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Characteristics and outcomes of reproductive-aged women with early-stage cervical cancer: trachelectomy *versus* hysterectomy

Hiroko Machida, MD, PhD¹, Rachel S. Mandelbaum, MD², Mikio Mikami, MD, PhD¹, Takayuki Enomoto, MD, PhD³, Yukio Sonoda, MD⁴, Brendan H. Grubbs, MD⁵, Richard J. Paulson, MD⁶, Lynda D. Roman, MD^{2,7}, Jason D. Wright, MD⁸, Koji Matsuo, MD, PhD^{2,7,*}

¹)Department of Obstetrics and Gynecology, Tokai University School of Medicine, Kanagawa, Japan.

²)Division of Gynecologic Oncology, Department of Obstetrics and Gynecology, University of Southern California, Los Angeles, CA, USA

³)Department of Obstetrics and Gynecology, Niigata University School of Medicine, Niigata, Japan.

⁴)Gynecology Service, Department of Surgery, Memorial Sloan Kettering Cancer Center, New York, NY, USA

⁵)Division of Maternal-Fetal Medicine, Department of Obstetrics and Gynecology, University of Southern California, Los Angeles, CA, USA

⁶)Division of Reproductive Endocrinology and Infertility, Department of Obstetrics and Gynecology, University of Southern California, Los Angeles, CA, USA

⁷)Norris Comprehensive Cancer Center, University of Southern California, Los Angeles, CA, USA

⁸)Department of Obstetrics and Gynecology, Columbia University College of Physicians and Surgeons, New York, NY, USA.

Abstract

Background: Trachelectomy is the treatment of choice for reproductive-aged women with early-stage cervical cancer who desire future fertility. Comprehensive population-based statistics have been missing to date.

*All corresponding to: Koji Matsuo, MD, PhD, Division of Gynecologic Oncology, Department of Obstetrics and Gynecology, University of Southern California, 2020 Zonal Avenue IRD520, Los Angeles, CA90033, USA, Tel: +1-323-409-3416, Fax: +1-323-226-3427, koji.matsuo@med.usc.edu.

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Condensation: There has been an increase in the proportion of reproductive-aged women who underwent trachelectomy for early-stage cervical cancer with similar survival to those treated with hysterectomy.

Part of the study was presented at 49th Annual Meeting on Women's Cancer, New Orleans, LA, March 24–27, 2018.

Objective: To compare characteristics and survival of reproductive-aged women who underwent trachelectomy for early-stage cervical cancer to those who had hysterectomy.

Methods: This is a retrospective observational study examining the Surveillance, Epidemiology, and End Results Program between 1998 and 2014. Women less than 45 years of age with stage IA and IB1 (tumor size ≤ 2 cm) cervical cancer who underwent trachelectomy were compared to those who underwent hysterectomy. Multivariable models were used to identify clinico-pathological factors associated with trachelectomy. Survival was compared between the two groups after propensity score matching.

Results: Among 6,359 women, 190 (3.0%, 95% confidence interval [CI] 2.6–3.4) underwent trachelectomy. The median age of the trachelectomy group was 31 years (inter-quartile range, 28–34). The proportion of women who underwent trachelectomy significantly increased during the study period (1.2% in 1998–2002, 3.0% in 2003–2008, and 4.5% in 2009–2014, $P<0.001$). Younger age, non-black race, single marital status, Eastern registry area, recent disease diagnosis, non-squamous histology, and higher stage were independent factors associated with trachelectomy use (all, adjusted- $P<0.05$). After propensity score matching, 5-year cause-specific survival (96.9% *versus* 96.6%, hazard ratio 0.73, 95% CI 0.23–2.30, $P=0.59$) and overall survival (96.1% *versus* 96.6%, hazard ratio 0.76, 95% CI 0.26–2.20, $P=0.61$) were similar between the trachelectomy group and the hysterectomy group.

Conclusion: Our study found that there was a significant increase in the proportion of reproductive-aged women with stage IA or IB1 (≤ 2 cm) cervical cancer who underwent trachelectomy in recent years. Survival with trachelectomy was similar to those who had hysterectomy in this population.

Keywords

trachelectomy; cervical cancer; trend; survival

INTRODUCTION

Cervical cancer remains the most common gynecologic malignancy in reproductive-aged women in the United States.¹ The American Cancer Society predicts that about 13,240 new invasive cervical cancer cases will be diagnosed in the U.S. in 2018,² and more than 4,000 women are expected to die from the disease this year.¹ Early-stage cervical cancer generally has a favorable prognosis with either surgery or radiation.³ Standard surgical management of early-stage cervical cancer includes simple or radical hysterectomy with or without pelvic lymphadenectomy depending on disease stage and histology.^{4,5} While these surgical treatments offers the potential for disease cure, they also result in the loss of future fertility in a reproductive-aged population.

Generally, the risk of occult corpus invasion is low in early-stage cervical cancer, and some argue that uterine preservation can be safe in this subset of young women.^{6,7,8,9} However, in women whose tumors exhibit factors that may increase the risk of cancer metastasis and recurrence, such as lymphatic or vascular invasion, large tumor size, and specific histological subtypes, uterine corpus preservation is generally not recommended.^{10,11,12}

The National Comprehensive Cancer Network (NCCN) guidelines suggest that trachelectomy, the removal of the uterine cervix and adjacent tissues, may be a reasonable fertility-sparing treatment option for stage IA and IB1 (tumor size ≤ 2 cm) cervical cancer.⁵ Uterine preservation should thus be considered “optional” after weighing risks and benefits of this treatment strategy. The utilization for trachelectomy among young women with early-stage cervical cancer has not yet been well examined. The objective of this study was to examine the trends, characteristics, and survival outcomes among young women with early-stage cervical cancer who underwent trachelectomy.

MATERIALS AND METHODS

Study Design and Eligibility

The Surveillance, Epidemiology, and End Results (SEER) Program is a population-based tumor registry that is supported and managed by the National Cancer Institute in the United States. It includes data beginning in 1973, and covers 27.8% of the US population from 11 States and 7 areas.¹³ It is both publicly available and deidentified, thus this study was deemed exempt by the University of Southern California and Tokai University Institutional Review Boards. Registrars responsible for entering data into SEER are trained by the National Cancer Registrars Association to maintain rigorous quality control.

SEER*Stat 8.3.5 (IMS Inc., Calverton, MD, USA) was used to extract data between 1973 and 2014. Cases were identified within the category for “Cervix Uteri” and limited to malignancy. Within the extracted dataset, stage I cervical cancer cases with known surgical procedure types between 1998 and 2014 were included in the study. Data from 1973–1997 were removed due to lack of detailed information regarding the surgical procedure. Eligible histologic types included squamous, adenocarcinoma, and adenosquamous. Other rare histology types such as small cell neuroendocrine tumors were excluded based on the NCCN guideline recommendation.⁵ Cervical sarcomas and metastatic tumors to the uterine cervix originating from other organs were also excluded, as were women who had received preoperative radiotherapy.

Clinical Information

Variables extracted from the database included patient demographics, tumor information, treatment types, and survival outcomes. Patient demographics included age, year at diagnosis, race/ethnicity, marital status, and registration area. Tumor information included cancer stage, histologic subtype, tumor differentiation grade, tumor size, and lymph node status. Treatment types included surgical treatment and postoperative treatment (radiotherapy and chemotherapy). Survival information included cause-specific survival and overall survival.

Study Definitions

Recorded disease stage was re-classified based on the American Joint Committee on Cancer TNM 7th edition classification.¹⁴ ICD-O-3 site/histology validation list and World Health Organization histological classification were used for grouping histologic subtypes as shown in Table S1.¹³ Women with a surgical code for trachelectomy were classified as having

undergone trachelectomy, removal of cervical stump, and cervicectomy, while women with a surgical code for hysterectomy were categorized based on the type of hysterectomy that was introduced as “RX Summ--Surg Prim Site” in Table S2. Cases in which surgical codes did not specify the type of hysterectomy were classified as hysterectomy, not otherwise specified.

An age cutoff of <45 years was chosen to capture reproductive age women based on previous work.¹⁵ In this database, survival data were collected *via* linkage with state mortality records and the National Death Index. Cause-specific survival was defined as the time interval between the initial cervical cancer diagnosis and death due to cervical cancer, while overall survival was defined as the time interval between the initial cervical cancer diagnosis and death from any reason (all-cause).

Statistical Analysis

The primary objective of the analysis was to examine trends and characteristics associated with trachelectomy use. The secondary objective was to examine survival in women who underwent trachelectomy for cervical cancer. For these analyses, women who underwent trachelectomy were compared to those who underwent hysterectomy.

Continuous variables were expressed as the mean ($\pm$ standard difference, SD) or as the median (interquartile range, IQR) based on normality, and the statistical significance was assessed by the Student *t* test or the Mann-Whitney *U* test as appropriate. Ordinal and categorical variables were examined with the chi-square or the Fisher exact test as appropriate. A binary logistic regression model was used for multivariable analysis to determine independent factors associated with trachelectomy use, and the magnitude of statistical significance was expressed as an odds ratio (OR) with 95% confidence interval (CI). In this model, patient demographics and tumor factors were entered in the final model. The Hosmer-Lemeshow test was used to assess the goodness-of-fit in the final model, and a *P*-value of 0.05 or greater was considered a good-fit model.¹⁶

The Joinpoint Regression Program (version 4.6.0.0) provided by the National Cancer Institute was utilized for evaluating temporal trends of the proportion of women <45 years of age with stage IA and IB1 (tumor size ≤ 2 cm) cervical cancer who underwent trachelectomy. Time point data were examined every calendar year to identify temporal changes. The presence of annual trend was examined with a linear segmented regression test, and log-transformation was performed to determine the annual percent change (APC) and 95% CI.

Survival analysis was performed to examine the association between trachelectomy and cause-specific / overall survival. The Kaplan-Meier method was used to construct survival curves, and the statistical difference between the curves was compared with the log-rank test. Survival estimate was examined using Cox proportional hazard regression models, and the magnitude of statistical significance was expressed with hazard ratios (HR) and 95% CI.

We performed propensity score matching as a validation measure when assessing survival following trachelectomy and hysterectomy by adjusting for background differences between the two treatment groups. The propensity score was determined by multivariable logistic

regression analysis (trachelectomy *versus* hysterectomy). Patient demographics (age at cervical cancer diagnosis, ethnicity, marital status, registered area and calendar year at cervical cancer diagnosis), tumor characteristics (stage, histology type, and grade), and treatment type (radiotherapy and chemotherapy) were entered in the propensity score model. An automated algorithm was used for one-to-one propensity score matching between the trachelectomy and hysterectomy groups. The optimal caliper width for estimating differences was equal to 0.2 of the SD for the logit of the propensity score, resulting in a propensity score difference cutoff of 0.01 in this study.¹⁷ Standardized difference was determined after propensity score matching, and a value of 0.10 or less was considered to indicate good balance between the two groups.^{18,19}

In a sensitivity analysis, a study population of only women with stage IA2 and IB1 (≥ 2 cm) cervical cancer who had pelvic lymphadenectomy was examined for trends, characteristics, and outcomes. This is based on the rationale that treatment recommendations for surgical modality (hysterectomy type and lymphadenectomy use) are largely different between stage IA1 disease and stage IA2-IB1 disease per the current guidelines.⁵

The variance inflation factor was determined among covariates in the multivariable analysis, and a value of 2.0 or greater was interpreted as multicollinearity. A *P*-value of less than 0.05 was considered statistically significant (two-tailed). Statistical Package for Social Sciences (IBM SPSS, version 25.0, Armonk, NY) was used for analyses. The Strengthening the Reporting of Observational studies in Epidemiology (STROBE) guideline was consulted for outlining this study.²⁰

RESULTS

The patient selection criteria are shown in Figure 1. Among 23,981 women with cervical cancer who underwent trachelectomy or hysterectomy, 6,359 women were younger than 45 years with stage IA-IB1 (tumor size ≥ 2 cm) cervical cancer. 190 (3.0%, 95% CI 2.6–3.4) underwent trachelectomy, and 6,169 (97.0%) underwent hysterectomy. The characteristics associated with trachelectomy are shown in Table 1.

The median age of the trachelectomy group was 31.0 (IQR 28–34) years. Women who underwent trachelectomy were more often younger, of non-black race/ethnicity, had single marital status, and were more likely to be residents of the Eastern U.S. (all, *P*<0.05). They also more frequently had stage IB1 disease, non-squamous cell carcinoma histology, and grade 2 tumors, with higher rates of lymphadenectomy compared to women who underwent hysterectomy (all, *P*<0.05).

The proportion of women who underwent trachelectomy in this study population was 1.2% between 1998 and 2002. This was followed by a 3.0% trachelectomy rate between 2003–2008. By the period of 2009–2014 it had reached nearly 5% (4.5%). Between 1998 and 2014, there was a significant increase in the utilization of trachelectomy among women aged <45 years with early-stage cervical cancer (APC 9.5%, 95% CI 4.2–15.2, *P*<0.001; Figure 2A). The frequency of trachelectomy declined significantly with each additional year of age

(APC -11.0 , 95% CI -14.2 to -7.8 , $P<0.001$; Figure 2B) between age 22 and 35. The age dependent decline in the frequency of trachelectomy reached a nadir at age 35.

In multivariable analysis (Table 2), women <40 years of age (adjusted-OR 7.38, 95% CI 4.17–13.0, $P<0.001$), women of White ethnicity (adjusted-OR 4.41, 95% CI 1.76–11.0, $P=0.002$), single women (adjusted-OR 2.68, 95% CI 1.95–3.68, $P<0.001$), those with a more recent year disease diagnosis (in 2003–2008, adjusted-OR 2.43, 95% CI 1.50–3.94, $P<0.001$; in 2009–2014, adjusted-OR 3.58, 95% CI 2.23–5.76, $P<0.001$), residents of the Eastern U.S. (adjusted-OR 2.14, 95% CI 1.32–3.48, $P=0.002$), women with higher sub-stage (stage IA2, adjusted-OR 2.35, 95% CI 1.53–3.62, $P<0.001$; stage IB1 (≥ 2 cm), adjusted-OR 2.36, 95% CI 1.59–3.50, $P<0.001$), and women with non-squamous histology (adjusted-OR 1.73, 95% CI 1.26–2.37, $P=0.001$) remained independent predictors for trachelectomy use.

Survival outcomes were examined in 6,359 women. There were 118 (1.9%) events classified as death from the disease and 235 (3.7%) events all-cause of death during the follow-up period. The median follow-up time of censored cases was 7.6 (IQR, 3.5–11.8) years for the whole cohort. Median follow-up time was 5.3 (IQR, 2.5–8.3) years for the trachelectomy group and 7.7 (IQR, 3.6–11.8) years for the hysterectomy group.

Results of propensity score matching, based on the baseline characteristics of women in both treatment groups, are shown in Table 3. Post-matching patient demographics, tumor characteristics, and treatment types were similar between the two groups (all, standardized difference ≤ 0.10). After propensity score matching, the trachelectomy group had an equivalent 5-year cause-specific survival rate (96.9% *versus* 96.6%, HR 0.73, 95% CI 0.23–2.30, $P=0.59$; Figure 3A) and had a similar 5-year overall survival rate (96.1% *versus* 96.6%, HR 0.76, 95% CI 0.26–2.20, $P=0.61$; Figure 3B) compared to the hysterectomy group.

A sub-group of 2,778 women with stage IA2-IB1 (≥ 2 cm) cervical cancer who underwent pelvic lymphadenectomy was examined (Table S3–4). Trachelectomy was performed in 137 of these women (4.9%, 95% CI 4.1–5.7), and similar to the entire cohort, women in the trachelectomy group were more likely to be young, single, non-black race/ethnicity, Eastern U.S. residents, and have a recent year of cervical cancer diagnoses compared to those in the hysterectomy group (all, $P<0.05$). Stage, histology type, and tumor grade were similar between the two groups (all, $P>0.05$).

After propensity score matching (Table S5), the patient demographics were well-balanced between the two groups. In this group of stage IA2-IB1 (≥ 2 cm) cervical cancer, cause-specific survival (5-year rates: 96.6% *versus* 96.2%, HR 0.68, 95% CI 0.15–2.03, $P=0.61$) and overall survival (96.6% *versus* 94.8%, HR 0.54, 95% CI 0.13–2.26, $P=0.39$) were similar between the trachelectomy group and the hysterectomy group (Figure S1).

DISCUSSION

In recent years, approximately one in 20 women less than 45 years of age with stage IA or IB1 cervical cancer (tumor size is less than 2cm in diameter) has undergone trachelectomy. This treatment was not associated with decreased cause-specific survival nor decreased

overall survival among young women with early-stage cervical cancer when compared to hysterectomy.

Our study demonstrated an increasing trend in the utilization of trachelectomy in reproductive-aged women with early-stage cervical cancer. It is possible that this can be partially explained by the concurrent increasing age of first marriage and the number of unmarried women in the United States.²¹ One recent study showed that the number of single women with cervical cancer has been substantially increasing despite a decreasing overall number of early-stage cervical cancer diagnoses among young women in the United States.^{22,23} Therefore, it is possible that there has been an increasing utilization for trachelectomy among reproductive-aged women with cervical cancer, for whom future fertility preservation is of great concern.

Another plausible explanation is that more women are choosing for various reasons to delay childbearing until later in life. The Center for Disease Control and Prevention has identified a steady rise in the birth rate among women aged 35–39 and 40–44 years in recent years.^{24,25} This trend clearly implies that increasing numbers of women are choosing to delay child-bearing until beyond 35 years of age, resulting in increased opportunity to be diagnosed with cervical cancer.

Previous studies have shown that trachelectomy is safe and affords a good prognosis for women with stage IA2-IB1 lesions less than 2cm in diameter.^{26,27} A systematic review in 485 women from 29 studies confirmed the safety of trachelectomy, as only 3.8% of women experienced recurrence and only 0.4% died during a median of 31.6 months of follow-up.⁷ Our study also demonstrated that trachelectomy had equivalent survival compared to hysterectomy in the treatment of reproductive-aged women with early-stage cervical cancer. Thus, these results support recent evidence-based guidelines regarding the safety and feasibility of fertility-sparing treatment as a reasonable treatment option in this subset of young women.

Despite good oncologic outcomes of fertility-sparing treatment in early-stage cervical cancer, individuals should be carefully selected and have a meticulous preoperative evaluation.⁵ A limited number of studies have examined fertility-sparing treatment in women with stage IB1 cervical cancer with larger tumors ranging between 2 to 4cm in diameter, and while they reported safe oncologic outcomes, more women in this subgroup required adjuvant therapy, which may consequently reduce fertility.^{11,28,29,30} Therefore, trachelectomy is not commonly utilized in women with stage IB disease with a larger tumor size.

Additionally, close attention should be paid to the surgical approach for trachelectomy. A minimally invasive approach has been shown to reduce intraoperative blood loss, postoperative complications, and hospital stay compared to laparotomy.³¹ However, a recent phase III randomized study reported higher recurrence rates and poorer survival in women who underwent minimally invasive radical hysterectomy compared to abdominal radical hysterectomy for early-stage cervical cancer.³² As this study did not address surgical approach, and there is currently no other study which has examined this association,

continued discussions and research regarding the optimal surgical approach for women undergoing radical trachelectomy is encouraged.

Given the relatively low mortality rates in young women with early-stage cervical cancer, the use of a large population-based sample was a particular strength of this study in examining trends, characteristics, and outcomes of trachelectomy. Propensity score matching additionally enhanced our analytic approach as patient demographics and tumor characteristics were largely different between the trachelectomy group and the hysterectomy group.

Our study is also clinically important because a randomized trial comparing the survival of trachelectomy and hysterectomy is not feasible for women who desire fertility preservation. Additionally, our study validated a recent population-based study using the National Cancer Institute-designated hospital data (National Cancer Database) that showed use of trachelectomy with early-stage cervical cancer has increased in the United States and that survival was similar between the trachelectomy and the hysterectomy group.³³ Similar survival results across the two different large datasets are reassuring that this surgical procedure for fertility-sparing treatment is safe.

We recognize a number of important limitations. First, we lack data on postoperative fertility outcomes. In a systematic review of 660 women who underwent abdominal radical trachelectomy, 235 women attempted pregnancy and 114 (49%) successfully conceived.^{7,34} These results are in contrast to another large retrospective study that reported a total of 61 pregnancies in 48 of 172 (28%) women who underwent abdominal trachelectomy.³⁵ In both studies, miscarriage, preterm labor, and stillbirth were prevalent. Thus, in addition to consideration of oncological outcomes, fertility and obstetric outcomes warrant additional discussion with patients to determine the most appropriate treatment modality on an individual basis.

A second limitation of this study is our inability to perform a complete risk adjustment given limitations in the types of data included in the SEER dataset. Data regarding the surgical approach for trachelectomy (simple *versus* radical), route (abdominal, vaginal, or minimally invasive), presence or absence of lympho-vascular space invasion in the tumor, details of postoperative chemotherapy administration, and postoperative hormonal function are not captured in the dataset but are associated with the development of recurrent disease and overall survival.^{7,36} Likewise, no information for recurrence is captured in this database. While not included in this study, these factors are still an important part of decisions regarding treatment strategy in these young women with early-stage cervical cancer, and the rates of post-childbearing hysterectomy are not available for this database. Finally, the SEER does not have information regarding a patient's desire for future fertility.

Our results suggest that trachelectomy is a reasonable fertility-sparing treatment option with similar survival outcomes as hysterectomy in young women with cervical tumors 2cm or less in diameter. Recently, the use of trachelectomy has been increasing in reproductive-aged women with early-stage disease, however utilization still remains low. In appropriate candidates for this treatment option, we recommend a tailored discussion regarding the

possibility of trachelectomy for young women with early-stage disease who desire to preserve fertility.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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Implications and Contributions:

A. As fertility-sparing trachelectomy is a relatively new treatment modality for reproductive age women with early-stage cervical cancer, utility and survival outcomes related to this procedure have not been well studied in a population-based setting.

B. Between 1998 and 2014, there was a significant increase in the utilization of trachelectomy reaching nearly 5% in recent years.

C. Women who underwent trachelectomy had comparable cervical cancer-specific survival (5-year rates: 96.9% *versus* 96.6%) and overall survival (96.1% *versus* 96.6%) to those who underwent hysterectomy.

Figure 1. Selection criteria.

*other than hysterectomy and trachelectomy. **other than SCC, AC, and AS histology.

Abbreviations: CxCA, cervical cancer; SCC, squamous cell carcinoma; AC, adenocarcinoma; AS, adenosquamous carcinoma; and NOS, not otherwise specified.

Figure 2. Temporal and age-related trends in frequency of trachelectomy.

A) Results of piecewise linear regression analyses by Joinpoint Regression Program are shown to display temporal trends in the proportion of women who underwent trachelectomy between 1998 and 2014. **B)** Age-specific frequency of trachelectomy is shown between ages 20–44. Dots represent actual observed values, and lines represent regression. Bars represent 95% confidence intervals.

Figure 3. Kaplan-Meier curves after propensity score matching.

Log-rank test for P -values. Survival curves were constructed for **A**) cause-specific survival and **B**) overall survival.

Table 1.Patient demographics of cervical cancer ($N=6,359$)

	Trachelectomy	Hysterectomy	P-value
Characteristic	n=190	n=6,169	
Age (years)	31.0 (28–34)	37.0 (33–41)	<0.001
40	13 (6.8%)	2,175 (35.3%)	
< 40	177 (93.2%)	3,994 (64.7%)	
Race/ethnicity			0.02
White	122 (64.2%)	3,654 (59.2%)	
Black	5 (2.6%)	554 (9.0%)	
Hispanic	50 (26.3%)	1,458 (23.6%)	
Others	13 (6.8%)	503 (8.2%)	
Marital status			<0.001
Single	93 (48.9%)	1,656 (26.8%)	
Married	79 (41.6%)	3,487 (56.5%)	
Others	18 (9.5%)	1,026 (16.6%)	
Registry area			0.004
West	104 (54.7%)	3,507 (60.7%)	
Central	25 (13.2%)	1,243 (21.5%)	
East	61 (32.1%)	1,419 (17.8%)	
Year at diagnosis			<0.001
1998–2002	23 (12.1%)	1,844 (29.9%)	
2003–2008	72 (37.9%)	2,313 (37.5%)	
2009–2014	95 (50.0%)	2,012 (32.6%)	
Stage			<0.001
IA1	43 (22.6%)	2,696 (43.7%)	
IA2	47 (24.7%)	1,330 (21.6%)	
IA NOS	2 (1.1%)	114 (1.8%)	
IB1	98 (51.6%)	2,029 (32.9%)	
Histology			<0.001
Squamous	92 (48.4%)	4,062 (65.8%)	
Adenocarcinoma	86 (45.3%)	1,863 (30.2%)	
Adenosquamous	12 (6.3%)	244 (4.0%)	
Grade			0.001
1	38 (20.0%)	1,138 (18.4%)	
2	76 (40.0%)	1,836 (29.8%)	
3 *	31 (16.3%)	875 (14.2%)	
Unknown	45 (23.7%)	2,320 (37.6%)	
Pelvic lymphadenectomy **			<0.001
No	17 (8.9%)	2,429 (39.5%)	
Yes	173 (91.1%)	3,728 (60.5%)	

	Trachelectomy	Hysterectomy	<i>P</i> -value
Characteristic	<i>n</i> =190	<i>n</i> =6,169	
Surgery type			
Trachelectomy	190 (100%)	-	
Total hysterectomy	-	3,200 (51.9%)	
Extended, mRH, RH	-	2,544 (41.2%)	
Hysterectomy, NOS	-	425 (6.9%)	
Adjuvant radiotherapy			0.33
None	183 (96.3%)	5,795 (93.9%)	
WPRT ± VBT	6 (3.2%)	349 (5.7%)	
RT NOS	1 (0.5%)	25 (0.5%)	
Adjuvant chemotherapy			0.50
None/unknown	185 (97.4%)	5,984 (97.0%)	
performed	5 (2.6%)	185 (3.0%)	

Number (% per column) or median (interquartile range) is shown. Univariable analysis for *P*-values. Significant *P*-values are emboldened.

* included high-grade tumors.

** excluding 12 cases unknown lymphadenectomy status.

Abbreviations: NOS, not otherwise specified; mRH, modified radical hysterectomy; RH, radical hysterectomy; WPRT, whole pelvic radiotherapy; VBT, vaginal brachytherapy; and RT, radiotherapy.

Table 2.Clinico-pathological factors for trachelectomy use ($N=6,359$).

	No.	Univariable		Multivariable	
		OR (95%CI)	P-value	OR (95%CI) [†]	P-value
Age (years)					
40	2,188	1		1	
< 40	4,171	7.41 (4.21–13.1)	<0.001	7.38 (4.17–13.0)	<0.001
Race/ethnicity					
White	3,776	3.70 (1.51–9.09)	0.004	4.41 (1.76–11.0)	0.002
Black	559	1		1	
Hispanic	1,508	3.80 (1.51–9.58)	0.005	4.17 (1.60–10.9)	0.003
Others	516	2.86 (1.01–8.09)	0.047	3.68 (1.25–10.8)	0.02
Marital status					
Single	1,749	2.48 (1.83–3.37)	<0.001	2.68 (1.95–3.68)	<0.001
Married	3,566	1		1	
Others	1,044	0.77 (0.46–1.30)	0.33	0.99 (0.60–1.69)	0.99
Registry area					
Western	3,611	1.47 (0.95–2.29)	0.09	1.27 (0.79–2.05)	0.32
Central	1,268	1		1	
Eastern	1,480	2.14 (1.33–3.43)	0.002	2.14 (1.32–3.48)	0.002
Year at diagnosis					
1998–2002	1,867	1		1	
2003–2008	2,385	2.50 (1.55–4.01)	<0.001	2.43 (1.50–3.94)	<0.001
2009–2014	2,107	3.79 (2.39–6.00)	<0.001	3.58 (2.23–5.76)	<0.001
Stage					
IA1	2,739	1		1	
IA2	1,377	2.22 (1.46–3.37)	<0.001	2.35 (1.53–3.62)	<0.001
IA NOS	116	1.10 (0.26–4.60)	0.89	0.69 (0.16–2.94)	0.61
IB1 (≥ 2 cm)	2,127	3.03 (2.11–4.35)	<0.001	2.36 (1.59–3.50)	<0.001
Histology					
Squamous	4,154	1		1	
Non-squamous	2,205	2.05 (1.54–2.74)	<0.001	1.73 (1.26–2.37)	0.001
Grade					
1	1,176	1		1	
2	1,912	1.24 (0.83–1.84)	0.29	1.32 (0.87–2.00)	0.20
3	906	1.06 (0.66–1.72)	0.81	1.15 (0.69–1.93)	0.60
Unknown	2,365	0.58 (0.38–0.90)	0.02	0.75 (0.58–1.48)	0.75

[†]A binary logistic regression model for multivariable analysis.

All covariates listed were entered in the final model.

Abbreviations: OR, odds ratio; CI, confidence interval; and NOS, not otherwise specified.

Table 3.

Patient demographics after propensity score matching.

	Trachelectomy	Hysterectomy	SD
Characteristic	n=179	n=179	
Age (years)			0.013
40	13 (7.3%)	14 (7.0%)	
< 40	166 (92.7%)	165 (93.0%)	
Ethnicity			0.015
White	117 (65.4%)	115 (64.2%)	
Black	5 (2.8%)	5 (2.8%)	
Hispanic	45 (25.1%)	46 (25.7%)	
Others	12 (6.7%)	13 (7.3%)	
Marital status			0.050
Single	83 (46.4%)	77 (43.0%)	
Married	79 (44.1%)	79 (44.1%)	
Others	17 (9.5%)	23 (12.8%)	
Registry Area			0.055
West	100 (56.8%)	104 (57.1%)	
Central	22 (12.5%)	25 (13.7%)	
East	54 (30.7%)	53 (29.1%)	
Year at diagnosis			0.072
1998–2002	23 (12.8%)	25 (14.0%)	
2003–2008	69 (38.5%)	74 (41.3%)	
2009–2014	87 (48.6%)	80 (44.7%)	
Stage			0.009
IA1	43 (24.0%)	37 (20.7%)	
IA2	45 (25.1%)	54 (30.2%)	
IA NOS	2 (1.1%)	0	
IB1 (≤ 2 cm)	89 (49.7%)	88 (49.2%)	
Histology			0.009
Squamous	88 (49.2%)	89 (49.7%)	
Adenocarcinoma	79 (44.1%)	76 (42.5%)	
Adenosquamous	12 (6.7%)	14 (7.8%)	
Grade			0.036
1	38 (21.2%)	46 (25.7%)	
2	72 (40.2%)	65 (36.3%)	
3	28 (15.6%)	25 (14.0%)	
Unknown	41 (22.9%)	43 (24.0%)	
Pelvic lymphadenectomy			0.055
None	17 (9.5%)	20 (11.2%)	
Performed	162 (90.5%)	159 (88.8%)	

	Trachelectomy	Hysterectomy	SD
Characteristic	n=179	n=179	
Adjuvant radiotherapy			0.084
None	173 (96.6%)	170 (95.0%)	
Performed	6 (3.4%)	9 (5.0%)	
Adjuvant chemotherapy			0.032
None/unknown	174 (97.2%)	173 (96.6%)	
performed	5 (2.8%)	6 (3.4%)	

Number (% per column) is shown.

Absolute SD of 0.10 indicates a good balance between the two groups.

Abbreviation: NOS, not otherwise specified; and SD, standardized difference.