Robotic Radical Hysterectomy: Surgical Technique

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Introduction

Radical hysterectomy remains the preferred method of treatment for patients with early cervical cancer (FIGO stages IA2-IB1-IIA1). The incorporation of robotic technology in the USA and other countries changed the avenue from laparotomy to a minimally invasive approach, something that laparoscopic technology did not fully do. Some of the major advantages of robot-assisted over conventional laparoscopy are its superior visualization (3D versus 2D) imaging of the operative field, its mechanical improvements such as its seven degrees of freedom (similar to the human arm and hand, while rigid conventional instruments have four degrees of freedom), the stabilization of instruments within the surgical field (in conventional laparoscopy, small movements by the surgeon are amplified including hand tremor), and its improved ergonomics for the operating surgeon. The technique of robotic radical hysterectomy or robotic-assisted radical hysterectomy will be described in this chapter. The reader must be knowledgeable of the indications, limitations, and location of metastatic nodes to indicate or not a robotic approach and to determine whether preoperative chemoradiotherapy is needed. Whenever chemoirradiation is contemplated, the radical hysterectomy should be avoided due to the increased morbidity of using both treatment modalities. In these cases systematic pelvic and aortic lymphadenectomy is done to limit the irradiation field.

A nerve-sparing approach, something which is not the scope of this chapter, is always preferable. Our results of robotic radical hysterectomy have been published elsewhere [1, 2] and compared with a laparoscopic and laparotomy approach [1] . In our hands, robotic radical hysterectomy has a shorter operating time than with laparoscopy and is therefore our preferred minimally invasive approach. The surgical steps and technique of the robotic radical hysterectomy described here follow those originally reported by Okabayashi in 1921 [3], which was designed to minimize the transection of the pelvic autonomic nerves and sympathetic and parasympathetic nerves. The Mayo classification of radical hysterectomy was previously reported by Symmonds in 1976 [4] and included simple, wide, modified radical, radical, and extended radical types. The extent of paracervical resection described with the robotic technique here is designated as radical hysterectomy types B1–C1 of the newly revised classification of radical hysterectomy [5]. Nerve-sparing technique was first

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G. G. Gomes-da-Silveira et al. (eds.), *Minimally Invasive Gynecology*,
https://doi.org/10.1007/978-3-319-72592-5_24

introduced in this standard classification. The nerve-sparing radical hysterectomy type C1 has been shown to decrease bladder and rectal dysfunction [6, 7] without compromising recurrence or survival rates [6, 8].

Indications

The B1 technique is indicated for patients with cervical cancer ≤2 cm, and the type C1 is indicated for cases >2 cm diameter, up to 4 cm. The extent of vaginal resection is dependent on the location of the tumor margins. The location of the ectocervical margin of the tumor will dictate whether a small or a longer segment of vaginal cuff is needed for adequate margins. In patients with a margin near or involving the vaginal fornix, a longer segment of vagina will be necessary. This technique is also applicable to patients with endometrial cancer with cervical stromal invasion.

Patient Set-Up

Patients are placed in the semi-**lithotomy** position using the Allen stirrups (Allen Medical, Acton MA) with the arms loosely tucked to each side. Foam padding is used to protect both arms and legs. Patients are placed with a naked back directly on an anti-skid foam material (Tyco/Kendall Prod #3-472, Mansfield, MA), which we evaluated and found to be satisfactory [9]. The operating table is placed in Trendelenburg position and observed if the patient descends or not. Patient is then returned to the supine position and then prepped and draped.

Technique Entry

A transumbilical open technique with a 12 mm trocar (8 mm with the da Vinci Xi) is used for all patients. The upper abdomen is explored in the supine position. Patient is then placed in the Trendelenburg position to a degree enough to displace the sigmoid and small bowel out of the pelvis and allow a safe pelvic operation.

Robotic Column Placement

The standard da Vinci, da Vinci Si, or da Vinci Xi robotic systems (Intuitive Surgical, Sunnyvale, CA) are adequate for the operation. The robotic column is side docked lateral to the patient's right knee. The robotic arms are fastened to the robotic trocars once these are inserted (see below).

Trocar Placement and Instrumentation

Two robotic trocars (8 mm each) are introduced 8 cm to the right and left of the umbilical optical trocar and in a position somewhat below the umbilicus. An assistant trocar (10 mm) is placed midway between the umbilical and left trocar and 2 cm cranial to the umbilicus in all patients. Another robotic trocar (8 mm), designated as fourth robotic arm, is introduced 7–8 cm lateral and 3 cm caudal to the right trocar (right lateral robotic arm). The configuration of the trocars is like a crescent with upper convexity (Fig. 24.1).

Instrumentation

An EndoWrist PK grasper (Intuitive Inc., Sunnyvale, CA) is used on the left robotic arm, and an EndoWrist monopolar scissors or spatula (Intuitive Inc., Sunnyvale, CA) is used in the

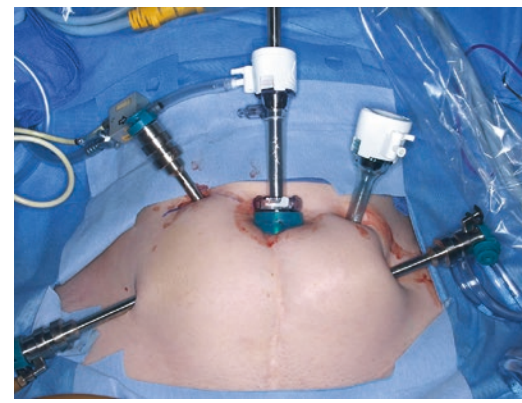

Fig. 24.1 Trocar position for robotic radical hysterectomy with the da Vinci S or Si system

right robotic arm. The EndoWrist Prograsper (Intuitive Inc., Sunnyvale, CA) is used in right lateral robotic arm to assist with retraction. An EndoWrist needle holder (Intuitive Inc., Sunnyvale, CA) is used to replace the monopolar scissors/spatula to suture the vaginal cuff.

The assistant sits to the left of the patient and performs the functions of sealing and division of vascular pedicles with a vessel sealer device, suction and irrigation, peritoneal cytology, sentinel node determination with polar probe, removal of small specimens (e.g., sentinel nodes), tissue retraction, and insertion and removal of sutures for closure of the vaginal cuff. A second assistant, sitting between the legs of the patient, manipulates a vaginal probe (Apple Medical, Marlborough, MA) for bladder dissection and during colpotomy and removes the uterus and lymph nodes vaginally (with endobags). The nurse, sitting to the right of the patient, cleans the lens of the laparoscope, switches the monopolar spatula for a needle holder, and maintains pneumoperitoneum during vaginal transection. A colpo-occluder balloon (Rumi Colpo-occluder, Cooper Medical, Trumbull, CT) is placed in the vagina to maintain pneumoperitoneum after removal of the specimen. No uterine manipulator is used.

Development of Lateral Retroperitoneal Spaces

The abdominal cavity was inspected and the retroperitoneal spaces were opened. A lateral peritoneal incision is made transecting the round ligament and anterior broad ligament peritoneum to above the pelvic brim. The paravesical and pararectal spaces are developed at start to identify the paracervix (also known parametria or lateral parametrium). The ureters are identified on the pelvic peritoneum and traced to the crossing with the uterine arteries.

Management of the Adnexa

In case of adnexal removal, a peritoneal window is made between the ureter and the infundibulopelvic ligament, which is then divided with a vessel sealer at the level of the pelvic brim. This window prevents ureteral injury at this level. If the adnexa are preserved, the tubo-ovarian pedicles are divided, as well as their peritoneal attachments, and placed above the pelvic brim. If there are other risk factors, an ovariopexy was carried out in order to remove the ovary of a possible field of pelvic radiation.

Pelvic and Aortic Lymphadenectomy

A systematic bilateral pelvic lymphadenectomy from the common iliac artery to the inferior boundary of the circumflex iliac vein was performed after the sentinel node procedure. The external iliac nodes, from the bifurcation of the common iliac vessels to the inguinal ligament, the obturator nodes above and below the obturator nerve, the ventral and lateral nodes of the hypogastric artery, and the ventral and lateral common iliac nodes from the middle of the common iliac vessels, are removed bilaterally using the PK grasper and monopolar scissors/spatula. We have the availability of obtaining frozen section of the removed nodes, which facilitates whether additional pelvic nodes and the aortic nodes need removal.

In the presence of positive sentinel node or positive pelvic nodes, a bilateral aortic lymphadenectomy is carried out to the renal vessels. Using the same trocar placement and instruments, the inframesenteric nodes can be safely removed. For the infrarenal nodes, the robotic system arms are undocked and the operating table rotated 180 degrees, resulting in the robotic column being now located at the patient's head or lateral to the right shoulder. You can also change the location of the robot (lateral to the right shoulder) without having to rotate the operating table. Two to three trocars are placed suprapubically, one to two for the assistant and one for the endoscopic camera (12 mm but 8 mm with da Vinci Xi). The robotic arms redocked, and using the same robotic instruments, the aortic lymphadenectomy is extended to the infrarenal group of nodes, up to the level of the renal vessels. The benefit of removing positive aortic nodes has

been addressed in the recent literature [10–12]. Our technique and experience with infrarenal aortic lymphadenectomy and rotation of the operating table has been described [13, 14]. The new da Vinci Xi system allows rotation of the robotic arms after undocking them from the pelvic position without the need to rotate the operating table or modify the location of the robot column. Once the arms are rotated 180 degrees, they are docked again. However, it still requires the placement of additional trocars suprapubically for the optical trocar and assistant.

Parametrial Division

With the paravesical and pararectal spaces dissected, the vascular portion of the paracervix or lateral parametrium is transected at the origin of its vessels from the internal iliac artery and vein with successive applications of a vessel sealer and continuing dorsally to the level of the deep uterine vein (Fig. 24.2). This level of transection separates the ligamentous portion from the neural portion of the lateral parametrium and serves to preserve the dorsal neural portion which contains the parasympathetic pelvic splanchnic nerves arising from the S2, S3, and S4 ventral root.

Uterosacral Ligament Division

The ureters are first separated from their pelvic peritoneal attachments, from the pelvic brim to the uterine arteries. The peritoneum of the cul-de-sac is divided horizontally with the monopolar scissors or spatula and to the level of the ureters laterally. The rectovaginal space is developed caudally to the upper vaginal half (Fig. 24.3). With the rectovaginal space developed and the ureters freed from their peritoneal attachments, the uterosacral ligaments are identified and transected with a vessel sealer at the level of the anterior rectal wall. The transection is directed toward the upper posterior vaginal third (and not to the sacrum) in order to preserve the caudal portion of the sympathetic nerves (lower hypogastric nerves), which are a continuation of the superior hypogastric plexus (the sympathetic fibers come from T11 to L2). They can be isolated and preserved on the lateral aspect of the uterosacral ligaments. For nerve-sparing technique it is important to identify and preserve the parasympathetic splanchnic nerves and sympathetic lower hypogastric nerves, who will join the inferior hypogastric plexus below the deep uterine vein, which emerge autonomic nerve fibers directly into the bladder. This technique decreases long-term associated morbidity such as bladder dysfunction, sexual dysfunction, and colorectal motility disorders.

In conclusion, laparoscopic robotic-assisted radical hysterectomy with nerve-sparing technique is an attractive surgical approach for early invasive cervical cancer. Robotic technology allows a stereoscopic visualization of blood vessels and autonomic nerve supplies (sympathetic and parasympathetic branches) to the bladder and rectum making nerve sparing a safe and feasible procedure.

Fig. 24.2 Division of the lateral parametrial vessels from the internal iliac artery and vein to the deep uterine vein

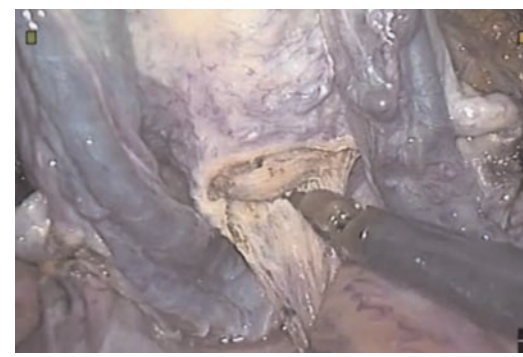

Fig. 24.3 Dissection of the rectovaginal space to the upper vaginal half

Bladder and Ureteral Dissection

The cervicovaginal peritoneum is divided horizontally with the monopolar scissors or spatula. The assistant then advances the vaginal probe to the anterior vaginal fornix, which facilitates the separation of the bladder from the cervix and vagina. The dissection is carried caudally to the upper vaginal third to half. The extent of lateral paracervical resection is shown here prior to ureteral dissection (Fig. 24.4). The ureters must be dissected completely in order to remove the entire resected parametrium.

The ureter is followed till its entrance into the parametrial tunnel. A space is created with the monopolar scissors or spatula and the PK grasper immediately above the ureter at the 12 o'clock position until the instrument appears on the vesicovaginal space. The space is widened until the posterior blade of the vessel sealer can be introduced in the created space above the ureter (Fig. 24.5). The ventral part of the vesicouterine ligament is then transected. These steps are repeated until the ventral vesicouterine ligament is transected completely and the ureter is unroofed. It is then mobilized laterally by dividing with the monopolar device its loose attachments to the dorsal aspect of the vesicouterine ligament, until the latter is exposed and identified. While the assistant is holding the ureter ventrally, the avascular space located immediately below the entrance of the ureter into the bladder is identified and widened with the monopolar spatula, clearly delineating the dorsal vesicouterine ligament (Fig. 24.6), which is transected by the assistant using a vessel sealer. The ureter is now totally free from its attachments and can be further elevated ventrally.

Fig. 24.4 The bladder has been dissected from the anterior vaginal wall, and the lateral extent of parametrial resection can be noted on the right side; it is cut out of the picture on the left

Paravaginal Tissues

With the ureter suspended ventrally and laterally with the monopolar spatula, the paravaginal tissues are divided by the assistant using a vessel sealer distal to the dorsal margin of the transected lateral parametrium and uterosacral ligaments and until reaching the lateral aspect of the vaginal wall.

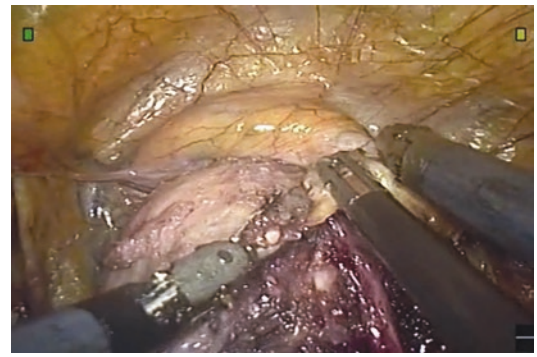

Fig. 24.5 Dissection of the right ureteral tunnel (vesicouterine ligament). The right anterior vesicouterine ligament is then transected with a vessel sealer as first step of the ureteral tunnel dissection

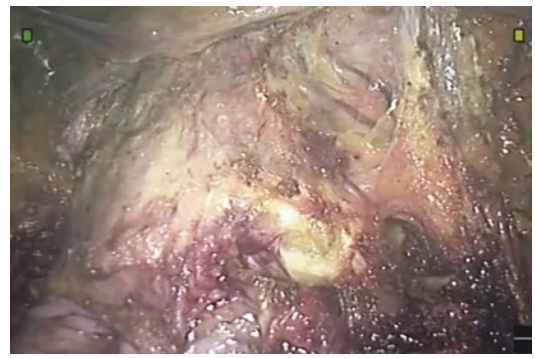

Fig. 24.6 The dorsal posterior ligament on the right side is exposed here with the middle and inferior vesical veins. The right anterior vesicouterine ligament has been already divided, and the right ureter has been mobilized and elevated out of the picture and not seen here (ventral to the dorsal vesicouterine ligament)

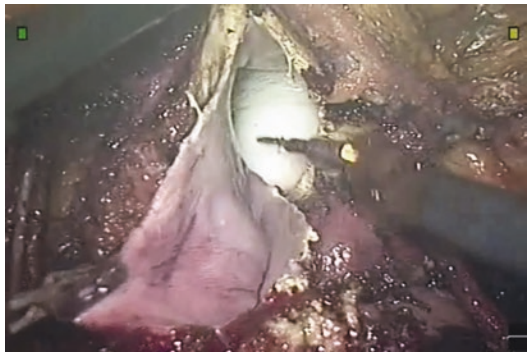

Fig. 24.7 Colpotomy with an adequate vaginal margin for this patient post-conization. The vaginal probe is seen

Fig. 24.8 The vaginal cuff has been closed. The ureters are dissected to their entrance to the bladder to remove the entire vesicouterine ligaments

Vaginal Resection

The assistant advances the vaginal probe to the anterior vaginal fornix, and the junction of the vagina and exocervix is identified. From there, we measure the length of the vaginal margin to excise using the diameter of the instruments as a measuring tool. It is important to consider that margins obtained with a stretched vagina will be shorter once the tension is removed. The vagina is entered at the 12 o'clock position and divided with the monopolar device (using cutting current) (Fig. 24.7). The assistant removes the uterus with the help of a Schroeder tenaculum (Aesculap, Germany) introduced vaginally. It is also possible to remove the lymph nodes with bags.

Vaginal Cuff Closure

The vaginal cuff is closed with a continuous suture of 2-0 V-loc (Ethicon Endo Surgery, Cincinnati, OH) incorporating a minimum of 5 mm of vagina with each bite and 5 mm of separation in between sutures, in order to avoid vaginal failure (Fig. 24.8). The pelvis is irrigated with physiological saline solution and inspected for complete hemostasis by lowering the CO2 pressure. No drains are used and the lateral pelvic peritoneum is left open.

Postoperative Course

The patient remains in the hospital overnight. Oral intake of liquids, food, and medications is started on the same day of the operation. Ambulation is started as soon as possible. The Foley catheter is removed at the beginning of deambulation, and residual urine measurements obtained on two separate occasions should be less than 100 mL. A postoperative visit is performed a week and 2 weeks to check the residual urine (must be less than 100 mL) and at 6 weeks from surgery to inspect the vaginal vault.

Conflict of Interest The authors have neither commercial, proprietary, nor financial interests in the products and companies described in this chapter.

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