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# Robotic-assisted colorectal procedures in a gynecologic oncology setting

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**Summary**

*Purpose:* Despite potential benefits, gynecologic oncology has not fully embraced use of the robot for concomitant colorectal procedures. The authors describe the robotic technique and outcomes of colorectal surgeries from an experienced gynecologic oncologist's practice. *Materials and Methods:* A review of robotic-assisted gynecologic surgeries between 2011 and 2016 was undertaken to identify patients with colorectal procedures and findings. *Results:* Sixteen patients had robotic-assisted colorectal procedures, including end-sigmoid colostomy (n=8), colon resection with anastomosis (n=5), low anterior resection with end-to-end anastomosis (n=3), and cecectomy (n=1). Median operative time was 130 minutes, blood loss 50 ml, and length-of-stay three days. There were no intra-operative complications or conversions. One postoperative ileus resolved with supportive care and one intermittent partial bowel obstruction not requiring hospitalization occurred. *Conclusions:* Robotic-assisted colorectal procedures by a gynecologic oncologist can be done safely and in reasonable operative time. Gynecologic oncology calls for overlapping training in multiple domains with a minimally invasive approach.

*Key words:* Robotic surgery; Gynecologic oncology; Colorectal surgery; Minimally invasive surgery; Surgical technique.

## Introduction

Gynecologic Oncology was officially recognized as a medical subspecialty with the formation of the Society of Gynecologic Oncology in 1969 [1]. Practitioners treat all aspects of gynecologic cancers and also perform surgeries that may involve adjacent structures including the urinary and bowel systems. The development of safe and efficacious laparoscopic techniques in the 1980s and 1990s, provided minimally invasive approaches to what were otherwise open surgical procedures. Childers and colleagues first introduced laparoscopic surgery to gynecologic oncologists for staging and management of endometrial, cervical and ovarian cancers [2-5]. Studies have shown that traditional laparoscopic surgeries are safe and can provide benefit to gynecologic oncology patients in terms of less intra-operative blood loss, fewer complications, and shorter hospital stay compared to laparotomy [6-11]. However, laparoscopy also comes with specific technical challenges, particularly with regard to issues of mechanical dexterity and two-dimensional imaging.

When robotic-assisted laparoscopic surgical devices were first approved by the FDA in the 1990s (e.g., AESOP and Zeus), general and colorectal surgeons used these new technologies to take advantage of the improved optics and articulation of instruments during procedures [12, 13]. The first comprehensive tele-robotic system was the da Vinci® Surgical System which was used for intra-abdominal procedures beginning in 2001 and gynecology in 2005. In the realm of gynecologic oncology, robotic surgery is now primarily used for treatment of endometrial and cervical cancer. Advantages of the robotic approach include improved dexterity and precision of the instruments, along with three-dimensional imaging of the operative field. Despite these potential benefits, the specialty of gynecologic oncology has not fully embraced the use of the robot for concomitant colorectal procedures. This paper reviews the techniques, experience, and initial outcomes with colorectal surgery based on patients from an experienced gynecologic oncologist's practice.

## Materials and Methods

A retrospective review of all robotic-assisted gynecologic surgeries performed by this surgeon between June 2011 and July 2016 was undertaken to identify patients with concomitant colorectal procedures.

Colorectal surgical procedures

*Port positioning and docking*

For the *da Vinci® Si* System, the optical port is positioned midline, approximately 22-24 cm above the symphysis pubis. Two lateral 8-mm robotic ports are introduced. The right 8-mm robotic port is positioned 10 cm lateral and 2 cm inferior to the optical port. The left 8-mm robotic port is placed 11-12 cm lateral and 2 cm inferior to the optical port. The left port is further lateralized in order to optimize dissection at the splenic flexure. The assistant utilizes two ports, one 12-mm port is placed at the right lateral

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side of the patient, and one 5-mm port in the right upper quadrant. The robot is centrally docked between the patient's legs, as this placement provides more range on the right side as compared to side docking.

If utilizing the *da Vinci® Xi* System, the two lateral 8-mm robot ports are placed at the same plane as the optical port, each 9-10 cm lateralized from the midline. The assistant utilizes two ports, one 12-mm port is placed at the right lateral side of the patient, and one 5-mm port in the right upper quadrant. For the *Xi* model, the robot is docked from the patient's left side.

*Initial preparation*

The patient is placed in the dorsal lithotomy position with arms tucked at the sides and in a 33-degree Trendelenburg positioning. For the end-sigmoid colostomy, a three- or four-arm technique is employed. A four-arm technique is employed for all cases in which an end-to-end anastomosis is performed. When the fourth arm is employed, it is used for retraction. If a three-arm technique is utilized, in addition to the midline optical scope, a bipolar Maryland dissector is used in the left arm and a monopolar scissors is used in the right robotic arm. If the fourth arm is added, a cadier is used.

*Sigmoid colostomy*

Prior to the start of the procedure, the site for colostomy is marked on the patient's skin by the endostomal therapy nurse. Laparoscopic assessment is performed to determine feasibility of the procedure. This is done with a 5-mm scope placed in the right upper quadrant. After docking the robot, the portion of the bowel that is to be incised is determined. The authors attempt to be at least 3 cm above any obvious pathology. Length can be obtained via simple mobilization near the sigmoid. If extra length is required, then it may be necessary to mobilize at the splenic flexure. The area to be severed is then re-identified and lightly marked with cautery. The bipolar is used to dissect and make a through and through incision along the mesentery just below the intestine at the area to be severed. The endowrist sealer is then used to go down along the mesentery until retro-rectal space is reached. The ureters are identified prior to this step. The bowel may be severed at this point. At this point, the appropriate length of the colon that needs to be mobilized is determined. The colon is held up by the right atraumatic robotic arm near the site where the ostomy is to be brought out. The left arm and the scope may be undocked. A circular incision is made on the skin at the ostomy site and the skin and fat are dissected down to the fascia. The cruciate incision is then made on the fascia. The incision is stretched manually with two fingers. The colon is then grasped as the assistant opens up the robotic arm holding the colon. The colon is then exteriorized. The colon is fixed to the fascia from above and all incisions are approximated and dressed. The ostomy is open and a rosebud formed in the usual fashion. A bag is placed over the colostomy site.

*Determining the length of the bowel for colostomy*

This is done by the assistant pressing on the site marked for the colostomy, while the surgeon pulls the bowel towards and past this point to measure the excess of bowel. The abdominal wall depth is also estimated. If there is not adequate length of bowel, the sigmoid and splenic flexure are mobilized. Then the mesentery of the proximal part of the colon can also be incised to acquire additional length.

*Low anterior resection*

After docking the robot, the sigmoid colon is mobilized robotically as noted for colostomy. If more mobility is need, it often can be achieved via the bilateral dissection of the pararectal spaces below the peritoneal reflection, once the rectovaginal septum has been created. A bipolar Maryland dissector is used in the left robotic arm and monopolar scissors are used in the right robotic arm. The fourth arm is used for traction. The proximal area of the sigmoid colon to be stapled is identified and marked on the mesentery with cautery. The Maryland dissector and monopolar scissors are used to dissect under the proximal colon mesentery through and through. The endowrist sealer is used to further transect the mesentery toward the retro-rectal space. At this point, the lateral mesentery and inferior hemorrhoidal vessels are desiccated with the robotic bipolar and subsequently divided with the monopolar scissors. This is continued to a point beyond the distal margin of the colon to be transected. After the retro-rectal space is reached, the proximal portion of the sigmoid colon is divided with an endowrist GIA stapler that is introduced from the right side. This may also be done with a laparoscopic GIA stapler through the assistant 12-mm port. The former is preferred as the endowrist stapler gives better angles to reach under the intestine. Multiple fires of the stapler may be necessary. The distal end is also divided in the same manner. The transected portion of the sigmoid colon is placed in an endoscopic specimen bag. Smaller specimens may fit into a 10-cm endoscopic specimen bag that is introduced through the left lateral 12-mm assistant port. Larger specimens require a 15 cm bag. The 15 cm specimen bag can be introduced through the 12 mm port or when the transverse incision is made. A 5-cm transverse incision just above the symphysis pubis is made. A wound retractor is placed. The endoscopic specimen bag is then grasped with a clamp and the robotic arm is opened to release the endoscopic bag. The bag is then removed. The proximal limb of the colon is brought up through the incision. The EEA sizers are used to assess the size of the EEA stapler required. A proline purse string stitch is placed. The anvil is introduced in the colon and the purse string is securely tied down. The stitch is tied around the anvil once and then retied in the opposite direction. The colon with anvil is dropped back into the abdomen. The fascia is closed at this point to maintain the pneumoperitoneum. The retractor is twisted accordingly. The assistant places the EEA stapler into the anus and advances it until the staple line is reached. The EEA is turned to grasp the sharp trocar through the previous staple line. The anvil is connected to the EEA and the anvil can be pushed from behind to be sure it locks into place. The EEA is then closed to the appropriate pressure and fired. Subsequently, the EEA is opened 1.5 turns and the device is removed slowly. The staple line is pushed down and placed into water to do an air test for anastomosis integrity. With the new *da Vinci® Xi*, one can change the Trendelenburg position to about 20 mm enabling the air test to be done with more security.

*Sigmoid and transverse colon resection*

After docking the robot, the lesion on either the transverse or sigmoid colon is identified. Note that for a transverse colon resection, this set-up works only if the transverse colon is very mobile. If not, other techniques are warranted. A bipolar Maryland dissector is used in the left robotic arm and monopolar scissors are used in the right robotic arm. The fourth arm is used for traction.The bowel is mobilized robotically, including the distal mobilization of the rectum described in the lower anterior resection procedure. The mesentery is dissected and divided and the colon divided using procedures similar to those for lower anterior resection. For a smaller specimen, a 10-cm bag is brought in from the lateral 12-cm port. For larger specimens, the 15-cm bag is brought in after hysterectomy or, alternatively, the 15-cm bag may be brought in through a 12-mm port or through the low transverse

Table 1. — *Surgical indications and robotic colorectal procedures for 16 gynecologic oncology patients.*

| Patient | Surgical indication | Robotic colorectal procedure |
|---|---|---|
| 1 | Metastatic primary peritoneal carcinoma | Transverse colectomy |
| 2 | Pelvic pain, Stage IV endometriosis | Sigmoid resection |
| 3 | Stage IB1 cervical cancer, recurrence to colon, rectovaginal fistula | End sigmoid colostomy |
| 4 | Stage IV, Grade 3 endometrial cancer, radiation therapy, rectovaginal fistula | End sigmoid colostomy |
| 5 | Stage IB1 endometrial cancer, radiation therapy, recurrence to rectum | Low anterior resection with primary anastomosis |
| 6 | Stage IIIB vaginal cancer, radiation therapy, rectovaginal fistula, debulking | End sigmoid colostomy |
| 7 | Pelvic mass with colonic lesion (final pathology metastatic colon adenocarcinoma), debulking | Sigmoid resection and low anterior resection |
| 8 | Carcinoma of cervical stump, radiation therapy, and status post-anterior exenteration for persistent disease, presenting with rectovaginal fistula, debulking | End sigmoid colostomy |
| 9 | Stage IA papillary serous endometrial cancer, radiation therapy, with focal recurrence to large bowel | Low anterior resection with primary anastomosis |
| 10 | Stage IIIB ovary and Stage 1A Grade 3 endometrial cancer focal recurrence to large bowel, debulking | End sigmoid colostomy |
| 11 | Pelvic pain, stage IV endometriosis | Sigmoid resection with primary anastomosis |
| 12 | Pelvic Pain, stage IV endometriosis | Cecectomy |
| 13 | Stage IIC2 endometrial cancer, staging surgery, repair of bladder laceration and injury to rectum | Sigmoid resection with end-to-end anastomosis |
| 14 | Stage IIB cervical cancer (previous), radiation therapy, rectovaginal fistula | End sigmoid colostomy |
| 15 | Invasive squamous cell vaginal carcinoma, fecal incontinence, vaginal bleeding, rectovaginal fistula | End sigmoid colostomy |
| 16 | Stage IVA cervical cancer (previous) involving the distal vagina and vulva, radiation therapy, rectovaginal fistula, debulking | End sigmoid colostomy |

incision. The specimen is then removed through the vagina, or a very low 4-5 cm transverse incision is made for removal of the specimen (as noted in procedures for low anterior resection). The proximal and distal limbs of the intestine are lined up. A silk stitch is placed at the end of each limb and then a second stitch about 6 cm away from the first stitch. This leaves the two limbs lined up for the anastomosis. Laparoscopic scissors are used to make a colpotomy on each limb of the colon and the endowrist GIA stapler is fired. A 60-mm endoscopic GIA stapler also is an option. The open area of the colon is then held in appropriate orientation perpendicular to its natural path, three silk sutures are placed to hold the intestines, and two firings are placed at the axis of the opening. Two silk sutures are then used to reinforce at the distal area of the anastomosis. The mesentery is closed. The robot is undocked and the incisions are closed in the normal manner. If a transverse incision was made, then the fascia is closed with interrupted 0-Vicryl suture.

*Cecectomy*

In the present case, disease was noted at the most distal end of the cecum. The ileocecal valve was 4-5 cm away from the distal aspect of the cecum and a distal cecectomy was performed.

Two atraumatics for robotic instruments (cadier and fenestrated bipolar) are brought in to hold the bowel. The assistant uses the GIA stapler for two fires to come across the cecum at the most distal aspect and clearly away from the pathology. Once severed, the portion of intestine is placed in a bag and later removed from the vagina. It is critical to be certain that the ileocecal valve is not in any way compromised.

*Data collection*

Data were collected on patient characteristics at the time of surgery (ethnicity, age, BMI, parity, previous hysterectomy, and abdominal surgeries), indications for surgery, surgical procedures, intra-operative characteristics (operative time, estimated blood loss), conversions, complications (intra-operative, at two and six weeks follow-up), and length of hospital stay.

*Statistical analysis*

Data are presented as frequencies and percent (categorical data) or median and range (continuous data). No formal statistical analysis was undertaken.

## Results

Sixteen patients were identified who had a robotic-assisted colorectal procedure in conjunction with gynecologic surgery (Table 1). They were predominantly Caucasian (87.5%) with median age of 58.5 years (range 38 - 82), parity of 2 (range 0 - 4), and BMI of 27.2 kg/m$^2$ (range 15.1 - 40.0). Previous hysterectomy was noted in nine (56.3%) patients. Surgical indications included eight (50%) patients with recto-vaginal fistula after previous gynecologic cancer surgery, six (37.5%) with primary disease (three women had benign disease diagnosed as advanced endometriosis, three had primary cancer), and two (12.5%) presented with recurrent disease to the recto-sigmoid after previous gynecologic cancer surgery. Oncologic debulking procedures were indicated in five (31.3%) of the 16 patients .

The robotic-assisted colorectal surgeries performed on these women were: formation of end-sigmoid colostomy (n=8, 50%), sigmoid/transverse colon resection with primary anastomosis (n=5, 31.3%; one of these patients also had a low anterior resection), low anterior resection with end-to-end anastomosis (n=3, 18.8%), and cecectomy (n=1, 6.2%).

Median operative time was 130 minutes (range 45 - 208), estimated blood loss 50 ml (range 50 - 200), and length of stay three days (range 1-11). The 11-day hospital stay was not related to the colon surgery, but to end-of-life issues with regard to Stage IIIB cervical cancer and failure to thrive. The patient died 2.5 weeks after surgery. There were no intra-operative complications among the 16 patients. Within the first two weeks, one patient had post-operative ileus that resolved with continued supportive care in the hospital and another had an intermittent partial small bowel obstruction that did not require hospitalization. No other complications were evident within the six-week follow-up period.

Operative times were shortest for the ten patients who had only a colorectal procedure (median = 113.5 minutes, range 45-144) compared to the other six who had colorectal procedures in conjunction with hysterectomy or oncologic debulking (median = 163.5 minutes, range 130-208). Operative time also varied by type of colorectal surgery: colostomy was the shortest procedure (median = 94.5 minutes, range 45-144), low anterior resection was longer (median = 135.0 minutes, range 127-154), and large bowel resection with end-to-end anastomosis the longest (median = 165.0 minutes, range 130-208).

## Discussion

Gynecologic oncology is unique in that it crosses over multiple medical specialties — gynecologic, urologic, and gastrointestinal surgery, as well as oncology/chemotherapy. The specialty was designed to create fluidity in surgical procedures used in the treatment of cancer with involvement over the entire pelvic anatomy. Peter Lim [14] was among the first to describe robotic-assisted pelvic exenteration, a complex minimally invasive surgery using the *da Vinci®* Robotic System in which his team performed a robotic total pelvic exenteration. His report discusses the advantages of the robotic approach: better surgical visualization with 3-D optics and the ability to operate in the confines of a narrow pelvic region with minimal patient blood loss. Despite the trend in general medicine to become more and more specialized, gynecologic oncology calls for overlapping training and experience in these multiple domains, and, with improvements in treatment approaches, these surgeries now need to be addressed in a minimally invasive fashion.

This paper describes the five-year experience of a skilled gynecologic oncologist who was motivated to train in robotic techniques to perform concomitant colorectal surgeries using the *da Vinci® Si* System. These procedures were done safely, in good operative time, with minimal blood loss and surgical complications. While outcomes were based on a retrospectively identified case series involving only 16 patients, there is a growing body of research describing the success of robotic surgery across gynecologic and colorectal specialties.

Recent meta-analyses of studies of endometrial cancer staging and treatment suggest that robot-assisted surgery results in lower conversion rates, fewer complications (in cancer staging only), less blood loss and shorter hospital stays when compared to the conventional laparoscopic approach [15, 16]. Robotic exenteration continues to be successfully performed to treat advanced or recurrent cervical cancer [17, 18], recurrent endometrial cancer [19], and patients with advanced ovarian [20] or rectal cancer [21]. In addition, robotic-assisted excision of retrocervical-rectal, deep, infiltrating endometriosis shows promising results in a recent case-series report [22].

The current colorectal study literature indicates that robotic-assisted compared to conventional laparoscopic surgery for rectal cancer also offers advantageous outcomes (lower complication rates, less blood loss, and shorter hospitals stays), particularly in more challenging situations in the lower rectum and among obese patients [23]. These results are similar to those found in a meta-analysis by Sun *et al.* [24] of eight earlier studies of low anterior resection for rectal cancer where robotic surgery was associated not only with lower overall complication rates and shorter hospital stays, but also with a lower rate of conversion and of circumferential margin involvement compared to the laparoscopic approach. The results of a meta-analysis of seven studies comparing peri-operative outcomes for robotic and conventional laparoscopic right colectomy also indicated that the robotic approach results in lower postoperative complications, less blood loss, and faster bowel function recovery, despite longer robotic operative times [25]. Meta-analysis of four randomized controlled trials of colorectal surgery demonstrated lower conversion rates, less estimated blood loss, and faster times to recovery of bowel function with robotic compared to laparoscopic techniques [26].

The majority of gynecologic oncologists are currently being well-trained in gastrointestinal (colorectal) surgery using an open approach and also in minimally invasive techniques for gynecologic procedures. Attempts to merge the two involve trainees rotating through colorectal services where minimally invasive procedures are undertaken. However, the greater challenge within this specialty is to provide opportunity and incentive for previously trained surgeons to learn and safely adopt these minimally invasive procedures. There are Society of Gynecologic Oncology webinars (SGO ConnectEd E-Learning), courses (e.g., provided by the robot manufacturer), videos and papers, the present and others [27], that focus on technique. Training options include observation of peers or colorectal surgeons who perform these procedures and appropriately trained co-surgeons on cases as teachers and observers. Learning to perform non-extensive, simple colorectal surgeries such as colostomy or small bowel resection, is a very good introduction to these minimally invasive procedures and provides the basics for the more complex colorectal procedures. A surgeon can become familiar with all the various materials and techniques (e.g., use of the stapler, use of the sealer for the mesentery) without the difficulty of performing an anastomosis. It is worthwhile noting that the learning curve for robotic-assisted colectomy, for example, has been shown to be faster than the simultaneous learning curve for the conventional laparoscopic approach [28]. It has been reported that a novice minimally invasive surgeon learning to perform both laparoscopic and robotic low anterior resections also achieved competency faster with robotics [29].

Large bowel resections by gynecological oncologists are generally for upfront debulking in ovarian cancer. Although not commonplace, ovarian cancer surgery has been performed using robotic-assisted and conventional laparoscopic procedures [30 – 32]. Most bowel resections are done using the abdominal approach; minimally invasive (robotic) surgery is typically not used if there is much disease to debulk and more than one other major procedure is being performed (called Type III disease by Magrina *et al.*) [30, 31]. This recommendation results from the prolonged operative time with longer hospital stays noted with robotic surgery when multi-quadrant, advanced disease is present.

Bowel resections are also done in surgeries for recurrence of endometrial, cervical, and ovarian cancers. A paper by Escobar *et al.* [33] describes their experience with robotic-assisted surgery in the management of recurrent ovarian cancer. While minimally invasive surgery is typically not performed in recurrent disease, these data suggest that better perioperative outcomes can be achieved with robotic surgical secondary cytoreduction compared to laparotomy when the ovarian cancer recurrence is of a more limited nature and carcinomatosis is absent. When cancer recurs in the colorectal region, as evident in some of the present patients, the bowel resection may become the primary surgery. In such instances, the expertise of a gynecologic oncologist who can safely and efficiently perform the procedure is necessary, providing a further rationale for the surgeon to learn and gain proficiency in a minimally invasive approach to this procedure. The difficulty is in performing enough surgeries to gain the needed expertise to learn the techniques described in this paper. Learning the critical steps and differences between the abdominal and robotic approaches can help to enable surgeons to safely and efficiently adopt a robotic approach for performing a bowel resection and anastomosis. These techniques include: a) four robotic arms are used to do perfor, anastomosis, b) two silk sutures are placed at the end of each intestinal limb to secure and align them, rather than to hold them down as in the abdominal approach, c) closure of the remaining opening after the first staple is fired is done using three silks to tent up the hole to make closure easier, d) the bowel must be kept in the visual field to perform an adequate air test for anastomosis integrity after stapling. Use of the new *da Vinci® Xi* compatible TruSystem™ 7000dV OR Table should be most helpful in executing these steps since the table can move while the robot is docked to aid in bowel work, orientation and multi-quadrant surgeries.

Gynecologic oncologists, by the nature of what they do, often have to undertake colorectal surgeries that are not straightforward. That is, they are often taking care of patients who have had prior significant surgeries and possibly radiation therapy, making surgeries much more challenging. These surgeons can become very proficient in robotics, as it is the minimally invasive approach of choice for most endometrial and cervical cancers and pelvic masses. The expertise thus gained can transfer to care of more difficult patients. In addition to learning colorectal approaches performing colostomies with low risk of complications, the gynecologic oncologist can perform procedures with a robotically-trained colorectal surgeon to watch the crucial steps and aid in postoperative care.

## Conclusions

There is a continued need to teach and incorporate minimally invasive surgery, and specifically robotic-assisted surgery, into the practice of gynecologic oncology. This paper argues in favor of surgeons in the present authors' specialty also learning how to perform minimally invasive colorectal procedures. The present data and that of others demonstrate that robotic-assisted colorectal procedures in a gynecologic oncology setting are feasible and can be performed safely with good perioperative outcomes. There is ample opportunity for gynecologic oncologists to embrace and gain proficiency in these minimally invasive techniques for colorectal surgery.

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