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Uterine artery sparing robotic radical trachelectomy (AS-RRT) for early cancer of the cervix

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ABSTRACT

Objective: To describe the surgical technique of uterine artery sparing robotic assisted radical trachelectomy (AS-RRT) for early stage cervical cancer. *Methods:* We used our experience with AS-RRT performed at the University of Wisconsin-Carbone Comprehensive Cancer Center, USA, to present a detailed description of the surgical technique. *Results:* The report details, step-by-step, our innovative surgical technique, supported by photos and illustrations. We also discuss potential difficulties with the surgical technique and offer solutions. *Conclusion:* Technically, the surgery is feasible and could be performed by any gynecologic oncologist who is skilled in radical pelvic surgery and the robotic system. The long-term obstetric and oncologic outcome of this technique would be expected to match the outcome of the other radical trachelectomy techniques in the published literature, but is yet to be fully elucidated.

1. Introduction

Cervical cancer affected an estimated 11 070 women in the United States in 2008. Although the median age of diagnosis is 48 years, 16.3% of patients are below the age of 35, and most of them are diagnosed at an early stage [1].

Historically, the surgical treatment for early stage cervical cancer has been total radical hysterectomy and pelvic lymphadenectomy. The advent of radical surgical techniques that preserve the uterine fundus has expanded the options for patients with early cervical cancer who desire future fertility. Initially, radical trachelectomy was performed vaginally, accompanied by laparoscopic lymphadenectomy. This was found to have acceptable oncologic and obstetric outcomes [2,3]. However, in nulliparous women—who constitute the majority of eligible patients—vaginal surgery is technically not easy to perform and an abdominal approach was introduced as an alternative. The radical abdominal trachelectomy has been associated with larger parametrial specimens than the vaginal approach [4]. Radical abdominal trachelectomy and lymphadenectomy has its own disadvantages, including longer hospital stay, higher wound complications, and more blood loss compared with the vaginal procedure [5]. The open approach may also contribute to pelvic adhesions that can possibly compromise future fertility.

A pure laparoscopic approach (without a vaginal component) would be expected to be more feasible in a nulliparous patient than a vaginal approach, while having a faster recovery, shorter hospital stay, and less wound complications than an open procedure. The pure laparoscopic technique would also closely resemble the widely practiced open radical hysterectomy; the familiarity of the latter technique will render the laparoscopic approach easier to adopt in the United States because the radical vaginal hysterectomy technique is not often performed. Unfortunately, the dissection required for a radical laparoscopic trachelectomy is very difficult to perform with straight laparoscopy. It is, however, possible to perform such delicate surgery with the robotic system owing to the articulating wrist action of the instruments and three-dimensional visualization.

The objective of this report is to describe, step-by-step, the surgical technique used in uterine artery sparing robotic radical trachelectomy (AS-RRT).

2. Materials and methods

We reviewed our experience of AS-RRT using the da Vinci Robotic system (Intuitive Surgical, Sunnyvale, CA, USA) at the University of Wisconsin Carbone Comprehensive Cancer Center, Madison, USA, between January 1, 2002, and August 31, 2009. From the video footage of all our robotic surgeries, we took a representative photo of the major surgical steps to help illustrate this surgical technique. No IRB approval was needed for an article on surgical technique.

As part of our multidisciplinary comprehensive approach, our center offers specialized cancer psychology and social support to our patients and their families if they need it, as well as the opportunity to

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meet with a network of cancer survivors. Our patients' continued feedback indicates a high level of satisfaction and appreciation.

In our center, patients who are younger than 40 years of age and interested in preserving their fertility are among those eligible for the procedure. It is preferable if the cervical cancer is of a squamous cell histology type and shows no lymph-vascular space invasion; we only perform this procedure when the tumor size is less than 2 cm in its greatest dimension [6].

Our surgical team consists of board certified gynecologic oncologists, gynecologic oncology fellows, and obstetrics and gynecology residents, along with a minimally invasive trained surgical nurse and surgical assistant technicians. All surgeries are performed in a specially designed operating room; a gynecologic cancer surgical pathology team is always available for possible frozen section analysis of the surgical margins and suspicious lymph nodes.

3. Results

The patient is positioned in a semi-lithotomy position over a gel mattress (Action products Inc., Hagerstown, MD, USA). Knee-high sequential compression devices (Kendall Health care, Mansfield, MA, USA) are put on both legs, which are in turn positioned with a 20-degree flexion at the hips and 90-degree flexion at the knees using Allen Stirrups (Allen Medical, Acton, MA, USA). A pelvic examination is performed and an indwelling urinary bladder catheter is placed.

The Colpo-Pneumo Occluder balloon (CooperSurgical, Trumbull, CT, USA) is placed over the EEA sizer (Ethicon, Somerville, NJ, USA) in the vagina. This will stay in the vagina during the entire surgery for delineation of the operative vaginal margin. We do not use any other type of uterine manipulator to avoid the manipulation of the cancer. The distribution of the surgical team in the operative room [7] is depicted in Fig. 1.

During the port placement and docking of the robot, the surgeon stands to the left of the patient, with both the surgical assistant and technician on the right side. The robotic tower is positioned between the patient's legs, waiting to be docked when the abdominal ports are to be secured. A laparoscopic monitor and the electrosurgical generators are positioned to the left of the patient, facing the surgical assistant during the procedure.

A Veress needle (Ethicon, Somerville, NJ, USA) is introduced though a small incision to insufflate the peritoneal cavity with carbon dioxide to a pressure of 15 mm Hg; this can also be achieved via a left upper quadrant entry [8]. Five ports (Ethicon) are placed though the abdominal wall: a 12-mm port just above the umbilicus for the robot camera; an 8-mm port on each side of the umbilicus for the two active robot arms; an 8-mm port in the left lower quadrant for the fourth robot arm; and a 12-mm port in the right lower quadrant for the surgical assistant (Fig. 2).

The robotic camera is placed though the 12-mm umbilical port. A robotic monopolar pair of curved scissors is placed though the right 8-mm port (designated as "Arm 1") to be used by the surgeon's right hand during the procedure, and a Maryland bipolar forceps (Intuitive Surgical) is placed through the medial 8-mm port (designated as "Arm 2") to be used by the surgeon's left hand. A ProGrasp forceps (Intuitive Surgical) is placed on the lateral 9-mm port (designated as "Arm 3") to be used as a retractor during surgery, which would be guided by the surgeon's left hand. During the surgery, the assistant will use the 12-mm port on the right for retraction, irrigating, handing needles to the surgeon, and retrieving specimens.

The surgery is performed in moderately steep Trendelenberg position, which allows the surgeon to flip the bowel over its mesentery to the upper abdomen, thereby maximizing the surgical field exposure.

An incision is made parallel to the gonad vessels bilaterally, and the pararectal and paravesical spaces are opened down to the pelvic floor.

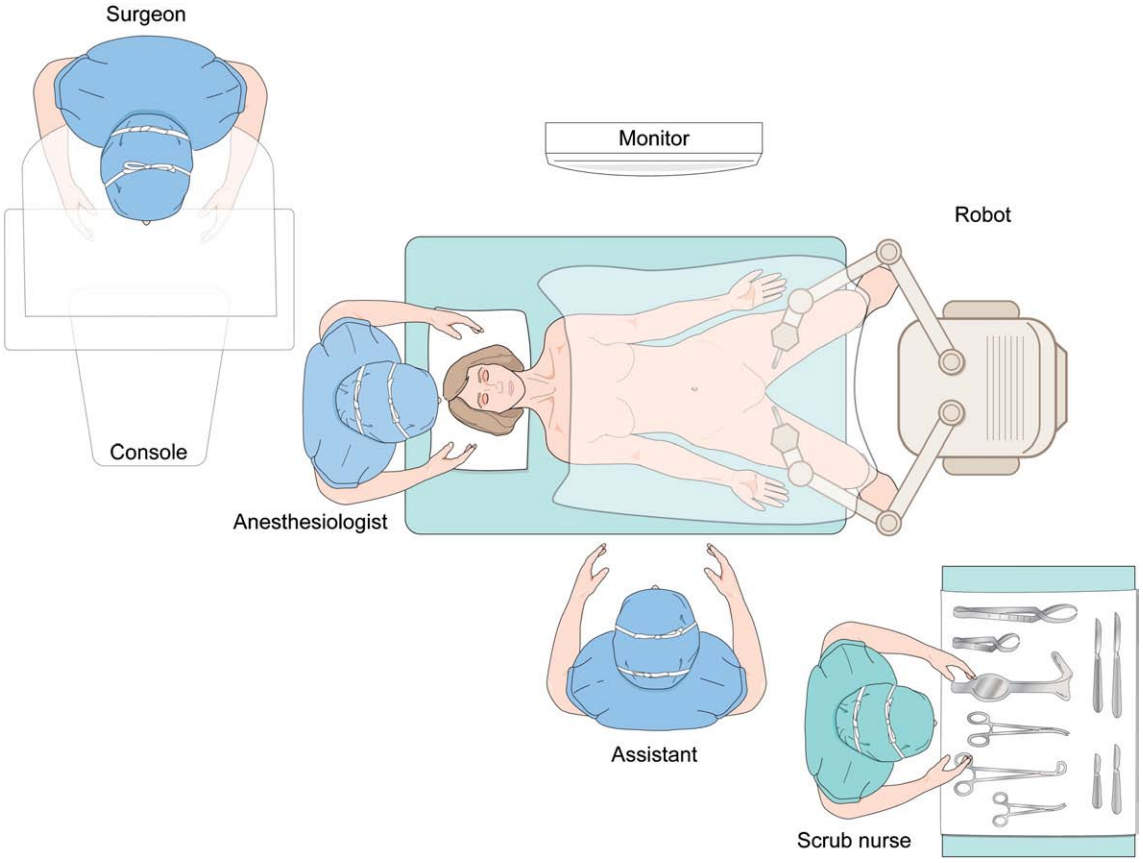

Fig. 1. The distribution of the surgical team in the operating room.

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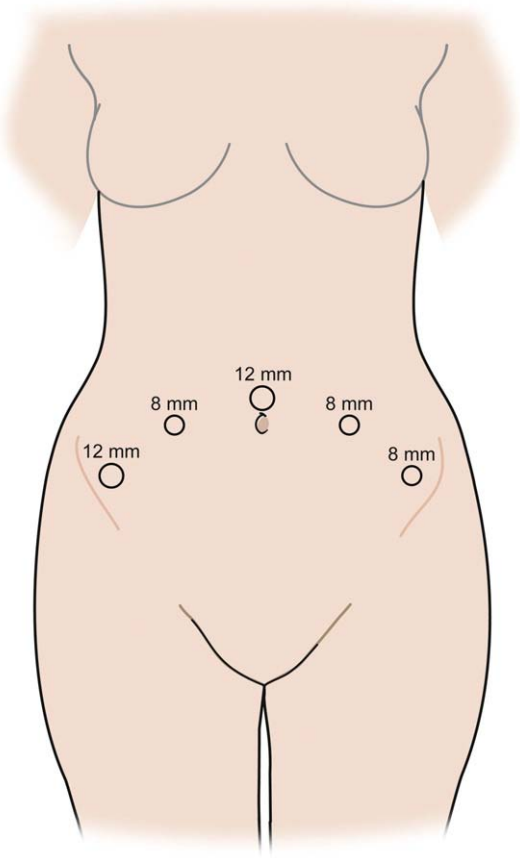

Fig. 2. Distribution of the abdominal ports.

Bilateral complete pelvic lymphadenectomies are performed with sharp and blunt dissection as well as with monopolar electrosurgery. This dissection includes removing the bilateral common iliac, external iliac, internal iliac, and obturator nodal basins in their entirety. Each side's lymph node bundles are put in Endo-bag pouches (Ethicon, Somerville, NJ, USA) separately. These are delivered through the assistant's port or through the vagina after colpotomy if the bag is too big to fit though a 12-mm port. We do not routinely send the lymph nodes for a pathologic frozen section, unless a lymph node is noted to be suspicious.

Both uterine arteries are dissected from their origin, over the ureter, and to their point of entry into the uterus using the monopolar curved scissors. The ureters are then dissected from their peritoneal attachments and freed of the overlying uterine arteries. This is technically one of the most challenging parts of the surgery. The uterine artery has a tortuous course over the ureter. In this part, it also gives off the cervical branch, which should be coagulated. Extreme care should be taken to coagulate the cervical branch rather than the tortuous main uterine artery. The paracervical tunnels are unroofed using bipolar and monopolar electrosurgery. This allows the ureters to be freely mobile in the pelvis (Fig. 3).

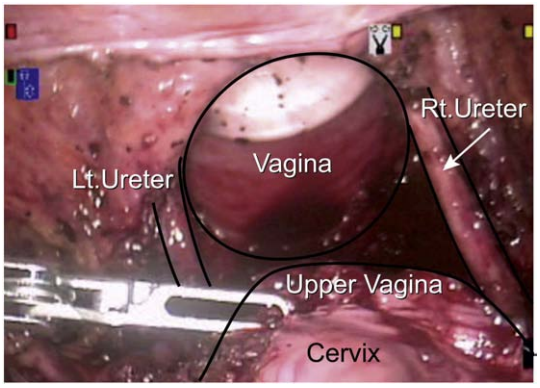

Fig. 4. The creation of a circumferential colpotomy.

The uterus is anteverted and the posterior peritoneum is incised between the uterosacral ligaments. The rectovaginal space is opened sharply and further defined with blunt dissection. The uterosacral ligaments are then dissected and cut accordingly.

The lateral cardinal ligaments and parametrium are dissected free at the level of the pelvic sidewall and excised using both monopolar and bipolar electrosurgery. Care should be taken to avoid injuring or avulsing the uterine artery, which is skeletonized and still attached to its origin. The dissection is carried out 2 cm down on the vagina, using the EEA sizer as a guide. A circumferential colpotomy is made (Fig. 4).

The radical trachelectomy specimen is amputated using the monopolar robotic scissors, 1 cm distal to the entrance of the uterine arteries into the cervix bilaterally. This leaves the upper 1-cm portion of the cervix in situ. The trachelectomy specimen (and often lymph node bundles) are put in laparoscopic bags and removed vaginally with the aid of a ring forceps. Frozen section analysis is performed on the trachelectomy specimen to ensure adequate margins. If the margin is less than 8 mm, an additional circular portion of the lower uterine segment is excised. If the sum of the negative margin from the initial specimen and the re-excision is at least 8 mm, the margin is considered adequate.

A cerclage is placed in a circumferential fashion around the lower uterine segment/upper cervix, using number 0 polypropylene (Prolene) on a CT-1 needle (Ethicon). Care is taken to avoid inadvertent uterine artery ligation. A Maryland forceps is placed in the lower uterine segment while tying down the knot to prevent over-tightening, which might in turn increase the likelihood of stenosis (Fig. 5).

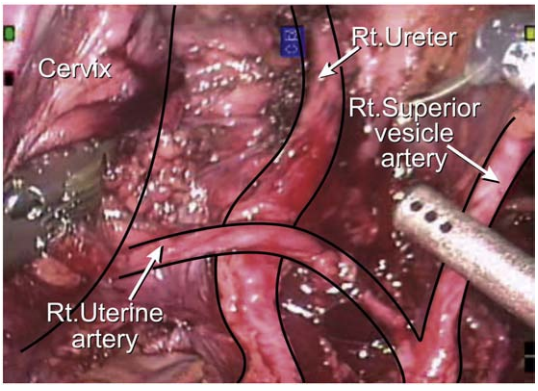

Fig. 3. Dissection of the parametrial from the ureters.

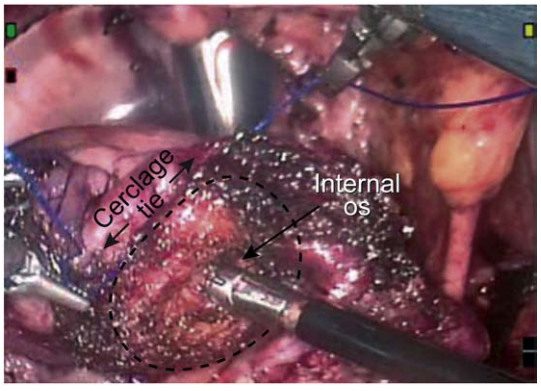

Fig. 5. A cerclage placed at the lower uterine segment.

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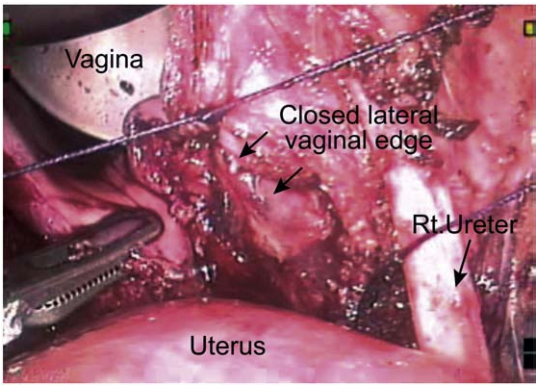

Fig. 6. Closing the redundant lateral vaginal apices.

When reconnecting the uterus to the vagina, it is important to decrease the size of the vaginal cuff to approximate the size of the lower uterine segment/cervical stump. We achieve this by closing the redundant lateral vaginal apices with figure-of-eight stitches using number 0 polyglactin 910 (Vicryl) suture (Ethicon) (Fig. 6). This portion of the surgery can also be performed vaginally.

When reattaching the lower uterine segment to the vagina we stitch the posterior aspect of the vagina, using an interrupted number 0 polyglactin 910 suture, to the posterior portion of the cervical stump, tying the knots in the upper vaginal canal. The second step is to attach the anterior aspect of the vagina in a similar manner.

4. Discussion

Many young women diagnosed with early cervical cancer have yet to start or complete their families. Radical trachelectomy has been shown to result in live births and have acceptable oncologic outcomes [6]. It would be ideal if patients with early cervical cancer who desire future fertility could be offered a minimally invasive surgery that has the same oncologic outcomes as other approaches. Our report shows that it is possible to perform a minimally invasive uterine artery sparing robotic radical trachelectomy (AS-RRT).

In 1973, a Romanian gynecologist named Aburel published a case report describing the first radical trachelectomy [9]. In 1987, the innovative French surgeon Daniel Dargent began performing laparoscopic assisted transvaginal radical trachelectomy [2]. He presented his work in 1994 at the 25th Annual Meeting of the Society of Gynecologic Oncologists, reporting successful pregnancies following the procedure and an acceptable recurrence risk of cervical cancer. His presentation ignited interest in offering patients a fertility preserving surgical approach for early cancer of the cervix. Sparing the uterine artery, using the "Dargent technique," is thought by many to be an important contributing factor to the low number of premature deliveries seen in successive pregnancies following radical trachelectomy [10,11]. Preserving the uterine arteries during such procedures preserves the normal uterine blood flow, which has been demonstrated using Doppler ultrasound [12].

One of the benefits of laparoscopic-assisted radical vaginal trachelectomy is its minimally invasive nature. However, patients with cervical cancer who desire future fertility are often nulliparous, some of whom are not good candidates for vaginal surgery. In addition, gynecologic oncologists in the United States are not trained to perform radical vaginal surgery. Nulliparous patients are candidates for abdominal trachelectomy, which has the added benefit, for the surgeon, of being a very similar operation to open radical hysterectomy. Unfortunately, abdominal and laparoscopic-assisted radical trachelectomies are not necessarily analogous procedures. Early radical abdominal trachelectomies were performed without sparing the uterine arteries [13,14], making it difficult to extrapolate pregnancy success rates using the Dargent technique to patients undergoing abdominal trachelectomy. Recently, authors have described radical abdominal trachelectomies that spare the uterine artery [15,16]. The biggest drawbacks of the open abdominal approach are the long postoperative recovery time and its potential to cause pelvic adhesions that could possibly compromise future fertility.

We believe that the da Vinci Robotic system provides the ability to perform a minimally invasive radical trachelectomy with more precision, faster recovery, and possibly fewer adhesions, as well as fewer surgical site infections than the open abdominal approach. Robotic-assisted radical trachelectomy was first performed without sparing the uterine artery [17], and more recently a case report was published [18] utilizing uterine artery sparing robotic-assisted radical trachelectomy.

Our report shows, step-by-step, the innovative new surgical technique of sparing the uterine artery during a robotic-assisted radical trachelectomy. There are a few potential difficulties in such a surgical technique, beginning with identifying the tortuous nature of the uterine arteries, making sure to dissect off the descending cervical branch, and coagulating it without damaging the main uterine artery itself. Next, it is essential to have an adequate margin both in the lower uterine segment and the vaginal end of the specimen, and to apply the lower uterine segment cerclage with appropriate tension. Finally, it is important to close the vaginal corners so that the diameter of the upper vagina matches that of the lower uterine segment, while being sure the opening is adequate enough to allow menstrual flow and not to cause epithelialization over the "new" cervical os.

The robot system offers many benefits over conventional laparoscopy, including a 3-dimensional view of the surgical field for the operating surgeon. It also provides articulation, which allows for a level of dexterity much greater than that of the conventional laparoscope. This improved visualization and dexterity leads to a level of precision for the parametrial dissection not previously attainable by laparoscopy. Some of the disadvantages of the robotic approach, aside from the high investment and maintenance costs of the da Vinci robot, include longer surgical operative times in some studies.

We have detailed our surgical technique for AS-RRT, which should theoretically maintain normal uterine artery blood flow to the gravid uterus. Technically, the surgery is feasible and could be performed by any gynecologic oncologist who is skilled in radical pelvic surgery and the robotic system. The long-term obstetric and oncologic outcome of this technique is yet to be fully elucidated, but could be expected to be similar to the promising results seen in patients who had vaginal radical trachelectomy [6].

Conflict of interest

The authors have no conflicts of interest.

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