Radical Abdominal Trachelectomy

102

Rene Pareja and Pedro Ramirez

Introduction

The standard recommendation for the treatment of patients with early-stage cervical cancer (stages IA2–IB1) interested in fertility preservation is radical trachelectomy [1]. In 1994, Dargent et al. [2] reported on the safety and feasibility of vaginal radical trachelectomy (VRT) with laparoscopic lymph node dissection for the treatment of early-stage cervical cancer. However, one of the major concerns with regard to the vaginal approach when considering radical trachelectomy is the fact that it requires surgeon expertise in radical vaginal surgery and also in advanced laparoscopic procedures. In 1997, Smith et al. published the first report of abdominal radical trachelectomy (ART) [3]. The advantages of ART include the reproducibility of the technique, the fact that the procedure can be performed without training in radical vaginal surgery, that it requires no laparoscopic equipment, and a wider parametrial resection can be achieved with this approach.

Radical trachelectomy has also been reported through a minimally invasive approach. The laparoscopic approach offers the benefits of minimally invasive surgery; however, it is also associated with the fact that it is a challenging technique requiring the expertise of a well-trained surgeon in radical laparoscopic pelvic surgery [4, 5]. Others have published on the robotic-assisted approach [6, 7]. However, the number of published data on these minimally invasive approaches is limited and the follow-up times are short thus limiting the information on long-term oncologic outcomes.

This chapter will describe the surgical technique, and the oncological and obstetric outcomes after radical trachelectomy. We will also provide details on the most common complications associated with this procedure.

R. Pareja (✉)
Clinica de Oncología ASTORGA, Medellin, Antioquia, Colombia
e-mail: ajerapener@gmail.com

P. Ramirez
Department of Gynecologic Oncology and Reproductive Medicine, University of Texas MD Anderson Cancer Center, Houston, TX, USA
e-mail: peramire@mdanderson.org

Surgical Technique

The initial entry into the abdominal and pelvic cavity is performed through either a low transverse (Pfannenstiel, Cherney, Maylard) or median incision. The main advantage of the median incision is the broader space that it provides. Careful inspection of the pelvic and peritoneal surfaces is performed in order to rule out any metastatic disease. To gain access into the retroperitoneum one may begin by transecting the round ligament and making an incision along the lateral aspect of the infundibulo-pelvic ligament. The round ligaments may also be preserved depending on the surgeon preference. However, as an alternative, one may also begin by opening the pouch of Douglas by making an incision between both uterosacral ligaments (Fig. 102.1). The paravesical (limited laterally by the iliac vessels, medially by the obliterated umbilical artery, caudally by the deep uterine vein, posteriorly by internal iliac artery and anteriorly by the pubic bone) and pararectal spaces (limited laterally by internal iliac artery, medially by the hypogastric nerve, anteriorly by the uterine artery and posteriorly by the sacral fascia) are developed (Figs. 102.2 and 102.3). Upon inspection of the retroperitoneum, if there is any evidence of obvious nodal disease, surgeons should consider sending the lymph node for frozen section evaluation to determine the status of the lymph node. If there is evidence of disease in the lymph node, the ART should be aborted and definitive chemotherapy and radiation recommended.

A complete pelvic lymphadenectomy is performed from the level of the bifurcation of the common iliac vessels proximally to the circumflex iliac vein distally. This dissection includes the external iliac nodes, internal iliac nodes, and obturator nodes (Fig. 102.4). There is no utility of sending normal appearing nodes to frozen section. As an alternative, sentinel node mapping can be performed, with

I. Alkatout, L. Mettler (eds.), *Hysterectomy*, DOI 10.1007/978-3-319-22497-8_102

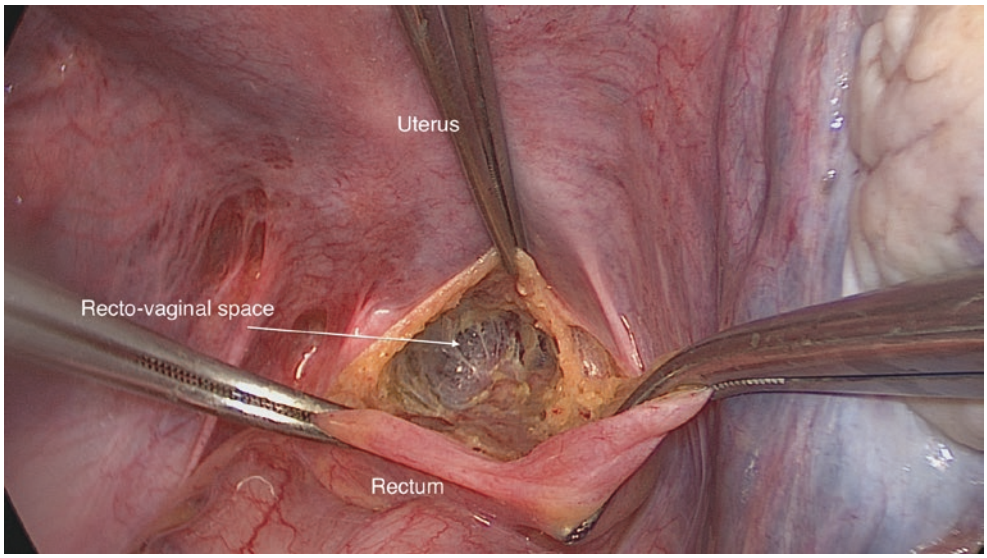


Fig. 102.1 Opening the pouch of Douglas

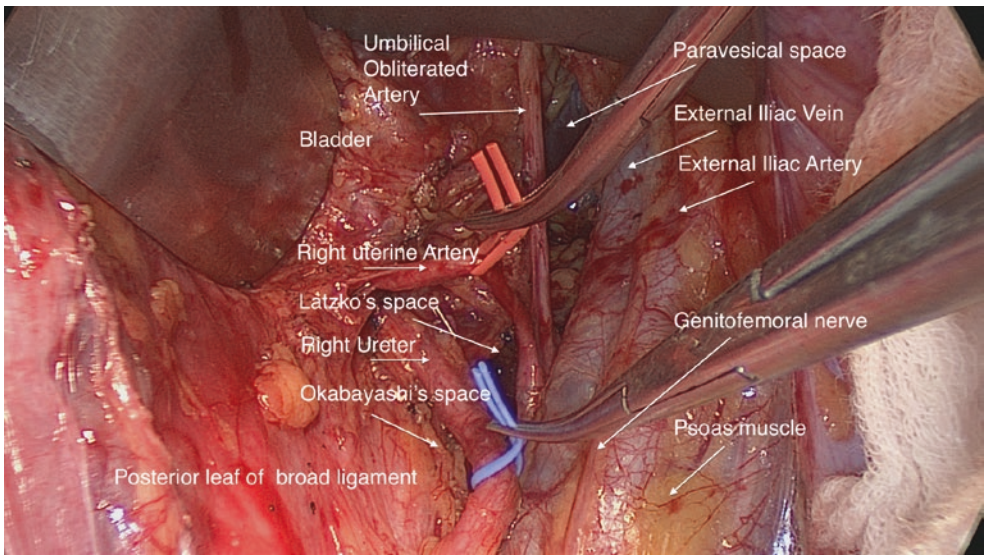


Fig. 102.2 Right pelvic lateral spaces

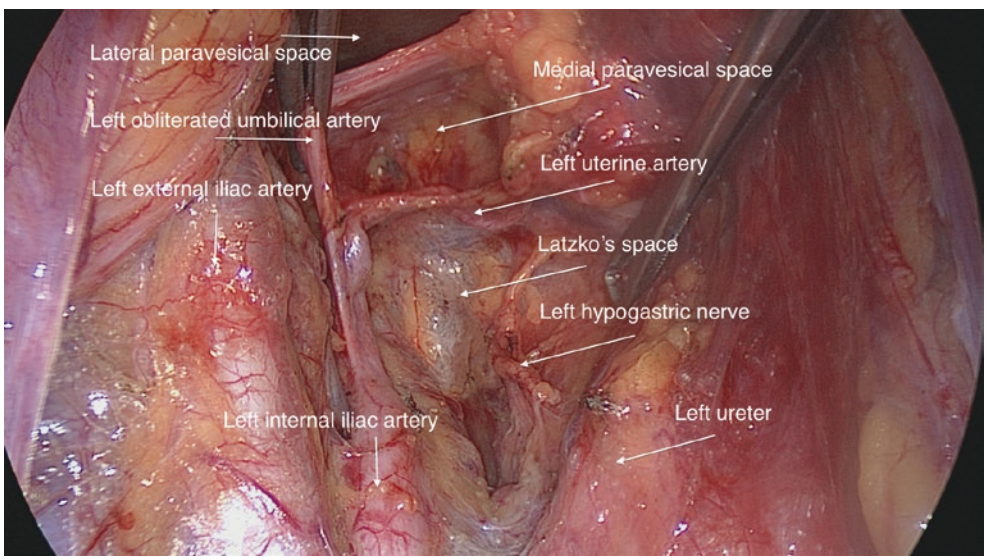


Fig. 102.3 Left pelvic lateral spaces

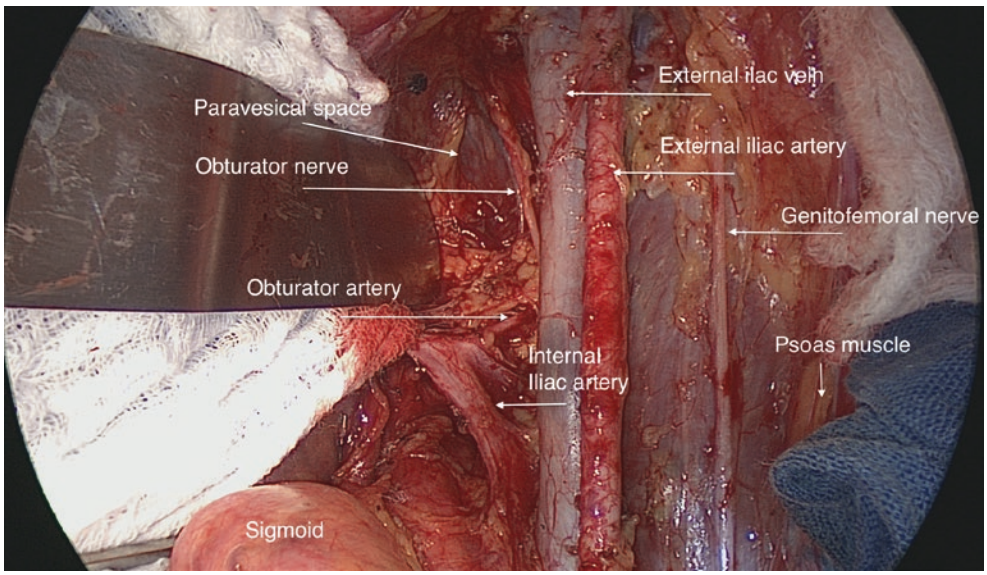


Fig. 102.4 Right lymph node dissection

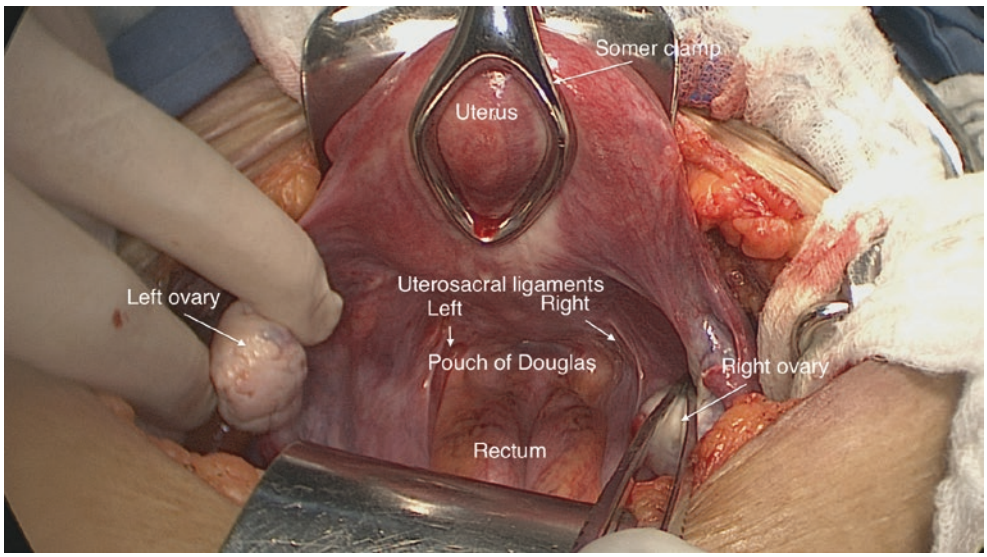


Fig. 102.5 Posterior view, uterine clamp

good performance regarding, detection rate , sensitivity and specificity [8].

The uterus is gently grasped with a Somer uterine elevating forceps (Aesculap Surgical Instruments, Tuttlingen, Germany) (Fig. 102.5). After exposing the paravesical and pararectal spaces bilaterally, the ureters must be identified bilaterally before proceeding with any pelvic dissection. Care must be taken to assure that the infundibulopelvic ligaments with the ovarian vessels are intact. In addition, special attention must be paid to assure that there is no injury to the fallopian tubes or the utero-ovarian ligament. Therefore, surgeons must place special emphasis to assure that fallopian tubes are not grasped during the surgery. The dissection continues by placing upward traction on the uterus and developing of peritoneal bladder fold. The bladder must be mobilized inferiorly to assure that at least a 1–2 cm margin of upper vagina is secured. The ureters are separated from the peritoneum medially starting the pelvic brim and continuing distally until the point where they course under the uterine vessels. .(Figs. 102.6, 102.7 and 102.8) Often one can also visualize the ureters entering the bladder in the Yabuki's space. (Figs. 102.9 and 102.10) The uterine arteries are then ligated at their origin.

There is some debate regarding preservation of the uterine vessels. According to Tang et al. [9] among 16 patients who had preserved uterine arteries, only two (12.5 %) showed identifiable bilateral uterine arteries, seven (43.6 %) showed unilateral uterine artery occlusion and seven (43.6 %) exhibited bilateral occlusion. The authors concluded that the uterine arteries, when dissected and pre-

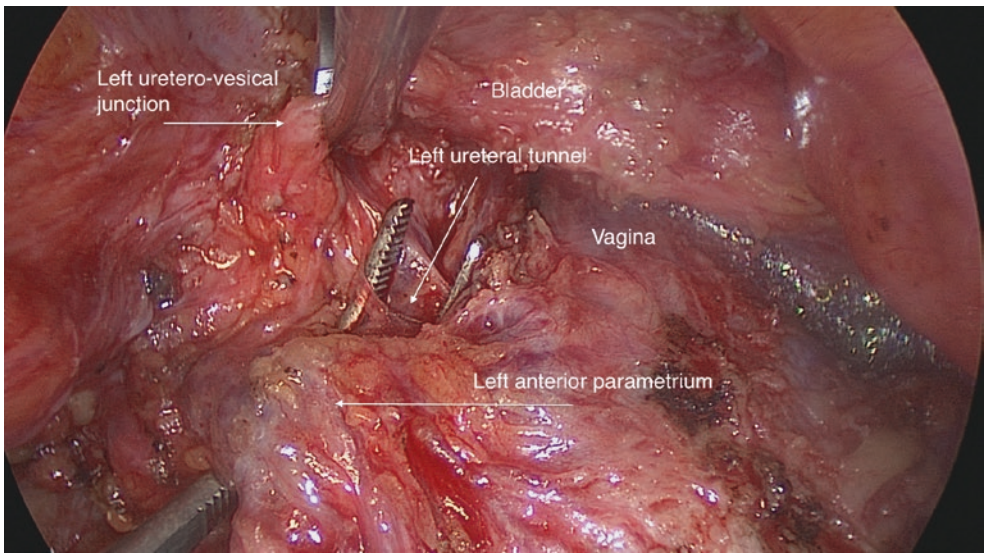


Fig. 102.6 Left ureteral tunnel

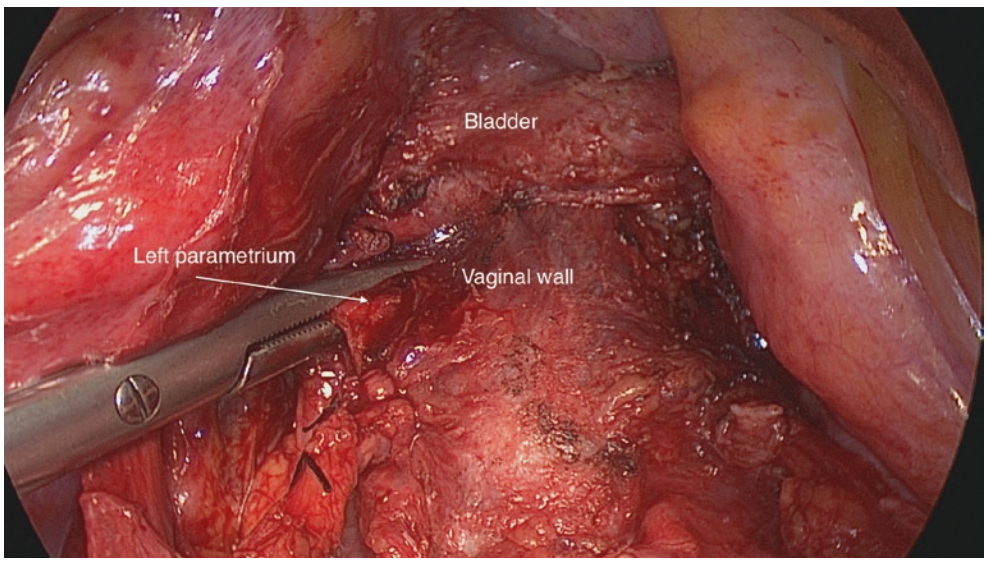


Fig. 102.7 Anterior parametrium

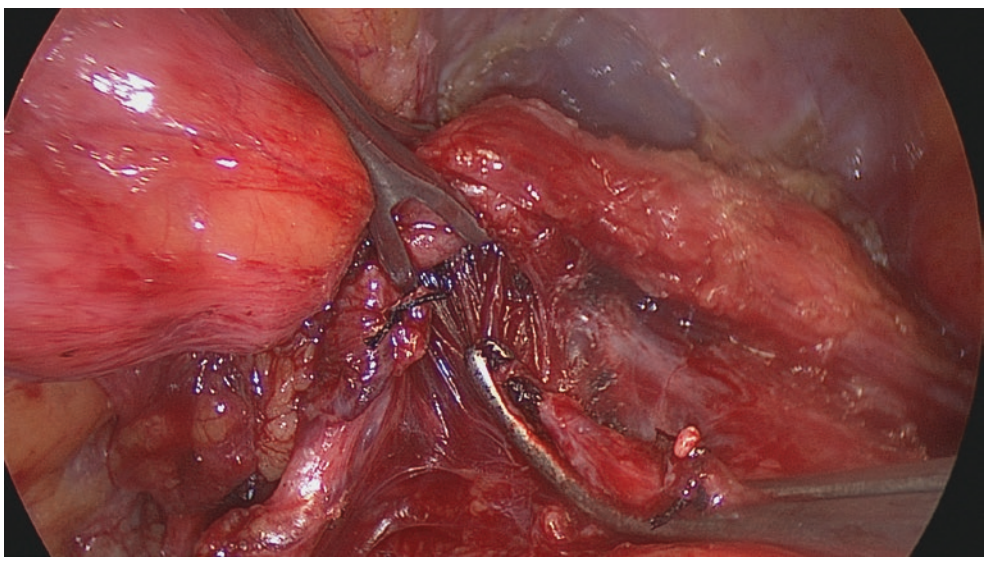


Fig. 102.8 Left uretero-vesical junction

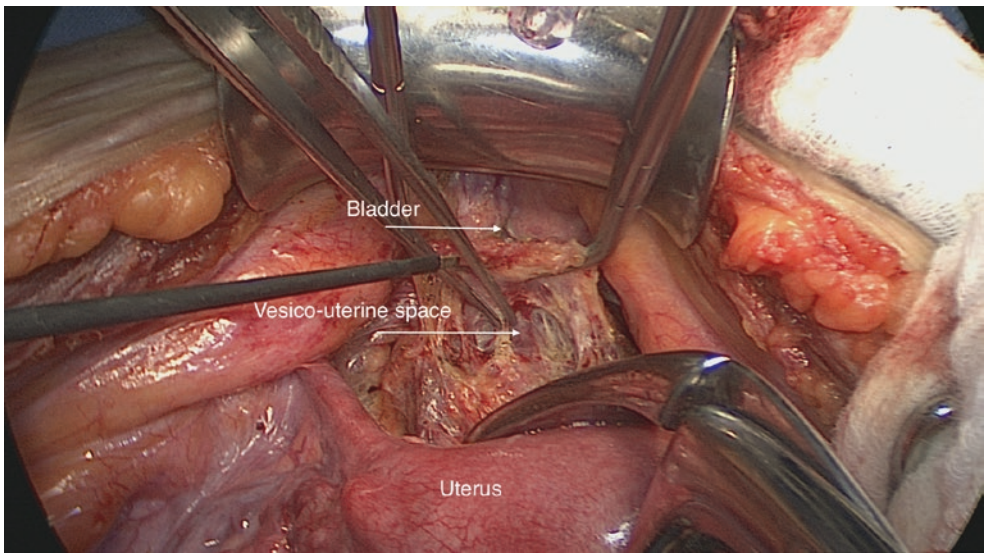


Fig. 102.9 Bladder fold dissection

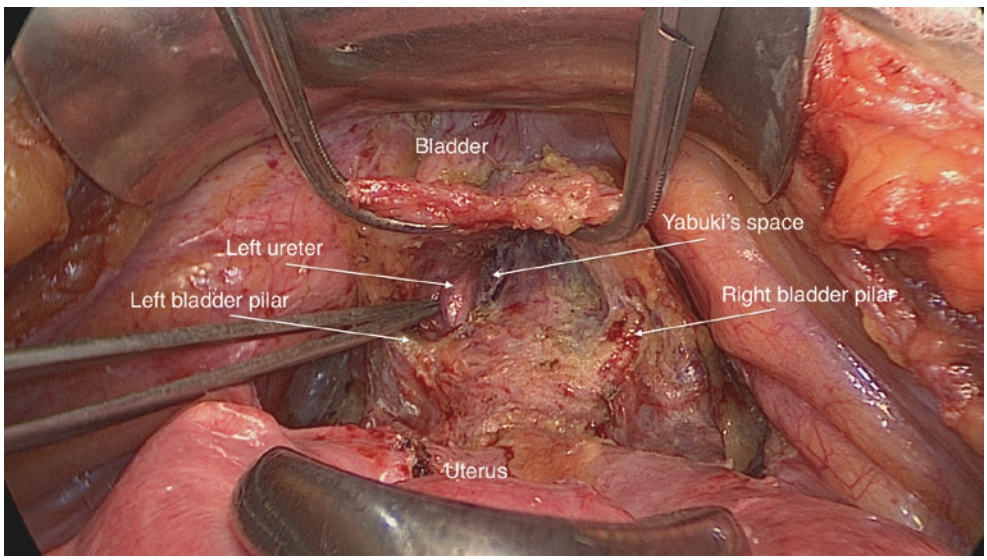


Fig. 102.10 Bladder pilars dissection

served, have an 87.4 % chance of obstruction in the postoperative period, thus the authors do not recommend uterine artery preservation when performing an abdominal radical trachelectomy.

Once the ureters have been properly mobilized bilaterally to the level of insertion into the bladder, surgeons must proceed with medial mobilization of the parametrial tissue bilaterally. This is done by assuring to mobilize the ureters inferiorly and laterally. In addition, surgeons must be certain to transect the vesico uterine ligament to further mobilize the bladder inferiorly. The uterosacral ligaments are then identified and transected bilaterally in medial-most third (Fig. 102.11). The parametrial tissue should be dissected so that there is a lateral margin of resection of approximately 3–5 cm (Fig. 102.12). A colpotomy is then performed circumferentially (Figs. 102.13 and 102.14). At this time, the cervix, parametrial tissue, and upper vagina are amputated from the uterus (Fig. 102.15). The landmark used to help guide with the amputation of the cervix is located approximately 0.5 or 1 cm below the internal uterine os, and the cut is preferably done with cold knife, in order to assure that there is no cauterized tissue that would potentially hinder the pathologic interpretation. The specimen is then sent for frozen section evaluation to assure that at least a 5-mm margin free of tumor (Figs. 102.16 and 102.17).

At this point, surgeons must determine whether they will place a cerclage at the same time of the procedure or do so when the patient becomes pregnant at a later time. In our institution, we prefer to place a cerclage at the time of the radical trachelectomy. The documented advantages of a cerclage are that it is important to reduce undesired obstetric complications such cervical incompetence, second trimester losses, premature rupture of membranes or preterm labor. The potential disadvantages are that it may cause cervical steno-

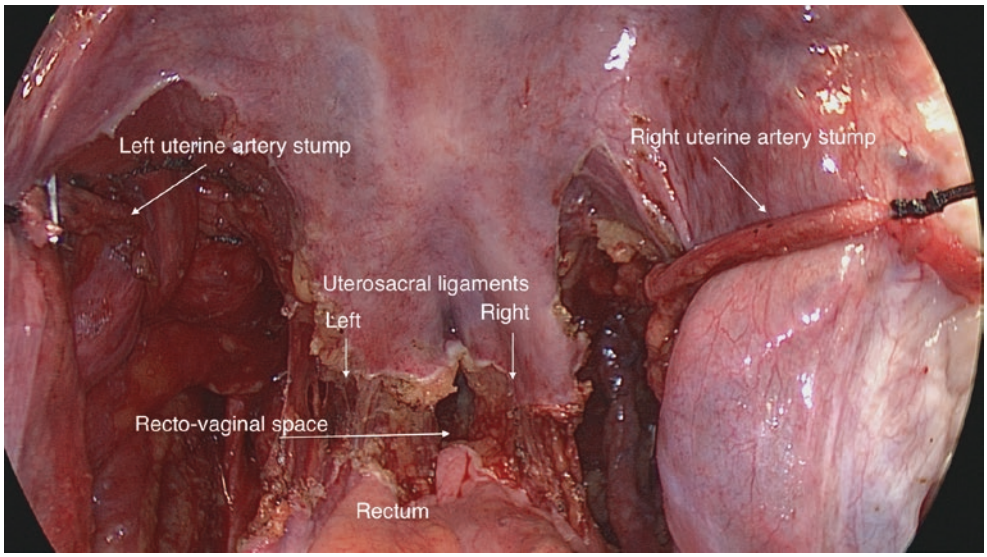


Fig. 102.11 Posterior view

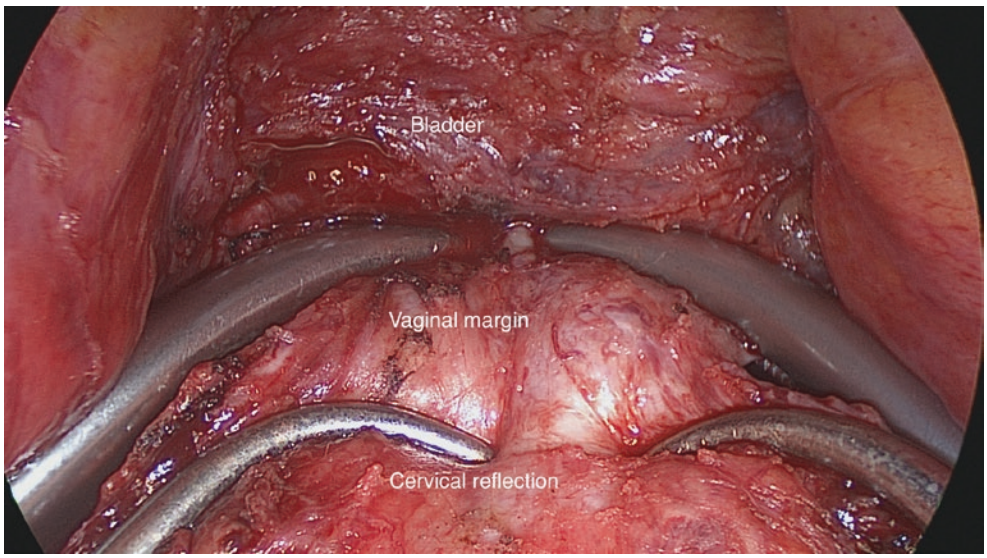


Fig. 102.12 Anterior margins

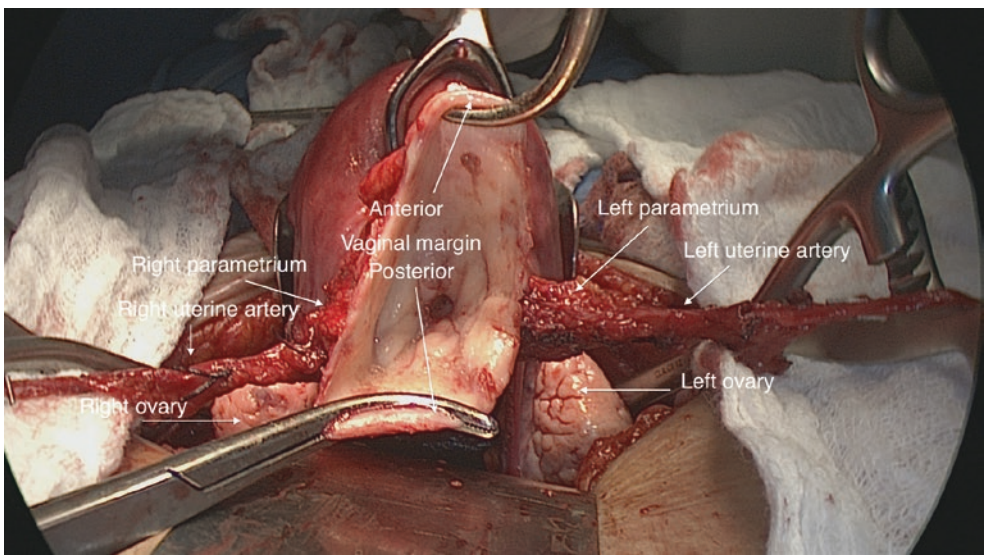


Fig. 102.13 Trachelectomy specimen pre-resection 1

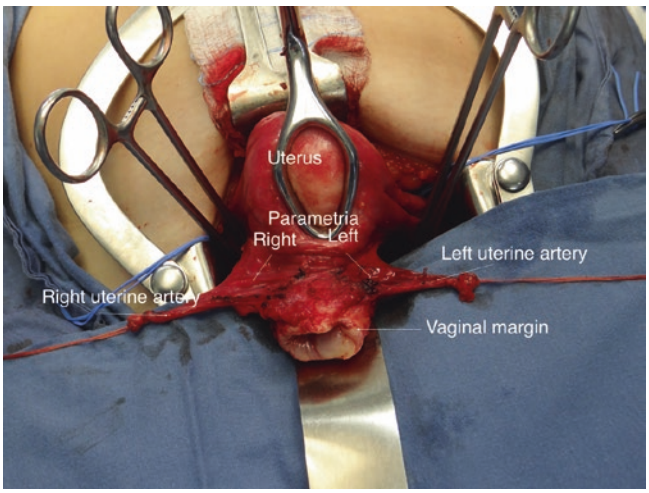


Fig. 102.14 Trachelectomy specimen pre-resection 2

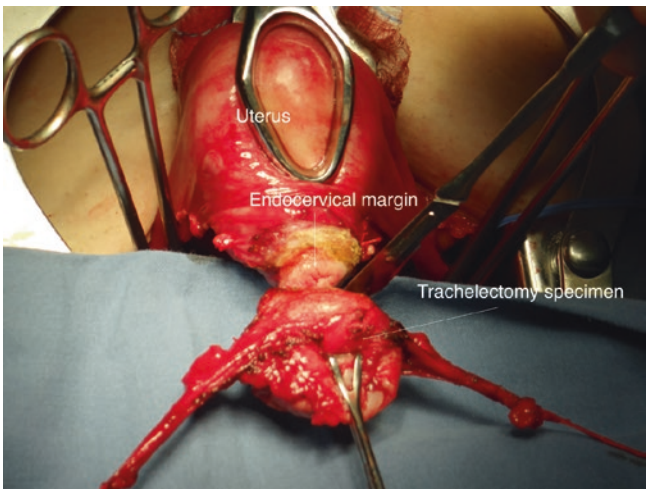
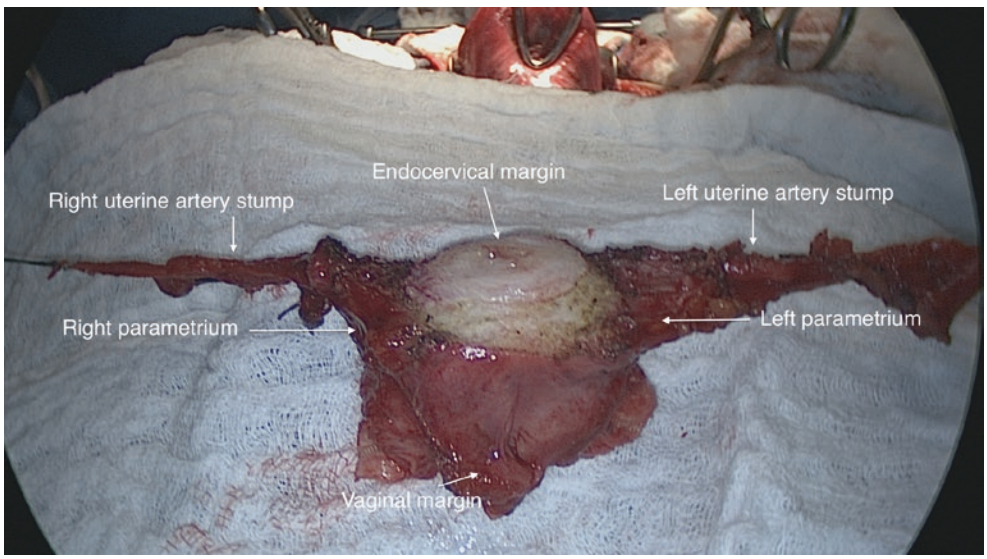


Fig. 102.15 Resection of the specimen

Fig. 102.16 Trachelectomy specimen 1



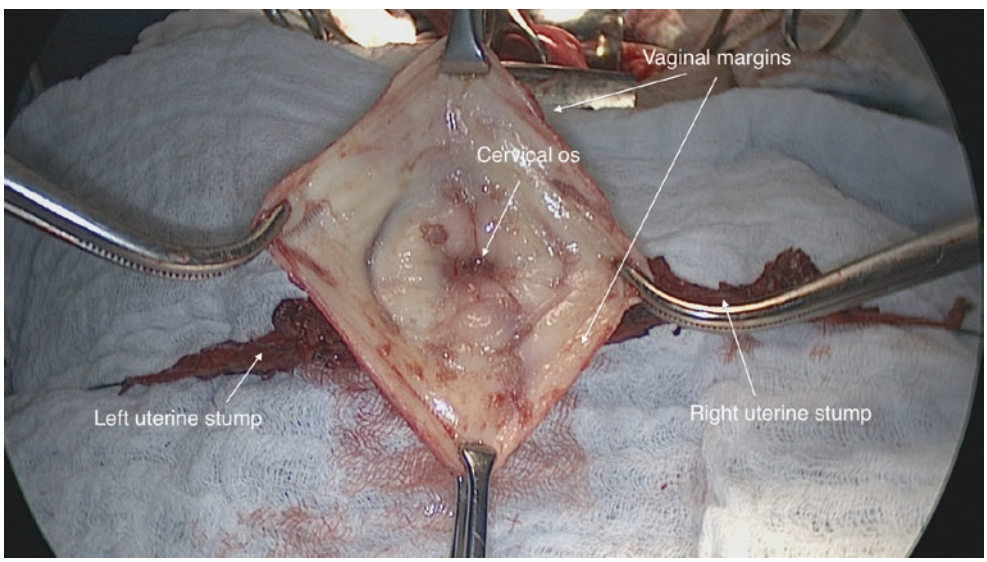


Fig. 102.17 Trachelectomy specimen 2

sis, chronic vaginal discharge, or it may potentially erode through the vagina. In a recent literature review, the investigators showed that the average rate of stenosis rate after radical trachelectomy was 10.5 % (0–73.3 %). The rates of cervical stenosis was 8.6 % when a cerclage was placed and 3.0 % when none was placed. In our institution, we do routinely place a cerclage at the time of radical trachelectomy.

When placing a cerclage, several suture may be used. We prefer to use 0-Ethibond suture(Johnsons & Johnsons, New Jersey, USA). The cerclage is placed approximately 2 cm superior to the lower edge of the uterus in order to decrease the likelihood of cerclage erosion into the vagina as a consequence of placing the cerclage too close to the uterine vaginal anastomosis. The suture of the cerclage should also be placed posteriorly to avoid erosion of the cerclage into the bladder. The abdominal wall is then closed in a routine fashion.

Another area of controversy is whether to place a uterine cannula to prevent the occurrence of future amenorrea after radical trachelectomy. A number of tools have been used such as pediatric Foley catheter or a Smitt sleeve (Elekta AB, Stockholm, Sweden) When placing the Smitt sleeve, it is important to suture the Smitt sleeve to the uterus using 4–0 Chromic suture. Among those in whom a cannula was placed the rate of stenosis was 4.6 % compared to 12.7 % when none was used ($P < 0.001$) [12]. In a recent study by Vieira el at. [10], the investigators used a pediatric Foley in 57 (62 %) of 92 patients versus a Smitt sleeve (Elekta AB, Stockholm, Sweden) in 23 (25 %) of 92 patients or none in 12 patients (13 %). In the Foley catheter group, six (10.5 %) developed cervical stenosis, compared with one (4.3 %) patient who developed stenosis in the Smitt sleeve group and one (8.3 %) patient with no catheter placement. Additionally, Nick et al. showed that the rate of cervical stenosis after radical trachelectomy prior to use of the Smitt sleeve was 14 % and 0 % after implementating its use in every case [11]. When a Smitt sleeve is secured to the uterus, it is then removed 3–4 weeks after the radical trachelectomy.

At this point, the uterus draws its blood supply from the utero-ovarian ligaments that in turn derive their blood supply from the ovarian vessels bilaterally (Fig. 102.18). The uterus is then anastomosed to the vagina using interrupted 2–0 Vicryl sutures. Sutures may be placed continuously or interrupted (Fig. 102.19). Alternatively, one may use a barbed suture, such as a V-loc suture (Covidien, London, UK).

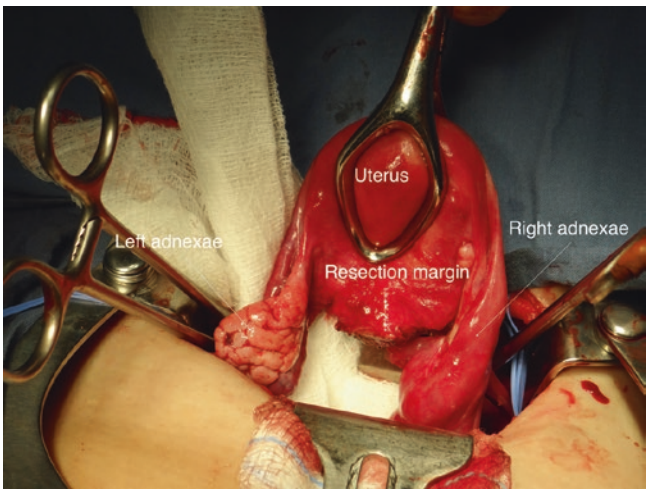


Fig. 102.18 Uterine corpus and adnexae pos-resection

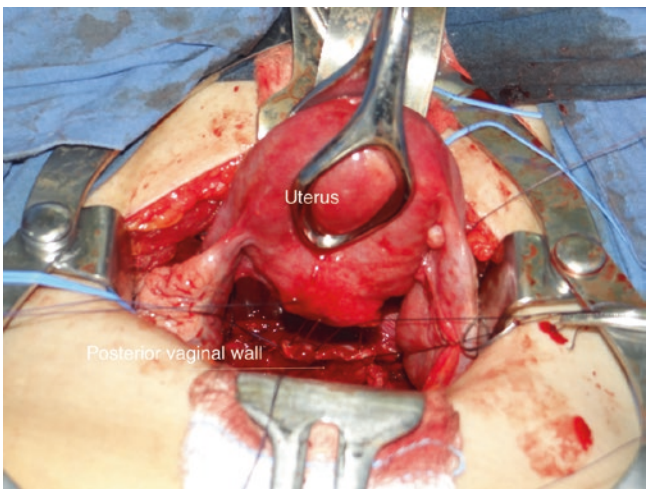


Fig. 102.19 Utero-vaginal anastomosis

Results

As of August 2015, there were a total of 663 intended ART's published in the literature [13–29]. The procedure was performed as planned in 608 patients, whereas in the remaining 55 patients a conversion to a radical hysterectomy was required. Conversions to radical hysterectomies were done for close margins or nodal involvement. The most common histology was squamous cell carcinoma (76 %), and the most frequent stage was IB1 (75 %). Lymphovascular space involvement was present in 21.5 % of cases (Table 102.1). The surgical time ranged from 100 to 611 minutes and the blood loss ranged from 50 to 4300 ml. The transfusion rate among those who reported this information was 42 % (102/238) (Table 102.2).

Intraoperative complications other than bleeding necessiting transfusion are rare, or not reported in most studies. The most common postoperative complication described is cervical stenosis occurring in 9.5 % of patients, followed by infection or abscess in 38 8.6 %, and lymphocyst in 5.9 % of patients [9] (Table 102.3). The global pregnancy rate after ART was 17.9 % which is very similar to 16.2 % described in a recent literature review [9]. Pregnancy rate was calculated as follows: total pregnancies/patients with

Table 102.1 Demographic and tumor information for patients who underwent abdominal radical trachelectomy

Author (year)	N	Median age (range), y	Histology			Stage				Tumor size	LVSI + preop N° (%)
			SCC	AC	Other	IA1 + LVSI	IA2	IB1	Other		
Ungar (2005) [8]	33[a]	+30.5 (23–37)	26	1	3 (1 adsq, 2 glassy)	0	10	15	5 (IB2)	NR	8 (26.6)
Pareja (2008) [8]	15	30 (25–38)	11	4	0	0	3	12	0	<2 cm	5 (33)
Jeremic (2009) [10]	12	+30.5 (22–40)	12	0	0	2	7	3	0	<2 cm	NR
Yao (2010) [11]	10	+29 (28–30)	8	2	0	0	5	5	0	<2 cm	NR
Du (2011) [12]	68	+28 (18–41)	68	0	0	3	28	37	0	56 <2 cm, 12 >2 cm	NR
Li (2011) [13]	64[b]	29.5 (11–41)	50	8	4 (3 bot, 1 adsq)	16	7	36	0	45 <2 cm, 14 >2 cm	NR
Nick (2011) [14]	25	28.8 (21.4–37.2)	7	15	3 (adsq)	2	7	16	0	NR	2 (8)
Saso (2012) [15]	30	+32.5 (23–41)	15	10	5 (4 adsq, 1 glassy)	0	2	25	3 (2 IB2 1 IIA)	25 <2 cm, 5 >2 cm	NR
Muraji (2012) [16]	23	33 (25–42)	16	6	1 (adsq)	2	2	19	0	NR	5 (21.7)
Karateke (2012) [17]	8	27 (18–35)	4	3	1 (clear)	0	0	7	1 (IIA)	3 <2 cm, 5 >2 cm	3 (37.5)
Wethington (2012) [18]	101	+31 (19–43)	40	54	7 (6 adsq, 1 clear)	3	8	88	2 (IB2, IIA)	NR	47 (47)
Testa (2013) [19]	30	31 (22–40)	20	59	0	0	6	19	0	1.2 (0.4–3.5)	5 (20)
Nishio (2013) [20]	114	33 (25–40)	99	14	1 (adsq)	9	12	93	0	NR	55 (48.2)
Cao (2013) [21]	73	31 (22–39)	64	9	0	5	10	58	0	0:20,<2:29,>2:24	NR
Kucukmentin (2014) [22]	16	26 (24–36)	13	3	0	0	0	16	0	NR	8 (57)
Capilna (2014) [23]	29	32 (24–40)	15	3	8 (adsq)	0	11	14	1 (IB2)	1.8 (0.3–4.2)	NR
Tokunaga (2014) [24]	42	32 (22–39)	42	0	0	1	4	37	0	NR	5 (11.9)

AC adenocarcinoma, *adsq* adenosquamous carcinoma, *bot* sarcoma botryoides, *clear* clear cell carcinoma, *glassy* glassy cell carcinoma, *LVSI* lymph-vascular space invasion, *NR* not reported, *preop* preoperative, *SCC* squamous cell carcinoma

[a]Histology and stage not reported for 3 patients

[b]Histology not reported for 2 patients; stage and tumor size not reported for 5 patients

[c]Histology and stage not reported for 10 patients

[d]Stage not reported for 3 patients

[e]Tumor size not reported in

+ Mean

fertility preservation. It is important to highlight that not all authors report the number of patients seeking to get pregnant, but among those reporting this information, the percentages fluctuate between 16.9 % [11] and 60 % [25]. Obtetrical outcomes show that there were 109 pregnancies out of a total 658 patients who maintained their fertility, with 25 miscarriages (14 first trimester and 9 s trimester). A total of 14 patients had an ongoing pregnancy at the time of report. There were 71 deliveries, 24 of them at term, 28 preterm, and 19 without information on delivery time. Table 102.4 summarizes the obstetrical results.

Given the current data on abdominal radical trachelectomy, it seems that this procedure is safe and feasible and offers patients with early-stage cervical cancer a very reasonable option for fertility preservation with excellent oncologic outcomes. In the future, perhaps less radical approaches, such as simple conization or simple hysterectomy, will be feasible for select patients with low-risk criteria.

Table 102.2 Intraoperative and postoperative outcomes for patients who underwent abdominal radical trachelectomy

				Outcomes of trachelectomy								
Author (year)	No. of planned trachelectomies	Trachelectomy done, n (%)	Immediate hysterectomy, n (%)	Median surgical time (range), min	Median blood loss (range), mL	Transfusions, n (%)	Median no. of pelvic nodes removed (range)	No. of patients with positive pelvic nodes	No residual disease, n (%)	Follow up, months (range)	Relapses	Deaths
Ungar (2005) [8]	33	30 (90.9)	3 (9)	+226 (170–300)	NR	20 (66.6)	+32.2 (17–44)	2	NR	32 (14–75)	0	0
Pareja (2008) [8]	15	15 (100)	0	265 (210–330)	400 (200–1000)	4 (27)	26 (11–48)	0	7 (47)	32 (5–32)	0	0
Jeremic (2009) [10]	12	11 (91.6)	1 (8.3)	NR	NR	NR	NR	1	NR	NR	0	0
Yao (2010) [11]	10	10 (100)	0	+261 (204–345)	+370 (150–500)	NR	NR	0	NR	(4–68)	0	0
Du (2011) [12]	68	60 (88.2)	8 (11.8)	NR	NR	NR	NR	8	NR	38 (3–84)	2	0
Li (2011) [13]	64	62 (96.8)	2 (3.12)	148 (110–230)	362 (100–700)	4 (6.45)	25 (12–53)	5	NR	22.8 (1–78)	0	0
Nick (2011) [14]	25	24 (96)	1 (4)	328 (203–392)	300 (50–1100)	2 (8)	18 (7–33)	3	16 (64)	26.4 (0.30–64.9)	0	0
Saso (2012) [15]	30	30 (100)	0	+170 (110–300)	+813 (50–4300)	6 (20)	24 (7–52)	3	NR	24 (7–113)	3	2
Muraji (2012) [16]	23	21 (91.3)	2 (8.7)	NR (175–352)	NR (200–988)	NR	NR	1	17 (68)	(2–45)	0	0
Karateke (2012) [17]	8	8 (100)	0	163 (120–210)	NR	1 (12.5)	32 (19–48)	0	2 (25)	33 (5–92)	0	0
Wethington (2012) [18]	101	81 (80)	20 (20)	NR	NR	NR	24 (2–60)	19	29 (44)	32 (1–124)	4	0
Testa (2013) [19]	30	27 (90)	3 (10)	240 (210–270)	350 (200–650)	0	21 (11–33)			29(4–68)	0	0
Nishio (2013) [20]	114	61 (85.9)	0	NR	NR	60(52 %)	NR	15	33 (54)	NR	6	NR

Cao (2013) [21]	73	73 (100)	0	177 (100–370)	322 (100–2700)	NR	26 (12–43)			20(6–42)	0	0
Kucukmentin (2014) [22]	16	16 (100)	0	NR	NR	NR	12 (8–19)			43 (8–110)	1	0
Capilna (2014) [23]	29	26 (89.6)	3 (11)	254 (182–302)	NR	NR	38 (16–60)			20(4–43)	1	0
Tokunaga (2014) [24]	42	42	0	304 (233–611)	848 (250–3984)	5(11.9 %)	35 (7–68)			29 (1–122)	3	2

NR not reported
[a]Twenty-one patients received adjuvant chemotherapy
[b]No available data to calculate outcomes
+ Mean

Table 102.3 Intraoperative and postoperative complications for patients who underwent abdominal radical trachelectomy

Reference	No. of patients undergoing trachelectomy	Intraoperative complications	Postoperative complications
Li	64	Transfusions (n = 4)	Cervical stenosis (n = 5), infected lymphocyst (n = 2), vesical dysfunction (n = 1)
Ungar	33	Transfusions (n = 20), ureteral injury (n = 1)	Antibiotic use (n = 14), endometrial cavity obliteration (n = 2)
Cibula	24	None	None
Abu Rustum	22	None	Cervical stenosis (n = 4), cerclage erosion (n = 1), infected lymphocyst (n = 2), amenorrhea (n = 1), leg lymphedema (n = 1)
Pareja	15	Transfusions (n = 4), injury to external iliac artery (n = 1)	Tuboovarian abscess (n = 1), cerclage expulsion (n = 2), voiding disfunction (n = 1), pelviperitonitis (n = 1)
Olawaiye	10	Pulmonary embolism (n = 1)	Cervical stenosis (n = 2), cerclage expulsion (n = 2)
Yao	10	None	Lymphocyst (n = 1)
Jeremic	12	Not reported	Not reported
Du	68	None	Cervical stenosis (n = 17), leg lymphedema (n = 7), infected lymphocyst (n = 5), amenorrhea (n = 3)
Saso	30	Not reported	Hematocolpos (n = 1), uterovaginal suture detachment (n = 1), omental prolapse through vaginal sutures (n = 1)
Nick	32	None	Urinary tract infection or urinary retention (n = 7), fever (n = 5) abnormal uterine bleeding or amenorrhea (n = 8) cerclage erosion (n = 4), cervical stenosis (n = 3)
Muraji	23	None	Amenorrhea (n = 2), lymphocyst (n = 4), cervical stenosis (n = 2)
Testa	30	None	Cervical stenosis (n = 3), tuboovarian abscess (n = 1), lymphocyst (n = 2)
Nishio	114	Transfusions (n = 60), secondary hemorrhage necessitating laparotomy (n = 1)	Cervical stenosis (n = 1), amenorrhea (n = 5), postsurgical infection (n = 15), lymphocyst requiring drainage (n = 9)
Cao	73	Pelvic vein tear (n = 1)	None
Kucukmentin	16	None	Urinary tract infection or urinary retention (n = 12), cerclage erosion (n = 1), ureterovaginal fistula (n = 1), cervical stenosis (n = 1)
Caplina	29	None	Cervical stenosis (n = 1)
Tokunaga	42	Ureteral injury (n = 1)	Lymphocyst (n = 4), ileus (n = 1)

Table 102.4 Pregnancy rates and obstetrical outcomes for patients who underwent abdominal radical trachelectomy

Author	No. of planned trachelectomies	Trachelectomy done, n (%)	Attempting to conceive, n (%)	Pregnancies	Miscarriages		Deliveries		Patients pregnant at time of report
					1st term	2nd term	At term	Preterm	
Ungar (2005) [8]	33	30 (90.9)	NR	3	1	0	2	0	0
Pareja (2008) [8]	15	15 (100)	6/14 (42.8)	3	0	0	2	1	0
Jeremic (2009) [10]	71	61 (85.9)	29/57 (50.8)	4	0	0	2	2	0
Yao (2010) [11]	12	11 (91.6)	NR	NR	NR	NR	NR	NR	NR
Du (2011) [12]	10	10 (100)	NR	2	0	0	1	1	0
Li (2011) [13]	68	60 (88.2)	15/60 (25)	8	1[a]		3	2	2
Nick (2011) [14]	64	62 (96.8)	10/59 (16.9)	2	0	0	1	0	1
Saso (2012) [15]	25	24 (96)	11/21 (52.3)	3	1	1	0	1	0
Muraji (2012) [16]	30	30 (100)	NR	3	0	1	2	0	0
Karateke (2012) [17]	23	21 (91.3)	NR	1	0	0	0	1	0
Wethington (2012) [18]	8	8 (100)	NR	3	0	1	1	1	0
Ungar (2005) [8]	101	81 (80)	38/70 (54.2)	31	3	6	16[b]		6
Testa (2013) [19]	30	27 (90)	6(20 %)	3	0		1	2	0
Nishio (2013) [20]	114	61 (85.9)	69(60 %)	31	5		4	17	5
Cao (2013) [21]	73	73 (100)	34(46 %)	3	0		3	0	0
Kucukmentin (2014) [22]	16	16 (100)	NR	1	0		1	0	0
Capilna (2014) [23]	29	26 (89.6)	7(27 %)	3	2		1	0	0
Tokunaga (2014) [24]	42	42	18(42 %)	5	2		3 ϕ		0

NR not reported
[a]Trimester in which miscarriage occurred not indicated
[b]Delivery time not indicated

References

1. NCC Network. Cervical cancer. NCCN clinical practice guidelines in oncology; 2015.
2. Dargent D, Brun JL, Roy M, Remy I. Pregnancies following radical trachelectomyfor invasive cervical cancer. Gynecol Oncol. 1994;52:105.
3. Smith JR, Boyle DC, Corless DJ, Ungar L, Lawson AD, Del Priore G, et al. Abdominal radical trachelectomy: a new surgical technique for the conservative manage- ment of cervical carcinoma. Br J Obstet Gynaecol. 1997;104:1196–200.
4. Kim JH, Park JY, Kim DY, Kim YM, Kim YT, Nam JH. Fertility-sparing laparoscopic radical trachelectomy for young women with early stage cervical cancer. BJOG. 2010;117:340–7.
5. Park JY, Joo WD, Chang SJ, Kim DY, Kim JH, Kim YM, et al. Long-term outcomes after fertility-sparing laparoscopic radical trachelectomy in young women with early-stage cervical cancer: an Asan Gynecologic Cancer Group (AGCG) study. J Surg Oncol. 2014;110:252–7.
6. Nick AM, Frumovitz MM, Soliman PT, Schmeler KM, Ramirez PT. Fertility sparing surgery for treatment of early-stage cervical cancer: open vs. robotic radical trachelectomy. Gynecol Oncol. 2012;124(2):276–80. doi:10.1016/j.ygyno.2011.09.035. Epub 2011 Oct 27
7. Persson J, Imboden S, Reynisson P, Andersson B, Borgfeldt C, Bossmar T. Reproducibility and accuracy of robot-assisted laparoscopic fertility sparing radical trachelectomy. Gynecol Oncol. 2012;127(3):484–8. doi:10.1016/j.ygyno.2012.08.022. Epub 2012 Aug 28
8. Du XL, Sheng XG, Jiang T, Li QS, Yu H, Pan CX, et al. Sentinel lymph node biopsy as guidance for radical trachelectomy in young patients with early stage cervical cancer. BMC Cancer. 2011;11:157.
9. Tang J, Li J, Wang S, Zhang D, Wu X. On what scale does it benefit the patients if uterine arteries were preserved during ART? Gynecol Oncol. 2014;134:154–9.
10. Vieira MA et al. Radical trachelectomy in early-stage cervical cancer: A comparison of laparotomy and minimally invasive surgery. Gynecol Oncol. 2015;138:585–9.
11. Nick AM, Frumovitz MM, Soliman PT, Schmeler KM, Ramirez PT. Fertility sparing surgery for treatment of early-stage cervical cancer: open vs. robotic radical trachelectomy. Gynecol Oncol. 2012;124:276–80.
12. Li X, Li J, Wu X. Incidence, risk factors and treatment of cervical stenosis after radical trachelectomy: a systematic review. Eur J Cancer. 2015;51(13):1751–9. doi:10.1016/j.ejca.2015.05.012. Epub 2015 Jun 3.
13. Ungar L, Palfalvi L, Hogg R, Siklos P, Boyle DC, Del Priore G, et al. Abdominal radical trachelectomy: a fertility-preserving option for women with early cervical cancer. BJOG. 2005;112:366–9.

14. Pareja FR, Ramirez PT, Borrero FM, Angel CG. Abdominal radical trachelectomy for invasive cervical cancer: a case series and literature review. Gynecol Oncol. 2008;111:555–60.
15. Jeremic K, Petkovic S, Stefanovic A, Stojnic J, Maksimovic M, Likic I, et al. Radical abdominal trachelectomy in managing early cervical invasion. Eur J Gynaecol Oncol. 2009;30:309–12.
16. Yao T, Mo S, Lin Z. The functional reconstruction of fertility-sparing radical ab- dominal trachelectomy for early stage cervical carcinoma. Eur J Obstet Gynecol Reprod Biol. 2010;151:77–81.
17. Du XL, Sheng XG, Jiang T, Li QS, Yu H, Pan CX, et al. Sentinel lymph node biopsy as guidance for radical trachelectomy in young patients with early stage cervical cancer. BMC Cancer. 2011;11:157.
18. Li J, Li Z, Wang H, Zang R, Zhou Y, Ju X, et al. Radical abdominal trachelectomy for cervical malignancies: surgical, oncological and fertility outcomes in 62 patients. Gynecol Oncol. 2011;121: 565–70.
19. Nick AM, Frumovitz MM, Soliman PT, Schmeler KM, Ramirez PT. Fertility sparing surgery for treatment of early-stage cervical cancer: open vs. robotic radical trachelectomy. Gynecol Oncol. 2012;124:276–80.
20. Saso S, Ghaem-Maghami S, Chatterjee J, Naji O, Farthing A, Mason P, et al. Abdom- inal radical trachelectomy in West London. BJOG. 2012;119:187–93.
21. Muraji M, Sudo T, Nakagawa E, Ueno S, Wakahashi S, Kanayama S, et al. Type II versus type III fertility-sparing abdominal radical trachelectomy for early-stage cervical cancer: a comparison of feasibility of surgical outcomes. Int J Gynecol Cancer. 2012;22: 479–83.
22. Karateke A, Cam C, Celik C, Baykal B, Tug N, Ozbasli E, et al. Radical trachelectomy in late pregnancy: is it an option? Eur J Obstet Gynecol Reprod Biol. 2010;152:112–3.
23. Wethington SL, Cibula D, Duska LR, Garrett L, Kim CH, Chi DS, et al. An interna- tional series on abdominal radical trachelectomy: 101 patients and 28 pregnan- cies. Int J Gynecol Cancer. 2012;22: 1251–7.
24. Testa R, Ramirez PT, et al. Abdominal radical trachelectomy: a safe and feasible option for fertility preservation in developing countries. J Low Genit Tract Dis. 2013;17(4):378–84.
25. Nishio H, Fujii T, et al. Reproductive and obstetric outcomes after radical abdominal trachelectomy for early-stage cervical cancer in a series of 31 pregnancies. Hum Reprod. 2013;28(7): 1793–8.
26. Cao DY, Yang JX, et al. Comparisons of vaginal and abdominal radical trachelectomy for early-stage cervical cancer: preliminary results of a multi-center research in China.China Gynecologic Oncology Group. Br J Cancer. 2013;109(11):2778–82.
27. Kucukmetin A, Biliatis I, et al. Laparoscopic radical trachelectomy is an alternative to laparotomy with improved perioperative outcomes in patients with early-stage cervical cancer. Int J Gynecol Cancer. 2014;24(1):135–40.
28. Căpîlna ME, Ioanid N, et al. Abdominal radical trachelectomy: a Romanian series. Int J Gynecol Cancer. 2014;24(3):615–9.
29. Tokunaga H, Watanabe Y, et al. Outcomes of abdominal radical trachelectomy: results of a multicenter prospective cohort study in a Tohoku Gynecologic Cancer Unit. Int J Clin Oncol. 2015; 20(4):776–80.