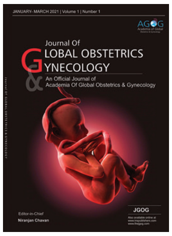
Academia of Global Obstetrics & Gynecology

Editorial



Future, Presence, and Past of Minimal Invasive Surgery in Gynecology with a Small Focus on Endometriosis

Lieslotte Mettler

Department of Obstetrics and Gynaecology, University Hospitals Schleswig-Holstein, Arnold-Heller-Str. 3, House C, 24105 Kiel, Campus Kiel, Germany

INTRODUCTION

With this article, we would like to invite you to the Section: Minimally Invasive Surgery (MIS) and Gyne Endoscopy for the Journal of Global Obstetrics and Gynecology (JGOG).

The future of MIS in our field of gynecology has just began. With robotic surgery, instruments with multiple degrease of liberty and image controlled intra- and retroperitoneal access it will even be more precise and more successful. This progress is based on the work of great surgeons of the past. It advances today with the great support of the medical technical industry.

Over the past 50 years, MIS has evolved in a relatively short period of time to overtake the centuries-old visionary and pioneering groundwork of our outstanding colleagues in all surgical disciplines. In this journal, we would like to emphasize future opportunities and possibilities to foster interdisciplinary collaboration and integrate emerging endoscopic, imaging and stereotactic surgical technologies to improve patient safety, enhance quality of care, and advance surgical education. We will introduce younger colleagues to the exciting world of contemporary gynecologic endoscopy and help them to appreciate the immense technology-laden opportunities that the future holds for those who are prepared to follow in the footsteps and aspirations of our founding surgical colleagues.

Minimal invasive surgery began with the innovative approach of Philipp Bozini who died in 1809 at the age of 36 years. He basically invented the illumination of body cavities using an extracorporeal light source to reflect light.

Corresponding Author:
Lieslotte Mettler, Department of Obstetrics and Gynaecology, University Hospitals Schleswig-Holstein, Arnold-Heller-Str. 3, House C, 24105 Kiel, Campus Kiel, Germany.
E-mail: profmettler@gmx.de

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The Beginning of Endoscopic Surgery from a Gynecologist's Perspective (History)

It has been a challenging journey since Georg Kelling presented the first endoscopic procedure, viewing the stomach of a dog, using Nitze's cystoscope and an air insufflation apparatus at the Natural Scientists' Meeting in Hamburg, Germany in 1901. Departed innovative thinkers and visionary mentors, such as Raoul Palmer, Hans Frangenheim, Kurt Semm, Daniel Dargent, Patrick Steptoe, Jordan M. Phillips, Maurice Bruhat, Robert B. Hunt, Jochen Lindemann, Thoralf Schollmeyer, and our general surgical colleague Gerhard Buess, all struggled to introduce less disabling diagnostic and therapeutic endoscopic technologies into daily clinical use for the betterment of our patients[1-4] [Table 1].

Jacques Hamon, Dennis Querleu, Marc Possover, Frank Loffer, Christopher Sutton, and Harry Reich are contemporary gynecological visionaries whose achievements have set the path which we now follow.

The Development of Gynecologic Endoscopic Surgery during the Past 50 Years

The worldwide development and popularization of gynecologic endoscopy and endoscopic surgery in all medical disciplines began when Professor Kurt Semm became chief of the Department of Obstetrics and Gynecology at the University of Kiel in 1970. I was than a 1st year resident.

After initial tubal sterilizations in Kiel in 1970, ovarian cyst resections, ectopic pregnancies, and myomectomies followed; however, sutures and ligatures were difficult to acquire. Manufacturers were eager to produce only if large quantities of surgical products were ordered.

With the introduction of laparoscopic cholecystectomy by Erich Mühe in 1985 and Phillipe Mouret in 1987, industry realized the importance and potential commercial benefits of this important development and became more interested in endoscopic surgery.

There are many milestones in the chronological development of minimal invasive surgery which are very well detailed in

Table 1: Founding fathers of laparoscopic surgery

1) Philipp Bozzini (1773–1809) and the light guide
2) Antonin Jean Desormeaux (1815–1894) and his endoscopes
3) Georg Kelling (1866–1945) and his air insufflation apparatus
4) Max Nitze (1848–1906), an early urological endoscopist who developed cystoscopy
5) Heinrich Kalk (1895–1973) and his insufflation apparatus which allowed abdominal biopsies of the liver, etc.
6) Raoul Palmer (1904–1985), the European father of endoscopy with the lithotomy position
7) Hans Frangenheim (1920–2001) built his first abdominal insufflator in 1959
8) Harold Hopkins (1918–1994) developed the rod lens system of modern endoscopes
9) Karl Storz (1911–1996) was responsible for the development of the cold light source in 1960
10) Patrick Steptoe performed many laparoscopies in Great Britain and developed the human *in vitro* fertilization and embryo transfer technique together with Robert Edwards
11) Hans-Joachim Lindemann (1920–2012) laid the groundwork for hysteroscopy based on the first book on hysteroscopy written by Duplay and Clado in 1898
12) Jordan M. Phillips (1923–2008) was a propagator and "prophet" for gyne endoscopic worldwide
13) Kurt Semm (1923–2003) was the father of operative gynecological endoscopy and operative endoscopic surgery for all disciplines. He performed the first endoscopic appendectomy as a gynecologist in 1981
14) Gerhard Buess (1943–2012) was an intensive promoter of minimal invasive new surgical techniques in the field of operative endoscopy worldwide.
15) Thoralf Schollmeyer (1964–2014) was the Leader of the Kiel School of Gynecological Endoscopy from 2007 to 2014
16) Maurice Bruhat (1934–2014) was the leader of the Clermont Ferrand Endoscopic School in France

our Practical Manual of Laparoscopic and Hysteroscopic Gynecological Surgery.[5]

Many national gynecological endoscopic societies as well as multidisciplinary societies of endoscopic or MIS/medicine (SLS, ITS, and SMIT) have since been formed.

From 1970 to 1990, gynecological laparoscopic surgery continued to be developed in Kiel under Kurt Semm. Numerous national and international endoscopy courses took place in Kiel, Clermont Ferrand, Brussels, Lyon, Strasbourg, and worldwide. In 1990, the Kiel School of Gynecological Endoscopy was founded by Liselotte Mettler and continues today under the leadership of Ibrahim Alkatout. Since 35 years, Prashant Mangeshikar of Mumbai, India, visited this school with annual courses of 30–40 Indian gynecologists and general surgeons for 2 weeks of intensive endoscopic surgery and training. This means dedication and recognition of our Indian colleagues.

Instruments and Apparatuses used in Gynecological Laparoscopic Surgery

In cooperation with industry, there has been a far-reaching development in technology and instrumentation which today facilitates the performance of precise surgery.[5]

All essential equipment for gynecological and general laparoscopic surgery are assembled on equipment trolleys which have now been integrated into panoramic operating rooms.

A realistic, true to life 3D picture is by now possible due to various technological elements, such as digital simulation, a second camera system or the use of shutter lens. The ENDOCAMELEON laparoscope provides a viewing angle that can be adjusted continuously between 0° and 120° (Karl Storz GmbH and Co. KG, Tuttlingen, Germany).

Instruments for perforation, dilation, holding and grasping, as well as screws have been developed cutting and irrigation instrument is available in various forms.

Morcellation instruments and instruments for hemostasis

The development of morcellation instruments was slow. In ovarian resection and enucleation of myoma, the tissue was cut with scissors and knives, depending on the size, and the specimen removed with big-toothed forceps directly through the 11 mm or 15 mm trocar with conical end. However, today, the so-called motor-driven morcellators in 10, 15, and 20 mm diameters are electrically powered and function well. The tissue is slowly cut electrically, nearly shaved from the surface, and pulled into the trocar sleeve.

Instruments for tying the blood vessels, such as the Roeder loop, the endoligature, or the endosutures with extra or intracorporeal knotting, are widely known. Needle holders for straight, curved, or ski needles are available in different variations.

Gynecologists prefer suturing and coagulation devices. However, clips and stapling devices, which are more frequently used by general surgeons, are also used.

Instruments for uterine manipulation are used as the third arm of the surgeon. Subtotal hysterectomy, as classic intrafascial supracervical hysterectomy or laparoscopic-assisted supracervical hysterectomy, is facilitated by the use of an electric loop or a monopolar driven hook.

Lenses and endoscopes

Scopes are available in rigid and flexible systems. The rigid system is based on Hopkins's experience with a rod lens system, which results in good resolution and depth of focus ratio. The 30° lens has the advantage of a wide panoramic view.

ENERGY SYSTEMS FOR OPERATIVE LAPAROSCOPY

Electrosurgery and Thermofusion

We use monopolar current for cutting and bipolar instruments when coagulation is required before cutting large vessels. Most of the systems have an auto stop so that only the necessary tissue is denatured. They are not designed for a very large coagulation zone.[6]

Bipolar vessel sealing, also described as thermofusion, combined with pressure between the branches of the instruments, is a new, easy to use technique that has been picked up by many companies in the production of disposable instruments with integrated cutting devices.

Laser and Harmonic Scalpel (Ultrasound Energy)

Three forms of laser are used in endoscopic surgery: 1. CO2 laser, 2. Nd: YAG laser, and 3. KTP lasers.

Ultrasonically activated laparoscopic instruments use mechanical energy to cut and coagulate tissues. The latest inventions combine thermofusion and ultrasound technology and increase surgical speed and precision.

Robotic Endoscopic Surgery

Among the currently available robotic systems and instruments, the da Vinci robot has proved to be the most advanced surgical system. Other robotic systems, such as the Senhance, the Cambridge robot, and others, are comping up quickly in the field.

Figure 1 shows the latest da Vinci side cart. The surgical console and the EndoWrist instruments complete this nice system that is in use at our Kurt-Semm-Center of Conventional and Robotic Endoscopic Surgery since more than 10 years.

Lately, new robotic systems have come on the market in different parts of our world. We had the chance to work with Senhance on an experimental level with good success.

Senhance [Figure 2] incorporates an eye-tracking system, force feedback characteristics, and is managed by one surgeon sitting unsterile at a computer console and an assistant interacting with the robotic arms of the second console, which can be easily moved around the table.

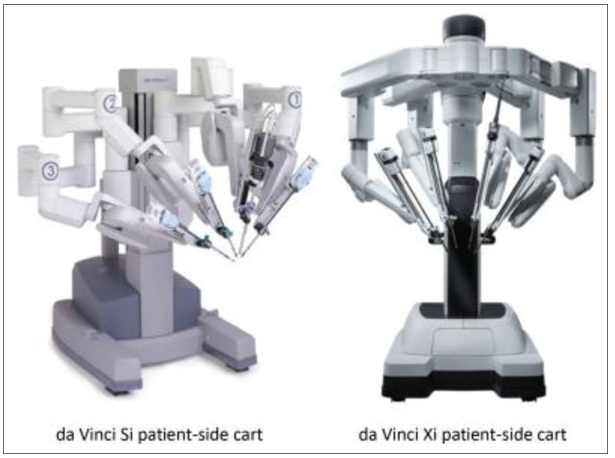

Figure 1: da Vinci intuitive robotic system

Figure 2: TransEnterix surgical robotic system: Senhance

SINGLE-PORT LAPAROSCOPIC ENTRY (SEL)

With the improved technology of today, SEL takes the idea of the early laparoscopy to new horizons. There are a multitude of SEL ports available.

Instruments and Apparatuses for Hysteroscopic Surgery

The development of hysteroscopic instruments and techniques has been influenced by many factors, such as safety, convenience of use, possible treatment, the invasiveness of the procedure, the extent of anesthesia, and hospitalization time. Clear vision in the cavity depends on a continuous flow of distention media. This was first described in 1956 by Norment.[7]

Since then, changes and developments have taken place in different fields. The most important changes concerning equipment and utensils are described as follows.

Distention media

In the early days, the uterine cavity was distended by the use of CO_2 which theoretically could lead to a gas embolism. It was possible to access the cavity under sight but no treatment was possible.

The change in fluid distention came with hypoosmolarity fluids, suitable for the use of monopolar diathermy, which was now possible during resection techniques, such as resection of the prostate. This led to different problems and resulted in a marked water intoxication in women during endometrial resection because more vessels were cut open.

It was necessary to have a strict measurement of the deficit of fluid during resection. Therefore, different hysteroscopic pumps and devices for measuring the deficit were used.

The diagnostic hysteroscope

It has already been mentioned that the uterine cavity was first entered with a scope in 1898. Laparoscopy paved the way for the development of scopes, light sources, and video cameras. Soon both the size of the hysteroscopes and the possible diagnostic/treatment techniques underwent a tremendous development.

The resectoscope and diathermy

Resectoscopes became more common and consequently also the need for safer procedures. With the development of bipolar diathermy, the whole hysteroscopic sphere changed. The risk of water intoxication disappeared due to the use of NaCl instead of mannitol, sorbitol, or glycine. The size of the hysteroscopes, the resection loops, and rollerballs became smaller or bigger depending on the demand. The devices used for resection and removal of intrauterine pathologies developed from the well-known loops over rollerballs in different sizes, a special knife for septate uteri to a special device for evaporation of fibroids.

Vaginoscopic approach, the no-touch technique, bipolar electrodes, and other small instruments

Dr. Steffano Bettocchi was one of the pioneers who radically changed the idea of hysteroscopy.[8] With the Bettocchi scope (5 mm in diameter), it is now possible to perform diagnostic hysteroscopy without any kind of anesthesia. It is possible to remove smaller polyps and submucosal fibroids with tiny bipolar electrodes.

Second generation – blind methods

Abnormal uterine bleeding (AUB) became the most common indication for a new non-surgical treatment. Instead of endometrial ablation by resection, a wide span of so-called blind methods developed.

The main issue was to destroy the endometrium by heat coagulation, either by warm water, radio waves, ultrasound, or microwaves.

Anesthesia/analgesia

As hysteroscopes were becoming smaller, many hysteroscopists found it more relevant to give the patient a cervical block (local anesthesia) rather than general anesthesia.[9] This change led to hysteroscopy procedures moving from an in-patient to an out-patient setting. Hysteroscopists became more confident as pain was related only to the passage of the internal os and the contraction of the uterus typically due to high pressure of the distention media and/or touching the myometrium.

The future

For all minimal invasive procedures, especially hysteroscopic procedures, the benefits of the use of natural orifices as entrance points will gain more importance in the future. This, together with new developments in smaller high-definition cameras and monitors, digital wireless transmission and telemedical communication, will make all hysteroscopic procedures easier to perform with less discomfort for the patient.

The big question is, when we discover the ultimate etiology of polyps, fibroids, and AUB, will treatment be diminished to a pill?

In the future, *in vitro* fertilization may be performed by hysteroscopic implantation of the conceived ovum and fetoscopic diagnosis and reimplantation of genes into the early fetus may become reality.

Laparoscopic robots will be used in the hysteroscopic field and remote cameras with a GPS transmitter will guide the surgeon. Computerized imaging and 3D modeling of organs will allow doctors to practice the procedures and train their skills.

Catalogue of Organ-oriented Indications for Operative Laparoscopy/Pelviscopy and Hysteroscopy in Gynecology – (Pelviscopy is the Term used by Kurt Semm for Gynecological Laparoscopy)

A variety of operating indications has been established during the past decades, including surgery on the uterus and the adnexa for benign and for malignant reasons.[10,11] Many patients have benefited from the use of laparoscopy, particularly those with extra uterine pregnancies or endometriosis. Today, the field of endometriosis includes intensive cooperation with general surgeons, especially in the treatment of deep infiltrating endometriosis reaching into the bladder and bowels. There are less complications, shorter hospital stays, and faster rehabilitation.[5] Laparoscopic interventions are now possible for intestinal adhesiolysis, genital suspension operations, resection of rudimentary uterine horn, incision of lymphocoele, and during pregnancy. Furthermore, the endoscopic treatment of malignant disorders, including multiorgan procedures such as lymphonodectomies or exenterations, will dominate progress in the next decades. The very well discussed results of the LACC study[12] brought cervical cancer surgery to a certain halt and reflection. However, newer studies have proofed that early cervical cancer surgery can only be performed laparoscopically in the hands of expert surgeons respecting two principals: 1. Application of a cervical vaginal tissue sleeve around the cervical tumor and 2. No use of intrauterine manipulators. This proofed to have the same results in cancer progress rates and long-term survival rates for the patients as open surgery.[13]

An editorial does not permit to go into selected examples of laparoscopic and hysteroscopic surgery. I will only give one example on current endometriosis surgery (Figures 3-9 further down). However, we sincerely wish to invite for this journal our colleagues from around the world to submit their surgical work and to discuss it with everyone.

Let us mention, therefore, only the names of present and future possibilities of selected examples of endoscopic surgery to be performed conventionally or with robotic assistance:

Laparoscopic Surgical Procedures in Benign Gynecology

Nearly, all procedures in benign gynecologic surgery can be performed today by laparoscopy and hysteroscopy:

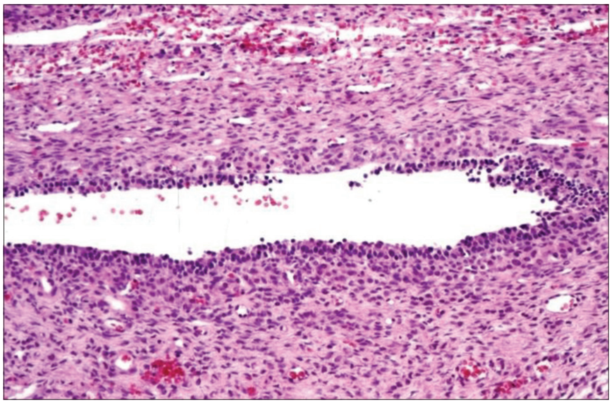

Figure 3: Histological picture of an endometriotic lesion in the myometrium

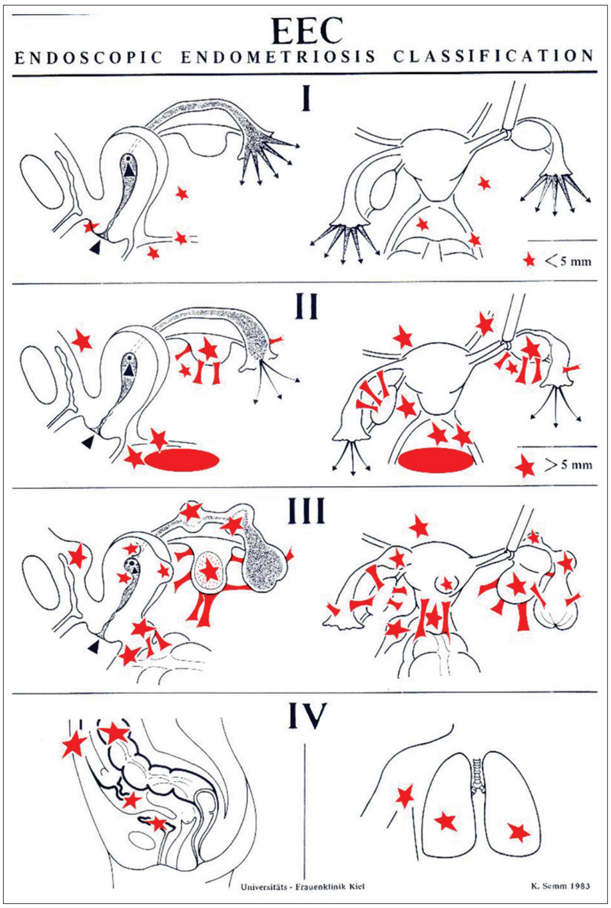

Figure 4: Endoscopic endometriosis classification (2005)

Ovarian and tubal surgery, uterine surgery for myomas, adenomyosis, hysterectomies, adhesiolysis, ectopic pregnancy treatment, endometriosis, etc.

1. Hysteroscopic surgical procedures for acquired and inherent uterine anomalies
2. Gynecological malignancies and endoscopic treatment

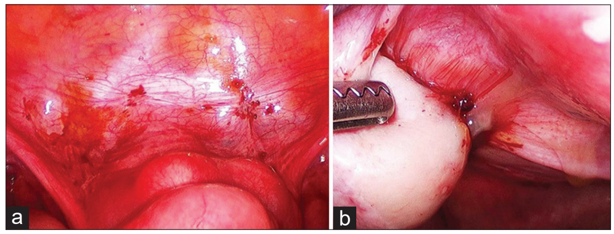

Figure 5: Laparoscopic lesions of endometriosis on the bladder roof (endoscopic endometriosis classification [EEC] Stage I) (a) EEC Stage II, endometriotic lesion fixing the ovary to the right pelvic sidewall (b)

3. Laparoscopic radical hysterectomy[14]
4. Laparoscopic nerve-sparing radical hysterectomy
5. Robotic radical hysterectomy
6. Laparoscopic anterior and posterior exenteration and uterine transplantations.

What procedures remain for open laparotomy surgery and vaginal surgery is self-explanatory and well appreciated by everyone.

Current Endometriosis Surgery

Endometriosis surgery has of course improved over the 50 years of laparoscopic diagnosis and treatment. However, histologically, the lesion remains the same [Figure 3]. While we show in Figure 4, the endoscopic endometriosis classification (EEC) classification which we published in 2006[11] which is a good accordance with the IFFS, rASRM, fertility index (endometriosis fertility index [EFI]), and ESHRE classification, we use since 2012 for deep infiltrating endometriosis also the Enzian classification [Figure 9]. EEC Stages 3 and 4 are further detailed with the Enzian classification. Recently in human reproduction, EQUSUM was published merging the three most frequently used classifications which are American Society for Reproductive Medicine (rASRM), Enzian, and EFI.[15]

In Figures 5-8, laparoscopic endometriosis resection is illustrated for the different EEC stages: Figure 5 EEC Stages I and II: Bladder and ovarian endometriosis, Figure 6: EEC Stage IV bowel endometriosis diagnosis and surgical resection using the circular stapler for a rectosigmoid anastomosis, Figure 7: EEC stage IV of ureter and bladder endometriosis, and Figure 8: Endometrioma surgery (EEC Stage III) in four steps.

Quality and Safety Issues in Endoscopic Surgery

Although minimally invasive endoscopic surgery was generally pioneered and popularized by gynecologists over the past decades, teaching institutions failed to inspire and invest in endoscopic education and research, with the same enthusiasm and dedication as our general surgical and other colleagues did.

Given the prevailing political, educational, industrial, and societal realities while facing most advanced economies, we are destined to grapple with a protracted period of fiscal restraint, consumer demands, and societal expectations. In Canada, with a relatively small health market (population 34,482,779 million), health expenditure in

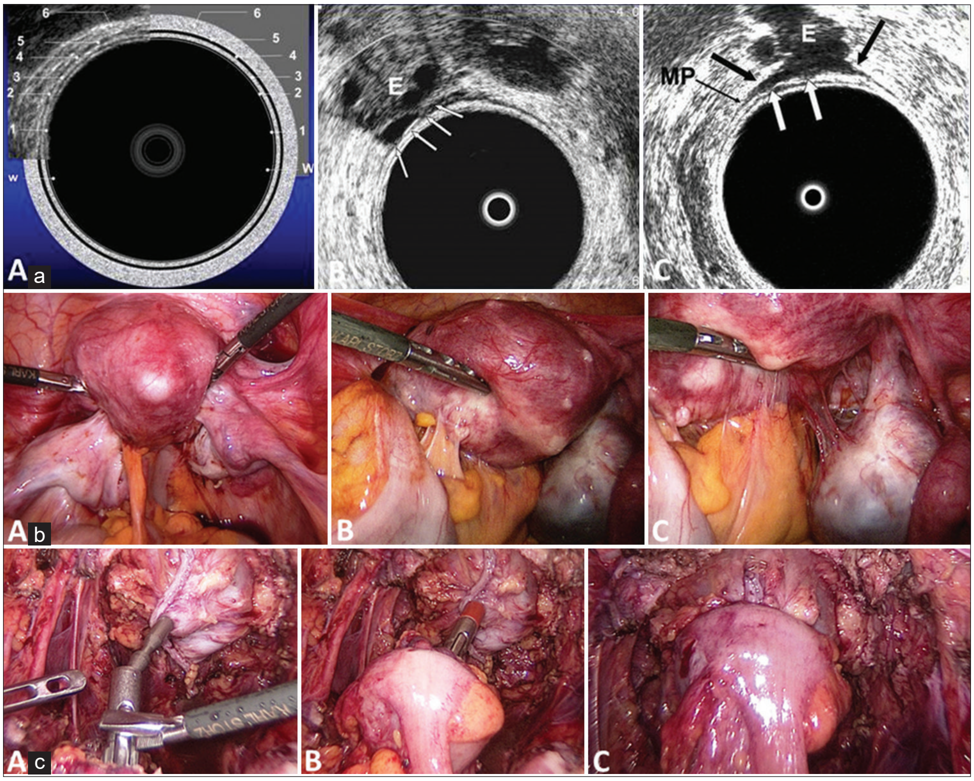

Figure 6: Endoscopic endometriosis classification (EEC) Stage IV upper line. (a): Recto sonography – middle line. (b): Laparoscopic situs with frozen pelvis – lower line. (c): Rectosigmoid anastomosis after resection of an endometriosis bowl lesion EEC Stage IV

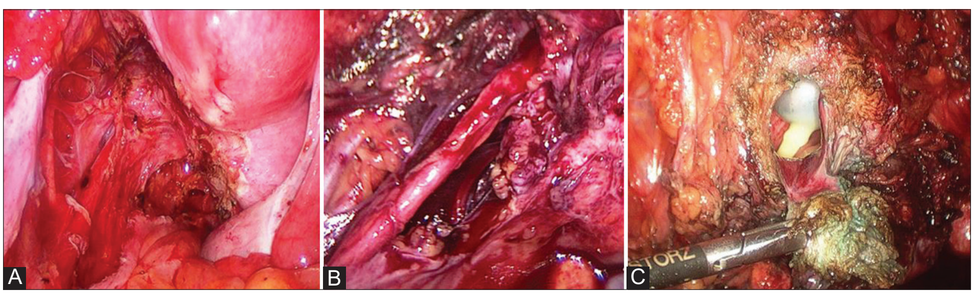

Figure 7: Endoscopic endometriosis classification Stage IV A+ B: Ureter endometriosis C: Bladder endometriosis

2019 was expected to reach $265 billion, although health spending actually decreased in proportionate terms. It was anticipated that, overall, health spending represented 11.5% of Canada's gross domestic product. Thus, every country has to set a certain amount of money for health and health-related technology aside.

Needless to say, that today already longer than 1 year our discipline, hand and hand with the global ups and downs of the global COVID19 crisis have also suffered. The current conundrum with all the global COVID19 challenges will influence future global health-care delivery and create enormous opportunities for decades to come. How to navigate the stormy and shifting health-care delivery landscape, while maintaining, if not improving, the quality of care offered to an ever-changing demographic client pool, is another important challenge facing our younger colleagues.

The prevailing climate of innovative thinking, coupled with continuous interdisciplinary surgotechnologic advancements, fosters exciting new possibilities that will challenge the young minds of tomorrow.

Be it in education, clinical practice, research, health promotion and policy, automation and miniaturization, licensing and credentialing, emerging virtual reality or augmented presence, automated remote sensing and surgery, or alternate non-surgical enabling remedies, all will influence the quality and safety of care we deliver and set the stage for further patient entitlement and accountability.

We cannot afford to keep training residents to manage the conditions of yesteryears using antiquated remedies. The non-surgical onslaught of innovative enabling therapies will continue to accelerate and challenge our conventional surgical treatments.

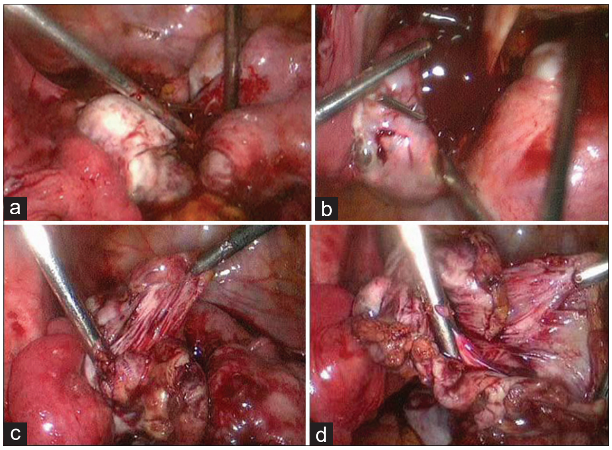

Figure 8: Ovarian endometrioma enucleation by laparoscopy, endoscopic endometriosis classification Stage III. (a) Bilateral ovarian endometriomas. (b) Spillage of ovarian cyst. (c) Identification of proper cleavage level. (d) Stripping of ovarian cyst

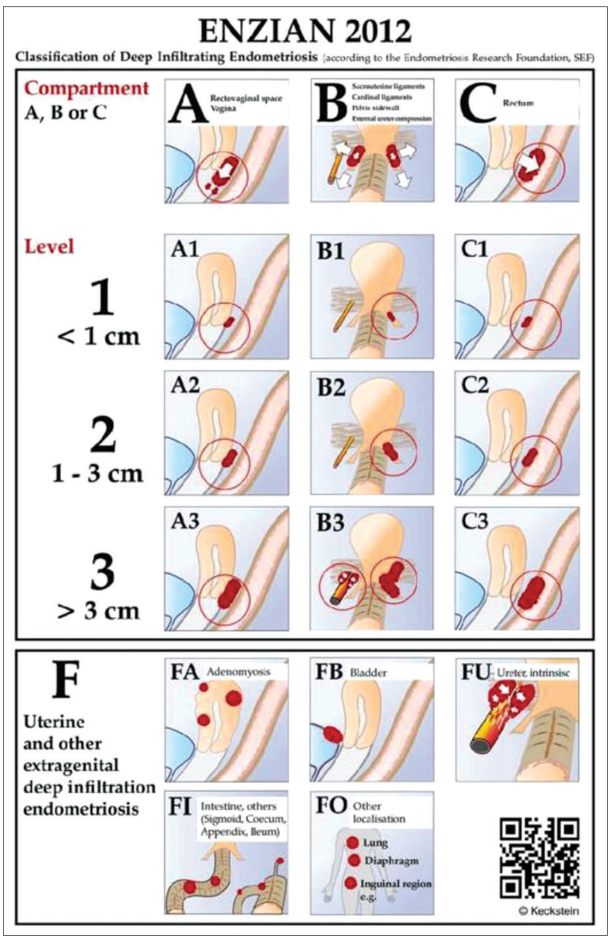

Figure 9: Enzian classification according to Mettler *et al.* (2012)[16]

A contemporary endoscopic technology-dependent team requires the assistance of several professionals, integrating horizontally to deliver optimal quality care. Webinars in our COVID-19 times help to train and educate better than ever before 2020 and 2021.

This is indeed the dawn of endoscopic innovation and it is clear that we have to be prepared to mentor students to evolve and innovate in sync. We have to attune our teaching capabilities to prepare not only present clinicians but also future gynecologic endoscopists.

Consequently, teachers must remain committed to patient safety, quality health delivery, and accountability. Dynamic, comprehensive, and interdisciplinary risk management programs are intent on raising awareness across the endoscopy team to combat complacency and reinforce the overriding national unqualified dedication to quality health while supporting MIS endoscopic remedies.[17]

In effect, evolving gynecologic endoscopy is more about improving health delivery, rather than about the enabling technologies, as our current surgical knowhow will evolve, but our commitment to patient well-being and safety remains.

Our responsibility in an upcoming new section: MIS and Gyne Endoscopy for JGOG is to give young colleagues a space for a presentation of their daily work to embrace and spearhead change it for the betterment and safety of all patients.

Endoscopic Surgery in the Female Today and Tomorrow. What are the Goals of Good Surgery?

They are identical whether we perform laparotomy, laparoscopy, or endoscopic procedures; regardless of the angle, location, or means of access:

- Recognition of relevant pathology
- Possibility of radical treatment in endometriosis and cancer
- Minimal trauma, bleeding, and tissue laceration
- Adhesion prevention
- Preservation of urogenital tract in women of reproductive age
- Utilization of the best instruments (with as many degrees of liberty as possible, robotic transmission, etc.).

Let us continue along the path of minimal trauma, maximum vision and good tactile feeling to ensure optimal surgical success until such time as protons or other magical bullets open up new options to remedy old pathologies.

It is conceivable that within the near future, pre-emptive early recognition of pathological conditions with contemporary imaging technologies – the merger of imaging and endoscopy has already occurred – and better molecular-genetic recognition of disease – the human genome has already been described – will make extensive radical surgical procedures unnecessary. We are already experiencing the next generation of genetics and metabolomics. These fields will render extensive surgeries unnecessary in the future and we will rely only on minimal invasive surgery which requires three fundamental components:

Skilled surgeon

Instruments and apparatuses are the key features that enable a skilled surgeon to perform optimal, precise, and indicated surgical procedures with minimal inflammation, adhesions, and complications.

Exchange of knowledge

Thanks to the ready exchange of knowledge between military institutions, aviation, space technology, informatics, engineering, mathematics, biology, genetics, and medicine as well as human dedication to disease exploration, technological advancements are no longer bound in one field. Journals are our present optimal exchange of ideas. Every written article needs special dedication and educates the writer as the same time.

Technical developments

Technological advances with improved endoscopic instruments for hemostasis and non-traumatic procedures as well as suturing skills allow us endless choices and possibilities.

Precise, endoscopic, and robotic surgery will be the only surgical tool in 2050. Bloodless surgery with articulated and robotic instruments with multiple degrees of liberty and precision coagulation will be possible. Computer-assisted instruments tips will allow the surgeon to position the angles to the desired tissue planes and give tactile feedback.

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