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Diploma thesis

Prevention of Complications in Gynecologic Endoscopic Surgery

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Written Declaration

I declare that I completed the submitted work individually and only used the mentioned sources and literature. Concurrently, I give my permission for this diploma thesis to be used for study purposes.

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Jerusalem, August 4th, 2009

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INTRODUCTION

I would like to start my thesis by presenting here several historical facts on endoscopic surgery development. Since this field is relatively new in a history of surgery and rapidly expanding – it is especially important to recognize and evaluate the consequences (early and late complications) of newly developed techniques. The following quote graciously summarize it:

"All progress is precarious, and the solution of one problem brings us face to face with another problem." - Jr. Martin Luther

The first "endoscopy" was performed in 1901 using a Nitze cystoscope on a dog. Shortly after this pioneering event Jacobaeus in 1911 performed abdominal and thoracic endoscopy on humans. In 1938, the first major technical advance occurred with the development of the Veress needle for insuflation. [2]

Endoscopy was initially developed by urologists and internists. Till the end of the nineteenth century, the main need for the evolution of endoscopy came from inspection of the bladder, rectum, and larynx.

Since the 1960s gynecologists began to carry out small surgical interventions.

At the beginning, gynecologic laparoscopy was used only for the diagnosis of pelvic pathology or tubal sterilization. With the development of specialized instruments and the use of video camera systems, laparoscopic surgery has become a primary therapeutic mode for many gynecologic problems.[1]

The first surgical intervention to be performed by laparoscope was tubal sterilization, by coagulation, rings, or clips. Work by MUDr. Jaroslav F. Hulka, established operative laparoscopy as a safe and effective technique. Soon others recognized the benefits of laparoscopic surgery, such as, decreased length of hospital stay, and decreased surgical morbidity.

Infertility surgeons quickly adapted the potential applications of endoscopic surgery. They began introducing laparoscopy in cases such as: to assess tubal patency, adhesion formation, and to diagnose prior to major surgical interventions. Shortly, it was recognized that endoscopy was an ideal means for lysing adhesions and fulgurating endometriosis. The carbon dioxide, Argon and KTP lasers were introduced to the endoscopic operating room for these procedures.[3]

Gynecologists also recognized the advantages to their patients that by avoiding a laparotomy they avoided inevitable scarring and adhesion formation. Patients with early-unruptured ectopic pregnancies benefited from the early improvements in laparoscopic surgical instruments, which made it possible to perform laparoscopic salpingectomy or salpingotomy (both are becoming widely accepted). Endoscopic ovarian cystectomy once considered taboo by most gynecologists, is now accepted practice under specific conditions.

As endoscopic surgery advanced, other gynecologists turned to hysteroscopy. Hysteroscopic procedures were first described by Pantaleoni in 1869, but real progress started in late 1970s. This technique, once used only to visualize the intrauterine cavity has become a primary route to perform intrauterine surgery.

Nowadays hysteroscopic surgery includes the removal of intrauterine devices (IUD's), the removal of endometrial polyps and submucous myomas, endometrial ablation, metroplasty in cases of congenital abnormalities, the removal of retained products of conception, adhesiolysis and tubal sterilization. Hysteroscopes most commonly used for intrauterine surgery have an outer sheath of 8-9mm diameter, requiring cervical dilatation and therefore regional or general anesthesia and an operating theatre. To allow optimal visibility irrigation fluid is circulated rapidly rinsing the uterine cavity of blood and tissue debris. Surgery can be performed with various instruments including scissors, forceps and electrodes. The use of monopolar electrodes requires non-conducting distension media (e.g. glycine,

sorbitol or mannitol), and excessive intravasation of this type of distension fluid can be life-threatening. Bipolar electrodes allow normal saline as a distending medium, thereby improving the patients' safety.

Furthermore, since hysteroscopes with a final outer diameter sheath of 5mm or less have enabled performance of diagnostic hysteroscopy in an outpatient setting, small mechanical instruments (e.g. grasping forceps or scissors) and bipolar electrosurgical technology have allowed for hysteroscopic procedures to be performed in an ambulatory setting as well. This primarily includes the removal of IUDs, small intrauterine lesions (e.g. polyps, small submucous myomas and adhesions) and hysteroscopic tubal sterilization. [4]

The introduction of hysteroscopic surgery has changed the surgical landscape from one previously dominated by hysterectomy to a surgical field containing a plethora of less invasive procedures that allow for uterine preservation, as well as reduced procedural and postoperative morbidity. These options have clear benefits for patients but challenges for gynecologic surgeons. With the continuous rapid development of new diagnostic and therapeutic procedures surgeons must now critically evaluate the role of these techniques in daily practice.

During my research of historical aspect of endoscopic surgery rapid evolution, it became clear to me that one of the ways to develop innovations and new procedures, there is a constant need to evaluate and manage various complications that are occurring.

Incidence of complications

Complications related to endoscopic surgery in gynecologic patients are not uncommon. A survey including over 1.5 million gynecologic patients reported complications in 0.1 to 10 percent of procedures. Over 50 % of these complications occurred at entry, and 20 to 25 % of complications were not recognized until the postoperative period. [3]

Hysteroscopic surgery is considered safe procedure depending on the complexity of the procedure. One of the first big surveys was the American Association of Gynecologic Laparoscopists (AAGL) in 1993 which found a complication rate of 2% for operative hysteroscopy. The rate of major complications — perforation, hemorrhage, fluid overload, and bowel or urinary tract injury — was less than 1%. The overall incidence of dilutional hyponatremia was 0.2%. [5]

Later on, another big prospective, multicenter study that estimated the incidence of complications of diagnostic and operative hysteroscopic procedures was in the Netherlands. Data on complications were collected from 82 hospitals in 1997.

Any unexpected events that required intraoperative or postoperative intervention were defined as complications in two groups:
(1) approach (entry-related)
(2) technique-related (caused by surgical instruments)

Results showed 38 complications occurred among 13,600 hysteroscopic procedures (rate 0.28%). Incidences of complications in following procedures were: intrauterine adhesiolysis 4.48%, endometrium resection 0.81%, myomectomy 0.75%, and removal of a polyp 0.38%.

Diagnostic hysteroscopic procedures had a significantly lower complication rate (0.13%) than operative procedures (rate 0.95%). Fluid overloads of distention medium were recorded five times of overall 38 complications (rate 0.20%). The most frequent surgical complication was perforation of the uterine cavity (rate 0.76%). Approximately half the perforations (18 of 33) were entry-related. Bleeding caused by perforation was seen in 0.16% of cases. [6]

Table 1: Hysteroscopic surgery complications can be divided into several categories

1. ***Preoperative complications***
    a. *improper evaluation of risk factors and contraindications*
2. ***Perioperative complications***
    a. *mechanical and traumatic (operator technique)*
    b. *bleeding*
    c. *Electrosurgical and gaseous complications*
    d. *distention media*
3. ***Postoperative complications***
    a. *early and late infections*
    b. *iatrogenic adenomyosis*
    c. *risk of endometrial cancer*
    d. *hematometria*
    e. *Post-ablation tubal ligation syndrome*

1. Preoperative complications

a. Improper evaluation of risk factors and contraindications

Incidence of complications is reduced if risk factors and contraindications are not ignored.

Procedures on patients who have had prior surgeries or intra abdominal disease (endometriosis, pelvic inflammatory disease) are associated with a higher risk of complications than simple procedures in women without this past history.

Contraindications include:

- Acute pelvic inflammatory disease

- Genital tract malignancies
- Inability to dilate the cervix
- Inability to distend the uterus to obtain visualization
- Poor surgical candidates who may not tolerate fluid overload because of renal disease, or radiofrequency current when a cardiac pacemaker is present
- The patient desires and expects complete amenorrhea [8]

2. Perioperative complications

a .Mechanical or traumatic complications

These types of complications are among the most common.

Inability to insert the hysteroscope - This may be caused by a stenotic, nulliparous cervix, menopause, GnRH agonists, previous cone biopsy, laceration, cryosurgery, or an acutely retroflexed/anteflexed uterus.

Inserting a laminaria tent the evening before surgery helps dilate the cervix easily and atraumatically. However, the laminaria can sometimes create a false passage, leading to perforation.

Laceration of the cervix - although this is a minor complication, substantial bleeding sometimes occurs when the cervix is lacerated by the tenaculum. Occasionally, a touch of cautery from the electrode at low power (20 to 30 W) can control the bleeding.

Collateral injury with uterine perforation - Perforation is a well-known risk of operative hysteroscopy. Although perforation is more common with thermal energy sources, it may occur mechanically when scissors are used to transect a uterine septum, synechiae, or polyps.

When the cervix is stenotic or the uterus is acutely ante- or retroflexed, sounds and dilators can perforate the uterus.

Most perforations—even those involving large dilators—usually do not require treatment, although further assessment may be necessary to rule out bowel injury. Most perforations occur in the fundal region or posterior lower segment.

A false passage can be created when entering the uterus. Occasionally the surgeon may be fooled into thinking the hysteroscope is in the uterine cavity, since the false passage distends.

Avulsion of the myometrium sometimes occurs during removal of incompletely resected myomas. Injuries can occur when the grasper perforates the uterus and bowel is inadvertently grasped. Large injuries require laparoscopic repair.

Perforation is more likely in repeat procedures. In a series of 75 repeat ablations compared with 800 primary ablations by the same surgeon, the rate of serious perioperative complications was significantly higher in the repeat ablation group (9.3% versus 2.0%) . [7]

b. Intraoperative bleeding

This types of complication is rare. Bleeding is unlikely unless vessels are lacerated or injured in the cervical canal or lower uterine segment during dilation or deep ablation or vaporization. Bleeding is more common when endomyometrial resection is performed with the wire loop electrode or during ablation or vaporization of fibroids. Bleeding sufficient to require intervention occurs at a rate of 0.5% to 1.9% in several reported series.

A vaporizing electrode may prevent significant blood loss during myoma resection by sealing blood vessels as the tissue is vaporized. [10]

c. Electrosurgical and gaseous complications

Most electrosurgical complications involve activation of an electrode at the time of perforation, or current diversion to the outer sheath.

Thermal injuries also can be caused by overheating of the return pad or use of a weighted speculum that has not fully cooled after removal from the autoclave.

Perforation with an active electrode - this usually occurs when current is applied as the electrode is extended or the resectoscope is moved toward the fundus. It can be avoided if the electrode is activated only when moving it toward the operator.

Perforations with intraabdominal burns also have occurred during attempts to coagulate —especially in the cornual regions.

Diversion of current - genital tract injuries have occurred as a result of current diversion. Vilos and colleagues reported electrical burns during endometrial ablation, and mention many more anecdotal reports. The usual cause: electrode insulation failure, which allows current to jump to the outer sheath of the resectoscope.

Capacitative coupling also diverts current - since the sheath-within-a-sheath design of the resectoscope resembles a capacitor, high-voltage current can jump to the outer sheath without direct contact from the electrode.

Gas embolism - initial reports of this potentially fatal complication came mostly from laser ablation procedures, but gas embolism can occur during all diagnostic and operative hysteroscopic procedures, especially the latter.

Sources of gas embolism: room air, carbon dioxide, carbon monoxide, and other gaseous products of vaporization or tissue combustion. The anesthesiologist is usually the first to identify the signs.

Signs of gas embolism: any sudden fall in oxygen saturation, as well as to hypotension, hypercarbia, arrhythmias, tachypnea, or a "mill wheel" murmur. If any of these signs are detected and a gas embolism is suspected, stop the procedure and ventilate the patient with 100% oxygen.

Carbon dioxide is a soluble gas, so these emboli generally resolve rapidly. In contrast, room air emboli are more likely to be fatal. [10]

d. Complications of distention media

Excess absorption of distention media is one of the most frequent complications. Most surgeons use low-viscosity, sodium free fluids for operative hysteroscopy, since fluids that contain electrolytes are incompatible with monopolar electrosurgical instruments. The use of 3% sorbitol, 1.5% glycine, or sorbitol-mannitol solutions can lead to dilutional hyponatremia and hypoosmolality. Although the vast majority of women quickly recover from these conditions, some cases of permanent morbidity and even death have been reported.

The brain swells as it attempts to become isoosmotic with the vascular system. If swelling exceeds 5%, the risk of severe neurological damage dramatically increases.

This is an important problem in premenopausal women, since estrogen and progesterone inhibit sodium-potassium adenosine triphosphatase (ATPase) activity in the brain. This sodium pump protects the brain against cerebral edema, which can cause herniation of the brain stem and death. Although postmenopausal women develop dilutional hyponatremia, they are less likely to suffer brain damage because the sodium pump is intact. [9]

3. Postoperative complications

a. Early and late infection

The rate of infectious complications is 0.3% to 2%.

Endometritis, parametritis, and pyometra are more common following resection of submucous myomas, with rates as high as 2% reported. Infection is more likely after prolonged procedures, especially when the hysteroscope is repeatedly inserted and removed.

b. Risk of endometrial cancer

This malignancy has been diagnosed at the time of endometrial ablation and reported in patients who have undergone prior endometrial ablations or fibroid resections.

Thus, endometrial sampling should be part of the workup of abnormal uterine bleeding before the patient is scheduled for operative hysteroscopy. In women at high risk for endometrial cancer, perform office diagnostic hysteroscopy, with directed biopsy of any suspicious areas.

When viable endometrial glands are "buried" during ablation, or synechiae develop, preventing the egress of blood, there is a chance that diagnosis of endometrial cancer will be delayed.[10,11]

c. Iatrogenic adenomyosis

Two theories suggest this is a late complication of operative hysteroscopy. According to the first, when the endometrium is incompletely resected, scarring over this tissue causes the viable glands to grow into the myometrium. The other theory suggests that viable endometrial debris is transported into the myometrium by vessels opened at resection.

d. Hematometria

This can occur following operative hysteroscopy if viable glands are left in the fundal or cornual region and synechiae develop in the lower segment, preventing egress of blood. It also can occur if the upper endocervix is ablated and subsequently scars, causing stenosis.

e. Post-ablation tubal ligation syndrome

This is cornual hematometria that develops when viable endometrial cells are left in the cornua when the cavity also contains synechiae, causing cyclic bleeding. Since there is no egress from the cervix or tubes, blood gradually builds up, leading to hematosalpinx and pain. One way to avoid this is to ensure complete ablation of the cornual endometrium. [10,11]

The outline of my thesis:

With the continuous rapid development of new diagnostic and therapeutic hysteroscopic procedures physicians must now recognize the risks of complications in daily practice.

In this introduction I tried to summarize all known complications that were classified in a chronological sequence of the procedures.

The above mentioned classification is very convenient from theoretical point of view but it is more practical in clinical practice to evaluate the risks of complications according to the operative difficulty.

In **chapter** 1 it will be discussed about complications according to the type of procedure which is chosen by physician.

Chapter 2 will address to the complications which can occur in patient with relative contraindication for the procedure.

Conclusions will present the results and compare the two approaches discussed in chapter 1 and 2 and followed by **discussion** and possibilities to implicate those approaches in clinical practice.

1. Evaluation and managing complications according to operative difficulty

Numerous data that were presented in the introduction state that operative hysteroscopy is safe and effective operative technique. But as more gynecologists perform an increasing number of procedures, there should be awareness of potential complications and steps should be taken to minimize risk to patients.
Complications cannot be completely prevented, and may occur when a procedure is done correctly by experienced doctors. But they are far more likely if techniques, equipment are used improperly or in hands of inexperienced operator.
Hysteroscopists not just must know the various types of operations but also be familiar with peculiar problems that associated with them.
In this chapter I would like to discuss typical pitfalls that are encountered in specific procedures.
The safety committee of the European Society of Hysteroscopy has issued a classification of the difficulty of hysteroscopy operative procedures.
It's seems reasonable to use such a classification to assess the possible complications.

Table 2: Classification of operative difficulties

1. ***Minor hysteroscopic surgery***
   a. *Endometrial biopsy*
   b. *Small polyps*
   c. *Non-embedded intrauterine contraceptive device*
   d. *Simple adhesion*

2. ***Intermediate hysteroscopic surgery***
   a. *Cannulation of the fallopian tube*
   b. *Sterilization*

3. ***Advanced hysteroscopic surgery***
   a. *Myomectomy*
   b. *Large polyps*

c. *Endometrial resection or ablation*
d. *Resection of uterine septum*
e. *Extensive adhesiolysis*

1. Minor hysteroscopic surgery

The above mentioned examples in this section (biopsy of intrauterine lesions, small polyps, and simple adhesion) represent relatively simple hysteroscopic procedures.

Many clinicians would consider endometrial biopsy with hysteroscopy as it reported to have high sensitivity, specificity (94%, 88.8% respectively). The highest accuracy is in diagnosing endometrial polyps, therefore the most beneficial approach for assessment of abnormal intrauterine bleeding is hysteroscopical biopsy.

Those procedures are associated have shorter duration, smaller extent of resections and do not require as highly professional skills as more complicated procedures. Hence this category of procedures associated with less serious degree of complication and their lower incidence.

Most common complications in this category were related to perioperative: inability to dilate cervix, inadequate operative view.

Another troubling issue that still not elucidated is that reflux of endometrial cells during fluid based hysteroscopy might cause dissemination of malignant cells into peritoneal cavity. [26]

There is not yet prospect randomized study for dissemination of carcinoma by hysteroscopic procedure, so no definite conclusions can be drawn.

2. Intermediate hysteroscopic surgery

a. Cannulation of the fallopian tube

Technological advances have led to major improvements in the design and application of Fallopian tube cannulation devices using the transcervical approach. Presently such cannulation systems are being used to overcome infertility disorders. These transcervical access systems are now able to displace debris that may block the tube, break down intraluminal adhesions or place egg, sperm or embryos in the tube to facilitate conception. Technical success rates for overcoming the obstruction and visualizing distal tubal anatomy range from 76% to 95%. Pregnancy rates after the procedure vary depending on the patient populations studied; however, early results indicate a greater than 50% intrauterine pregnancy rate by 1 year. No significant complication was reported apart of poor tubal visualization .More studies should be done on finding out incidence of complications in this procedure. [27]

b. Sterilization

Currently method of transcervical sterilization was approved by the European Union and received FDA approval in year 2002. In this nonincisional method of sterilization, a metal micro insert is placed under hysteroscopic guidance into the interstitial portion of each fallopian tube. The insert comes loaded in a single-use delivery system and consists of an inner coil of stainless steel and polyethylene terephthalate (PET) fibers and an outer coil of nickel-titanium (nitinol).

Subsequent to placement, the PET fibers stimulate a benign tissue response that elicits the invasion of macrophages, fibroblasts, foreign body giant cells, and plasma cells.

There were no major adverse events reported in the phase II and Privotal trial data obtained from 745 women undergoing placement of Essure between 1998 and 2001, although uterine perforation was noted in 2.8% of the patients. Also a

review of the FDA's Manufacturer and User Facility Device Experience databases had shown 2 reports of devices embedding into abdominal structures and requiring removal after procedures complicated by uterine perforations. More data should be collected on comparison between this method and other available sterilization methods. [21]

3. Advanced hysteroscopic surgery

a. Myomectomy

Hysteroscopic myomectomy currently represents the standard minimally invasive surgical procedure for treating submucous fibroids, with abnormal uterine bleeding and reproductive issues being the most common indications.

Hysteroscopic myomectomy is one of the most advanced operative hysteroscopic procedures as it is associated, particularly for complex cases, with a significantly higher rate of complications than other hysteroscopic procedures [14].

Reported data show a rate of complication ranging from 0.3 to 28%, fluid overload and uterine perforation being the most frequent complications occurring during surgery. Other intraoperative complications include bleeding, cervical trauma and air embolism, while late complications include post-operative intrauterine adhesion (IUA) [15].

Bellow discussed the management of those complications:

Uterine perforation may occur during cervical dilatation, hysteroscope insertion and intramyometrial tissue resection. In particular, the risk of perforation increases in case of fibroids with intramural component whereas an aggressive uterine fibroid resection into the myometrium is carried out [14].

In case of uterine perforation, the procedure should be terminated immediately and, if there is a mechanical perforation in which bowel damage is not suspected, the patient can be observed and discharged if stable. If a perforation occurs secondarily to an activated electrode then it should be assumed that there is a bowel injury until proven otherwise, and laparoscopy must be done without delay [16].

The most dangerous complication during hysteroscopic myomectomy is an ***excessive intravasation of the fluid*** used to distend and irrigate the uterine cavity. Severe fluid overload can cause pulmonary edema, hyponatremia, heart failure, cerebral edema and even death. Fluid absorption occurs through the open veins of the fibroid and possibly through transperitoneal absorption from retrograde flow through the Fallopian tubes. Guidelines indicate that fluid intravasation of 750 ml during surgery requires planned termination of the operation [13] and that the intervention must be immediately stopped when balance exceeds of 1000 ml. The risk factors for intravasation during hysteroscopic myomectomy are not completely elucidated because no studies have tested their independent contribution or relation to fluid loss. **The main factor seems to be the intramural extension of the fibroid** indeed; in cases of fibroids with deep intramural extension intravasation will increase mainly because of damage to larger-sized vessels. Other factors possibly associated with a higher risk of intravasation during myomectomy include the length of the operation, the size of the fibroid and the total inflow volume. [17]

Management of this risk relies on close monitoring of the fluid balance and interruption of the procedure before excessive fluid absorption occurs. The difference between the amount of inflow and outflow fluid could be assessed by operating room personnel or by modern electronic devices. [14]

The incidence of ***post-operative intrauterine adhesions (IUA)*** represents the major long term complication of hysteroscopic myomectomy ranging from 1 to 13%. To minimize the risk of post-operative IUA, it is necessary to avoid forced cervical manipulation, and trauma of healthy endometrium and myometrium surrounding the fibroid; it is also advisable to reduce the usage of electrosurgery especially during the removal of fibroids with extensive intramural involvement and multiple fibroids on opposing endometrial surfaces .An early second-look hysteroscopy after any hysteroscopic surgery is another effective preventive and therapeutic strategy.

Several pharmacologic (conjugated estrogen, levonorgestrel releasing intrauterine device) and barrier agents, including Foley's catheter, hyaluronic acid gel have been used to reduce IUA development [19].

A more extensive discussion on IUA will be on following section.

Uterine rupture may occur in a subsequent pregnancy after surgery invading the myometrium, perforation during entry or during surgery. Therefore when any of the above events occurs, it is important that the surgeon explains to the patient about the risk of uterine rupture in a subsequent pregnancy.

According to some authors the interval between uterine operation infringing on the myometrium and attempts for pregnancy should not be less than one year from the date of uterine surgery. Although some surgeons believe that caesarean section should be preferred whenever you are dealing with fibroids with intramural development, currently there is lack of strong evidence to suggest this mode of delivery to reduce the risk of uterine rupture. [20]

As a conclusion on hysteroscopic myomectomy complications it can be said that ideally, it should result in the complete removal of the fibroid (reducing the chance of recurrence and re-growth) without traumatizing the normal surrounding uterine tissue.

But it is not a case, therefore the resection of fibroids with intramural extension is advisable only for expert surgeons as it is technically difficult and has a higher risk of complications than other hysteroscopic procedures.

b. Large polyps

Endometrial polyps and fibroids are well known to cause irregular vaginal bleeding. Menorrhagia due to symptomatic submucosal fibroids is the most common indication for surgical intervention.

Polyps and submucosal fibroids can be definitively diagnosed with hysteroscopy, and hysteroscopic resection is an effective treatment. The advantages of hysteroscopic resection are numerous and include treating irregular bleeding and obtaining tissue diagnosis.

Resectoscopic polypectomy generally require more operating time, had more glycine absorption and complications, but less recurrence than other hysteroscopic techniques. The resectoscope had a 0% recurrence rate and that grasping forceps had a 15% recurrence rate.

A total of 21 (8.7%) complications occurred, but no major complications were noted. After long-term follow-up of 9 years and 2 months, those with abnormal uterine bleeding resumed normal menstruation in 93.1% and those with infertility had a cumulative pregnancy rate of 42.3%. There is no statistical difference in reproductive outcome between patients having polyps ≤ 2.5 cm and >2.5 cm. [28]

c. Endometrial resection or ablation

The ablation techniques were compared with hysterectomies, proving that it is possible to prevent 90% of these procedures performed in patients with abnormal drug-resistant uterine bleeding. However, these techniques were not always entirely successful, and additional surgical treatments are necessary in some cases. A hysterectomy rate of 15% was reported after a six-year follow-up.

Currently, the hysteroscopically controlled techniques are preferable over the methods without direct vision, both for their efficacy and ability to evidence and treat possible intrauterine lesions.

Several researches showed that failure and complication rates are higher when the size of the uterus exceeds 12 cm, which would be a relative contraindication for the procedure.

The presence of associated conditions, such as intramural and submucous leiomyomas or intracavitary polyps, was not related to failure. [29, 30]

Some case studies report on particular complication called ***post-ablation tubal ligation syndrome.*** This is cornual hematometra that develops when viable endometrial cells are left in the cornua when the cavity also contains synechiae, causing cyclic bleeding. Since there is no egress from the cervix or tubes, blood gradually builds up, leading to hematosalpinx and pain. One way to avoid this is to ensure complete ablation of the cornual endometrium.

As prevention some experts recommend that the small rollerball electrode be placed in the cornua, with slightly reduced intrauterine pressure, to allow the corneal endometrium to collapse around the rollerball. A short burst of current is then applied to ablate the tissue. This complication is less likely after hydro-therm-ablation, since the free-flowing saline ablates the cornua completely.

Pregnancy after endometrial ablation occurs at a rate of 0.2% to 1.6%. Patients should be advised that this procedure does not prevent pregnancy and that contraception is vital. Uterine rupture after fibroid resection has been reported. [10]

d. Resection of uterine septum

Mullerian defects are observed in 3–5% of the general population, but their frequency increases between 5 and 25% in women with recurrent miscarriages, late abortions and preterm deliveries. Uterine septum is the most common congenital anomaly of the female reproductive tract, with an incidence of 2–3% in the general population. Its presence is associated with poor reproductive performance, including high incidence of first and second trimester abortion, preterm delivery (often as a result of premature rupture of the membranes), as well as abnormal presentations and increased Caesarean section rates.

Hysteroscopic metroplasty may lead to patients at risk in subsequent pregnancy, these patients should be considered that they have a history of scarred uterus. Uterine perforation and/or the use of current monopolar section during operative hysteroscopy increase this risk, but are not an independent risk factor.

Uncomplicated hysteroscopic resection of submucous myomas and endometrial polyps do not alter obstetrical outcome.

Uterine rupture following hysteroscopic metroplasty remains a rare event, which may however result in neonatal and maternal death. Considering hysteroscopic metroplasty, the use of rigid scissors should be preferred, while current monopolar section must be avoided. Hysterosalpingogram or ultrasound scan follow-up, long interval between operative hysteroscopy and subsequent pregnancy, and elective caesarean section are not effective to prevent and detect impending ruptures. Fertile patients, in whom hysteroscopic metroplasty and/or uterine perforation

with use of electrosurgery occurred, should be advised of a potentially hazardous uterine rupture during subsequent pregnancies.[31]

e. Extensive adhesiolysis

Adhesions are defined as abnormal fibrous connections joining tissue surfaces in abnormal locations usually due to tissue damage caused by surgical trauma, infection, ischemia, exposure to foreign materials.

Adhesions divided into two types, primary or de novo adhesions (those that are freshly formed, on locations where no adhesions were found before) and secondary or reformed adhesions (those adhesions that undergo adhesiolysis and recur at the same location).

Although many adhesions resulting from hysteroscopic surgery have little or no detrimental effect on patients, a considerable proportion of cases can lead to serious short- and long-term complications, including infertility. [19]

When lysed, adhesions have a tremendous propensity to reform over time with recurrence ranging from days to decades after surgery.

Diamond remarked that adhesion reformation occurs post-operatively in 55–100% of patients, with a mean incidence of 85%. [22]

Any factor leading to a trauma of the endometrium may engender fibrous intrauterine bands at opposing walls of the uterus into conditions varying from minimal, marginal adhesions to complete obliteration of the cavity. The etiology of intrauterine adhesions (IUAs) is multi-factorial, as it recognizes multiple predisposing and causal factors [20] as summarized in **Table 3**.

Table 3: Predisposing and causative factors of intrauterine adhesions

Predisposing factor
Individual predisposition
Gravid uterus
Infections
Retained placenta remnants

Breast-feeding

Causative factors

Forced intrauterine intervention

-post partum or post abortion dilatation and curettage

-operative hysteroscopy

-uterine surgery

Pelvic irradiation

Genital particulate infections (tubercolous endometritis, puerperal and post abortion sepsis

IUAs represent the major long-term complication of operative hysteroscopy. The frequency of post-operative IUA development depends on the pathology initially treated and is particularly high following resectoscopic myomectomy and metroplasty.

However, the actual prevalence of IUA is difficult to determine for a number of reasons including the widely diverging number of therapeutic and illegal abortions in different parts of the world, the high incidence of genital tuberculosis in some countries, the degree of awareness of the physician and the criteria set in defining IUA, and the progressively widespread use of hysteroscopic surgery [5]. Furthermore, it should be considered that some patients with IUA remain asymptomatic, which makes their clinical and epidemiological assessment difficult. IUA may be asymptomatic, but their development may also result in hypomenorrhoea/amenorrhoea, infertility, recurrent spontaneous abortion, irregular periods with dysmenorrhoea and pelvic pain.

Prevention of IUA in hysteroscopic surgery

Surgical technique

As for laparoscopy, the adherence to an appropriate hysteroscopic surgical technique may minimize the risk of post-operative IUA.

General recommendations include avoiding trauma of healthy endometrium and myometrium surrounding the lesions to be removed, reducing the usage of electrosurgery whenever possible especially during the removal of myomas with extensive intramural involvement and avoiding forced cervical manipulation. [23]

Early second-look hysteroscopy

An early second-look hysteroscopy after any hysteroscopy surgery has been advocated as an effective preventive and therapeutic strategy. Indeed, although IUAs are recognized, they are likely to be 'mild' and they can be easily dissected by hysteroscope sheath alone or by microscissors.

However, the relevance of removing 'mild' intracavitary adhesions has not yet been proven. Furthermore, diagnostic hysteroscopy has been demonstrated to be an "unforced intrauterine intervention" with no increased risk of IUA development. [19, 23]

Pre – operative hormonal administration

Pre-operative hormonal endometrial suppression GnRH analogues and danazol are widely administrated before some major hysteroscopic procedures (e.g. transcervical resection of endometrium, myomectomy and metroplasty) to provide technically optimal conditions for the surgery (by suppressing the endometrium and by decreasing vascularity and oedema), as well as to minimize perioperative complications (perforation, fluid overload and bleeding). The role of endometrial suppression before resectoscopic surgery on the frequency of post-operative IUA has been questioned. Recent research demonstrated in the only randomized study available in the English language that the frequency of post-operative IUA was dependent on the pathology initially treated with no difference between placebo- and danazol-treated (200 mg twice/day) groups.

However, the small sample size does not allow for a definite conclusion to be drawn. Data pertaining to the role of pre-operative GnRH analogues on the development and/or re-development of IUA after hysteroscopic surgery were not found in the English language [24].

Post-operative hormonal treatment

The post-operative administration of conjugated oestrogen (dose: 1.25–5 mg daily) for 30–60 consecutive days and progestin therapy in a cyclic regimen seem to stimulate the endometrium so that the scarred surfaces are re-epitheliazed. However, the efficacy of this method needs to be validated by large randomized studies. The insertion of a levonorgestrel-releasing intrauterine device (IUD) might represent another promising tool to prevent IUA adhesions, but studies addressing this issue are still missing.[23]

Barrier methods

The maintenance of the freshly separated uterine cavity after any uterine forced intervention is an essential prerequisite for prevention of subsequent adhesion formation, whereas rapid endometrial re-growth might be enhanced by oestrogen and progestogens cyclic administration. Few studies evaluating the efficacy of barrier methods for the prevention of IUA after hysteroscopic surgery are available at present.

Auto-cross-linked HA gel.

In the beginning of this decade there was described the introduction of APC gel into the uterine cavity at the end of the hysteroscopic surgery through the out-flow channel of the resectoscope, whereas the surgeon progressively limits the entering of the distension medium through the in-flow channel. The procedure is considered complete when, under hysteroscopic view, the gel seems to have replaced the entire liquid medium and the cavity appears completely filled by the gel from tubal osthia to internal uterine orifice. Its high viscosity and adhesiveness make it easier to introduce the gel into the uterine cavity and ultrasound scans have confirmed that ACP gel remains in situ for at least 72 h.

It was demonstrated that the intrauterine application of ACP gel following hysteroscopic adhesiolysis significantly reduces the reformation of postoperative

IUA. Furthermore, ACP gel was associated with a significant reduction of the severity of IUA. In a further it was showed that ACP also significantly reduces the incidence and severity of de novo formation of IUA after resectoscopic removal of myomas, polyps and septa. [25]

The real effect of the prevention of IUA on long-term reproductive outcome is not clear but will emerge from ongoing works.

The discussion ends with the general complications to all hysteroscopical procedures:

- *Complications associated with distending media*
- *Gaseous Embolization*
- *Bleeding*

- ***Complications associated with distending media***

The uterus must be distended in order to provide a cavity with visible operative field. The intrauterine pressure created by distension must be high enough to prevent clouding of the distending media by bleeding from the endometrium and myometrium. Ideally only enough intrauterine pressure would be used to equal the vascular pressure. If the intrauterine pressure is less, blood will obscure good visualization. Therefore, the intrauterine pressure must always be equal to and generally above the intravascular pressure. Since some open vessels are always encountered, this means that there will always be some intravasation of distending media into the vascular system. [3]

There are several factors which must be taken into account when discussing intravasation of distending media. They are:

Intrauterine pressure - The single most important factor that the surgeon has control over is the pressure used to distend the uterine cavity. Higher pressures do not provide for better visualization and usually increase intravasation by increasing the rate of flow from the uterine cavity into the vascular system.

A partial perforation of the uterus or tear in the lower uterine segment during dilation may also be an unexpected source of intravasation. While the surgeon has

little control over the number or size of these open vascular channels, those procedures where intravasation is potentially high can and should be anticipated.

Overdilatation of the cervix is an equally common mistake that results in excessive leakage of distending media and inability to maintain distention. [7]

When Hyskon is chosen as distending medium, overdilatation is less common problem. [10]

Length of procedure - Since some intravasation will occur in every hysteroscopic case, the amount is dependent not only upon the amount of pressure used to drive distending media into the vascular system and the number and size of vascular channels open, but also the length of the procedure. [7]

- ***Gaseous Embolization***

When carbon dioxide is used as a distending media intravasation will occur for all the same reasons as when a liquid media is used. Because of the body's ability to rapidly exhale intravasated carbon dioxide, this is not a problem unless excessive flow rates are used. Using laparoscopic insufflator instead of hysteroscopic insufflator is another possible mistake.

The diagnosis is made by presence of a cog-wheel murmur accompanied by a rapid fall in expired air. In 70 women that were observed during carbon dioxide hysteroscopy, 10% present with cog-wheel murmur that disappeared after hysteroscopy was stoped. Investigators concluded that carbon dioxide clearance is very efficient owning high solubility in blood. [13]

Reduce the risk of air embolism by avoiding the Trendelenburg position and leaving the last dilator in the cervix until just before inserting the resectoscope.

Also limit repetitive removal and reinsertion of the resectoscope, as often occurs during myoma resection. By vaporizing rather than resecting myomas, it is possible to eliminate the need to continually remove fibroid chips. Preoperative GnRH agonists narrow venous sinuses and help prevent this complication.

Intracervical injection of dilute vasopressin prior to dilatation of the cervix creates vascular spasm and may help prevent gas from entering the circulation. [10]

- ***Bleeding***

Serious bleeding is seldom a problem during hysteroscopic surgery since when the uterus contracts, the vascular supply is essentially occluded similarly to what occurs in the post partum uterus. Avoidance of cutting deep into the myometrium especially in the lateral lower segment where the large branches of the uterine artery reside will prevent the occurrence of this problem. When excessive bleeding does occur, the use of a diluted pitressin solution or very rarely a uterine balloon can be used. [7]

2. Identifying patients at risk of complications in hysteroscopic operations

As more obstetricians/gynecologists perform hysteroscopy, they must remain aware about the patients at risk.

Apart from contraindications of hysteroscopic surgery, there is little information analyzed and published on how patient risk factors affect incidence of complications of hysteroscopic procedure. This data could provide useful information as for a gynecologist and as for individual patient.

Here I present data from a study that was focusing on this issue.

According to information that was abstracted from medical records (including age, gravidity, parity, weight, uterine surgery) patients characteristics and medical histories were used to present an odd ratios of hysteroscopical complications in **Table 4**. [32]

Table 4: Odds of operative complications by selected patient characteristics

Variable	Odd ratio
Age 35-50 [1]	0.6
Age 50 [1]	0.2
Premenopausal [2]	2.8
Preoperative GnRH therapy	6.6
1-2 live birth [3]	1.2
Weight >200lbs	0.4
History of cesarean delivery	0.3
Previous myomectomy	0.8
Cervical stenosis	1.5

[1] *Relative to those < 35*

[2] *Relative to postmenopausal women*

[3] *Relative to null parity*

As the results show – the most significant factor that increases risk of complications is pretreatment with GnRH agonist. However the higher risk may be attributed to more complex procedures where GnRH agonist was used. 55% of

women that were pretreated underwent myomectomies and 26% endometrial ablations. [32]

Premenopausal age also increases risk of complications, probably due higher blood supply and endometrial function. Other patients characteristics change incidence of complications but not significant. In a future other patient characteristics that affect complication incidence should be thought.

Meticulous detail should be paid to fluid management, and consultation sought with a critical care specialist when fluid overload or hyponatremia is suspected. Especially if hypotonic media in patients with hyponatremia, use of glycine in patients with liver disease, and use of sorbitol in patients with severe diabetes patients.

Women becoming pregnant after operative hysteroscopic procedures need careful antepartum and intrapartum care. Special attention to unusual pain complaints during pregnancy or with fetal distress in labor need prompt intervention.

CONCLUSION AND DISCUSSION

As it was said in previous chapters, it is impossible totally avoid complications. But there is a way to prevent great numbers of them by minimizing their number and manage those that cannot be prevented.

A chapter 1 has shown that type of hysteroscopic procedure is a strong predictor of complications. But not less important contributor are individual patient characteristics that were presented in Chapter 2.

In most of the studies incidence of complications is not accurate since it is based on the type of procedure only, without taking into considerations the increase of incidence in patients with relative contraindications.
My proposition is to combine both risk evaluation (type of procedure and patients with relative contraindication) into one computerized data base that will be able to merge and calculate incidence based on chosen procedure and relative risk factor. This will give the possibility to asses in each level- (individual surgeon/ department/ country), more accurately that is done before and by that - to control and prevent complications. Another future emphasis will probably be on a multimodality therapy, including the use of pharmacologic adjuvant in conjunction with a operative instruments tailored to the specific operative procedure and a precise surgical technique.

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