10 Additional Gynecologic Indications for Robotic-Assisted Surgery

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Introduction

The introduction of contemporary, minimally invasive procedures designed for the female reproductive system dates back to 1898 [1], when early forms of intrauterine evaluation, currently termed hysteroscopy, were first described by Duplay and Clado. Gynecologic surgeons began to investigate the role of diagnostic laparoscopy in the late 1960s [2], but they did not begin to tackle more complex procedures, such as hysterectomy, until the first case was described in 1988 by Dr. Harry Reich [3]. Several decades later, innovative technologies such as the Zeus robotic surgical system (Computer Motion, Goleta, CA) were devised to facilitate more intricate procedures and enable surgeons to operate in difficult to reach locations. Despite its technology, this particular device was not widely adopted by gynecologists and was discontinued in 2003, only two years after being cleared by the US Food and Drug Administration (FDA), likely because of low volume of procedures.

The next robotic surgical system that was introduced to the market was the da Vinci platform (Intuitive Surgical, Sunnyvale, CA), which, unlike Zeus, rapidly gained popularity and received FDA approval for gynecologic procedures in 2005. Since that time, the da Vinci surgical system has been used by gynecologic surgeons for myomectomy, hysterectomy, microscopic tubal reanastomosis (MTR), sacrocolpopexy, excision of endometriosis, extirpative surgery for reproductive cancers, and adnexal surgery.

The introduction of robotic-assisted surgery (RAS) has not been without controversy or debate. This, in part, is borne from financial and competitive pressures at the institutional and physician levels. The relative saturation documented in both urologic and certain gynecologic procedures represents a strong indicator of these pressures to change and how best to provide surgical care. The combination of the almost "too-quick" implementation of a complex device into the healthcare setting represents a potential quagmire of large-scale safety concerns, but also limits our capacity to evaluate these tools in a systematic fashion. This dilemma is further heightened by the related challenge of how we should implement multi-disciplinary educational programs. The lack of consistent outcomes

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reporting further restricts our ability to establish treatment paradigms specific to RAS, especially when proven, non-robotic minimally approaches already exist.

The objective of this chapter is to provide the reader with a current and evidence-based review to facilitate a thoughtful approach to the surgical care for women. Please see Table 10.1 for a summative comparison of the below disease states and how they compare based on surgical approach.

Disease States

Uterine Myoma

One of the most perplexing findings when evaluating women with a variety of pelvic complaints is the presence of uterine myomas, frequently called fibroids. These benign tumors of the reproductive tract are so common that in population studies they can be detected by ultrasound in 40–60% of women by age 35 and 70–80% by age 50, with a higher prevalence among those of African ancestry [4]. The clinician is then faced with the task of linking the findings with the symptoms, rather than simply treating something which could otherwise be coined an unrelated bystander, given the high prevalence in women. Uterine myomas can cause pelvic pressure, urinary frequency, constipation, and abnormal uterine bleeding. In specific circumstances, depending on location and size, they can be linked with reduced fertility in couples trying to conceive. Surgical management of uterine myoma, the focus of this segment, represents only one of many options for women who are symptomatic. Figure 10.1 demonstrates location of myoma and their potential for abnormal uterine bleeding or pressure-related symptoms.

Myomectomy

The original uterus-sparing surgical concept is actually a group of procedures collectively called myomectomy, whereby the myoma is enucleated and the muscular defect reconstructed with suture in a layered fashion. This repair is critical to the integrity and contractile function of this smooth muscle during pregnancy. The open approach was first reported by Atlee in 1845 [5] and is considered the gold standard for women wishing to conceive.

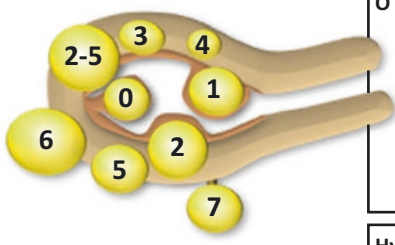
The most appropriate myomectomy approach and technique depends upon a number of factors including the patient's desire for future fertility as well as the size, number, location, and relationship of the deepest aspect of the myoma(s) to the uterine serosa. An abdominal approach [open, laparoscopic (LM) or robotic-assisted laparoscopic myomectomy (RALM)] is most appropriate for transmural lesions, when the myoma extends from a submucosal location to the serosa.

The principle potential advantages of LM and RALM, compared to the open approach, include reduced morbidity, shorter hospitalization, improved cosmesis, and faster return to normal activity (Table 1) [6]. Notwithstanding these benefits, an open approach remains a commonplace procedure due to the complexity of the laparoscopic approach, primarily due to the skillset needed to identify the myoma(s) of interest with less tactile feedback and to place multiple sutures laparoscopically, which are often in deep and difficult-to-access spaces.

The da Vinci robotic surgical system was designed to overcome these dynamic surgical obstacles. The first case series of RALM was reported by Advincula more than a decade ago [7]. Although the average procedural time was 230 min, the perioperative outcomes were promising. As a result, the robotic platform seemed to represent an enabling device for an otherwise complex procedure. Early adopters believed that the instrument articulation, which allowed the surgeon to enucleate anatomically challenging myomas and effectively reconstruct large surgical defects, may be the defining feature of the device when it comes to myomectomy. Evidence-based guidelines for surgical candidacy of either LM or RALM have yet to be defined. Experts typically refer to 15 cm as a relative maximum size limit for an isolated myoma when considering a laparoscopic or robotic-assisted approach, but location, number of myomas, and volume of

Table 10.1 Comparison of outcomes based on surgical approach

	RAS vs. laparotomy	RAS vs. laparoscopy
Myomectomy		
OR time	Longer	Same (slightly longer)
EBL	Less	Less
LOS	Shorter	Same
Recovery	Faster	Same
Complications	Fewer	Same
Clinical outcome	Same	RAS: more complex cases
Hysterectomy		
OR time	Longer	Longer
EBL	Less	Same
LOS	Shorter	Same
Recovery	Faster	Same
Complications	Fewer	Same
Clinical outcome	Same	Same
Endometriosis		
OR time	Longer	Longer
EBL	Less	Same
LOS	Shorter	Same
Recovery	Faster	Same
Complications	–	Same
Clinical outcome	–	Same
Fallopian tube surgery		
OR time	Longer	Longer
EBL	Same	Greater
LOS	Same	Same
Recovery	Faster	Same
Complications	–	–
Clinical outcome	Similar pregnancy rate	Similar pregnancy rate
Adnexal surgery		
OR time	Longer	Same (slightly longer)
EBL	Less	Same
LOS	Shorter	Same
Recovery	Faster	–
Complications	–	Higher
Clinical outcome	–	–
Endometrial CA		
OR time	Longer	Same (slightly shorter)
EBL	Less	Less
LOS	Shorter	Shorter
Recovery	Fewer	Same
Complications	Shorter	–
Clinical outcome	More nodes	More nodes; obese women
Cervix CA		
OR time	Same	Similar
EBL	Less	Less
LOS	Shorter	Similar
Complications	Same	Similar
Recovery	–	–
Clinical outcome	–	Similar nodes



		Not yet classified
SM - Submucosal	0	Pedunculated intracavitary
	1	<50% intramural
	2	≥50% intramural
O - Other	3	Contacts endometrium; 100% intramural
	4	Intramural
	5	Subserosal ≥50% intramural
	6	Subserosal <50% intramural
	7	Subserosal pedunculated
	8	Other (specify e.g. cervical, parasitic)

Hybrid leiomyomas (impact both endometrium and serosa)	Two numbers are listed separated by a hyphen. By convention, the first refers to the relationship with the endometrium while the second refers to the relationship to the serosa. One example is below	
	2-5	Submucosal and subserosal, each with less than half the diameter in the endometrial and peritoneal cavities, respectively.

Fig. 10.1 Leiomyoma subclassification system

disease represent equally critical variables when considering this approach.

With clear benefits of a minimally invasive approach to myomectomy, both LM and RALM, specific questions remain as to which represents the ideal approach for the individual patient. The leiomyoma recurrence rates and likelihood of severe complications appear to be similar in women undergoing myomectomy by either approach [8], but it would appear that when performed by a skilled operator, RALM may allow for a minimally invasive completion of more complex cases. The data currently available on fertility outcomes indicate that the two approaches are also similar, with about 50–60% conception rates in the follow-up period with resulting pregnancy outcomes, as well comparable risk of spontaneous abortion, preterm delivery, and uterine rupture [9].

Gargiulo and colleagues evaluated the perioperative outcomes of similar groups of women undergoing either LM or RALM, both by high-volume surgeons who had a preference for surgical approach. Both the laparoscopic and robotic surgeons had reached the perceived learning curves for the respective technique. In this observational study, the authors documented similar findings in each group with two exceptions: a longer operating time (absolute difference of 77 min) and a higher estimated blood loss (absolute difference 24 mL) for the robotic group. A major confounder was the introduction of barbed suture, only utilized by the laparoscopic group. This suture type allowed for faster uterine reconstruction with the potential for decreased blood loss because of its ability to close the defects more efficiently and by creating an internal tourniquet within the myometrium [9]. Barakat and colleagues evaluated the outcome of 575 women undergoing myomectomy performed at a single institution, comparing all three approaches [10]. The majority of cases (68.3%) were performed by laparotomy with the remaining evenly distributed between LM and RALM. Consistent with other study findings, patients undergoing the open approach experienced a shorter procedure compared to LM (absolute difference 29 min), whereas those undergoing RALM experienced the longest operating time (absolute difference of 55 min vs. 26 min for open and LM, respectively). Patients who underwent open myomectomy had more blood loss compared to both LM or RALM, as well as a longer hospital stay. Mean myoma size and weight of those in the RALM were closer to

that of those undergoing open myomectomy, suggesting an increased capacity to address larger myomas. Reproductive outcomes were not assessed in this retrospective trial. The authors concluded that RALM may allow surgeons to perform more difficult cases laparoscopically and prevent conversion to laparotomy.

One critical surgical tenet for performing RALM is that the surgeon utilizes the same technique(s) described for the abdominal counterpart. Surgical planning with appropriate imaging and knowledge of where the myomas sit within the uterus allows for better efficiency in the operating room. Specifically, this allows the surgeon to decide which myomas to address and in what particular order, allowing for streamlined removal and repair. Maintaining proper surgical planes between the myoma itself and overlying myometrium will minimize bleeding and subsequent hematoma formation which impedes muscular repair. Gentle tissue handling and appropriate use of electrosurgery will further aid in tissue repair and minimize adhesion formation.

Robotic instruments commonly used are monopolar Metzenbaum scissors or hook, using a low voltage setting, a Maryland dissector that can aid in enucleation of the myoma from its bed, and a single tooth tenaculum or claw grasper that can be used to place traction on the myoma. Many surgeons typically use a dilute form of vasopressin (example: 20 units vasopressin diluted in 50 mL normal saline) to minimize bleeding as the overlying serosa and myometrium are incised. Bleeding during this portion is expected since these muscular tissues have abundant blood supply, and so a combination of vasoactive agents and electrosurgery will help to keep the surgical field clear. An incision is created to allow for adequate exposure, but smaller serosal injuries will minimize subsequent adhesion formation.

Enuclation is the process by which the myoma is removed from its bed. Typically, there is a relatively avascular cleavage plane between the myoma surface and myometrium. Excessive bleeding during this portion of the procedure may indicate dissection within an incorrect plane. Once removed, the defect must be repaired in layers with absorbable suture of the surgeon's choosing. The advent of barbed suture resulted in a similar phenomenon as did the robotic platform, allowing for a more efficient and hemostatic myometrial reconstruction and enabling surgeons not as skilled in laparoscopic suturing to offer this procedure.

Upon completion of the myomectomy, the myomas must be extracted from the peritoneal cavity. With the current and limited use of mechanical morcellators, many surgeons are removing uterine myomas with a scalpel and some form of a containment system. Adhesion prevention with use of a barrier remains a separate discussion, but it is the opinion of this author that surgical technique and use of a minimally invasive approach are key to reducing this potentially morbid phenomenon.

Hysterectomy

Notwithstanding an arsenal of options currently available for women with uterine myoma, hysterectomy remains one of the most commonly performed procedures in North America, with over 400,000 cases performed on an inpatient basis [11]. Common indications for hysterectomy include both benign and malignant disorders, with myoma being the most common. Substantive literature exists in support of vaginal hysterectomy as the route of choice when feasible, given the excellent outcomes and shorter convalescence when compared to abdominal hysterectomy (AH) [12]. Nevertheless, the utilization of this approach seems to have stalled at approximately 20% of all cases performed in the U.S. [12]. Laparoscopic approach to hysterectomy (LH) confers similar outcomes, but at a higher overall direct cost, primarily due to longer operating times and use of disposable instruments such as trocars and electrosurgical devices.

Early publications addressing the role of robotic assistance in hysterectomy focused on patients who had undergone multiple prior Cesarean deliveries and developed significant anterior cul de sac adhesions [13]. Although only six patients were described in this retrospective review, the authors believed the tool could enable surgeons to undertake more challenging cases. Since then, two randomized trials were published

evaluating perioperative outcomes of robotic-assisted laparoscopic hysterectomy (RALH) and LH for benign disorders, representing more typical clinical scenarios. Both studies, of similar design, documented significantly longer total operating times (31–72 min) in the robotic arms for a comparable group of patients with uterine weights of approximately 250 g. Other variables related to the procedure, including postoperative complications, were similar in both arms of both studies. In an attempt to minimize the impact of surgical experience, both groups enlisted surgeons skilled in conventional laparoscopy and who had completed at least 20 robotic procedures. Other reasons that could account for differences in operative time include setup and the complexity of the device, both of which require a well-versed team in the operating room and electrosurgical instrumentation. It could be argued, however, that the robotic surgeons were still in the early phase of their learning curve. At the time of publication, it was felt that only 20 cases were needed for the average surgeon. However, for effective team functionality, the flattening of the learning curve more likely occurs upward of 50 cases [14].

In 2007, less than 1% of all hysterectomies in the U.S. were performed with robotic assistance [11]. An astonishing uptake of procedures was noted nationwide, such that by 2010, the number of cases increased to 9.5%. Early adopters were seeing rates as high as 22% only 3 years after implementing this service within their institutions (Fig. 10.2). Prior to the introduction of the robot, the rates of all minimally invasive hysterectomies remained relatively static in prior years. It was felt that this disruptive technology could represent the next phase in surgical management for women with reproductive disorders. A robust database review of sample cases from 2007 to 2010 documented similar findings from earlier work with regard to clinical outcomes and cost, with a typical RALH resulting in a direct cost increase of over $2000. Perhaps limited by errors in misclassification and missing variables, this population-based analysis provided data consistent with other prospective trials and highlighted the need to strategically implement robotic services.

Using the same database, reviewing outcomes from 2005 to 2010, a separate group of authors demonstrated slightly different findings [15]. They found that more surgeons performing RALH were able to perform hysterectomy on larger uteri (>250 g) compared to those using conventional laparoscopy (7.4% vs. 5.5%), while operating on women with more comorbidities (21.6% vs. 15.2%) and experiencing fewer conversions to laparotomy (2.5% vs. 7.2%). An interesting and unexpected finding, in contrast to other studies, was that the overall complication rate was significantly lower in the robotic group, even when compared to women who underwent any other approach to hysterectomy including open, laparoscopic, and vaginal hysterectomy. Women undergoing open hysterectomy had a mortality rate ten times higher compared to any other approach; however, the rate of this event was low at ≤0.2% in all groups. Selection bias may have also contributed to worse outcomes in the open group.

Endometriosis

Endometriosis is defined as the existence of endometrial glands and stroma external to the endometrial cavity and myometrium. It is a common condition that occurs in approximately 15% of reproductive aged women, but has been documented in all stages of life [16, 17]. The prevailing theory of pathogenesis of endometriosis, postulated over 90 years ago by Sampson, is one of reimplantation of endometrial glands and stroma that gain access to the peritoneal cavity via retrograde menstruation. It has been suggested that, in women with endometriosis, there is a deficient cell-mediated immune response and therefore a resultant failure of the peritoneal mechanisms designed to clear the menstrual effluent. Separately, the peritoneum may demonstrate altered physiology and response to foreign stimuli resulting in increased levels of inflammatory markers in women with endometriosis, resulting in adherence and perpetuation of endometrial glands and stroma [18].

Endometriosis is frequently asymptomatic, and its presence in a patient with pain may not

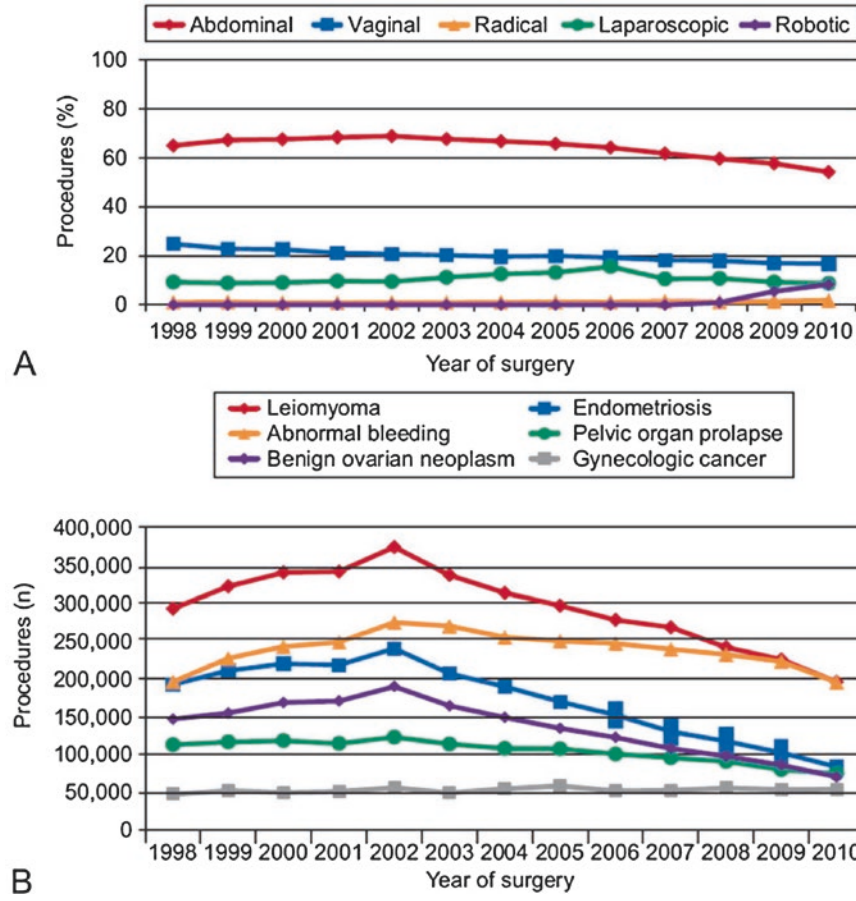


Fig. 10.2 (**a**) Hysterectomies (%) performed via each surgical route by year of procedure. (**b**) Procedures (*n*) performed each year stratified by indication for surgery. From [11]; with permission

always be the actual cause of the pain. In fact, endometriosis is commonly encountered in women with pelvic pain of other etiologies. However, in many instances, endometriosis is clearly the cause of any one or combination of dyspareunia (pain with sexual intercourse), dyschezia (pain with bowel movements during menstrual period), dysmenorrhea (cyclic menstrual pain), and other types of pelvic pain. Although neither the stage of endometriosis nor the site of implantation necessarily correlates with the degree of pain experienced, the depth of infiltration beneath the peritoneal or mesothelial surface does [19]. Furthermore, it appears that noncyclical pain is more common in women with deep infiltrating endometriosis. Women with endometriosis may also experience subfertility, even in the absence of pain.

Although a host of nonsurgical treatment paradigms exist, women with deep infiltrating endometriosis are more likely to represent a group of women recalcitrant to medical therapy. Radical excisional procedures are often required to improve chronic pain, and the infiltrative process of this category of endometriosis represents a known surgical challenge, even in the most experienced of hands. Significant alteration in normal anatomic relationships not only predisposes to inadequate resection, but also predisposes the patient to surgical complications. Historically, surgical options were managed by laparotomy, followed by the advent of modern day laparoscopy. The role of robotic surgery for deep infiltrating endometriosis remains to be defined, as outcomes data have been limited to retrospective analyses. Nezhat and colleagues

published one of the larger initial series, describing 30-day perioperative outcomes in 86 women. In this single surgeon review, the majority of patients (>75%) had more advanced stages of endometriosis, yet outcomes were similar in both robotic and conventional laparoscopic groups [20]. The main difference between the groups was operative time, with the robotic group requiring an additional 77 min (mean difference) (longer operative time in the robotic group). The use of hysterectomy as part of the treatment plan and rate of surgical complications were also similar.

In 2015, Magrina and colleagues published data on 493 women, all of whom had advanced stages of disease [21]. A large team was involved in their care and surgeons were adept in both traditional and robotic-assisted surgical techniques. Although surgeon preference influenced which patient was treated with which modality, perioperative outcomes were not drastically different among the groups, with the exception of two key patient characteristics: those who were managed with RAS were more likely to have undergone more procedures and more radical procedures specific to endometriosis-related surgery during the incident. This finding likely accounted for the difference in operating time of 26 min. In the absence of a randomized trial, which is currently underway, the role of RAS for patients for deep infiltrating endometriosis remains controversial. At this point in time and for this indication, surgeon preference remains the driving force for perioperative decision making.

Fallopian Tube Surgery

Microsurgical tubal anastomosis allows for reconstruction of the fallopian tube after interruptive procedures designed for permanent sterilization. A small percentage of these women will reinvest in their desire to conceive, and this option, if successful, represents their ongoing ability to conceive in the future and avoid costly cycles of in vitro fertilization (IVF). Further, the success rates are quite high, making this an attractive option for some couples. This procedure requires delicate tissue handling, and the reanastomosis is dependent on the use of extremely fine suture. Historically performed by laparotomy under microscopic guidance, the procedure has more recently been performed by conventional laparoscopy. Falcone described the first robotic technique in 2007, having performed his first case in 2001, and all studies since have been retrospective in design [22]. Similar to other procedures within gynecology, operative times have been consistently longer when compared to laparoscopy or mini-laparotomy, at greater cost and with similar reproductive outcomes (tubal patency and subsequent rate of pregnancy) [23]. Robotic assistance represents yet another option for surgeons who offer this procedure.

Adnexal Surgery

Surgical management of benign adnexal masses involves either adnexectomy (removal of the ovary and tube) or cystectomy (removal of the cystic portion while preserving the ovary and/or tube) and can be managed either by laparotomy or conventional laparoscopy. In an attempt to define the role of RAS for managing adnexal masses, Wright and colleagues evaluated surgical outcomes from 87,514 women who underwent either conventional laparoscopic surgery or robotic-assisted surgery for this indication [24]. They found that the rate of intraoperative complications was significantly higher in women who underwent both robotic adnexectomy and cystectomy, although the absolute difference was small (3.4% vs. 2.1%, OR = 1.60; 95% CI, (1.21–2.13) and (2.0% vs. 0.9%, OR = 2.40; 95% CI, (1.31–4.38), respectively. Based on these findings, it would be difficult to justify use of the device for this indication as a standalone procedure. However, when performed at the time of robotic sacrocolpopexy, the additional cost of oophorectomy is little more than operative time and pathological processing.

The above data specifically refers to adnexal pathology as the primary surgical indication. Offering women salpingoophorectomy (removal of the ovary and tube) as a concomitant procedure during hysterectomy or sacrocolpopexy depends on the age and desire of the patient, as well as incidental abnormal findings encountered

during surgery. Emerging data regarding women's heart health has changed the historical paradigm of removing ovaries prematurely [25]. Mathematical models that reference population-based studies suggest women should strongly consider preserving their ovaries if younger than 50 years if no increased genetic predisposition exists. Since many women undergoing sacrocolpopexy are well into menopause, offering salpingoophorectomy is quite reasonable. Adnexal structures are not always imaged in anticipation of pelvic reconstructive surgery, so awareness of some abnormality may not always be known beforehand. If an abnormal appearing ovary is encountered in a younger patient who might otherwise preserve her ovaries, intraoperative consultation with a gynecologist may help to guide urologists with the decision to leave the ovary in place or to recommend removal.

Reproductive Cancers

Reproductive cancers were readily targeted as disease states amenable to robotic-assisted surgery, and prior to the introduction into mainstream surgery, the majority of women with such cancers were treated by laparotomy. A recent survey published in 2015 of the Society of Gynecologic Oncology members showed a remarkable increase in the overall use of robotic surgery among members compared to the previous survey in 2007 [26]. This survey demonstrated that 97% of respondents performed robotic surgery compared to 27% who responded in the previous survey less than a decade prior [26]. Similar to trends in urologic oncology, robotic-assisted laparoscopic hysterectomy with lymphadenectomy for endometrial and cervical cancers were procedures identified by gynecologic oncologists as almost more appropriate or commonly performed than by conventional laparoscopic approach.

Endometrial Cancer

In the developed world, endometrial cancer is the most common cancer of the female genital tract with an estimated 60,050 new cases in the most recent cancer statistics report [27]. Obesity represents an established risk factor, and as the rates of obesity increase in North America, epidemiologists predict a continued increase in the rates of endometrial cancer. Fortunately, most patients present with early stage disease and treatment are focused on surgical staging followed by adjuvant treatment for more advanced stages of disease and with more aggressive cell types. Hysterectomy and bilateral salpingoophorectomy, with or without nodal assessment, is the mainstay of surgical management. For grade 1 endometrioid adenocarcinoma, the most commonly diagnosed variant, no further treatment is needed. RAS has been performed for endometrial cancer since 2005.

Studies have consistently demonstrated the feasibility of RAS for surgical staging of endometrial cancers and report significantly reduced surgical morbidity while maintaining similar survival curves when compared to laparotomy [28]. Perioperative measures such as estimated blood loss, length of stay, and cancer-specific markers including lymph node yield are enhanced with RAS [29]. When evaluating outcomes of this approach to surgery based on age, an independent risk factor for postoperative morbidity, RAS had an improved safety profile in women over the age of 65 years when compared to a similarly aged group undergoing laparotomy [30]. Although most of the trials to date are nonrandomized, comparative, or observational, even larger scale multi-centered trials evaluating women with higher grade disease demonstrate similar safety and outcome profiles of minimally invasive approaches compared to laparotomy [31]. A 2010 meta-analysis reported findings from trials comparing robotic to conventional laparoscopic approach and found that women who underwent RAS experienced less blood loss and a lower rate of complications, although not statistically significant [8]. What remains difficult to assess from these studies is the experience of the operator and bias towards using one approach over the other, especially as the trend in the US has been shifted towards robotic surgery in recent years. Nevertheless, consistent with literature focusing on benign disease, longer operative times were

seen with robotic surgery compared to laparotomy [29].

Of real clinical significance, however, is the demonstration by several studies of the safety of robotic surgery in the obese and super obese populations [Body Mass Index (BMI) greater than 40 and 50, respectively] [32, 33]. Women with significant BMI represent surgical challenges not only to the surgeon, but also to the anesthesiologist, and are at greater risk for perioperative morbidity. When the robotic platform was used in these populations of women, no differences were seen when comparing outcomes to women with lower BMI with respect to length of stay, blood loss, complication rates, number of nodes retrieved, recurrence, and ultimate survival [32]. Not surprisingly, there was a correlation between increasing BMI and conversion to an open procedure [33].

Cervical Cancer

Cervical cancer is the third most common malignancy found in women worldwide [26]. Fortunately, due to good screening programs, the majority of patients in North America are diagnosed in early stages of disease and survival rates are relatively high. Radical hysterectomy is the standard surgical procedure for the treatment of early stage disease. As with endometrial cancer, laparotomy represents the historical benchmark for surgical management. The first case series of robotic radical hysterectomy for cervix cancer was published in 2008 [34]. Since that time, numerous studies have further evaluated the role of the robotic platform. A recent systematic review and meta-analysis comparing intraoperative and short-term postoperative outcomes of robotic radical hysterectomy to laparoscopic and open approaches for early stage cancer has been conducted [35]. The study found that robotic-assisted radical hysterectomy may be superior to open approaches, with lower blood loss, shorter hospital stays, less febrile morbidity, and fewer wound-related complications [35]. When compared to conventional laparoscopy, robotic radical hysterectomy resulted in comparable outcomes.

While radical hysterectomy is the standard surgical procedure for the treatment of early stage cervical cancer, another option that exists for women who desire to preserve fertility and have a tumor size of less than 2 cm is radical trachelectomy. During the trachelectomy procedure, a cervical cerclage is typically placed to assist with future pregnancies and decreased risk of preterm birth. The first robotic-assisted trachelectomy was performed in 2007 [36]. In 2012, a study examined the accuracy and reproducibility of robot-assisted trachelectomy in women with early stage cervical cancer and demonstrated no differences between this approach and vaginal radical trachelectomy, in terms of remaining cervical length, a marker for future pregnancy outcomes [36]. The placement of the cerclage, however, was more precise with the robotic-assisted surgery [36]. This procedure remains a viable option for select women.

Ovarian Cancer

While ovarian cancer is a relatively uncommon tumor of the female reproductive tract [27], it is the most common cause of cancer death from a gynecologic tumor in the developed world, accounting for 5% of all cancer deaths. Because early ovarian cancer causes minimal, nonspecific symptoms or no symptoms at all, the majority of cases are diagnosed in the advanced stage, with only 15–20% of cancers diagnosed in early stages. The traditional surgical approach consisted of a midline laparotomy incision to perform staging and debulking. While robotic surgery has become widely accepted for treatment of endometrial and cervical cancer, its role in managing ovarian cancer remains controversial. Data to support the role of robotic-assisted surgery in ovarian cancer is currently limited to case reports and case series [37, 38] for staging procedures for those with early disease and surgical debulking in patients with advanced and recurrent disease [39].

Conclusions

Technological advances and innovation play an integral role in how gynecologists provide surgical care for women, but few have had such a

dramatic and rapid impact as the da Vinci surgical platform. The mechanical advantages enable surgeons trained in minimally invasive techniques to offer patients nontraditional surgical options and add clinical value to patients with more complex disease states. From an epidemiological viewpoint, this technology has transformed surgical practice more than any other device in such a short period of time. Whether this trajectory continues on the same path remains uncertain. Nevertheless, as surgical performance becomes more of a transparent measure and the dollars for healthcare more restricted, surgeons must be strategic about new modalities until well-designed studies demonstrate consistent and true benefit.

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