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Robotic Surgery in Gynecologic Oncology

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1. Introduction

Approximately 83,000 women were diagnosed in the United States with gynecologic malignancies in 2010 (Jemal et al., 2010). Treatment typically involves major abdominal surgery to remove the primary cancer. In addition to a hysterectomy, staging procedures such as pelvic and para-aortic dissection are often needed. In order to minimize the morbidity of surgery, a minimally invasive approach has been shown to provide numerable benefits to patients. These include shorter hospitalizations, reduced blood loss, faster recovery, and fewer postoperative complications.

The da Vinci Surgical System (Intuitive Surgical, Inc, Sunnyvale, California, USA) was approved by the FDA in 2005 for use in gynecology. This system has several advantages over traditional laparoscopy including 7 degrees of motion, 3-dimensional views, tremor filtration, and improved dexterity. Potential drawbacks of this system include lack of haptic feedback, cost, and the size of the system that often requires special operating rooms. In this chapter, we will focus on the outcomes, safety and feasibility reported on robotic assisted surgery in cervical, endometrial and ovarian cancer.

2. Cervical cancer

Cervical cancer is the second most common malignancy in women worldwide (Schiffman et al., 2007). The number of cancer cases in developed countries has dramatically declined since the advent of frequent screening with "Pap" smears. In 2010, 12,200 cervical cancer cases were diagnosed in the U.S., and 4,210 cervical cancer deaths were reported (Jemal et al., 2010).

2.1 Radical hysterectomy

Historically, patients with stages IA2 to IB1 cervical cancer have been managed with radical hysterectomy performed by laparotomy. The first laparoscopic radical hysterectomy with pelvic and para-aortic lymphadenectomy was published in 1992 (Nezhat et al., 1992). Since that time, laparoscopic radical hysterectomy has been shown to be a safe and feasible alternative for treatment of early-stage cervical cancer. (Ramirez et al., 2006; Frumovitz et al., 2007). However, the use of laparoscopic radical hysterectomy has not been embraced by most gynecologic oncologists due to its technical difficulty.

Sert & Abeler described the first robotic-assisted radical hysterectomy with pelvic lymph node dissection (Sert & Abeler, 2006). The same group went on to publish the first

comparative study investigating the feasibility of robotic assisted laparoscopic radical hysterectomy and pelvic lymphadenectomy in patients with early stage cervical cancer compared to conventional laparoscopy. The mean operating time was 241 minutes and 300 minutes in the robotic and laparoscopic group, respectively. However, this difference was not statistically significant. The robotic-assisted group had less blood loss (71 mL vs. 160 mL, p=0.038). There was no difference in the number of lymph nodes, parametrial tissue, and cuff size between the two groups. The robotic-assisted group had a shorter hospital stay (4 days vs. 8 days, p= 0.004) (Sert & Abeler, 2007).

In a case-control cohort study, fifty one patients underwent robotic-assisted type III radical hysterectomy and pelvic lymph node dissection, while forty-nine patients underwent traditional laparotomy radical hysterectomy. The robotic group had significantly less blood loss (96 mL vs. 417 mL), and operative time (211 minutes vs. 248 minutes). The robotic group also had significantly higher lymph node retrieval (33.8 vs. 23.3). The robotic group had a shorter hospital stay (1 day vs. 3.2 days). The laparotomy group had a higher complication rate than the robotic group, 16.3% versus 7.8%; however, this was not statistically significant (Boggess et al., 2008a).

Magrina et al. compared perioperative results of 27 patients undergoing robotic radical hysterectomy from 2003 to 2006. Comparisons were made with laparoscopic and laparotomy patients matched by age, BMI, type of hysterectomy (radical or modified radical), site and type of malignancy, and FIGO staging. The operating times of the robotics and laparotomy groups were similar (189.6 minutes vs. 166.8 minutes), and significantly shorter compared to laparoscopy (220.4 minutes). There were no differences in the number of lymph node retrieval between the three groups. Blood loss (133.1 mL vs. 208.4 mL) was similar between the robotic and laparoscopic group, and highest for laparotomy group (443.6 mL). The length of hospital stay was similar between robotic and laparoscopic group (1.7 vs. 2.4 days, respectively). The laparotomy group had the longest average length of hospital stay (3.6 days). There were no differences in the complication rates between the 3 groups (Magrina et al., 2008).

2.2 Setup & technique

The patient is placed in the dorsal lithotomy position using Allen stirrups (Allen Medical, Acton MA) with arms tucked to the side. The robotic tower and the tower containing the electrosurgical generators and smoke evacuator are positioned lateral to the patient's right foot. A uterine manipulator is often used. The da Vinci column is positioned between the patient's legs.

A 10 mm transumbillical trocar is introduced approximately 20 cm above the pubic symphisis. Another 10 mm trocar is placed approximately 8 cm lateral in the left upper quadrant in the left mid-clavicular line. This trocar is used as an assistant port. The robotic trocars are then placed. These are all 8 mm trocars. The first is placed 8-cm lateral to the assistant port, the second is placed 8 cm lateral and 15 degrees below the midline camera port, and the third trocar is placed 8 cm lateral to the last trocar on the right side (Figure 1). The operating table is placed in Trendelenburg position until the small bowel and sigmoid are displaced out of the pelvis and to a maximum of 30 degrees.

Once the robotic column is advanced to the operating table and placed between the patient's legs, the robotic system is docked and instruments are introduced. There are a number of instruments that may be used and surgeons are encouraged to test several before deciding what is ideal for their practice. We prefer to use an EndoWrist bipolar grasper (Intuitive Surgical, Sunnyvale, CA) on the left upper quadrant port, an EndoWrist monopolar scissor

in the right hand through the right sided trocar immediately next to the camera port, and an EndoWrist Cadiere grasper in the most lateral right trocar.

The robotic radical hysterectomy is performed in the same manner as a traditional Piver type III abdominal radical hysterectomy with the use of scissors and monopolar cautery for isolation and ligation of small vessels and bipolar cautery for the ovarian vessels, uterine artery, and vascular branches of the cardinal and uterosacral ligaments. After isolation of the uterine artery and division at its origin on the pelvic sidewall, the artery is dissected free of the ureter, exposing the ureteral tunnel of Wertheim. The ureter is freed from the medial leaf of the broad ligament until it enters the cardinal ligament. The anterior vesical ligament is then coagulated and divided with scissors. Any remaining medial attachments of the ureter to the vagina is then released, and the ureter and bladder is dissected free of the anterior vagina to allow vaginotomy with an adequate margin.
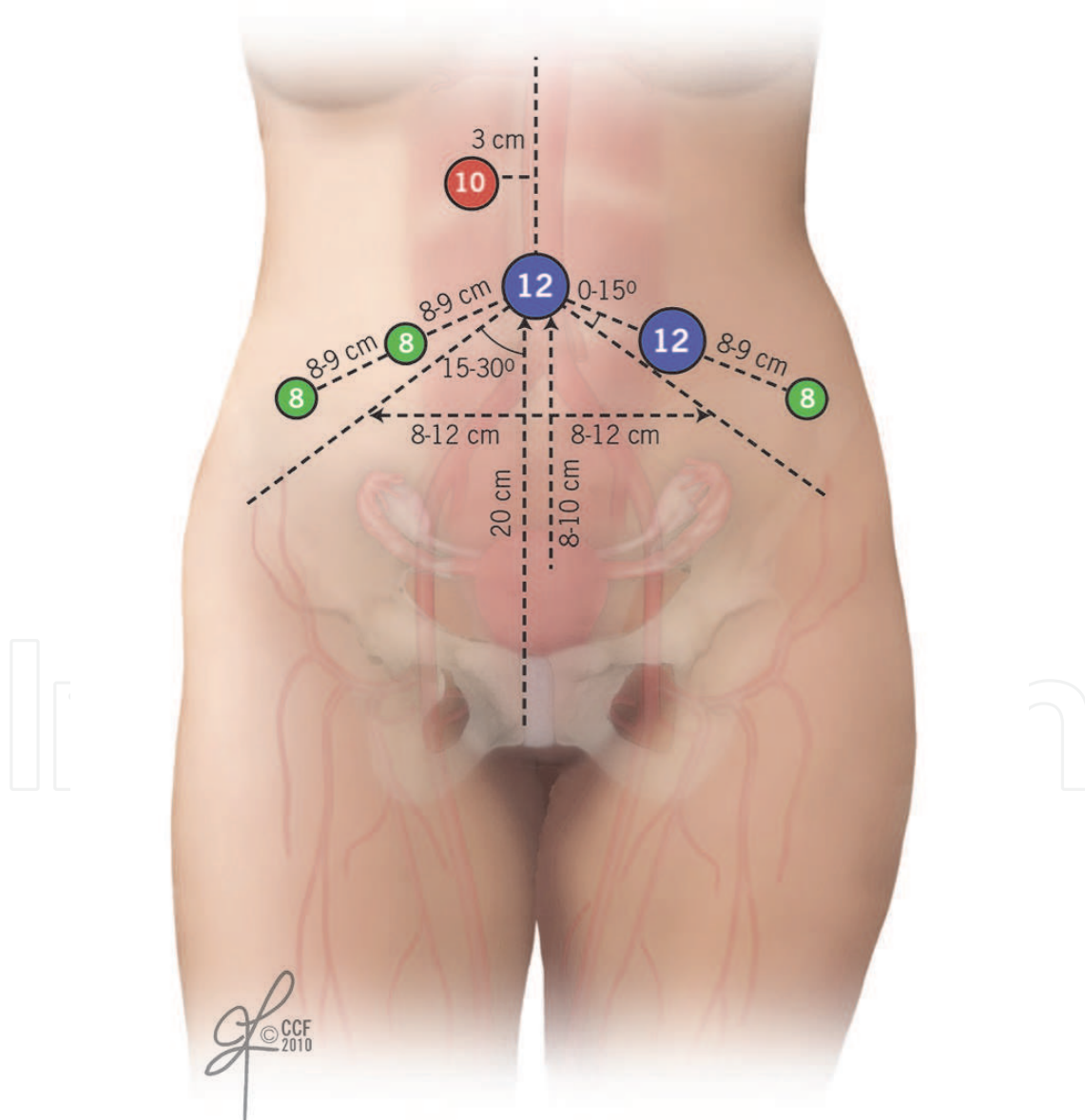

Fig. 1. Trocar placement in radical hysterectomy

The rectovaginal space is developed by an incision of the peritoneum over and between the uterosacral ligaments. The uterosacral ligament is then transected to its insertion into the posterior vaginal wall, and the remainder of the cardinal ligament is resected to the sidewall of the vagina. After the same dissection on the patients left side is completed, vaginotomy is performed. Once the vaginotomy is completed, the specimen is delivered vaginally, and a sponge is placed in the vagina to restore pneumoperitoneum. The specimen is inspected to evaluate the adequacy of the vaginal and parametrial margins. If additional vaginal margin is required, then it is resected easily at this point in the procedure.

Once the radical hysterectomy is completed a complete bilateral pelvic lymphadenectomy is performed from the common iliac artery proximally to the circumflex iliac vein distally. The specimens are placed in an EndoCatch bag (Ethicon Endo-Surgery Inc, Cincinnati, OH) and delivered vaginally. The vaginal cuff is closed using a continuous barbed suture.

2.3 Radical trachelectomy

Radical trachelectomy has been shown to be a safe and feasible option in patients diagnosed with cervical cancer who wish to preserve their fertility (Beiner et al., 2008; Plante et al., 2011). The procedure was first described by Dargent et al. in 1994 (Dargent et al., 1994). Most of the published literature on radical trachelectomy has been on the vaginal approach. However, the vaginal approach can be technically difficult in nulliparous women without pelvic descent and requires a surgeon comfortable with a radical vaginal approach. Alternatively, several studies have reported the safety and feasibility of the abdominal approach (Ungar et al., 2005; Pareja et al., 2008). The robotic approach can offer the same advantages of minimally invasive surgery (decreased blood loss, decreased pain, quicker return of bowel function, etc.) to patients requiring this challenging procedure. The literature on this procedure is limited to isolated case reports and small case series.

A study by Ramirez et al. reported on four patients with stage IA1-1A2 cervical cancer that underwent robotic radical trachelectomy and bilateral pelvic lymphadenectomy. The median operative time was 339.5 minutes. The median blood loss was 62.5 mL. The median number of pelvic lymph nodes removed was 20. There were no conversions to laparotomy and no intraoperative complications. The median length of hospital stay was 1.5 days. One patient experienced a transient left lower extremity sensory neuropathy postoperatively (Ramirez et al., 2010). Another study by Burnett et al. reported their experience with robotic radical trachelectomy. Six women underwent this procedure with stage IBI squamous cell carcinoma or adenocarcinoma of the cervix. Median age was 27 years old. The mean duration of surgery was 360 minutes. Mean blood loss was 108 mL. None of the women had positive lymph nodes. Five out of the six women had negative margins. All patients were discharged on postoperative day one or two. There were two postoperative complications. One patient developed a herniation of small bowel through 8 mm port site on day 4 and one patient had ecchymosis of anterior abdominal wall to the left flank consistent with hemorrhage from the inferior epigastric vessels which required no intervention except for transfusion with 2 units of blood. Follow up from 9-13 months revealed no recurrences or pregnancies (Burnett et al., 2009).

2.3.1 Setup & technique

The patient is placed in the dorsal lithotomy position. A V-Care manipulator (Utica, NY) is placed in the uterus for manipulation. Once the manipulator is placed, attention is focused on the abdominal part of the procedure. A 12 mm bladeless trocar (Ethicon Endosurgery,

Cincinnati, OH) is introduced in the left upper quadrant approximately 2 cm below the left costal margin at the midclavicular line and the abdomen is insufflated. This trocar is used during the procedure by the patient-side assistant. The patient is then placed in the steep Trendelenburg position. The abdomen is explored for evidence of metastatic disease. Another 12 mm bladeless trocar is placed in the umbilicus under direct visualization. Alternatively, this trocar may be placed 2 cm above the umbilicus to gain better visualization of the pelvis. This second trocar is used for the robotic camera. The robotic trocars are then placed. The first robotic trocar is placed 8 cm lateral to and 15 degrees below the patient-side assistant's trocar. The second robotic trocar is placed 8 cm to the right of and 15 degrees below the trocar at the umbilicus. The third robotic trocar is placed 8 cm lateral to the second robotic trocar (Fig. 2).

Fig. 2. Trocar placement for robotic radical trachelectomy

The robotic instruments are then placed. These include an EndoWrist bipolar grasper (Intuitive Surgical, Sunnyvale, CA) through the first robotic trocar, an EndoWrist monopolar scissor through the second robotic trocar, and an EndoWrist Cardiere grasper through the third robotic trocar. The da Vinci System is then docked. The radical trachelectomy is performed as follows: An incision is made over the round ligament and the peritoneum lateral to the infundibulopelvic ligaments is opened bilaterally. The paravesical and pararectal spaces are then developed. The ureters are then separated from the peritoneum down to where they enter the lateral parametrial tissue. The level of resection of the parametria is as follows: the ureters are dissected from the parametria and mobilized completely to the bladder after division of the anterior and posterior vesicouterine

ligaments. The peritoneum over the bladder is then incised, and the bladder is mobilized inferiorly over the anterior vaginal wall. The uterine vessels are transected bilaterally at their origin and dissected over the ureters bilaterally. The anterior vesicouterine ligaments are then divided. The peritoneum over the rectovaginal space is then incised, and the uterosacral ligaments are divided bilaterally. While upward traction is placed on the vaginal cuff, a circumferential incision is made in the vagina to assure an adequate 2 cm margin. The V-Care manipulator is then removed.

The specimen is then held by the parametria bilaterally using graspers. A monopolar scissor or Harmonic scalpel (Ethicon Endo-Surgery, Cincinnati, OH) is used to amputate the cervix, leaving approximately 1 cm of residual cervical stump. The specimen—including cervix, bilateral parametria, and upper vaginal margin—is then removed through the vagina. The specimen is then sent for frozen section evaluation. The endocervical margin should be tumor-free at least 5mm from the level of the tumor. A Smit sleeve cannula (Nucletron, Columbia, MD) is then introduced vaginally and placed into the uterus by using the robotic graspers. We use the Smit sleeve cannula (See figure 3) to decrease the potential for scarring of the residual cervix. It is usually left in the uterus for approximately 2–4 weeks. A cerclage is placed using 0-Ethibond suture (Ethicon, Inc.), and the uterus is sutured to the upper vagina using interrupted 0-Vicryl sutures placed using the EndoWrist Mega Needle driver. Alternatively, a single continuous barbed suture may be used to anastomose the uterus to the vagina. The cerclage is placed abdominally using the robotic system. The pelvic lymphadenectomy is performed bilaterally from the level of the mid-common iliac vessels to the circumflex iliac vein distally.

Fig. 3. Smit sleeve cannula used in radical trachelectomy

3. Endometrial cancer

Endometrial cancer is the most common gynecologic malignancy in developed countries. The American Cancer Society estimates that 43,470 American women were diagnosed in

2010 and approximately 7,950 women died of the disease during that time. (Jemal et al., 2010). The majority of patients are diagnosed with early stage disease. Endometrial cancer is staged surgically. Historically, surgical staging in endometrial cancer has been done by open laparotomy which includes hysterectomy, bilateral salpingo-oophorectomy, and bilateral pelvic and para-aortic lymphadenectomy in select patients with specific risk factors. In the 1990s, small single institution studies showed the safety and feasibility of laparoscopic surgical staging in endometrial cancer (Querleu et al., 1991; Childers et al., 1994; Spirtos et al., 1995). In 2009, a prospective, multi-institutional, randomized trial showed the feasibility and safety of laparoscopic comprehensive surgical staging for endometrial cancer. Of the 1,682 patients, 74.2% were completed without conversion to laparotomy. The laparotomy group did have a shorter operative time despite no difference in intraoperative complications. No difference in overall detection of advanced stage (stage IIIA, IIIC, or IVB) was seen. The laparoscopy group had fewer postoperative adverse events and significantly shorter hospital stay than the laparotomy group (Walker et al., 2009). Therefore, minimally invasive surgery is a safe and feasible option for surgical staging in endometrial cancer.

3.1 Robotic assisted hysterectomy and staging

Robotic surgery has several advantages over laparotomy in the management of endometrial cancer. It has been shown to be potentially equivalent to laparoscopy in this setting. In a study by Boggess et al., the authors compared the outcomes in women who underwent hysterectomy and staging by robotic, laparoscopy or laparotomy. The number of cases was 138 for the laparotomy group, 81 for the laparoscopy group, and 103 for the robotic group. The robotic cohort had a statistically significant higher BMI (p= 0.0008). Operative time was longest for the laparoscopy group at 213.4 minutes followed by robotic group at 191.2 minutes and laparotomy group at 146.5 minutes. The estimated blood loss was lowest for the robotic technique (p<0.0001). Lymph node retrieval was highest for robotic group. Length of hospital stay was lowest for the robotic group (p<0.0001). The postoperative complications rates were lower for the robotic group versus laparotomy group, 5.8% versus 29.7% respectively. The complication rate between laparoscopy and robotic group were not statistically different (Boggess et al., 2008b). Similar results were seen in other studies (Veljovich et al., 2008; Bell et al., 2008, Seamon et al., 2009).

Comparison of clinical outcomes of robotic cases versus laparoscopic or laparotomy for endometrial cancer was evaluated in a meta-analysis by Gaia et al. in 2010. The analysis included 1,591 patients from eight comparative studies. Operative time was similar between robotic and laparoscopic cases, but longer than laparotomy group. The estimated blood loss was lower in the robotic hysterectomy group compared to the laparotomy and laparoscopy group. There were no differences in the pooled analysis on the number of pelvic and para-aortic lymph nodes in all three groups. The length of hospital stay was shorter for both robotic and laparoscopic groups compared to the laparotomy group. Differences in complication rates were not seen between the three groups. Therefore, clinical outcomes between laparoscopy and robotic surgery for endometrial cancer seem similar with the exception of less blood loss in robotic surgery (Gaia et al., 2010).

3.1.1 Setup & technique

The trocar placement for the robotic-assisted hysterectomy for endometrial cancer is the same as that described above for robotic-assisted radical hysterectomy. To initiate the

hysterectomy, the bipolar device grasps the right round ligament. This is then coagulated and transected. An incision is made lateral to the infundibulopelvic ligaments. The right ureter is identified, and the ovarian vessels are coagulated and transected. The broad ligament is then skeletonized with monopolar scissors as the bipolar graspers are used to apply medial traction of the right adnexa. Dissection is continued along the broad ligament to the vesicouterine peritoneum. The assistant places upward traction on the uterine manipulator while the surgeon advances the dissection, and the bladder flap is created. The uterine vessels are coagulated with the bipolar forceps and transected with the monopolar scissors. The same procedure is performed on the left side of the uterus.

The vaginal incision is made anteriorly with the monopolar scissors just below the cervix. This incision is extended lateral to the right and left fornix. Exposure is further facilitated by upward traction in the anterior vaginal fornix. The vaginal assistant places counter tension in the posterior fornix and the posterior vaginal incision follows the scored peritoneum to meet the anterior incision and the uterus is removed through the vagina. Once hemostasis of the vaginal cuff is confirmed, the assistant exchanges the monopolar scissors for robotic needle drivers. The recto sigmoid colon is retracted with the suction irrigator or bipolar grasper, and the blunt grasper displaces the bladder away from the vagina. The cuff may be closed with a single running or multiple interrupted sutures.

For the pelvic lymphadenectomy, the bipolar grasper and monopolar scissors are used to perform the dissection. The pararectal and paravesical spaces are developed, and the ureter and superior vesicle artery is identified. The bipolar grasper then provides gentle retraction at the bifurcation and displaces the ureter medially. After the landmarks are established, the pelvic lymphadenectomy is performed adhering to the following boundaries: mid-psoas muscle laterally, above the bifurcation of the common iliac proximally, the deep circumflex iliac vein distally, and the obturator nerve inferiorly. During the obturator dissection, the assistant provides gentle traction on the external iliac vein with the blunt grasper, and the suction irrigator is used to retract the superior vesicle artery. Each side of the pelvic lymph node dissection results in 1 or 2 large node bundles that are placed in 1 bag for each side.

To begin the right aortic lymphadenectomy, the peritoneum over the right common iliac artery is grasped and incised with the monopolar scissors. The Cadiere grasper is used to place lateral traction on the peritoneum on the right side and the assistant grasps the peritoneum overlying the aorta, also placing lateral traction to the left side. The incision is extended along the right side of the aorta mobilizing the duodenum.

The ureter is identified by retroperitoneal dissection under the lateral peritoneal reflection between the right common and ovarian vessels. The right psoas muscle, genitofemoral nerve, ovarian vessels, and ureter are visualized. The assistant reflects the ureter laterally. The node dissection is performed by skeletonizing the nodal bundle over the inferior vena cava from the bifurcation of the common iliac vessels to just below the right renal vein. A wide field of dissection is essential for optimal exposure. Once the planes are created, the assistant may provide lateral ureteral retraction with the blunt grasper allowing the suction-irrigator to remain free to facilitate a dry operative field and to retract small bowel. The lymph node bundle is skeletonized from the right common iliac artery and aorta. Further dissection is performed just under the lymph node bundle and away from the inferior vena cava, creating small pedicles so that lymphatics or small venous perforators can be safely coagulated and sealed before the transection. The surgeon must be visually aware of the amount of tension that is placed on the lymph nodes. After the medial aspect of the

dissection is completed, the superior boundary of the bundle is coagulated and cut; the bundle is freed from its loose lateral attachments down to the inferior boundary. Once the en-bloc dissection is complete, the lymph nodes are placed in an Endo Catch Gold bag (Auto Suture Division, Tyco Healthcare, and Norwalk, CT) and removed.

For the left aortic lymphadenectomy, the peritoneal incision is extended over the left common iliac artery and above the inferior mesenteric artery (IMA). The ideal dissection plane is created by sharply opening the retroperitoneal areolar tissue close to the aorta and left common iliac artery in the direction of the psoas muscle. The bedside assistant places gentle counter tension on the aorta and the blunt grasper retracts the distal ureter and mesentery out of the field of dissection. Next, the bipolar grasper gently retracts the superior aspect of the peritoneal window created a few centimeters distal to the IMA insertion into the aorta. The lymph nodes on the left side lie lateral and often posterior to the great vessels and are first dissected away from the aorta, and pedicles are created and ligated close to the node bundle. Occasionally, the assistant is able to grasp the nodal bundle and provide counter tension during dissection. The lymph node bundle lateral to the aorta is removed en-bloc from just above the bifurcation of the common iliac vessels to the IMA. Dissection above this level may be performed at the discretion of the surgeon.

The pelvis is irrigated, and the abdomen/pelvis including all vascular pedicles are inspected. The midline port is closed at the fascial level with interrupted suture. Depending on surgeon preference, the 5- to 12-mm port is either left open or sutured with the Inlet Carter-Thomason CloseSure System (Ascent Healthcare Solutions, Phoenix, AZ).

4. Ovarian cancer

The studies for ovarian cancer staging in minimally invasive surgery are very limited. There is a paucity of data on the feasibility and safety of robotic surgery in patients with ovarian cancer. In a recent study by Magrina et al., a retrospective analysis case-control analysis of 25 patients who underwent robotic surgical treatment were compared to similar patients who underwent standard laparoscopy and laparotomy. The rate of intraoperative complications was similar for the 3 groups. Laparoscopy and robotics were preferable in patients with primary tumor excision (hysterectomy, adnexectomy, omentectomy, pelvic and para-aortic lymphadenectomy, appendectomy, and removal of metastatic peritoneal disease). However, with advanced ovarian cancer, laparotomy was the preferred method as robotic outcomes were not improved because operative times were 138 minutes longer, and length of stay were similar between the two groups. There was no difference in overall survival among the 3 groups. The median length of follow up was 2.2 years for the robotic group, 4.4 years for the laparoscopy group, and 2.9 years for the laparotomy group. Progression free survival was significantly higher for the robotic and laparoscopy group compared to laparotomy group. This difference in progression free survival was most likely due to selection bias as patients with more disseminated disease underwent laparotomy. Furthermore, the robotic and laparoscopy groups had an overall higher rate of neoadjuvant or intra-peritoneal chemotherapy as compared to the laparotomy group, which likely, further contributed to the improved progression free survival (Magrina et al., 2010). Although robotic assisted surgery in treatment and staging of ovarian cancer seems promising especially in early stage cancer, further long term outcome data are needed. At this time, we do not find robotic assisted surgery to be a safe and feasible option for surgical staging in advanced ovarian cancer.

5. Conclusion

Robotic surgery in gynecologic oncology provides the benefits of minimally invasive surgery (shorter hospital stay, decreased blood loss, faster recovery, and fewer postoperative complications with the added benefits of 7 degrees of motion, 3-dimensional views, tremor reduction, improved dexterity and decreased surgeon fatigue). The main drawbacks are the expense, absence of haptic feedback, and longer term outcome data are needed since it is a new technology.

 Robotic surgery in gynecologic oncology holds great promise. If long term and large population data show its efficacy and safety to be comparable or superior to conventional laparoscopy and laparotomy, then robotic surgery will play a pivotal role in gynecologic oncology surgery. Short term data and small case series, comparing robotic surgery with laparoscopy in cervical and endometrial cancer, show comparable or superior outcomes for robotic surgery. With regard to ovarian cancer, although the data is scant, robotic surgery may hold promise in surgical staging for treatment of ovarian cancer, especially in the early stages of ovarian cancer.

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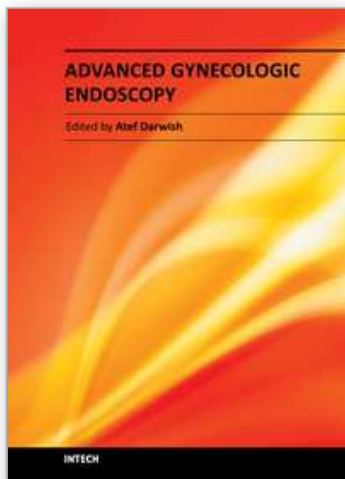
Advanced Gynecologic Endoscopy

Edited by Dr. Atef Darwish

The main purpose of this book is to address some important issues related to gynecologic laparoscopy. Since the early breakthroughs by its pioneers, laparoscopic gynecologic surgery has gained popularity due to developments in illumination and instrumentation that led to the emergence of laparoscopy in the late 1980's as a credible diagnostic as well as therapeutic intervention. This book is unique in that it will review common, useful information about certain laparoscopic procedures, including technique and instruments, and then discuss common difficulties faced during each operation. We also discuss the uncommon and occasionally even anecdotal cases and the safest ways to deal with them. We are honored to have had a group of world experts in laparoscopic gynecologic surgery valuably contribute to our book.

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