status, nulliparity, previous cervical trauma or cervical procedures. Incidence rates of cervical stenosis after cervical procedures vary between 10.2% after laser conisation and 4.3% after loop electrosurgical excision procedure [15].

Cervical tears may result in significant bleeding due to tissue trauma. Lateral cervical lacerations can extend up towards the uterus and include uterine arteries, producing substantial bleeding [14]. When applying a single-toothed tenaculum, these should be used with caution as they can easily tear the cervix [16]. Preference should be given to a double-toothed tenaculum or valsellum forceps that distribute the force applied to a broader area, providing a less traumatic grasp.

Pre-operative evaluation is important to recognise patients that are at a higher risk of cervical trauma, by identifying relevant antecedents that may increase the risk of cervical stenosis, as well as examination of cervix. In these patients, consideration should be given to the use of cervical ripening agents prior to the intervention. Studies have shown that misoprostol administered pre-operatively reduces the force required to dilate the cervix and intraoperative complications, such as cervical lacerations and false passages [17, 18]. Other options include the insertion of osmotic dilators 24 hours prior to procedure to aid in cervical softening and the use of smaller diameter scopes [19].

Management options include applying pressure with a swab on a stick to the affected area. If bleeding persists, Monsel’s solution can be applied or diathermy used. In case of heavy bleeding or an extensive laceration, cervical suturing may be required.

2.3 False passage

The creation of a false passage is another complication associated with difficult entry into the uterine cavity and one of the factors associated with a failed hysteroscopy [20]. Women with cervical stenosis, abnormal uterine positions (i.e. acute anteflexion or retroversion), multiple caesarean sections, Asherman’s syndrome or cervical fibroids are at a higher risk of false tracks [21].

False passages occur when the dilator or scope enters laterally into the muscle fibres of the cervix, instead of progressing into the uterine cavity through the internal cervical os. A high degree of suspicion should be held when the slight resistance of the dilator passing the internal cervical os is not present. On inserting the hysteroscope a criss-cross pattern of the cervical muscle fibres will be seen, instead of the normal anatomical landmarks that include a triangular cavity with bilateral tubal ostium. At this point, the operator should slowly remove the scope to correctly identify the true cervical canal for confirmation of the diagnosis.

Once the diagnosis is confirmed, the procedure should be suspended as false passages can be associated with excessive fluid absorption. Further uterine procedures
should be differed for 2–3 months to allow for healing [22]. Recent papers have reported procedures being completed after the diagnosis of false passages, but case numbers are still small and further large-scale studies are required to demonstrate the safety of continuing the procedure once a false passage has occurred [21, 23].

Like any complication, prevention is essential and in high-risk patients extreme caution should be taken if proceeding with cervical dilation, using steady pressure when introducing dilators. Ideally, entry should be done with vaginoscopy with direct visualization and slow introduction of the scope through the cervical canal. If resistance is found on entry through the internal os, maintaining the inflow and closing of the outflow will increase intracervical pressure allowing for hydrodilatation of internal cervical os and allowing for the progression of the scope into the uterine cavity.

In the case of cervical stenosis, medical options such as osmotic dilators and use of cervical ripening agents (i.e. misoprostol, oestrogen in post-menopause) may be considered [24, 25]. Initial dilation with a pipelle® or entry with 2 mm diagnostic hysteroscope may also be considered before advancing with larger operative hysteroscopes [20]. Other options to navigate the stenosed cervix include surgical management (i.e. use of scissors, forceps, bipolar electrode or hysteroscopic morcellators) and ultrasound-guided entry [26–29].

2.4 Uterine perforation

Uterine perforation is the most frequent type of complication associated with hysteroscopy, with the reported rates varying between 0,12 and 3% [30]. A number of individual factors increase the risk of uterine perforation, including menopause, nulliparity, an extremely anteverted or retroverted uterus, history of a previous cervical procedure that can result in a stenosed cervical canal, intrauterine synechiae, use of gonadotropin-releasing hormone agonists and operator inexperience [5, 31].

Around 55% of uterine perforations occur during entry into the uterine cavity, whilst the remaining 45% are procedure-related [5, 32]. Patients with Asherman’s syndrome have the highest risk for this type of complication, with an incidence rate as high as 10% [19]. Operator experience also seems to have an important role in the risk of uterine perforation, with around 33% of uterine perforations occurring during the surgeon’s first procedure and a further 52% during the first five procedures [33]. Perforations are more frequent in patients undergoing repeat procedures, with one study demonstrating that patients undergoing a repeat endometrial ablation had an eightfold increased risk of uterine perforation [34].

Prevention begins even before the procedure with a comprehensive history that should include past medical and surgical history and completed with a thorough physical examination to help identify potential risk factors. It is important to question the patient on factors that may increase the risk of intra-abdominal adhesions, thus contributing to extreme positions of the uterus (e.g. history of endometriosis, pelvic inflammatory disease, history of peritonitis and previous abdominal surgeries including caesarean sections). Prior to beginning the procedure, it is important to examine the patient so as to determine the size and position of the uterus. One study demonstrated that 64,2% of surgeons routinely examined the patient before beginning the procedure, but 4,7% never examined the patient before the starting the procedure.

In case of uterine perforation, like any complication, early diagnosis and management can reduce severe morbidity, long-term sequelae and ultimately mortality. On blind entry into the cavity, perforation should be suspected when a sudden loss of tissue resistance is felt or the instrument depth in the pelvis seems further than
expected. During the operative procedure, a sudden loss of intrauterine pressure or heavy bleeding should also raise concerns about possible uterine perforation. It can also be confirmed by direct visualization of intra-abdominal organs, such as a loop of the bowel or omentum, in the scope’s visual field. The procedure should be suspended if there is suspicion of uterine perforation.

The anterior wall is the most frequent site for uterine perforation, followed by the cervical canal [14]. Anterior wall perforations can lead to bladder lesions, whilst lateral wall perforations are at risk of ureteral injury. Perforations occurring in the lateral walls are also more likely to cause vascular injury that can lead to broad ligament hematomas or significant intra-abdominal bleeding, with haemodynamic instability [16].

When uterine perforation occurs with a dilator, uterine sound or hysteroscope with a diameter below 5 mm and without significant bleeding, it can be managed expectantly [35]. In these cases, overnight admission for observation and a short course of antibiotics are usually the only required treatment. If there are any complaints of abdominal pain or shoulder tip pain, with haemodynamical instability, a prompt diagnostic laparoscopy is warranted. When damage occurs with larger instruments, electrosurgical or laser instruments, a systemic laparoscopic inspection of bladder, ureters, bowel and blood vessels is required to identify possible damage to these structures. In cases where organ lesion is suspected, it is crucial to obtain early support from general surgery, urology or vascular surgery depending on the type of injury. Delayed thermal injury to the bowel can manifest up to 2-week post-intervention. On discharge the patient should be informed that if any signs or symptoms of bowel perforation, such as fever, increasing pain, nausea, or vomiting, should arise they should present immediately to the emergency department.

2.5 Bleeding

Bleeding during hysteroscopy can result from entry-related complications, as previously described in this chapter, or can be procedure-related. The latter result from the transaction of vessels in the myometrium during the operative procedure. It is the second most common complication after entry-related complications, with rates varying between 0.16% and 0.61% in published reports [5, 36, 37]. Higher incidence rates are described for adhesiolysis (2.51%) and myomectomies that involve intramural components (3–4%) [38, 39].

It is often not problematic as the pressure required for uterine distention prevents loss from venous vessels. Spot electrocautery with rollerball or wire loop can be used to control bleeding from small vessels during the procedure [16]. Continuous-flow systems facilitate the removal of blood from the cavity allowing for prompt continuation of the procedure. On completing the operative procedure, intruterine cavity pressure should be lowered slightly to identify any occult bleeding and allow for timely management.

Most operative hysteroscopies may be associated with a small amount of bleeding postoperatively, which usually stops promptly. Dilute vasopressin solution (0.05 U/mL) injected into the cervix has been shown to reduce significantly blood loss in patients with a high risk of bleeding during the procedure [40]. Vasopressin stimulates uterine contractions, thus reducing the blood loss during surgery, but it also has a direct vasoconstrictor effect and can result in serious cardiovascular complications, such as bradycardia, arrhythmias, pulmonary oedema and cardiac arrest [41, 42]. When using this medication, it is essential to ensure negative aspiration before injecting the vasopressin to avoid direct administration into a vessel resulting in systemic effects.
After completing the procedure if bleeding persists, a Foley catheter may be inserted and inflated to 20–30ml to tamponade the bleeding [43]. The balloon can be removed up to 24 h after insertion. In cases of persistent and heavy bleeding, uterine artery embolization should be considered and ultimately hysterectomy if all other interventions fail [16].

2.6 Fluid overload

Fluid overload, due to excess absorption of distention medium, occurs in 0.2–6.0% of operative hysteroscopies and is a potentially serious complication [44]. In 2018, ISGE/BSGE joint guideline on fluid management for hysteroscopy, defined fluid overload as a fluid deficit of more than 1000 ml with hypotonic solutions and 2500 ml when using isotonic solutions [45]. Risk factors that increase fluid intravasation include high intrauterine distension pressure, low mean arterial pressure, prolonged surgery, extensive surgical resection and large uterine cavities [39]. Elderly women with cardiovascular, renal or other medical comorbidities are also at a higher risk. In high risk patients the ISGE/BSGE guideline recommends using lower upper limits for defining fluid overload, with 750 ml for hypotonic solutions and 1500 ml for isotonic solutions.

This type of complication can occur with all types of distending medium and the associated pathophysiology is dependent on the type of medium used during the procedure. Fluid distending medium used in operative hysteroscopy can be broadly divided into high viscosity (e.g., dextran 70) and low viscosity, which include hypotonic (e.g. glycine 1.5%, dextrose 5% and sorbitol 3%) and isotonic media (e.g. normal saline, Ringer’s lactate and 5% mannitol). High viscosity dextran 70 has fallen out of use due to its safety profile (i.e. risk of anaphylactic reactions) and potential to damage operative instruments due to crystallization [31]. In recent years, with the development of bipolar electrosurgical equipment and mechanical instruments, professional organizations have started recommending the use of isotonic media over hypotonic media due to a better safety profile [45, 46].

When intrauterine pressure exceeds the mean arterial pressure, there is an increased risk of intravasation of the distention media into the vascular system [32]. Fluid overload with hypotonic solutions will lead to hyponatremia with a rapid drop in osmolarity. In the brain, where water easily travels across the blood-brain barrier, the decreased osmolarity will allow for fluid to enter the cells resulting in cerebral oedema if left untreated. This mechanism increases intracranial pressure that can result in hypoxia and lead to cerebral herniation, resulting in irreversible brain damage [47, 48]. Premenopausal women are 25 times more likely to die or have permanent brain damage when developing hyponatraemic encephalopathy [49]. Other risks associated with specific hypotonic medium are hyperammonaemia with glycine that result in muscle aches, visual disturbances and encephalopathy. In case of using sorbitol potential complications are associated with hyperglycaemia and haemolysis [14]. The use of isotonic media reduces the risk of dilutional hyponatraemia, but fluid overload can lead to hypervolemia with the accumulation of fluid in the extracellular space, giving rise to pulmonary oedema and congestive cardiac failure.

Signs of fluid overload can include nausea, vomiting, headache, agitation, confusion, visual disturbances, blindness, dyspnoea and chest pain [50]. If not identified and left untreated, the patient may develop seizures, pulmonary oedema, bradycardia and ultimately cardiopulmonary collapse.

Prevention is crucial to avoid fluid overload and careful fluid monitoring throughout operative procedures is essential. In recent years, the introduction of closed
systems and automated fluid measurement systems have brought improvement as they allow for more accurate measurement of the fluid output when compared to manual measurements. During the procedure, the surgeon should use the lowest pressure to achieve a clear view of the uterine cavity, usually between 50 and 80 mmHg. In one study that included 250 operative hysteroscopies, there was no significant fluid absorption when the intrauterine pressure was kept below 80 mmHg [51].

Other important measures include obtaining baseline bloods with serum electrolytes prior to beginning surgery in high-risk patients or in those patients where a longer procedure is expected. Symptoms usually present when serum sodium concentration has fallen below 25 mmol L$^{-1}$, at which point the procedure should be suspended [52]. The use of intracervical injection of dilute vasopressin prior to cervical dilation has been shown to decrease fluid absorption [46]. Consideration can also be given to the pre-operative administration of gonadotrophin-releasing hormone, especially in older women, to help reduce the intravasation of fluid [45].

In cases where the patient develops fluid overload, strict fluid balance monitoring should be started and serum electrolytes measured. Patients with an asymptomatic hypervolaemia with or without hyponatraemia are easily managed with fluid restriction with or without diuretics. In patients who develop symptoms, admission to a high dependency unit may be required and early management by a multidisciplinary team (i.e. anaesthetists and intensivists). Patients should be carefully monitored for any further development of cardiac, pulmonary or cerebral changes. Management includes correction of hyponatremia with 3% hypertonic sodium chloride [45].

2.7 Neuropathies

Postoperative neuropathy is a rare complication in operative hysteroscopy as most procedures have a short duration. Nevertheless, the hysteroscopic surgeon should be aware of these and how proper patient positioning plays a crucial role in preventing this type of lesion. The most common neuropathies are related to injuries to the femoral, common peroneal and sciatic nerves [53].

The femoral nerve can be injured due to extreme angulation and compression against the inguinal ligament, caused by excessive hip flexion or extreme abduction and external rotation of the thigh when positioning the patient [54]. This type of neuropathy will result in difficulty in hip flexion/adduction and knee extension. These patients will present with inability climbing stairs in severe cases with motor damage. Patients may also complain of paraesthesia over the anterior and medial aspects of the thigh or medial aspect of the calf and foot [55].

Injury to the common peroneal nerve can occur by compression, as this nerve is in close proximity with the fibular head. Correct positioning of the patient lower limbs in padded boot stirrups can help prevent this type of lesion by avoiding direct contact of the knee or lower leg with a hard surface that can lead to nerve compression [56]. Lesions to this nerve result in the inability to perform foot dorsiflexion, lateral rotation of the ankle and extension of the toes. These lesions result in paraesthesia in the calf and dorsum of the respective foot, accompanied by foot drop.

Sciatic nerve injury, similar to the femoral nerve lesion, can occur due to excessive stretching of the respective nerve when the patient is inappropriately positioned in lithotomy with excessive hip flexion with knee extension or hip abduction with excessive external rotation of the thighs at the hips [57]. This type of neuropathy can result in paraesthesia over the posterior part of the thigh, calf and sole of the foot and cause weakness in hip extension and knee flexion [58].
2.8 Local anaesthetic systemic toxicity

Complications associated with anaesthesia in an operating theatre go beyond the scope of this chapter, but as operative hysteroscopy becomes more frequent in an outpatient setting the gynaecologist should be aware of complications arising from the use of local anaesthetics. Local anaesthetic systemic toxicity (LAST) although rare is a life-threatening adverse event. Important risk factors in the hysteroscopic patient include the type and dose of local anaesthetic administered, age > 60 years, and renal and cardiac disease [59, 60].

Clinical manifestations are highly variable, but are associated with neurological and cardiac toxicity. Neurological manifestations are the most common feature, occurring usually in 68–77% of cases, and usually precede the cardiac manifestations [61]. Initial symptoms may include metallic taste, tinnitus, perioral paraesthesia, agitation and dysarthria [60]. Central nervous system toxicity can progress to seizures and ultimately coma if not managed. Cardiac signs usually manifest initially as excitation (i.e. hypertension, tachycardia or ventricular arrhythmias), and posteriorly as depression (i.e. bradycardia, conduction block and asystole) [62].

Toxicity with local anaesthetic can occur with the unintentional intravascular injection or administration of toxic doses. An important preventative measure is to aspirate before injecting the local anaesthetic to confirm that it is not being directly administrated into a blood vessel. The use of premixed syringes with epinephrine also helps reduce systemic absorption. Gynaecologists should be aware of the maximum doses for the different types of local anaesthetic [63].

If any symptoms of LAST should develop prompt consideration should be given to initiating general resuscitation measures. Administration of the local anaesthetic should be immediately stopped stop and further assistance requested. Intravenous access should be sited, standard monitoring with cardiac monitoring started, the emergency trolley should be made available and local anaesthetic/resuscitation team contacted. In severe cases, treatment with 20% intravenous lipid emulsion may be required [61].

2.9 Gas embolism

Gas embolism during operative hysteroscope is a rare complication, but extremely fatal with a mortality rate of up to 46% [64]. The pathological mechanism associated with a gas embolism is complex and triggered by the entry of gas into the systemic venous system when a pressure gradient is created between the surgical site and the right atrium [65, 66]. In operative hysteroscopy, gas can derive directly from the room air or from gas products subsequent to electrosurgical vaporization. A lethal dose can range from 3 to 5 ml/kg. With room air lethal doses can be as low as 50 ml, due to the fact that it is rich in nitrogen that is less soluble than carbon dioxide or oxygen [53, 67].

During operative hysteroscopy, gas can be inadvertently introduced into the uterus due to inappropriate purging of distention fluid systems pre-operatively, multiple entries into the womb during the surgical procedure which can inject air into the cavity or in cases where there is extensive vascular lesion during procedure or cervical trauma and air can directly enter the venous system when the cervix and vagina are left open. When positioning a patient in Trendelenburg, a pressure gradient is created, facilitating the entry of gas into the incised or open veins, as the patient’s head is lower than the surgical site thus increasing venous return to heart and any air bubbles present.

During hysteroscopic procedures, the intrauterine pressure created by distention fluid can reach a pressure of up to 100 mm-hg, which surpasses the mean venous
pressure. This creates a dangerous gradient that facilitates fluid absorption directly from the cavity, but also the entry of any air bubbles present in the cavity into the venous system. Dyrbye et al. demonstrated that during operative hysteroscopy gas embolism was not dependent on the type of electrosurgical equipment used, but the grade of the gas embolism was more severe when the intravasation of the distension fluid surpassed one litre [68].

When entering the venous system, the gas bubbles travel to the right ventricle and can progress further to the pulmonary circulation. In the right ventricle, larger volumes of gas can occlude the outflow tract and pulmonary artery, leading to cardiovascular collapse. Likewise, when smaller amounts of gas bubbles travel to the pulmonary circulation, it can lead to pulmonary vasoconstriction, increased pulmonary artery pressure, increased resistance to right ventricular outflow, and subsequently right ventricle failure [69]. There is also a reduced ventricular preload, with a subsequent decrease in left cardiac output that leads to systemic cardiovascular failure [70]. Gas emboli can also trigger an intense inflammatory response that results in bronchoconstriction and pulmonary capillary leakage leading to pulmonary oedema and alveolar collapse [68].

During an office hysteroscopy, the gynaecologist should consider an air embolism in the differential diagnosis when the patient complains of a sudden onset of chest pain or difficulty breathing, as this can be the presenting symptom in 20–52% [63]. On pulmonary auscultation, wheezing or rales can be detected, as signs of bronchospasm and pulmonary oedema. The classic sign in cases of air embolism is the ‘mill wheel’ murmur, due to intracardiac air emboli [71]. A decrease in oxygen saturation can be identified in 30–72% of patients. In patients under general anaesthetic, gas embolism presents with a fall in the end-tidal CO₂, decrease in saturation of peripheral oxygen and cardiovascular symptoms [64].

In case of any suggestive symptoms or signs, the gynaecologist should have a high degree of suspicion as early identification and prompt management is crucial for patient survival. The procedure should be halted immediately to avoid further entry of air into the venous circulation. The surgeon ought to remove all instruments, and deflate the uterus and occlude the cervical os (e.g. uterine dilator and wet swabs) to avoid further entry of gas. It is also important to place the patient in reverse Trendelenburg to reduce the passage of further air emboli to the heart. The patient should additionally be placed in the left lateral position (Durant’s Manoeuvre), in an attempt to move the gas emboli into the right atrium away from the right ventricular outflow tract [72]. At this point, it is crucial to initiate basic life support and that the emergency rapid response team be contacted promptly.

Prevention is a crucial step in avoiding this serious complication. During operative hysteroscopy in an office setting, patients should be monitored with pulse oximetry and if there are any signs of decreased oxygen saturation, accompanied by bradycardia or tachycardia, consideration should be given to suspending the procedure immediately. Before beginning the procedure, the surgeon should ensure that the irrigation system is fully purged of all air bubbles. When dilating the cervix, leaving the last dilator in the cervix until inserting the hysteroscope will avoid the entry of room air into the cavity. During the procedure, the surgeon should not place the patient in Trendelenburg position and limit instrument exchanges to a minimum (e.g. removal and reinsertion of the resectoscope during a procedure). Whilst performing the procedure distension pressures should be kept to the minimum required for adequate vision [63]. Pre-operative priming with GnRH agonists to reduce venous sinuses and the administration of cervical vasopressin preoperatively may help reduce the degree of intravasation during the procedure, thus reducing the risk of gas embolism [22, 73].
3. Post-operative complications

3.1 Infection

Complications associated with infection after an operative hysteroscope are rare events and the incidence ranges from 0.3% to 1.6% [74]. These include urinary tract infections, endometritis, pyometra and pelvic inflammatory disease [31].

Women with a history of pelvic inflammatory disease seem to be at an increased risk of developing infectious complications. Other risk factors are associated with the duration and type of intervention. The risk is higher in patients undergoing longer procedures, in hysteroscopic interventions with extensive endometrial destruction that may leave necrotic tissue fragments in the uterine cavity and surgeries that require multiple reinsertions of the operative instruments through the cervix [16].

Studies have demonstrated that the use of prophylactic antibiotics provides no statistical difference in relation to the incidence of postoperative infections [75–77]. Antibiotic prophylaxis is required in women with cardiac conditions at risk for endocarditis and in those patients with insertion of laminaria for cervical dilatation [19]. Some authors also recommend the administration of antibiotics in women with a history of pelvic inflammatory disease [16, 19].

Management of post-hysteroscopic infections complications should include broad-spectrum antibiotics and patients usually respond within 48 h of beginning treatment.

In patients with pyrexia, leukopenia and abnormal liver function tests not responding to antibiotics, although extremely rare, disseminated herpes should be considered. Price et al. describe a fatal case of fulminant hepatic failure in a healthy woman after a hysteroscopy due to herpes simplex virus [78], demonstrating the importance of differing hysteroscopic procedures if active genital herpes is identified.

3.2 Postoperative hematometra

Postoperative hematometra is a complication that occurs mainly after endometrial ablation/resection or intrauterine adhesiolysis for Asherman’s syndrome [19]. Its incidence rate is estimated to be between 1 and 3% in patients undergoing endometrial ablation [79, 80]. Postoperative hematometra can develop centrally or in the cornual areas.

The patient is usually amenorrhoeic and presents with cyclic pelvic pain during the menstrual phase of the cycle. Symptoms can begin a few weeks after the procedure, with some patients presenting up to 16 months after the intervention. Hematometra occurring centrally result from the regeneration and sloughing of residual endometrium behind a cervical or lower uterine segment stenosis resulting from the previous hysteroscopic procedure [81]. In cornual hematometra, there is usually both a proximal and distal cornual obstruction that does not allow for decompression of the menstrual bleeding and patient will complain of homolateral pelvic pain [82].

Diagnosis is made by pelvic ultrasound, whilst the patient is symptomatic, but in cases of smaller cornual hematometra pelvic MRI may be required. In most cases, central hematometra treatment is simple requiring only cervical dilatation [83]. In recurrent cases, stent placement may be considered. Treatment of cornual hematometra involves a higher degree of complexity, with a high risk of uterine perforation due to difficulty in access, extensive adhesions and also due to the fact that the myometrium in these areas is thinner. Hysteroscopic treatment should be done under ultrasound guidance and the remaining endometrium should be resected/ablated to prevent recurrence. In case of recurrence of cornual hematometra, hysterectomy should be considered.
In order to reduce the risk of postoperative hematometra some authors recommend that when performing endometrial resection or ablation the destruction of the endometrium be terminated at the lower uterine segment, avoiding trauma to the internal cervical os that can lead to cervical stenosis.

### 3.3 Post-ablation tubal sterilization syndrome

Post-ablation sterilization syndrome (PATSS) is another complication associated with focal-residual endometrial tissue in uterine cornea with retrograde menstruation into an occluded tube, resulting in a hemosalpinx. It was first described by Townsend et al. in 1993 and later confirmed by Webb et al. [84, 85]. The true incidence of this syndrome is unknown with the reported incidence rates ranging from 3 to 10%, but it is believed to be underestimated as it may go undiagnosed [86, 87].

Similarly, for cornual hematometra women, PATSS will present with lateral or bilateral pelvic pain coinciding with the menstrual period. On physical examination, when symptomatic, the patient may have significant adnexal tenderness, but with no significant adnexal mass. Symptoms may start as early as 2 months post-procedure, but in one study with a 10 year follow-up some patients were diagnosed with symptoms presenting as late as 20 months after the procedure [86].

A high degree of suspicion is required in symptomatic women with a history of tubal ligation, as ultrasound may be reported as normal in cases with minimal hemosalpinx. In these cases, a T2 image-weighted MRI will aid in identifying the hemosalpinx. When diagnostic exams are performed out of the menstrual cycle, findings may be reported as normal as blood in the fallopian tube may be absorbed [80]. As this is a rare and fairly unknown pathology, the radiologist should be made aware of the clinical impression when ordering diagnostic exams.

Treatment involves laparoscopic salpingectomy and hysteroscopic adhesiolysis to prevent further cornual hematometra recurring. Salpingectomy should be performed bilaterally as there are reports of contra-lateral recurrence [39]. In cases of recurring pelvic pain, consideration should be given to a hysterectomy.

When performing endometrial ablation with first-generation equipment, the destruction of endometrial tissue in the cornual area may be challenging, due to concerns of uterine perforation in these areas where the myometrial thickness is the thinnest. MRI studies performed on women who underwent endometrial ablation with rollerball demonstrated that 95% had persistent endometrial tissue, most frequently identified in fundal area close to the ostium [85]. Second generation equipment, with shorter operating times and less complications, have gained popularity over the last few years, but also seem to be associated with PATSS [88, 89].

### 3.4 Intrauterine adhesions

Intrauterine adhesions (IUA) or synechiae are a significant long-term complication in women undergoing operative hysteroscope, especially in those still wishing for future pregnancies. The incidence of post-operative adhesions is dependent on the type and extent of the hysteroscopic procedure performed. In a randomized prospective study, Taskin et al. found that the incidence of IUA on a second-look hysteroscopy was 3.6% after polypectomy, 6.7% in metroplasties, 31.3% after a single myo-mectomy and as high as 45.5% in patients undergoing multiple myomectomies [90].

IUA result when there is damage to the basal layer of the endometrium with opposing uterine walls coalescing together forming adhesions that can result in a
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partial or total obliteration of the uterine cavity [91]. Patients will frequently complain of menstrual irregularities that include amenorrhea or hypomenorrhea, but may also include dysmenorrhea due to retrograde menstruation [92]. IUA are also an important risk factor for infertility, miscarriage, premature rupture of membranes, caesarean section due to non-cephalic presentation, low birth weight and increased risk of admission to neonatal intensive care unit [93, 94].

Although historically hysterosalpingography was used for diagnosis, presently hysteroscopy is considered the gold standard as it permits not only diagnosis, with direct inspection of the cavity to evaluate the extent of the process, but also allows for treatment during the same procedure. Multiple management approaches to adhesiolysis have been published including expectant management, hydro-dissection of thin adhesions and use of mechanical instruments, such as scissors or use of electrosurgery [92]. Recurrence rates vary from 20 to 23% in simple cases, but can be as high as 48.9% to 62.5% in cases with extensive synechiae [95, 96].

Prevention of adhesion formation is the most relevant part of any operative hysteroscopy, especially in fertile women undergoing extensive intrauterine procedures. Numerous approaches have been proposed for the prevention of IUA adhesions, but the numbers of cases included in study groups are usually small and there are few comparative studies. Prevention begins before the surgery and patients should be informed of the risks of IUA prior to any operative hysteroscopy. In cases of hysteroscopy for suspected IUA, the patient should be informed about the clinical risks involved when undertaking adhesiolysis, including uterine perforation. The patients should also be warned that normal cavity anatomy may not be obtained and that multiple procedures may be required due to extensive adhesions and recurrence.

In a recent systemic review that included 4953 women who had undergone adhesiolysis, it was demonstrated that these patients had an increased risk of ectopic pregnancy, pregnancy loss, placenta previa, placenta abruption, premature rupture of membrane, placenta accreta, neonatal death and stillbirth when compared to women in the general population [97].

During adhesiolysis, some authors favour the use of mechanical instruments over electrosurgical energy due to concerns about theoretical endometrial damage caused by instruments that use energy sources [98]. Recent studies have demonstrated lower adhesion rates when using bipolar instruments, which is attributed to a selective resection process, with less endometrial damage, when compared to monopolar equipment. More research is required to compare the different techniques including the newer mechanical instruments.

Post-procedure preventative measures include early repeat second-look hysteroscopy [99], the use of mechanical barriers (i.e. intrauterine device [100], intrauterine balloon stent [101] and folley catheter [102]), use of hyaluronic acid, and other anti-adhesion barriers [103, 104] and medical therapies [105] to aid in the restoration of the endometrium. More recently the use of stem cells has been proposed to help regenerate the endometrium [106].

3.5 Pregnancy following endometrial resection and endometrial ablation

Endometrial resection or ablation has become a largely disseminated technique for treating heavy menstrual bleeding refractory to medical management, with several benefits over the more invasive hysterectomy [107, 108]. Multiple techniques have been developed, but the principle remains the same across the different methods, aiming for the complete destruction of the endometrium down to the basalis layer.
Endometrial ablation is not contraceptive and when pregnancy does occur in the remaining refractory endometrium, it can be associated with multiple adverse outcomes resulting from implantation in a scarred uterus. The number of pregnancies after endometrial ablation has been increasing and the reported rates range from 0.24% to as high as 5.2%, with the highest rate being for patients having undergone balloon ablations [109, 110]. In a recent systemic review by Kohn et al., the majority of cases occurred in patients who had undergone an endometrial ablation with a first-generation technique (83% in trials and cohorts and 71% in case studies), with smaller numbers after a second-generation technique (17% in trials and cohorts and 19% in case studies) [109].

Any pregnancy occurring after an ablative procedure should be considered a high-risk pregnancy and added surveillance is required. The risk of ectopic is high 6–7%, when compared to the 2% in the general population and may occur in rare locations such as cervical and cornual locations [111–113]. In patients who have undergone an endometrial ablation and have a positive pregnancy test, an early pregnancy scan is required to exclude an ectopic pregnancy. Pregnant women with a history of endometrial ablation are at a higher risk of miscarriage, preterm premature rupture of membranes, premature delivery, intrauterine growth restriction, caesarean section and abnormal placentation [110, 114].

One of the major concerns in pregnant patients with a history of an endometrial ablation are of a placenta accreta spectrum disorder. Kohn et al. found in their review that included 258 post-ablation pregnancies, an incidence rate of approximately 12%. In this same group, 81% underwent a hysterectomy and 40% were complicated by a postpartum haemorrhage. Taking this into consideration, these patients should be reviewed in tertiary centers that have experience in diagnosing placenta accreta spectrum disorders and the delivery should take place in units with surgeons that have experience in postpartum hysterectomies.

3.6 Uterine rupture

Operative hysteroscopy has greatly evolved over recent years, reducing the need for traditional open surgery for the treatment of uterine septa, synechiae and fibroids. Nevertheless, information on the long-term obstetrical outcomes after these types of procedures is limited and most published research is derived from case reports on individual cases with adverse outcomes.

Uterine rupture is an extremely rare, but devastating complication resulting in adverse outcomes for both mother and foetus. In recent decades, there have been an increasing number of reports on uterine rupture in patients who underwent an operative hysteroscopy that was complicated by a uterine perforation [115–118]. Other reported risk factors related to hysteroscopy that can result in a uterine rupture during pregnancy include metroplasty, adhesiolysis and myomectomy [119–123].

It is hypothesized that these types of procedures weaken the myometrium ultimately leading to a uterine rupture during pregnancy when the muscle fibers are required to stretch so as to accommodate the growing pregnancy [124]. In a review by Sentilhes et al., it was found that monopolar energy had been used in 9 of the 13 reported cases (69%) [125]. It was theorised that the use of electrosurgery during hysteroscopy may provoke thermal damage to tissue leading to the weakening of the muscle fibers that can eventually result in a uterine rupture [126].

When obtaining consent for operative hysteroscopy in women of reproductive age, it is important to counsel women on the obstetrics risks that may result from the
procedure. There is no consensus on the safe interval between procedure and pregnancy with reported cases of a uterine rupture occurring between 1-month and 5-year post-procedure [125]. Nevertheless, women who have undergone extensive operative hysteroscopy are at a high risk of adverse obstetric outcomes, especially when there has been a uterine perforation and will require increased surveillance during their pregnancy.
References

[1] Pantaleoni DC. On endoscopic examination of the cavity of the womb. Medicine Press Clinic. 1869;8:26


[49] Ayus JC, Wheeler JM, Arieff AI. Postoperative hyponatremic
Updates in Endoscopy


[57] Batres F, Barclay DL. Sciatic nerve injury during gynecologic procedures using the lithotomy position.

Obstetrics and Gynecology. 1983;62 (3 Suppl):92s-94s


[65] Groenman FA, Peters LW, Rademaker BM, Baklum E.A. Embolism of air and gas in hysteroscopic


[119] Angell NF, Domingo JT, Siddiqi N. Uterine rupture at term after uncomplicated hysteroscopic metroplasty. Obstetrics & Gynecology. 2002;100(5):1098-1099


