Robotic-Assisted Radical Hysterectomy

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Indications for Robotic Radical Hysterectomy

Piver, Rutledge and Smith originally described five types of hysterectomy for treatment of cervical cancer in 1974 [1]. A type I hysterectomy is an extrafascial or simple hysterectomy and is appropriate for the treatment of stage IA1 carcinoma of the cervix without lymph-vascular space invasion. In a type II hysterectomy, the uterine artery is ligated at its junction with the ureter and the para-cervical tissue medial to this is removed. This allows for preservation of the blood supply to the ureter and a decreased risk for ureteral vaginal fistula formation. A type II radical hysterectomy along with pelvic lymphadenectomy is appropriate treatment for IA2 carcinoma of the cervix, with or without lymph-vascular space invasion. A type III radical hysterectomy mandates removal of the parametria medial to the origin of the uterine artery as it branches off the internal iliac artery, removal of the uterosacral ligaments at their origin and an upper vaginectomy. A type III radical hysterectomy along with pelvic lymphadenectomy is the standard treatment for IB1 cervical cancer and may also be used for select IB2 as well as IIA lesions. Radical hysterectomy, either type II or type III can also be used to treat cases of uterine cancer with gross cervical involvement (Table 67.1).

Soon after the introduction of the robotic platform in 2005, Sert and Abeler published the first case report of robotic assisted type III radical hysterectomy [2]. The technique was later described in a series of 51 patients where robotic hysterectomy was found to decrease complications, specifically blood loss, and to shorten hospital stay when compared to open radical hysterectomy [3]. In addition, retrospective studies have shown that robotic assisted radical hysterectomy has equivalent survival to open radical hysterectomy [4–6]. The oncologic indications for robotic type III radical hysterectomy are the same as those for the open procedure. Laparoscopy and the robotic platform also require appropriate patient selection. Insufflation and steep Trendelenberg positioning promote physiologic cardiopulmonary changes that can result in increased hypercarbia, decreased cardiac output, and decreased pulmonary compliance. Thus, patients with significant pulmonary or cardiac conditions may not be able to tolerate the required positioning for the duration of the operation. This patient positioning also increases both the intraocular pressure and intracranial pressure. Thus, any intracranial pathology associated with intracranial hypertension or disruption of the blood-brain barrier are contraindications (Table 67.2). Additionally, among patients with glaucoma, preoperative tonometry should ensure that intraocular pressure is not increased, as robotic surgery in addition to an already elevated intraocular pressure can result in permanent ocular damage (Fig. 67.1).

Uterine size is another contraindication to a minimally invasive approach. A large bulky uterus can limit visualization and given that morcellation should be avoided in the case of cervical carcinoma, the uterine specimen must be able to be delivered through the vagina at the conclusion of the surgery. Previously described contraindications include increased patient BMI and extensive prior surgical history. While it is true that patients with a high BMI can provide a challenge in terms of increased weight on the diaphragm and the resulting decreased pulmonary compliance, we have found that many morbidly obese patients without significant cardiopulmonary co-morbidities are able to tolerate required positioning and do not experience an increased risk of perioperative pulmonary complications based on the degree of obesity [7]. Additionally, the surgical benefits of wristed instruments within the abdomen and pelvis as well as a camera that is able to descend into the pelvis actually offers increased visualization and dexterity in the obese patient over open surgery. Extensive prior surgical history has also been noted as a contraindication to minimally invasive surgery, however, we do not consider this a contraindication.

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Table 67.1 Types of radical hysterectomy

	Indications	Location of uterine artery ligation	Uterosacral ligaments	Vaginal margin
Type I (extrafascial)	IA1 cervical carcinoma without LVSI	Insertion into the cervix	Insertion into cervix	At cervico-vaginal junction
Type II (modified radical)	IA2 cervical carcinoma, uterine cancer with cervical involvement	Junction with the ureter	Midpoint between cervix and sacral attachments	1–2 cm of vaginal margin
Type III (radical)	IB1 cervical carcinoma and select IB2 and IIA lesions, uterine cancer with cervical involvement	Origin at the internal iliac artery	At sacral attachment	2–3 cm of vaginal margin

Table 67.2 Contraindications to a robotic approach

	Degree of contraindication	Rationale
Uterine size	Absolute	Morcellation should not be performed. Therefore, the specimen must be able to be delivered vaginally at the conclusion of the procedure
Conditions with increased ICP	Absolute	Required positioning will exacerbate intracranial hypertension ad can result in disruption of blood-brain barrier
Glaucoma with increased IOP	Absolute	Required positioning increases the intraocular pressure and can result in permanent vision loss and even blindness
Morbid obesity without cardiopulmonary compromise	None	These patients are generally able to be ventilated and the benefits of minimally invasive surgery and the wristed instruments of the robotic platform are even more pronounced in the morbidly obese
Cardiopulmonary compromise	Relative	Depending on the degree of compromise, patients may not be able to tolerate the required positioning, however, this is difficult to predict preoperatively and thus patients should have a trial of positioning before deeming this a contraindication
Extensive surgical history	None	Robotic platform allows for increased dexterity and visualization allowing the surgeon to perform lysis of adhesions

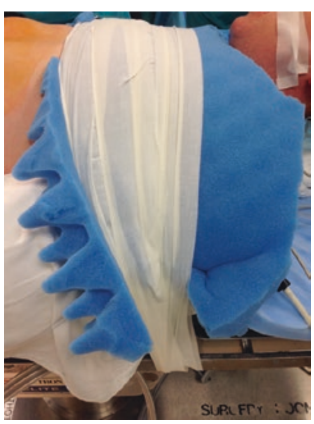

Fig. 67.1 Securing patient for steep Trendelenberg positioning. The patient's chest is padded and she is secured to the bed using thick cloth tape. The tape is passed around the patient and the bed 3–5 times depending on the patient's weight

Robotic Versus Laparoscopic Versus Abdominal Radical Hysterectomy

Minimally invasive radical hysterectomy, including both robotic and laparoscopic radical hysterectomy, offers advantages over abdominal radical hysterectomy. Minimally invasive radical hysterectomy has been associated with decreased blood loss, lower rates of transfusion, decreased length of hospital stay, equal or lower rates of postoperative complication, and an equal or increased number of lymph nodes sampled when compared with an open procedure [8–11].

Studies examining robotics versus traditional laparoscopy have found that traditional laparoscopy is associated with similar postoperative outcomes, but longer operative times. In addition, most laparoscopic radical hysterectomy series are limited to patients with a BMI under 30 whereas robotic papers include obese and morbid obese patients in their cohorts. Traditional laparoscopy is also associated with a longer learning curve and does not offer the same ergonomic benefits as robotic surgery. In contrast with other surgical procedures such as benign hysterectomy, robotic radical hysterectomy is not associated with increased cost compared with traditional laparoscopy [11]. In the only study to examine the cost of robotic, abdominal and laparoscopic radical hysterectomy for the treatment of cervical cancer using a large national database, the authors found that laparoscopic radical hysterectomy was associated with median costs of $11,774 whereas robotic radical hysterectomy actually had a statistically significant lower median cost of $10,176 [11].

Data on oncologic outcomes are similarly reassuring. One study showed no difference in 3-year overall and recurrence free survival for patients undergoing robotic versus abdominal radical hysterectomy [4]. A multicenter retrospective study examined 517 patients and demonstrated no difference in recurrence or survival between patients undergoing open or robotic radical hysterectomy with a median follow up of 34 months [12]. The same is true for laparoscopic versus open radical hysterectomy with both having similar risk of recurrence and mortality [6].

Surgical Procedure

Clinic Evaluation and Patient Counseling

History and physical examination are essential to identify patients who are good candidates for robotic radical hysterectomy. Evidence of parametrial spread on examination or imaging that reveals metastatic disease necessitates primary treatment with pelvic chemoradiation or systemic chemotherapy. Preoperative assessment should also screen for the previously mentioned contraindications to robotic surgery. Standard preoperative assessment with indicated laboratory work including a type and screen should be performed. Bowel preparation is not necessary.

As with any surgical procedure, patients should have an informed consent discussion regarding the risks and benefits of robotic radical hysterectomy. Standard risks such as bleeding, infection and injury to blood vessels, nerves, bladder, ureter, and bowels should be discussed. Additionally, for robotic radical hysterectomy, the risk of conversion to a laparotomy, risk of fistula formation and risk of both short-term and long-term bladder dysfunction should all be discussed. Patients should also be informed of the possibility of postoperative radiation depending on the final surgical pathology.

Preoperative Positioning

The patient is brought to the operating room and placed under general anesthesia. Prior to induction, sequential compression devices are placed on the lower extremities. She is then positioned in the low dorsolithotomy position using Allen stirrups to allow for adequate space to bring the robot to the bedside. Examination under anesthesia is performed prior to beginning the surgery to reorient the surgeon to the patient's anatomy and to confirm the absence of parametrial or pelvic sidewall disease, which would preclude a surgical approach. After the patient is positioned in the dorsolithotomy position, she is secured to the table to allow for steep Trendelenberg positioning. This can be done using shoulder blocks, chest padding with taping or a beanbag device which molds to the patient. Given the risk of brachial plexus injuries relying only on shoulder blocks and the cost of bean bag devices, we prefer to use chest padding and taping to secure the patient to the bed. Although uterine manipulation is standard in robotic hysterectomy, for a robotic radical hysterectomy, we prefer to avoid disruption of the tumor and instead place a large rectal dilator (EEA sizer) in the vagina prior to draping for use at the time of colpotomy. A pneumo-occluder balloon is also placed in the vagina to prevent loss of pneumoperitoneum during the colopotomy. A foley catheter is also placed to decompress with bladder and decrease the risk of bladder injury. Prophylactic antibiotics are administered prior to skin incision (Fig. 67.2).

Abdominal Entry

We routinely enter the abdomen in the left upper quadrant at Palmer's point (left upper quadrant 2 cm below the costal margin in the mid-clavicular line) after an orogastric tube has been placed to suction. This allows us to avoid adhesions from prior surgery and will be the site for our assistant port [13]. We inject the skin with local anesthetic prior to incision and enter the abdomen with a 2 mm miniport. Once the abdomen is insufflated, a 2 mm camera is inserted into the abdomen and an abdominal survey is performed focusing on the anterior abdominal wall and presence of any adhesive disease. An alternative technique is to insufflate at this site with a veress needle and place a 5 mm visiport under direct visualization.

Port Placement

Five total trocars are used. Two traditional laparoscopic trocars are used for the camera and assistant port and three robotic trocars are used for the robotic arms. A 12 mm trocar is placed in the umbilicus and functions as the camera port. The robotic camera is introduced through this port and a complete abdominopelvic survey is completed to identify any evidence of metastatic disease or adhesive disease that

Fig. 67.2 EEA sizer and vaginal balloon. A rectal end-to-end anastomosis (EEA) sizer is placed into the vagina to allow for uterine manipulation and to assist in identification of the cervico-vaginal junction. A pneumo-occluder balloon is placed around the handle and inflated to prevent the loss of pneumoperitoneum during colpotomy

will prevent port placement. Any abnormalities encountered in the abdomen or pelvis that are suspicious for metastatic disease should be biopsied and sent for frozen section. Confirmation of metastatic disease should prompt the surgeon to consider aborting the surgery in favor of radiation therapy depending on the clinical scenario. Any encountered adhesive disease, which prevents port placement or will not be accessible with the robot is taken down laparoscopically. Additional robotic trocars are placed as follows: arm 1 is placed 8–10 cm lateral to the camera port in the right upper abdomen, arm 2 is placed in the left upper abdomen again, 8-10 cm lateral to the camera port, mirroring arm 1, and arm 3 is placed in the left lower quadrant just superior to the anterior iliac spine and at least 8 cm in distance from arm 2. A 10/12 mm assistant port is placed in the left upper quadrant at the site of laparoscopic entry. All trocars are placed under direct visualization and all ports are advanced to the thick black line on the trocar cannula to allow for optimal range of motion for the robotic arms. The patient is then placed in steep Trendelenberg. If tolerated, we use 30 ° of Trendelenberg. The robot is moved into position either between the patient's legs or over the left leg in a side docking position. The camera arm is docked first. The robotic arm clutch button is pressed and the angle of the camera arm is aligned with the angle of the trocar. The trocar is stabilized with one hand and the other hand is used to press the robotic arm clutch button and deliver the arm to the trocar, clipping both wings to secure the robotic arm to the trocar. The remaining three robot arms are docked to their respective trocars in the same fashion (Fig. 67.3).

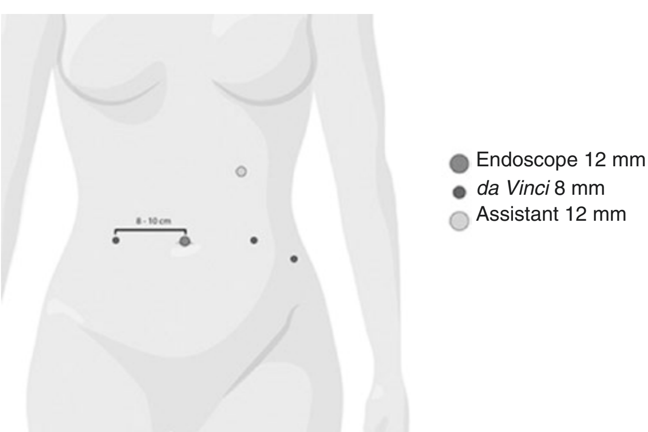

Fig. 67.3 Port placement. A 12 mm trocar is placed in the umbilicus and functions as the camera port. Arm 1 is placed 8–10 cm lateral to the camera port in the right upper abdomen and arm 2 is placed in the left upper abdomen mirroring arm 1. Arm 3 is placed in the left lower quadrant just superior to the anterior iliac spine and at least 8 cm in distance from arm 2. A 10/12 mm assistant port is placed in the left upper quadrant at the site of laparoscopic entry (With kind permission from John F. Boggess, MD 2007)

Robotic Instruments

Once the robot arms have been docked, the robotic camera is introduced through the camera port. We use a 0-degree camera throughout the surgery. The robotic instruments are then introduced. The monopolar scissors are used in the right hand and the fenestrated bipolar in the left hand. A blunt grasper, such as a prograsp or a cadiere, is used in arm 3. All instruments are introduced into the abdomen under direct visualization.

Opening the Retroperitoneum and Avascular Spaces of the Pelvis

The uterus is manipulated with the fourth robotic arm. The right uterine cornua is grasped and moved to the patient's left. The right round ligament is transected using monopolar cautery as far laterally as possible and this peritoneal incision is extended cephalad parallel to the infundibulopelvic ligament. The medial umbilical ligament is placed on tension medially and caudad to allow for identification of the superior vesical artery. The peritoneum just lateral to the artery is incised cephalad to its origin. The monopolar scissors and fenestrated bipolar graspers are then used to spread perpendicular to the pelvic sidewall to bluntly open the paravesicle space down to the level of the levator muscles. The pararectal space is opened in a similar fashion by spreading in a perpendicular manner in between the ureter and internal iliac artery and vein. After the paravesical and pararectal spaces have been opened, the parametria to be resected can be easily identified as the remaining tissue between the two spaces. At this time, any extension of tumor into the parametrial tissues is evaluated and as evidence of extension indicates the need for postoperative radiation and the surgeon evaluates whether or not to proceed depending on the clinical scenario (Fig. 67.4).

Pelvic Lymphadenectomy

A bilateral pelvic lymphadenectomy is then performed. The fourth robotic arm is used to reflect the superior vesical artery medially and open the paravesical space. The operative assistant using a laparoscopic grasper retracts the proximal peritoneum at the pelvic brim to expose the entire area of nodal dissection. The nodal tissue just inferior to the bifurcation of the common iliac artery is grasped and elevated with the fenestrated bipolar forceps. The monopolar scissors are used to make an incision overlying the psoas muscle just lateral to the artery and the genitofemoral nerve is mobilized laterally. Once the sur-

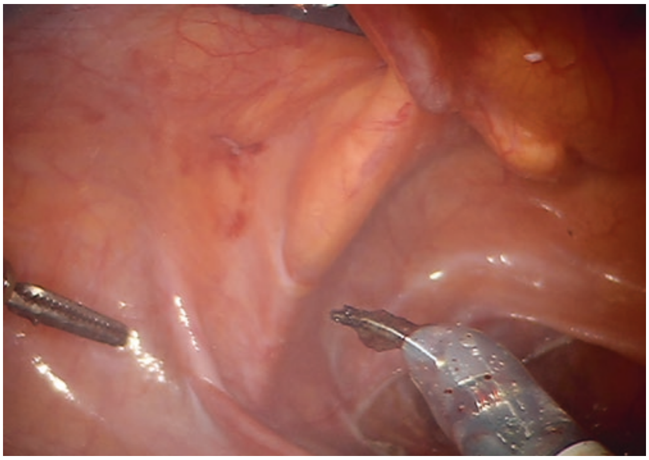

Fig. 67.4 Identification of the superior vesical artery. The median umbilical ligament is identified on the anterior abdominal wall. It is placed on tension medially and caudad which in turn pulls the superior vesical artery medially and away from the pelvic sidewall to allow for easy identification

face of the external iliac artery is identified, the nodal tissue is dissected free from the artery caudally using a combination of blunt dissection and cautery, as appropriate, until the deep circumflex iliac vein is encountered. The nodal bundle is reflected medially and gentle dissection is used to identify the surface of the external iliac vein and the nodal tissue is freed from its attachments to the vein cephalad to the bifurcation. The nodal bundle is grasped at the midpoint between the bifurcation of the common iliac artery and the crossing of the deep circumflex iliac vein. The vein is pushed laterally in order to enter the space between the nodal bundle and the pelvic sidewall. The obturator nerve is identified and the caudad portion of the nodal bundle in the obturator space is grasped with the fenestrated bipolar forceps and reflected medially and cephalad. The surface of the vein is pushed laterally and the obturator nerve is pushed inferiorly to free the nodal bundle from the obturator space. This process is continued cephalad until the bifurcation is reached and the specimen is freed. It is placed in a specimen bag in the upper abdomen for subsequent removal. The same is done on the left side (Figs. 67.5 and 67.6).

Ureteral Dissection

The ureter is identified along the medial leaf of the broad ligament. It is dissected free from its medial attachments and mobilized laterally to the level of the uterine artery and cardinal ligament in order to allow adequate visualization for the origin of the uterine artery. Care is taken to preserve the blood supply, adventitia and muscularis of the ureter to decrease the risk of fistula (Fig. 67.7).

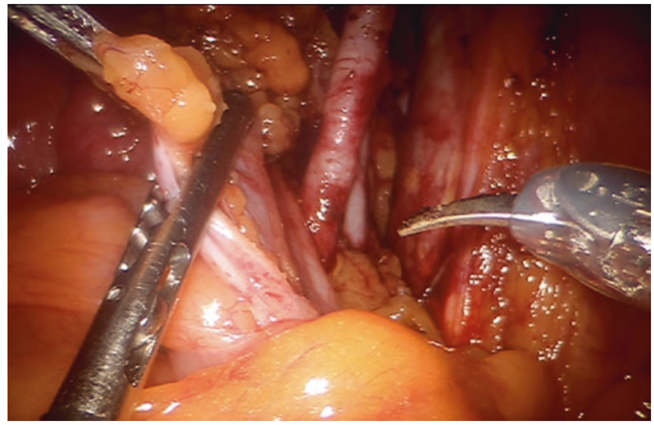

Fig. 67.5 Peritoneal retraction. The assistant retracts the peritoneum at the pelvic brim medially to allow for exposure to perform the nodal dissection

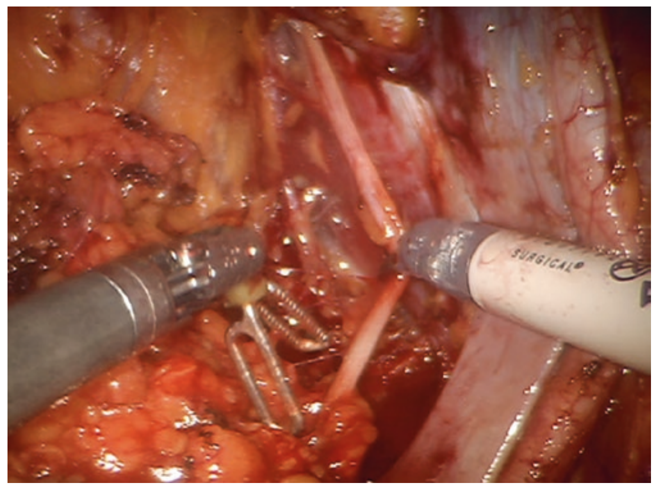

Fig. 67.6 Obturator nerve. The obturator nerve is identified and the nodal bundle is dissected free by grasping the nodal bundle, moving it cephalad and medially, and pushing the nerve laterally and inferiorly

Bladder Flap, Uterine Artery Transection and Parametrial Dissection

The vesico-uterine fold is incised with monopolar cautery and extended laterally to create the bladder flap. The vesico-uterine peritoneum is elevated and the vesico-uterine space is entered using a combination of blunt and sharp dissection with use of cautery as appropriate. This space is further dissected caudally until the bladder has been taken down sufficiently off the anterior vaginal wall to achieve an adequate margin. The uterine artery is identified at its origin from the internal iliac artery. The origin is isolated by dissecting away the surrounding tissue with blunt dissection with the fenestrated bipolar forceps. The artery and vein are then cauterized with bipolar cautery and transected. The artery is then freed from its attachments to the ureter and the ureter is

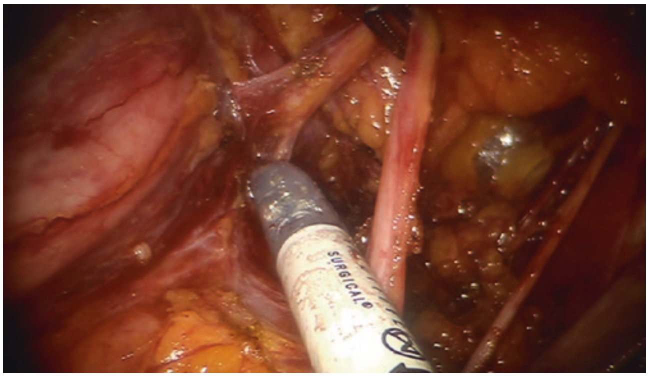

Fig. 67.7 Ureteral dissection. The ureter is reflected laterally and dissected free from its medial attachments

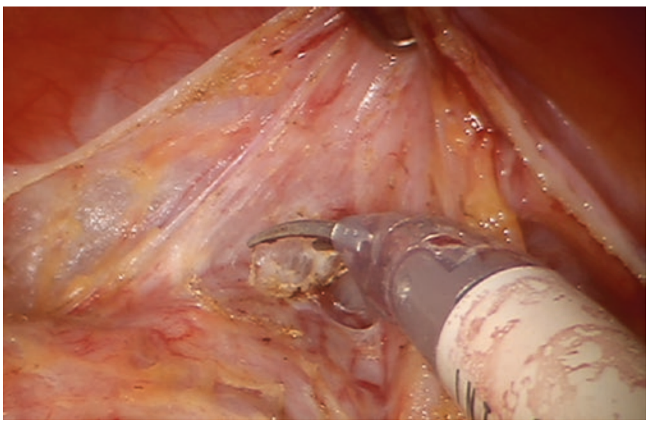

Fig. 67.8 Bladder flap. The vesico-uterine peritoneum is elevated and the bladder is dissected off the cervix and vagina

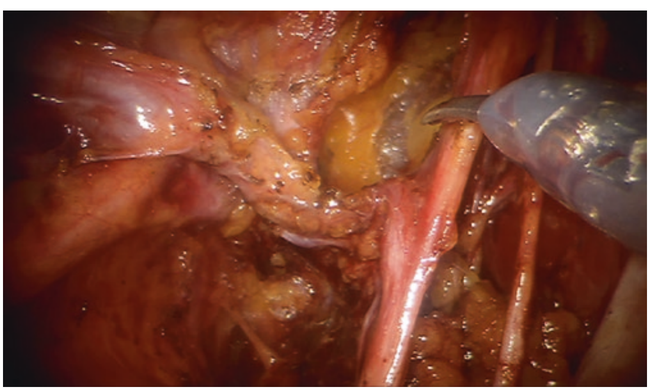

Fig. 67.9 Uterine artery isolation. The uterine artery is isolated at its origin

further mobilized laterally. The parametrial tissue is dissected off the ureter and mobilized medially. This allows for exposure of the ureteral tunnel of Wertheim and the ureter is unroofed to its insertion into the bladder by bipolar coagulating the anterior vesico-uterine ligament (Figs. 67.8, 67.9 and 67.10).

Transect the Utero-Ovarian Ligament or Infundibulopelvic Ligament

At this time, either the infudibulopelvic ligament or the utero-ovarian ligament is transected depending on the patient's age and the clinical circumstance. If the ovary is preserved, salpingectomy should be considered in order to reduce the future risk of ovarian cancer [14]. The paravesical space has been previously opened and the ureter is again identified. A window is made in the broad ligament below the infundibulopelvic ligament and above the ureter using the monopolar scissors. Blunt traction is used to extend this incision along the length of the infundibulopelvic ligament. Bipolar cautery followed by transection with the monopolar scissors is used to transect either the infundibulopelvic ligament at its origin or the utero-ovarian ligament (Fig. 67.11).

Transect Uterosacral Ligaments While Preserving the Sacral Nerve Plexus

The uterus is retracted anteriorly using the third robotic arm. The incision along the posterior broad ligament is continued medially towards the uterosacral ligament. As this is performed, the endopelvic fascia containing the hypogastric nerve plexus is dissected laterally. The peritoneum overlying the rectovaginal space between the two uterosacral ligaments is incised and the rectovaginal space is developed with blunt dissection. The uterosacral ligaments are cauterized with bipolar cautery at their insertion into the posterior vaginal wall and the remainder of the cardinal ligament is resected to the pelvic sidewall (Figs. 67.12, 67.13 and 67.14).

Colpotomy with Upper Vaginectomy

The EEA sizer which was previously placed in the vagina is advanced to identify the cervicovaginal margin. An incision is made along the anterior vaginal wall 2–3 cm inferior to the cervicovaginal junction to allow for an adequate margin. This incision is made with the monopolar cautery and continued around circumferentially, freeing the specimen. The specimen is removed through the vagina as are the specimen bags with the previously dissected pelvic lymph node specimens (Fig. 67.15).

Vaginal Cuff Closure

A mega suture cut needle driver is introduced into the right hand and a 0-vicryl suture on a CT-1 needle cut to 25 cm is passed through the assistant port. The vaginal cuff is closed in a running unlocked fashion from right to left. It is important

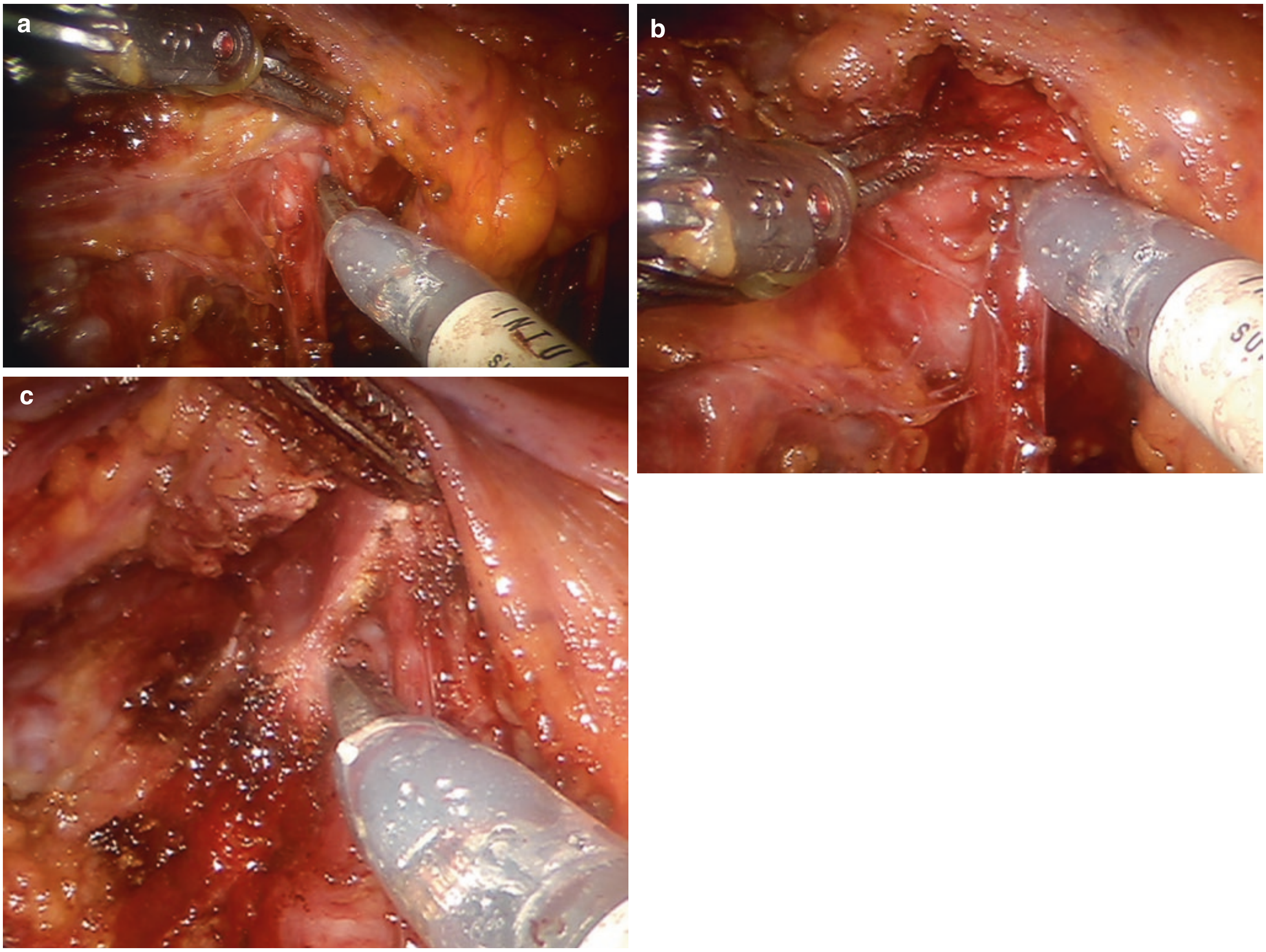

Fig. 67.10 Anterior vesicouterine ligament and tunnel of Wertheim. The ureter is unroofed through the tunnel of Wertheim (**a**). The anterior vesicouterine ligament is coagulated (**b**) and transected (**c**) exposing the insertion of the ureter into the bladder

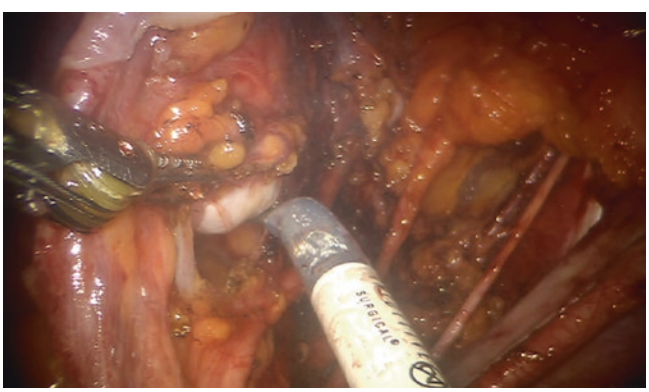

Fig. 67.11 Infundibulopelvic ligament. A window is made in the broad ligament and the infundibulopelvic ligament is cauterized and transected

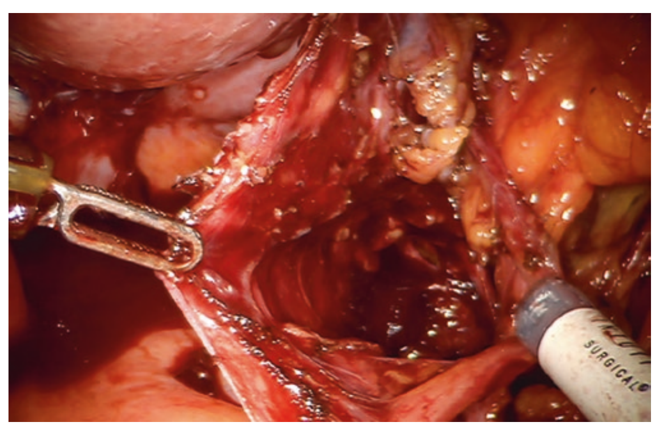

Fig. 67.12 Preserve the hypogastric plexus. The peritoneum is grasped and the endopelvic fascia containing the hypogastric nerve plexus is dissected off the peritoneum by sweeping laterally

to incorporate approximately 1 cm of vagina in each suture bite, to include the fascia and to keep the running closure on tension throughout by having the surgical assist “follow” with a laparoscopic needle driver holding the suture. The suture cut needle driver is used to cut the suture and the needle is

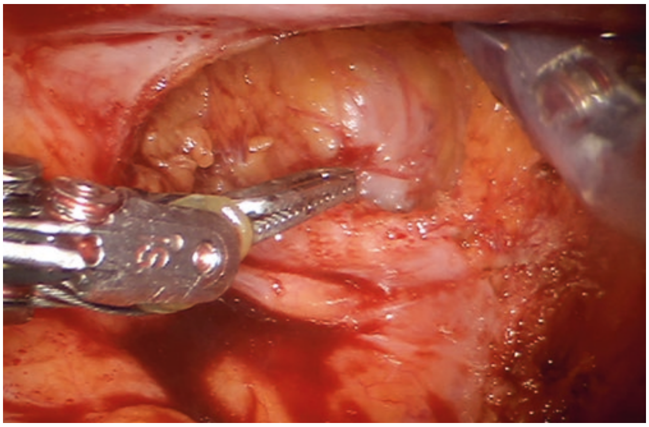

Fig. 67.13 Open rectovaginal space. The rectovaginal space is developed using blunt dissection

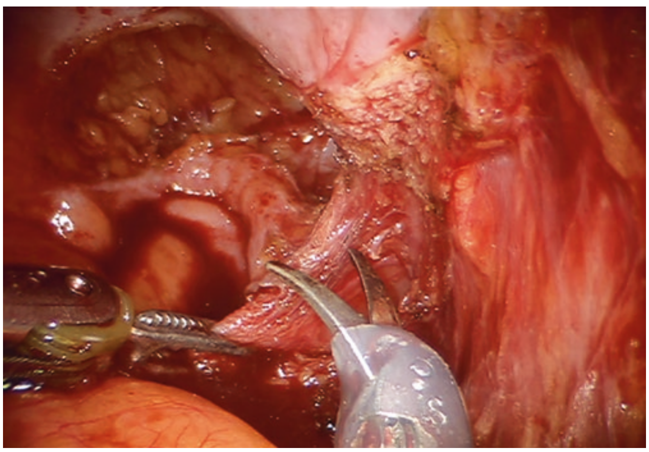

Fig. 67.14 Uterosacral transection. The uterosacral ligaments are transected at their sacral insertion after the hypogastric nerve plexus has been dissected laterally

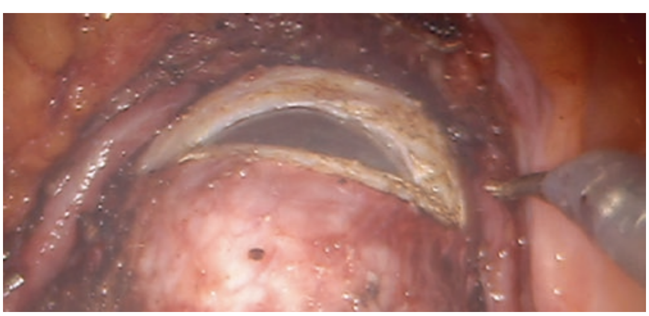

Fig. 67.15 Colpotomy. An incision is made along the vaginal wall 2-3 cm inferior to the cervico-vaginal junction. The EEA sizer is used to provide anatomic orientation

passed out of the assistant port. The abdomen and pelvis are irrigated and all operative sites are assessed for hemostasis (Fig. 67.16).

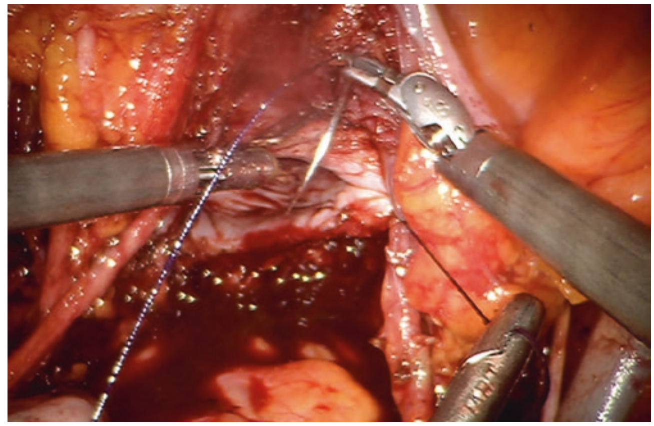

Fig. 67.16 Vaginal cuff closure. The assistant follows the surgeon using a laparoscopic needle driver to ensure continuous tension is maintained

Oophoropexy

If the ovaries are left in situ, oophoropexy may be performed to protect ovarian function in the event that adjuvant radiation is required. The peritoneum surrounding the infundibulopelvic ligament is further skeletonized using the monopolar scissors to allow increased mobility. The adnexa is mobilized above the pelvic brim. A 0-vicryl suture is passed through the assistant port and the ovary is sutured and tied to the pelvic peritoneum above the pelvic brim using a figure of eight stich. If desired, the ovaries can be marked with surgical clips for identification in radiation planning. The needle is removed via the assistant port.

Closing

After the abdomen and pelvis are irrigated and hemostasis is achieved, all robotic instruments are removed from the patient's abdomen. The robotic arms are undocked from the trocars and the robot is moved from the bedside. The abdomen is desufflated and manual breaths are given by the anesthesiologist to decrease residual intra-abdominal gas. The fascia at the 12 mm ports is closed with 0-vicryl to prevent hernia formation. The skin is closed in a subcuticular fashion with 4–0 vicryl or using dermabond (Fig. 67.17).

Postoperative Care

The postoperative management and recovery after a robotic radical hysterectomy mirrors that of other minimally invasive surgery. Patients are given a general diet on postoperative day zero and in our experience, all patients are able to tolerate oral pain medications and do not require any intravenous narcotics.

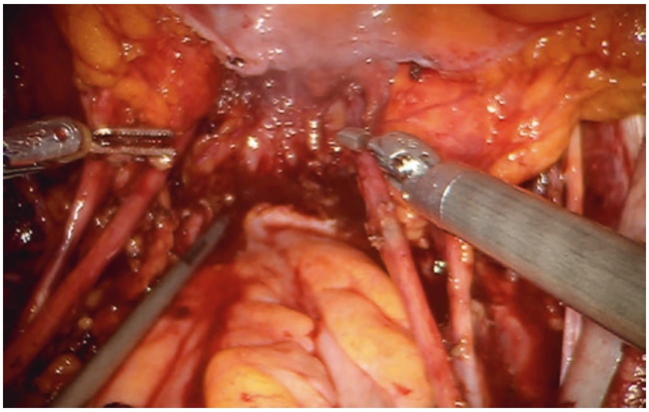

Fig. 67.17 Irrigation and hemostasis. At the conclusion of the procedure, irrigation is performed and hemostasis is assured

Patients do not require intravenous fluids by early postoperative day one. The vast majority of patients are able to go home on postoperative day one. Given the extensive bladder dissection and resulting parasympathetic and sympathetic denervation required for type III radical hysterectomy, all patients are sent home with a foley catheter and present to clinic four to seven days postoperatively for a voiding trial to ensure adequate bladder function prior to catheter removal.

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