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Robotic Radical Trachelectomy for Preservation of Fertility in Early Cervical Cancer: Case Series and Description of Technique

A. F. Burnett, MD*, P. J. Stone, MD, L. A. Duckworth, MD, and J. J. Roman, MD

From the Division of Gynecologic Oncology, Department of Obstetrics and Gynecology, University of Arkansas for Medical Sciences, Little Rock.

ABSTRACT **Study Objective:** To present a case series of robotic radical trachelectomy for preservation of fertility in early cervical cancer.
Design: Descriptive study.
Design: Canadian Task Force Classification III.
Setting: Tertiary referral center.
Patients: Women with early cervical cancer who wish to maintain fertility potential.
Interventions: Robotic radical trachelectomy with bilateral pelvic lymphadenectomy. The procedure also uses a cervical cerclage and permits preservation of the ascending branches of the uterine arteries to the uterus.
Measurements and Main Results: Report of the technique, and operative and immediate postoperative complications. To date, 6 women have undergone robotic radical trachelectomy, with preservation of the uterine arteries in all patients. One patient underwent completion hysterectomy when the frozen section of the trachelectomy margin revealed inability to clear the cancer. Five women have maintained their fertility potential after the procedure.
Conclusion: Robotic radical trachelectomy is a feasible technique that permits radical removal of the cervix. Improved visualization with the robot and fine dissection permissible with the instrument facilitate this procedure. Journal of Minimally Invasive Gynecology (2009) 16, 569–72 © 2009 AAGL. All rights reserved.

Keywords: Radical trachelectomy; Cervical cancer; Robotics; Fertility

Radical trachelectomy was originally developed by Dargent et al [1] as an alternative therapy in early cervical cancer in women who wish to retain fertility. The combination of laparoscopic removal of the pelvic lymph nodes with radical vaginal trachelectomy has been effective in early cancers and permits future child-bearing [2–4]. However, the procedure can be technically difficult in nulliparous women without pelvic descent and requires the surgeon to be adept at radical vaginal surgery.

Alternatively, abdominal radical trachelectomy has been performed at several centers [5,6]. This procedure is technically easier to accomplish for those not facile with radical vaginal surgery but has had limited results in terms of subsequent successful pregnancies [7,8]. Most authors advocate ligation of 1 or both uterine arteries to perform the abdominal radical trachelectomy, and, although normal menses return, this could affect fertility.

The robotic approach may offer advantages in performing radical trachelectomy. Anatomic restrictions to the vaginal approach such as lack of pelvic descent or large lesion size are overcome using the robotic technique. It also enables preservation of the uterine vessels and increased precision and visualization during surgery. Case reports have been published recently [9–11]; however, to our knowledge, the present study is the first published case series of robotic radical trachelectomy.

We present a retrospective review of our experience with robotic radical trachelectomy. Patients with early cervical cancer who requested an attempt at preserving fertility were informed of an alternative approach to radical vaginal trachelectomy with use of a surgical robot. This procedure represents an extension of our experience with robotic radical hysterectomy.

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Corresponding Author: Alexander F. Burnett, MD, Division of Gynecologic Oncology, Department of Obstetrics and Gynecology, University of Arkansas for Medical Sciences, 4301 W Markham St, Winthrop P. Rockefeller Cancer Center, Rm. 235, Little Rock, AR 72205.
E-mail: aburnett@uams.edu

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Technique

The Da Vinci Surgical System (Intuitive Surgical, Inc., Sunnyvale, California) is used with a camera port, 3 robotic instrument ports, and 1 assistant port. The entire procedure is accomplished with bipolar Maryland forceps and monopolar scissors. The avascular spaces in the retroperitoneum are opened. The magnification of the robot permits fine dissection with minimal bleeding. The anterior peritoneum is also opened, and the bladder is dissected below the surgical field. Complete lymphadenectomy is performed bilaterally from the bifurcation of the iliac vessels to the circumflex iliac vein. The obturator space is cleared of its lymph nodes as well. The nodes are removed en bloc and submitted to pathology for frozen evaluation. Positive lymph nodes necessitate postoperative radiation therapy and, therefore, preclude completion of the fertility-sparing operation.

After both sets of nodes are removed, the ureter is dissected free from the peritoneum, and the uterine artery is freed from its connections in the retroperitoneum. Care is taken to preserve the artery and vein from the hypogastric vessels to their entry into the uterus. Dissection of the ureter from the tunnel is accomplished on the medial and inferior borders, moving the ureter anteriorly with the uterine vessels. The exterity afforded by the robot enables these maneuvers. The posterior peritoneum is incised, the rectovaginal space is opened, and the rectum is dissected below the surgical field. The uterosacral ligaments are cauterized and cut.

The descending branches of the uterine vessels are cauterized at the isthmus of the uterus and cervix. Care is taken to preserve the ascending uterine vessels that flow to the corpus. This maneuver is possible because of wrist flexibility while using the robotic instruments. The parametrium is cauterized after the ureter has been displaced anteriorly and is resected to a level below the cervix.

Vaginotomy is performed circumferentially over a plastic vaginal probe (Apple Medical Corp, Marlborough, Massachusetts) that delineates the extent of the vaginal margin. The cervix is amputated from the uterus just below where the uterine arteries ascend to the corpus. Sharp dissection is performed at the canal to facilitate frozen section evaluation of the endocervical margin. The specimen is removed through the vagina with minimal manipulation of the uterus. Pathologic evaluation of the endocervical margin is done to assure clearance of the cancer. The distal vagina is occluded with a lap-filled sponge to maintain pneumoperitoneum.

A cerclage is performed in the residual cervix using a permanent suture tied in the posterior aspect of the uterus. This is performed as a Shirodkar-type cerclage with a continuous suture placed circumferentially around the isthmus of the cervix and uterus. The sutures are placed to a depth of approximately 1 cm and approximately 0.5 cm apart. The cervix is then reattached to the vagina with interrupted absorbable polygycan sutures. The bladder is catheterized for 1 week after the procedure. Post-procedure residual cervix is shown in Fig. 1.

Fig. 1. View of residual cervix 6 months postoperatively.

Results

Patient data are given in Table 1. Six women underwent the procedure. All women had stage Ib1 cervical cancer, adenocarcinoma in 4 and squamous cell cancer in 2. Median (range) patient age was 27 (25–30) years. Body mass index was 20.25 (18.5–31). Three women were nulligravida, and 3 had 1 child. Five had previously undergone conization. Lymphovascular space invasion was identified in 3 patients preoperatively. None of the women smoked. Only 1 patient underwent preoperative magnetic resonance imaging, which revealed no evidence of tumor high in the cervical canal.

Duration of anesthesia during the procedure was 360 (278–396) minutes. This included the time for patient positioning, placing of the ports, docking the robot, performance of the surgery, and closure of the port sites. Therapeutic bilateral pelvic lymphadenectomy was performed in all women, and the nodes were submitted for frozen-section analysis.

Table 1
Patient data

No. of patients	6
Age, median (range)	27 (25–30)
Parity	
None	3
One	3
Body mass index,[a] median (range)	20.25 (18.5–31.0)
Histologic findings	
Squamous cell carcinoma	2
Adenocarcinoma	4
Cancer stage Ib1	6
Previous conization	5
Lymphovascular space invasion	3

[a]Calculated as weight in kilograms divided by height in meters squared.

None of the women had involved lymph nodes at either frozen-section or permanent sectioning analysis. The radical trachelectomy specimen was submitted for frozen-section analysis of the endocervical margin in all patients. In 4 patients, this margin was negative. In 1 patient, the margin suggested adenocarcinoma in situ, and a decision was made to preserve the uterus. Final pathologic evaluation of this specimen revealed reactive changes at the margin without evidence of carcinoma in situ. In 1 patient, frozen-section analysis of the endocervical margin revealed invasive adenocarcinoma, and complete hysterectomy was performed. Final pathologic analysis showed residual cancer in the uterine specimen with all surgical margins negative. In the 5 women who retained their uterus, 1 had residual cancer in the trachelectomy specimen but with clear margins, and the others had no residual cancer. Estimated blood loss was 108 (50–250) mL. In all patients, the ascending branches of the uterine arteries were preserved.

Five of the 6 women were discharged on the first postoperative day, and 1 stayed for 2 days because of postoperative nausea. All women successfully passed a bladder challenge by postoperative day 7, and the urinary catheters were removed. There were 2 postoperative complications. One patient developed herniation of the small bowel through a lateral 8-mm port site on day 3 to 4. This required an incision over the port site to release the small intestine, which did not have any ischemic insult, and to repair the fascial defect. Subsequent recovery was uneventful. One patient came to the clinic on postoperative day 4 with ecchymosis of the anterior abdominal wall to the left flank consistent with hemorrhage from the inferior epigastric vessels. This resolved without intervention, but the patient required a blood transfusion of 2 units. Subsequent recovery was uneventful. Menses has remained normal in the 5 women who retained their uterus. Overall follow-up ranged from 9 to 13 months. There have been no recurrences and no pregnancies to date. In 1 patient, the cerclage extruded through the vagina at about 5 months after surgery.

Discussion

Radical trachelectomy enables young women with early cervical cancer to maintain fertility. The initial approach, radical vaginal trachelectomy, is effective cancer therapy in properly selected patients. In a collected series of 310 women undergoing radical vaginal trachelectomy, there were more than 100 term deliveries [12]. The major drawback to this approach is the necessity that the surgeon be trained in radical vaginal procedures, which are an infrequent component of oncology training programs. Technical challenges can occur in the nulliparous patient who lacks pelvic descent, and this can be exacerbated if the habitus is large. In addition, with lesions larger than 2 cm, adequate exposure of the parametrium and adequate surgical margins may be more difficult to obtain, leading some to advocate that this procedure be attempted only if lesions are 2 cm or smaller [13].

To circumvent some of the disadvantages of radical vaginal trachelectomy, some advocate an abdominal approach to radical trachelectomy [5,6]. This technique is a modification of the standard radical abdominal hysterectomy and can be accomplished by the trained gynecologic oncologist. This approach does not require pelvic descent and can be performed with any size lesion that would be amenable to radical hysterectomy. Surgical capability to remove pelvic lymph nodes laparoscopically is not required. The largest series describing the technique recommended resection of the uterine arteries at their origin along the hypogastric artery, maintaining the blood supply to the uterus from the gonadal vessels via the utero-ovarian ligaments. After resection of the uterus, cervix, parametrium, and vaginal cuff from the vagina, the cervix is amputated at the isthmus and submitted for pathologic analysis. A cerclage is placed in the residual proximal cervix or lower uterine segment, and the corpus is sutured to the vaginal cuff. There is a single case report of the superior (abdominal) approach laparoscopically, which proved to be technically difficult [14].

Normal menses returns after radical abdominal trachelectomy, documenting the viability of the uterus; however, with more than 55 procedures reported in the literature, only 6 live births have been reported, which seems to be significantly lower than reported after radical vaginal trachelectomy [5–8,14–18]. What is the reason for this seeming diminished fertility? One possibility is that live births after radical abdominal trachelectomy have been unreported or underreported in the literature. In that case, it is incumbent on those familiar with this procedure to present adequate follow up. Another possibility is that the decrease in blood supply to the uterus from resection of the uterine arteries affects the ability to successfully carry a pregnancy. Doppler studies of the lower uterine segment before and after radical vaginal trachelectomy, in which the ascending branches of the uterine arteries are not transected, have documented normal uterine blood supply after the vaginal approach; however, such studies have not been performed with the abdominal trachelectomy [19]. In the reproductive literature, a recent review of patients who underwent either laparoscopic myomectomy or uterine artery embolization because of symptomatic myomas showed the live birth rate to be superior if myomectomy was performed rather than uterine artery embolization [20]. This suggests that preservation of the uterine arteries is advantageous for subsequent pregnancies. In radical abdominal trachelectomy, attempts have been made to preserve the uterine blood supply using microvascular techniques for vessel reanastomosis [18]. These techniques seem to be beyond the standard purview of the gynecologic oncologist but further suggest the importance of trying to maintain these vessels. An additional concern with the abdominal approach to trachelectomy is that the extensive manipulation of the reproductive organs required in such an approach will increase the likelihood of adhesions in the pelvis. It is well recognized that minimally invasive surgery is much less likely to cause adhesions than open surgical

techniques [21] and that pelvic adhesions significantly affect future fertility [22,23].

We believe that a robotic approach to radical trachelectomy may circumvent some of the disadvantages of either radical vaginal trachelectomy or radical abdominal trachelectomy. The robotic system has the advantages of (1) improved visualization due to 3-dimensional optics; (2) improved tissue manipulation due to flexibility of the instruments; (3) improved fine dissection; and (4) minimal invasion resulting in decreased adjacent tissue trauma and adhesions, diminished operative pain, shorter postoperative hospitalization, and better cosmesis. With the Da Vinci system, the uterine vessels can be dissected from the hypogastric artery to the corpus. At the corpus, the ascending branch of the uterine artery can be maintained with cauterization of the descending branches to the cervix. In all of our patients, the uterine arteries were successfully maintained. While none of the patients have as yet attempted to conceive (we recommend waiting at least 6 months after the procedure and after a normal Papanicolaou smear test), all continued with normal menses after the surgery except the patient who underwent completion hysterectomy.

Another advantage of the robotic system is ease of suturing. The vaginal cuff is sutured to the residual cervix or lower uterine segment using absorbable sutures that can be either tied or secured with Lapra-Tys (Ethicon Endo-Surgery, Inc., Cincinnati, OH). The permanent cerclage requires an instrument tie that is easily accomplished with the robot. As with other types of radical trachelectomy, patients will deliver via cesarean section.

To our knowledge, this is the first series using a robot to perform radical trachelectomy with preservation of the uterus for future child-bearing. The technique described combines the advantages of the vaginal approach and the abdominal approach. It can easily be adapted by those performing robotic radical hysterectomy. Larger series must be performed to document pregnancy success after this procedure.

Supplementary data

Supplementary data associated with this article can be found, in the online version, at doi:10.1016/j.jmig.2009.06.005.

References

1. Dargent D, Brun JL, Roy M, Remy I. Pregnancies following radical trachelectomy for invasive cervical cancer. *Gynecol Oncol*. 1994;52:105.
2. Mathevat P, Laszlo de Kaszon E, Dargent D. Fertility preservation in early cervical cancer. *Gynecol Obstet Fertil*. 2003;31:706–712.
3. Plante M, Renaud M-C, Hoskins IA, Roy M. Vaginal radical trachelectomy: a valuable fertility-preserving option in the management of early-stage cervical cancer; a series of 50 pregnancies and review of the literature. *Gynecol Oncol*. 2005;98:3–10.
4. Bernardini M, Barrett J, Seaward G, Covens A. Pregnancy outcomes in patients after radical trachelectomy. *Am J Obstet Gynecol*. 2003;189:1378–1382.
5. Ungár L, Pálfalvi L, Hogg R, et al. Abdominal radical trachelectomy: a fertility-preserving option for women with early cervical cancer. *BJOG*. 2005;112. 366–369.
6. Abu-Rustum NR, Sonada Y, Black D, Levine DA, Chi DS, Barakat RR. Fertility-sparing radical abdominal trachelectomy for cervical carcinoma: technique and review of the literature. *Gynecol Oncol*. 2006;103:807–813.
7. Smith JR, Boyle DC, Corless DJ, et al. Abdominal radical trachelectomy: a new surgical technique for the conservative management of cervical carcinoma. *BJOG*. 1997;104:196–1200.
8. Rodriguez M, Guimares O, Rose PG. Radical abdominal trachelectomy and pelvic lymphadenectomy with uterine conservation and subsequent pregnancy in the treatment of early invasive cervical cancer. *Am J Obstet Gynecol*. 2001;185:370–374.
9. Chuang LT, Lerner DL, Liu CS, Nezhat FR. Fertility-sparing robotic-assisted radical trachelectomy and bilateral pelvic lymphadenectomy in early-stage cervical cancer. *J Minim Invasive Gynecol*. 2008;15:767–770.
10. Geisler JP, Orr CJ, Manahan KJ. Robotically assisted total laparoscopic radical trachelectomy for fertility sparing in stage IB1 adenosarcoma of the cervix. *J Laparoendosc Advanced Surg Tech*. 2008;18:727–729.
11. Persson J, Kannisto P, Bossmar T. Robot-assisted abdominal laparoscopic radical trachelectomy. *Gynecol Oncol*. 2008;111:564–567.
12. Burnett AF. Radical trachelectomy with laparoscopic lymphadenectomy: review of oncologic and obstetrical outcomes. *Curr Opin Obstet Gynecol*. 2006;18:8–13.
13. Roy M, Plante M. Pregnancies after radical vaginal trachelectomy for early stage cervical cancer. *Am J Obstet Gynecol*. 1998;179:1491–1496.
14. Cibula D, Ungár L, Pálfalvi L, Binó B, Kuzel D. Laparoscopic abdominal radical trachelectomy. *Gynecol Oncol*. 2005;97:707–709.
15. Wang YF, Liu L, Liu FH, et al. Modified abdominal radical trachelectomy for treatment of cervical carcinomas. *Chinese J Obstet Gynecol*. 2006;41:226–228.
16. Matthews KS, Numnum TM, Conner MG, Barnes M. Fertility-sparing radical abdominal trachelectomy for clear cell adenocarcinoma of the upper vagina: a case report. *Gynecol Oncol*. 2007;105:820–822.
17. Hatami M, Del Priore G, Chudnoff SG, Goldberg GL. Preserving fertility in invasive cervical adenocarcinoma by abdominal radical trachelectomy and pelvic lymphadenectomy. *Arch Iran Med*. 2006;9:413–416.
18. Wan XP, Yan Q, Xi X, Cai B. Abdominal radical trachelectomy: two new surgical techniques for the conservation of uterine arteries. *Int J Gynecol Cancer*. 2006;16:1698–1704.
19. Klemm P, Tozzi R, Kohler C, Hertel H, Schneider A. Does radical trachelectomy influence uterine blood supply? *Gynecol Oncol*. 2005;96:283–286.
20. Goldberg J, Pereira L. Pregnancy outcomes following treatment for fibroids: uterine fibroid embolization versus laparoscopic myomectomy. *Curr Opin Obstet Gynecol*. 2006;18:402–406.
21. Chen MD, Teigen GA, Reynolds HT, Johnson PR, Fowler JM. Laparoscopy versus laparotomy: an evaluation of adhesion formation after pelvic and paraaortic lymphadenectomy in a porcine model. *Am J Obstet Gynecol*. 1998;178:499–500.
22. American Fertility Society. The American Fertility Society classification of adnexal adhesions, distal tubal occlusion, tubal occlusion secondary to tubal ligation, tubal pregnancies, Müllerian anomalies and intrauterine adhesions. *Fertil Steril*. 1988;49:944–955.
23. di Zerega GS, Roth R, Johns DB. Quantitation of peritoneal adhesions and correlation with clinical outcomes. *Infert Reprod Med Clin North Am*. 2003;14:431–456.