International Journal of Progressive Sciences and Technologies (IJPSAT)
ISSN: 2509-0119.

http://ijpsat.ijsht-journals.org
Vol. 28 No. 1 August 2021, pp.224-237

Robotic Surgery in Gynecology
Critical Review

Maged MN[1], Mohamed MN[2], Lamia H. Shehata[3], And Laila Abdelfattah[4]

[1]Mazahmiya Hospital, Ministry of Health, Kingdom of Saudi Arabia, Department of ob/gyn,
[2]King Fahd Hospital, Ministry of Health, Kingdom of Saudi Arabia, Department of Surgery,
[3]Care National hospital, Department of Radiology,
[4]University of Leeds, Faculty of Engineering (Mechatronics), UK.

Abstract – Minimally invasive surgery (MIS) can be considered as the best surgical innovation in the course of recent years. It changed surgical practice with all well demonstrated benefits over conventional open a surgical procedure: reduced surgical trauma and incision related complications, like surgical site infections, postoperative pain, hernia, decreased hospital stay, and improved surgical outcome. Regardless, capability in MIS can be technically challenging as conventional laparoscopy is related with several constraints as the two-dimensional (2D) screen decrease in-depth perception, camera instability, restricted scope of movement, and steep learning curves.

The surgeon has a low force feedback, which permits straightforward motions, respect for tissues, and more effective treatment of complications. Since the 1980s, many PC sciences and robotic projects have been set up to beat the challenges experienced with regular laparoscopy, to increase the surgeon's abilities, accomplish exactness and increased accuracy during conventional laparoscopy, and work with widespread of MIS. Surgical instruments are coordinated by haptic interfaces that replicate and filter hand movements. Robotically assisted technology offers benefits that incorporate worked on three-dimensional stereoscopic vision, wristed instruments that further develop ability, and tremor cancelling software that improves surgical precision.

Keywords – Endometriosis, Fibroid Uterus, Uterine Prolapse, Hysterectomy, Gynaecologic Cancer, Minimally Invasive Surgery, Robotic Surgery.

I. Background and History

Robotic applications to surgery began in 1970s as military tasks supported by the National Aeronautics and Space Administration (NASA) and subsidized by the Defense Advanced Research Project Administration (DARPA) to supplant the surgeon's actual presence and give care to astronauts or to soldiers in war zones (1). From 1980s to late 1990s, the first generation of robots was utilized to perform image-guided precision tasks, yet these stages were restricted by fundamental PC interfaces and required an extensive preoperative arranging. The real-time tele-manipulators was set in a master slave configuration, wherein the master unit (the surgeon's consol) controls a separate slave unit formed by robot arms with various degrees of freedom. Two tele-controllers were created and supported by the US Food and Drug Administration (FDA): The Zeus® framework (Computer Motion, Goleta, CA, USA) and the da Vinci® Surgical System (Intuitive Surgical, Sunnyvale, CA, USA). In 2003, Intuitive Surgical obtained Computer Motion, which caused a situation of corporate monopoly in the surgical robotic market, a situation that has not changed to date. After the consolidation of Computer Motion and Intuitive Surgical, improvement of the Zeus® robot was stopped for the da Vinci® system, which was equipped with a compact platform moving on wheels, three to four robotic operating arms and a stereoscopic vivid camera having the option to give a 10-fold amplified view and under control of the surgeon, for a stable and precise navigation. Ergonomics and skill are enormously improved by handles imitating human hand developments by Endowrist® innovation. The da Vinci® Surgical System has been redesigned over ongoing years to incorporate extra provisions, for example, near infrared technology, and to facilitate setup. The most recent da Vinci Xi™ system, released in 2014, is less bulky, and its arms are thinner and more arranged in a more ergonomic manner, empowering multi quadrant procedures without the need to replace the system. Nonetheless, absence of force feedback is still one of the major technical drawbacks.

II. Penetrance of Robotic-Assisted Surgery in Gynecology

Just a brief time after its leeway for gynecologic applications, 24% of US gynecologist oncologists announced utilizing robotic assisted surgery, with 66% showing that they intended to expand their utilization of the innovation in the following years. Most of gynecologic oncology surgeons have a robotic platform at their organizations, and 95% were prepared to utilize it (2). As indicated by a similar report, 74% of colleagues were prepared to perform robotic assisted lymph node dissection, and 44% performed radical hysterectomies (3). Nonetheless, even though robotic-assisted surgery has been shown to be safe and feasible in gynecological surgery procedures, evaluation in randomized controlled trials comparing it with conventional laparoscopy which is limited, and there is a lacking of good evidence to show superiority or clear indication for its use (4).

III. Hysterectomy for Benign Disease

Robotic surgery has acquired somewhat rapid acceptance in benign hysterectomy in recent years (5). A detailed study, that robotic hysterectomy expanded practically 1,000% somewhere in the range of 2007 and 2010 – from 0.5 to 9.5% of all hysterectomies – while rates of laparoscopic hysterectomy increased significantly more leisurely, from 24.3 to 30.5%. Rates of robotic hysterectomy were higher in hospitals that had the da Vinci® robot, where they represented very nearly a fourth of hysterectomies. The general complexity rates were comparable for robotically assisted and laparoscopic hysterectomies. (6)

Concerning specific indications for robotic-assisted laparoscopic hysterectomy (RLH), potential advantage has been displayed over conventional laparoscopy in obese women (7) and if there should arise an occurrence of large uteri (8–10). More limited hospital stay, reduced blood loss, diminished postoperative pain, and more limited hospital stay were related with RLH compared with vaginal hysterectomy, laparoscopic-assisted vaginal hysterectomy, and total laparoscopic hysterectomy. Additionally, surgeon preference considered as another indication in US as numerous surgeons are not very much trained in laparoscopy and vaginal route and may favor robotics as it is easier to learn, until this point, there are as yet limited well designed studies straightforwardly comparing results and expenses of regular laparoscopic hysterectomy with RLH.

A retrospective study compared 100 patients treated by conventional laparoscopy hysterectomy before robotic adoption with 100 patients with RLH: the mean usable time (skin to skin) 27 min longer in the RLH group ($P < 0.001$) (3, 11). Longer operative time was affirmed by Nezhat et al. (12). No difference in length of stay, blood loss, and postoperative complications were demonstrated.

The first prospective study with 40 patients going through RLH (13) affirmed a longer operative time over conventional laparoscopy. Regardless of whether a slight longer hospital stay was noticed, significant higher costs were found in RLH patients ($2,861 versus $5,410) in the laparoscopy group.

A randomized report by studied results and expenses of RLH versus laparoscopic hysterectomy in 95 patients and discovered again a longer operative time for RLH (14). Regardless of whether a more prominent improvement in quality-of-life 6weeks after RLH was shown over LSC, there was no distinction in postoperative analgesic use or return to normal activities between the groups.

Many investigators consider increased costs per procedure secondary to longer operative time and disposable equipment. Nonetheless, similar preliminaries can be biased by surgical experience, as operative times are usually shorter in procedures, in which surgeons are experts in comparison with methods they are new to or they are learning, other than operative time and costs, some other technical concerns appear to conceivably influence results of RLH in a negative way.

In the first place, vaginal cuff dehiscence is a serious complication of laparoscopic hysterectomy, and a robotic assistance could be a significant risk factor, conceivably due to electrosurgical techniques or vaginal closure technique. RLH is related with a higher rate of cuff dehiscence versus conventional laparoscopic hysterectomy (1.64 versus 0.64%). (15)

Sensible utilization of electrocautery at the vaginal cuff by blended cutting electrosurgical current rather than coagulation current and the utilization of a two-layer cuff closure or bidirectional barbed suture are prescribed to diminish the risk of vaginal cuff dehiscence. Second, the safety communication delivered by the US FDA in September 2014 (16) in light of the risk of dissemination of undiagnosed uterine sarcoma in patients going through hysterectomies or myomectomies with power morcellation might diminish the rate of RLH and conventional laparoscopic hysterectomy in the US and Europe, except if diagnostic tests for uterine sarcoma developed or deemed safe are effective for uterine power morcellation.

Until now, proof proposes no clear indication for RLH over other routes of minimally invasive hysterectomy for benign disease, for which robotics offer few surgical benefits over laparoscopy in the hands of surgeons in conventional laparoscopy, at an increased cost. Deficient data exist comparing robotics with conventional laparoscopy in the hands of non-experienced surgeons. Notwithstanding missing of obvious indication for utilization of robotics over other routes of minimal invasive hysterectomy (vaginal and conventional laparoscopy), a large number of women could benefit with minimal invasive hysterectomy in light of the fact that the robot is a simple to learn, rapidly adopted, minimal invasive tool (5).

IV. Myomectomy

Robotic myomectomy was developed and embraced by surgeon's dependent on success laparoscopy had effectively accomplished. The robotic approach has expanded in popularity as it is a suture intensive surgery, and help with robotic arms makes stitching easy and simple and permits surgeons with restricted or no laparoscopic experience in suturing technique to perform the procedure in a minimal invasive way. Nonetheless, there are a few restrictions of robotic assisted myomectomy, like diminished field of vision and inability to use torque, which makes evacuation of very large myomas troublesome. Some authors suggest mixture approach (conventional laparoscopy and robotic assistance) in case of myomas bigger than 10 cm, beyond the pelvis, to preserve tactile sensation and avoid robotic equipment damage during traction and dissection (17). Lack of haptic feedback can cause breakage in stitch material during stitching; however, this can be overwhelmed by expanding experience of the surgeon. Robotic approach might assist surgeons with expanding their limits as far as size and number of myomas treated by invasive techniques. Notwithstanding, prevalence over laparoscopy has not been affirmed by data up until this point. In retrospective studies robotic assistance appears to offer less blood loss and hospital stay however longer operative time when compared with conventional laparoscopy (18).

V. Endometriosis

Endometriosis is a common gynecologic problem characterized as the presence of endometrial glands and stroma outside the uterine cavity, with an estimated incidence of 11% in the population (19). It commonly affects the pelvic organs and can likewise be found external the pelvic cavity. In spite of the fact that patients with endometriosis can be asymptomatic, 35–50% of them experience the ill effects of severe pelvic pains, infertility, and different symptoms that rely upon the area of the lesion [20,21]. Endometriosis can likewise decrease quality of life (QOL) and increase health care costs [22].

Surgical resection of endometriosis utilizing laparoscopy has been viewed as the highest quality level for treating endometriosis when medical treatment fails [23,24]. A total resection of endometriosis is imperative to prevent disease recurrence, relieve of pain, and improve fertility.

In any case, in complex cases of endometriosis, e.g., stage III or IV as indicated by the updated American Society for Reproductive Medicine classification, accomplishing that goal through laparoscopy can be technically difficult in any event, for experienced surgeon. The technical limits of laparoscopy, like the surgeon's dexterity, surgical precision, coordination, and visualization, can cause major complications (e.g., bowel perforation, bladder injury, or ureter injury) during surgical dissection [25-27]. Thus, some surgeons wonder whether or not to perform laparoscopic surgery, and some surgeons like to perform a laparotomy for severe endometriosis.

The robotic surgery (RS) has helped some surgeons with circumvent the technical challenges of laparoscopy. RS is currently utilized broadly in gynecology for hysterectomy, myomectomy, adnexal surgery, Sacro colpopexy, and malignancy staging, which require extensive stitching and precise control [28,29]. The advantages of a robotic system can particularly help in the careful management of advanced stage endometriosis that requires complex pelvic dissection, which includes a long operative time and a high risk of intraoperative complications.

5.1 RS for endometriosis compared with conventional laparoscopy (CL)

The objective of endometriosis surgery is to extract all visible endometriosis lesions and associated adhesions and restore normal anatomy [30]. It is notable that total resection of endometriosis lesions is the only reliable treatment to diminish the recurrence rate and pain [31]. Superficial endometriosis can undoubtedly be treated by laparoscopy. Notwithstanding, the altered tissue planes and dense adhesions caused by deep infiltrating endometriosis (DIE) makes it hard to do a total resection utilizing laparoscopy. Because of technical impediments of laparoscopy, inadequate resections and significant complications happen occur frequently during complex endometriosis surgery. In fact, the conversion rate to laparotomy is roughly 10%, even among skilled surgeons [24,32].

Since the presentation of robot systems, the technology of robot surgery has grown quickly. RS gives 3-dimensional and magnified visualization, wristed instruments, movement scaling, and ergonomic positioning for the surgeon. These technological advances enable a surgeon to do precise and careful dissection, for example, clearing the rectovaginal space, pelvic side wall dissection, ureter dissection, and resection of densely adherent endometrioma. In addition, during RS, the surgeon sits at a control center away from the surgical field and controls the robotic instruments and camera through finger graspers and pedals. The operator would thus be able to feel comfortable and experience less fatigue regardless of long operative times [29,33]. The close infrared fluorescence-indocyanine green (NIRF-ICG, firefly) method of robot surgery can likewise work on the recognition of endometriosis lesions invisible to the naked eye in white light (WL) enlightenment [34,35]. These benefits help robot surgery guarantee a total resection of endometriosis.

The principal study to look at RS and CL for endometriosis treatment was directed in 2010 by Nezhat et al. [36]. They tracked down no significant differences in perioperative outcome between the two groups besides in operative time (mean [range]; RS, 191 [135–295] minutes versus CL, 159 [85–320] minutes; P=0.045). Notwithstanding, most patients had stage I or II disease; just 22% (27/78) of patients had advanced stage endometriosis. They concluded that RS is feasible and safe for the treatment of endometriosis yet that the superiority of RS for beginning phase disease is unclear. From that point forward, several studies have evaluated the role of RS in advanced stage endometriosis. Chu and partners [37] reflectively thought about RS (n=25) and CL (n=96) for the treatment of extreme endometriosis. They additionally discovered equivalent careful results between the groups and that RS required a longer time operative time than CL (238 versus 190 minutes, P=0.05). As per a study of 280 patients with endometriosis (RS, 180 versus CL, 100) performed by Dulemba et al. [38], RS had similar surgical outcomes including mean operative time (RS, 77.4 minutes versus CL, 72.3 minutes; P=0.23), as compared to the previous study results with respect to operative time. interestingly, their group compared to the rate of biopsy-confirmed endometriosis patients between the two groups and found that the RS group had a higher confirmation rate than the CL group (RS, 80% versus CL, 56.8%; P<0.001) because of its better visualization. They revealed that robot surgery can improve the diagnosis and excision of embedded tissue over that available with CL, with similar perioperative results. In a study of patients with advanced stage endometriosis (n=118) by Nezhat and Sirota [39], RS was a more time-consuming method than CL, and other surgical results, such as, complications and conversion rate, were equivalent between the two groups. Specifically, they assessed the impact of obesity on surgery. After obesity stratification, they found no significant differences in operative time among RS and CL among normal weight and overweight patients. In obese patients, notwithstanding, the operative time for RS was longer than that for CL [range]; 282.5 [224–342] versus 174 [130–270] minutes; P<0.05). They contended that RS is a feasible and safe strategy for the treatment of endometriosis however that it ought to be utilized uniquely for complex operations that require fine dissection. They uncovered that the more extended operation time of RS compared with CL is related to obesity.

Nezhat et al. [40] of 420 patients who went through a surgery for advanced stage endometriosis (RS, 147 versus CL, 273) discovered no distinctions in careful results between the two groups. In any case, the RS group had a longer mean operative time (196 versus 135 minutes, P<0.001) and longer hospital stay (P<0.001). Their findings were consistent with past studies as far as the increment in operative time with RS. They additionally analyzed the factors that add to the more operative time and found that docking and undocking time, the size of endometrioma, the way that a CO2 laser isn't accessible in the RS setting, the presence of upper abdomen disease, and the absence of tactile sense with RS added to the longer operative time. In another large study of 493 patients with advanced stage endometriosis (RS, 331 versus CL, 162) [41], the only difference between two groups was operative time. They clarified that the longer operative time with RS originated from the higher number of additional procedures and more radical operations performed in the robot group.

The only randomized clinical preliminary (RCT) looking at RS versus CL for advanced endometriosis was led with 73 patients (RS, 35 and CL, 38) by Soto et al. [42] in 2017. They discovered no statistically significant difference among RS and CL in surgical outcome, including operative time (mean standard deviation; 106±48.4 and 101.6±63.2 minutes; P=0.71). This study likewise analyzed QOL scores from baseline, 6weeks, and 6 months after surgery and found no significant differences between the two groups. The two groups revealed significant improvement in QOL at both postoperative time compared with their preoperative baseline.

One past meta-examination by Chen et al. [43] assessed the wellbeing and adequacy of RS versus CL for the treatment of advanced stage endometriosis. RS has a significant longer operative time than CL (P<0.01). In any case, they discovered no contrast among RS and CL in the duration of hospital stay, complications rate, or blood loss. They presumed that RS is a safe and efficient alternative to CL for the treatment of advanced stage endometriosis, despite the fact that RS is time consuming and the general expense stays high. The advantages of RS for the treatment of advanced stage endometriosis subsequently stay uncertain.

5.2 Robotic single-site surgery to treat endometriosis

With an increment in the demand for minimal invasive surgery (MIS), robotic single site (RSS) surgery has developed since 2013 as an alternative to RS in different surgical fields. RSS surgery requires just a small incision of 3 cm to place a single multichannel port, while RS requires the placement of four trocars. In this manner, RSS is less invasive, causes less pain, and offers preferable cosmoses after surgery over RS [44,45]. Given that most women who experience the disease effects of endometriosis are young and susceptible to scarring, the cosmoses of the surgical scar are a significant issue [46,47]. Single-port laparoscopy (SPL) is more troublesome than CL since restrictions in space and development of conflicts among instruments. RSS surgery overcomes those issues with crossed and flexible instruments. Surgeons can eliminate endometriosis lesions more effectively utilizing RSS surgery than SPL and that RSS can accomplish cosmetic goals better than RS surgery.

In our writing audit, we discovered some case reports about the extraction of endometriosis utilizing RSS medical procedure and one review study contrasting the results of RSS medical procedure and SPL for endometriosis. The principal case report of one patient utilizing RSS medical procedure for endometriosis was composed by Guan et al. [48] in 2015. They effectively resected advanced endometriosis utilizing RSS surgery and an ICG injection. Jayakumaran and associates [49] announced their experience performing RSS surgery for endometriosis in seven patients. All the apparent endometriosis injuries in those seven patients were effectively resected with no complication or the transformation to another surgical method. their group compared the number of endometriosis lesions found utilizing different endoscopic visualization methods: laparoscopic WL enlightenment, automated WL brightening, and NIRF-ICG imaging. The NIRF-ICG imaging distinguished more endometriosis lesions than the other visualization method. They contended that RSS surgery joined with this high-level visualization method worked with more complete endometriosis lesion detection and excision. A review concentrate in 2018 looked at the careful results from RSS surgery (n=68) with those from SPL (n=52) for the therapy of advanced stage endometriosis [30]. RSS surgery showed equivalent careful results, including duration of hospital stay and perioperative complications, with SPL aside from mean operative time (RSS surgery, 107.8 minutes versus SPL, 76.9 minutes; P=0.001) and assessed blood loss (106.6 versus 57.1 mL, P=0.001). That review proposed that RSS surgery is feasible, safe, and compelling for the therapy of advanced stage endometriosis.

Another clever single port mechanical stage, the da Vinci® SP Surgical System (Intuitive Surgical, Sunnyvale, CA, USA) utilizes a solitary robotic arm that contains an articulating camera and instruments docked from a solitary laparoscopic trocar. Starting reports on this framework were distributed in different fields, for example, urologic surgery, and they recommended that this new innovation is a safe and feasible choice compared with prior methods [50,51]

5.3 RS for die and extragenital endometriosis

DIE is diagnosed when endometriosis occurs in excess of 5 mm deep into the peritoneum. Roughly 40% of patients with endometriosis have DIE [52]. It is typically found in the rectovaginal space (70%), yet it likewise occurs in the bowel (12%), urinary lot (9%), and pelvic peritoneum [48,49]. The infiltrative nature of DIE can cause dense adhesions and fibrosis and distort pelvic structure, including genital organs, the bowel, and urinary tract. This can cause severe pelvic pain. Since DIE lesions are not easily treated medicinally, complete radical excision and the restoration of normal anatomy to decrease pain and the recurrence rate are the main focuses in managing such patients. To accomplish that objective, particular skills, for example, diagnosing the deep retroperitoneal space, isolating the ureter and the bowel, and suturing techniques, are fundamental. Nonetheless, those methodologies are challenging utilizing CL. Thusly, particularly in DIE and extragenital endometriosis, RS can be a strong, attractive option.

5.4 DIE in bowel

Bowel involvement with deep endometriotic nodules is accounted for 8–12% of endometriosis cases. Of them, the recto-sigmoid intersection (65%) is the most well-known site, followed by the rectum (15–20%). Bowel-involved endometriosis can cause cyclic gut side effects, dyschezia, swelling, and rectal bleeding [53-55]. The surgical treatment for bowel endometriosis relies upon the depth of the bowel wall invasion and ranges from shaving to segmental resection [56]. Albeit the current surgical standard depends on laparoscopic surgery, some bowel surgery procedures are hard to perform utilizing laparoscopy because of the chance of major complications like bowel perforation and leakage. Consequently, many surgeons leave laparoscopic surgery when they need to do bowel surgery and convert to laparotomy. Unmistakably, RS offers benefits over laparoscopy in complex bowel operations.

Many attempts have been made to assess the feasibility of RS in treating progressed colorectal endometriosis with DIE. Nezhat et al. [57] revealed the initial two instances of effective RS management for gut endometriosis (segmental gut resection and disc excision of the anterior rectal wall) with no complications. From that point forward, many investigations have announced careful results of RS for bowel endometriosis. Lim et al. [58] comparing the careful results of RS (n=8) and laparotomy (n=10) for low anterior resection to treat endometriosis, RS showed comparative careful results with less complications than laparotomy. Ercoli et al. [59] utilized RS to perform total extraction from 22 patients who had DIE with colorectal association (segmental resection, 12 and gut wall shaving, 10). Just one case had a significant postoperative difficulty (small bowel obstruction), and there was no conversion to laparotomy. They showed that utilizing RS for complete debulking of DIE with colorectal involvement is feasible and safe and should be possible without change to other surgical methods. Collinet and partners [60] announced that their group effectively utilized RS in 96 patients who got segmental rectal resection, rectal shaving, and ileocecectomy with no major postoperative complications. Neme et al. [61] revealed that they effectively performed bowel resection utilizing RS in 10 patients with no complications or change to laparotomy. Manifestations identified with endometriosis (dysmenorrhea, dyspareunia, dyschezia, intestinal cramping, diarrhea, and constipation) had disappeared in all women a year after surgery. They additionally recommended that RS bowel resection surgery for the therapy of deep invading gut endometriosis is feasible, successful, and safe, moreover, Vitobello et al. [62], Siesto et al. [63], Pellegrino et al. [64], and Abo et al. [65] reports effective encounters utilizing RS for gut endometriosis, including rectal shaving and segmental gut resection, most cases were effective and without complications.

5.5 DIE in the urinary tract

The urinary tract, including the ureter, bladder, and kidney, is oftentimes influenced by endometriosis, which can cause manifestations like dysuria, hematuria, urinary frequency, and ureteral obstruction. The occurrence of urinary tract endometriosis is roughly 10% of endometriosis patients, and the bladder is the most widely recognized site [66]. Shallow endometriotic injuries on the bladder and ureter can without much of a stretch be treated with simple excision or fulguration. Notwithstanding, profound endometriotic lesions, for example, an invasion of the detrusor muscle of the bladder or the muscularis, lamina propria, or lumen of the ureter can require broad resection and re-anastomosis. In those surgeries, fine dissection to distinguish the ureter and precise suturing for anastomosis of the resected ureter are the most important techniques, and laparoscopy presents numerous limits to performing them. In this way, we expect that RS is appropriate to those kinds of surgical interventions in view of its benefits.

Our writing survey returned a few case reports about treating urinary bladder endometriosis utilizing RS. Be that as it may, no RCT examines have been finished. All previous reports had small sample sizes. A relatively large multicenter study Collinet et al. [60].

Performed ureterolysis (n=62), ureteroneo-cystostomy (n=3), and partial bladder resections (n=22) and reported significant complications to the urinary tract in roughly 4% of patients. An investigation by le Carpentier et al. [67] looked at careful results among RS and CL for bladder endometriosis. RS showed similar surgical results, including perioperative complications and recurrence rate.

VI. Pelvic Organ Prolapse Repair

Minimally invasive surgery (MIS) abdominal surgery has progressively been utilized to treat pelvic organ prolapse. Besides, several benefits associated with minimal invasiveness, this methodology overcame any barrier between the advantages of vaginal surgery with the surgical achievement rates of open abdominal procedures.

The procedure performed for suspension of the vaginal apex for postoperative vaginal prolapse by robotic assisted laparoscopy is the sacrocolpopexy (5). Conventional laparoscopic utilization of this system was first revealed in 1994 by Nezhat et al. what's more, had not gained widespread adoption because of lengthy learning curve associated with laparoscopic suturing (68). Since FDA endorsement of the da Vinci® robot for gynecologic surgery in 2005, minimal invasive abdominal surgery for pelvic organ prolapse has gotten progressively famous, as robotic-assisted laparoscopic sacrocolpopexy is a possibility for those surgeons without experience or preparing in the conventional route. At present, few randomized studies assessed results of robotic assisted sacrocolpopexy versus conventional laparoscopy with robotic groups having longer operative times, short term higher postoperative pain, and greater expenses (69,70). Complications, anatomical outcomes, and quality of life didn't vary overall between the groups (70). Repair of pelvic organ prolapse can be performed robotically, and sometimes surgeons can feel suturing and exposure during the procedures with the help of the robot. Notwithstanding, regardless of whether robotic surgery might present many advantages over conventional laparoscopy, these benefits should keep on being weighed against the expense of the technology. To date, as long term results, there is almost no proof about minimally invasive laparoscopy for a maintenance of pelvic organ prolapse, and considerably more examinations are expected to assess subjective and objective results, perioperative and postoperative adverse events, and expenses related with these procedures (5).

VII. Gynecologic Oncology

7.1 Robotic-Assisted Surgery in Cervical Cancer

Abdominal radical hysterectomy (ARH) has been the standard of care for patients with early disease (FIGO stage 1A2-2A). Laparoscopic approach of the method has been taken on by just few surgeons as a result of its complexity. Conversely, radical hysterectomy can be made less challenging by robotic platform and can be considered as an ideal surgery for the adoption of the technology.

Multiple studies have assessed the feasibility, the safety, and the results of robotic assisted radical hysterectomy (RRH). Comparative preliminaries have shown similar complications rates, improved operative outcomes, for example, estimated blood loss and infections in the RRH groups, and variable operative times whenever compared and ARH and total laparoscopic radical hysterectomy (TLRH) (71-75). Besides, it appears to be that the traditional laparoscopic radical hysterectomy experience isn't needed to utilize the robotic-assisted approach (71). Generally, intraoperative and postoperative complications rate don’t appear to be significantly between RRH, TLRH, and ARH, and both minimal invasive approaches (RRH and TLRH) could be related with fewer requirements in blood transfusions and a shorter hospital stay. long term results in patients going through a RRH are sparse. In any case, equivalent disease free recurrence rate appears to be equivalent in the RRH groups over after ARH 24 and 48months (95 and 97%, separately) (76). Several reports have exhibited that the number of lymph nodes recovered is essentially equivalent, in RRH compared with traditional approaches (77).

7.2 Robotic-Assisted Surgery in Endometrial Cancer

Endometrial cancer is the most common indication to use the robotic platform in gynecologic oncology. MIS has become the accepted standard of care for endometrial cancer surgical staging. In any case, proof from randomized clinical trials comparing robotic assisted approach and conventional laparoscopy is lacking, and most information’s are from retrospective studies. Benefits of robotic technology over laparotomy seem obvious in a large prospective study (78), where 377 patients going through robot-assisted hysterectomy had many less serious complications, like wound dehiscence, bleeding and urologic injury, and shorter length of stay at hospital when compared with 131 patients who had open surgery for the same indication. Gaia et al., discovered less blood loss in robotic group versus conventional laparoscopy (79). Operative times for robotic-assisted surgery procedure were like laparoscopy (219 versus 209 min, $P = ns$) however fundamentally more than laparotomy ($P < 0.005$). The robotic approach can be challenging in event of lymphadenectomy when evaluating of lymphatics over the level of the inferior mesenteric artery is required. Notwithstanding, the similar number of lymph nodes recovered between robotic assisted surgery and laparotomy in several studies proposes that the concern doesn't convert into clinical practice. Advantages of robotic platform have been seen in preliminaries assessing results between surgical approaches in obese patients. When compared with laparotomy, Seamon et al. (80) have exhibited that robotic surgery would be advised to wound complication rates (2 versus 17%, chances proportion 0.10, CI95% 0.02–0.43, $P = 0.002$) and less significant complications (11 versus 27%, OR 0.29, CI95% 0.13–0.65, $P = 0.003$) in large patients with a body mass index (BMI) more than 35. Gehrig et al. (81), robotic assisted surgery was related with shorter operative time ($P = 0.0004$) and hospital stay ($P = 0.001$), higher lymph node count ($P = 0.004$), and less blood loss ($P < 0.0001$) over conventional laparoscopic approach in obesity and morbidly obese patients going through endometrial cancer surgical staging.

7.3 Robotic- Assisted Surgery in Ovarian Cancer

The role of robotic surgery in ovarian cancer isn't clear, as published data are still extremely inadequate. Upper abdominal surgery is often required in advanced stages, and as of now, the da Vinci® S and Si powerlessness to get to the pelvis and the upper quadrants at the same time has been a significant restricting component to the utilization of the da Vinci® surgical platform in ovarian malignancy. Feuer et al., (82) assessed surgical and postoperative results in 63 patients going through mechanical helped a medical procedure for ovarian cancer. A longer operative time, less blood loss, and a shorter hospital stay were shown. Complication rates, lymphadenectomy yields, recurrence risk, and survival at 1 year didn't differ between assisted robotic surgery and laparotomy. Until now, surgical centers utilizing the robot for ovarian malignant growth as a rule do a surgery just in the setting of isolated recurrences or for diagnostic purposes. Regardless, capacity to perform multi-quadrant complex surgery is a significant resource of the new da Vinci Xi™ surgical platform and could add to enhance spread of MIS in ovarian cancer patients in the next few years.

VIII. Expenses

In a time of contracting repayments and included monetary pressing factors on hospitals, health care's cost has arisen as a significant main force for the adoption of surgical technology (77). The expense of possession for a robotic surgery system relies upon the combined use of the capital, consumables, and service contract. The current generation of robots costs more than $1.5 million upfront, which is a significant investment for most hospitals. Consumables expenses can add an extra $1,500–$3,000 to every procedure, while service expenses can be more than $140,000 each year. In view of 150 procedures each year over a 5-year time span, this means an expense of $4,450–$6,000 per patient. Notwithstanding innovation costs, training for the two surgeons and clinical staff will likewise be an enormous thing; train costs start at $20,000 per surgeon and can be higher relying upon the expertise level of the surgeon and the procedure. Furthermore, operative and recovery room time, hospital stay, time to return back to work, and cost of readmission for complications should all be calculated (77,83).

High utilization will be the key for a program to have positive margins. Extremely high volume programs commonly perform 200–380 procedures per system, each year, albeit 150–200 systems each year are normal for active programs. In many centers, there are necessities set up for minimum annual robotic case volumes to keep up with advantages. if the organization buys the stage, it should ensure its utilization due to beginning money expense and cost of upkeep. As recently expressed, various preliminaries have shown that robotic hysterectomies are more expensive than laparoscopic hysterectomies. Notwithstanding, almost certainly, cost would go down with decreased operative time and that operative time would go down with expanded experiences. In the current medico-economic environment, similar expense has gone under scrutiny with robotics because of the expanded upfront cost however would really be material for any innovation which is new (83).

As any arising innovation, costs will be decreased as an innovation develops and contest enters the market. Next generation systems are relied upon to be estimated more than $600,000, albeit some robotic systems could be evaluated as low as $250,000. This decrease in cost could permit suppliers performing 200 procedures each year to see margins of $1.3 million over a 3-year time span, which would make this innovation exceptionally alluring to bring down volume suppliers.

IX. Learning Curve

Achievement in adoption of a surgical modality is highly dependent of the expectation to learn and adapt related with securing of the fundamental abilities to comfortably and efficiently perform it. For the surgeon, robotic surgery overcomes some problems of conventional laparoscopic surgery. Muscular efforts are limited in light of the fact that further developed ergonomics when sitting at a control center separate from the patient. Besides, mix of further developed imaging and instrument control could take into account a faster surgical learning curve compared to conventional laparoscopy, which incorporates two-dimensional imaging and counter intuitive hand movements (84). Nonetheless, regardless of whether the utilization of robot assisted technology is accepted to shorten the learning curve of minimal invasive procedures, it has not been completely shown at this point in writing. The quantity of cases needed for capability in robotic assisted gynecological surgery isn't clear. One review study assessed robotic learning curves dependent on time for completion of the index gynecologic procedures (85). investigators detailed that times plateaued after 50 cases. Lim et al., surveyed the expectation to absorb information related with playing out the initial 122 cases of robotic assisted endometrial cancer surgical staging versus the initial 122 procedures performed by laparoscopy (86). The authors showed that 24 cases were needed in the robotic arm before adjustment of the operative time, though twofold that many were required when procedures were performed by laparoscopy. Also, a subsequent report showed that capability in robotic assisted hysterectomy and lymphadenectomy for endometrial cancer were accomplished by20 cases (87). Sandadi et al., assessed the expectation to learn and adapt for fulfillment of a robotic assisted hysterectomy and showed that 33 cases were needed before an individual can be efficient to perform the technique (88).

Robotics might allow less experienced laparoscopic surgeons to perform minimally invasive procedures that beforehand would have required laparotomy. Components that influence this expectation to learn and adapt incorporate abdominal or laparoscopic experience with methods being performed, earlier laparoscopic abilities of the surgeon, and the experience of the robotic surgery group. Preparing of the surgery group is fundamental and has been accounted for to diminish operative time and complications rates (84,85,89).

X. Advantages and Disadvantages of Robotic Surgery

Table 1. Advantages of the Da Vinci robot system compared to conventional laparoscopy

Ergonomics
Intuitive handling of instruments
3-D optics without additional equipment
7 degrees of freedom
Faster learning curve
Digital networking
Dual console
Integrated fluorescence visualization (Firefly)
Less postoperative pain

Table 2. Disadvantages of the Da Vinci robot system compared to conventional laparoscopy

Limitations of the Da Vinci robot system compared to conventional laparoscopy
Higher costs of disposable materials and maintenance
Absence of tactile feedback
Additional learning curve
Additional time for docking
Usually requires more numerous and larger puncture sites (Si System)

XI. Conclusion

Conventional laparoscopic hysterectomies make up a small percentage of all hysterectomies acted in the United States and the remainder of the world, despite the fact that the innovation has been accessible for almost 40 years.54 Robotic-assisted surgery has overcome a considerable lot of the restrictions of conventional laparoscopy and quantifiably affects the use of minimal invasive approaches.7,45,55 Patients with endometrial cancer have seen the largest advantage from the presentation of robotic assisted surgery, in light of the fact that these patients are typically obese and have a high complications rate from laparotomy; likewise, they are not suitable contender for conventional laparoscopy because of the restricted scope of movement and poor visualization related to their body habitus. Hence, robotic technology permits these high-risk patients the ability to have minimally invasive surgery, bringing about faster recovery times and less morbidity than other traditional methods.

In spite of the fact that worries about the expense of robotics remain and may conceivably stop a few hospitals, organizations, or healthcare professionals from offering this methodology, expected exists for cost saving over laparotomy if the robotic surgical system is enough used to compensate for its underlying expense and upkeep. The robotic surgery systems utilized in gynecological oncology are not intended to replace laparoscopy but instead to give patients who might somehow or another go through laparotomy, the alternative of an insignificantly minimal invasive approach. The financial analysis of the effect of robotics in gynecological oncology will vary among hospitals and, accordingly, needs should be individualized. Many variables should be thought of, including every one of the different administrations utilizing the robot (e.g., urology, thoracic, gastrointestinal, head and neck). A financial analysis should incorporate every one of the various types of cases that will be performed utilizing robotic assistance, the overall effect on length of hospital stay, payer mix, and volumes. Maybe staying away from robotic assisted surgery for simple procedures in thin and healthy patients with no prior history of surgery might assist with controlling expenses. It might likewise be feasible to ideally foster an advanced robotic program in gynecological oncology that is fiscally responsible, in this manner offering a significant benefit to patients with gynecological malignancy.

Conflict Of Interest

All authors declare no conflicts of interest.

Author's Contribution

Authors have equally participated and shared every item of the work.

References

[1] Daiana, M., and J. Marescaux. "Robotic Surgery." *Br J Surg* 102.2 (2015): e15-e28.

[2] Sfakianos, Gregory P., et al. "Robotic surgery in gynecologic oncology fellowship programs in the USA: a survey of fellows and fellowship directors." *The International Journal of Medical Robotics and Computer Assisted Surgery* 6.4 (2010): 405-412.

[3] Carbonnel, M., and N. Thu. "'Guyen H, Abbou H, de la Joliniere JB, Ayoubi JM. Robotic laparoscopy in benign gynecologic surgery: a retrospective study comparing vaginal, laparoscopic and robotic hysterectomy procedures." *Reprod Syst Sex Disord* 2.2 (2013): 1-4.

[4] Worldwide, AAGL Advancing Minimally Invasive Gynecology. "AAGL position statement: route of hysterectomy to treat benign uterine disease." *Journal of minimally invasive gynecology* 18.1 (2011): 1-3.

[5] Paraiso, Marie Fidela R. "Robotic-assisted laparoscopic surgery for hysterectomy and pelvic organ prolapse repair." *Fertility and sterility* 102.4 (2014): 933-938.

[6] Wright, Jason D., et al. "Robotically assisted vs laparoscopic hysterectomy among women with benign gynecologic disease." *Jama* 309.7 (2013): 689-698.

[7] Nawfal, A. Karim, et al. "Effect of body mass index on robotic-assisted total laparoscopic hysterectomy." *Journal of minimally invasive gynecology* 18.3 (2011): 328-332.

[8] Orady, Mona E., A. Karim Nawfal, and Ganesa Wegienka. "Does size matter? The effect of uterine weight on robot-assisted total laparoscopic hysterectomy outcomes." *Journal of robotic surgery* 5.4 (2011): 267-272.

[9] 9Payne, Thomas N., et al. "Robotically assisted hysterectomy in patients with large uteri: outcomes in five community practices." *Obstetrics & Gynecology* 115.3 (2010): 535-542.

[10] Orady, Mona, et al. "Comparison of robotic-assisted hysterectomy to other minimally invasive approaches." *JSLS: Journal of the Society of Laparoendoscopic Surgeons* 16.4 (2012): 542.

[11] Payne, Thomas N., and Francis R. Dauterive. "A comparison of total laparoscopic hysterectomy to robotically assisted hysterectomy: surgical outcomes in a community practice." *Journal of minimally invasive gynecology* 15.3 (2008): 286-291.

[12] Nezhat, Camran, et al. "Laparoscopic hysterectomy with and without a robot: Stanford experience." *JSLS: Journal of the Society of Laparoendoscopic Surgeons* 13.2 (2009): 125.

[13] Sarlos, Dimitri, et al. "Robotic hysterectomy versus conventional laparoscopic hysterectomy: outcome and cost analyses of a matched case–control study." *European Journal of Obstetrics & Gynecology and Reproductive Biology* 150.1 (2010): 92-96.

[14] Sarlos, Dimitri, et al. "Robotic compared with conventional laparoscopic hysterectomy: a randomized controlled trial." *Obstetrics & Gynecology* 120.3 (2012): 604-611.

[15] Uccella, Stefano, et al. "Vaginal cuff closure after minimally invasive hysterectomy: our experience and systematic review of the literature." *American journal of obstetrics and gynecology* 205.2 (2011): 119-e1.

[16] U.S. Food and Drug Administration. *Quantitative Assessment of the Prevalence of Unsuspected Uterine Sarcoma in Women Undergoing Treatment of Uterine Fibroids: Summary and Key Findings*. Silver Spring, MD: FDA (2014).

[17] Rooma Sinha, Madhumati Sanjay, B. Rupa, and Samita Kumari. "Robotic surgery in gynecology." *Journal of Minimal Access Surgery* 11.1 (2015): 50.

[18] Dedeoğlu, Emine Nihan, Mithat Erenus, and Pinar Yörük. "Effects of hormone therapy and tibolone on body composition and serum leptin levels in postmenopausal women." *Fertility and sterility* 91.2 (2009): 425-431.

[19] Kolanska, Kamila, et al. "L'endométriose génitale: épidémiologie et facteurs étiologiques." *Médecine de la Reproduction* 22.2 (2020): 111-114.

[20] Sensky, T. E., and D. T. Y. Liu. "Endometriosis: associations with menorrhagia, infertility and oral contraceptives." *International Journal of Gynecology & Obstetrics* 17.6 (1980): 573-576.

[21] De Graaff, A. A., et al. "Quality of life outcomes in women with endometriosis are highly influenced by recruitment strategies." *Human Reproduction* 30.6 (2015): 1331-1341.

[22] HOUSTON, DIANA E. "Evidence for the risk of pelvic endometriosis by age, race and socioeconomic status." *Epidemiologic reviews* 6.1 (1984): 167-191.

[23] Kaur, Kulvinder Kochar, Gautam Allahbadia, and Mandeep Singh. "Utilizing Adipose Tissue-Derived Stem Cell Strategies for Obtaining Regeneration of Respiratory Tract Fistulas-A Systematic Review." *J Reg Med Biol Res* 1.2 (2020): 1-21.

[24] Yeung Jr, Patrick Peter, James Shwayder, and Resad P. Pasic. "Laparoscopic management of endometriosis: comprehensive review of best evidence." *Journal of Minimally Invasive Gynecology* 16.3 (2009): 269-281.

[25] Jansen, Frank Willem, et al. "Complications of laparoscopy: a prospective multicenter observational study." *BJOG: An International Journal of Obstetrics & Gynecology* 104.5 (1997): 595-600.

[26] Worley Jr, Michael J., Brian M. Slomovitz, and Pedro T. Ramirez. "Complications of laparoscopy in benign and oncologic gynecological surgery." *Reviews in Obstetrics and Gynecology* 2.3 (2009): 169.

[27] Park, Jin-Young, et al. "Laparoendoscopic single site (LESS) surgery in benign gynecology: perioperative and late complications of 515 cases." *European Journal of Obstetrics & Gynecology and Reproductive Biology* 167.2 (2013): 215-218.

[28] Sinha, Rooma, et al. "Robotic surgery in gynecology." *Journal of minimal access surgery* 11.1 (2015): 50.

[29] Lawrie, Theresa A., et al. "Robot-assisted surgery in gynecology." *Cochrane Database of Systematic Reviews* 4 (2019).

[30] Kennedy, Stephen, et al. "ESHRE guideline for the diagnosis and treatment of endometriosis." *Human reproduction* 20.10 (2005): 2698-2704.

[31] Vignali, Michele, et al. "Surgical treatment of deep endometriosis and risk of recurrence." *Journal of minimally invasive gynecology* 12.6 (2005): 508-513.

[32] Marchal, Frédéric, et al. "Telerobotic-assisted laparoscopic hysterectomy for benign and oncologic pathologies: initial clinical experience with 30 patients." *Surgical Endoscopy and Other Interventional Techniques* 19.6 (2005): 826-831.

[33] Advincula, Arnold P., and Anthony G. Visco. "Robotic Gynecologic Surgery." *Obstetrics & Gynecology* 114.1 (2009): 168-169.

[34] Guan, Xiaoping, et al. "Robotic single-site endometriosis resection using firefly technology." *Journal of minimally invasive gynecology* 23.1 (2016): 10-11.

[35] Jayakumaran, Jayapriya, et al. "Robotic single-site endometriosis resection using near-infrared fluorescence imaging with indocyanine green: a prospective case series and review of literature." *Journal of robotic surgery* 14.1 (2020): 145-154.

[36] Jayakumaran, Jayapriya, et al. "Robotic single-site endometriosis resection using near-infrared fluorescence imaging with indocyanine green: a prospective case series and review of literature." *Journal of robotic surgery* 14.1 (2020): 145-154.

[37] Chu, C. M., S. C. Chang-Jackson, and F. R. Nezhat. "Retrospective study assessing laparoscopic versus robotic assisted laparoscopic treatment of severe endometriosis." *Journal of Minimally Invasive Gynecology* 18.6 (2011): S101.

[38] Dulemba, John F., Cyndi Pelzel, and Helen B. Hubert. "Retrospective analysis of robot-assisted versus standard laparoscopy in the treatment of pelvic pain indicative of endometriosis." *Journal of robotic surgery* 7.2 (2013): 163-169.

[39] Moon, Hye-Sung, et al. "The comparison of robotic single-site surgery to single-port laparoendoscopic surgery for the treatment of advanced-stage endometriosis." *Journal of Laparoendoscopic & Advanced Surgical Techniques* 28.12 (2018): 1483-1488.

[40] Nezhat, Camran R., et al. "Robotic-assisted laparoscopy vs conventional laparoscopy for the treatment of advanced stage endometriosis." *Journal of minimally invasive gynecology* 22.1 (2015): 40-44.

[41] Magrina, Javier F., et al. "Surgical excision of advanced endometriosis: perioperative outcomes and impacting factors." *Journal of minimally invasive gynecology* 22.6 (2015): 944-950.

[42] Magrina, Javier F., et al. "Surgical excision of advanced endometriosis: perioperative outcomes and impacting factors." *Journal of minimally invasive gynecology* 22.6 (2015): 944-950.

[43] Chen, Shao-Hui, Zhao-Ai Li, and Xiu-Ping Du. "Du XP. Robot-assisted versus conventional laparoscopic surgery in the treatment of advanced stage endometriosis: a meta-analysis." *Clin Exp Obstet Gynecol* 43.3 (2016): 422-426.

[44] Haueter, Reto, et al. "Meta-analysis of single-port versus conventional laparoscopic cholecystectomy comparing body image and cosmesis." *Journal of British Surgery* 104.9 (2017): 1141-1159.

[45] Fagotti, Anna, et al. "Postoperative pain after conventional laparoscopy and laparoendoscopic single site surgery (LESS) for benign adnexal disease: a randomized trial." *Fertility and sterility* 96.1 (2011): 255-259.

[46] Demirayak G, Özdemir İA, Comba C, Aslan Çetin B, Aydogan Mathyk B, et al. Comparison of laparoendoscopic single-site (LESS) surgery and conventional multiport laparoscopic (CMPL) surgery for hysterectomy: long-term outcomes of abdominal incisional scar. J Obstet Gynaecol 2020; 40:217–21.

[47] Bucher, Pascal, et al. "Population perception of surgical safety and body image trauma: a plea for scarless surgery?" *Surgical endoscopy* 25.2 (2011): 408-415.

[48] Fagotti, Anna, et al. "Postoperative pain after conventional laparoscopy and laparoendoscopic single site surgery (LESS) for benign adnexal disease: a randomized trial." *Fertility and sterility* 96.1 (2011): 255-259.

[49] Di Maida, Fabrizio, et al. "Robotic treatment for urinary tract endometriosis: preliminary results and surgical details in a high-volume single-institutional cohort study." *Surgical endoscopy* 34.7 (2020): 3236-3242.

[50] Dobbs, Ryan W., et al. "Single-port robot-assisted laparoscopic radical prostatectomy: initial experience and technique with the da Vinci® SP platform." *BJU international* 124.6 (2019): 1022-1027.

[51] Kaouk, Jihad, et al. "Extraperitoneal single-port robot-assisted radical prostatectomy: initial experience and description of technique." *BJU international* 125.1 (2020): 182-189.

[52] Bellelis, Patrick, et al. "Epidemiological and clinical aspects of pelvic endometriosis: series of cases." *Revista da Associacao Medica Brasileira* 56.4 (2010): 467-471.

[53] Garry, Ray, Richard Clayton, and Jeremy Hawe. "The effect of endometriosis and its radical laparoscopic excision on quality of life indicators." *BJOG: An International Journal of Obstetrics & Gynaecology* 107.1 (2000): 44-54.

[54] 54. Redwine, David B., and Jeremy T. Wright. "Laparoscopic treatment of complete obliteration of the cul-de-sac associated with endometriosis: long-term follow-up of en bloc resection." *Fertility and sterility* 76.2 (2001): 358-365.

[55] Ruffo, Giacomo, et al. "Laparoscopic rectal resection for severe endometriosis of the mid and low rectum: technique and operative results." *Surgical endoscopy* 26.4 (2012): 1035-1040.

[56] Donnez, Olivier, and Horace Roman. "Choosing the right surgical technique for deep endometriosis: shaving, disc excision, or bowel resection?" *Fertility and sterility* 108.6 (2017): 931-942.

[57] Collinet, Pierre, et al. "Robot-assisted laparoscopy for deep infiltrating endometriosis: international multicentric retrospective study." *Surgical endoscopy* 28.8 (2014): 2474-2479.

[58] Neme, Rosa Maria, et al. "Deep infiltrating colorectal endometriosis treated with robotic-assisted rectosigmoidectomy." *JSLS: Journal of the Society of Laparoendoscopic Surgeons* 17.2 (2013): 227.

[59] Vitobello, Domenico, et al. "Robotic surgery and standard laparoscopy: a surgical hybrid technique for use in colorectal endometriosis." *Journal of Obstetrics and Gynaecology Research* 39.1 (2013): 217-222.

[60] Siesto, Gabriele, et al. "Robotic surgery for deep endometriosis: a paradigm shifts." *The International Journal of Medical Robotics and Computer Assisted Surgery* 10.2 (2014): 140-146.

[61] Pellegrino, Antonio, et al. "Robotic shaving technique in 25 patients affected by deep infiltrating endometriosis of the rectovaginal space." *Journal of minimally invasive gynecology* 22.7 (2015): 1287-1292.

[62] Abo, C., et al. "Management of deep infiltrating endometriosis by laparoscopic route with robotic assistance: 3-year experience." *Journal of gynecology obstetrics and human reproduction* 46.1 (2017): 9-18.

[63] Comiter, Craig V. "Endometriosis of the urinary tract." *Urologic Clinics* 29.3 (2002): 625-635.

[64] Le Carpentier, M., et al. "Partial cystectomy for bladder endometriosis: robotic assisted laparoscopy versus standard laparoscopy." *Gynecologie, obstetrique & fertilite* 44.6 (2016): 315-321.

[65] Nezhat, Ceana H., Farr Nezhat, and Camran Nezhat. "Laparoscopic sacral colpopexy for vaginal vault prolapse." *Obstetrics and gynecology* 84.5 (1994): 885-888.

[66] Freeman, R. M., et al. "A randomized controlled trial of abdominal versus laparoscopic sacrocolpopexy for the treatment of post-hysterectomy vaginal vault prolapse: LAS study." *International Urogynecology Journal* 24.3 (2013): 377-384.

[67] Paraiso, Marie Fidela R., et al. "Laparoscopic compared with robotic sacrocolpopexy for vaginal prolapse: a randomized controlled trial." *Obstetrics & Gynecology* 118.5 (2011): 1005-1013.

[68] Boggess, John F., et al. "A case-control study of robot-assisted type III radical hysterectomy with pelvic lymph node dissection compared with open radical hysterectomy." *American journal of obstetrics and gynecology* 199.4 (2008): 357-e1.

[69] Estape, Ricardo, et al. "A case matched analysis of robotic radical hysterectomy with lymphadenectomy compared with laparoscopy and laparotomy." *Gynecologic oncology* 113.3 (2009): 357-361.

[70] Sert, M. Bilal, and Vera Abeler. "Robot-assisted laparoscopic radical hysterectomy: comparison with total laparoscopic hysterectomy and abdominal radical hysterectomy; one surgeon's experience at the Norwegian Radium Hospital." *Gynecologic oncology* 121.3 (2011): 600-604.

[71] Soliman, Pamela T., et al. "Analgesic and antiemetic requirements after minimally invasive surgery for early cervical cancer: a comparison between laparoscopy and robotic surgery." *Annals of surgical oncology* 20.4 (2013): 1355-1359.

[72] Soliman, Pamela T., et al. "Analgesic and antiemetic requirements after minimally invasive surgery for early cervical cancer: a comparison between laparoscopy and robotic surgery." *Annals of surgical oncology* 20.4 (2013): 1355-1359.

[73] Tinelli, Raffaele, et al. "Robotics versus laparoscopic radical hysterectomy with lymphadenectomy in patients with early cervical cancer: a multicenter study." *Annals of surgical oncology* 18.9 (2011): 2622-2628.

[74] Sinno, Abdulrahman K., and Amanda N. Fader. "Robotic-assisted surgery in gynecologic oncology." *Fertility and sterility* 102.4 (2014): 922-932.

[75] Paley, Pamela J., et al. "Surgical outcomes in gynecologic oncology in the era of robotics: analysis of first 1000 cases." *American journal of obstetrics and gynecology* 204.6 (2011): 551-e1.

[76] Gaia, Giorgia, et al. "Robotic-assisted hysterectomy for endometrial cancer compared with traditional laparoscopic and laparotomy approaches: a systematic review." *Obstetrics & Gynecology* 116.6 (2010): 1422-1431.

[77] Cohn, David, et al. "Comprehensive surgical staging for endometrial cancer in obese patients." *Obstetrics and Gynecology* 114.1 (2009): 16-21.

[78] Suri, Anuj, et al. "Preoperative pathologic findings associated with residual disease at radical hysterectomy in women with stage IA2 cervical cancer." *Gynecologic oncology* 112.1 (2009): 110-113.

[79] Feuer, Gerald A., et al. "Perioperative and clinical outcomes in the management of epithelial ovarian cancer using a robotic or abdominal approach." *Gynecologic oncology* 131.3 (2013): 520-524.

[80] Laskaris, James, and Katie Regan. "Soft Tissue Robotics–The Next Generation (Vol. VII)." *md buyline* (2014).

[81] American College of Obstetricians and Gynecologists. "Robotic surgery in gynecology. Committee Opinion No. 628." *Obstet Gynecol* 125 (2015): 760-767.

[82] Lenihan Jr, John P., Carol Kovanda, and Usha Seshadri-Kreaden. "What is the learning curve for robotic assisted gynecologic surgery?" *Journal of minimally invasive gynecology* 15.5 (2008): 589-594.

[83] Lim, Peter C., Elizabeth Kang, and Do Hwan Park. "A comparative detail analysis of the learning curve and surgical outcome for robotic hysterectomy with lymphadenectomy versus laparoscopic hysterectomy with lymphadenectomy in treatment of endometrial cancer: a case-matched controlled study of the first one hundred twenty-two patients." *Gynecologic oncology* 120.3 (2011): 413-418.

[84] Landrum, Lisa M., et al. "Prognostic factors for stage III epithelial ovarian cancer treated with intraperitoneal chemotherapy: A Gynecologic Oncology Group study." *Gynecologic oncology* 130.1 (2013): 12-18.

[85] Sandadi, Samith, et al. "Fellowship learning curve associated with completing a robotic assisted total laparoscopic hysterectomy." *Gynecologic oncology* 132.1 (2014): 102-106.

[86] Sgarbura, Olivia, and Catalin Vasilescu. "The decisive role of the patient-side surgeon in robotic surgery." *Surgical endoscopy* 24.12 (2010): 3149-3155.