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MINIMALLY INVASIVE GYNECOLOGICAL SURGERY:

ADVANCES AND NEW APPLICATIONS

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CHAPTER I: HISTORICAL BACKGROUND

1.1 Endoscopy

Endoscopy is a word of Greek origin and literally means *to observe within* or *to look inside*. Even Though many are still led to believe that the meaning of endoscopy is simply that of a technology or instrumentation, a more precise definition would firmly place endoscopy as a new kind of philosophy, one which is deeply rooted in what is now referred to as *minimally invasive surgery*. If we look at the history of its development, which has been carefully traced back over centuries, it would be unfair to credit any one individual with the pioneering of this technique.

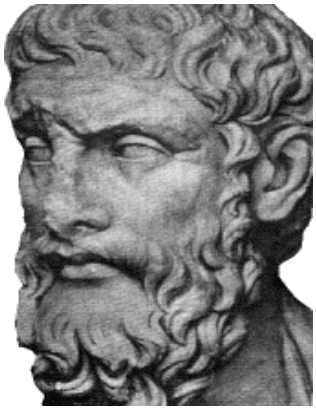


Fig. 1

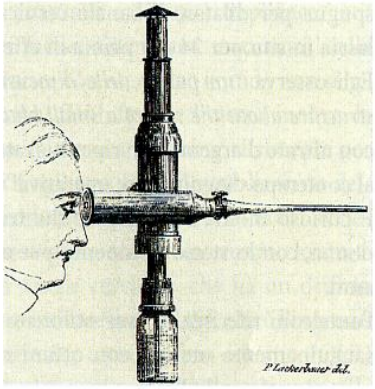
The earliest references attributing to endoscopy date back to the ancient times of Hippocrates (Fig. 1), where in his accounts there is a description of a rectum examination with a speculum. A lot of the Hippocratic Corpus can be interpreted as favouring this minimalist approach, which can be observed even in the modern version of the Hippocratic edict in Latin: *Primum non nocere* (First, do no harm).

The main problem in designing open tubes to explore or retract tissues allowing the examiner to observe these structures was the difficulty of reflecting light onto organs located deep within the body.

Aranzi was the first to employ a light source for an endoscopic procedure in the year 1585 by directing sunlight through a flask of water and then projecting the light into the nasal cavity.

in 1804, Philip Bozzini (Fig.2) managed to build a device that could actually be introduced into the human body permitting the observation of externally accessible body cavities such as the mouth, nose, ears, vagina, cervix and uterus, urethra and urinary bladder, and rectum. He called this instrument the "LICHTLEITER".

Fig. 2



While in 1853 the Frenchman Antoine Jean Desormeaux (Fig. 3) developed an instrument capable of examining the urinary tract and the bladder and he named it the “endoscope.” This was the first time this term was ever used in medical history.

Fig. 3

The intuitions Bozzini had put forward were only verified 60 years after his death. In fact, it was only in 1869, when Commander DC Pantaleoni of Ireland not only diagnosed an endometrial polyp with the aid of the Desormeaux endoscope (which is a modified cystoscope lit by reflected candlelight), but even cauterized it by hysteroscopic view. Questionably, he was the first to combine these two main functions which characterise modern endoscopy: diagnosis and treatment.

Maximilian Nitze (1848-1906) created the first electrical light bulb as the light source. Again this was only used for urologic procedures. In 1883, Newman of Glasgow described using a miniaturized version of the incandescent bulb in a cystoscope.

In 1902 the first laparoscopic procedure was carried out on a dog by German surgeon Georg Kelling (Fig. 4), of Dresden, Saxony, utilizing a cystoscope to peer into the abdomen of a dog after having previously insufflating it with air.

Fig. 4

Then Hans Christian Jacobaeus (fig. 5) of Sweden reported the first laparoscopic procedure in humans in 1910, publishing a discussion of the inspection of the peritoneal, pleural and pericardial cavity.

Fig. 5

1.2 Hysteroscopy

Fig. 6

Philip Bozzini made an instrument that could be introduced into the human body for the observation of internal organs and called it the "LICHTLEITER" (Fig. 6) which basically consisted of a covering within which a candle was placed. Then on one side he attached open aluminium tubes in assorted sizes and configurations that would facilitate their introduction into the various externally accessible body cavities such as the vagina, cervix and uterus, urethra and urinary bladder. While on the opposite side of the covering an eyepiece was fitted. Making Bozzini one of the first inventors to insert reflecting, strategically inclined mirrors (flat, concave and convex) between the visual tract and the candlelight in a way that the light would be reflected just toward the organ and not back into the examiner's eye.

Even though Bozzini did published a short article describing his new instrument in 1804 in a Frankfurt newspaper, it was only in 1805 that he declared in through another newspaper that he had created a device that made the inspection of the inner cavities of the human body now possible. Bozzini's medical colleagues were extremely unreceptive towards his endoscopic endeavours and scorned his publications and lectures. But later on he did received his first positive response, when he recommended that the first prospective study of the instrument be carried out in military hospitals in 1807. Gynaecologists as well as ear, nose, and throat specialists obviously expressed great interest. Nevertheless he still got harsh criticism from the influential Dr. Stifft, who held a prominent position at the time at the medical academy in Vienna.

The opposition Bozzini got from his colleagues was such that he was asked to take the state examination on the grounds that he came from another city. When he did take it in 1803, he somehow failed it on his first attempt. Although afterwards he passed a repeat examination, thanks to his exceptional performance as a military doctor and after some important political pressure from the Austrian government, which now gained him permission to practice medicine. Without a doubt, and despite the actual limitations of his invention, he is still considered to be one of the first to illuminate and examine deeply located body organs.

Though it is very important to point out that Bozzini did in fact realize the significance of the operative potential of the endoscope and his designs justly established the *Lichleiter* as one of the most significant forerunners to modern operative endoscopy. He expressed his hopes in the following passage:

"*Surgery will gain not only from the new operations that could not easily be performed until now, but also all other uncertain operations, which depended on mere luck and chance, will now be relieved of uncertainty by the influence of sight…But extirpation of carcinoma of the uterus, many of the unfortunate women who otherwise could not escape certain death will be returned to the enjoyment of life and health. Deformations of the uterine orifice, the vagina, polyps and ulcers of the same, and of the rectum and the bladder stone can be operated by sight*" – Bozzini, 1805

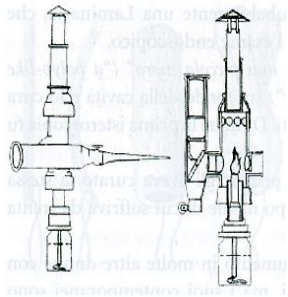


Fig. 7

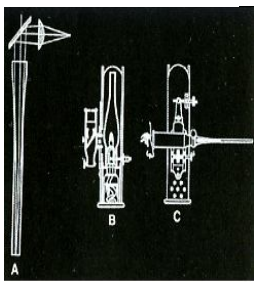


Fig. 8

The Frenchman Antoine Jean Desormeaux developed an instrument to examine the urinary tract and the bladder in 1853 and called it the "endoscope" (Fig. 7) which was the first time this term was ever used.

Then some improvements to this endoscope were made 12 years later by a Dubliner named Cruise, he replaced the alcohol and turpentine with petroleum and some dissolved camphor and also added a small glass vent to contain the vapours (Fig. 8).

The hunch Bozzini had was eventually demonstrated 60 years after his death in 1869 by the Irishman Commander DC Pantaleoni who had actually learned from Cruise how to work the endoscope, and performed the first hysteroscopy, on a 60-year-old woman with abnormal uterine bleeding, with the aid of the Desormeaux endoscope (an adapted cystoscope which was lit by reflected candlelight). Not only did he diagnosed an endometrial polyp, but even cauterized it with silver nitrate by hysteroscopic view. He later attempted to use the same endoscope to observe the nasal passages and to treat some polyps in a analogous way 3 years later. Making him probably the first to combine the two main functions of the modern endoscopy: diagnosis and treatment.

After Pantaleoni's first known hysteroscopic diagnosis and treatment many other physicians followed suit; even though the development and applications of hysteroscopy were slowed down by ever inadequate light transmission, internal bleeding within uterus, and the inability to distend the organ properly slowed. Needless to say that in the following years, hysteroscopy remained more of a curiosity kind of intervention rather than a useful clinical technique.

The clinical importance of hysteroscopy took over 100 years to become completely apparent, mainly due to the developments in optic systems and distension media, which eventually made it possible to obtain satisfactory visualization of the uterine cavity.

Undeniably many ingenious modifications to the earlier versions of endoscopes were introduced to overcome awkward uterine bleeding while maintaining sufficient uterine distension for panoramic viewing. Heineberg in 1914 and Seymour in 1926 independently introduced the in-flow and out-flow channels for uterine irrigation. Heineberg used a endoscope with an internal channel for illumination and included a system of irrigation with low-viscosity fluids to wash away any blood and to permit uterine distension. Soon this method was to be the foundation of continuous-flow hysteroscopy and the basis for all such methods that were to be introduced later on.

In 1925, Rubin reported on his acquired experience and the excellent results he obtained by using CO2 to distend the uterine cavity in hysteroscopies. Though the use of this gas remained uncommon nevertheless as most physicians, especially the German ones, preferred working with low viscosity fluids.

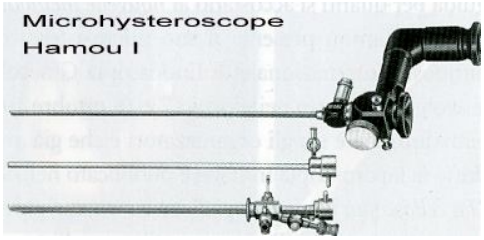


Fig. 9

Fig. 10

Jacques Hamou revolutionized the field of hysteroscopy during the late 70s and early 80s with a new and very refined instrument (Fig. 9). Initially, as a youth in Paris, Hamou was primarily interested in mathematics and physics before taking the decision to dedicate his entire life to medicine. Soon he became very concerned in the emerging hysteroscopic technique, so he went to USA to learn all he could about it.

Eventually, when he came back to Paris, he built a innovative device that had a total diameter of no more than 5 mm (Fig. 10) .

This new instrument presented improved visual optics, using a 4-mm rod lens system scope that would then be inserted into a diagnostic sheath as to precisely guide the distension medium into the uterine cavity.

The “Hamou I microcolpohysteroscope”, as it was called, offered a new combination of hysteroscopy and microscopy and even permitted for multiple magnifications (X1, X20, X60, and X150) for cellular exploration and it even presented new diagnostic opportunities by combining the data offered by hysteroscopy, colposcopy, and cytology

Then throughout the 1980s, no significant technological improvements were reported in the field of hysteroscopy, which continued to be invariably performed using the so called “traditional

technique”. Where speculum and tenaculum (Fig. 11-12) were used to visualize and grasp the cervix and CO_2 was the most commonly used distension medium, though very often cervical dilatation and local or general anaesthesia along with hospitalization were required due to the wide diameter of the hysteroscopes.

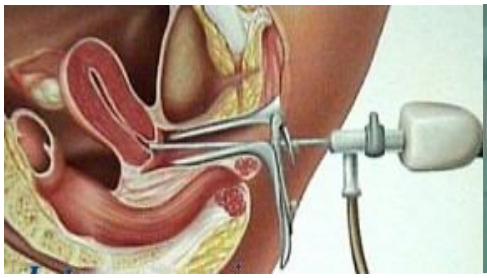


Fig. 11

Fig. 12

On the other hand, in the early 1990s there were several important developments in the technical and instrumental areas that did make hysteroscopy less invasive and painful, increasing its widespread use by reducing the number of hysteroscopies performed in operating theatres and increasing those performed in an outpatient setting.

Such developments included:

- the introduction of an atraumatic technique for the insertion of the scope into the uterus without the aid of speculum or tenaculum (the so called "*vaginoscopic approach*" or "*no touch technique*"- Fig. 13).
- the miniaturization of the optics which reduced the overall diameter of the hysteroscopes (Fig. 14).
- the widespread use of saline as a distension medium (Fig. 15).

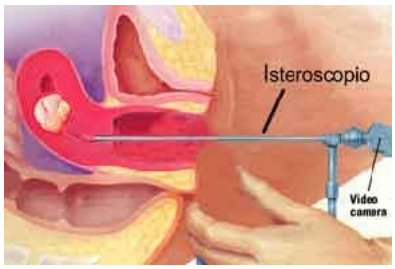


Fig. 13

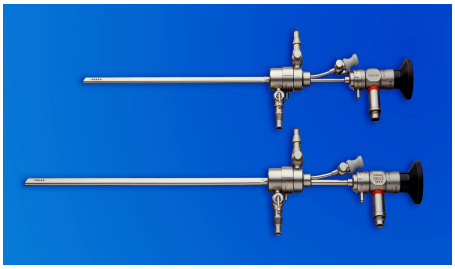


Fig. 14

Fig. 15

Several studies have confirmed that outpatient hysteroscopy does show a good correlation of results when compared to inpatient hysteroscopy; the distinct advantages presented are the reduced anaesthesiologic risks, enhanced time-cost effectiveness as well as it being preferred by the patient. Nowadays outpatient hysteroscopy represents the gold-standard when assessing of the uterine cavity.

During the 90s, a new kind of philosophy came underway: the so called “see & treat” hysteroscopy, or office operative hysteroscopy, which minimised yet again the distinction between a diagnostic and an operative procedure, introducing the concept of a single procedure in which the operative part is perfectly integrated into the diagnostic work-up.

The most distinct technical innovation contributing to the development and widespread diffusion of this new philosophy was the development of hysteroscopes of ever small-diameter that had continuous flow features and operative sheaths through which mechanical instruments (Fig. 16) could easily be introduced.

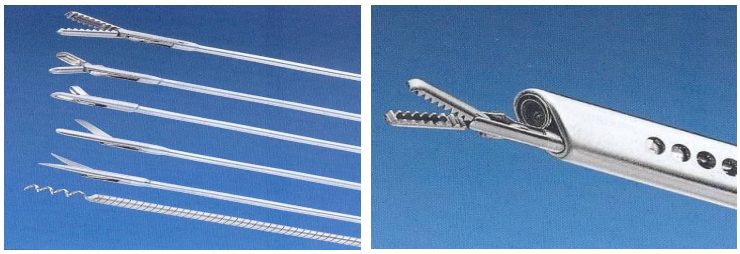


Fig. 16

The option of visual examination of the uterine cavity and contextual operative facilities has finally given endoscopists the perfect “diagnostic” means they needed: they could now examine the cavity and take biopsy or treat benign intrauterine pathologies without any premedication or anaesthesia in a relatively short time.

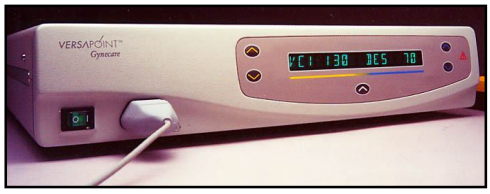


Fig. 17

Finally in 1997, a medical revolution took place with the introduction of a versatile electrosurgical bipolar system dedicated to hysteroscopy called Versapoint, by Gynecare and Ethicon, which symbolizes a key point in the history of office operative hysteroscopy (Fig. 17). Since 5 Fr bipolar electrodes (Fig. 18) began to be used the amount of pathologies treated by office operative hysteroscopy has increased immensely, therefore reserving the use of resectoscopes and operating theatres to a very limited number of cases.

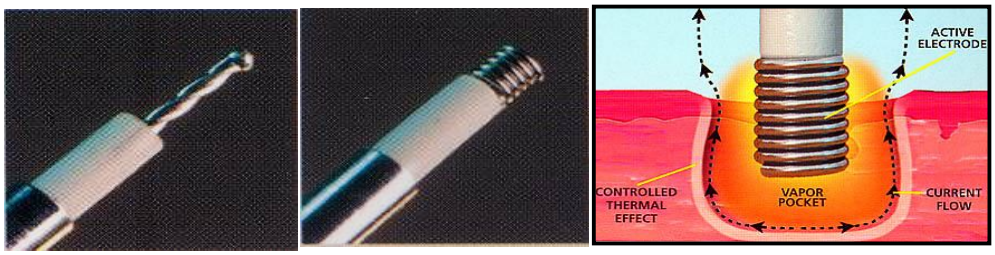


Fig. 18

Simplified instrumentation and an ever safer and easier admission of energy sources is the aim of the future. The operative procedures carried out in office settings will increase as the simplified technology will guarantee ever more safety and accuracy and expedites performance. In turn, this trend will boost the use of diagnostic and operative hysteroscopy. What is now the present was a distant future at the beginning of hysteroscopy, and the future will soon be the present as we continue to build on the foundations that our predecessors have laid for us.

1.3 Laparoscopy

On 23 September 1901, at the 73rd meeting of the Society of German Natural Scientists and Physicians in Hamburg, following his lecture “On the inspection of the gullet and the stomach with flexible instruments”, the surgeon and gastroenterologist Georg Kelling from Dresden performed a laparoscopy on a dog. He called this procedure *koelioskopie*. While experimenting with pneumoperitoneum, using air as to prevent intra-abdominal bleeding (what he called the "Luft-tamponade" or "air-tamponade" technique), he also introduced a cystoscope into the abdomen to observe the effects of increased pressure on abdominal organs. Kelling’s ingenious idea to connect his oral insufflation device with the Fiedler trocar and the Nitze cystocope, led to the coelioscopy in 1901 and marked the hour of birth of laparoscopy.

Fig. 19

In 1910 the Swedish surgeon, Dr. Hans Christian Jacobaeus, published the first description of *laparothorakoskopie* in humans beings He used air pneumoperitoneum and a cystoscope to analyse the peritoneal cavity of tuberculosis patients with ascites. Not long afterwards Dr. Bertram M. Bernheim, of the Johns Hopkins Hospital, reported a list of the first human

laparoscopies performed in the United States, which he called *organoscopy*. The instrument used was a proctoscope, a half inch in diameter with ordinary light used for illumination.

At the beginning of the 20th century diagnostic laparoscopy had a substantial complication rate and was used by a very restricted number of general surgeons instead of diagnostic laparotomy.

Supporters of this procedure continued to develop ever improved laparoscopic equipment during the 1920s and 1930s. In 1918, O. Goetze, developed an automatic pneumoperitoneum needle characterized by its very safe introduction the peritoneal cavity. In 1920, Zollikofer of Switzerland discovered the benefit of CO2 as an insufflation gas, rather than filtered atmospheric air or nitrogen.

Fig. 20

In 1929, Kalk (Fi. 20), a German physician, introduced the forward oblique (135° angle) view lens systems.

In 1934, John C. Ruddock, an American surgeon used an instrument for diagnostic laparoscopy which consisted of a built-in forceps with electro coagulation facility, describing laparoscopy as a good diagnostic method being superior to laparotomy.

In 1938, Dr. Janos Veress (Fig. 21), a Hungarian internist, developed a spring-loaded needle which consisted of an outer cannula with a beveled needle tip for cutting through tissues, within the cannula of the Veress needle is an inner stylet, and the stylet is loaded with a spring that springs forward in reaction to any sudden decrease in pressure encountered upon crossing the abdominal wall while entering the peritoneal cavity.

Fig. 21

Interestingly enough, Veress did not encourage the use of his Veress needle for laparoscopy procedures. He used the Veress needle mostly for the induction of pneumothorax. The Veress needle continues to be used to this today to create a pneumoperitoneum (Fig. 22).

Fig. 22

In 1944 Raoul Palmer of Paris performed gynaecological examinations using laparoscopy while placing the patients in the Trendelenberg position, so that air could fill the pelvis. Furthermore he always stressed the importance of continuous intra-abdominal pressure monitoring during a laparoscopic procedure.

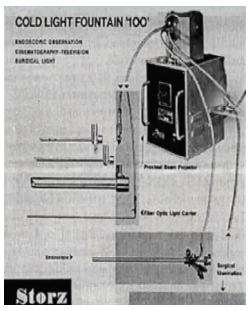


Fig. 23.

One major step forward regarding the development of laparoscopy was the development of a safer laparoscopic lighting system in the 1950s. Up until then, intra-abdominal light was supplied by a small electric light bulb at the distal tip of the laparoscope analogous to a bronchoscope. Karl Storz discovered that it was possible to transmit light from a light source outside the body via a light cable through an endoscope to the examination site The use of a quartz

light rod in transmitting light from an external source to the tip of the laparoscope increased brightness and decreased the risk of intra-abdominal burns. This discovery marked the birth of "cold light endoscopy" (fig. 23) . This was soon followed by the application of fiber-optic technology which is still used in modern laparoscope procedures.

Fig. 24 Old lens based optic

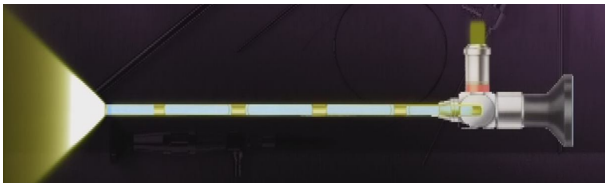


Fig. 25 Modern lens based optic (Hopkins system)

Another fundamental step was the development of the rigid rod lens system discovered by Professor John Hopkins from Baltimore, USA, in 1953. He introduced a great innovation by modifying the shape and length of the lens inside the instruments: from small lens with spherical shape (Fig 24) to longer and cylindrical ones (Fig. 25) This resulted in an inverted ratio between air and lens in favor of lens which provided lower optical aberrations, greater brightness and higher definition. All the modern rigid endoscopes are based on Hopkins rod-lens system. Moreover, the credit for videoscopic surgery goes to this surgeon who revolutionized the concept by making this instrument.

A French gynaecologist named Dr. Raoul Palmer, who specialized in infertility, was an early pioneer in the development of laparoscopy in the mid 20th century. In addition to advocating the monitoring of intra-abdominal pressure, he expanded the therapeutic use of laparoscopy for such tasks as intra-abdominal electrocoagulation of bleeding sites, puncture of ovarian cysts, and lysis of pelvic adhesions. In 1961, he described the first laparoscopic retrieval of oocytes, and then in 1974 he described the point of intervention which is 3 cm below the last rib on the left

mid-clavicular line. To this day Palmer's point is often used for left upper quadrant laparoscopic entry (Fig. 26).

Fig. 26

Dr. Kurt Semm, a German gynecologist specialized in infertility, was perhaps the most influential early promoter of modern operative laparoscopy. In 1960, he invented the automatic insufflator. In 1966 he published the experiences he had with this new device which was capable of monitoring intra-abdominal pressures. Although not acknowledged in his homeland, across the Atlantic, American physicians and instrument makers alike appreciated Semm's insufflator for its simple application, clinical value, and safety. As it reduced the dangers previously associated with insufflation of the abdomen and allowed for safer laparoscopies.

In the 1960s and 1970s, Dr. Semm invented hundreds of laparoscopic instruments (Fig 27), including a thermocoagulator, a loop ligature, and various devices for extracorporeal and intracorporeal endoscopic knot tying.

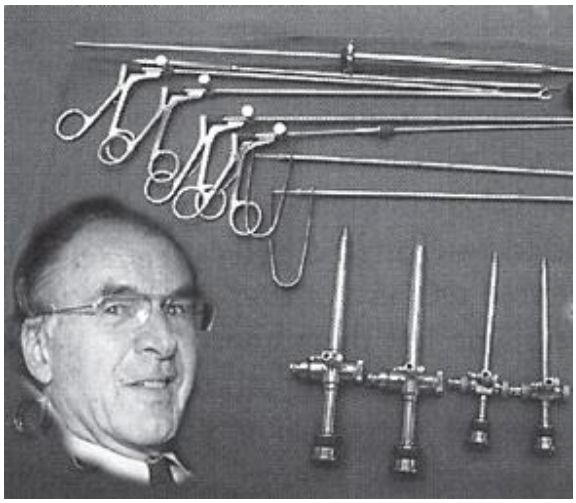


Fig. 27

He was one of the first to push for video monitoring during laparoscopy, using a series of lenses and mirrors on an articulated arm to connect the laparoscope to a ceiling-mounted video camera.

He performed the first laparoscopic appendectomy in 1981. After following his lecture on laparoscopic appendectomy, the president of the German Surgical Society wrote to the Board of Directors of the German Gynaecological Society suggesting suspension of Semm from medical practice. Subsequently, Semm submitted a paper on laparoscopic appendectomy to the *American Journal of Obstetrics and Gynaecology*, which was first rejected considered unacceptable for publication on the grounds that the technique reported on it was 'unethical,' but finally he managed to get it published in the journal *Endoscopy*. Semm went on to establish several standard procedures that were regularly performed, such as ovarian cyst enucleation, myomectomy, ectopic pregnancy treatment and finally laparoscopic-assisted vaginal hysterectomy (nowadays termed as cervical intra-fascial Semm hysterectomy).

In addition he developed laparoscopic techniques for ovarian cystectomy, myomectomy, ectopic pregnancy treatment, appendectomy and hysterectomy.

Despite the work of Dr. Semm and other remarkable pioneers, gynaecologic laparoscopy continued to be used primarily for diagnosis and tubal ligations well into the 1980s.

A major breakthrough came about with the introduction of the solid state video camera for laparoscopy (Fig. 28-29) . With the widespread application of these compact cameras, both laparoscopist and assistants could simultaneously view the operative field on a video screen.

Fig. 28: Laparoscopic surgeon before introcuction of endocamera

Fig. 29 : One of the first cameras used for video-laparoscopic surgery

Many have described the advent of operative *video-laparoscopy* as a change to surgery as "revolutionary to this century as the development of anesthesia was to the last century." Some of the most sensational moments in endoscopy's history came with the debuts of the world's first television and color film broadcasts by French pioneers; Palmer's 1955 color film debut of the first live laparoscopy. By 1960, Inui, Berci, and others had either invented or collaborated with industry to bring miniaturized video endo-cameras into endoscopy. However, all of these systems were definitely not designed with advanced operative video laparoscopy in mind. Even as late as 1977, Berci revisited the role of TV and video devices – referred to as "teaching attachments" – as technologies to enhance teaching only. The conceptual idea of combining these technologies and using them in an entirely different way had been entirely overlooked until Nezhat's contribution. To achieve this, Nezhat rigged together video cameras intended for other uses and

began operating off the monitor in the late 1970s (Fig. 29), which then allowed him to perform advanced procedures never before done by the laparoscope. For the first time, laparoscopic treatment of extensive endometriosis involving extragenital organs was shown to be possible when Nezhat presented his work at the Annual Meeting of the American Fertility Society in 1985. A year later, his early clinical results on the subject were published in the *Journal of Fertility & Sterility* under the title of "Surgical treatment of endometriosis via laser laparoscopy."

Fig. 30: Camran Nezhat doing videolaparoscopy in early 1980.

By the end of the decade, video-laparoscopy had become standard and operative laparoscopy became widely accepted as a safe and effective surgical approach.

Then in 1989, Harry Reich described the first laparoscopic hysterectomy using bipolar desiccation and later on he demonstrated the use of staples and finally sutures for laparoscopic hysterectomy.

Today, laparoscopy is one of the most common surgical procedures performed by gynaecologists. But over the last 35 years, gynaecologic laparoscopy has evolved from a limited surgical procedure used only for diagnosis and tubal ligations to a major surgical tool that is used to treat a multitude of gynaecologic indications.

Laparoscopy has become the treatment of choice for many procedures, such as removal of an ectopic pregnancy, treatment of endometriosis, or ovarian cystectomy. When compared to laparotomy, multiple studies have shown laparoscopy to be safer, to be less expensive, and to have a shorter recovery time.

Despite the advantages of laparoscopy to other procedures, including the staging and treatment of gynaecologic cancers, which continue to be elucidated, along with new indications which are continuously proposed.

In recent years the two innovations that have been introduced or reintroduced to the field of laparoscopy are: robotic surgery and single incision laparoscopic surgery. Both of which have their advantages and disadvantages compared to traditional laparoscopy.

The first FDA-approved robotic surgical device called AESOP (Automatic Endoscopic System for Optimal Positioning, Computer Motion, Inc, Santa Barbara, Calif.) was introduced back in 1994. This system allowed the surgeon to control the orientation of the laparoscope through vocal commands.

The *da Vinci Robotic Surgical System* (Intuitive Surgical, Sunnyvale, Calif.) (Fig. 31) and *Zeus Robotic Surgical System* (Computer Motion, Inc, Santa Barbara, Calif.) were later introduced, allowing the surgeon to operate from a remote station by means of hand controls, providing ever improved dexterity while minimizing fatigue, tremors, or incidental hand movement. These two companies merged later on in 2003.

Fig. 31

Robotic equipment can be attached to traditional laparoscopic ports and the robotic system is placed between the patient's legs for a hysterectomy. The surgeon controls the instruments from a console located within the same room.

Compared to a traditional laparoscopy, the robotic system has the advantage of making it easier for surgeons to acquire the new skills necessary to operate safely and effectively with this system. Another advantage is direct correlation between hand movements and instrument movements, that is a contrast to traditional laparoscopy, where hand movements are translated into grasping or cutting movements in different flat planes, and drastic movements of the laparoscopic instrument handles result in mirror image movements of the instrument tips. As a result, surgeons can become proficient in robotic surgery in a matter of months and it appears that robotic technology is allowing for the more widespread application of laparoscopy for complicated gynaecologic procedures. Moreover this technology provides the possibility to perform laparoscopic surgery by means of multi-armed robots remotely controlled by real surgeons located hundreds or thousands of kilometres away (Robotic Telesurgery). A recent review describes a feasible

concept to extend telemedicine beyond the Earth's orbit, with even a possible foundation of an extra-planetary human outpost either on the Moon or on Mars and now space agencies are carefully looking for effective and affordable solutions for life-support and medical care

Single incision laparoscopic surgery (SILS) refers to performing laparoscopy through a single incision. While the laparoscopic approach decreases surgical morbidity and has some well established advantages in laparoscopic surgery over open surgery, it still requires however three to four incisions with punctures. The multiple puncture sites increase the cost of trocars and trocar-associated complications, such as bleeding, hernias, internal organ damage and wound infection with the goal of improving morbidity and cosmesis, continued efforts towards the refinement of laparoscopic techniques leading to minimize the number of ports required for these procedures (Fig. 32).

Single site laparoscopic surgery has the primary advantage of limiting port incisions and surgical scars to one site hidden within the umbilicus, rendering the surgery virtually "scarless". This approach is a promising surgical innovation that results not only in improved cosmesis but it also reduces the convalescence period, the postoperative analgesia requirements as well as trocar-associated complications

Single-port access surgery may be the next generation of minimally invasive surgery

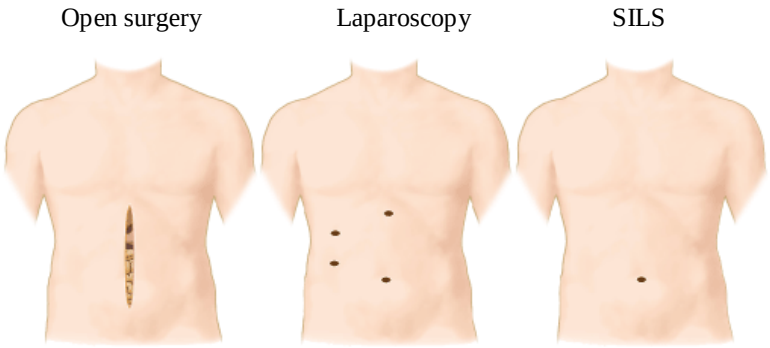


Fig. 32

Single-port transumbilical laparoscopy, also known as embryonic natural orifice transumbilical endoscopic surgery (E-NOTES), has emerged in the attempt to further enhance cosmetic benefits and reduce morbidity associated with minimally invasive surgery.

The first reported E-NOTES procedures were performed for tubal sterilization in 1969 by Clifford Wheeless. Through a curved infraumbilical incision of 1-cm, he managed to established pneumoperitoneum and then inserted a laparoscope with an offset eyepiece. The uterus itself was manipulated externally with a tenaculum inserted through the vagina, bringing the fallopian tubes into view. A biopsy forceps was used to grasp and cauterize each fallopian tube.

In 1991, Pelosi et al. performed a single port laparoscopic total hysterectomy with bilateral salpingo-oophorectomy, the first complex extirpative procedure of its kind using the single-puncture technique. The following year a supracervical hysterectomy, for benign uterine disease, was performed on four patients, with the application of the term minilaparoscopy. A laparoscope was used with an offset eyepiece and a 5-mm working channel through which standard laparoscopic instruments were inserted, very similar to the technique used for tubal sterilization, and where the uterus was manipulated with a transvaginal cannula.

The quest to make minimally invasive surgery ever more `minimal' is pushing the surgical community to constantly explore novel ways of achieving better results. Simplified instrumentation and an ever safer and easier admission of energy sources is the aim of the future.

In the hysteroscopic field, this trend will produce a low complication rate of inpatient operative hysteroscopies and an increase of operative procedures carried out in office settings as the simplified technology will guarantee ever more safety and accuracy and expedites performance.

In the laparoscopic field, this has given surgeons the challenge to either decrease the number of trocars placed throughout the abdominal wall or eliminate them completely. The transition from multiple port access surgery to single port access surgery represents a paradigm shift in reconstructive and extirpative surgery and is a testament to the recent advances in surgical technology.

What is now the present was a distant future at the beginning of hysteroscopy, and the future will soon be the present as we continue to build on the foundations that our predecessors have laid for us.

CHAPTER II: A NEW DIAGNOSTIC ROLE OF HYSTEROSCOPY

Improvements in office hysteroscopy, both in technology and technique, such as the use of saline solution as distension medium , the availability of high-resolution mini-endoscopes, and the atraumatic insertion of the instruments (***Guida M, Di Spiezio Sardo A, Acunzo G, Sparice S, Bramante S, Piccoli R, Bifulco G, Cirillo D, Pellicano M, Nappi C. Vaginoscopic versus traditional office hysteroscopy: a randomized controlled study. Hum Reprod. 2006 Dec;21(12):3253-7..),*** have led to recommend it as a first-line diagnostic tool in any situation in which a cervical anomaly or benign and malign intrauterine disease ***(Bramante S, Guida M, Sparice S, Lavitola G, Pellicano M, Acunzo G, Cirillo P, Nappi C. Hysteroscopy in the diagnosis of endometrial carcinoma. Tumori. 2003 Jul-Aug;89(4 Suppl):237-*** **8; *Guida M, Bramante S, Acunzo G, Lavitola G, Sparice S, Cerrota G, Nappi C.Evaluation of endometrial carcinoma using hysteroscopy and transvaginal echography. Tumori. 2003 Jul-Aug;89(4 Suppl):253-4..)*** is suspected or has to be ruled out.

Outpatient hysteroscopy in fact is associated with minimal patient discomfort, excellent visualization, and very low complication and failure rates

Office hysteroscopy can be considered to be a valid diagnostic and eventually therapeutic instrument also for numerous less common pathologies such as: stromomyoma, hydatidiform mole endouterine cysts, vaginal polyps (Fig. 1), vaginal septa (Fig. 2) (***Di Spiezio Sardo A, Bettocchi S, Bramante S, Guida M, Bifulco G, Nappi C. Office vaginoscopic treatment of an isolated longitudinal vaginal septum: a case report. J Minim Invasive Gynecol. 2007 Jul-Aug;14(4):512-5.),*** vaginal endometriosis (Fig. 3) and chronic pelvic pain. Some pathological

conditions causing chronic pelvic pain that can be hard to diagnose by, or that may not be diagnosed by, noninvasive techniques (Transvaginal ultrasound or MRI) or even by laparoscopy (i.e., chronic endometritis, intrauterine pathologies, Mullerian anomalies, superficial adenomyosis) may be identified by hysteroscopy.

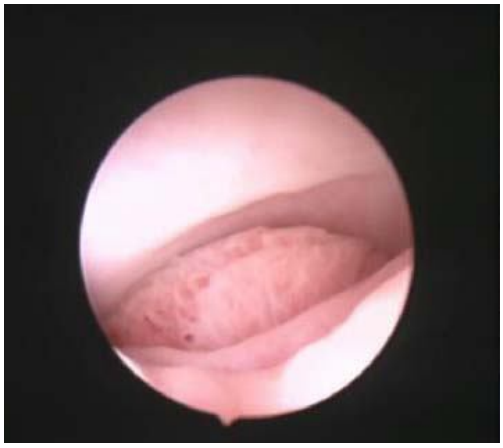


Fig. 1

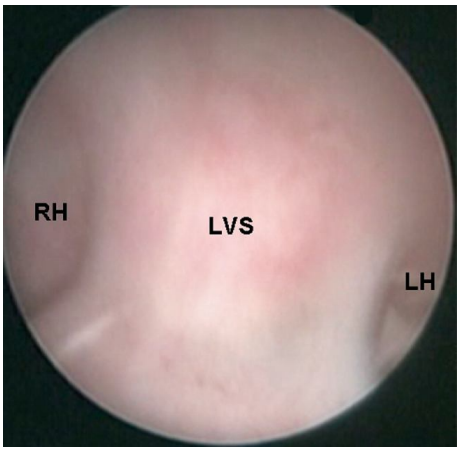


Fig. 2; RH right hemivagina, LH: left hemivagina, LVS: longitudinal vaginal septum

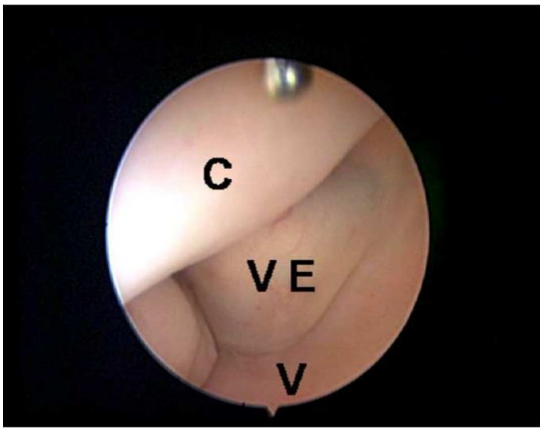


Fig. 3: C cervix, VE vaginal endometriosis, V vagina

2.1 “Tubal ostia’s sunshine”: an hysteroscopic sign of salpingitis

Recently we observed a peculiar hysteroscopic vascular pattern, to which we refer as “tubal ostium sunshine” , that seems to have a role in the hysteroscopic evaluation of the fallopian tubes status.

Currently, hysterosalpingography and laparoscopy are the gold standard in assessment and management of fallopian tube occlusion. However, several authors have investigated the role of hysteroscopy in assessing the status of the fallopian tubes.

We report the cases of 13 infertile women in which a strong diagnostic suspicion of salpingitis was posed because we found this peculiar hysteroscopic vascular pattern to which we refer as “tubal ostium sunshine” (Fig. 1) .

Fig. 1: A right tubal ostia; B left tubal ostia

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Abstract: Several authors have investigated the role of hysteroscopy in assessing the status of the fallopian tubes.
We report on a peculiar hysteroscopic vascular pattern (tubal ostium sunshine) which is likely to be associated with salpingitis.

"TUBAL OSTIA SUNSHINE": AN HYSTEROSCOPIC SIGN OF SALPINGITIS

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Fallopian tube abnormalities, including tubal occlusion, hydrosalpinx, peritubal adhesion and salpingitis isthmica nodosa, are major causes of female infertility, accounting for 30%–40% of all cases. A tube may be obstructed as a result of an inflammation or a previous surgery. Most commonly fallopian tube occlusion is due to an infection such as pelvic inflammatory disease (PID) typically caused by a sexually transmitted agent, including Chlamydia trachomatis and Neisseria gonorrhoeae. Occlusion may occur at any site along the course of the tube. When the blockage involves the ampullary portion, the tube may dilate, thus forming a hydrosalpinx.

Currently, hysterosalpingography and laparoscopy are the gold standard in assessment and management of fallopian tube occlusion. However, several new techniques have been recently introduced.

Several authors have investigated the role of hysteroscopy in assessing the status of the fallopian tubes. A recent study found the measurement of the fluid spilled over in the peritoneal cavity following hysteroscopy to be a valid tool to confirm the patency of at least one tube with minimal pain (1) Other studies have explored the value of hysteroscopic visual assessment of the uterotubal ostium (2) as well as the effectiveness of hysteroscopic approach for fallopian tissue sampling in establishing an etiologic diagnosis of salpingitis (3).

We report the case of a 33-year-old woman scheduled for IVF due to severe oligoasthenospermia. A diagnostic hysteroscopy was required as part of the infertility work-up to evaluate the uterine cavity status prior to commencing IVF.

Office hysteroscopy was carried out via vaginoscopic approach, using a 5 mm continuous-flow office hysteroscope (Bettocchi Office Hysteroscopes, Karl Storz, Tuttlingen, Germany), with a 30° grade optic and an incorporated 5 Fr working channel. The distension of the uterine cavity was obtained using normal saline solution and intrauterine pressure was automatically controlled by an electronic irrigation-and-suction device (Endomat, Karl Storz, Tuttlingen, Germany).

An hyperaemic area patterned by radial arrangement of the vessels around the uterotubal ostia, as well as a sunshine sign were detected **(Figure 1)**. These findings were suggestive of bilateral salpingitis. Hysterosalpingography was requested in order to confirm the diagnosis as well as to assess tubal patency. Hysterosalpingography showed bilateral tubal dilatation with signs of salpingitis and absence of intraperitoneal spillage of contrast medium **(Figure 2).**

Such peculiar hysteroscopic vascular pattern observed in the index case, to which we refer as *"tubal ostium sunshine"* was found in other 13 women undergoing hysteroscopy and in which a strong diagnostic suspicion of salpingitis was posed. The sign was bilateral in 7 cases and unilateral in 6. Hysterosalpingography was advocated in order to confirm diagnosis in all cases. In 6 out of 7 patients with bilateral "tubal ostium sunshine" hysterosalpingography showed unilateral (n=1) or bilateral (n=5) signs of salpingitis with tubal occlusion associated with hydrosalpinx in 4 of these cases.

In 5 out of 6 patients with unilateral hysteroscopic sign of salpingitis, hysterosalpingography confirmed the diagnosis of salpingitis with unilateral tubal occlusion associated with hydrosalpinx in 4 out of these 5 cases.

The present report suggests that a thorough hysteroscopic inspection of the utero-tubal ostia, possibly combined with fallopian tissue sampling, may be crucial for the correct diagnostic work-up of infertile patients prior to IVF. It is indeed well known that tubal disease, and particularly hydrosalpinx, has a detrimental effect on the outcome of IVF and that surgical treatment should be considered in all women with such a diagnosis prior to IVF treatment (4).

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Legend for figures

Figure 1: Hysteroscopic view of right (A) and left (B) tubal ostium: both of them are surrounded by an hyperaemic area patterned by radial arrangement of the vessels *("Tubal ostia sunshine")*

Figure 2: Hysterosalpingography showing bilateral tubal dilatation with signs of salpingitis and absence of intraperitoneal spillage of contrast medium

Figure 1

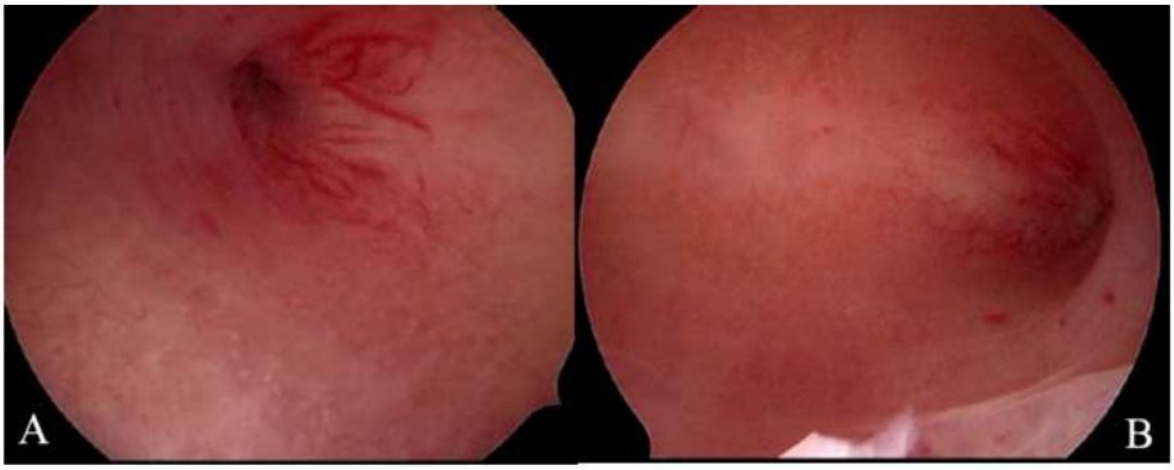

Figure 2

CHAPTER III: NEW INDICATIONS FOR ENDOSCOPIC SURGERY

Thanks to technological advancement and increased operator experience, some pelvic, uterine (***Di Spiezio Sardo A, Mazzon I, Bramante S, Bettocchi S, Bifulco G, Guida M, Nappi C. Hysteroscopic myomectomy: a comprehensive review of surgical techniques. Hum Reprod Update. 2008;14:101-19.)*** and vaginal pathologies ***(Di Spiezio Sardo A, Bettocchi S, Bramante S, Guida M, Bifulco G, Nappi C. Office vaginoscopic treatment of an isolated longitudinal vaginal septum: a case report. J Minim Invasive Gynecol. 2007;14:512-5.),*** previously treated only by conventional surgery, may be today cared by minimally invasive approach with significant advantages for patient and with potentially significant cost savings.

In1985, for the first time, laparoscopic treatment of extensive endometriosis involving extragenital organs was shown to be possible when Nezhat presented his work at the Annual Meeting of the American Fertility Society. After demonstrating the safety and feasibility of performing these complicated surgeries laparoscopically, Nezhat predicted that if such a complicated and extensive disease as endometriosis could be treated laparoscopically, then almost all other pathologies could be managed in that way, too, as long as a cavity existed or could be created in the body.

Despite the advantages of laparoscopy to other procedures, including the staging and treatment of gynaecologic cancers, which continue to be elucidated, along with new indications which are continuously proposed.

We evaluated endoscopic treatments of uterine submucous fibroids, pelvic organ prolapse and bowel and urinary endometriosis.

3.1 Hysteroscopic myomectomy: a comprehensive review of surgical techniques.

The development of endoscopy has made these fibroids accessible and resectable from the inner surface of uterus (Fig. 1) but hysterectomy and laparotomic excision have long been considered the two standard routes of surgical treatment for symptomatic submucous fibroids.In particular, hysterectomy has been routinely proposed to those patients in whom the desire to procreate had been satisfied, while the abdominal myomectomy has represented the only possible solution in young patients desiring a pregnancy. However, the conservative approach requires the opening of the uterine cavity, which may be one of the factors responsible for altering the likelihood of subsequent conception. Furthermore, such an approach may compromise any future parturition as it requires caesarean section; in addition, it may lead to the development of pelvic post-operative adhesions which may further reduce rather than enhance fertility. During the last 20 years, thanks to advances in instruments and the refining of techniques, hysteroscopic myomectomy has acquired the status of 'surgical technique' and, at present it represents the standard minimally invasive surgical procedure for treating fibroids entirely or mostly located within the uterine cavity.

We performed a review that provide a comprehensive survey of all techniques used to treat fibroids completely within the uterine cavity as well as those with intramural development. Finally, the effects on menstrual pattern and infertility and the operative and long- term complications have been reviewed.

Fig. 1

Human Reproduction Update, Vol.14, No.2 pp. 101–119, 2008 doi:10.1093/humupd/dmm041

Hysteroscopic myomectomy: a comprehensive review of surgical techniques

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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. While hysteroscopic myomectomy has been shown to be safe and effective in the control of menstrual disorders, its effects on infertility remain unclear. The review provides a comprehensive survey of all hysteroscopic techniques used to treat fibroids found completely within the uterine cavity (G0) and those with intramural development (G1 and G2). MEDLINE and EMBASE searches identified published papers from 1970. The choice of the technique mostly depends on the intramural extension of the fibroid, as well as on personal experience and available equipment. 'Resectoscopic slicing' still represents the 'gold standard' technique for treating fibroids G0, even if several other effective techniques including ablation by neodymium-yttrium-aluminum-garnet laser, morcellation and office myomectomy have been proposed. On the other hand, the present review clearly indicates that there is still no single technique proven to be unequivocally superior for treating fibroids G1 and G2. Most techniques aim at the transformation of an intramural fibroid into a totally intracavitary lesion, thus avoiding a deep cut into the myometrium. At present, the 'cold loop' technique seems to represent the best option as it allows a safe and complete removal of such fibroids in just one surgical procedure, while respecting the surrounding healthy myometrium.

Keywords: hysteroscopic myomectomy; fibroids; menstrual disorders; infertility; complications.

Introduction

Uterine fibroids (also known as myomas or leiomyomas) are the most common benign solid tumours found in the female genital tract. They occur in ~20–25% of women of reproductive age (Fernandez *et al.*, 2001; Valle and Baggish, 2007) causing 3–5% of gynaecology consultations (Vidal, 1998).

Uterine leiomyomas arise from the muscular part of the uterus. As they grow, they usually migrate to a place of lower resistance: towards the abdominal cavity, thus becoming subserous masses or following the path of the intrauterine cavity thus becoming submucous fibroids (5–10% of uterine fibroids) (Ubaldi *et al.*, 1995).

Localization of uterine fibroids seems to be an important factor in determining frequency and severity of symptomatology. Indeed, submucous fibroids may induce severe clinical symptoms such as excessive bleeding, usually during menses, colicky dysmenorrhoea (as the uterus tries, by means of contractions, to expel fibroids), and are thought to predispose patients to reproductive failure (Fernandez *et al.*, 2001; Litta *et al.*, 2003; Takeda *et al.*, 2004; Indman, 2006; Sutton, 2006; Valle and Buggish, 2007). Furthermore, submucous fibroids are associated with chronic endometritis, they may have a greater risk for malignant change (Valle and Buggish, 2007) and are source of pre-term delivery, abnormal presentation, post-partum haemorrhage and puerperal infections (Bernard *et al.*, 2000).

Most submucous fibroids occur at the corporeal sites of the uterine cavity. Some are fundal, others are anteriorly, posteriorly or laterally situated. Small fibroids may also arise from the cornual regions, thus interfering with the utero–tubal junction lumen. A few are located at the cervical canal (Valle and Buggish, 2007).

Hysterectomy and laparotomic excision have long been considered the two standard routes of surgical treatment for symptomatic submucous fibroids (Garcia and Tureck, 1984; Smith and Uhlir, 1990; Verkauf, 1992, Sudik *et al.*, 1996; Glasser, 1997; Haney, 2000; Munoz *et al.*, 2003; Campo *et al.*, 2005).

In particular, hysterectomy has been routinely proposed to those patients in whom the desire to procreate had been satisfied, while the abdominal myomectomy has represented the only possible solution in young patients desiring a pregnancy.

However, the conservative approach requires the opening of the uterine cavity, which may be one of the factors responsible for altering the likelihood of subsequent conception (Berkeley *et al.*, 1983). Furthermore, such an approach may compromise any future parturition as it requires caesarean section; in addition, it may lead to the development of pelvic post-operative adhesions which may further reduce rather than enhance fertility (Buttram and Reiter, 1981; Starks, 1988; Ubaldi *et al.*, 1995).

The development of hysteroscopic techniques

The development of endoscopy has made these fibroids accessible and resectable from the inner surface of uterus (Walker and Stewart, 2005; Bradley, 2005).

At the beginnings of endoscopic surgery, the lesions were removed by somewhat rugged methods (e.g. ovum forceps were used to twist pedunculated fibroids off their pedicles and scissors were inserted outside the hysteroscopic sheath to cut the fibroid pedicle).

The first reported hysteroscopy myomectomy was performed in 1976, when Neuwirth and Amin resected a fibroid using an urologic resectoscope, monopolar current and 32% dextran 70 as distension medium.

In 1987, Hallez (1995) reported on the development of a gynaecologic resectoscope, changing the urologic instrument into a continuous-flow device with a 0° optic; cutting current was used but with 1.5% glycine as the distension medium.

During the last 20 years, thanks to advances in instruments and the refining of techniques, hysteroscopic myomectomy has acquired the status of 'surgical technique' and, at present it represents the standard minimally invasive surgical procedure for treating fibroids entirely or mostly located within the uterine cavity (Vercellini *et al.*, 1999; Takeda *et al.*, 2004).

Indications for hysteroscopic myomectomy

Abnormal uterine bleeding (AUB) represents the most common indication for hysteroscopic myomectomy in most publications reviewed with a percentage ranging from 60 to 84.1% (Neuwirth and Amin, 1976; Brooks *et al.*, 1989; Derman *et al.*, 1991; Indmann, 1993; Wamsteker *et al.*, 1993; Donnez *et al.*, 1994; Wortman and Dagget, 1995; Hallez, 1995; Phillips *et al.*, 1995; Glasser, 1997; Emanuel *et al.*, 1999; Hart *et al.*, 1999; Vercellini *et al.*, 1999; Munoz *et al.*, 2003; Loffer, 2005; Campo *et al.*, 2005; Marziani *et al.*, 2005; Polena *et al.*, 2007). Indeed, submucous fibroids have been advocated more than subserous and intramural ones as a cause of AUB, presumably due to distortion of the cavity and to an increase in the bleeding surface of the endometrium (Maher, 2003).

Although most women affected with fibroids are fertile, available evidence suggests that fibroids may interfere with fertility, with submucousal fibroids being reported to exert the most detrimental effects on pregnancy rates (Pritts, 2001; Donnez and Jadoul, 2002; Benecke *et al.*, 2005; Somigliana *et al.*, 2007).

Even though this association is not supported by a clear biological rationale, several hypotheses have been suggested to explain how submucous fibroids may cause infertility or repeated abortions. However, at present, none of these hypotheses is definitive (Somigliana *et al.*, 2007).

Fibroids might interfere with sperm migration, ovum transport or embryo implantation; these effects might be mediated by alteration of uterine cavity contour causing mechanical pressure or by the occurrence of abnormal uterine contractility (Buttram and Reiter, 1981; Richards *et al.*, 1998; Bettocchi *et al.*, 2002; Farrugia *et al.*, 2002; Oliveira *et al.*, 2004). Fibroids may also be associated with implantation failure or gestation termination due to focal endometrial vascular disturbances, endometrial inflammation, secretion of vasoactive substances or an enhanced endometrial androgen environment (Buttram and Reiter, 1981; Cicinelli *et al.*, 1995; Richards *et al.*, 1998; Ng and Ho, 2002).

Reproductive problems represent the second leading indication for intervention, though the lack of randomized studies does not allow any definitive conclusion to be drawn regarding the improvement of spontaneous fertility after hysteroscopic myomectomy (Donnez and Jadoul, 2002; Somigliana *et al.*, 2007; Stamatellos and Bontis, 2007).

Less frequent reported indications include dysmenorrhea (Hallez, 1995), aspecific pelvic pain (Munoz *et al.*, 2003) and asymptomatic submucous fibroid in a woman candidate to start hormone replacement therapy (Hallez, 1995).

With the present review, we offer gynaecologists with special interest in endoscopy information regarding the instrumentation required to perform hysteroscopic myomectomy and the diagnostic tools and medications commonly used for an appropriate presurgical evaluation. Furthermore, it provides a comprehensive survey of all techniques used to treat fibroids completely within the uterine cavity as well as those with intramural development. Finally, the effects on menstrual pattern and infertility and the operative and long- term complications have been reviewed.

Materials and Methods

This review includes medical papers published in the English language on hysteroscopic myomectomy since 1970 and identified through a MEDLINE and EMBASE search using combinations of medical subject heading terms: hysteroscopy, myomectomy, pharmacological agents, gynaecological surgery, surgical technique, fibroid, fibroid, loop, laparoscopy and resectoscope. All pertinent articles were retrieved and reports were then selected through systematic review of all references. In addition, books and monographs of different languages on hysteroscopy and gynaecological surgery were consulted.

Pre-surgical evaluation of submucous fibroids

As hysteroscopic myomectomy may be sometimes a highly complex procedure, its real feasibility must be thoroughly evaluated preoperatively in order to minimize the incidence of incomplete resection and the complications that might occur during procedure.

The most widespread investigative techniques for pre-surgical evaluation are office hysteroscopy, transvaginal ultrasound scanning (TVS) and sonohysterography (SHG) (Fedele *et al.*, 1991; Fukuda *et al.*, 1993; Dodson, 1994; Cicinelli *et al.*, 1995; Corson, 1995; Tulandi, 1996; Laifer-Narin, 1999; Perez-Medina

et al., 2000; Cheng and Lin, 2002; Clark *et al.*, 2002; Leone *et al.*, 2003, 2007; Trew, 2004; Lasmar *et al.*, 2005; Murakami *et al.*, 2005; Salim *et al.*, 2005; Vilos and Abu-Rafea, 2005; Sutton, 2006; Alborzi *et al.*, 2007).

Besides giving us the certainty of the presence of the submucous fibroid, office hysteroscopy also enables the assessment of the intracavity component of the mass, its localization, its relationship with the uterine structures, the characteristics of the endometrium as well as the presence of possible associated intracavitary pathologies. Furthermore, it provides subjective assessment of fibroid size and indirect information regarding the depth of myometrial extension (Fedele *et al.*, 1991; Corson, 1995; Emanuel and Wamsteker, 1997; Emanuel *et al.*, 1997, 1999; Wieser *et al.*, 2001; Clark *et al.*, 2002; Murakami *et al.*, 2005; Lasmar *et al.*, 2005; Sutton, 2006).

However, even if a protruding dome of fibroid is identified at outpatient hysteroscopy, there is the possibility that it could sink into the myometrium ('sinking fibroid') during a hysteroresectoscopic procedure because of an increase in intrauterine pressure caused by the distension medium (Lin *et al.*, 2000; Murakami *et al.*, 2005).

TVS is not as useful as hysteroscopy in assessing the degree of intracavitary development of the fibroid. However, it is irreplaceable in the preoperative assessment as it provides two elements which would be otherwise unobtainable: the 'myometrial free margin' (thickness of the outer myometrial layer of the fibroid) as well as the presence of any other possibly associated pathology. For a submucous fibroid to be approached hysteroscopically, the 'myometrial free margin' should be at least 1 cm thick or in more expert hands at least a few millimetres thick. Scanning evidence of other associated pathologies (multiple fibroid, adnexial pathologies) may indicate the need for a different surgical approach. Furthermore, ultrasound scanning allows to evaluate the real size of the nodule (Lasmar *et al.*, 2005; Murakami *et al.*, 2005; Sutton, 2006).

SHG has been demonstrated to be superior to TVS in terms of diagnostic accuracy; furthermore, it allows to identify the exact location of the fibroid as well as the portion protruding into the cavity (Fukuda *et al.*, 1993: Cicinelli *et al.*, 1995; Farquhar *et al.*, 2003; Leone *et al.*, 2003, 2007; Salim *et al.*, 2005; Botsis *et al.*, 2006; Alborzi *et al.*, 2007). Although many authors report that SHG could reduce the number of diagnostic hysteroscopies for pre-surgical evaluation (Turner *et al.*, 1995; Bronz *et al.*, 1997; Saidi *et al.*, 1997; Williams and Marshburn, 1998; Bonnamy *et al.*, 2002; Leone *et al.*, 2003, 2007), this technique is limited by the inability or difficulty in obtaining tissue diagnosis (Botsis *et al.*, 2006).

In case of a large uterus, with multiple fibroids, or if ultrasound scanning is technically difficult (i.e. obese patients), magnetic resonance imaging (MRI) can provide valuable information, being also helpful in differentiating between fibroids and adenomyosis (Hricak *et al.*, 1986; Takeda *et al.*, 2004; Lasmar *et al.*, 2005; Murakami *et al.*, 2005; Indman, 2006). Costs have prohibited its general use in clinical practice (Valle and Buggish, 2007).

Recently, Takeda *et al.* (2004) have proposed the use of 'virtual hysteroscopy' for preoperative evaluation of submucosal fibroids. Virtual endoscopy is a non-invasive technology used to display the image of the cavity inside the organ by processing the images acquired by a multislice helical computed tomography (CT) scanner using 3D computer graphics (3DCG) software as if one is observing the organ by real endoscopy.

Hysteroscopic classification of submucous fibroids

As the intramural extension of submucous fibroids may considerably vary, thus influencing the chance of achieving complete resection, a classification of different types of submucous fibroids was shown to be indispensable since the beginning of resectoscopic surgery for weighting the limits of surgical technique.

The classification developed by Wamsteker *et al.* (1993) and adopted by the European Society for Gynaecological Endoscopy (ESGE), which considers only the degree of myometrial penetration of the submucous fibroid, is currently worldwide used. According to this classification, a fibroid G0 is completely within the uterine cavity and appears only jointed to the cavity wall by a thin pedicle; a fibroid G1 has its larger part (>50%) in the uterine cavity; and a fibroid G2 has its larger part (>50%) in the myometrium (Wamsteker *et al.*, 1993; Salim *et al.*, 2005).

Lasmar *et al.* (2005) recently proposed a new preoperative classification of submucous fibroids which considers not only the degree of penetration of the fibroid into the myometrium, but also other parameters including the extension of the base of fibroid with respect to the wall of the uterus, the size of the nodule (cm) and the topography of the uterine cavity. A score ranging from 0 to 2 is given for each parameter and the patients are then allocated into one of the three groups of the classification on the basis of the total score (Table I). The authors found a higher correlation of this new scoring system with completeness of the myomectomy, time spent in surgery and fluid deficit, than scoring only based on the percentage of myometrial penetration (Lasmar *et al.*, 2005).

Preoperative hormonal treatment

Whether treatment with GnRH agonist before myomectomy offers any significant advantage is still a matter of debate (Lethaby *et al.*, 2001, 2002). However, a recent review by Gutmann and Corson (2005) reports that 'the most clinically relevant indication for preoperative GnRH agonist use appears to be in patients with submucous fibroids'.

Table I: Lasmar's pre-surgical classification of submucous myomas

Points	Penetration	Size, cm	Base[a]	Third	Lateral wall (+1)	
0	0	≤2	≤1/3	Lower		
1	≤50%	>2–5	>1/3 to 2/3	Middle		
2	>50%	>5	>2/3	Upper		
Score	+	+	+	+		=

[a]It refers to the extension of the base of the nodule with respect to the uterine wall on which the myoma is located. Score 0–4 (Group I): low complexity hysteroscopic myomectomy. Score 5–6 (Group II): complex hysteroscopic myomectomy, consider preparing with GnRH analogue and/or two stage surgery. Score 7–9 (Group III): recommend an alternative non-hysteroscopic technique.

Benefits claimed include the following:

(i) resolution of preoperative anaemia: these drugs create a state of amenorrhea, thus enabling patients suffering from menorrhagia to build up their blood counts and reducing the need for transfusion (Donnez *et al.*, 1989, 1992, 1993; Isaacson, 2003)
(ii) reduction of endometrial thickness as well as the size and vascularization of fibroids (Donnez *et al.*, 1989, 1992, 1993; Mencaglia and Tantini, 1993). This results in an improved operator's visibility by limiting blood loss; furthermore, it leads to a reduced fluid absorption (through a reduction of uterine blood flow) (Parazzini *et al.*, 1998) and a reduced length and difficulty of surgery.
(iii) possibility of surgical scheduling. Indeed, as patients do not necessarily need to be operated in the early proliferative phase, preoperative treatment also has a practical benefit in that it allows surgery to be performed at any time (Parazzini *et al.*, 1998)

Universally accepted guidelines on the indications and duration of pretreatment with GnRH agonist (administered either as a long-acting monthly intramuscular injection or with daily dosing) are lacking in the international literature.

Hallez (1995, 1996) does not recommend any preoperative treatment; Hart *et al.* (1999) does not believe analogue use to be a risk factor for submucous fibroid reintervention; Donnez *et al.* (1995) claims that fibroids up to 2 cm do not require any preparation, those ranging from 2 to 4 cm have to be treated for 3 weeks with a progestogen or danazol, while GnRH agonist should be reserved only for those fibroids >4 cm. Other authors consider a large size as a contraindication for GnRH agonist therapy as severe haemorrhage after the administration of these drugs has been described (Indman, 1993).

We agree with those authors who consider these drugs particularly indicated for those fibroids with a diameter of >3 cm and/or with intramural portion as well as for patients suffering from secondary anaemia (Romer, 1998; Tulandi and al-Took, 1999; Romer *et al.*, 2000; Valle and Buggish, 2007). A 6–8 weeks administration of GnRH agonist preoperatively is sufficient to shrink the fibroid by 30–50% (Donnez *et al.*, 1992; Perino *et al.*, 1993; Mencaglia and Tantini, 1993), for patients presenting with anaemia and a large submucous fibroid, such therapy can be prolonged up to 2–4 months to correct anaemia (in combination with iron supplement therapy) as well as to shrink the intrauterine lesion (Stamatellos and Bontis, 2007).

Evidence supporting the use of these drugs before hysteroscopic myomectomy only comes out from a few small [$n = 20$, Donnez *et al.* (1989); $n = 25$, Mencaglia and Tantini (1993); $n = 58$, Perino *et al.* (1993)] prospective studies. In the only one randomized study, Perino *et al.* (1993) have compared the post-operative outcomes following resectoscopic myomectomy for submucous fibroids <3 cm, showing a decreased volume of distension fluid, surgical time and bleeding in those patients ($n = 33$) preoperatively treated with GnRH agonist in comparison with controls ($n = 25$).

Conversely, it is well known that the preoperative treatment with these drugs is associated with some disadvantages including: (i) high costs; (ii) side effects (i.e. hot flushes, spotting); (iii) increased recurrence rate (these drugs may render small fibroids less visible) (Fedele *et al.*, 1990) and (iv) increased risk of uterine perforation (due to a reduced myometrial thickness) (Bradley, 2002) and an increased risk of the 'sinking' phenomenon (due to a decreased elasticity of myometrial tissue caused by estrogen deficiency) (Lin *et al.*, 2000).

Furthermore, a recent retrospective study by Campo *et al.* (2005) suggests that preoperative treatment with GnRH agonist does not seem to offer any advantage in terms of short- and long-term outcomes. In particular, those patients treated with GnRH agonist had significantly longer surgical times, compared with untreated patients, which has been ascribed by the authors to an increased cervical resistance to dilatation. However, such data needs to be confirmed by larger randomized studies.

Instrumentation

The operating hysteroscope (resectoscope) is the instrument that allows the performance of a submucous myomectomy under direct and constant visual control. It includes a straight-forward telescope (0°) or a slightly fore-oblique 12–30-° telescope with an outer diameter of 3–4 mm; an internal and an external sheaths of 24–27 Fr outer diameter (Table II) that provide a constant inflow and outflow of distension fluid for generating a continuous and efficient lavage system of the uterine cavity.

The operating hysteroscope contains a working element wherein electrosurgical (thermal loops and vaporizing electrodes) (Fig. 1) and mechanical instruments (cold loops) (Fig. 2) for the traditional resectoscopic surgery or laser fibres or a new Intra Uterine Morcellator (IUM) (Fig. 3) device can be attached.

The application of resectoscopic surgery has been made possible by using the electric current. The electrosurgical system can be monopolar or bipolar: in the monopolar one, from the extremity of the resectoscope (active electrode) the flow of current, in order to close the circuit, must reach the plate (passive electrode). The use of monopolar electrodes requires non-conducting distending solution (sorbitol 5% or glycine 1.5%). The use of a bipolar set of instruments, in which both electrodes are introduced into the thermal loop, would be much safer. In this way the current will only have to pass through the tissue with which the thermal loop comes into contact, thus minimizing the danger deriving from the random passage through the corporeal structures. An intrauterine bipolar diathermy allows the use of an electrolitic uterine distension medium (normal saline). The passage of the electrical energy from the thermal loop to the tissues determines the cutting or coagulation action of the resectoscope.

Table II. Main characteristics of the widely-used resectoscopes

Manufacturer	Diameter	Telescope	Electrosurgical system
Storz	26 Fr	0°, 12°, 30°	Monopolar Bipolar
Circon ACMI	25 Fr	12°, 30°	Monopolar
Wolf	27 Fr	30°	Monopolar Bipolar
Gynecare	27 Fr	12°, 30°	Bipolar
Olympus	26 Fr	0°, 12°	Monopolar Bipolar

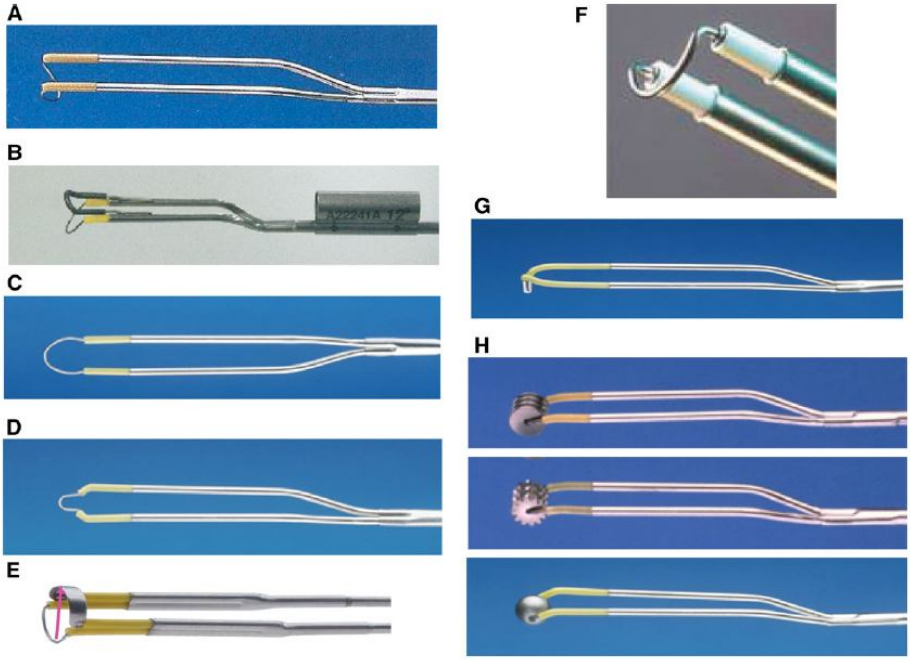

Figure 1: Conventionally-used thermal loops for resectoscopic myomectomy
(**A**) 24 Fr 30° U-shaped cutting loop for monopolar 26 Fr resectoscope (Karl Storz GmbH Co., Tuttlingen, Germany): it has a maximum cutting depth of 4 mm and represents the most frequently used loop; (**B**) 5 mm equatorial loop for monopolar 26 Fr resectoscope (Karl Storz GmbH Co); (**C**) 45° loop electrode with a short-arm safeguard (Olympus Medical System GmbH); (B) and (C) are used to treat submucous fibroids arising from uterine fundus; (**D**) 3 mm equatorial loop for monopolar 26 Fr resectoscope (Karl Storz GmbH Co): it is used to resect submucous fibroids located near the interstitial portions of the Fallopian tubes; (**E**) 8 mm 90° U-shaped cutting loop for bipolar 26 Fr resectoscope (Karl Storz GmbH Co): the direct current return via the electrode (arrow) prevents a current flow via the sheath; (**F**) Magnified view of 2.5 mm cutting loop for bipolar 27 Fr resectoscope (Gynecare; Ethicon Inc., Somerville, NJ); (**G**) Collin's Electrode (Karl Storz GmbH Co): it is a cutting knife electrode, conventionally used to perform hysteroscopic metroplasty; however it can also be employed to perform hysteroscopic myomectomy (i.e. enucleation *in toto*); (**H**) Vaporizing electrodes (Karl Storz GmbH Co): they can have a cylindrical or spherical shape or a multidentate surface; this design works like an array of electrodes which, whether provided with pure cutting energy of high power, can vaporize tissue quite quickly and effectively without generating the 'chips' created by loop resection

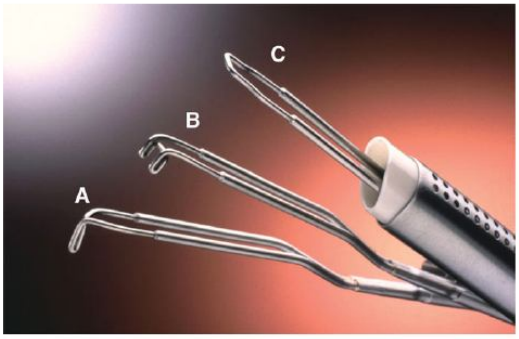

Figure 2: Mazzon's mechanical loops (Karl Storz GmbH Co) used for 'cold loop' myomectomy
A) Pointed loop (Knife-shaped): used to hook and lacerate the connective bridges which join the fibroid and the adjacent myometrium; (**B**) Rake loop (rake shaped with teeth): nearly completely replaced by pointed loop; (**C**) Cutting loop (rectangular): used to identify the cleavage plane between the fibroid and myometrium

There are various types of thermal loops with different shapes and sizes (Fig. 1A–F).

The diameters of thermal loops for bipolar resectoscopes are usually smaller than loops for a monopolar instrument with the same outer diameter, thus increasing the time required for resection (Indman, 2006). The bipolar loop operates in a similar way to a monopolar electrode; however, as tissue contact is not necessary for activation, the electrodes do not 'stick' in the tissue while cutting (Stamatellos and Bontis, 2007).

The cold loops are structurally more robust than the others as they are used in a mechanical way without electrical energy to carry out the enucleation of the intramural component of the fibroid (Fig. 2).

The resectoscope can also fit bipolar and monopolar vaporizing electrodes (Fig. 1H); The power required to vaporize tissue is 150–300 W of pure cut current delivered by any electrosurgical generator (Brooks, 1995; Vilos and Abu-Rafea, 2005). The vaporizing electrodes are also useful mechanical tools to be used to dissect the fibroid from its bed without electrosurgical activation.

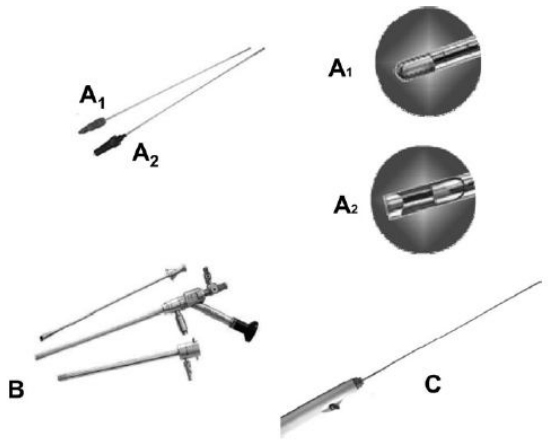

Figure 3: Intrauterine morcellator (IUM) (prototype: Smith & Nephew Endoscopy, Andover, MA)
It consists of a set of two metal, hollow, rigid, disposable tubes (**A**) that fit into each other and then are inserted into the working channel of a 9 mm operating hysteroscope (**B**). The inner tube rotates within the outer tube, driven mechanically by an electrically powered control unit and controlled by a foot pedal that activates rotation and regulates the direction of rotation of the inner tube. The control unit is connected to a handheld motor drive unit in which the IUM is inserted. Both tubes have a window-opening at the end with cutting edges. The rotary morcellator (A_1) is recommended for polypectomy, while the reciprocating one (A_2) for myomectomy. By means of a vacuum source (**C**) connected to the inner tube, the tissue is sucked into the window-opening and cut and 'shaved' as the inner tube is rotated. The removed tissue is discharged through the device and is available for pathology analysis

The transhysteroscopic approach for the treatment of submucous fibroid includes also the use of lasers and of a new instrument called IUM.

Although argon, krypton and neodymium-yttrium-aluminum-garnet (Nd:yAG) lasers have all been successfully used, only the latter has found widespread application in hysteroscopic surgery (Ubaldi, 1995), being very popular in the late 1980s and early 1990s. Two techniques 'touch' and 'non-touch' may be used in hysteroscopic Nd:yAG laser surgery (Goldrath *et al.*, 1981; Loffer, 1987). In the former, the laser fibre is in contact with the surface to be treated, whereas in the latter it is separated from it by a few millimetres. In hysteroscopic myomectomy both techniques are used (Ubaldi, 1995).

The 4–5 mm IUM (prototype: Smith & Nephew Endoscopy, Andover, MA) represents a new cutting device inserted into a straight working channel of a continuous flow 9 mm rigid operating hysteroscope (Fig. 3).

Hysteroscopic techniques

The choice of the technique for the hysteroscopic removal of submucous fibroids mostly depends on its type and location within the endometrial cavity. Furthermore, personal experience and the available equipment might then favour a particular technique rather then the other ones.

Fibroids completely within the uterine cavity (G0)

The operator has the possibility to choose among several alternative procedures: all of them are usually performed in the operating theatre under general anaesthesia, except office myomectomy.

Resectoscopic excision by slicing

The classical resectoscopic excision of intracavitary fibroid is carried out with the technique of slicing. It consists of repeated and progressive passages of the cutting loop, carried out with the standard technique (loop carried beyond the neoformation, with cutting only taking place during the backward or return movement of the loop). Excision usually begins from the top of the fibroid, progressing in a uniform way towards the base, also in the case of a pedunculated fibroid (Neuwirth and Amin, 1976; Mazzon and Sbiroli, 1997; Isaacson, 2003; Indman, 2006).

During the resection of the fibroid, particularly when there are voluminous neoformations or small cavities, the fragments sectioned and then accumulated into the cavity may interfere with a clear vision. Thus they must be removed from the uterine cavity by taking out the resectoscope after grasping the loose tissue elements with the loop electrode. Although the removal of tissue under visual control with the resectoscope is the most effective way, it requires a large number of steps which are tiring in the long run (Mazzon and Sbiroli, 1997; Emanuel and Wamsteker, 2005). Recently, a resectoscope with automatic chip aspiration (Resection Master by Gallinat, Richard Wolf GmbH, Knittlingen, Germany) has been developed. Thanks to an extremely effective pump with integrated pulse aspiration, the chips are aspirated immediately after they are produced and removed from the uterine cavity without the uterine water distension being impaired (Gallinat, 2005).

When dealing with the base of the fibroid, care must be taken to limit the surgical traumatism only to the area of the implant, thus avoiding the damage of the surrounding structures. As soon as the excision of the fibroid is finished, the base of the implant must be cleaned out until smooth and regular; the operation should be considered finished when the fasciculate structure of the myometrium is visualized.

It is well ascertained that intracavitary fibroids can be easily removed in a one-step procedure with fibroid size representing the main limiting factor. The operation may also be carried out by operating surgeons with average resectoscopic experience (Mazzon and Sbiroli, 1997; Isaacson, 2003; Indman, 2006).

Cutting of the base of the fibroid and its extraction

Ideally, when approaching a peduncolated fibroid, the basis of the pedicle might be cut by resectoscopic loop (Murakami *et al.*, 2005) or Nd:yAG laser with the 'no-touch' technique (Valle and Baggish, 2007) or vaporizing electrode (Glasser, 1997). The resected node is then usually extracted with forceps. The fibroid can be grabbed blindly with a Corson forceps (Thomas Medical, Inc., Indianapolis, IN) or under direct visualization with an Isaacson optical tenaculum (Karl Storz Endoscopy, Culver City, CA) (Isaacson, 2003). Some other reports suggest that the resected fibroid node should be left in place until the remnant fibroid is excreted spontaneously during the first menstruation after surgery (Donnez *et al.*, 1990; Isaacson, 2003). This is an attractive

procedure but limited by frequent side effects including continuous colicky pain and intrauterine infection (Darwish, 2003).

Ablation by Nd:yAG laser

For fibroids 2 cm or less in diameter the Nd:yAG laser fibre may be used to ablate the fibroid. The technique first coagulates the surface vessels with the defocused laser fibre. Then the fibre is dragged repetitiously over the fibroid until it is flattened (touch technique). The disadvantages with this method are the time expended to reduce the fibroid and the lack of a tissue specimen for pathologic evaluation (Donnez *et al.*, 1990; Gallinat *et al.*, 1994; Smets *et al.*, 1996; Valle and Baggish, 2007). Furthermore, laser equipment at present tends to be very expensive which significantly reduces its widespread use.

Vaporization of fibroid

The vaporization of fibroid is performed using spherical or cylindrical electrodes (Fig. 1H); the electrode is dragged along the surface of the fibroid until the nodule is reduced to a size compatible with removal by the means of Corson forceps or Isaacson optical tenaculum. The depth of vaporization depends on duration of contact, resistance (debris on the electrode) and wattage of the generator. It is important to move the electrode slowly across tissue, applying current only when moving in the direction towards the operator. Prolonged pressure in one spot exposed to this high current could result in uterine perforation (Glasser, 1997).

Fibroid vaporization has been reported to be significantly faster than traditional resectoscopic surgery (no fibroid chips to be removed) with an estimated blood loss <100 ml and a discrepancy between inflow and outflow volumes ranging 0–200 ml (Brooks, 1995; Vilos and Abu-Rafea, 2005).

The main disadvantage of vaporizing electrodes is the lack of tissue sample for pathology. While uterine sarcomas are vary rare, unfortunately they are not homogeneous. Therefore, a simple sample prior to vaporization does not rule out the disease. Consequently, it is mandatory that no fibroid be vaporized in its entirety but that substantial portions been retrieved for microscopic examination (Brooks, 1995; Glasser, 1997; Isaacson, 2003).

Another disadvantage is related to the use of high power which produces numerous gas bubbles which enter the vascular system. Providentially, these bubbles dissipate rapidly in the blood; as long as the rate of formation does not exceed the rate of dissipation, there are no significant clinical sequelae. A constant monitoring of patient's end-tidal CO_2 together with a close cooperation between surgeon and anaesthesiologist is needed to avoid serious complications (Isaacson, 2003).

Morcellation by IUM

Contrary to some other alternative techniques that use heat, coagulation or vaporization, the morcellation by IUM represents a new alternative technique which preserves tissue for histological examination.

Recently, Emanuel and Wamsteker (2005) have conducted a retrospective comparison between this technique and conventional resectoscopy.

They have shown that morcellation by IUM was effective for the treatment of fibroid G0 and G1 and faster than conventional resectoscopy. Indeed, the aspiration of tissue fragments through the instrument allowed the surgeons to save much time. However, further data are needed to evaluate long-term follow-up and to demonstrate whether this new technique might result in fewer fluid-related complications (physiological saline solution is used for distension and irrigation) and a shorter learning curve.

On the other hand, it should be underlined that this new technique cannot be used for the treatment of submucous fibroids with $>50\%$ intramural extension (G2).

Office hysteroscopic myomectomy

The development of smaller diameter hysteroscopes (<5 mm) with working channels and continuous flow systems has made it possible to treat several uterine pathologies in outpatient regimen without cervical dilatation and consequently without analgesia and/or local anaesthesia.

This new philosophy ('see and treat hysteroscopy') has reduced the distinction between a diagnostic and an operative procedure, introducing the concept of a single procedure in which the operative part was perfectly integrated in the diagnostic work-up (Bettocchi *et al.*, 2003).

Mechanical operative instruments (scissors, biopsy cup, grasping and corkscrew) have long been the only way to apply the see and treat procedure in an outpatient setting (Bettocchi *et al.*, 2004). The advent of bipolar technology, with introduction of electrosurgical systems dedicated to hysteroscopy and several types of 5 Fr electrodes, has increased the number of pathologies treated by office operative hysteroscopy, including fibroids $<1.5-2$ cm.

Endocavitary fibroids (G0) are first divided into two half-spheres and then each of these is sliced from the free edge to the base into two/three fragments (Fig. 4). These fragments must be large enough to be pulled out through the uterine cavity using 5 Fr. grasping forceps (Bettocchi *et al.*, 2002).

Few studies have investigated the effectiveness of this new approach (Farrugia and McMillan, 2000; Bettocchi *et al.*, 2002; Clark *et al.*, 2002) and are characterized by potential methodological weaknesses including the lack of a control group of women (Farrugia and McMillan, 2000; Bettocchi *et al.*, 2002; Clark *et al.*, 2002) and the relatively short-term follow-up (Farrugia and McMillan, 2000; Bettocchi *et al.*, 2002; Clark *et al.*, 2002). Larger prospective comparative studies are needed to better evaluate this promising approach in terms of symptom response and cost saving.

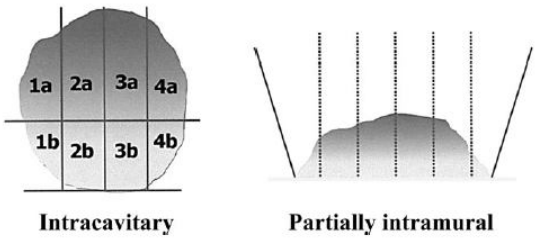

Figure 4: Slicing technique to treat totally intracavitary and partially intramural submucous fibroid in office setting with 5Fr bipolar electrodes
'a' refers to the first half-sphere and 'b' to the second. Modified from Bettochi *et al.* (2002)

Fibroids with intramural development (G1-G2)

It is advisable to use expert operating surgeons for hysteroscopic resection of fibroids with intramural extension as it is technically difficult with a slow learning curve and it is associated with an higher risk of complications (Emanuel *et al.*, 1999). The intramural extension of submucous fibroids influences the chance of achieving complete resection in one surgical session.

Conventionally, fibroids G1 and G2 should not exceed 5–6 and 4–5 cm, respectively, to be removed hysteroscopically, even if reports of removal of larger fibroids are available in the English literature (Neuwirth, 1983; Fried and Hulka, 1987; Hamou, 1993; Donnez *et al.*, 1995; Phillips *et al.*, 1995).

Several techniques have been proposed for the treatment of such submucous fibroids, most of them sharing the objective of producing an intracavitary protrusion of the intramural component. The advantages and limits of the most widely-used techniques are shown in Table III.

Excision only of the intracavitary component

In the past, several authors have proposed a progressive resectoscopic excision of only the intracavitary component of those fibroids with extensive intramural involvement (Neuwirth, 1978). Indeed, it was believed that the endometrium would recolonize the surgically operated area and that the residual intraparietal component of the fibroid would remain in the thickness of the wall, behaving like an intramural fibroid (usually asymptomatic). However, the constant intracavitary expulsion and the subsequent volumetric increase of the residual intramural component of the fibroid lead to the persistence of the initial symptomatology. That explains the clinical uselessness of such a treatment and its consequent fall into disuse.

Complete excision of fibroid by a two-step procedure

The observation of the rapid migration of the residual intramural component of the fibroid towards the uterine cavity (Loffer, 1990), with the parallel increase of myometrial thickness during hysteroscopic myomectomy (Yang and Lin, 2001), is the basis of this treatment, which represents the logical evolution of the earlier treatment which involved the excision of the only intracavitary component of the fibroid.

The technique described by Donnez *et al.* (1990) represents an effective mixture of hormonal treatment and hysteroscopic laser surgery. After 8 weeks of preoperative GnRH agonist therapy, a partial myomectomy of the intracavitary portion of the fibroid is carried out. The Nd:yAG laser fibre is then directed, as perpendicularly as possible, at the remaining (intramural) fibroid portion with the aim to reduce its size by decreasing its vascularity (transhysteroscopic myolysis). After another 8 weeks course of GnRH agonist therapy, a second hysteroscopic myomectomy is performed to remove the remnant intramural portion of the fibroid protruded in the uterine cavity as a consequence of uterine shrinkage. This technique has been successfully reported in 12 patients by Donnez in his original paper (Donnez *et al.*, 1990), with a restoration of normal menstrual flow in all of them. In his largest series of fibroids with the biggest portion located into the uterine wall ($n = 78$), the author reports a success rate of 95% with only four patients requiring a third-look laser hysteroscopy to completely remove the fibroid (Donnez *et al.*, 1995).

At present, most surgeons prefer to remove a fibroid through a two-steps procedure, by means of traditional resectoscopic surgery, as originally hypothesized by Loffer (1990). The technique consists of the following steps:

(i) First surgical operation: excision only of the intracavitary portion of the fibroid, by means of the usual progressive resectoscopic excision. A hysteroscopic reassessment is carried out 20–30 days after the operation or after the first menstruation to verify that the intracavitary migration of the residual intramural component of the fibroid has taken place: once this has been verified, the second operation can be done.
(ii) Second surgical operation: complete excision, by means of slicing, of the residual component of the fibroid, which has now become intracavitary.

Optionally, first and second surgical operation can be preceded by GnRH agonist therapy.

Complete excision of fibroid by a one-step procedure

Excision of intramural component by slicing

With this technique, after the usual progressive excision of the intracavitary portion of the fibroid, the operation continues with the slicing of the neoformation, included into the thickness of the uterine wall, until the operation is completed (Fig. 5). The main limit of this technique is the use of electrosurgery during the removal of the intramural component of the fibroid with the inevitable damage of the surrounding healthy myometrium (either directly during the cutting or indirectly because of thermal damage) and the increased risk of operative complications (such as perforation, bleeding, intravasation).

'Cold loop' myomectomy

This technique, developed by Mazzon (1995), is characterized by a sequence of three different operating steps:

(i) *Excision of the intracavitary component of the fibroid*: this is carried out with the usual technique of slicing. It consists of repeated and progressive passages of the monopolar angled cutting loop, carried out with the standard technique. This action must stop at the level of the plane of the endometrial surface, so that the identification of the passage between the fibroid and the adjacent myometrial tissue is not impaired (cleavage plane).
(ii) *Enucleation of the intramural component of the fibroid*: once the cleavage plane is identified the usual cutting loop of the resectoscope is substituted by a suitable blunt dissection cold loop. Usually the rectangular loop is used first. This loop, once inserted into the plane between the fibroid and myometrium, is used in a mechanical way along the surface of the fibroid (usually clearly recognizable by its smooth, white and compact surface), thus bringing about its progressive blunt dissection from the myometrial wall (Fig. 6A). Then the single tooth loop is used to hook and lacerate the slender connective bridges which join the fibroid and the adjacent

Table III: Advantages and limits of the most widespread techniques for hysterosocpic treatment of myomas G1-G2

Author (year)	Technique	Advantages	Limits
Loffer *et al.* (1990) Donnez *et al.* (1990)	Two-step myomectomy: the procedure can be performed only by means of traditional resectoscopic surgery (Loffer *et al.*, 1990) or by Nd:yAG laser (Donnez *et al.*, 1990).	- Safeness (possibility to operate at an intracavitary level)	- Two separate interventions - High costs (GnRH agonist therapy, Nd:yAG laser, two surgeries) - Only myomas with a reduced intramural development or of small dimensions can be treated with this technique. Indeed, in the case of myomas with a volumetrically significant intramural component, the part which remains after the first surgical operation may be excessively big: such a component, when migrating to the uterine cavity, will meet with resistance to its progression caused by the controlateral myometrial wall. As a result, during the second operation we will find a myoma which still has a significant intramural component, which will remain in the thickness of the wall at the end of the new excision only of the intracavitary part: it will therefore be necessary to carry out more surgical operations. However this limit might be solved by GnRH agonist therapy. - 'Sinking' phenomenon (due to GnRH agonist therapy) - Increased recurrence rate (due to GnRH agonist therapy)
Mazzon (1995)	'Cold loop' myomectomy	- Theoretically one intervention - Safeness (although the surgical action goes deeply into the uterine wall during enucleation with a cold loop, it always follows a reference plane (the surface of the intramural pole of the myoma) and constantly maintains the loop action under direct visual control; this means a smaller possibility of complications (perforation, bleeding) - Respect of the surrounding healthly myometrium avoiding any needless cutting of the muscular fibres adjacent to the surgical area and reducing the thermal damage deriving from the loop of the resectoscope. This avoids any negative effect on the likelihood of subsequent conception and the uterine wall resistance - Suitable also for large myomas - Suitable also in case of myometrial free margin <1 cm	- Availability of cold loops - Training and high experience
Lasmar *et al.* (2002)	'Enucleation *in toto*'	- Theoretical one intervention	- The success of the procedure is higher for myomas with a intramural development >50%
Litta *et al.* (2003)		- Safeness (possibility to operate at an intracavitary level) - Theoretical respect of the surrounding health myometrium	- The expulsion force of the myometrium is inversely correlated with the diameter of uterine cavity
Hamou (1993)	Hydromassage	- Theoretical one intervention - Safeness (possibility to operate at an intracavitary level)	- Need of electronically controlled irrigation and suction device - The contractile reaction of the myometrium to such manoeuvres is neither predictable nor standardizable

Continued

Table III: *Continued*

Author (year)	Technique	Advantages	Limits
		- Theoretical respect of the surrounding health myometrium	- The migration of the intramural component of the myoma into the cavity is maximum for myomas with a reduced intramural development or of small dimensions
Bettocchi *et al.* (2002)	Office hysteroscopic myomectomy	- Office procedure	- Availability of 5Fr bipolar electrodes and generator
		- Reduced anaesthetic risks	- Myoma G0-G1 <1.5 cm
		- Reduced costs	- Limited by patient's compliance
		- Theoretical one intervention	- Training and high experience
Indaman (2004)	Pharmacological-aided techniques (PGF-2α or carboprost)	- Theoretical one intervention	- The contractile reaction of the myometrium to such drugs is neither predictable nor standardizable
Murakami *et al.* (2003, 2006)		- Safeness (possibility to operate at an intracavitary level)	- Extreme contraction of the uterus can interfere with visualization and one's ability to manipulate the resectoscope in the small cavity
			- Need of laparoscopic monitoring (Murakami's technique)
		- Theoretical respect of the surrounding health myometrium	- Side effects drug-related (nausea, vomiting, diarrhea, fever, bronchospasm in patients with bronchial asthma)

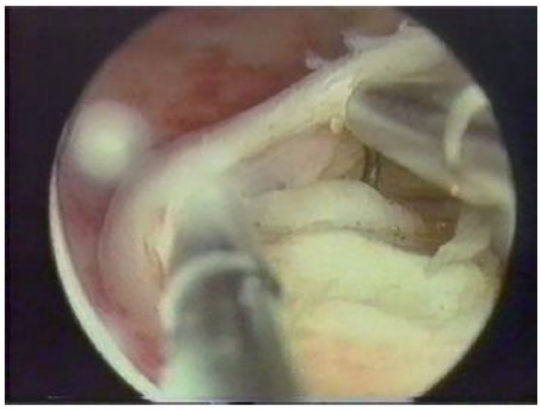

Figure 5: Excision of intramural component by slicing: the electrosurgery is used to slice the neoformation, included into the thickness of the uterine wall (Image kindly donated by I. Ardovino)

myometrium (Fig. 6B). During the entire phase of enucleation, electric energy must not be used in the thickness of the wall, and the loop must be used 'cold' or in a mechanical way.

(iii) *Excision of the intramural component*: at the end of the enucleation phase, the intramural part of the fibroid is totally dislocated inside the uterine cavity. At this point it can be treated as a neoformation with a total intracavitary development and therefore it can be completely and safety excised by means of the usual progressive excision using an angled cutting loop.

At present, studies evaluating of the effects of this technique are still lacking in the international literature. However, this technique is largely widespread through the Europe and since 1992, Mazzon himself has carried out >2000 hysteroscopies using this technique reporting good functional and anatomical results and a low complication rate (<2%). The fibroid was completely removed in one-step procedure in nearly 80% of cases (unpublished data).

'Enucleation in toto'

Litta's technique: an elliptic incision of the endometrial mucosa that covers the fibroid is performed with a 90° Collins electrode (Fig. 1G), at the level of its reflection on the uterine wall until the cleavage zone of the fibroid is reached. Connecting bridges between fibroid and surrounding myocytes are slowly resected. The effect of such action is that the fibroid protrudes into the cavity, thus facilitating its removal by traditional slicing. The fibroid is pushed into the uterine cavity, enabling the surgeon to work safely and completely resect the intramural component with an angled cutting loop. This technique has been successfully reported in 41 out of 44 women with submucous fibroids G2 ranging from 2 to 4 cm (means diameter 3.2 cm) and myometrial free margin >4 mm at ultrasound (Litta *et al.*, 2003).

Lasmar's technique: the Collins electrode is used in shape of a 'L', to dissect the endometrium around the fibroid until getting to it. At this time, the direct mobilization of the fibroid is started in all directions, doing the coagulation only of the vessels that are

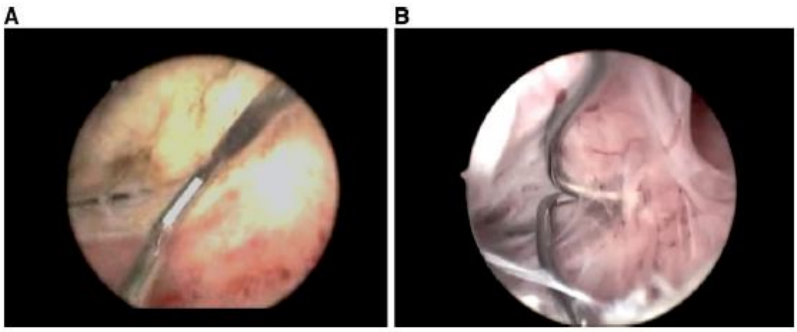

Figure 6: (**A**) The rectangular loop is inserted into the plane between the fibroid and myometrium to progressively dissect it from the myometrial wall (**B**) Connective bridges which join the fibroid and the adjacent myometrium are hooked by the single tooth cold loop (Images by I. Mazzon)

bleeding. When the fibroid is in the cavity it is possible to remove it with grasping forceps (small fibroids) or to slice it in several pieces using the Collins electrode. This technique has been successfully reported in 98 cases (50 out of 98: direct mobilization plus grasping; 46 out of 98: direct mobilization plus slicing) (Lasmar and Barrozo, 2002).

Technique of 'hydromassage'

Starting form the observation that the intramural portion of a submucous fibroid squeezes out of its base after contractions of the uterus during the removal of tissue chips (Loffer, 1990), Hamou (1993) proposed a 'fibroid massage' through rapid changes of intrauterine pressure using an electronically controlled irrigation and suction device (Endomat; Karl Storz GmbH Co., Tuttlingen, Germany). Indeed, interrupting and restarting the supply of distension liquid several times, myometrial contraction is stimulated, obtaining the maximum possible migration of the intramural component of the fibroid into the cavity. At present, series evaluating the effects of this technique are lacking in international literature.

'Manual massage' technique

At the beginning of 1990s, Hallez (1995) introduced a single-stage technique in which, after a partial myomectomy of the protruding dome of the fibroid, uterine contractions were induced by finger massage of the uterus (similar to obstetric manoeuvres as Crede's one), thus expelling the residual intramural fibroid into the uterine cavity and making it accessibile for a safe hysteroscopic resection. Hallez (1995) reports good anatomical and functional results after resection with such technique of 222 submuocus fibroids with intramural development.

'Two-resectoscope technique'

Lin *et al.* (2000) proposed a one-procedure hysteroscopic myomectomy by using two resectoscopes. A 7-mm resectoscope is first used to cut the capsule of the fibroid next to muscular layer of the uterus. This prevents the fibroid from sinking in the muscular layer as the procedure progresses. The fibroid is then dissected from the muscular layer. Then, after the fibroid has been dissected from the muscular layer, a standard resectoscope with a 9-mm external outer sheath is used to shave the body of the fibroid. A Lin fibroid grasper (Atom Medical Co., Tokyo, Japan) may be used to pull the fibroid further into the intrauterine cavity. The procedure is continuously monitorized by ultrasonography. The index technique has been successfully reported in only two infertile women presenting with menorrhagia.

Office hysteroscopic myomectomy

Fibroids $<1.5-2$ cm, with a minimal intramural component, can be removed in outpatient setting using smaller diameter hysteroscopes and 5Fr mechanical and bipolar instruments. In these cases, to avoid any myometrial stimulation or damage of the surrounding healthy myometrium, the fibroid is first gently separated from the capsule using mechanical instruments (grasping, forceps or scissor) as described for 'cold loop' resectoscopic myomectomy. Once the intramural section becomes intracavitary then it is sliced with the bipolar electrode (Fig. 5B) (Bettocchi *et al.*, 2002).

Pharmacological-aided techniques

Several drugs may stimulate uterine contractions pushing the intramural part of the fibroid into the cavity, thus anticipating what generally happens spontaneously during the weeks following the operation. Murakami and colleagues (2003, 2006) proposed a transabdominal injection of prostaglandin F (PGF)-2α under laparoscopic monitoring, while Indman (2004) reported the successful use of intracervical carboprost, a methyl analogue of PGF-2α, in 8 out of 10 cases in which the drug was administered to facilitate resection of fibroids that otherwise could not be resected completely.

Global endometrial ablation

New instrumentation and the off-label use of some global (non-hysteroscopic) ablation techniques allow some selected patients with submucous fibroids, who have completed their family planning, to be treated only by endometrial ablation (Hickey and Farquhar, 2003; Loffer, 2006).

Conventional endometrial ablation techniques cannot be used when the uterine cavity is remarkably enlarged (>12 cm) and distorted as result of submucous or intramural myomas. Indeed, in such situation it is hard for most devices with a rigid intrauterine probe to access all areas of the endometrium.

Hydrothermal ablation system circulates free heated saline under hysteroscopic visualization and thus very readily adapts to

an irregular cavity. It has already been demonstrated to be safe and effective in treating women with menorrhagia and submucous fibroids up to 4 cm in diameter (Glasser and Zimmerman, 2003).

Microwave endometrial ablation (MEA) is based on a generator supplying microwave energy to a 8 mm hand-held reusable probe. This results in a reliable 5–6 mm depth of endomyometrial penetration. Recently, a thinner (4 mm) curved microwave probe has been developed, in order to accomplish the complete coverage of the uterine cavity, even in case of enlarged (12–16 cm in length) and distorted cavity as a result of large submucous fibroids (Kanaoka *et al.*, 2003, 2005). Available data about the outcome of MEA in patients with menorrhagia caused by submucous myomas are few but encouraging. The improvement of menorrhagia is accompanied with a significant shrinkage of myoma related to a necrotic degeneration recognizable by MRI 1–2 months after the procedure (Kanaoka *et al.*, 2003, 2005).

Effects of hysteroscopic myomectomy on menstrual pattern and infertility

No meta-analysis of the association of submucous fibroids and AUB has been performed; however, most studies have shown that hysteroscopic myomectomy is safe and effective in the control of menstrual disorders with a success rate ranging from 70 to 99%. Usually the success rate declines as the follow-up period increases; this could be to due to a number of factors including the incomplete removal of fibroid (which could in time become larger and cause bleeding) as well as the occurrence of other dysfunctional factors as a cause of menorrhagia (Mazzon and Sbiroli, 1997).

The hysteroscopic technique (Table IV) adopted does not seem to significantly affect the success rate.

The failure of hysteroscopic treatment seems to be related to the growth of fibroids in other sites, the association of fibroids with adenomyosis and the incomplete treatment of partially intramural submucous fibroids (Donnez *et al.*, 1995). The complete resection of the intramural part of the fibroid is certainly advisable to improve the control of menorrhagia, with lower chance of subsequent recurrence (Wamsteker *et al.*, 1993; Parent *et al.*, 1994; Van Dongen *et al.*, 2006).

Furthermore, uterine size (Emanuel *et al.*, 1999; Hart *et al.*, 1999), fibroid size (Hart *et al.*, 1999) and the number of fibroids (Emanuel *et al.*, 1999) found at hysteroscopy seem to have an independent prognostic value for recurrence of AUB.

In women who have completed their family planning, good long-term results in controlling bleeding have been achieved by concomitant hysteroscopic endometrial ablation which leads to an amenorrhoic status in up to 95.5% of patients (Brooks *et al.*, 1989; Derman *et al.*, 1991; Phillips *et al.*, 1995; Glasser, 1997; Loffer, 2000, 2005; Polena *et al.*, 2007).

The effects of hysteroscopic myomectomy on the reproductive outcome in infertile women have been investigated by several authors (Hunt and Wallah, 1974; Donnez *et al.*, 1990; Valle, 1990; Corson and Brooks, 1991; Goldenberg *et al.*, 1995; Preutthipan and Theppisai, 1998; Giatras *et al.*, 1999; Varasteh *et al.*, 1999; Vercellini *et al.*, 1999; Bernard *et al.*, 2000; Fernandez *et al.*, 2001; Pritts, 2001; Donnez and Jadoul, 2002; Munoz *et al.*, 2003; Shokeir, 2005; Stamatellos *et al.*, 2006; Somigliana *et al.*, 2007), but unfortunately the evidence thus far is not of the highest quality. Reported post-surgical pregnancy rate varies from 16.7 to 76.9% with a mean of 45%. This large variation may be mainly related to difficulty in controlling for multiple infertility factors, to sample size and follow-up discrepancies and to differences in patients' (i.e. age, primary or secondary infertility) and fibroid characteristics (i.e. number, size, intramural portion and presence of concomitant intramural fibroids) (Cheong and Ledger, 2007; Somigliana *et al.*, 2007).

Uterine fibroids as an isolated cause of infertility are very uncommon. Two papers (Buttram and Reiter, 1981; Verkauf, 1992), generally cited as sources of epidemiological data about this issue, reported that uterine fibroids as an isolated cause of infertility range from 1 to 2.4%. However, these studies do not provide a reliable estimate of the real impact of fibroids on infertility as routine diagnostic evaluations performed were not listed and they precede the advent and widespread use of new instrumentations (i.e. TVS and endoscopic procedures) (Somigliana *et al.*, 2007).

Several studies (Ubaldi *et al.*, 1995; Bernard *et al.*, 2000; Fernandez *et al.*, 2001) have shown that post-operative reproductive outcome is adversely affected by the presence of additional infertility factors. Particularly, Fernandez *et al.* (2001) reported in their retrospective series that the pregnancy rate was 41.6% when the fibroid was the only apparent cause, compared with 26.3% with the presence of one factor and 6.3% with two or more additional factors.

In another retrospective study (Bernard *et al.*, 2000) a statistically significant difference in delivery rate was found between patients with one fibroid and those with a number of fibroids equal or superior to two. Furthermore, the authors report that patients without an intramural fibroid associated had a significantly greater delivery rate and a significantly shorter delay of conception than those found in patients with associated intramural fibroids. These differences cannot be due to uterine cavity abnormalities as the associated intramural fibroids did not cause any distortion of the uterine cavity as assessed by an office hysteroscopy performed four weeks after resection. These results reinforce the hypothesis that other mechanisms associated with fibroids may contribute to infertility.

In a recent prospective study, Stamatellos *et al.* (2006) has reported increased fertility rates after hysteroscopic myomectomy of type 0 and type 1 fibroids in previously infertile women. Interestingly, in patients with type 2 fibroids fertility rate did not increase, in contrast with patients with type 2 fibroids who received expectant management (control group).

Fernandez *et al.* (2001) described higher pregnancy rates after the removal of larger fibroids, although the difference was not statistically significant. Indeed, the pregnancy rate after the removal of fibroids >5 cm in size was 57%, whereas it was 23% for fibroids <5 cm.

Finally, assessing the real impact of hysteroscopic myomectomy on subsequent fertility seems to be highly hampered by the fact that most studies addressing this issue were retrospective (Donnez *et al.*, 1990; Goldenberg *et al.*, 1995; Giatras *et al.*, 1999; Varasteh *et al.*, 1999; Vercellini *et al.*, 1999; Bernard *et al.*, 2000; Fernandez *et al.*, 2001; Munoz *et al.*, 2003) and did not have a control group (Donnez *et al.*, 1990; Valle, 1990; Hallez, 1995; Goldenberg *et al.*, 1995; Vercellini *et al.*, 1999; Giatras *et al.*, 1999; Bernard *et al.*, 2000; Fernandez *et al.*, 2001; Munoz *et al.*, 2003; Shokeir, 2005).

Only one study (Varasteh *et al.*, 1999) had a control group of infertile women and the authors showed that the removal of

Table IV: Bleeding control after hysteroscopic myomectomy (1976–2007)

Author	Cases (*n*)	Main indications (%)	Technique (*n*)	Follow-up years[a]	Bleeding control (%)
Neuwirth and Amin (1976)	5	80 AUB 20 Infertility	Resectoscopic excision of myoma by slicing	5	100
Brooks *et al.* (1989)	62	79 AUB 21 AUB+infertility	Resectoscopic excision of myoma by slicing (57) Resectoscopic excision of myoma by slicing with endometrial ablation (5)	>3 months	74
Derman *et al.* (1991)	156	90.4 AUB 9.6 Infertility	Resectoscopic excision of myoma by slicing (94) Endometrial ablation with or without resectoscopic myomectomy (62)	4 (1–16)	83.9 77.5
Indmann (1993)	51	100 AUB	Resectoscopic excision of myoma by slicing	(1–5)	94
Wamsteker *et al.* (1993)	51	100 AUB	Resectoscopic excision of myoma by slicing	1.7 (0.8–2.5)	94.1
Donnez *et al.* (1994)	366	100 AUB	Resectoscopic excision of myoma by slicing and Nd:yAG laser (two-step procedure)	2	89
Wortman *et al.* (1995)	75	100 AUB	Resectoscopic excision of myoma by slicing with endometrial ablation	(1–5)	84
Brooks (1995)	12	100 AUB	Hysteroscopic myomectomy by electrosurgical vaporization	(0.5–1)	100
Hallez (1995)	284	79 AUB 11 Infertility	Resectoscopic excision of myoma by slicing	(0.5–8.8)	76.3
Phillips *et al.* (1995)	208	100 AUB	Resectoscopic excision of myoma by slicing (120) Resectoscopic excision of myoma by slicing with endometrial ablation (88)	(0.5–6)	84.1 88.5
Glasser (1997)	35	100 AUB	Hysteroscopic myomectomy by electrosurgical vaporization (6) Hysteroscopic myomectomy plus endometrial ablation by electrosurgical vaporization (29)	2	97
Vercellini *et al.* (1999)	101	71 AUB 29 AUB+infertility	Resectoscopic excision of myoma by slicing	3.4 ± 1.9[b]	70
Hart *et al.* (1999)	122	93 AUB 7 Infertility	Resectoscopic excision of myoma by slicing	2.3 (1–7.6)	81.9
Emanuel *et al.* (1999)	266	100 AUB	Resectoscopic excision of myoma by slicing	3.8 (0.1–8.6)	84.5
Munoz *et al.* (2003)	96	84 AUB 12 Infertility	Resectoscopic excision of myoma by slicing	2.8 (1–7)	88.5
Loeffer (2005)	177	91 AUB 9 AUB+infertility	Resectoscopic excision of myoma by slicing (104) Resectoscopic excision of myoma by slicing with endometrial ablation (73)	(1–15)	80.8 95.9
Campo *et al.* (2005)	80	79 AUB 17 Infertility	Resectoscopic excision of myoma by slicing	(0.5–2)	69.5
Marziani *et al.* (2005)	107	78 AUB 23 Infertility	Resectoscopic excision of myoma by slicing	(2–5)	80.9
Polena *et al.* (2007)	235	84.7% AUB 6.8% Infertility	Resectoscopic excision of myoma by slicing (with endometrial ablation in 37% of patients)	3.3 (1.5–5.5)	94.4

AUB includes menorrhagia, metrorrhagia, post-menopausal bleeding, menorrhagia or metrorrhagia on hormonal replacement therapy. [a]Data are expressed as median (range) if not otherwise stated; [b]mean ± SD.

submucosal fibroids >2 cm carried a significant benefit in terms of pregnancy and live birth rates. However, the limited sample size (control group: $n = 19$; myomectomy group: $n = 36$) reduces the strength of these results.

Only a randomized controlled study would provide a definitive assessment of the advantages of such technique on reproductive outcomes and would be useful to confirm that fibroids are not purely coincidental with infertility (Donnez and Jadoul, 2002, Somigliana *et al.*, 2007); such a study should be performed comparing pregnancy rates between infertile women with submucous fibroids resected or left *in situ* (Pritts, 2001). However, such a study would be hard to justify because such lesions often cause menorrhagia, they require histologic diagnosis and they are likely to contribute to infertility (Varasteh *et al.*, 1999).

Also, technical factors such as the surgeon's skill and experience as well as the applied techniques surely play an important role (Stamatellos *et al.*, 2006). Thus, as similar studies are lacking in international literature, it might be interesting to evaluate whether the choice of a myometrial sparing technique would further increase the reproductive outcomes.

The advent of assisted reproductive techniques and in particular of IVF has offered a useful tool to elucidate the impact of fibroids on embryo implantation. However, there is no definite consensus on whether fibroids affect the outcome and should be removed prior to any attempt. Their location, followed by size, is considered the main factor determining this impact (Gianaroli et al., 2005; Kolankaya and Arici, 2006).

Four meta-analysis (Pritts, 2001; Donnez and Jadoul, 2002; Benecke *et al.*, 2005; Somigliana *et al.*, 2007) have aimed to assess the impact of fibroids on IVF cycles.

Pritts (2001) reported significantly lower pregnancy (RR 0.32), implantation (RR 0.28), and delivery (RR 0.75) rates in patients with submucosal fibroids and abnormal uterine cavities in comparison with infertile controls without fibroids. Results from Donnez and Jadoul (2002) confirm a negative impact only of submucous fibroids on embryo implantation.

Conversely, Benecke *et al.* (2005) reported a negative impact also of intramural fibroids. Recently, Somigliana *et al.* (2007) performed an updated meta-analysis reporting significantly lower pregnancy and delivery rates for patients with submucosal fibroids [odds ratio (OR): 0.3; OR: 0.3) and intramural fibroids (OR: 0.8; OR: 0.7).

The impact of hysteroscopic myomectomy on IVF outcome has been less extensively investigated. Among the three studies evaluating the impact of previous myomectomy on IVF cycles (Seoud *et al.*, 1992; Narayan *et al.*, 1994; Surrey *et al.*, 2005), only two (Narayan *et al.*, 1994; Surrey *et al.*, 2005) include patients operated for submucousal fibroids.

Meta-analysis of these two studies reports that hysteroscopic myomectomy does not appear to negatively affect the chance of pregnancy in IVF cycles (Somigliana *et al.*, 2007). However, positive answers could be doubted, as they were based on two retrospective studies only, both of them characterized by a limited number of patients.

Operative and long-term complications

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 (Jansen *et al.*, 2000; Propst *et al.*, 2000; Aydeniz *et al.*, 2002; Murakami *et al.*, 2005). 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 (Loffer, 1990; Valle, 1990; Corson and Brooks, 1991; Derman *et al.*, 1991; Serden and Brooks, 1991; Pace, 1993; Wamsteker *et al.*, 1993; Hallez, 1995; Jansen *et al.*, 2000; Propst *et al.*, 2000; Agostini *et al.*, 2002; Darwish, 2003). Other intraoperative complications include bleeding, cervical trauma and air embolism, while late complications include post-operative intrauterine adhesion (IUA) (Wamstecker *et al.*, 1993; Hallez, 1995; Giatras *et al.*, 1999; Taskin *et al.*, 2000; Acunzo *et al.*, 2003; Guida *et al.*, 2004; Nappi *et al.*, 2007) and uterine rupture during pregnancy (Derman *et al.*, 1991; Yaron *et al.*, 1994; Darwish, 2003; Valle and Buggish, 2007).

Uterine perforation

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 (Mazzon, 1995; Murakami *et al.*, 2005). 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 (Indman, 2006). 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 (Indman, 2006).

Intravasation and electrolyte imbalance

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 (Emanuel *et al.*, 1997). 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 (Loffer, 2000) and that the intervention must be immediately stopped when balance exceeds of 1000 ml (Munoz *et al.*, 2003) or, according to other authors, 1500–2000 ml (West and Robinson, 1989; Baumann *et al.*, 1990; Istre *et al.*, 1994). 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 (Emanuel *et al.*, 1997); indeed, in cases of fibroids with deep intramural extension, intravasation will increase mainly because of damage to larger-sized vessels (Emanuel *et al.*, 1997). Other reported factors possibly associated with a higher risk of intravasation include the length of the operation (Corson *et al.*, 1994, Emmanuel *et al.*, 1997), the size of the fibroid (Maher and Hill, 1990) and the total inflow volume (Corson *et al.*, 1994).

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 (including also fluid leaking from the vagina) could be assessed by dedicated operating room personnel or by modern electronic balances and pumps (i.e. Hydromat Gyn and Equimat, Karl Storz GmbH Co., Tuttlingen, Germany; HysteroBalance/HysteroFlow, Olympus Medical System GmbH, Hamburg, Germany).

The use of normal saline combined with bipolar energy reduces the risk of hyponatremia (eliminating the problem of the accumulation of the free water), but an excessive intravasation (>1500 ml) still remains a risk and might cause cardiac overload (Murakami *et al.*, 2005).

Post-operative IUA

The incidence of post-operative IUAs represents the major long-term complication of hysterosocpic myomectomy ranging from 1 to 13% (Wamstecker *et al.*, 1993; Hallez, 1995; Giatras *et al.*, 1999). 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 (Mazzon, 1995) and multiple fibroids on opposing endometrial surfaces (Indman, 2006). An early second-look hysteroscopy after any hysteroscopic surgery is another effective preventive and therapeutic strategy (Wheeler and Taskin, 1993).

Several pharmacologic (conjugated estrogen, levonorgestrel-releasing intrauterine device) and barrier agents, including foley catheter, hyaluronic acid gel and hyaluronic acid and carboxymethylcellulos (Seprafilm) have been used to reduce IUA development. A recent review has clearly indicated that there is no single modality proven to be unequivocally effective at preventing post-operative adhesion formation for hysteroscopic surgery (Nappi *et al.*, 2007).

Uterine rupture during pregnancy

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 and to document this discussion clearly in the medical records (Valle and Buggish, 2007).

A recent review of the complications after hysterosocpic myoemctomy only reports two cases of uterine rupture following such surgery (Derman *et al.*, 1991; Yaron *et al.*, 1994).

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 (Valle and Buggish, 2007). Although some surgeons believe that caesarean section should be preferred whenever you are dealing with fibroids with intramural development (Keltz *et al.*, 1998; Cravello *et al.*, 2004), currently there is lack of strong evidence to suggest this mode of delivery to reduce the risk of uterine rupture.

Conclusions

Hysteroscopic myomectomy currently represents one of the greatest advances in the field of hysteroscopic surgery. Ideally, it should result in the complete removal of the fibroid (reducing the chance of recurrence and re-growth) (Wamsteker *et al.*, 1993; Parent *et al.*, 1994; Van Dongen *et al.*, 2006) without traumatizing the normal surrounding uterine tissue.

It is well ascertained that fibroids developing completely within the uterine cavity can be easily removed in a single procedure with fibroid size representing the main limiting factor (Mazzon and Sbiroli, 1997; Isaacson, 2003; Indman, 2006).

Resectoscopic slicing still represents the standard widely-used technique for treating such fibroids (Neuwirth, 1995; Mazzon and Sbiroli, 1997; Isaacson, 2003; Gallinat, 2005; Indman, 2006) though several other techniques have been introduced. It is less expensive than laser treatment and quick to perform when you have adequate training. Recently, an innovative and effective device called IUM has been proposed and it may become in the near future a valid alternative to the traditional transcervical resectoscopic myomectomy (Emanuel and Wamsteker, 2005).

Furthermore, the development of smaller diameter scopes with working channels and continuous flow systems together with the establishment of bipolar technology, have made possible the outpatient treatment of small (<1.5–2 cm) totally intracavitary fibroids as well as those with minimal intramural development thus avoiding both cervical dilatation and any anaesthesia or analgesia (Bettocchi *et al.*, 2002; Clark *et al.*, 2002).

On the other hand, 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 (Propst *et al.*, 2000). The frequency of complications and the chance of achieving the complete resection of the lesion at one surgical time, may widely vary depending on the extension of intramural component and the operative technique (Loffer, 1990; Valle, 1990; Derman *et al.*, 1991; Corson and Brooks, 1991; Serden and Brooks, 1991; Pace, 1993; Wamsteker *et al.*, 1993; Hallez, 1995; Jansen *et al.*, 2000; Propst *et al.*, 2000; Agostini *et al.*, 2002; Darwish, 2003; Van Dongen *et al.*, 2006). Furthermore, while differences in equipment do not seem to have significant effects on surgery for fibroids G0, advanced 'state of the art' equipment is necessary for carrying out safe hysteroscopic myomectomy for fibroids with intramural extension (Murakami *et al.*, 2005).

Several techniques have been developed to completely remove such fibroids, all of those aiming at the transformation of an intramural fibroid into a totally intracavitary lesion, thus avoiding a deep cut into the myometrium.

While G1 fibroids may be often completely removed in one step, as the uterus contracts and tends to expel the intramural component into the cavity during surgery, the removal of G2 fibroids may be much more problematic.

In such cases, despite of recent evidence indicating that an incomplete removal does not always necessitate subsequent surgery, patients should always be advised regarding the possibility of another surgical step (Van Dongen *et al.*, 2006).

The present review clearly indicates that there is still no single technique proven to be unequivocally superior to the others for treating fibroids with intramural development (G1-G2). The

two-step technique seems to be very effective and safe; however, the extended GnRH agonist treatment and repeated hysteroscopies can cause greater distress in patients. One-step myomectomy remains more desirable and the 'cold loop' myomectomy seems to represent the best option as it allows a safe and complete removal of such fibroids in just one surgical procedure, while respecting the surrounding healthy myometrium. This might reduce the risk of operative (i.e. bleeding, perforation) and long-term complication (i.e. IUA and uterine rupture).

Other techniques including 'enucleation *in toto*', 'hydromassage' and pharmacologic aided-techniques may be helpful to induce the shrinkage of the intramural portion in the uterine cavity, but the contractile reaction of the myometrium is neither predictable nor standardizable, and this represents an uncertain variable.

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3.2 Laparoscopic sacrocervicopexy for apical support

Pelvic organ prolapse is a common condition and a major cause of gynecological surgery. The aim of pelvic surgery should be to restore as much as feasible the anatomy of the pelvic floor, thus preserving vaginal axis, length, and function in terms of urologic, bowel and sexual functions, with the lowest possible morbidity and recurrence rate. Two primary routes of access in reconstructive pelvic surgery are conventionally used: abdominal and vaginal access.

Hysterectomy is still considered the standard procedure for correcting prolapse. In recent years, some physicians have suggested laparoscopic assisted vaginal hysterectomy as a less invasive alternative for most abdominal hysterectomies because of reduced morbidity and faster recovery.

Vaginal vault prolapse is the main long-term complication of all type of pelvic surgery that includes total hysterectomy. Hence, it is necessary to perform the vaginal vault suspension procedure during hysterectomy.

Abdominal sacrocolpopexy is a vaginal suspension procedure associated with a lower rate of recurrent vault prolapse, reduced grade of residual prolapse, longer time to recurrences and less dyspareunia, when compared to the vaginal. Though sacrocolpopexy – performed interposing a synthetic mesh between the vaginal cuff and the bone – is effective, it is associated to a mesh erosion rate between 0.8 to 9%.

An alternative surgical technique to avoid this complication is the laparoscopic sacrocervicopexy (Fig. 1), a procedure similar to sacrocolpopexy, in which a graft material is used to suspend the cervix to the anterior longitudinal ligament of the sacrum.

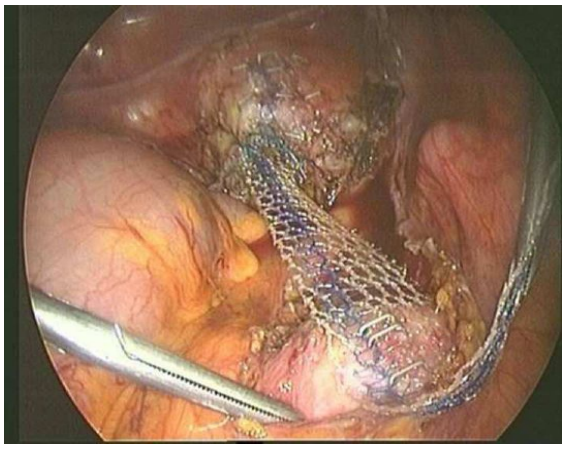

Fig. 1

EFFICACY OF LAPAROSCOPIC SACROCERVICOPEXY FOR APICAL SUPPORT: A NON RANDOMIZED STUDY OF 135 PATIENTS.

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PRĖCIS

Laparoscopic sacrocervicopexy is an effective technique in the treatment of severe pelvic organ prolapse. The advantages include low recurrence rate, absence of mesh erosion and preserving an adequate vaginal length.

ABSTRACT

Study Objective: To evaluate efficacy of laparoscopic sacrocervicopexy for apical support in sexually active patients with pelvic organ prolapse.

Design: Observational case series.

Design classification: Level III according to the Canadian Task Force Classification of Study Designs

Setting: General hospital "San Camillo" in Trento, Italy

Patients: 135 women with symptomatic prolapse of central compartment (Pelvic Organ Prolapse Quantitative – POP-Q – stage 2) associated or not to anterior or posterior compartment prolapse

Interventions: All patients underwent laparoscopic sacrocervicopexy. The operating physicians used synthetic mesh to attach the anterior endopelvic fascia to the anterior longitudinal ligament of the sacral promontory with or without subtotal hysterectomy. We performed anterior and posterior colporrhaphy when necessary. The patients returned for follow up exams one month after surgery and then over subsequent years. On follow up a physician evaluated each patient for the recurrence of genital prolapse and for recurrent or the de-novo development of urinary or bowel symptoms. The study uses pelvic organ prolapse quantification system measurements (POP-Q) to assess pre- and post-operative pelvic organ prolapse. We define "surgical failure" as any grade of recurrent prolapse of score II or more of the POP-Q test. Patients also supplied feedback about their satisfaction with the procedure.

Measurements and Main Results: 13 patients dropped out during the follow up period. The mean follow up period was 33 months. Success rate was 98.4 % for central compartment, 94.2% for anterior and 99.1% for posterior compartment. Postoperatively, the percentage of asymptomatic patients (51.6%) increased significantly ($p<0.01$), and we observed a statistically significant reduction ($p<0.05$) of urinary urge incontinence, recurrent cystitis, pelvic pain,

dyspareunia and discomfort. Stress urinary incontinence (SUI) was resolved in 20 out of 36 patients with preoperative SUI while 18 patients had a de novo SUI. The present study showed 70.5% of patients who stated to have very high satisfaction about the operation and 18.8% high satisfaction.

Conclusion: Laparoscopic sacrocervicopexy is an effective option for sexually active women with pelvic organ prolapse.

Keywords: Laparoscopy; Sacrocervicopexy; Pelvic organ prolapse; Colporrhaphy, pelvic floor repair. Uterine prolapse.

INTRODUCTION

Pelvic organ prolapse is a common condition and a major cause of gynecological surgery. The lifetime risk of having an operation for prolapse may be 11%, and in most cases in which surgery is required, about one-third require re-operation (1-2). The most common etiological factor may be the increased intra-abdominal pressure and softening of the connective tissue mass during pregnancy or the hormonal effects related to pregnancy. However, the existence of pelvic organ prolapse is also associated with several other factors. Such factors include obesity, family history, chronic diseases causing increment in abdominal pressure or congenitally defective genital support (3-6). The aim of pelvic surgery should be to restore the anatomy of the pelvic floor, thus preserving vaginal axis, length, and function in terms of urologic, bowel and sexual functions, with the lowest possible morbidity and recurrence rate. There are three primary routes of access in reconstructive pelvic surgery (abdominal, vaginal, and laparoscopic) for the repair of pelvic floor disorders.

Hysterectomy is still considered the standard procedure for correcting prolapse. In recent years, some physicians have suggested laparoscopic assisted vaginal hysterectomy as a less invasive alternative for most abdominal hysterectomies because of reduced morbidity and faster recovery. More recently, with the availability of morcellators, some physicians have revived the supracervical hysterectomy procedure via laparoscopy.

Vaginal vault prolapse is the main long-term complication of all types of pelvic surgery, and than includes total hysterectomy. The incidence of vaginal vault prolapse is approximately 11.6% when assessed at surgery for prolapse and 1.8% for other benign diseases (7-8) Hence, it is necessary to perform the vaginal vault suspension procedure during hysterectomy.

Abdominal sacrocolpopexy is associated with a lower rate of recurrent vault prolapse, reduced

grade of residual prolapse, longer time to recurrences, and less dyspareunia when compared to the vaginal repairs . A recent Cochrane review stated that abdominal sacrocolpopexy is the more effective procedures and it is considered by many authors the gold standard in the treatment of vaginal vault prolapse.

Vaginal operations for vaginal vault prolapse include sacrospinous ligament fixation and uterosacral ligament suspension. Vaginal prolapse repairs are often faster and offer patients a shorter recovery time.

Laparoscopic sacrocolpopexy aims to bridge the gap between abdominal and vaginal procedure to provide the best outcomes of abdominal sacrocolpopexy with decreased morbidity similar to vaginal procedures (15).

Though sacrocolpopexy – performed interposing a synthetic mesh between the vaginal cuff and the bone – is effective, it is associated to a mesh erosion rate between 0.8 to 9% (1, 11, 13, 15, 16).

An alternative surgical technique to avoid this complication is the laparoscopic sacrocervicopexy. Sacrocervicopexy is a procedure similar to sacrocolpopexy, in which a graft material is used to suspend the cervix to the anterior longitudinal ligament of the sacrum. Sacrocervicopexy can be performed either with uterine preservation or after supracervical hysterectomy.

In our study, we evaluate operative and post-operative complications, recurrence rate, reduction of prolapse related symptoms, and patient satisfaction in 139 consecutive laparoscopic sacrocervicopexies performed with or without subtotal hysterectomy for severe pelvic prolapse.

MATERIALS AND METHODS

From January 1999 through December 2009, all patients with symptomatic genital prolapse who

were referred to the Department of Obstetrics and Gynaecology of General Hospital “San Camillo” in Trento, Italy, were asked to be enrolled in this prospective study. IRB approval of the hospital board was obtained. All women who entered the study received a clear explanation of the study’s purpose and all women provided consent to be included in the study.

Inclusion criteria were: age between 35 and 70 years; sexually active; symptomatic prolapse of central compartment with a Pelvic Organ Prolapse Quantitative (POP-Q) stage (2; associated or not to anterior or posterior compartment prolapse (Figure 1 and 2); normal Pap smear; no chronic systemic disease; no current pregnancy; including ectopic pregnancy; no concurrent use of systemic corticosteroids; and no active pelvic or abdominal infection.

All women wished to restore the anatomical defects as well as to preserve a normal sexual function. Four women also requested to preserve their uterus.

Preoperatively, all patients underwent pelvic organ prolapse quantitative assessment (POP-Q), vaginal ultrasound examination, and a Pap smear. Other demographic variables like parity, BMI, menopausal status, HRT use, previous surgical procedures, and prolapse related symptoms of each patient were recorded. The hospital administered the following questionnaires to assess prolapse related symptoms: Cleveland Clinic Constipation Score (CCCS), Cleveland Clinic Incontinence Score (CCIS), Pelvic Organ Prolapse/Urinary Incontinence Sexual Function Questionnaire (PISQ-12), Urogenital Distress Inventory–Short Form (UDI-6), Incontinence Impact Questionnaire–Short Form (IIQ-7), Patient Global Impression of Severity (PGI-S) and of Improvement (PGI-1), constipation scoring system, and the Patient Assessment of Constipation-Quality of Life Questionnaire (PAC-QOL).

Surgical technique

All the laparoscopic sacrocervicopexies were performed under general anesthesia. Patients were placed in the semi-lithotomy position, which allowed both vaginal and laparoscopic access, and a Foley catheter was placed in the bladder. A curette was placed into the uterus was used as uterine manipulator. After having prepared and draped the patient in sterile conditions, pneumoperitoneum was achieved by Veress needle, and a 10-mm trocar was inserted in the umbilicus, two 5-mm trocars were placed lateral to the inferior epigastric vessels and one 10 mm trocar was placed medially in suprapubic area. With the patient in the Trendelenburg position, the procedure began with subtotal hysterectomy performed by conventional technique, using bipolar forceps for coagulation and monopolar hook for cutting. Bilateral salpingo-oophorectomy was performed in patients with menopausal status in those aged between 50 and 65 years for prevention of ovarian cancer (17-18)

Unilateral salpingo-oophorectomy was performed in cases of ovarian cysts. After the morcellation of the uterus (Rotocut G1 Mocellator - size 15 mm Karl Storz GmbH & Co Tuttlingen, Germany) the operation continued with anterior or posterior vaginal repair performed by conventional vaginal technique. Vaginal procedures were avoided only in case of POP-Q score = 0 for anterior or posterior compartment. Repair of cystocoele and rectocoele should be done initially from below. In fact, if sacral cervicopexy is done first, vaginal colporrhaphy will be more difficult later (19).

The identification of the presacral space, including the common iliac arteries and the middle sacral vessels, was performed. Special attention was paid to identifying the location of the left common iliac vein, which can be more difficult to visualize during laparoscopy because of the

effects of pneumoperitoneum. In addition, the course of the right ureter was identified by its peristalsis. The peritoneum was elevated over the sacral promontory and incised using CO2 laser (Smart Clinic 50w, DEKA, Florence, Italy). The dissection was carried down to the anterior longitudinal ligament of the sacrum (Figure 3), with care taken to avoid injury to the middle sacral vessels.

The peritoneal incision began from cervix and was carried cranially into the pelvis, lateral to the rectosigmoid and medial to the right uterosacral ligament (Figure 4) to avoid injury to the right ureter.

A 10 x 2 cm piece of a wide-pore polypropylene mesh (Gynecare Gynemesh; Ethicon, Somerville, NJ, USA) was introduced through the suprapubic port and secured to the cervix by approximately 5 to 8 agraphes (Endopath EMS 20, Ethicon, Somerville, NJ, USA) and 2 nonabsorbable, braided, polyester sutures (Ethibond Exel 0RH - Ethicon, Somerville, NJ, USA) using an extracorporeal knot-tying technique (Figure 5). The mesh was attached to the anterior longitudinal ligament of the sacral promontory by 2-4 agraphes (Endopath EMS 20, Ethicon, Somerville, NJ, USA) (Figure 6) without undue tension on the mesh (Figure 7).

After the suspension, the extra mesh is shortened and completely covered by re-approximating the peritoneum over the Mesh with 2 continuous sutures (Figures 8) performed by conventional absorbable polymer sutures (Dexon II 0-V20 - Syneture, U.S. Surgical; Norwalk, Connecticut, USA) using an extracorporeal knot-tying technique.

One month after surgery and then each year, all patients were followed up with pelvic exam, including transperineal ultrasound scan to evaluate the recurrence of genital prolapse. The follow-

up visit was not performed by members of surgical equipe. As described in the literature (20), we consider “surgical failure” to be any grade of recurrent prolapse of score II or more of the POP-Q test. During these visits, the recurrent or the de-novo urinary or bowel symptoms were also evaluated via the same questionnaires previously described (CCCS, CCIS, PISQ-12, UDI-6, IIQ-7, PGI-S, PGI-1, PAC-QOL). Patients were also asked about their level of satisfaction regarding the surgical procedure. Women had to choose between five different assessments of satisfaction: no satisfaction, low satisfaction, moderate satisfaction, high satisfaction, and very high satisfaction). Furthermore, we asked if they would recommend the same surgical procedure to others with apical prolapse.

Three months after surgery, an adjunctive follow-up visit was performed with patients with urinary or bowel symptoms. Patients with urinary symptoms underwent cotton-swab determination of urethral mobility, post-void residual by ultrasound or catheterization, and urodynamic testing with prolapse reduction. Patients with stress urinary incontinence (SUI) during urodynamic testing underwent tension free vaginal tape procedure (TVT). Patients with bowel symptoms underwent physical examination, anoscopy, endoanal ultrasound, anorectal manometry and defecography. Patients with obstructed defecation syndrome (ODS) underwent stapled transanal rectal resection (STARR).

Comparison of preoperative and postoperative POPQ score in central, anterior and posterior compartments and preoperative and postoperative frequency of symptoms, was done using paired Z-test (a variant of the Student t test). All p values were 2-sided, and those less than 0.05 were considered to indicate statistical significance.

RESULTS

From January 1999 to December 2009, 136 patients with symptomatic genital prolapse were enrolled. Patients' characteristics, previous surgery, and concomitant pathologies are listed in Table 1.

Pre-operative prolapse related symptoms were as follows: SUI (36 cases – 24.5%), urinary urge incontinence (21 cases- 15.4%), urinary retention (4 cases – 2.9%), high urinary frequency (3 cases – 2.2%), recurrent cystitis (9 cases – 6.6%), bowel symptoms (5 cases- 3.7%), pelvic pain (11 cases – 8,1%), dyspareunia (9 cases – 6.6%), and discomfort (72 cases – 52.9%). 29 women (21.3%) were asymptomatic (Table 2).

Accordingly preoperative prolapse severity graded by the POP-Q stages is shown in Table 3.

One patient enrolled in the study was excluded because of impossibility to identify sacral promontory related to high patient's BMI and to the presence of severe adhesions. She underwent vaginal hysterectomy.

All other patients (135 women) underwent supracervical hysterectomy and sacrocervicopexy. Anterior and/or posterior vaginal repairs were also performed in 118 (87,4%) and 113 (83.7%) patients respectively. Bilateral salpingo-oophorectomy was performed in 90 patients (66.7%). Three Moschowitz procedures, 2 enucleation of ovarian cysts, 7 unilateral salpingectomy and 8 unilateral salpingo-oophorectomy were also performed. Hydrosalpinx and ovarian cysts were diagnosed intraoperatively in 2 and 7 cases respectively.

Mean operative time was 244 minutes (± 51 SD; range 114-425 min), mean hospitalization days was 5.7 days (± 1.2SD; range 3-15 days) and mean hemoglobin decrease was 2.1 gr/dl (± 0.8 SD; range 0.5-4.1 gr/dl) as listed in Table 4.

We had 5 cases with temperature of 38° C. One of these patients developed pneumonia and had a

prolonged hospital course of 15 days. Other complications included two cases of deep vein thrombosis without pulmonary involvement and one case of urinary retention, treated with suprapubic catheter placement.

One month after surgery and then subsequently, all patients were interviewed by telephone and were called in for follow up evaluation. Among these women, 13 patients were lost during the follow-up stages. The mean follow up period was 33 months (12-114 months).

The following data refer to the last follow-up visit of study group. 117 patients (95.9%) were found at POP-Q stage 0 for central compartment; 99 (81.1%) for anterior compartment and 119 (97.5%) for posterior compartment. Three women (2.5%) were diagnosed a stage I relapse in the central compartment, 16 (13.1%) were diagnosed a stage I in the anterior compartment, and 2 (1.6%) were diagnosed a stage I in the posterior compartment (Table 3).

We defined "surgical failure" as any recurrent prolapse of stage II or more of the POP-Q test. Two patients (1.6 %) had a stage II central prolapse, seven patients (5.7%) had a stage II anterior prolapse, and one (0.8%) had a stage II posterior prolapse. There were no cases of grade III or IV recurrences. Therefore, success rate was 98.4 % (120 out of 122 patients) for central compartment, 94.2% (115 out of 122 patients) for anterior compartment and 99.2% (121 out of 122 patients) for posterior compartment.

One of the two patients with stage II recurrence in the central compartment had a detachment of the mesh at the site of the cervical stump. She underwent laparotomy for sacrocervicopexy without any further recurrence. The other woman refused re-operation and has been lost to follow up. No mesh erosions occurred in our study.

Any improvement about the pre-operative complaints was also assessed (Table 2). Postoperatively percentage of asymptomatic patients (51.6%) increased significantly ($p<0.01$)

while a statistically significant reduction ($p<0.05$) of urinary urge incontinence, recurrent cystitis, pelvic pain, dyspareunia, and discomfort was observed.

On the contrary, 34 patients (27.9%) suffered from SUI but 18 out of 34 patients had a de novo SUI. Preoperatively 36 cases of preoperative SUI were observed. After surgery, 3 patients were lost to follow-up while SUI was resolved in 20 cases and persisted in 16 patients.

When asked about their personal satisfaction, 86 women (70.5%) stated to have very high satisfaction, 23 (18.8%) high satisfaction, 9 (7.4%) moderate satisfaction, 3 (2.4%) low satisfaction (score 2) and only 1 (0.8%) expressed a negative feeling about the operation. Furthermore, when requested if they would recommend the same surgical procedure, 117 women (95.9%) answered YES and only five (4.1%) said NO.

Three months after surgery 34 patients had urinary symptoms and two had bowel symptoms. 45 patients underwent urodynamic tests. Urinary urge incontinence was diagnosed in 11 women, and SUI were diagnosed in 34 patients. Of the patients with SUI, 18 cases were de novo and 16 cases were persistent. Only ten patients underwent TVT procedure because the others did not consider it necessary to treat their urinary symptoms. Only 1 patient underwent proctoscope. No case of obstructed defecation syndrome was confirmed by tests.

DISCUSSION

Surgery for pelvic organ prolapse is associated with an incidence of vaginal vault prolapse significantly higher than surgery for other benign diseases (11. 6% versus 1.8%). (7, 8)

Abdominal sacrocolpopexy, performed interposing a synthetic mesh between the vaginal cuff and

the bone, is one of the more effective procedures and many authors consider it the gold standard in the treatment of vaginal vault prolapse (9). On the other hand, this procedure is associated to a long operating time, long time to return to activities of daily living and high cost. A laparoscopic approach for this procedure, described by Nezhat in 1992, made possible to avoid these disadvantages.(21-23)

Even if vaginal sacrocolpopexy is highly effective, it is associated to a mesh erosion rate between 0.8 to 9%.(1, 9, 11, 12, 15). An alternative surgical technique to avoid this complication is laparoscopic sacrocervicopexy.

The sacrocervicopexy, first described in 1976, was never applied routinely, because of its imprecise clinical role. Until now, sacrocervicopexy was performed to treat uterovaginal prolapse in women who desired to preserve their uterus and fertility (5, 24). In 2001, Leron et al described their results from 13 women with symptomatic uterovaginal prolapse treated by sacrohysteropexy. No complications occurred, and only one patient had first-degree uterine prolapse.(25) A small study of three patients who underwent abdominal sacrohysteropexy for preservation of fertility was published. (5) The study of Rosenblatt (24) is a retrospective case series of 40 women with uterine prolapse who underwent sacrohysteropexy. Success was defined in that study as an improvement in point C from the preoperative position and that point C was above the hymen postoperatively. No patient failed for apical suspension.

In our study, we treated pelvic organ prolapse by sacrocervicopexy after supracervical hysterectomy in those patients with other benign diseases (meno-metrorrhagia, fibromatous uterus, large myomas, etc) or if they wanted to remove the uterus. We added vaginal repair, anterior colporrhaphy, or posterior colporrhaphy at the same surgery in case of the anterior or

posterior compartment prolapse.

Until now most surgeons have not performed supracervical hysterectomy for the theoretical risk of cervical cancer. As reported from a Cochrane review (26), the true risk of cervical stump carcinoma among women with previously normal Pap smears is approximately 0.3% (27). That percentage is the same risk of vaginal carcinoma following hysterectomy for benign disease. (28) A review of several several studies reveals that subtotal hysterectomy offers no true benefit for urinary, bowel, and sexual function, when compared with total hysterectomy, despite the procedure being significantly faster with a lower blood loss and a reduced post-operative morbidity. (26, 29-32).

We performed urodynamic and clinical investigation three months after surgery in symptomatic patients. The incidence of postoperative SUI after laparoscopic sacrocolpopexy is 17.8% (range: 2.4–44%) as reported by a recent review. (15) Postoperative SUI includes de novo and preoperative functionally occult SUI becoming clinically manifest during postoperative period. One of the main purposes of a clinical and urodynamic examination before surgery is to identify women at risk of postoperative SUI. In these cases, some authors (33-34) suggest that performing anti-incontinence procedure at the time of initial surgery may reduce postoperative SUI. Conversely, de novo SUI can also appear after surgery despite a normal previous assessment. Performing anti-incontinence procedure has been shown to reduce postoperative SUI rates. (35). This approach is not preferable considering that up to 20% of women who undergo anti-incontinence procedures have complications including difficulty in voiding, urgency, and urge incontinence. (34) Performing urodynamic tests three months after surgery allows diagnosing and treating both de novo and preoperative functionally occult SUI.

Our technique of supracervical hysterectomy, sacrocervicopexy, anterior colporrhaphy, and posterior colporrhaphy obtained a 91.8 % success rate, a reduced number of recurrence (10 out of 122 patients) with a recurrence rate of 0.8 % in the posterior, 5.7 % in the anterior and 1.6% in the central compartment. From a recent review (15) emerges that long-term failure rates for abdominal sacrocolpopexy range from 0% to 26% and laparoscopic sacrocolpopexy has similar rates.

In the present study, we did not have a single incidence of mesh erosion in 135 cases of sacrocervicopexy. The preservation of the cervix allows the surgeon to avoid opening the vagina. During a sacrocolpopexy after a total hysterectomy, the vaginal cuff may have a reduced vascular supply secondary to scar tissue, which can compromise the healing process and lead to erosion. A vaginal repair performed at the same time of an abdominal sacrocolpopexy has been associated with a slightly higher incidence of mesh erosion. (36) In addition, because sacrocervicopexy does not require an anterior extension, less mesh is used compared with sacrocolpopexy. Reduction of mesh load is thought to be a factor in reducing the risk of mesh erosion in pelvic reconstructive surgery.

Our study showed a significant reduction of prolapse related symptoms and a very low percentage of postoperative complaints. In nine studies evaluated in a recent review (15) laparoscopic sacrocolpopexy has been associated with postoperative sexual dysfunction (7.8% - range: 0–47%) and postoperative bowel dysfunction (9.8% - range: 0–25%), including constipation, anal pain, and one case of fecal incontinence. In our study, only 1.6% of patients had bowel symptoms and only 0.8% had dyspareunia (0.8%). The presence of the utero-sacral ligaments seems to improve the quality of sexual life. (16, 37)

The laparoscopic route has several well-known advantages such as short hospitalization and low postoperative pain. Also it is aesthetically appealing and it allows a rapid return to work and normal activities. Laparoscopy also provides a magnification of the surgical field, which might allow a better placement of the stitches thereby increasing the likelihood of an improved long-term outcome. However, at the beginning this procedure may be time consuming because of a long learning curve.

Vaginal hysterectomy with anterior and posterior colporrhaphy may cause dyspareunia because of necessity to reduce vaginal size to obtain an optimal suspension of the vaginal vault. (38-39). For these reasons, in case of severe pelvic prolapse (POP-Q II-IV), we choose vaginal hysterectomy only in women who did not desire normal sexual activity, whereas we prefer laparoscopic sacrocervicopexy in patients who wish to correct their anatomical pelvic floor defects as well as to maintain a normal sexual function. (Figure 9)

In conclusion, sacrocervicopexy is an effective technique in the treatment of severe pelvic organ prolapse. The advantages include a low recurrence rate, absence of mesh erosion, preserving an adequate vaginal length, and maintaining the proper physiological vaginal axis.

In our series, preserving the cervix avoided the possibility of mesh erosion, which is a complication that affects sacrocolpopexy. It would be of clinical interest to compare sacrocervicopexy and sacrocolpopexy as there are no prospective, randomized trials comparing the two techniques.

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Legend of figures

Figure 1 Diagrammatic representation of POP Q staging

Figure 2 Pelvic Organ Prolapse Quantitative (POP-Q) staging

Figure 3 Anterior longitudinal ligament in the presacral space.

Figure 4 Pelvic peritoneum opened up to lay the mesh.

Figure 5 Mesh secured to the cervix.

Figure 6 Mesh secured to the sacral promontory.

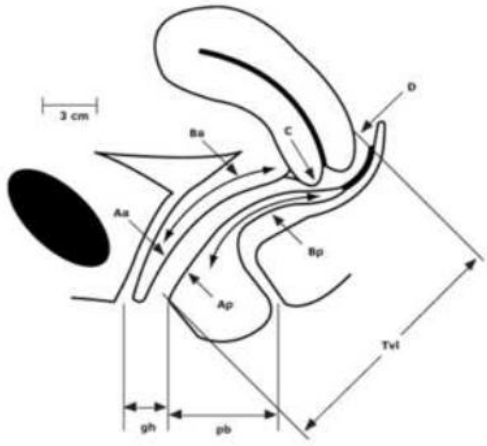
Figure 7 No undue tension in the mesh noted.

Figure 8: Pelvic peritoneum reapproximated.

Figure 9: Guide-lines

(SLH: subtotal laparoscopic hysterectomy; AC: anterior colporrhaphy; PC: posterior colporrhaphy; VH: vaginal hysterectomy).

Figure 1



Point	Description	Range of Values
Aa	Anterior vaginal wall 3 cm proximal to the hymen	-3 cm to +3 cm
Ba	Most distal position of the remaining upper anterior vaginal wall	-3 cm to +tvl
C	Most distal edge of cervix or vaginal cuff scar	
D	Posterior fornix (N/A if post-hysterectomy)	
Ap	Posterior vaginal wall 3 cm proximal to the hymen	-3 cm to +3 cm
Bp	Most distal position of the remaining upper posterior vaginal wall	-3 cm to + tvl

Genital hiatus (gh) – Measured from middle of external urethral meatus to posterior midline hymen
Perineal body (pb) – Measured from posterior margin of gh to middle of anal opening
Total vaginal length (tvl) – Depth of vagina when point D or C is reduced to normal position

Figure 2

POP-Q Staging Criteria	
Stage 0	Aa, Ap, Ba, Bp = -3 cm and C or D ≤ – (tvl – 2) cm
Stage I	Stage 0 criteria not met and leading edge < -1 cm
Stage II	Leading edge ≥ -1 cm but ≤ +1 cm
Stage III	Leading edge > +1 cm but < + (tvl – 2) cm
Stage IV	Leading edge ≥ + (tvl – 2) cm

Figure 3

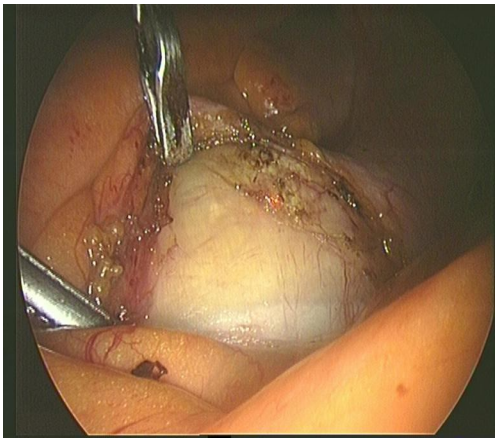


Figure 4

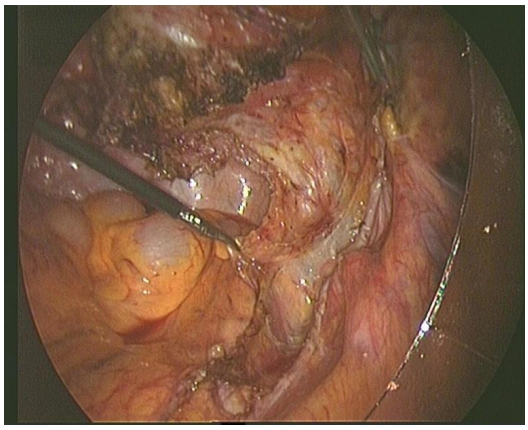


Figure 5

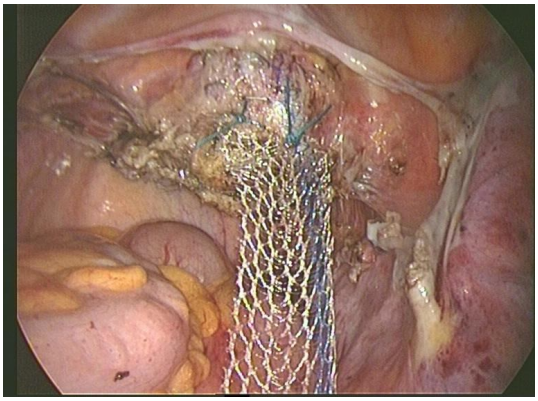


Figure 6

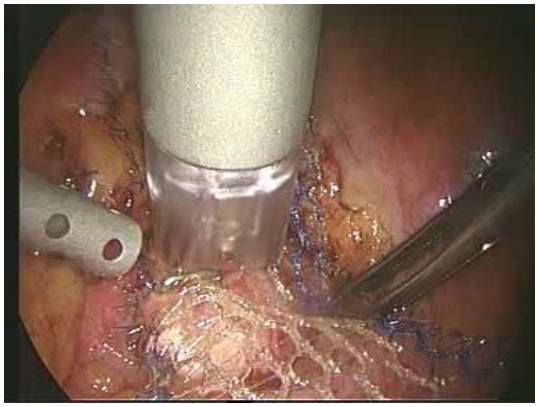


Figure 7

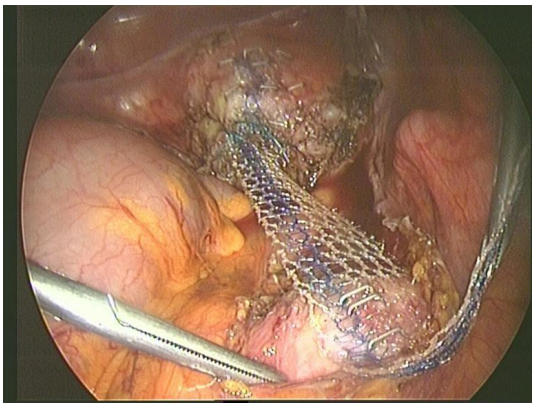


Figure 8

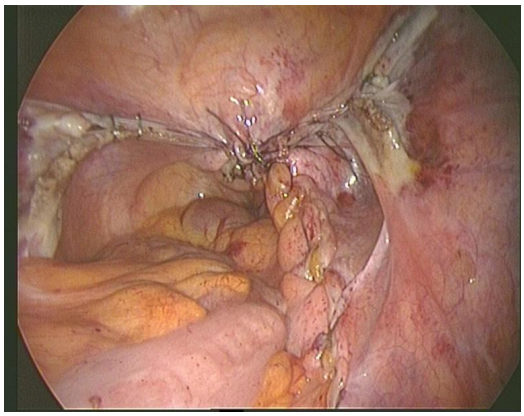


Figure 10

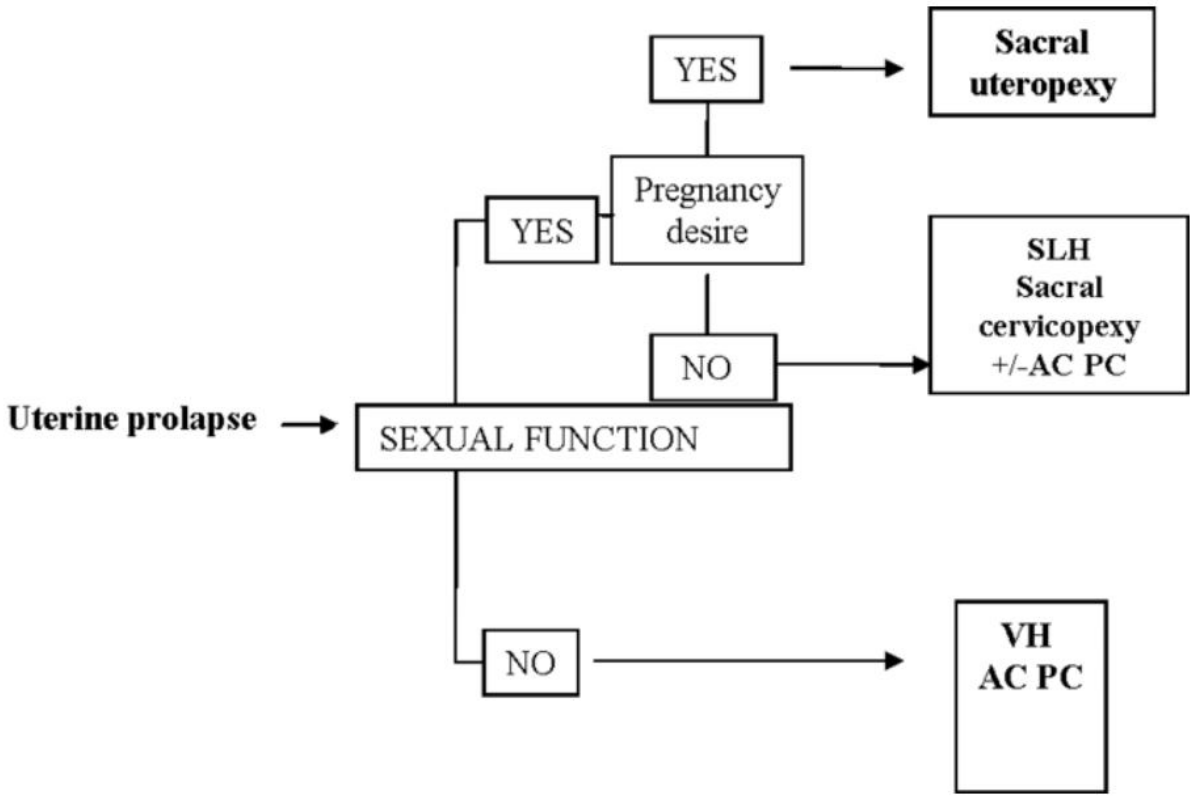


Table 1: Patients' characteristics

Age (Mean ± SD)	53,4 ± 8 SD (95% CI 52,07 - 54,73)
Parity (Mean ± SD)	2.02 ± 0,9 SD (95% CI 1,87 - 2,17)
BMI (Mean ± SD)	24,1 ± 3,3 SD (95% CI 23,67 - 24,73)
Smoke (%)	8,1%
Menopause (%)	55,9%
HRT use (%)	6,6%
Previous abdominal surgery (%)	60.3%
Concomitant pathologies (%)	24,3%
Fibromatous uterus (%)	5,7%
Myomas (%)	11%
Metrorrhagia (%)	6,6%
Post-menopausal bleeding (%)	2,2%
Ovarian cysts (%)	5,1%

Table 2: Difference between Pre and post operative findings.

	SYMPTOMS (%)									
	No symptoms	**SUI**	**Urinary urge incontinence**	**Urinary retention**	**High urinary frequency**	**Recurrent cystitis**	**Bowel symptoms**	**Pelvic pain**	**Dyspareunia**	**Discomfort**
Pre-operative	21,3	24,5	15,4	2,9	2,2	6,6	3,7	8,1	6,6	52,9
Post-operative	51,6	27,9	9,8	3,3	0	0,8	1,6	1,6	0,8	5,7
Z score	**5,110**	**-0,627**	**1,364**	**0,188**	**1,673**	**2,451**	**1,053**	**2,421**	**2,451**	**8,287**
P-value	**<0.0001**	**0,5041**	**0,048**	**0,887**	**0,054**	**0,009**	**0,199**	**0,004**	**0,015**	**<0,0001**
Significant α = 0,05	Yes	No	Yes	No	No	Yes	No	Yes	Yes	Yes

Table 3: pre and postoperative prolapse severity graded by the POP-Q stages

					Significant $\alpha = 0,05$
	STAGE 0				
Compartment	**pre-operative**	**post-operative**	**Z-score**	**P-value**	
central	0	117 (95,9%)	15,734	<0,0001	yes
anterior	17 (12,5%)	99 (81,1%)	11,265	<0,0001	yes
posterior	21 (15,4%)	119 (97,6%)	13,860	<0,0001	yes
	STAGE I				Significant
Compartment	**pre-operative**	**post-operative**	**Z-score**	**P-value**	
central	0	3 (2,5%)	1,896	0,291	no
anterior	14 (10,3%)	16 (13,1%)	0,726	0,932	no
posterior	55 (40,5%)	2 (1,6%)	7,911	<0,0001	yes
	STAGE II				Significant
Compartment	**pre-operative**	**post-operative**	**Z-score**	**P-value**	
central	65 (47%)	2 (1,6%)	8,748	<0,0001	yes
anterior	40 (29,4%)	7 (5,8%)	5,055	<0,0001	yes
posterior	53 (39 %)	1 (0,8%)	7,834	<0,0001	yes
	STAGE III				Significant
Compartment	**pre-operative**	**post-operative**	**Z-score**	**P-value**	
central	67 (49,3%)	0	9,242	<0,0001	yes
anterior	64 (47,1%)	0	8,965	<0,0001	yes
posterior	7 (5,1%)	0	2,618	0,011	yes
	STAGE IV				Significant
Compartment	**pre-operative**	**post-operative**	**Z-score**	**P-value**	
central	5 (3,7%)	0	2,205	0,019	yes
anterior	1 (0,7%)	0	0,978	0,342	no
posterior	0	0	0,000	1,000	no

Table 4: Operative time, hospitalization, hemoglobin decreased.

	Median	SD	Range
operative time (minutes)	244.35	50.69	114-425
hospitalization (days)	5.72	1.19	3-15
hemoglobin decreased (gr)	2.12	0.81	0.5-4

3.3 Laparoscopic multivisceral resection for deep pelvic endometriosis

Deep infiltrating endometriosis treatment is recommended when the disease is symptomatic and causes a reduction in the quality of life. A complete excision of endometriosis seems to provide longterm pain relief, improved quality of life, and a low rate of recurrent disease also in case of bowel involvement (Fig. 1). Therefore there is a wide acceptance even if a bowel resection is necessary.

Ureteral tract endometriosis (Fig. 2) is characterized by endometrial glands and stroma in or around the urinary tract. The use of ureterolysis for extrinsic endometriosis is a safe and effective technique In cases of intrinsic endometriosis it is generally accepted that a ureteral resection is mandatory, along with primary ureteroureterostomy or ureteral reimplantation with or without a vesicopsoas hitch.

Both bowel resection and ureteral resection and ureteroneocystostomy with vesicopsoas are surgical procedures usually performerd via laparotomy. Our manuscript ***(Pignata G, Bramante S, Merola G, Bracale U. Laparoscopic multivisceral resection for deep pelvic endometriosis. Acta of 113° Congress SIC 2011)*** shows some data demonstrating that the treatment of bowel and ureteral endometriosis by laparoscopy and open surgery result in a similar improvement in symptoms and quality of life but blood loss, analgesic consumption and complication rate are lower in patients undergoing laparoscopy.

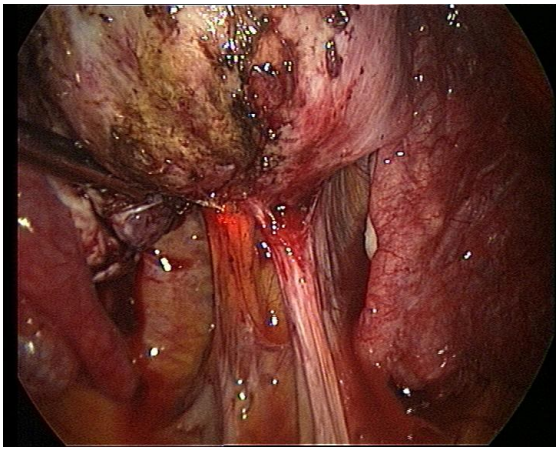


Fig. 1

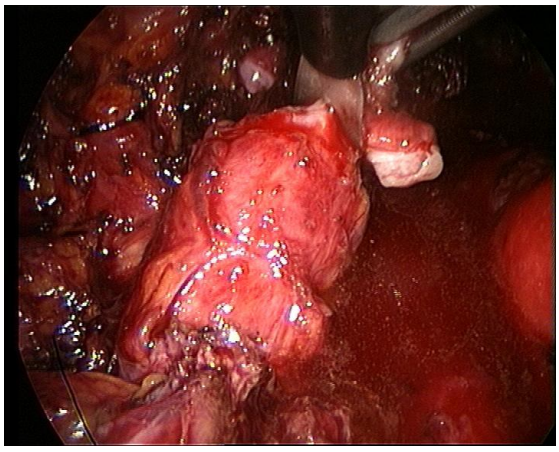


Fig. 2

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BARBATO D. »
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BERTOZZI S. »
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CAGOL M. »
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CAMANDONA M. »

BRACALE U. STAMPA »

Atti 113° congresso SIC 2011

Topic: ENDOMETRIOSI INTESTINALE

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Titolo Relazione:
LAPAROSCOPIC MULTIVISCERAL RESECTION FOR DEEP PELVIC ENDOMETRIOSIS

Prevalence and Symptoms of Bowel and Urinary Tract Endometriosis

Endometriosis is defined as the presence of endometrial gland and stroma outside the uterus and affects 5-10% of the women of child bearing age [1-3]. Deep Infiltrating Endometriosis (DIE) is defined as a lesion reaching a depht of 5 mm or more into the peritoneum and it involves the

Torna al menù »

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Prevalence and Symptoms of Bowel and Urinary Tract Endometriosis

Endometriosis is defined as the presence of endometrial gland and stroma outside the uterus and affects 5-10% of the women of child bearing age [1-3]. Deep Infiltrating Endometriosis (DIE) is defined as a lesion reaching a depht of 5 mm or more into the peritoneum and it involves the Douglas pouch, the rectovaginal septum and the uterosacral ligaments [4-6].

Although endometriosis rarely involves the full thickness of the rectosigmoid colon, it may invade the muscularis of the bowel wall [7].

The prevalence of Bowel Endometriosis (BE) in the general population is unknown, although it is estimated that it affects between 3.8 and 37% of women with endometriosis [8]. The rectum and rectosigmoid junction together account for 70 to 93% of all intestinal lesions [9, 10], followed by the ileum, the appendix and the cecum [8].

Urinary tract endometriosis (UTE) is characterized by the presence of endometrial glands and stroma in or around the urinary bladder wall, ureters, urethra, and kidney [11]. It is estimated to affect between 0.3 and 6% of patients with a diagnosis of endometriosis [12]. The ratio of bladder/ureter/ kidney/ urethral endometriosis is 40:5:1:1 [12-14]. Although Ureteral Endometriosis (UE), as first described by Cullen in 1917 [15], is rare (fewer than 1% of all UTE), it can asymptomatically lead to a compromised renal function secondary to hydronephrosis. Up to 47% of patients with UE require nephrectomy at the time of diagnosis [16, 17]. There are two types of UE: intrinsic and extrinsic. Extrinsic is the most common, accounting for 80% of cases of UE, and is characterized by ectopic endometrial tissue involving the ureteral adventitia or surrounding connective tissues. Intrinsic UE involves the uroepithelial and submucosal layers.

Small endometriotic lesions reaching only the subserosal fat tissue do not cause symptoms [18]. Larger nodules infiltrating the intestinal muscular layer cause a wide range of symptoms: dyschezia, constipation, diarrhea, abdominal bloating, painful bowel movements, passage of mucus in the stools and cyclical rectal bleeding [18, 19].

Patients may complain of dysmenorrhea, deep dyspareunia, chronic pelvic pain (acyclic) and/or infertility. Particularly when the bowel and the bladder are affected, patients may also experience pain during micturition and evacuation.

Although UE can cause flank pain and gross hematuria in some patients, in more than 50% of cases there are nonspecific symptoms; thus, there are often delays in diagnosis leading to substantial morbidity [20, 21].

Obviously, large nodules may thicken the visceral wall, resulting in a stenosis of the visceral lumen and mechanically hampering visceral transit.

Diagnosis of Bowel and Urinary Tract Endometriosis

The intestinal diagnosis is a controversial subject. The double contrast barium enema used in colon evaluation and scientific literature has long reported on the use of this technique in intestinal endometriosis [22].

Radiographic findings are constituted as masses extrinsic to the colon wall, with irregular and speculated limits, determining thin defects of the parietal profile [22, 23].

Transvaginal ultrasonography may not only accurately diagnose the presence of rectosigmoid endometriosis but it may also estimate the depth of infiltration of the nodules in the intestinal wall [24-26].

Endometriotic lesions have a typical signal in Magnetic Resonance Imaging (MRI): high intensity in T1 weighted images and in T2 weighted images. Some studies comprising patients with suspected endometriosis demonstrated that MRI has a sensitivity of 88%, a specificity of 98%, a positive predictive value of 95%, a negative predictive value of 95%, and an accuracy of 95% in diagnosing intestinal endometriosis [27-31].

Colonoscopy has value only in the diagnosis of intestinal endometriosis caused by large nodules infiltrating the mucosa and/or causing a severe stenosis of the intestinal lumen.

Recently the Multi Slides Computered Tomography Enteroclysis has been proposed as a method to detect intestinal endometriotic wall lesions.

There are no specific diagnostic tests for UE and the diagnosis requires a high index of suspicion. The diagnostic tests include ureteroscopy with endoluminal ultrasound, laparoscopy, computerized tomography, pelvic ultrasound, and excretory urography [32].

Treatment of Bowel and Urinary Tract Endometriosis

Surgical options for management of bowel wall involvement include cautery excision, laser vaporization, disc excision of bowel wall or bowel resection.

The choice of the surgical technique is based on the characteristics of the intestinal lesions such as number of nodules, size of the nodules, depth of infiltration of the intestinal wall.

Since the first case of laparoscopic sigmoid resection for endometriosis [33], a few small studies have confirmed the feasibility of laparoscopic colorectal resection for endometriosis. Many improvements about risk of complications and long-term efficacy have been made [34-37].

DIE is recommended when the disease is simptomatic and causes a reduction in the quality of life [38, 39]. A complete excision of endometriosis seems to provide longterm pain relief, improved quality of life, and a low rate of recurrent disease [40-42] also in case of bowel involvement [33, 43, 44-47]. Therefore there is a wide acceptance even if a bowel resection is necessary [3, 38, 48, 49]. A recent trial (laparoscopic *vs* open colorectal resection) demonstrated that the two surgical techniques result in a similar improvement in symptoms and quality of life [50]. However, blood loss, analgesic consumption and complication rate were higher in patients undergoing open surgery [50].

BE often is a multicentric and multifocal disease and involves enteric nervous system and the interstitial cells of Cajal [4, 51].

Kavallaris concludes saying that in more than one third of patients a distance of 2 cm from the main lesion is not sufficient to obtain clean margins. Remorgida affirms that full thickness colorectal resection is associated with a risk of incomplete resection in nearly half of the patients. Kavallaris showed not obvious difference in complicance rate between resection and ablation [4] while the recurrence rate is higher when a local excision or disc resection is practiced [4, 36, 46, 52].

We think that laparoscopic bowel resection for DIE must be practiced in all Stage IV cases (Adamyan Classification) [53].

Segmental resection may be associated with several complications including urinary retention, inadvertent ureteral lesions, anastomotic leakage, rectovaginal fistulas, anastomotic stenosis, pelvic abscesses and postoperative constipation [8, 54, 55].

Ureteral Tract Endometriosis (UTE) is characterized by endometrial glands and stroma in or around the urinary tract [56]. Ureteral resection and ureteroneocystostomy with vesicopsoas is a surgical procedure usually performerd via laparotomy [57]. Recent studies have reported that this technique provides positive long-term results; in addition, it is associated with minimal complications and a high success rate [58]. Reported side effects include injury to the femoral nerve branches during placement of the psoas muscle sutures.

The use of ureterolysis for extrinsic endometriosis is a safe and effective technique [57, 59]. Others maintain that a ureteral resection should be performed in all cases of hydroureteronephrosis. In cases of intrinsic endometriosis it is generally accepted that a ureteral resection is mandatory, along with primary ureteroureterostomy or ureteral reimplantation with or without a vesicopsoas hitch [20, 57, 60]. It is important to achieve a tension-free anastomosis, and a vesicopsoas hitch procedure may be needed. The largest series of ureterolysis reports a 15% recurrence rate. It also recommends that patients should be informed about the need of close follow-up [59]. Our opinion is that simple ureterolysis is effective in cases of extrinsic UE. With regard to ureteroneocystostomy, many techniques have been described. Unlike short distal ureteric defects which are suitable to an end-to-end anastomosis or ureteroneocystostomy, the cases with longer defects require more complex reconstructive procedures. Gozen et al. [61] reported a series of laparoscopic psoas hitch with

excellent results. There are other reconstructive techniques which use replacements with bowel segments or bladder flaps [62, 63].

Lich-Gregoir technique is used in the management of vesicoureteral reflux in renal transplantion [64].

In conclusion, it must remarked that DIE is a progressive desease, difficult to diagnose with heavy evolution. BE and UTE should be managed in specialised centers with a multidisciplinary equipe (radiologist, gynecologist, surgeon and urologist); it requires a high surgeon skill and it must be practiced considering the risks and the benefits without forget that it should be a radical but not a demolition surgery.

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CHAPTER IV : PREVENTION OF ADHESIONS FORMATION AFTER ENDOSCOPIC SURGERY

Adhesions resulting from gynaecological endoscopic procedures (Fig. 1- 2) are a major clinical, social and economical concern as they may result in pelvic pain, infertility, bowel obstruction and additional surgery to resolve such adhesion-related complications. Although minimally invasive endoscopic approach has been shown to be less adhesiogenic than traditional surgery, at least with regard to selected procedures, it does not totally eliminate the problem.

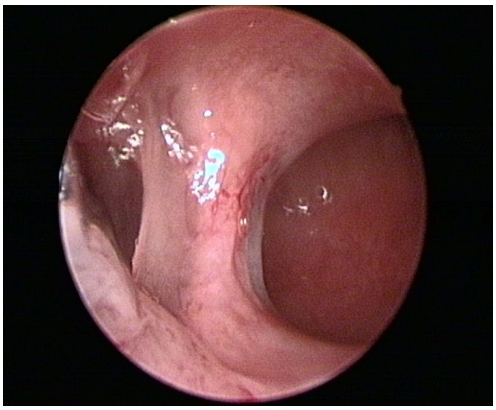

Fig. 1

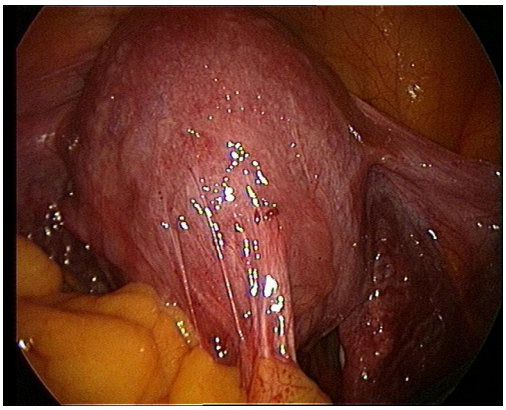

Fig. 2

Consequently, many attempts have been made to further reduce adhesion formation and re-formation following endoscopic procedures and a wide variety of strategies, including surgical techniques, pharmacological agents and mechanical barriers have been advocated to address this issue.

In a prospective, randomised, controlled study, our group ***(Pellicano M, Bramante S, Cirillo D, Palomba S, Bifulco G, Zullo F, Nappi C. Effectiveness of autocrosslinked hyaluronic acid gel after laparoscopic myomectomy in infertile patients: a prospective, randomized, controlled study. Fertil Steril. 2003 Aug;80(2):441-4.)*** have already assessed

the efficacy of a resorbable agent barrier, the autocrosslinked hyaluronic gel (Fig. 3) (ACP gel), in postsurgical adhesion prevention after laparoscopic myomectomy. The antiadhesive effect is believed to be a consequence of its barrier effect, keeping the traumatized surfaces separated for a sufficient duration.

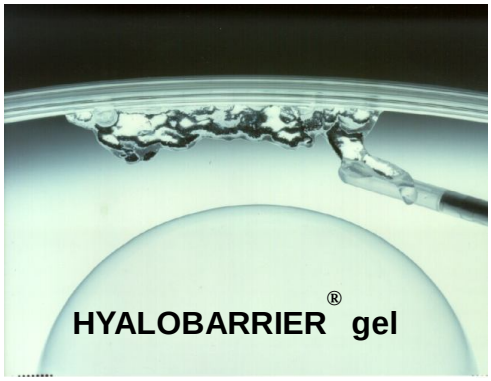

Fig. 2

We showed that in patients treated by laparoscopic myomectomy and application of the ACP gel, the rate of subjects who developed postoperative adhesions was significantly lower in comparison with patients treated by laparoscopic myomectomy alone. Moreover the rate of postsurgical adhesions was also significantly dependent on the types of laparoscopic sutures that were used to close uterine defects, in both treated patients and controls. Further, we demonstrated that the application of ACP as an antiadhesive barrier in infertile patients undergoing laparoscopic myomectomy, is associated with more increased pregnancy rates than laparoscopic myomectomy alone (***Pellicano M, Guida M, Bramante S, Acunzo G, Di Spiezio Sardo A, Tommaselli GA, Nappi C. Reproductive outcome after autocrosslinked hyaluronic acid gel application in infertile patients who underwent laparoscopic myomectomy. Fertil Steril. 2005 Feb;83(2):498-500.).***

Here we show the results of our recent studies evaluating both the role of some adjusts in the surgical technique of laparoscopic treatment of ovarian endometrioma and the efficacy of intrauterine administration of a resorbable agent barrier (Intercoat - Gynecare, division of

Ethion, Inc.) in the prevention of abdominal adhesions formation after endoscopic surgery.

4.1 Efficacy of a Polyethylene Oxide–Sodium Carboxymethylcellulose Gel in Prevention of Intrauterine Adhesions After Hysteroscopic Surgery

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. Intrauterine adhesions (IUA) mostly develop as a result of forced intrauterine intervention such as post-partum or post-abortion overzealous dilatation and curettage . Secondary causes of IUA include postabortal and puerperal sepsis , particulate infections such as tubercolous endometritis pelvic irradiation and previous uterine surgery (e.g. caesarean section, myomectomy, metroplasty). Furthermore, IUA represent the major long-term complication of operative hysteroscopy. The frequency of postoperative IUA development depends on the pathology initially treated and is particularly high following resectoscopic myomectomy and metroplasty.

IUA may be asymptomatic, but their development may also result in hypomenorrhea/amenorrhea, infertility recurrent miscarriages irregular periods with dysmenorrhoea and pelvic pain as well as obstetric morbidity, mainly related to abnormal placentation**.**

Several strategies have been developed in an attempt to minimize the risk of postsurgical IUAs including administration of pharmacologic agents such as antibiotics, gonadotropin-releasing hormone analogues , and postoperative conjugated estrogens; use of barrier methods such as a Foley catheter or an intrauterine device; and application of gel. However, at present, no single method has proved unequivocally effective in preventing postoperative IUAs .

We report our experience with intrauterine administration of Intercoat Absorbable Adhesion Barrier Gel (Fig. 1) (a viscoelastic gel formulated for laparoscopic application) in the prevention of intrauterine postoperative adhesions formation

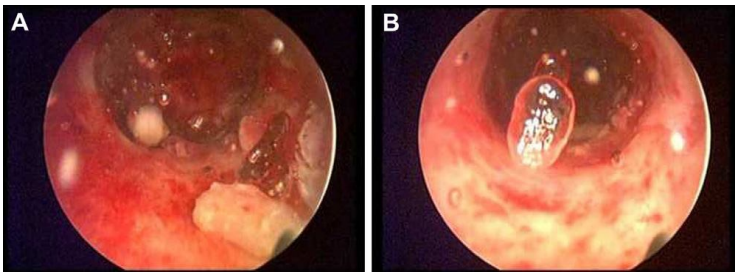

Fig. 1

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Original Article

Efficacy of a Polyethylene Oxide–Sodium Carboxymethylcellulose Gel in Prevention of Intrauterine Adhesions After Hysteroscopic Surgery

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ABSTRACT **Study Objectives:** To assess the efficacy of a polyethylene oxide–sodium carboxymethylcellulose gel (Intercoat; Gynecare, division of Ethicon, Inc., Somerville, NJ) in preventing the development of de novo intrauterine adhesions (IUAs) after hysteroscopic surgery and to rate the patency of the internal uterine ostium at 1-month follow-up diagnostic hysteroscopy.
Design: Randomized controlled study (Canadian Task Force classification I).
Setting: University hospital.
Patients: One hundred ten patients diagnosed during office hysteroscopy as having single or multiple lesions suitable for surgical treatment or resistant dysfunctional uterine bleeding requiring endometrial ablation.
Interventions: Patients were randomized to 2 groups. Group 1 underwent hysteroscopic surgery plus intrauterine application of Intercoat gel, and group 2 underwent hysteroscopic surgery only (control group). Follow-up office hysteroscopy was performed at 1 month after surgery to assess the rate and severity of IUA formation and to rate the patency of the internal uterine ostium after the surgical intervention.
Measurements and Main Results: Compared with the group 2, group 1 demonstrated a significant reduction in the incidence (6% vs 22%; $p < .05$) of de-novo IUAs. Application of the gel seemed to reduce the severity of IUAs, with fewer moderate and severe IUAs at follow-up in group 1 in comparison with group 2 (33% vs 92%). Furthermore, group 1 demonstrated significant improvement in the degree of patency of the internal uterine ostium (41.9% of cases) in comparison with diagnostic office hysteroscopy performed at enrollment ($p < .05$). In contrast, in group 2, worsening of patency of the internal uterine ostium was recorded in 18.2% of cases ($p < .05$).
Conclusions: Intercoat gel seems to prevent de novo formation of IUAs and to improve the patency of the internal uterine ostium at follow-up hysteroscopy. However, larger studies are needed to confirm these findings. Journal of Minimally Invasive Gynecology (2011) ■, ■–■

Keywords: Barrier agent; Cervical patency; hysteroscopic surgery; Intrauterine adhesions; prevention

Intrauterine adhesions (IUAs) are fibrous intrauterine bands on opposing walls of the uterus. The primary factors that may trigger IUA formation include curettage after abortion or postpartum, when the uterus is more prone to injury; infections; prolonged retention of an intrauterine device; and operative hysteroscopy [1–4].

Recent developments in technique and technology have encouraged the rapid widespread use of hysteroscopic surgery while reducing the need for traditional curettage. Therefore, as the number of operative hysteroscopic procedures has increased, the rate of postsurgical IUAs has also become higher, currently representing the major long-term complication of operative hysteroscopy [3,5,6].

The frequency of postsurgical IUAs varies according to the indication for surgery, severity of the condition, patient age, and type of surgical procedure [1,7]. Few articles reporting the incidence of postsurgical IUAs (6%; single

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myomectomy, 33%; and multiple myomectomy, 45%) have demonstrated that the complexity of the hysteroscopic surgery is one of the primary determinants of IUA formation metroplasty [1,3,8,9].

Intrauterine adhesions can be classified as de novo when they develop at sites that did not have adhesions initially, and as re-formed when they redevelop at sites where adhesiolysis had been previously performed [2]. They can be also classified by the degree of obliteration of the uterine cavity. Over time, several scoring systems have been described to classify the severity of IUAs [8–14]. However, the American Fertility Society classification system is used by most of the gynecologic community [10].

Intrauterine adhesions are important clinically because they may result in infertility, recurrent miscarriage, and irregular cycles with dysmenorrhea and pelvic pain [9–18]. Furthermore, an IUA that either partially or completely obstructs the isthmus or the internal uterine ostium may cause hematometra, severe cramping pelvic pain, and difficulties in accessing the uterine cavity during office hysteroscopy.

Adherence to appropriate hysteroscopic surgical techniques may minimize the risk of postoperative IUAs. General recommendations include preventing trauma to healthy endometrium and myometrium surrounding the lesions to be removed; reducing the use of electrosurgery when possible [19], especially during removal of myomas with extensive intramural involvement [20]; and averting forced cervical manipulation [21].

Several strategies have been developed in an attempt to minimize the risk of postsurgical IUAs [22–24] including administration of pharmacologic agents such as antibiotics [25], gonadotropin-releasing hormone analogues [1], and postoperative conjugated estrogens [26]; use of barrier methods such as a Foley catheter or an intrauterine device [27–29]; and application of gel [3,6]. However, at present, no single method has proved unequivocally effective in preventing postoperative IUAs [21].

Intercoat Absorbable Adhesion Barrier Gel (Gynecare, division of Ethicon, Inc., Somerville, NJ) is a viscoelastic gel formulated for laparoscopic application. It is composed of polyethylene oxide and sodium carboxymethylcellulose stabilized with calcium chloride, and has high tissue adherence and persistence sufficient to prevent adhesion formation [30–32].

The objective of this prospective, randomized, controlled study was to assess the efficacy of Intercoat gel in preventing postsurgical de novo adhesions after hysteroscopic surgery and in improving the patency of the internal uterine ostium at 1-month-follow-up hysteroscopy.

Materials and Methods

The protocol of this study was approved by our institutional review board, and the study was performed according to the guidelines of the 1975 Declaration of Helsinki on human experimentation.

All premenopausal women diagnosed at office diagnostic hysteroscopy as having single or multiple lesions suitable for surgical treatment or with resistant dysfunctional uterine bleeding requiring endometrial ablation were invited to participate in the study. Between September 2008 and June 2009, 110 premenopausal women were enrolled in the study. Before enrollment, the objectives of the study were explained clearly to all patients, and written consent was obtained.

Exclusion criteria were body mass index greater than 30, Q2 menopause (follicle-stimulating hormone concentration >40 mIU/mL and 17β-estradiol <20 pg/mL) or pregnancy (positive beta-human chorionic gonadotropin test results), uterovaginal prolapse, and severe urinary symptoms, malignancy, or other serious concurrent condition (e.g., coagulative disorders, systemic disease, and severe cardiac disease). Preexisting IUAs were considered an exclusion criteria because evaluation of re-formed IUAs was not the focus of the study.

Office diagnostic hysteroscopy was performed using a 5-mm-diameter continuous-flow hysteroscope with oval profile, a 30-degree fore-oblique telescope, and a 5F operating channel (Karl Storz GmbH & Co. KG, Tuttlingen, Germany). Saline solution was used as distention medium (0.9% NaCl), and was administered using an electronic system of irrigation/aspiration (Endomat; Karl Storz GmbH & Co. KG). A stable intrauterine pressure of approximately 40 mm Hg was obtained by setting the flow rate at 220 to 350 mL/min, negative pressure suction at 0.2 bar, and irrigation pressure at 100 mm Hg. No analgesic drugs or anesthesia was administered to the patients.

The type and characteristics of pathologic conditions and the patency of internal uterine ostium (Table 1) were thoroughly recorded on a dedicated form. After diagnostic hysteroscopy, patients were randomized via computer-generated randomization list into group 1 (treatment group: operative hysteroscopy plus intrauterine application of Intercoat gel; n = 55) and group 2 (control group: operative hysteroscopy alone; n = 55).

Operative hysteroscopy was performed using a rigid 27F resectoscope with a 30-degree fore-oblique telescope with various bipolar loops and a bipolar energy source (Versapoint; Gynecare, division of Ethicon, Inc.). Normal saline solution (0.9% NaCl) was used as the distention medium. The cervical canal was cautiously and progressively dilated using Hegar dilators before introduction of the resectoscope into the uterine cavity. Polyps were treated by positioning the loop behind the base of the pedicle and pushing from back to front. Depending on the size of the lesion being treated, 1 or several passages of the activated loop were necessary. Myomectomy was performed via resection of the free side of the myoma by moving the activated bipolar loop from back to front until normal myometrium was exposed. When the intramural part of the myoma was removed using the bipolar loop, particular care was used to avert any damage to the underlying myometrium. Metroplasty was performed using a modified 0-degree equatorial loop.

Table 1

Classification of patency of internal uterine ostium

Passage	Procedure
Easy	Hysteroscope passes through the cervix without difficulty
Moderately difficult	Slight cervical adhesions are present and are passed over using 1 of the following techniques: Blunt adhesiolysis with tip of hysteroscope Grasping forceps are inserted within fibrous tissue with jaws closed, then gently opened Scope is rotated 90 degrees on the endoscopic camera to align the main axis of the hysteroscope with the axis of the internal uterine ostium
Very difficult	Dense adhesions are present and are passed over using 1 of the following techniques: Scissors are gently inserted in the fibrous tissue, which is cut at 2 or 3 sites 5F bipolar electrodes are used to made 3 or 4 radial incisions at approximately 3-, 6-, 9-, and 12-o'clock positions on the internal uterine ostium

Uterine septae were cut in the midline portion from the proximal part to the uterine fundus until a normal fundus shape was achieved. Endometrial ablation was performed by resecting progressively the posterior, anterior, and lateral uterine walls, preserving the isthmic portion, using a 90-degree bipolar loop. Then the fundus and tubal ostia were resected using a modified 0-degree equatorial loop.

After surgery, group 1 underwent intrauterine application of 10 mL Intercoat gel under hysteroscopic guidance through the inflow channel of the resectoscope while the operator gradually moved the resectoscope from the fundus of the uterus back to the external uterine ostium to apply the gel throughout the cavity and the cervical canal (Fig.1). The procedure was considered complete when under hysteroscopic visualization the gel seemed to have replaced all of the liquid medium and the cavity appeared completely filled by the gel from the tubal ostia to the external uterine orifice.

In group 2 (control), only hysteroscopic surgery was performed.

Patients in both groups underwent follow-up office hysteroscopy at 1 month after the surgical procedure (during the early proliferative phase of the following menstrual cycle), during which rate and severity were assessed. At 3 months after hysteroscopic surgery, the menstrual pattern was assessed in all patients. Intrauterine adhesions were defined as mild, moderate, or severe according to the American Fertility Society score (Table 2). In both groups, ease of passage through the cervical canal was assessed as previously described (Table I). Instrumentation and settings at follow-up hysteroscopy were the same as those used during hysteroscopy performed at enrollment.

Both the initial and follow-up diagnostic hysteroscopy were performed by the same surgeon (G.M.), who, blinded Q3 to patients' randomized allocation, also evaluated the rate and severity of adhesions in each patient. Operative hysteroscopy and application of the Intercoat gel were performed by another surgeon (A.D.S.S.). To prevent any bias related to the surgical treatment, the surgeon was informed of a patient's allocation immediately after surgical removal of the intrauterine lesion or after endometrial ablation.

Statistical Analysis

The primary outcome was measured by the incidence of de novo IUAs. On the basis of data previously published by our group [3,6], the incidence of adhesions at follow-up in patients undergoing hysteroscopic procedures with application of the gel was expected to be 10%, and without the gel to be 28%. These percentages are consistent with the current literature [1,3,6,7], which gives a mean incidence of IUAs of 25% after common resectoscopic procedures (polypectomy,

Fig. 1

The operator gradually moves the resectoscope from the fundus of the uterus back to the external uterine ostium to apply the gel throughout the cavity (**A**) and the cervical canal (**B**).

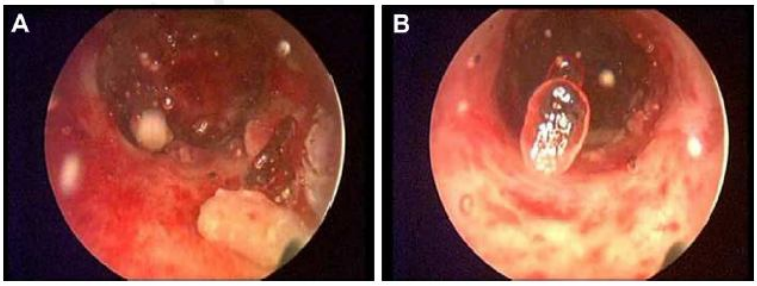


Table 2

Classification of intrauterine adhesions according to AFS guidelines [21]

Variable	Characteristic and AFS Classification		
Extent of cavity involvement	<1/3 1	<1/3 to 2/3 2	>2/3 4
Type of IUAs	Filmy 1	Filmy and dense 2	Dense 4
Menstrual pattern	Normal 0	Hypomenorrhea 2	Amenorrhea 4
Prognostic classification		HSG score[a]	Hysteroscopy score
Stage I, mild	1–4	AF	AF
Stage II, moderate	5–8	AF	AF
Stage III, severe	9–12	AF	AF

AF = additional findings; AFS = American Fertility Society; HSG = hysterosalpingography; IUA = intrauterine adhesion.
[a] All adhesions should be considered dense.

myomectomy, and metroplasty) if adjusted by taking into account that the present study was meant to include more adhesiogenic procedures such as endometrial ablation. For the probability of a type 1 statistical error to be less than .05, it was calculated that a sample of 55 patients per group would provide 80% statistical power. Secondary outcome measures included severity of post-surgical IUAs and patency of the internal uterine ostium at 1-month follow-up hysteroscopy. However, no statistical power analysis was attempted for these latter variables.

Statistical analysis was performed using commercially available software (Statistica for Windows; StatSoft, Inc., Tulsa, OK). The intention-to-treat analytical method was used. Data distribution was performed using the Shapiro-Wilks test. Differences in age, weight, and parity, which exhibited a normal distribution, were compared using the *t* test for unpaired data. The χ^2 test was used to compare the rate and severity of IUAs and the degree of patency of the internal uterine ostium between groups before and after the intervention. Statistical significance was considered at $p < .05$.

Results

Between September 2008 and June 2009, 136 patients attending our Office Hysteroscopy Clinic met the inclusion criteria and were invited to participate in the study. Of 26 patients who declined to participate, 8 declined after being explained the study protocol, and 18 were excluded because they were not willing to undergo surgery (Fig. 2). Characteristics of patients enrolled in the study are given in Table 3. At baseline, there were no significant differences in age, weight, uterine size, parity, and clinical symptoms between groups 1 and 2. In addition, there were no significant differences in size and type of lesions between the 2 groups and in the number of patients requiring endometrial ablation (Table 3). All submucous myomas were classified as grade 0, 1, or 2 according to the international classification of uterine myomas [33].

Intention-to-treat was the analysis method used; however, there were no deviations from random allocation. At 1-month follow-up, a significantly lower rate of post-surgical IUAs was observed in group 1 (3 of 55) compared with group 2 (12 of 55) (6% vs 22%; $p < .05$).

The severity of IUAs was lower in group 1 compared with group 2. In particular, the rate of moderate and severe IUAs was lower in group 1 (1 of 3) compared with group 2 (11 of 12) (33% vs 92%) (Table 4). Q4

Patency of the internal uterine ostium was classified on the basis of difficulty of passage through the cervical canal (i.e., easy, moderately difficult, and difficult) (Fig. 3). At baseline hysteroscopy, in group 1, passage of the hysteroscope through the cervical canal was assessed as easy in 29 patients (53%), moderately difficult in 18 patients (32%), and difficult in 8 patients (15%). At follow-up hysteroscopy, passage was assessed as easy in 44 patients (80%), and moderately difficult in the remaining 11 patients (20%). In group 2, passage of the hysteroscope through the cervical canal was assessed as easy in 33 patients (60%), moderately difficult in 17 patients (31%), and difficult in 5

Fig. 2

Patient enrollment and randomized assignation. In group 1, patients underwent hysteroscopy plus application of Intercoat gel. In group 2, patients underwent hysteroscopy alone (control group).

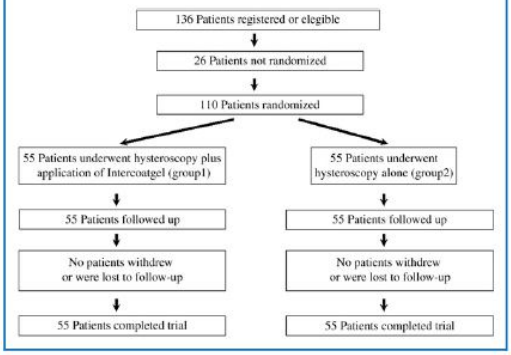


Table 3

Characteristics of enrolled patients[a,b]

Variable	Group 1, ACP Gel (n = 55)	Group 2, Control (n = 55)
Age, yr	37 (3.1)	36 (2.9)
BMI	24.6 (2.8)	24.8 (2.7)
Uterine size at hysterometry, cm	7.4 (1.3)	7.3 (2.4)
Parity	1.5 (0.3)	1.6 (0.2)
Indication for hysteroscopy, No. of patients		
AUB	36	38
Infertility	7	5
AUB and infertility	5	4
Other	7	8
Lesion type, No.		
Polyp	22	20
Myoma	16	15
Grade 0	8	6
Grade 1	4	6
Grade 2	4	3
Lesion size, cm		
Polyp	3.2 (0.3)	3.1 (0.4)
Myoma	2.5 (0.4)	2.7 (0.5)
Septae, No.	6	7
DUB, No. of patients	11	13

AUB = abnormal uterine bleeding; BMI = body mass index; DUB = dysfunctional uterine bleeding; NS = not significant.
[a] Unless otherwise indicated, data are given as mean (SD).
[b] p = NS for all comparisons.

patients (9%). At follow-up hysteroscopy, passage was assessed as easy in 30 patients (55%), moderately difficult in 14 patients (25%), and difficult in 11 patients (20%).

Overall, compared with baseline, at follow-up hysteroscopy, improvement in the degree of patency of the internal uterine ostium was reported in 23 of 55 patients (41.9%) in group 1. Of these, moderately difficult passage in 15 patients and difficult passage in 8 became easier at follow-up hysteroscopy. In the other 31 patients (56%), no modification in patency of the internal uterine ostium occurred. In 1 patient (2.1%), worsening of patency of the internal uterine ostium was recorded (Fig. 3). In contrast, in group 2, worsening of patency of the internal uterine ostium was reported in 10 patients (18.2%). In the other 42 patients (76%), no modification in patency of the internal uterine ostium occurred. In 3 patients (5.8%), improvement in patency of the internal uterine ostium was recorded (Fig. 3). Improvement in patency of the internal uterine ostium at follow-up hysteroscopy was significantly higher in group 1 (23 of 55) than in group 2 (3 of 55) (41.9% vs 5.8%; $p < .05$). In contrast, worsening of patency at follow-up hysteroscopy was significantly higher in group 2 (10 of 55) in comparison with group 1 (1 of 55) (18.2% vs 2.1%; $p < .05$). No adverse gel-related adverse effects were detected in group 1.

Discussion

Intrauterine adhesions were first described at the end of the 19th century by Heinrich Fritsch, who in 1894 reported IUAs in a patient with amenorrhea after postpartum curettage. In 1950, Joseph Asherman published data from the first large series of IUAs.

The most important causes of IUAs are previous trauma to the uterine cavity [34]. With damage to the basilar layer of the endometrium, granulation tissue on either side of the endometrial cavity can fuse, forming tissue bridges [35–37]. Approximately 90% of severe IUAs are related to curettage performed because of complications of pregnancy [34]; however, adhesions can develop in the nongravid uterus as a result of endometrial injury from procedures such as operative hysteroscopy [1–3]. Similar to the basalis layer of the endometrium, the endocervical mucosa is also susceptible to iatrogenic damage, the inflammatory response causing bridging connecting the anterior and posterior cervical walls. Adhesions that partially or completely obstruct the internal uterine ostium may result in variable narrowing of the cervical canal.

In clinical practice, we have observed worsening of patency of the internal uterine ostium after operative hysteroscopy, probably related to trauma to the cervical tissue during progressive dilation using Hegar probes that necessarily precedes introduction of a standard 27F resectoscope into the uterine cavity. Other factors that influence development of cervical stenosis include postmenopausal status [38,39], nulliparity [40], and cervical surgery [38,41]. Currently, cervical stenosis is a troublesome clinical problem and is the main cause of failure of office hysteroscopy [42,43].

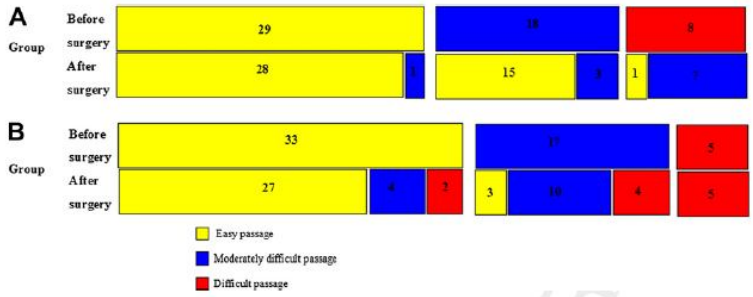
Table 4

Severity of post-surgery intrauterine adhesions

Severity	Group 1	Group 2
Mild	2 (1 myomectomy, 1 endometrial ablation)	1 (1 metroplasty)
Moderate	1 (endometrial ablation)	8 (2 myomectomy, 4 endometrial ablation, 2 metroplasty)
Severe	0	3 (1 myomectomy, 2 endometrial ablation)
Total	3	12

Fig. 3

Graphic representation of degree of difficulty in passage of the hysteroscope through the internal uterine ostium (IUO) at baseline and at follow-up hysteroscopy in groups 1 and 2.



Strategies for prevention of post-surgical IUAs include a wide variety of adjuvant pharmacologic agents including antibiotics [25], gonadotropin-releasing hormone analogues [1], and estroprogestinics [26]. A new category of adhesion prevention methods is barrier systems that maintain opposing uterine walls apart, averting formation of fibrin bridges and subsequent adhesion formation [3,6,34,44]. Such systems include intrauterine insertion of a Foley catheter or an intrauterine device [27-29, 45], as well as synthetic and natural polymer barriers [46–53].

In 2003, Acunzo et al [6] described the introduction of auto-cross-linked hyaluronic acid (ACP) gel into the uterine cavity at the end of the hysteroscopic surgery, demonstrating that the intrauterine application of ACP gel after hysteroscopic adhesiolysis significantly reduces re-formation of postoperative IUAs. In a further randomized controlled study, Guida et al [3] demonstrated that ACP also significantly reduces both the incidence and severity of de novo formation of IUAs after resectoscopic removal of myomas, polyps, and septae.

One of the most recently developed products is the Intercoat absorbable adhesion barrier gel (Gynecare, division of Ethicon, Inc.), a clear single-use flowable gel that is a sterile absorbable combination of polyethylene oxide and sodium carboxymethylcellulose. Manufactured as a thin sheet, it was proved effective in a rabbit laparoscopy model [31], and in human beings, it reduces epidural fibrosis and radiculopathy after lumbar surgery [54,55]. The antiadhesive effect of Intercoat is believed to be a consequence of its barrier effect, keeping the traumatized surfaces separated for a sufficient duration [32].

Currently, few studies in the literature have evaluated the efficacy of Intercoat gel in prevention of adhesions in gynecologic laparoscopic and open surgery [56]. However, to our knowledge, no study has investigated the role of Intercoat gel in preventing post-surgical IUAs and obstruction of the internal uterine ostium. The latter issue seems to be of particular interest because it may result in failure of follow-up office hysteroscopy after resectoscopic surgery.

Our randomized controlled trial demonstrated a significant reduction in de novo IUAs in patients treated with intrauterine application of Intercoat gel after hysteroscopic surgery in comparison with patients treated with hysteroscopic surgery alone. In both groups, the incidence of de novo IUAs was slightly lower than expected. This may be explained by increased surgical experience and use of a modern bipolar resectoscope with lower power settings.

Between the 2 groups, a trend in different severity of adhesions was observed. However, because of the small number of cases included, this trend did not reach statistical significance. Because of the paucity of samples, the rate and severity of adhesions was not assessed within individual pathologic subgroups in the presence or absence of Intercoat gel because of loss of statistical power. However, clinical experience and previous studies report that a higher frequency of postoperative adhesions is frequently observed after endometrial ablation resectoscopic myomectomy and metroplasty but not endometrial polypectomy [20]. Our data are consistent with both the current literature and clinical experience, which report a lower incidence of IUAs after polypectomy compared with other procedures including metroplasty, myomectomy, and endometrial ablation (Table 3).

The present study has demonstrated a significant improvement in the degree of patency of the internal uterine ostium at follow-up hysteroscopy in patients treated with intrauterine application of Intercoat gel after hysteroscopic surgery. In contrast, in the control group, significant worsening of patency was recorded in 18.2% of cases. This positive effect of Intercoat gel may be due to the particular technique used to apply the gel in the uterine cavity: the operator gradually moved the resectoscope from the fundus of the uterus to the external uterine ostium to apply the gel throughout the cervical canal. A potential shortcoming of Intercoat gel may be due to incomplete or patchy application of the gel, leaving some parts of the uterine walls without the protective film.

Previous studies that evaluated the efficacy of another viscoelastic gel to prevent post-surgical IUAs reported that

the gel should be applied in the uterine cavity but not in the cervix [3,19]. The efficacy of our technique has been confirmed by ultrasonographic data that demonstrate that Intercoat gel was able to keep both uterine and cervical walls separated for at least 24 hours (data not shown).

According to our previous protocol, intention to treat was the chosen analytical method, although strictly speaking, the present study was an explanatory investigation rather than a pragmatic trial for effectiveness. No deviation from random allocation and no dropouts occurred, probably because of short interval before follow-up. The choice to schedule follow-up hysteroscopy at only 1 month was made because the adhesiogenic process starts immediately after endometrial injury, and at 2 to 4 weeks after surgery, IUAs can be evaluated at diagnostic hysteroscopy [57]. In addition, early hysteroscopy provides the opportunity to perform adhesiolysis, if needed, when post-surgical IUAs are still thin and soft [57]. Conversely, IUAs discovered at late hysteroscopy are thicker, more organized, and fibrous [57]. This progression of development over time is well documented in the surgical literature [57–59].

Furthermore, early follow-up hysteroscopy may influence the mechanism of adhesiogenesis after hysteroscopic surgery [57]. For this reason, we decided to not schedule patients for a second late hysteroscopy because the rate and severity of IUAs may have been biased by the earlier surgery. The lack of late follow-up hysteroscopy and the small sample size may be a limitation of this study, and more multicenter trials will be needed to confirm our observations.

No adverse effects occurred in group 1. Intercoat gel and other reabsorbable solid or semisolid barriers seem to be safe, which is not surprising because they are based on natural products. In the few available previous trials, no device-related adverse effects have been reported [31,54,55].

Conclusions

Although not definitive, the present data demonstrate that Intercoat gel seems to prevent de novo formation of intrauterine adhesions and also to improve patency of the internal uterine ostium at follow-up hysteroscopy. This new absorbable barrier agent could represent a safe and effective strategy to improve women's health, reducing the need for repeat intervention after hysteroscopic surgery because of postoperative IUA formation and decreasing the failure rate of office hysteroscopy. However, these results need to be confirmed in larger controlled, randomized, multicenter studies.

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4.1 Ovarian endometrioma: postoperative adhesions following bipolar coagulation and suture.

Laparoscopic excision with stripping of the cyst wall is considered an adequate treatment for endometriotic ovarian cysts (Fig. 1). Current surgical technique has been shown as insufficient for postoperative adhesion prevention.

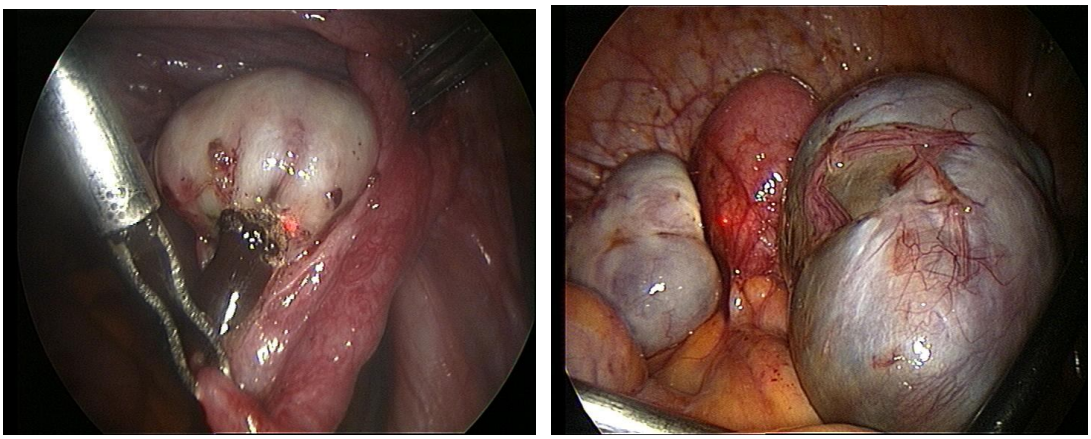

Fig.1

Although many adhesions resulting from gynaecological 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 and intestinal obstruction, resulting in a reduced quality of life often requiring readmission to hospital and additional more complicated surgical procedures and indeed increased surgical costs.

Surgical technique has a determinant role in inluencing the posts-operative adhesion development. Although conclusive evidences of scientific literature suggest a comparable or reduced adhesion formation rate in women who underwent laparoscopic procedures in comparison with laparotomy, for some laparoscopic procedures defined “high-risk”, as well as drainage and excision of cyst, the risk of adhesion-related readmission have been shown to be considerable and substantially higher than for the conventional approach.

The high incidence of adhesion formation after surgery for endometriosis underscores the importance of optimizing surgical technique limiting trauma to intra-abdominal structures, and the possible role of antiadhesion drugs, to potentially reduce adhesion formation .

Particularly, in our study we compare two different haemostasis methods, bipolar coagulation and suturing of the ovary treated for endometrioma, in terms of postoperative ovarian adhesions. Performing a good haemostasis is essential to avoid the presence of free blood and ischemic tissues which provide a source of fibrin and also result in adhesion formation by releasing thromboplastin with subsequent activation of the clotting cascade.

Bipolar coagulation is widely used in surgical haemostasis and ablation of endometriotic implants but its influence on adhesion formation has rarely been studied. Some authors have been demonstrated that bipolar high-frequency coagulation causes large zones of destruction, judging by macroscopic, microscopic, and ultrastructural cellular alterations increasing the risk of postoperative adhesion formation.

Ovarian endometrioma: postoperative adhesions following bipolar coagulation and suture

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Objective: To compare bipolar coagulation and suturing of the ovary in terms of postoperative ovarian adhesions after laparoscopic ovarian cystectomy for endometriosis.
Design: Prospective, randomized, controlled study.
Setting: Department of Obstetrics and Gynecology, University of Naples "Federico II."
Patient(s): Thirty-two women with a single endometriotic cyst were randomly divided into two groups of 16 women each (groups A and B).
Intervention(s): All patients underwent laparoscopic ovarian cystectomy for endometriosis. In group A, hemostasis was performed by closure of the ovary with an intraovarian suture. In group B, complete hemostasis was achieved only with bipolar coagulation on the internal face of the ovary.
Main Outcome Measure(s): Rate and extension of postsurgical ovarian adhesions at 60–90 days follow-up.
Result(s): At follow-up, a significantly lower rate of postsurgical ovarian adhesions was observed in group A than in group B (30.8% vs. 57.1%). The extension of ovarian adhesions was significanlty higher in group B than in group A.
Conclusion(s): The use of sutures on ovaries treated for endometrioma is associated with a lower rate of postoperative ovarian adhesion formation compared with bipolar coagulation. (Fertil Steril® 2008;89:796–9. ©2008 by American Society for Reproductive Medicine.)

Key Words: Endometriosis, laparoscopy, ovarian cyst, adhesion, prevention

Endometriosis is characterized by ectopic endometrial tissue with the formation of adhesions (1). The major consequences of adhesions are infertility, pelvic or abdominal chronic pain, and intestinal obstruction (2). Laparoscopic excision with stripping of the cyst wall is considered an adequate treatment for endometriotic ovarian cysts (1, 3–7). Unfortunately, pelvic surgery for endometriosis has been associated with high rates of adhesion formation and reformation (5, 8). After laparoscopic endometriosis surgery, odds of adhesion formation range from 80% to 100% (5, 8, 9). The high incidence of adhesion formation after surgery for endometriosis underscores the importance of optimizing surgical technique and the possible role of antiadhesion drugs to potentially reduce adhesion formation.

Several methods, as well as physical barriers interposed between adjacent injured surfaces, have been used to prevent pelvic adhesions both after laparoscopy and laparotomy. An oxidized regenerated cellulose absorbable barrier (10), a hydrophilic polyethylene glycol–based adhesion barrier (11), an autocrosslinked hyaluronic acid gel (12–14), and a 4% icodextrin solution (15) have recently been used with inconclusive results.

Current surgical technique has been shown as insufficient for adhesion prevention (16). Moreover, the influence of bipolar coagulation, widely used in surgical hemostasis and ablation of endometriotic implants, has rarely been studied on adhesion formation (17).

The aim of this prospective, randomized, controlled study was to compare bipolar coagulation and suturing of the ovary treated for endometrioma in terms of postoperative ovarian adhesions.

MATERIALS AND METHODS

From April 2004 to July 2005, 32 infertile women, each with a single endometriotic cyst, referred to the Department of Obstetrics and Gynaecology of the University of Naples "Federico II," were included in this randomized trial. The study was approved by the Institutional Review Board, and written informed consent was obtained from each patient.

Inclusion criteria were age between 18 and 45 years; history of infertility >2 years, no male factor of infertility; single endometriotic cysts >3 cm or <7 cm on preoperative ultrasound screen; no earlier surgery for endometriotic cysts

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or additional surgical procedure planned to be performed during the laparoscopic procedure; good general health, including an American Society of Anaesthesiologists score of 2 or less; no current pregnancy, including ectopic pregnancy; serum glutamic-oxaloacetic transaminase, serum glutamate pyruvate transaminase, and/or bilirubin <20% above the upper range of normal and considered clinically significant; azothemia and creatinine <30% above the upper range of normal and considered clinically significant; no concurrent use of systemic corticosteroids, antineoplastic agents, and/or radiation; and no active pelvic or abdominal infection.

The enrolled patients were preoperatively randomized and allocated to one of the two groups according to a computer-generated random list of 16 women each (groups A and B). Both groups underwent laparoscopy for endometriosis.

Laparascopy was performed by use of a 10-mm scope (Karl Storz, Tuttlingen, Germany) with two or three ancillary ports. After careful exploration of the pelvic organs and upper abdomen, patients with clinical evidence of cancer, pregnancy including ectopic pregnancy, rectovaginal endometriosis, endometriosis American Society for Reproductive Medicine (ASRM) (18) stage III or IV, or endometriotic cyst not stripped were excluded. Light adhesions on the contralateral adnexa and/or small subserousal uterine myomas observed at first surgery were not considered as exclusion criteria and were treated after second-look evaluation. Tubal chromopertubation was performed in all patients after second-look evaluation.

In all cases, endometrioma was treated moving the ovary from the ovarian fossa. The two groups had the same degree of adhesiolysis during the first surgery. Ovarian capsula was completely removed using two atraumatic forceps. In group A, hemostasis was performed by closure of the ovary with an intraovarian absorbable monofilament suture (2-0 PDSII; Ethicon, Somerville, NJ). The suture was performed with intraovarian knots and was not detectable on the surface of ovary. Before closure of the ovary, light coagulation with bipolar forceps was obtained only if necessary. Light coagulation has been used exclusively inside the ovarian parenchyma. After ovarian closure, no coagulated tissue was detectable outside. In group B, complete hemostasis was achieved with a 40-W current applied using bipolar forceps (Karl Storz) on the internal face of the ovary without coagulation of external surface and ovary was left open.

At the end of surgical procedure, all patients received application of 4% icodextrin solution (Adept; Shire, London, UK). The maximum volume of solution used for intraoperative irrigation was 1000 mL and, at the end of laparoscopic procedure, 1000 mL had been left in peritoneal cavity.

Postsurgical adhesions were evaluated 60–90 days after laparoscopy. The surgeon performing second-look laparoscopy for the evaluation of adhesion extension was blinded to the treatment. A subject was defined as adhesion free if there were no ovarian adhesions. At second-look adhesions, extension of treated adnexa were evaluated according to ASRM adhesion score system and were compared with adhesions present at first laparoscopy.

Statistical significance of between-group comparisons was assessed by χ^2 test for proportions. The Student t test for unpaired data was used for comparison between groups when appropriate. Operative time was compared using the Wilcoxon rank-sum test. In all analyses, statistical significance was assessed at the 5% level.

RESULTS

Patients included in the study had a mean age of 27.5 ± 1.9 years (mean ± SD), a weight of 58.6 ± 6.3 kg, and an endometrioma diameter of 5.1 ± 0.5 cm. There were no significant differences between the two groups for age, weight, diameter of endometrioma, and its localization.

Five patients, 3 from group A and 2 from group B, dropped out of the study because they did not meet intraoperative inclusion criteria (2 patient) or refused laparoscopic second look (3 patients).

At follow-up, a significantly ($P<.001$) lower rate of postsurgical ovarian adhesions was observed in group A (4 out of 13 patients) than in group B (8 out of 14 women) (30.8% vs. 57.1%, respectively; Table 1). The extension of adhesions at first laparoscopy, evaluated according to the ASRM adhesion score system, was not significanlty different between the two groups (8.3 ± 1.9 in group A vs. 7.9 ± 2.2 in group B). At second look, the adhesion score was significantly higher in group B than in group A ($P<.001$; Table 2). The mean adhesion score was significantly lower between first and after laparoscopic cystectomy in group A ($P<.05$), whereas it was significantly higher after laparoscopic cystectomy in group B ($P<.01$). We did not observe significant differences between cystectomies performed on left and right ovaries ($P=.08$). We did not observe any correlation between the diameter of endometrioma and the extension of adhesive disease.

The operating time was not different between group A and group B. First laparoscopy operative time was higher, but not

TABLE 1

Rate of postsurgical adhesions between groups treated with ovarian suture (group A) and bipolar coagulation (group B).

	Group A, 13 patients	Group B, 14 patients
Postoperative adhesion formation	4 (30.8%)[a]	8 (57.1%)[a]
No postoperative adhesion formation	10 (69.2%)	7 (42.9%)

[a] Postoperative adhesion formation, group A vs. group B: $P<.001$.

Pellicano. Postoperative adhesions: bipolar vs. suture. Fertil Steril 2008.

TABLE 2

Extension of ovarian adhesions, evaluated according to the ASRM adhesion score system, in groups treated with ovarian suture (group A) or with bipolar coagulation (group B), before surgery and at second look.

	Score of pelvic adhesion, mean ± SD	
	Before surgery	Second look
Group A	8.3 ± 1.9[a,c]	5.4 ± 2.1[b,c]
Group B	7.9 ± 2.2[a,d]	10.3 ± 2.9[b,d]

[a] Before surgery, group A vs. group B: not significant.
[b] Second look, group A vs. group B: $P<.001$.
[c] Group A, before surgery vs. second look: $P<.05$.
[d] Group B, before surgery vs. second look: $P<.01$.

Pellicano. Postoperative adhesions: bipolar vs. suture. Fertil Steril 2008.

significantly, in patients who developed postoperative adhesion compared with adhesions-free patients at the second-look laparoscopy (Table 3).

The time of ovarian hemostasis was not significantly different between the two groups, but it was higher in group B than in group A (Table 4).

No major complications were reported between the first and the second laparoscopy, with the exception of one episode of postoperative fever.

DISCUSSION

Laparoscopic excision with stripping of the cyst wall usually involves the use of bipolar current to obtain good hemostasis of the exposed ovarian parenchyma. Removal of the cyst by stripping and bipolar coagulation is swift, well accepted, and safe (1, 3–7). However, there aren't enough data to evaluate the side effects of this surgical procedure.

TABLE 4

Time of ovarian hemostasis procedure in group A and group B.

Suture time (group A)	6.2 ± 2.1 min[a]
Bipolar time (group B)	6.9 ± 3.4 min[a]

[a] Suture time vs. bipolar time: not significant.

Pellicano. Postoperative adhesions: bipolar vs. suture. Fertil Steril 2008.

Bipolar high-frequency coagulation causes large zones of destruction, judging by macroscopic, microscopic, and ultrastructural cellular alterations (19). In particular, the incidence of adhesion after bipolar coagulation has rarely been studied. Our data show an adverse influence of bipolar current use on postoperative adhesions formation. A significantly lower rate of postsurgical adhesions was observed when the ovary was only sutured (28.6% of patients in group A) compared with use of bipolar coagulation (53.3% of patients in group B). Moreover, the extension of pelvic adhesions, classified according to the ASRM adhesion score system, was significanlty higher when bipolar coagulation was applied (group B). A recent study on an animal model (17) confirms the hypothesis that bipolar current use induces peritoneal adhesion formation independently from type of antiadhesion agent used. In that study, severe peritoneal wounds were induced by peritoneal coagulation during a short laparoscopy using bipolar coagulation. The authors observed that no rats were free of adhesions. Although the use of antiadhesion agents was effective in postoperative adhesion prevention (10–13, 15), our data show the influence of surgical technique and hemostasis on postsurgical adhesion development.

In the present study, no significant difference was observed between cystectomies performed on left and right ovaries in terms of postoperative adhesion formation. Moreover, we did not observe any correlation between the diameter of endometrioma and the extent of adhesive disease. These data are in

TABLE 3

First laparoscopy operative time in patients who developed postoperative adhesion in adhesions-free patients at the second-look laparoscopy in each group.

	First laparoscopy operative time	
	Group A (ovarian suture), mean ± SD	Group B (bipolar coagulation), mean ± SD
Postoperative adhesion formation	39.0 ± 8.3 min[a]	41.3 ± 9.6 min[b]
No postoperative adhesion formation	36.2 ± 10.5 min[a]	37.3 ± 7.7 min[b]
Total	37.1 ± 9.6 min[c]	39.5 ± 8.8 min[c]

[a] Group A, postoperative adhesion formation vs. no postoperative adhesion formation: not significant.
[b] Group B, postoperative adhesion formation vs. no postoperative adhesion formation: not significant.
[c] Group A vs.group B: not significant.

Pellicano. Postoperative adhesions: bipolar vs. suture. Fertil Steril 2008.

agreement with those reported by other authors (20). First laparoscopy operative time was higher, although not significantly, in patients who developed postoperative adhesion compared with adhesions-free patients, therefore first laparoscopy operative time did not influence postoperative adhesions formation. Operative time was higher, although not significantly, in group B than in group A. However, it is important to note the great variability of standard deviation in each group. Sometimes a complete hemostasis with use of bipolar coagulation alone required more time than apposition of an intraovarian suture. In fact, we observed that hemostasis performed by closure of the ovary with an intraovarian suture required less time than the use of bipolar coagulation. Hemostasis technique influences, but not significantly, operative time, which was lower in group A.

Bipolar electrocoagulation of the ovarian parenchyma also adversely affects ovarian function. A recent study (21) compared the functional ovarian damage associated with the use of bipolar coagulation versus ovarian suture after laparoscopic excision of ovarian endometriomas in patients with a single ovary. The authors observed significantly more patients with elevated FSH levels on day 3 of the cycle among women who received bipolar coagulation of the cystic bed. Another study confirmed the adverse effects of bipolar electrocoagulation on ovarian function, observing that a treated ovary developed a mean of 0.3 follicle per cycle as opposed to 1 follicle per cycle of untreated controlateral ovary (22).

Prospective comparative studies including more patients should be conducted to confirm our preliminary results both for adhesion evaluation and for reproductive outcome.

In conclusion, the use of the suture on ovaries treated for endometrioma is a simple, safe, and effective surgical procedure associated with a lower rate of postoperative adhesion formation compared with bipolar coagulation of the ovarian surface.

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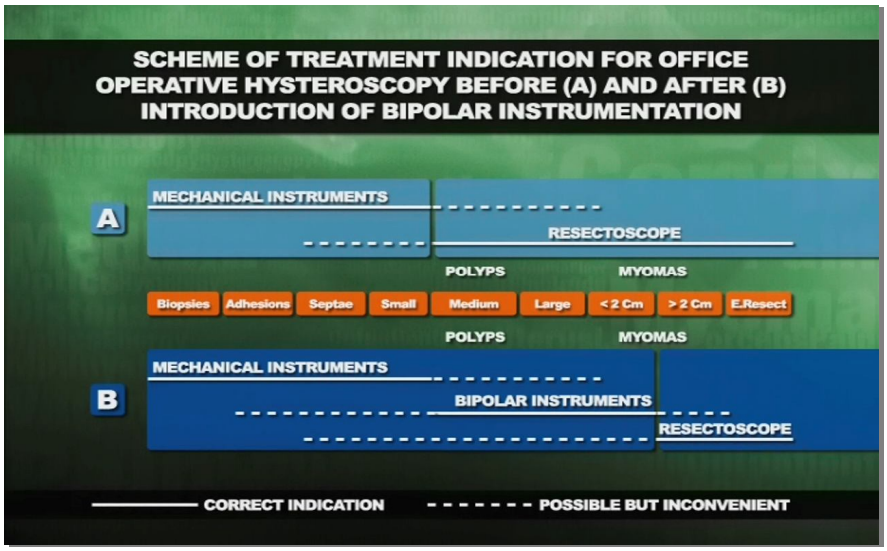
CHAPTER V: ATTEMPTS TO MAKE MINIMALLY INVASIVE SURGERY EVER MORE `MINIMAL'

Minimally invasive surgery aims to provide effective treatment of surgical diseases inside a body cavity, while decreasing access-related morbidity.

Both in laparoscopic and hysteroscopic field technological advancements helped to further decrease access-related morbidity and improve acceptability of surgical treatment.

In the hysteroscopic field, this trend will produce a low complication rate of inpatient operative hysteroscopies and an increase of operative procedures carried out in office settings (Fig. 1) as the simplified technology will guarantee ever more safety and accuracy and expedites performance.



In the laparoscopic field, this has given surgeons the challenge to either decrease the number of trocars placed throughout the abdominal wall or eliminate them completely. The transition from multiple port access surgery to single port access surgery represents a paradigm shift in reconstructive and extirpative surgery and is a testament to the recent advances in surgical technology.

5.1 Single Access Laparoscopic Sutureless Hysterectomy

Since 1989 when Reich performed the first laparoscopic hysterectomy, laparoscopic surgery has become the standard treatment for gynecologic diseases. Minimally invasive surgery has substantially decreased the length of hospital stay, the need for postoperative analgesia, and improved the recovery time.

With the goal of improving morbidity and cosmesis, continued efforts towards refinement of laparoscopic techniques have lead to minimization number of ports required for these procedures and finally to the introduction of multichannel access systems that allow simultaneous passage of several laparoscopic instruments through only one incision.

Laparo-Endoscopic Single-Site surgery is the latest advancement in minimally invasive surgery. It has the primary advantage to limiting port incisions and surgical scars to one site hidden within the umbilicus, rendering the surgery virtually “scarless”. This approach is a promising surgical innovation that results not only in improved cosmesis but it also reduce the convalescence period, the postoperative analgesia requirements and the cost of trocars and trocar-associated complications, such as bleeding, hernias, internal organ damage and wound infection.

Single port access surgery may be the next generation of minimally invasive surgery both in gynaecoly and abdominal surgery **(*Bracale U, Nastro P, Bramante S, Pignata G. Single incision laparoscopic anterior resection for cancer using a "QuadiPort access system". Acta Chir Iugosl. 2010;57(3):105-9.***

We report our experience with a single access device named QuadPort (Fig. 1) and enclose a video of a single access subtotal hysterectomy.

First in Italy we performed 10 total and subtotal hysterectomy using this device. It has a retractor consisting of one internal ring and two external rings, and a doubled-over cylindrical plastic sleeve. The valve component incorporates three or four inlets for

introducing laparoscopic instruments and a separate port for insufflation. The valve contains a thermoplastic elastomer that allows the smooth introduction of instruments, including needles, with negligible air leak. The valve can be easily attached or removed from the retraction ring during specimen extraction. The valve has one inlet for a 12-mm instrument, two for 10 mm instruments and one for 5 mm instruments.

Fig. 1

Surgical Endoscopy

Single Access Laparoscopic Sutureless Hysterectomy

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Keyword:	Single access laparoscopy, hysterectomy, fibromatous uterus
Note: The following files were submitted by the author for peer review, but cannot be converted to PDF. You must view these files (e.g. movies) online.	
Single access laparoscopic subtotal hysterectomy.mpg	

Single Access Laparoscopic Sutureless Hysterectomy

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Short Running Title: Single Access Laparoscopic Hysterectomy

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Abstract

Background

Laparoscopic surgery represent the standard approach for gynecologic benign diseases. With the goal of improving morbidity and cosmesis, continued efforts towards refinement of laparoscopic techniques have lead to reduce the ports number.

Single access laparoscopic surgery reduce the number of port incision and surgical scars. This approach results not only in improved cosmesis but it could improve the postoperative morbidity and pain. We report our recent experience in single access laparoscopic hysterectomy, showing a sutureless subtotal procedure.

Methods:

Using Quadport device (Advanced Surgical Concept, Tokyo, Japan) we perform a suturless laparoscopic hysterectomy with bipolar Ensael device (Ethicon Endo-Surgery Inc, Cincinnati, OH, USA). Bipolar Enseal device is useful during a single access laparoscopic procedure because it permits to seal and cut. We reproduced the same steps of the laparoscopic conventional multiport hysterectomy using straight instruments. The final skin incision was approximately 3 cm large.

Results From November 2010 to June 2011, 10 patients with menometrorrhagia and uterine fibroids underwent to total or subtotal single access laparoscopic hysterectomy. The mean longitudinal length of uterus evaluated by ultrasound was 12.5 cm (range, 10–14 cm). The mean operative time was 137.5 min (range, 120–150 min), and the hospital stay was 3 days for all patients. There was no significant blood loss. Postoperative fever (37.5°C) was observed in one case. We had no major complications and conversion to conventional laparoscopy. At 3 months follow-up patients did refer any problem.

Conclusions

Single access laparoscopic hysterectomy provides an uncontroversial cosmetic advantage. It can be performed easely and safely by an high skilled laparoscopic surgeon. It could also reduce some postoperative trocar associated complication such as bleeding, incisional hernias and wound infection.

Key Words: Single access laparoscopy, hysterectomy, fibromatous uterus

Disclosure

Drs. Silvia Bramante, Umberto Bracale, Giusto Pignata, Giovanni Merola and Maurizio Rosati have no conflicts of interest or financial ties to disclose.

5.2 Challenging the cervix: "tips and tricks" to overcome cervical stenosis at office hysteroscopy: experience with 31.000 cases

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Precis: Technical and technological advances, as well as the increased operators' experience, have made it possible to overcome even severe cervical stenosis at office hysteroscopy, reducing significantly the need for anaesthesia and operating room.

Abstract

Study objective: To report our experience on 10,156 cases of cervical stenosis diagnosed at office hysteroscopy.

Design: Retrospective study

Setting: Department of General and Specialistic Surgical Sciences, Section of Obstetrics and Gynaecology, University of Bari; Department of Gynaecology, Obstetrics and Pathophysiology of Human Reproduction, University of Naples "Federico II", Italy.

Patients: 31,052 patients undergoing office hysteroscopy of whom 10,156 (32.7%) with cervical stenosis.

Interventions: Cervical stenosis were classified on the basis of their localization in: stenosis of external cervical ostium (ECO), stenosis of distal third of cervical channel and the internal cervical ostium (ICO), stenosis of the ICO and stenosis of ECO and ICO

All hysteroscopies were performed using a 5 or a 4mm rigid continuous-flow office operative hysteroscope. Cervical stenosis were faced with technical manoeuvres and miniaturized mechanical and/or bipolar instruments.

Main Outcome Measure: The success rate at over-passing cervical stenosis was the primary outcome measure. Secondary outcome measures were frequency and localization of cervical stenosis in fertile and postmenopausal women and the frequency of use of technical manouvres and/or miniaturized mechanical or bipolar instruments to overcome them.

Results: Cervical stenosis were identified in 10,156 women (32.7% of all procedures) and were significantly more frequent in postmenopausal than fertile age (39% vs 29% p=.00).

Stenosis involving both ECO and ICO (45%) represented the most commonly detected. Stenosis of ECO alone and ECO plus ICO resulted more frequent in fertile than post-menopausal women (p=.035 and p =.028, respectively) while stenosis of ICO plus distal third of cervical channel were more common in post-menopausal women (p=.028)

Overall, cervical stenosis were managed successfully in 96.82% of cases. The adhesiolisys with the distal tip of the hysteroscope by rotating the scope on the endocamera resulted the significantly more used strategy to overpass all types of cervical stenosis (97% of cases), generally used in combination with miniaturized operative instruments, while bipolar electrodes were significantly more used in cases of stenosis of ECO alone or in combination with stenosis of ICO (p=.00).

Conclusions: Recent technical and technological innovations, together with the increased operators' experience, have made it possible to overcome even severe cervical stenosis' at office hysteroscopy, thus significantly reducing the rate of failed procedures and the need for operating room and general anaesthesia.

Introduction

Hysteroscopy is currently regarded as the gold standard for the diagnosis of intrauterine pathologies, including abnormal uterine bleeding, infertility, recurrent pregnancy loss and suspected intrauterine pathology.

Hysteroscopy can be performed both in a office-based setting (office or ambulatory hysteroscopy) or under general anaesthesia (inpatient hysteroscopy).

Both procedures have been shown to be equally accurate. However, office hysteroscopy has shown additional advantages over the traditional inpatient procedure, in terms of anaesthetic risks, cost effectiveness as well as patient preference.

Data available in the international literature report the success rate of office hysteroscopy as ranging from 90% to 95%. Pain experienced throughout the procedure as well as the various anatomical obstacles which challenge the access to the cervical canal represent the main limiting factors to the widespread use of office hysteroscopy.

Among the most relevant anatomical obstacles are *cervical stenosis,* usually defined as cervical scarring of variable degree, and comprising both subjective impression of narrowing and the completely obliterated external (ECO) or internal cervical orifice (ICO).

In a recent review of 5000 office hysteroscopies performed in a teaching Hospital, cervical stenosis was demonstrated to be one of the main causes of failed hysteroscopies.

Cervical stenosis can be congenital or acquired. Congenital cervical stenosis' are rare and include cervical atresia and cervico-vaginal agenesis whereas acquired cervical stenosis are more common and mainly associated with aging and use of progestogens. Indeed, some authors have suggested post-menopausal patients and women on progestin-based contraception to be at higher risk of *cervical stenosis*, due to the lack of estrogens. Nulliparity, curettage and cervical surgery are also strictly associated with *cervical stenosis.* The lack of consensus on the definition of cervical stenosis may account for the variable incidence observed by different Authors after cervical surgery which ranges from 0 to 25%.

Cervical stenosis, both of congenital and acquired origin, have also been reported as a contributing factor in infertility, due to mechanical occlusion and decreased production of cervical mucus. Furthermore, mechanical obstruction of the cervix may lead in turn to dysmenorrhea, hematometra and pyometra and is also believed to be a causative factor in endometriosis.

In the last decade several technical and technological advances as well as increased operators' experience have allowed hysteroscopists to challenge severe cervical stenosis in the office-based setting, reducing the rate of failed procedures.

In this article we report our 15-year-experience on 31,052 patients undergoing office hysteroscopy of whom 32.7% (10,156 cases) with cervical stenosis.

Materials and methods

Study design

We conducted a retrospective review of 31,052 patients who underwent office hysteroscopy between January 1995 and December 2010. The hysteroscopies were performed at the Department of General and Specialistic Surgical Sciences, Section of Obstetrics and Gynaecology, University of Bari and at the Department of Gynaecology, Obstetrics and Pathophysiology of Human Reproduction, University of Naples "Federico II". The study was approved by both Institutional Review Boards, and all patients had given their informed consent for the hysteroscopy.

Population

The women were defined as fertile or postmenopausal according to the following criteria:

- fertile : all women with regular and/or irregular menstrual cycles;
- postmenopausal: women at least 1 year after the last menses (FSH > 40 mU/ml) or those who were taking hormonal replacement therapy.

Instrumentation and technique

Office hysteroscopy was performed using a rigid hysteroscope with an oval profile and a mean diameter of 5 mm (3.9 mm and 5.9 mm) or 4 mm (3.2 mm and 5.3 mm) and a 5 Fr operating channel *(Office Continuous Flow Operative Hysteroscopy "size 5" and "size 4", Karl Storz, Tuttlingen, Germany).* Saline solution was used as distension medium (NaCl 0.9%) which was provided through an electronic system of irrigation/aspiration (Endomat, Karl Storz, Tuttlingen, Germany). A stable intrauterine pressure of approximately 40 mmHg was obtained by setting the flow rate on 220-350 ml/min, a negative pressure suction of 0.2 bar and an irrigation pressure of 100 mmHg. Neither analgesic nor anaesthetic drugs were administered to the patients. Vaginoscopic approach was used to access the uterine cavity.

This approach avoids the need to introduce a speculum and a tenaculum; the vagina, being a cavity, can be distended by introducing the distension medium through the hysteroscope placed into the lower vagina; the anatomy can then be followed by gentle movement of the instrument towards the cervix and cervical canal.

Operative instruments used were 5Fr grasping forceps with teeth (crocodile forceps), 5Fr scissors and 5Fr bipolar electrode (Versapoint twizzle electrode)

Definition and classification of cervical stenosis

Cervical stenosis was defined as that requiring the use of technical manoeuvres and/or miniaturized mechanical or bipolar instruments to overcome it at office hysteroscopy.
Where found, cervical stenosis were classified on the basis of their localization in:

- Stenosis of the external cervical ostium (ECO);
- Stenosis of distal third of cervical channel and ICO;
- Stenosis of the internal cervical ostium (ICO);
- Sstenosis of ECO and ICO

Strategies for overcoming cervical stenosis

Cervical stenosis were overcome by the following strategies used individually or in combination:

- *Adhesiolysis with the tip of the hysteroscope*: the 30° angle view gives to the distal tip of the hysteroscope the shape of a wedge. The distal tip of the hysteroscope is first gently inserted in the stenotic cervical os and thanks to the rotation of the scope on the endo-camera a mechanical adhesolysis is performed (Fig. 1).
- Adhesiolysis with 5Fr grasping forceps with teeth

The grasping forcep with teeth (crocodile forcep) is inserted within the fibrous ring with the jaws first closed and then gently opened in order to stretch the fibrotic tissue (Fig 2)

- Adhesiolysis with 5Fr scissors

  Once the fibrous tissue has been identified, the fibrous ring may be cut at two or three points by using sharp or blunt scissors (Fig. 3)

- Adhesiolysis with 5Fr bipolar electrodes.

Three or four radial incisions, at approximately 3, 6, 9 and 12 o'clock positions of the fibrous ring are performed (Fig. 4)

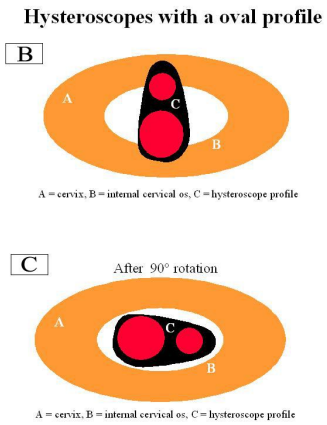
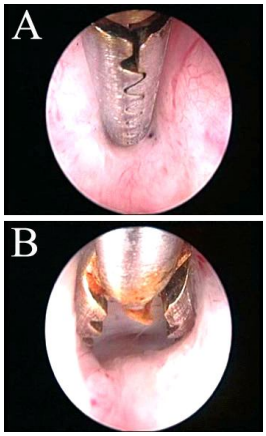


Fig. 1



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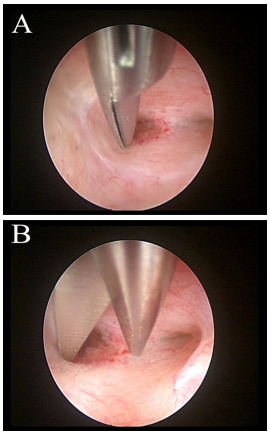

Fig. 3

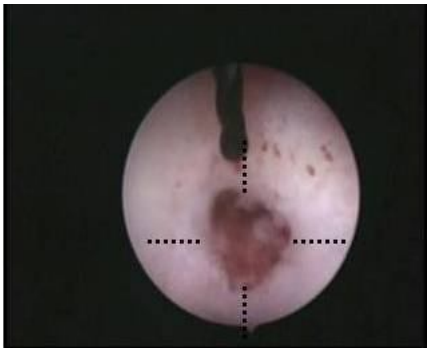

Fig. 4

Main outcome measures

Hysteroscopies were classified as successful or failed according to the following criteria:

- *Successful:* when access to and visualization of the entire uterine cavity (including both tubal ostia) was possible
- *Incomplete:* when access to uterine cavity was possible, but the entire uterine cavity could not be examined
- *Failed:* when access to uterine cavity was not possible. Failed hysteroscopies were then referred for an ultrasound-guided hysteroscopy under general anaesthesia.

The primary outcome measure was the success rate at over-passing cervical stenosis (including both successful and incomplete hysteroscopies). Secondary outcome measures were: frequency and site-preference of cervical stenosis in fertile and postmenopausal women and frequency of use of technical manouvres and/or miniaturized mechanical or bipolar instruments to overcome them.

Statistical analysis

Data collection was performed using a dedicated Access database (Microsoft, Redmond, WA). Data analysis was done using Access, Excel (Microsoft), and SPSS 9.0 (SPSS, Chicago, IL). Statistical significance was assessed using Chi-square and Fisher exact tests. $P < .05$ was considered to be statistically significant.

Results

Overall, 31,052 patients underwent office hysteroscopies between January 1995 and December 2010, of which 20,702 (66.7%) were fertile and 10,350 (33.3%) postmenopausal. The main indications for hysteroscopy were: abnormal uterine bleeding (AUB) (42%), infertility (33%), and sonographic appearance of thickened endometrium or focal intrauterine pathologies (21%).

An access to the uterine cavity with a complete evaluation of the whole endometrial surface was possible in 97.6% of cases. The main reasons of the 165 (0.53%) incomplete and 580 (1.86%) failed hysteroscopies are shown in Figure 5.

The hysteroscopies were performed with vaginoscopic approach in all cases with the exception of 201 cases (0.65 %) where a speculum was required in order to identify the external uterine ostium.

The Office Continuous Flow Operative Hysteroscopy “size 5” was used in 58% of cases while the “size 4” was used in the remaining 42% patients.

Cervical stenosis were identified in 10,156 women (32.7% of all procedures) and were more frequent in postmenopausal than fertile patients (29% vs 39%, respectively; p =.00). Stenosis involving both E.C.O.. and I.C.O. (45%) represented the most commonly detected one (Table 1) (45% vs 16%; 45% vs 18%; 45% vs 21%; p = .00 in all cases).

Stenosis of EOC alone and ECO plus ICO resulted more frequent in fertile than post-menopausal women (p=.035 and p =.028, respectively) while stenosis of ICO plus distal third of cervical channel were more common in post-menopausal women (p=.028) (table 1).

Cervical stenosis were managed successfully in 96.82% of cases with 324 (3.2%) hysteroscopies requiring a further ultrasound-guided hysteroscopy under general anaesthesia.

The adehsyolisis with the distal tip of the hysteroscope by rotating the scope on the endocamera resulted the significantly more used strategy to overpass all types of cervical

stenosis (97% vs 50%; 97% vs 45%; 97% vs 11%; p = .00 in all cases) (Table 2) This strategy was generally used in combination with miniaturized operative instruments.

Mechanical adhesiolysis performed by means of crocodile forceps and/or scissors was used for overpassing all types of cervical stenosis with no specific instrument preference in relation to the site of the stenosis.

On the other hand bipolar electrodes were significantly more used in case of stenosis of ECO alone or in combination with stenosis of ICO (p=.00).

Discussion

Cervical stenosis consists of partial or complete obstruction of the cervical canal. However, to date, there is still no consensus on the definition of this condition. Baldauf et al. defined stenosis as a cervical narrowing precluding insertion of a 2.5 mm Hegar dilator. In the study by Suh-Burgmann et al., cervical stenosis was defined as that requiring dilatation to collect endocervical samples or as an endocervical narrowing of less than 3 mm. Since different definitions are used, the incidence observed by each author also varies, ranging from 0 to 25.9 %.

In our study we defined a cervical stenosis every cervical narrowing of variable degree, that makes challenging the access to endometrial cavity, thus requiring technical manoeuvres and/or miniaturized mechanical or bipolar instruments. According to our definition, we observed a global incidence of cervical stenosis of 32.7%, that is slightly higher than that reported in the current literature. This data may be explained by the fact that a considerable percentage of patients (more than 30%) were in post-menopausal age, when the observed incidence of cervical stenosis is higher than the fertile one.

Cervical stenosis are well recognized as one of the most common causes of failure of office hysteroscopy. They may negatively affect the success of the procedure both by impairing the patency of the cervical canal, and by significantly increasing the patients' pain in the attempts of the operator to overcome cervical obstructions. Furthermore the subsequent necessity to repeat the procedure under general anaesthesia, in an in-patient regimen increases significantly the social and health burden of this condition.

There are specific subgroups of patients, with an increased risk of cervical stenosis, which have a concomitant, absolute necessity to undergo cervical or uterine evaluation. These include post-menopausal women with increased endometrial thickness, patients previously undergone cervical surgery (i.e. LEEP, cold knife and laser conization) who require follow-up

(cytological sampling or endocervical evaluation by hysteroscopy and/or curettage) and infertile women with severe cervical stenosis impairing intrauterine insemination or embryo transfer. In these latter patients it has been already shown that overcoming the cervical obstruction may improve subsequent pregnancy rate, while reducing the costs of assisted reproduction.

In our study, we observed a significantly higher incidence of cervical stenosis in postmenopausal women than fertile one (39% vs 29%). These data are in accordance with the available literature.

We observed that stenosis of ECO alone or ECO and ICO were more frequent in fertile than post-menopausal women, while stenosis of ICO alone or ICO and distal third of cervical channel were more frequent in post-menopausal than fertile women. The first data may be explained by the higher prevalence in fertile women of previous cervical surgery (12%), nulliparity (31%) and history of cervico-vaginal infections (13%). On the other hand, the second data may be due to the senile atrophy of cervical tissue.

Overcoming the stenosis in the office-based setting may allow a safer hysteroscopic examination while avoiding peri-operative anaestesiologic risks and reducing costs.

Hysteroscopy is currently regarded as the *gold standard* for the evaluation of both the uterine cavity and cervical canal and in most centres it is performed in an office-based setting. Indeed, office hysteroscopy has shown good correlation of findings compared with inpatient hysteroscopy while offering distinct advantages in terms of reduced anaesthetic risks, enhanced time-cost effectiveness as well as patient's preference.

Notwithstanding the international literature reports that office hysteroscopy is a well tolerated procedure with a high success rate, in everyday's practice, it is still perceived as an invasive and painful technique by most gynaecologists and patients and it is therefore widely overlooked.

Patients' discomfort/pain and cervical stenosis represent the main reason of failure of the hysteroscopic procedure and thus they are limiting factors to the widespread use of office hysteroscopy. In a recent review of 5000 office hysteroscopies, performed in a teaching hospital, the authors reported cervical stenosis to cause over 35 % of failed hysteroscopies.

Recent technological advances including the development of small–diameter rigid hysteroscopes with an oval profile, the use of normal saline as distension medium as well as the introduction of 5Fr operative instruments and bipolar electrodes have turned office hysteroscopy into a nearly painless, faster and virtually complication-free technique. The latter improvements have also made it possible to treat in the office-based setting a number of cervical and uterine pathologies, including cervical stenosis. In this respect, the oval profile of the hysteroscope together with the possibility of introducing operative instruments through the working channel allow to easily overcome most of the cervical stenosis', involving either the external uterine ostium (ECO) or the internal uterine ostium (ICO).

In our series, the adhesiolisys with the distal tip of the hysteroscope by rotating the scope on the endocamera resulted the significantly more used strategy to overpass all types of cervical stenosis (97% of cases). Indeed, an oval-profile hysteroscope conforms more strictly to the anatomy of the cervical canal which is normally oval, with a transverse main axis and a diameter of approximately 4-5mm. Thus, a simple rotation of the scope on the endo-camera by 90-degree is adequate to align the longitudinal main axis of the scope the with the transverse axis of the internal uterine orifice.

Mechanical adhesiolysis performed by means of crocodile forceps and/or scissors were used for over-passing all types of cervical stenosis with no specific instrument preference in relation to the site of the stenosis.

Currently, a wide set of 5Fr mechanical instruments may be used to overcome stenosis of of cervical channel in the office-based setting**.** No sensitive nerve terminals or blood vessels have been demonstrated in the fibrous tissue. Therefore, in case of moderate

stenosis, semi-rigid instruments, such as 5-Fr grasping forceps and sharp scissors (Karl Storz, Tuttlingen, Germany), may be used to obtain the resection of fibrous tissue responsible for the stenosis without causing any pain or bleeding. Once the fibrous tissue has been identified, the fibrous ring may be cut at two or three points by using sharp scissors. Alternatively, it may be stretched by grasping forceps inserted within it with the jaws closed and then gently opened.

The main advantage of this technique lies in the prompt identification of false passages. Indeed, a sudden increase of patient's pain, bleeding or the visualization of red tissue are warning signs of creating a false passage into the cervical myometrium.

The main disadvantage of this technique has been recognised in the fragility of the instruments used which are prone to break and damage during the lisys of strong fibrous adhesions.

On the other hand, bipolar electrodes were significantly more used in case of stenosis of ECO alone or in combination with stenosis of ICO. Stenosis involving the ECO are generally more severe than the others and very often it can be difficult even to identify a punctiform access to the uterine cavity. This precludes the use of mechanical instruments, allowing only the possibility to insert a needle-like bipolar electrode in order to cut the fibrotic ring.

Severe stenosis of the ECO may be resolved by creating three or four radial incisions, at approximately 3, 6, 9 and 12 o'clock positions, by means of the bipolar electrode. In these cases, the mildest energy of vapour cutting mode should be used, since it provides the lowest energy flow into the tissue, thus avoiding any pain or discomfort to the patient.

Overall, our strategies led to the resolution of most of cervical stenosis, with minimal discomfort. Totally, cervical stenosis' were successfully overcome in over 97.6% of cases with only a 2.3% of hysteroscopies failed, requiring an inpatient approach.

Conclusion

Recent technical and technological innovations, together with the increased operators' experience, have made it possible to overcome even severe cervical stenosis' at office hysteroscopy, thus significantly reducing the rate of failed procedures requiring a further ultrasound-guided hysteroscopy under general anaesthesia.

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Table 1: Localization of cervical stenosis in fertile and postmenopausal women

CERVICAL STENOSIS	Total	Fertile women	Postmenopausal women	p
ECO	1625 (16%)	1050	575	.035
ICO	1828 (18%)	768	1060	P=ns
ICO + distal third of cervical channel	2133 (21%)	463	1670	.028
ECO +ICO	4570 (45%) °	3811	759	.028
Total	10156	6092	4064	

° Stenosis involving E.C.O.. and I.C.O. (45%) represented the most commonly detected ones (p=.028)

Table 2: Frequency of use of technical manoeuvres and miniaturized instruments (individually or in combination) for over-passing cervical stenosis at office hysteroscopy

CERVICAL STENOSIS	N %	Rotation of the scope on the endocamera N %	Grasping forceps with teeth N %	Scissors N %	Bipolar electrode N %
ECO	1625 (16%)	1582 (16%)	585 (12%)	820 (18%)	220 (20%)*
ICO	1828 (18%)	1725 (18%)	1108 (22%)	868 (19%)	52 (5%)
ICO + distal third of cervical channel	2133 (21%)	2025 (21%)	1234(24%)	987 (22%)	67 (6%)
ECO +ICO	4570 (45%)	4448 (45%)	2125(42%)	1860 (41%)	755 (69%)*
Total	10156 (100%)	**9780 (97%**)**	**5052 (50%**)**	**4535 (45%**)**	**1094 (11%**)**

* Bipolar electrodes were significantly more used in case of stenosis of ECO alone or in combination with stenosis of ICO (p=.00).

**** % of total cervical stenosis**

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