

# We are IntechOpen, the world's leading publisher of Open Access books Built by scientists, for scientists

5,500

Open access books available

136,000

International authors and editors

170M

Downloads

Our authors are among the

154

Countries delivered to

TOP 1%

most cited scientists

12.2%

Contributors from top 500 universities



WEB OF SCIENCE™

Selection of our books indexed in the Book Citation Index  
in Web of Science™ Core Collection (BKCI)

Interested in publishing with us?  
Contact [book.department@intechopen.com](mailto:book.department@intechopen.com)

Numbers displayed above are based on latest data collected.  
For more information visit [www.intechopen.com](http://www.intechopen.com)



# Minimally Invasive Surgery in Gynecology

*Morena Antonilli, Vasileios Sevas, Maria Luisa Gasparri, Ammad Ahmad Farooqi and Andrea Papadia*

## Abstract

The first laparoscopic procedure was performed by 1901 by Georg Kelling in dogs while the first laparoscopic procedure in humans was performed by Hans Chrisitan Jacobaeus in 1910. Minimally invasive surgery offers multiple advantages over conventional laparotomy and is associated with reduced estimated blood loss, a lower incidence of complications and a shorter hospital stay and recovery. Over a century later, the vast majority of surgical procedures in gynecology are performed via minimal invasive technique. These include laparoscopy, minilaparoscopy, robotic surgery, laparoendoscopic single site surgery (LESS) and natural orifices transluminal endoscopic surgery. In this chapter we review these surgical techniques, analyze the main differences among these techniques and comment on their advantages and disadvantages.

**Keywords:** Gynecology, Minimally invasive surgery, Laparoscopy, Robotic Surgery, Ergonomics, artificial intelligence

## 1. Introduction

Minimally invasive surgery (MIS) can be considered as the greatest surgical innovation over the past 30 years. The major change and innovation of this surgery was to entry inside the abdomen avoiding large incisions on the skin, without affecting the surgical result and safety. The first description of minimal invasive approach as part of an endoscopy is attributed to Phillip Bozzini in 1805, who has visualized the urethral mucosa with a simple tube and candle light. Pantaleoni in 1869 has performed the first gynecologic procedure identifying uterine polyps. In 1910, in Sweden Hans Christian Jacobaeus performed the first Laparoscopy using a Nitze cystoscope. Heinz Kal, a German physician was revolutionary when developing laparoscopy into a diagnostic and surgical procedure in the early 1930's. The use of gaseous distention with lithotomy Trendelenburg position was firstly conceived by a French gynecologist Raoul Albert Charles Palmer a pioneer of Gynecologic Laparoscopy. The use of "cold light" and fiberoptics were landmark innovations in the endoscopy development. These outriders of endoscopic surgery as well as several other scientists and physicians have led the crucial groundwork that has enabled modern gynecology surgeons to perform laparoscopy on a routine basis, with a variety of energy systems under increasingly ergonomic and efficient conditions. Over time variants of the conventional laparoscopic technique have been developed to improve post-operative pain, cosmetic results and minimized trauma to tissue. (Minilaparoscopy, LESS, NOTES). In addition, since the 1980s surgical

robots have been developed to address the limitation of laparoscopy in term of two dimensional visualization, incomplete articulation of instruments and ergonomic limitations. The Da Vinci System developed by the Stanford Research Institute along with the Defense department comprises of three components: a surgeon's console, a patient-side cart with four robotic arms manipulated by the surgeon (one to control the camera and three to manipulate instruments), and a high-definition three-dimensional (3D) vision system. Articulating surgical instruments are mounted on the robotic arms, which are introduced into the body through cannula. The need for remote interventions led to create a project by the National Aeronautics and Space Administration (NASA) in 1970s and funded by the Defense Advanced Research Project Administration (DARPA), for astronauts and soldiers in battlefields. Surgical robotics were first used in 1985 in neurosurgery; applications soon followed in urology (1988), orthopedics (1992) and gynecology (1998). It is important to notice that both traditional laparoscopic and robotic surgery have been widely adopted prior to emergence of data supporting efficacy and safety, because of its clear advantages compared to conventional surgery.

The patient is placed in a supine lithotomy position. Trendelenburg position is typically used to properly visualize the pelvis by displacing the bowel loops in the superior abdominal quadrants. The correct positioning of the patient plays a crucial role in the laparoscopic technique in terms of neurologic injury, ergonomic surgeon positioning, and adequate access to the vagina, if necessary. The patient's legs are placed in booted stirrups and it is important to maintain moderate flexion at the knee and hip with minimal abduction or external rotation at the hip. The buttocks should be a few centimeters beyond the edge of the table to allow uterine manipulation. To prevent migration in Trendelenburg position there are different methods: egg-crate foam directly beneath the patient, a vacuum-beanbag mattress, or shoulder braces. A variety of uterine manipulators are available to displace the uterus to facilitate access to pelvic structures. To manipulate the vaginal cuff, for women without uterus, a sponge stick can be positioned in the vagina.

To date, numerous studies have shown the superiority of minimal invasive surgery over laparotomy in terms of perioperative complications, hospitalization and quicker return to normal activity. On the other hand it was initially evident that there was a longer operating time and steeper learning curve for the laparoscopic technique. Today a greater surgical experience of surgeons and innovation of instrumentation have enabled a time overlap of most surgical procedures. In addition, a careful assessment of the patients (comorbidities, BMI and body habitus, patient's surgical history, type of pathology: size, shape, and mobility) to allow an appropriate safe and efficient procedure is crucial.

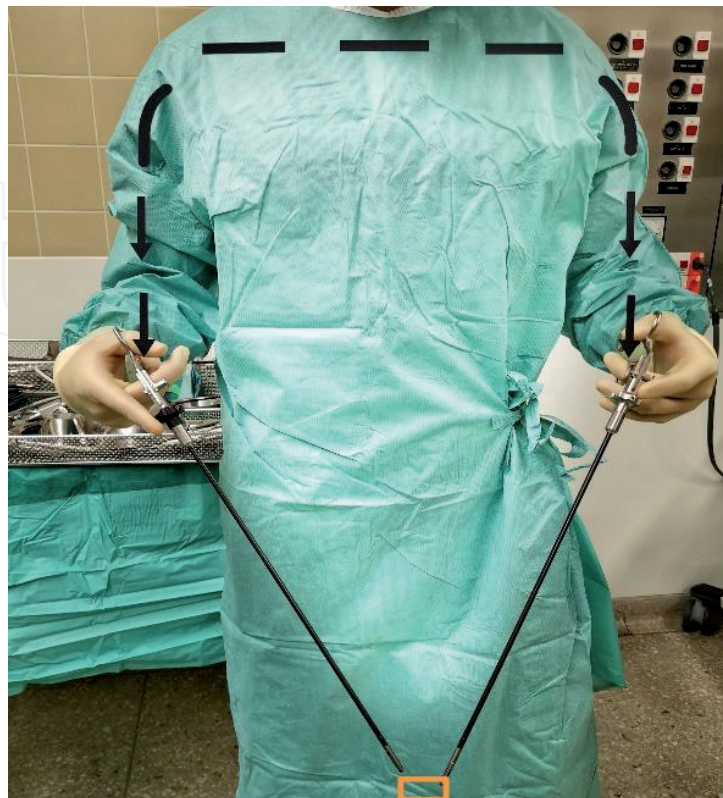
## **2. Minimally invasive techniques and approaches**

### **2.1 Diagnostic and operative laparoscopic surgery**

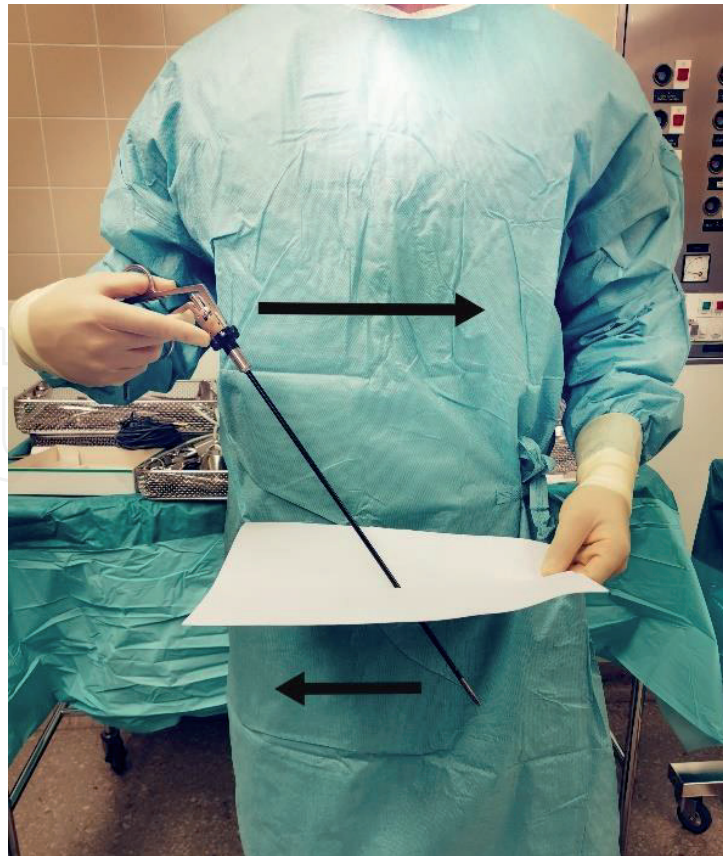
The laparoscopic technique uses a laparoscope that is introduced into the abdomen by means of small incisions on the skin (into or near the umbilicus) and that projects the images on an external screen. The laparoscope consists of a camera and a light source. Thanks to the gas insufflation inside the abdominal cavity, the operating space is increased for better visualization of the operating field and instruments. To date we have a wide range of laparoscopic instruments that mimic the ones used in conventional laparotomy. Two or three additional accesses are required for most surgical procedures. In gynecological surgery, usually the ancillary trocars are placed 2 cm medial and cranial to the lateral iliac spines, lateral to the inferior hypogastric artery [1–5].

Laparoscopes range from 1.8 mm to 12 mm in diameter having a distal end available in different angles. The 0-degree telescope is most commonly used and provides a straightforward view. While in contrast, a 30-degree fore-oblique lens allows for visualization in a large frontal view. Light is introduced through the laparoscope with a fiber optic cable powered by a light source. The camera unit consists of camera head, cable and camera control. The image resolution is dependent on the number of pixels on the chip. Most laparoscopic cameras have 250,00 to 380,000 pixels. Newer developments include the use of voice-activated, wireless systems designed to provide central control over operating room devices using either a microphone or a movable touch-pad screen.

Laparoscopy, as well as other endoscopic techniques, is based on two concepts that make it quite different from the open approach. These are triangulation and the fulcrum effect. Triangulation is a fundamental principle for endoscopic surgery as it allows to perceive the position of the instruments in three-dimensional space by sensing the position of our upper joints and arms across our chest together with visualization of the instrument tips (**Figure 1**). In fact, it is quite challenging to assess the distance or depth of the tip of a long instrument held in one hand. However, when a second instrument is used, the human brain can process the operative field visualized in the monitor with an impressive accuracy. Fulcrum effect is called the phenomenon where a handle movement of an instrument towards one direction is followed by a tip movement in the exact opposite direction. The tissue acts as a fulcrum or pivotal point. The tip movements ability and the right force needed to perform it, depends on the distance of the middle sign of the length of the instrument from the pivotal point according to the rules of physics (rule of moments). In other words, if more than 50% of the instrument length is beyond the fulcrum point, the tip movements are forceless and with a greater spectrum of movements (**Figure 2**) compared with the position when most of the instrument length is below the contact with the tissue.



**Figure 1.**  
*Triangulation principle: the instrument will converge from different angles avoiding crossing and collision.*



**Figure 2.**  
*Fulcrum effect: the abdominal wall, where the trocars are inserted, work as a fulcrum for the laparoscopic instruments. By moving the handle of the instrument to the left, through the fulcrum effect, the tip of the same instrument will move to the right.*

Gynecologic laparoscopic entry is commonly at or through the umbilicus. The traditional technique is to blindly pass a sharp Veress needle, at the umbilicus, insufflate, and then to pass a sharp trocar. Other closed technique entry, such as direct trocar entry, the radially expanding access system and open techniques are widely used. The method by which incisions are made to introduce the laparoscope may influence the likelihood of complications of the first step (injury to surrounding blood vessels or the bowel). However, a recent systematic Cochrane review comparing groups of patients undergoing laparoscopy with different entry technique, concludes that evidence is insufficient to show whether there were differences between groups in the rate of failed entry, vascular injury, or visceral injury, or in other major complications with the use of an open-entry technique in comparison to a closed-entry technique [6].

In general, complications of laparoscopy include nerve injury, vascular injuries, gastrointestinal injuries, trocar site hernia and urinary tract injury. Successful laparoscopy, just as in laparotomy, requires adequate visualization of the operative field and safe retraction of non-target tissues. An inability to displace bowel out of the pelvis, such as in morbidly obese women, and indistinct events such as acute intra-abdominal hemorrhage, may prompt a conversion to laparotomy. Poor candidates for laparoscopy are those with ventilatory problems, severe cardiorespiratory problems or elevated intracranial pressure as well as patients who cannot tolerate steep Trendelenburg or peritoneal insufflation.

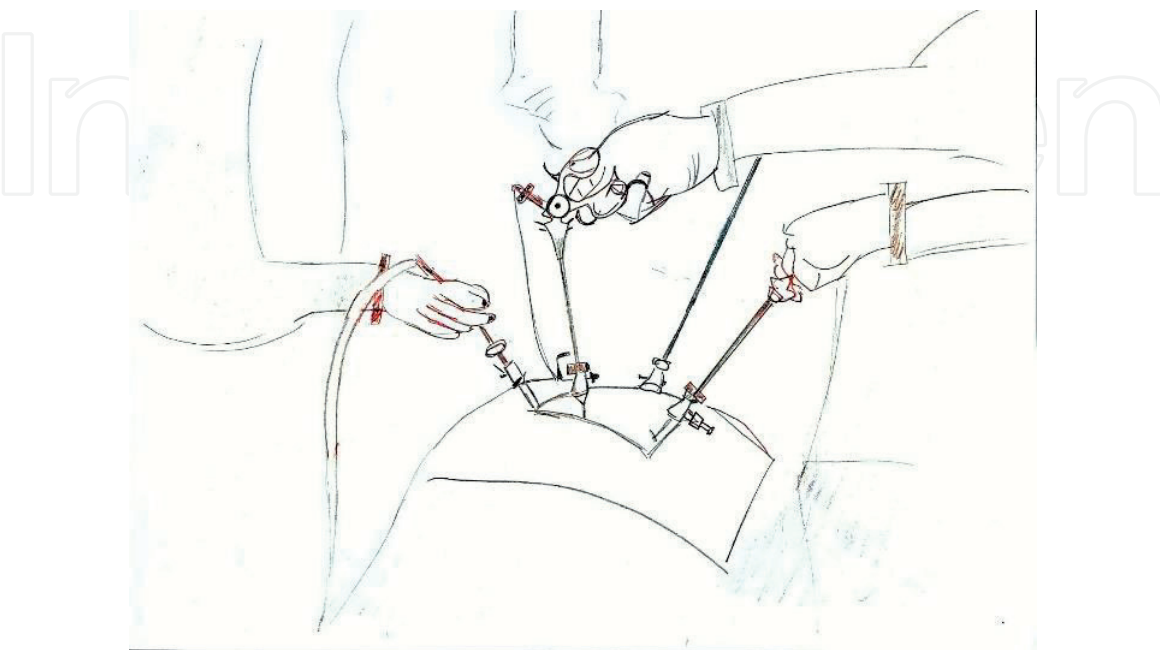
## 2.2 Minilaparoscopy

Minilaparoscopy uses smaller abdominal incisions than contemporary laparoscopy and refers to the use of instruments and port sites of 5 mm or less. The 5 mm

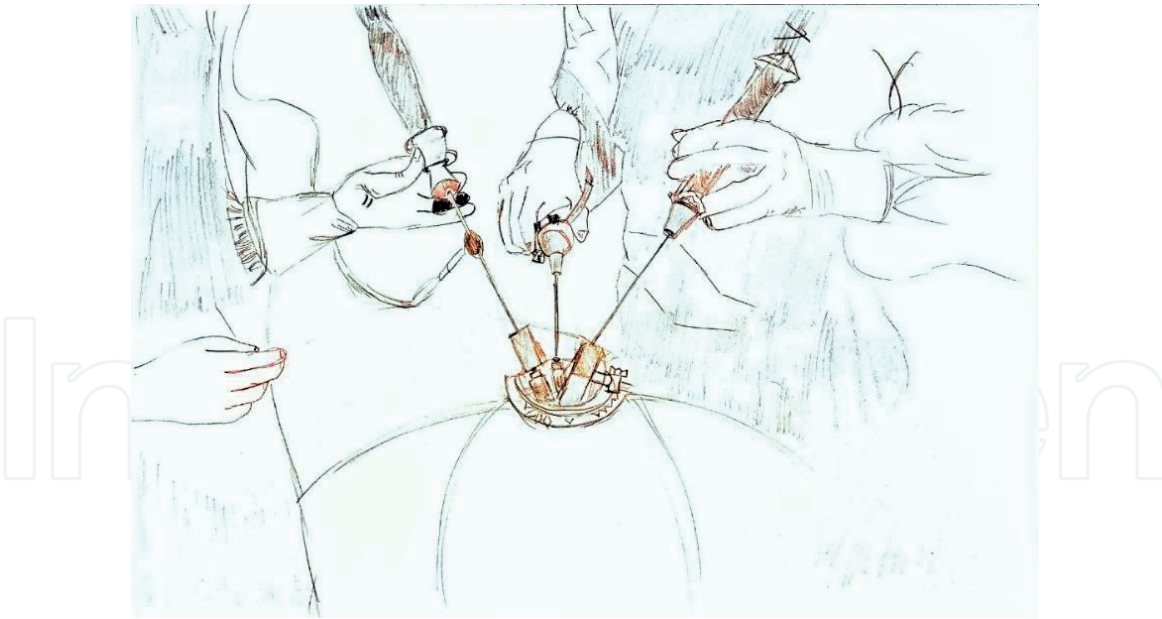
laparoscopes show high resolution and transport enough energy to properly illuminate the surgical field. These smaller port sites may be used for camera and/or accessory instruments (**Figure 3**). Although minilaparoscopy has been studied more extensively in general surgery and urology applications in gynecology have been described since 1991. A 3-mm incision was made for visualization with a plastic sheath. Two additional 3-mm incisions were used for accessory instruments to aid in adhesiolysis, biopsy of endometriosis, and laser myomectomy. The use of smaller instruments enhances the chance of decreased incisional pain, less need for post-operative opioid pain medication, shortened recovery time, minimization of tissue trauma, and provides a more favorable cosmetic outcome. One of the advantages that arise from minilaparoscopy in comparison with other forms of MIS is that it uses the same operating techniques, patient positioning, and instrument configuration as conventional laparoscopy. Few studies have shown contradictory results concerning operation time. No difference was proven in postoperative complications such as infection, conversion to laparotomy, reoperation, hospital readmission, estimated blood loss, and venous thrombosis although the literature in that field is still scarce [7]. Minilaparoscopy is an intriguing alternative to traditional laparoscopy and may gradually prove to be even superior.

### 2.3 Laparoendoscopic single site surgery

Laparoendoscopic single-site surgery (LESS), which is also called single-port surgery or single-incision laparoscopy is a procedure in which all instruments are inserted through a single skin incision, normally at the umbilicus (**Figure 4**). The first reported case of LESS was a gynecological procedure (tubal sterilization) performed by Wheeler in 1969. Approximately 20 years later, Pelosi et al. reported the first case of hysterectomy through LESS [8]. Currently, LESS is used in different surgical fields (general surgery, gynecology, urology). Compared with conventional laparoscopy, LESS shows substantial technical differences in procedure which, however, continue to be improved. These include: loss of triangulation and depth perception because the camera and working instruments are parallel to each other, limited extra-abdominal working space and decreased field of view due to suboptimal instrument or camera position. For this reason a specialized training is needed



**Figure 3.**  
*Standard laparoscopy/Minilaparoscopy illustration: 3–4 entry sites are used on the abdomen for insertion of the instruments. The instruments will converge from different angles and will neither collide nor cross.*



**Figure 4.** *Laparoendoscopic single-site surgery (LESS): a single port access is used and through this port, laparoscope and instruments are inserted. The instruments will cross at the umbilicus and will collide inside the abdomen.*

to minimize these limits, but for surgeons experienced with standard laparoscopic techniques, adopting LESS seems to be feasible and safe. Essentially the advantage of this technique over the multiport laparoscopy would lie in the improvement of cosmesis, less pain, and decreased incisional morbidity. Recent data in gynecological surgery do not support the added advantages of LESS over MLS. From an analysis of six randomized controlled trials (RCTs), conducted by Schmitt et al. in 2017 in patients undergoing LESS or MLS for adnexal pathology, there were no differences in length of hospital stay, blood loss, postoperative pain, and cosmetic outcomes [9]. In summary, the choice of LESS depends to a large extent on the skills and preferences of the surgeon after a thorough assessment of the morbidity of the patient and her pathology.

#### 2.4 Natural orifice transluminal endoscopic surgery

Natural orifice transluminal endoscopic surgery (NOTES) has emerged as the newest concept of MIS (Minimally Invasive Surgery) as an experimental alternative to conventional laparoscopy which provides an access to the peritoneum traversing a “natural” orifice (stomach, bladder, vagina, or rectum) with a multichannel endoscope [10]. When the procedure involves only transluminal access it is coined “pure” NOTES, compared with “hybrid” NOTES, which refers to a procedure performed through a natural body orifice with transabdominal assistance. The key technical elements in a NOTES procedure are access via a hollow viscus, performance of the desired maneuver once in the target cavity, and closure of the port upon exit. The choice of the entry site depends on the topography of the organ that must be subjected to surgery, considering a good visualization and proper manipulation of the instruments. For example, the trans-gastric pathway is appropriate for lower abdominal and pelvic procedures, while a trans-vaginal approach is preferable for upper abdomen organs. The conceptual bases that led to the development of NOTES have been the potential benefits of an incision of a viscus compared to the skin, the decrease in the risk of post-operative hernias and the obvious cosmetic result. On the other side, there are some limitations: many of the current instruments in use today are difficult to maneuver when the uterus is retroflexed.

Furthermore, a thorough closure of the viscerotomy is crucial to avoid bacterial contamination of the peritoneal cavity and abscess formation.

Of all the approaches, presently the transvaginal access to NOTES is the most common and seems to be the safest and most feasible for clinical application (**Figure 5**). Transvaginal NOTES (vNOTES) has been used for several operations other than cholecystectomy and appendectomy in humans. Potential complications of this approach include: dyspareunia, infertility, rectal and urinary injury. In 2012, Ahn et al. demonstrated firstly the feasibility and safety of vNOTES in gynecologic surgeries, which represented the key milestone in the evolution of NOTES [11]. The innovative and positive aspects of natural orifice surgery in gynecology include the lack of abdominal incisions, less operative pain, shorter hospital stay, improved visibility, and the possibility to skip lysis of adhesion to reach the pelvic cavity. However, for patients with severe adhesion and obliteration in the pouch of Douglas, vNOTES may be a contraindication due to higher risk of rectal injury. To date, two studies compared the surgical outcomes of vNOTES with conventional laparoscopic technique in gynecologic surgery. Both studies demonstrated that vNOTES could be safely performed for benign and large ovarian tumors and vNOTES might offer superior operative outcomes including blood loss, operating time and length of stay, compared to conventional laparoscopic technique [12, 13]. It seems obvious that sexual dysfunction may be an essential reservation of the females. Surprisingly, a study about transvaginal surgery has showed no problems of sexual intercourse and almost no cases of dyspareunia in a long-term follow-up [14]. The transvaginal peritoneal access for a gynecologist might not cause stress because of being familiar with the pelvic anatomy. Although transvaginal NOTES represents one of the most important innovations in surgery since the advent of laparoscopy, there are still technical limitations that must be overcome before the widespread use of this approach.

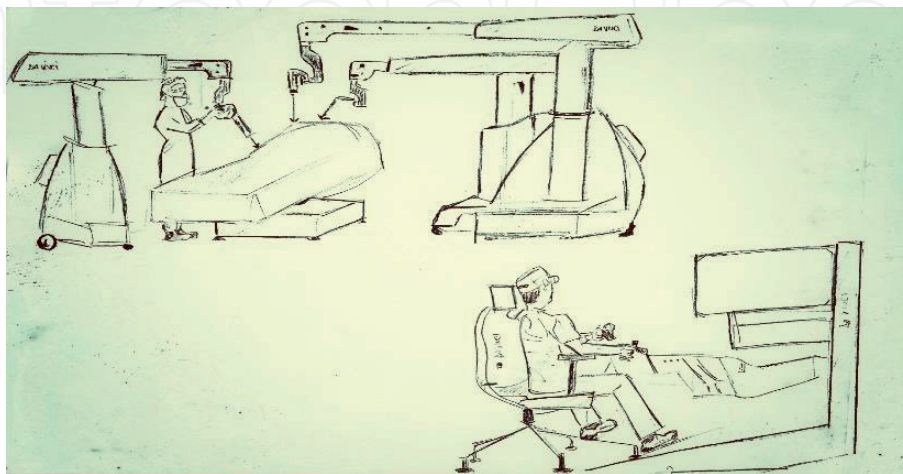


**Figure 5.** *Transvaginal natural orifice transluminal endoscopic surgery (vNOTES). An incision is made in the posterior vaginal fornix through which camera and instruments are inserted in the abdominal cavity.*



## 2.5 Robotic surgery

Similar to laparoscopy, robotic surgery uses abdominal ports to create pneumoperitoneum to expand the operative field and to introduce the endoscopic instruments. The most known and currently the only commercially available system is the Da Vinci System (**Figure 6**). The patient is placed in the standard low dorsal lithotomy position with the legs supported in stirrups. One or two surgeon consoles are used to control robot arm movement. A separate robot column is positioned by the bedside and serves as the base for the four robotic arms. One of these arms controls the laparoscope while the other arms hold the robotic instruments. If port sites in addition to the basic four are needed, an assistant surgeon can operate by the patient bedside through one or two additional laparoscopic accessory ports. Port placement for robotic surgery is unique in that ports must be placed with a minimum interval distance of 8 cm. This makes sure that robot arms do not collide with each other and with any accessory port. Importantly, the depth of the inserted trocar in the abdomen is marked by a black ring around the cannula in order to adjust the right fulcrum during the operation. Robotic surgery presents significant technical advantages and some disadvantages compared with conventional laparoscopy. Advantages include 3D visualization of the operative field, mechanical improvement (instrument with seven degrees of freedom of movement), stabilization of instruments within the surgical field, and improved ergonomics. Disadvantages are mainly lack of tactile perception, increased cost, increased operating room time, large size of the devices and risk of mechanical failure. However, the robotic procedure is very useful and decisive in complex surgical procedures where extensive demolition is necessary with consequent restoration of the anatomy. In particular, the Endo Wrist technology is able to overlap with open techniques facilitating the execution of complex maneuvers even for the less experienced. Certainly, surgical simulation, tele-mentoring and telepresence surgery are potential novel benefits of robotic technology. Through robotic surgery most gynecological surgical interventions can be safely performed with an increased comfort for the operator as compared with conventional laparoscopy. However, randomized studies have not demonstrated the superiority of this technique compared to conventional laparoscopy and a clear indication of its use. Moreover, in comparison to conventional laparoscopy the learning curve for becoming proficient in robotic surgery is less steep and has



**Figure 6.** Robotic surgery set up. It includes 3 components. A surgeon's console, a patient-side cart with four robotic arms manipulated by the surgeon (one to control the camera and three to manipulate instruments), and a high-definition three-dimensional (3D) vision system. Articulating surgical instruments are mounted on the robotic arms, which are introduced into the body through cannulas.

	Laparoscopy	Minilaparoscopy	LEES	Notes	Robotic Surgery
Advantages:	<ul style="list-style-type: none"> <li>• Affordable cost</li> <li>• Proven efficacy in RCT's</li> <li>• Ubiquitous technology</li> <li>• Low post-operative pain</li> <li>• Good cosmetic result. Shortened recovery time</li> </ul>	<ul style="list-style-type: none"> <li>• Decreased incisional pain</li> <li>• Decrease in narcotic pain medication use</li> <li>• Minimization of trauma to tissue</li> <li>• More favorable cosmetic outcome</li> </ul>	<ul style="list-style-type: none"> <li>• Reduction in postoperative pain</li> <li>• Improved cosmetic outcome</li> </ul>	<ul style="list-style-type: none"> <li>• Lack of abdominal incisions</li> <li>• Less operative pain</li> <li>• No risk of post-operative hernias</li> <li>• No abdominal scars</li> </ul>	<ul style="list-style-type: none"> <li>• 3-D Visualization</li> <li>• Seven degrees of freedom</li> <li>• Tremor elimination</li> <li>• No fulcrum effect</li> <li>• Tele-surgery capability</li> </ul>
Disadvantages:	<ul style="list-style-type: none"> <li>• 2-D Visualization</li> <li>• Long learning curve</li> <li>• Limited degree of freedom</li> <li>• Reduced haptic feedback</li> <li>• Fulcrum effect</li> <li>• Amplified tremor</li> </ul>	<ul style="list-style-type: none"> <li>• Similar flaws to standard laparoscopic approach</li> <li>• More delicate and fragile laparoscope</li> <li>• Lower light quality and operative field visualization</li> </ul>	<ul style="list-style-type: none"> <li>• Slightly higher incidence of incisional hernia in comparison to multi-port laparoscopy</li> <li>• Restricted triangulation</li> <li>• Risk of external hand collision</li> <li>• Long learning curve</li> </ul>	<ul style="list-style-type: none"> <li>• Higher risk of rectal injury</li> <li>• Long learning curves.</li> <li>• Extended procedure times</li> <li>• Possible dyspareunia</li> <li>• Inability to deal with major complications</li> </ul>	<ul style="list-style-type: none"> <li>• High cost</li> <li>• Absence of touch sensation</li> <li>• Special training in specific centers.</li> <li>• Scarce proof of benefit on RCT's</li> </ul>

**Table 1.**  
*Advantages and disadvantages of various types of MIS in Gynecology.*

allowed a smooth transition to minimally invasive surgery for many gynecologists [15–20]. Last but not least, a newer Single Port Robot is currently available although not yet FDA approved for gynecologic procedures.

As it comes clear, nowadays there are various available minimally invasive techniques in the field of gynecology, each of them presenting specific advantages and disadvantages as shown below in **Table 1**.

### **3. Ergonomics in minimally invasive surgery**

The term ergonomics derives from 2 Greek words: “Ergon” that means work and “nomos” that means law. In simple words it describes the science that prepares the worker to best fit his job by developing his working environment and necessary tools by offering the maximum favorable conditions [21]. Usually, when we talk about safety in the OR, anyone might be automatically thinking of safety concerning the patient and not the safety of medical and paramedical staff. Despite the proven safety and efficiency for patients, the development of laparoscopy came with exclusive ergonomic risks such as instrument length and handle design, inappropriate monitor position, and excessively high operating tables. Work-related musculoskeletal injuries and disorders are extremely common in the surgical staff with specific risk situations present in open, laparoscopic, vaginal, and robotic surgery. Needless to point out, that surgeon’s safety has received scarce consideration, throughout the passage from laparotomy to MIS. Studies have shown that, despite significant impact of surgeon injury on productivity and career longevity, surgeons seldom and almost never report work-related injuries to the hospitals, building up a tendency of silent suffering. Although surgical ergonomics guidelines do exist, most surgical staff is not aware of guidelines, while targeted surgical ergonomics training is rare.

Work-related musculoskeletal disorders (WMSDs) as being the official term of this emerging phenomenon contribute immensely to reduced productiveness and job absenteeism. According to the guidelines, behaviors such as repetitions, application of more than 30% of strength, excess body segment positioning, prolonged static posture, use of vibration equipment and exposure to cold shall be averted. Given all that, it comes clear that WMSDs have the highest prevalence in the group of surgeons [22]. These sometimes inevitable movements could have important consequences to the admittedly long career life of a surgeon. Therefore, evidence based ergonomics training protocols should be available and become a compulsory part of residency programs to all teaching hospital around the world as it is well known, in the medical life but as well as in other scenarios bad habits hardly dissolve.

#### **3.1 Ergonomics of conventional laparoscopy**

The importance of ergonomics in the field of laparoscopy cannot be over-emphasized. Studies have shown that ergonomics awareness and structured training can reduce chronic pain among surgeons as well as suturing time. The commonest sites of injury include the neck, back, shoulder, elbow, and wrist. This is no surprise as in comparison to conventional open surgery, in laparoscopy the surgeon presents prolonged static posture with no dynamic movements of the body resulting in decreased blood supply in the muscles and consequently elevated lactic acid and toxins in the blood circulation due to anaerobic metabolism. Moreover, redundant internal rotation of shoulder and deviation of elbow and wrist are more common in laparoscopy and have a huge impact in the mechanism of strain of the described regions. Risk factors for WMSDs include physician’s traits such as younger age, shorter stature, female sex, smaller glove size, and higher volume, as well

as higher patient BMI. On the other hand, protective factors include ergonomics awareness and training, excessive practice and higher surgeon age. Monitor position is a key component in laparoscopic surgery. Ergonomically, the ideal monitor position for laparoscopy is with the monitor image at or within 25 optimal degrees below the horizontal plane of the eye at a distance of approximately 60 cm. The same height, at which the video monitor used to be set for surgeons of different heights, has been demonstrated to be the underlying cause of neck pain and spondylosis in high-volume laparoscopic centers in the first decade after the onset of MIS in routine clinical practice [22–24].

### **3.2 Ergonomics of robotic surgery**

Robotic surgery offers certain improvements in ergonomics such as greater degrees of freedom, motion scaling, tremor reduction, and 3-D immersive optics. Robotic equipment permits performance of fine tasks without the ‘arcing’ motions characteristic of conventional laparoscopy. Overall pain with robotics is decreased in comparison to open surgery and laparoscopy. Nevertheless, recent studies have questioned this demonstrated ergonomic advantage of robotics as McDonald et al. in 2017 concluded that robotic procedures were associated with more discomfort, stiffness and fatigue in a survey study of 350 surgeons [25]. Another study by Franasiak et al. has shown that approximately 45% of robotic surgeons experienced WMSDs while an impressive percentage of 26% showed to have experienced permanent damage. As resulted by the same study none of the observed surgeons reported injury to institutions while less than 17% of the total number had formerly received appropriate ergonomics training [26]. Given the rapidly emerging field of robotics in gynecologic surgery it comes clear that more solid evidence is needed in order to make safe comparisons between the ergonomic limitations of robotics versus laparoscopy [27].

## **4. Artificial intelligence and training the next generation of minimally invasive surgeons**

Artificial intelligence (AI) and augmented reality have been steadily permeating the healthcare field and are expanding into gynecology. Although virtual artificial intelligence systems are still lacking in gynecology, gynecologic surgery has already integrated augmented reality (AR) technology into the operating room. For instance, cervical cancer models using AI have been used to foresee survival after surgery [28]. Over the past decade, gynecologic surgery has incorporated augmented reality in the form of computer-assisted or robotic platforms to close the native gap between open and minimally invasive surgical skills [29]. A.I applications range from simple prognostic tools to more complex models that incorporate clinical data, imaging, and histopathology to contribute into the optimal therapy decision. Various researchers argue that artificial intelligence is superior to traditional regression models in predicting outcomes. Another example of augmented reality in surgery is projecting preoperatively obtained radiologic images to the operating field during surgery to allow surgeons to understand the anatomical relationship between pathologic and healthy organs. Real time detection of the ureter during surgery is currently experimentally tested for eventual future use [30]. 3D printing is already reality in many centers and it permits advanced preoperative surgical planning and as a result minimizes potential injury. The most applicable example is by understanding the variation in uterine myomas where parameters such as size, location, and depth vary a lot and as a result 3D printing could guide the gynecologist to achieve an outstanding level of pre-op planning [31]. A recently

published case report has had success in mapping endometriosis nodules with spatial organ involvement preoperatively with a 3DP model [32].

Virtual simulators have been recently utilized in training gynecologic surgeons for laparoscopic and robotic surgery. The simulator's efficacy has been assessed through published studies and has been shown to improve basic and advanced laparoscopic skills in all training levels. Novice residents improved their speed of execution, accuracy, and maintenance of horizontal view, while senior residents shortened their speed of execution. Virtual simulators could be incorporated into compulsory residency training as tools for practicing coordination and precision [33]. Hopefully we will reach to a point where as in aviation, it could become a requirement for novice trainees to practice and demonstrate adequate mastery of minimally invasive surgical skills before boarding on real surgery.

## **5. Conclusions**

In conclusion, endoscopic approach remains the best choice in most of gynecological interventions. Despite the continuous groundbreaking advances in the medical technology concerning gynecologic procedures, the standard laparoscopic approach remains the universal king of the endoscopic gynecologic surgery. In everyday clinical practice, the final decision of the preferred technique depends on different variables: surgeon experience with the proposed technique, patient's characteristics and desire and finally costs. In particular, surgical costs can be divided into equipment costs and operating room time and surgical staff has to be more familiar with these costs as there is evidence that when surgeons are well informed and educated about operating room outlay, the cost of the procedure decreases. Moreover, the cost differential between robotic and laparoscopic hysterectomy decreases as surgeon and hospital volume increase [34]. For example, in selected cases such as hysterectomies for large uteri greater than 750 gr, robotic surgery has been shown to have cost-effective benefits compared to laparoscopic hysterectomy [35]. Minilaparoscopy, LESS and NOTES gave new perspectives to the minimal invasive conception, however despite of specific important flaws they are not frequently used into clinical practice up to date. Laparoscopic training as well as reduction of robotic-assisted technology costs by expanded use seem to be the constant for the future of minimal access surgery in the field of gynecology.

## **Conflict of interest**

The authors declare no conflict of interest.

# IntechOpen

## Author details

Morena Antonilli<sup>1,2</sup>, Vasileios Sevas<sup>1,2</sup>, Maria Luisa Gasparri<sup>1,2</sup>,  
Ammad Ahmad Farooqi<sup>3</sup> and Andrea Papadia<sup>1,2\*</sup>

1 Service of Gynecology and Obstetrics, Department of Gynecology and Obstetrics,  
Regional Hospital of Lugano EOC, Lugano, Switzerland

2 Faculty of Biomedical Sciences, University of Italian Switzerland, Lugano,  
Switzerland

3 Institute of Biomedical and Genetic Engineering (IBGE), Islamabad, Pakistan

\*Address all correspondence to: [andrea.papadia@eoc.ch](mailto:andrea.papadia@eoc.ch)

## IntechOpen

© 2021 The Author(s). Licensee IntechOpen. This chapter is distributed under the terms of the Creative Commons Attribution License (<http://creativecommons.org/licenses/by/3.0>), which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited. 

## References

- [1] Kaistha, Sumesh, et al. "Laparoscopic access: direct trocar insertion versus open technique." *Journal of Laparoendoscopic & Advanced Surgical Techniques* 29.4 (2019): 489-494. DOI: 10.1089/lap.2018.0408
- [2] Boruta, David M. "Laparoendoscopic single-site surgery in gynecologic oncology: an update." *Gynecologic oncology* 141.3 (2016): 616-623. DOI: 10.1016/j.ygyno.2016.03.014
- [3] Dorsey, J. H., and C. R. Tabb. "Mini-laparoscopy and fiber-optic lasers." *Obstetrics and gynecology clinics of North America* 18.3 (1991): 613-617.
- [4] Ghezzi, Fabio, et al. "Minilaparoscopic versus conventional laparoscopic hysterectomy: results of a randomized trial." *Journal of minimally invasive gynecology* 18.4 (2011): 455-461 DOI: 10.1016/j.jmig.2011.03.019
- [5] Acton, Jade N., et al. "Outcomes of total laparoscopic hysterectomy using a 5-mm versus 10-mm laparoscope: a randomized control trial." *Journal of minimally invasive gynecology* 23.1 (2016): 101-106. DOI: 10.1016/j.jmig.2015.09.001
- [6] Ahmad, Gaity, et al. "Laparoscopic entry techniques." *Cochrane database of systematic reviews* 1 (2019).DOI: 10.1002/14651858.CD006583.pub5
- [7] Layne, Alyssa Small, Lauren Pinkard, and Jessica Shepherd. "Current trends in minilaparoscopy." *Current Opinion in Obstetrics and Gynecology* 28.4 (2016): 255-260. DOI: 10.1097/GCO.0000000000000290
- [8] Pelosi, Marco A., and M. A. Pelosi 3rd. "Laparoscopic hysterectomy with bilateral salpingo-oophorectomy using a single umbilical puncture." *New Jersey medicine: the journal of the Medical Society of New Jersey* 88.10 (1991): 721-726.
- [9] Schmitt, Andy, et al. "Single-port laparoscopy vs conventional laparoscopy in benign adnexal diseases: a systematic review and meta-analysis." *Journal of minimally invasive gynecology* 24.7 (2017): 1083-1095. DOI: 10.1016/j.jmig.2017.07.001
- [10] Escobar, Pedro F., et al. "Laparoendoscopic single-site and natural orifice surgery in gynecology." *Fertility and sterility* 94.7 (2010): 2497-2502. DOI: 10.1016/j.jmig.2017.07.001
- [11] Ahn, Ki Hoon, et al. "Transvaginal single-port natural orifice transluminal endoscopic surgery for benign uterine adnexal pathologies." *Journal of minimally invasive gynecology* 19.5 (2012): 631-635 DOI: 10.1016/j.jmig.2012.04.001
- [12] Wang, Chin-Jung, et al. "Natural orifice transluminal endoscopic surgery-assisted versus laparoscopic ovarian cystectomy (NAOC vs. LOC): a case-matched study." *Surgical endoscopy* 30.3 (2016): 1227-1234. DOI: 10.1007/s00464-015-4315-6
- [13] Lee, Yi-Le, et al. "Transvaginal natural orifice transluminal endoscopic surgery for female-to-male transgender men." *Journal of minimally invasive gynecology* 26.1 (2019): 135-142. DOI: 10.1007/s00464-015-4315-6
- [14] Mofid, Hamid, et al. "Is the transvaginal route appropriate for intra-abdominal NOTES procedures? Experience and follow-up of 222 cases." *Surgical endoscopy* 27.8 (2013): 2807-2812. DOI: 10.1007/s00464-013-2812-z
- [15] Daiana, M., & Marescaux, J. (2015). *Robotic Surgery*. *Br J Surg*, 102(2), e15-e28. DOI: 10.1007/s00464-013-2812-z
- [16] Sinha, Rooma, et al. "Robotic surgery in gynecology." *Journal of minimal access surgery* 11.1 (2015): 50 DOI: 10.1007/s00464-013-2812-z

- [17] Paraiso, Marie Fidela R. "Robotic-assisted laparoscopic surgery for hysterectomy and pelvic organ prolapse repair." *Fertility and sterility* 102.4 (2014): 933-938 DOI: 10.1016/j.fertnstert.2014.08.010
- [18] Wright, Jason D., et al. "Robotically assisted vs laparoscopic hysterectomy among women with benign gynecologic disease." *Jama* 309.7 (2013): 689-698. DOI: 10.1001/jama.2013.186
- [19] Orady, Mona, et al. "Comparison of robotic-assisted hysterectomy to other minimally invasive approaches." *JLS: Journal of the Society of Laparoendoscopic Surgeons* 16.4 (2012): 542. DOI: 10.4293/108680812X13462882736899
- [20] Sinha, Rooma, et al. "Robotic surgery in gynecology." *Journal of minimal access surgery* 11.1 (2015): 50. DOI: 10.4103/0972-9941.147690 DOI: 10.4103/0972-9941.147690
- [21] Supe, Avinash N., Gaurav V. Kulkarni, and Pradnya A. Supe. "Ergonomics in laparoscopic surgery." *Journal of minimal access surgery* 6.2 (2010): 31.31. DOI: 10.4103/0972-9941.65161
- [22] Catanzarite, Tatiana, et al. "Ergonomics in surgery: a review." *Female pelvic medicine & reconstructive surgery* 24.1 (2018): 1-12. DOI: 10.1097/SPV.0000000000000456
- [23] Park, Adrian, et al. "Patients benefit while surgeons suffer: an impending epidemic." *Journal of the American College of Surgeons* 210.3 (2010): 306-313. DOI: 10.1097/SPV.0000000000000456
- [24] Lee, Gyusung, et al. "Ergonomic risk associated with assisting in minimally invasive surgery." *Surgical endoscopy* 23.1 (2009): 182-188. DOI: 10.1007/s00464-008-0141-4
- [25] McDonald, Megan E., et al. "Physician pain and discomfort during minimally invasive gynecologic cancer surgery." *Gynecologic oncology* 134.2 (2014): 243-247. DOI: 10.1016/j.jygyno.2014.05.019
- [26] Franasiak, Jason, et al. "Feasibility and acceptance of a robotic surgery ergonomic training program." *JLS: Journal of the Society of Laparoendoscopic Surgeons* 18.4 (2014). DOI: 10.4293/JLS.2014.00166
- [27] Stylopoulos, Nicholas, and David Rattner. "Robotics and ergonomics." *Surgical Clinics* 83.6 (2003): 1321-1337. DOI: 10.1016/S0039-6109(03)00161-0.
- [28] Obrzut, Bogdan, et al. "Prediction of 5-year overall survival in cervical cancer patients treated with radical hysterectomy using computational intelligence methods." *BMC cancer* 17.1 (2017): 1-9. DOI: 10.1186/s12885-017-3806-3
- [29] Sørensen, Stine Maya Dreier, et al. "Three-dimensional versus two-dimensional vision in laparoscopy: a systematic review." *Surgical endoscopy* 30.1 (2016): 11-23. DOI: 10.1186/s12885-017-3806-3
- [30] Song, Enmin, et al. "A novel endoscope system for position detection and depth estimation of the ureter." *Journal of medical systems* 40.12 (2016): 1-11. DOI: 10.1007/s10916-016-0607-1
- [31] Bourdel, Nicolas, et al. "Augmented reality in gynecologic surgery: evaluation of potential benefits for myomectomy in an experimental uterine model." *Surgical endoscopy* 31.1 (2017): 456-461. DOI: 10.1007/s00464-016-4932-8
- [32] Ajao, Mobolaji O., et al. "Case report: three-dimensional printed model for deep infiltrating endometriosis." *Journal of minimally invasive gynecology* 24.7 (2017): 1239-1242. DOI: 10.1016/j.jmig.2017.06.006
- [33] Paquette, Joalee, et al. "Virtual laparoscopy simulation: a promising



pedagogic tool in gynecology." *JSLs: Journal of the Society of Laparoendoscopic Surgeons* 21.3 (2017). DOI: 10.4293/JSLs.2017.00048

[34] Misal, Meenal, Ritchie Delara, and Megan N. Wasson. "Cost-effective minimally invasive gynecologic surgery: emphasizing surgical efficiency." *Current Opinion in Obstetrics and Gynecology* 32.4 (2020): 243-247. DOI: 10.1097/GCO.0000000000000636

[35] Moawad, Gaby N., et al. "Comparison of cost and operative outcomes of robotic hysterectomy compared to laparoscopic hysterectomy across different uterine weights." *Journal of robotic surgery* 11.4 (2017): 433-439. DOI: 10.1097/GCO.0000000000000636

IntechOpen