Efficacy and long-term prognosis of nerve-sparing radical hysterectomy for cervical cancer

Running title: Nerve-sparing radical hysterectomy

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Abstract

19 Background

20 Radical hysterectomy (RH) is a type of radical surgery performed for cervical cancer. Urinary dysfunction due to RH exacerbates the postoperative quality of life of cervical cancer patients.

21 The nerve-sparing RH (NSRH) technique has been used as an effective measure to conserve urinary function. However, few reports have been published on the long-term prognosis. This study described performance of our nerve-sparing technique and the long-term prognosis of patients.

22 Methods

23 Sixty-one patients underwent radical hysterectomy in a 5-year period during which the nerve-sparing technique was introduced; of these, 31 patients underwent NSRH and 30 underwent conventional RH. We retrospectively examined the medical records and compared postoperative urinary function and treatment outcome between the two groups.

24 Results

25 The median time required for urinary residual volume to fall to ≤50 ml after removal of the urinary catheter was 6 days (range, 2–20 days) in the NSRH group and 13.5 days (range, 3–46 days) in the RH group. The results were significantly better in the NSRH group (p < 0.05).

26 The mean follow-up period was 2,456.3 days (range, 48–4,213 days). Investigations on
curability revealed no significant difference between the two groups in local recurrence and long-term survival rates. The 5-year survival rate was 0.861 in the NSRH group and 0.782 in the RH group; the 10-year survival rate was 0.861 in the NSRH group and 0.679 in the RH group.

Conclusions

Surgical procedures for NSRH significantly improved postoperative urinary function without deteriorating local recurrence rates and long-term prognosis.

Key words

Uterine Cervical Neoplasms, Radical Hysterectomy, Urination Disorders, Prognosis, Organ-Sparing Treatments
Introduction

Radical hysterectomy (RH), a surgical treatment for cervical cancer, includes removal of the uterus as well as the parametrium and upper vagina and also includes bilateral pelvic lymphadenectomy. This surgical approach, which can cure cervical cancer, was first described by Wertheim more than 100 years ago, was subsequently modified by Okabayashi in 1921, and was made popular again by Meigs in the 1950s and by Piver in the 1970s. In Japan, Okabayashi-style RH has a history of use as an optimal therapy for International Federation of Gynecology and Obstetrics (FIGO) stage Ib–IIb cervical cancer. RH, although useful with good therapeutic efficacy, is associated with bladder dysfunction as a long-term postoperative complication due to damage to the pelvic autonomic nervous system. The incidence of postoperative bladder dysfunction has been reported to occur in 70%–85% of cases. The pelvic splanchnic nerve is the pathway for neural control of the rectum, bladder, and sexual function. The hypogastric nerve is a sympathetic nerve fiber that is involved in relaxation of the bladder detrusor and contraction of the urethral sphincter. To maintain postoperative bladder function, these neural networks should be preserved as intact as possible without sacrificing the therapeutic effects of surgery. Cervical cancer is one of the most important women's cancers, but its age of onset is lower than that of other cancers and maintaining the postoperative quality of life is a critical issue. Achieving maximum therapeutic
effect with minimal invasiveness in the surgical treatment of invasive cervical cancer has always been a challenge for gynecological oncologists. As a solution to this dilemma, in 1961, Kobayashi proposed a surgical procedure to preserve the pelvic plexus and its bladder branch. Later, nerve-sparing radical hysterectomy (NSRH) was improved by many of his successors and has now become widely accepted as a procedure that can maintain postoperative urinary function. However, the anatomical structures of the pelvic autonomic nerves have not been completely described, and it is extremely difficult to clearly visualize these structures in all cases during surgery. Therefore, in order to obtain a complete preservation of postoperative urinary function, it is important that the surgeon familiarize himself or herself with the nerve fiber tracts, which cannot be clearly seen, and spare them as much as possible. Consequently, we have improved these surgical procedures and have established nerve-sparing techniques. The most crucial surgical step we perform is a procedure to completely dissect and preserve the nerve fibers around the pelvic plexus from the paracolpium outward, the points of which will be described later. In addition, the results after nerve-sparing surgery are frequently reported in the short-term, whereas long-term outcomes longer than five years are rarely reported. In this study, we report the long-term outcomes of nerve-sparing surgery.
Materials and Methods

Patient selection

The patient enrollment period was five years and lasted from March 2007 to February 2012, which included time before and after the surgical procedure improvement. The period until February 2020 was established as the prognostic study period, and information was extracted from the medical records. This patient enrollment period was the operative transition period, and patients underwent mainly RH during the first half of the study and mainly NSRH during the second half. All consecutive patients who were diagnosed with cervical cancer during this period and underwent a RH at our hospital were included in this study. Exclusion criteria included preoperative voiding dysfunction, previous pelvic radiation therapy, previous pelvic reconstruction surgery, and a history of cerebrospinal disease. Prior to surgery, all patients underwent a detailed medical review, physical examination, serum biochemical examination, tumor markers, chest x-ray, abdominal and pelvic computed tomography, and pelvic magnetic resonance imaging. The tissue containing the tumor removed by surgery was sent for histopathological examination, and the stage of tumor progression in all cases was confirmed by microscopy. All surgeries were performed by gynecological oncologists.
This study was approved by the ethics committee at our institution (No. 30-01-1068). All patients received written explanations and provided consent for the surgery performed. This study was conducted retrospectively by examining the patient medical records. The survey items were age, body mass index, histopathologic type, staging, operation time, intraoperative blood loss, operation-related complications, postoperative urination, number of days to establish urinary function, presence or absence of local recurrence, disease-free survival, and overall survival. Local recurrence was defined as any recurrence in the lesser pelvis, including the vagina and pelvic lymph nodes.

Surgical techniques

RH

Even with conventional methods, some consideration was given to avoiding damage to the autonomic nerve, but this was not sufficient. Conventionally, nerve injury due to amputation of the cardinal ligament was considered the leading cause of urination disorders. The nerve-sparing method that we have conventionally performed involves the addition of only one step, in which the cutting of the cardinal ligament was moved to the uterine side, by cutting the blood vessel part of the cardinal ligament and then lifting the end to the uterine side.

NSRH
The key points of the nerve-sparing procedure that we have improved and performed are described below.

1. The ureter and hypogastric nerve were detached from the dorsal pelvic peritoneum. These were marked with tape and kept outside the body. The pararectal space was developed by advancing the detachment to the dorsal side.

2. The detachment of the hypogastric nerve was advanced caudally to the uterosacral ligament. Beyond this ligament, the hypogastric nerve was joined to the pelvic plexus. To avoid damage to the pelvic plexus, we did not advance the dissection beyond it.

3. The uterine artery was cut from the internal iliac artery bifurcation and isolated toward the uterus. Sufficient isolation beyond the intersection with the ureter was then performed.

4. The anterior layer of the vesicouterine ligament was excised and the ureter was moved outward. It was excised from the entrance of the ureter tunnel, and instead of being cut all at once, it was divided into small parts of approximately several millimeters each, as if the roof of the tunnel was broken down little by little. Since the blood vessels are abundant in the vesicouterine ligament, severe bleeding interferes with subsequent detailed operations, and thus, these resections must be carefully performed. The anterior layer of the vesicouterine ligament was unfolded and the ureter moved outward up to the site where the vesicoureteral junction was completely exposed (Fig. 1). When the ureter
was sufficiently removed, the ureteral insertion angle into the bladder was observed horizontally. Sufficient separation between the back of the bladder and the anterior vaginal wall was necessary for subsequent development of the paravaginal space. If the bladder detaches in a shallow manner, the paravaginal tissue including the autonomic nervous bladder branch would not be visible during subsequent procedures.

5. The posterior layer of the vesicouterine ligament was carefully separated and ligated in small portions. During this procedure, a venous plexus was observed between the bladder and the cervix. In our experience, two or three bladder veins were usually found, which were cut from the deep uterine veins (Fig. 2). The posterior layer of the vesicouterine ligament and paracolpium, including the autonomic bladder branch, was continuous and had no border. Therefore, it was necessary to prevent damage to the bladder branch. The point of the processing was to first exfoliate the tissue from the position on the uterine side from the middle part of the ligament, and second, to finish the exfoliation at the depth that the bladder veins were cut and separated from the deep uterine vein. Conversely, a wide incision in the caudal and dorsal layers of the posterior vesicouterine ligament caused damage to the bladder branch of the pelvic plexus.

6. A portion of the cardinal ligament vessel, which was well-exposed after lymphadenectomy, was cut distally and lifted toward the uterus. Since the bladder veins
that meet from the anterior had already been cut, the deep uterine vein could be easily
lifted to a shallow position. The pelvic nerve plexus was located inside and dorsal to the
venous plexus (Fig. 3).

7. The nerve plexus was formed where the autonomic nerves exit S2-S4 and the
hypogastric nerve exits the cranial side and were joined at the site of the cardinal ligament.
Branches of the nerve then advanced in the direction of the uterus and bladder from the
plexus. A procedure was performed to protect this bladder branch passing through the
lateral portion of the paracolpium that was exposed in the previous step. The outer
portion of the paracolpium was detached from the vagina toward the paravesical space,
taking care not to damage the vascular plexus inside the paracolpium. This was marked
and protected using tape and by moving it outward.

8. The hypogastric nerve and the pelvic splanchnic nerve were crossed; these nerves,
which are located around the pelvic plexus, and the branching nerves (i.e., the uterine
branch and the bladder branch), could be confirmed. Only the uterine branch was cut
from this cross, and the pelvic plexus was peeled outward with the cut site as a starting
point (Fig. 4). After careful dissection of the pelvic plexus toward the dorsal side, the
paravesical space and pararectal space were continuous as the lateral vaginal space,
and the pelvic plexus was laterally displaced in a plate-like form (Fig. 5). The plate-like
tissue, including nerve fibers completely separated from the uterus and parametrium,
became a T-shape without the uterine branch from the cross (Fig. 6).

9. The rectovaginal septum was developed, and the rectum was detached from the posterior wall of the vagina. After resection of the uterosacral ligament and the rest of paracolpium, the uterus was connected only to the vagina. The vagina was cut to the required length depending on the degree of tumor invasion. According to the previous step, the pelvic plexus and its branches were completely outside the surgical field, and thus, they were not damaged.

The difference between our improved surgical technique and the conventional method is that the pelvic plexus and bladder branch are completely outwardly separated. A crucial goal of the procedure is to maximize the protection of the nerves by ensuring nerve plexus detachment, which has been unpopular because of major bleeding due to venous plexus damage. Therefore, the procedure as it relates to hysterectomy was revised. The procedure that was historically performed from the cranial side to the caudal side (in the order of cardinal ligament, uterosacral ligament, vesicouterine ligament, paracolpium, vagina) had been changed from the ventral side to the dorsal side (in the order of vesicouterine ligament, cardinal ligament, nerve plexus dissection, uterosacral ligament, paracolpium, vagina). This was because completing the excision of the posterior layer of the vesicouterine ligament and
substantially raising the cardinal ligament to the uterine corpus were essential steps in
detaching the pelvic plexus and its bladder branch in an outward fashion.

Residual urine measurement

The indwelling bladder catheter was placed at the time of surgery and removed after
7 days. After removal of the catheter, the patients were free to urinate, and the urination
volume and residual urine volume were recorded at the prescribed six times a day. On-time
measurement of residual urine volume was performed at 3:00, 7:00, 11:00, 15:00, 19:00, and
23:00. The residual urine volume was measured by a nurse immediately after urination and
was accurately performed by inserting a catheter into the bladder cavity of the patient. When
the residual urine volume was less than or equal to 50 ml for two consecutive days at the
same time of day, the residual urine measurement was terminated only at that time. When
all measurement times were cleared, it was determined that urination ability was completely
established. In addition to the measurement of residual urine volume, micturition desire was
also recorded. If no improvement in urinary function was observed even after more than 3
weeks from the start of residual urine measurement, the patient was instructed on the method
of self-catheterization and discontinued residual urine measurement. If urinary function
improved over time even after more than 3 weeks, measurement of residual urine was continued until urination was established.

Follow-up

All patients were staged according to the FIGO and TNM classification systems. Patients in the high-risk group for recurrence received additional postoperative adjuvant therapy. After treatment, the patients underwent regular medical checkups at monthly intervals equivalent to the number of years passed, such as a monthly checkup during the first year and a bimonthly checkup during the second year. After more than six years, all patients had regular medical examinations every six months for at least 10 years after treatment was completed. At the regular medical examinations, patients underwent an internal examination, transvaginal ultrasonography, and serum biochemistry tests, including detection of tumor markers, to assess recurrence. In addition, patients underwent annual computed tomography scans of the chest, abdomen, and pelvis to evaluate the presence or absence of recurrent lesions, including those at distant sites. All patient clinical data were stored in an in-hospital electronic medical record system.

Statistical analysis
The results are expressed as the mean ± standard deviation (SD) or median as appropriate. The normality of the distribution was examined for all variables that were continuous data. The t-test was used for comparisons of age and BMI between the two groups, where the data showed a normal distribution. For comparisons between the two groups with respect to the operative time, the amount of blood loss, and the number of days until establishment of urination, where the data did not show a normal distribution, the difference between the medians was evaluated using the Mann-Whitney U test. Fisher's exact test was used to compare the nominal variables between the two groups. The log-rank test was used for prognostic comparison between the two groups. All tests were two-sided, and p < 0.05 was considered statistically significant. All statistical analyses were performed with EZR (Saitama Medical Center, Jichi Medical University, Saitama, Japan), which is a graphical user interface for R (The R Foundation for Statistical Computing, Vienna, Austria). More precisely, it is a modified version of R commander designed to add statistical functions frequently used in biostatistics.

Results

During the 5-year period from March 2007 to February 2012, 61 patients with cervical cancer underwent RH. Patients were divided into two groups according to the type of
treatment received: 31 patients were in the NSRH group and 30 were in the RH group. No significant differences in the measured parameters, including staging and histology, were observed between the two groups (Table 1). In the NSRH group, one patient had diabetes, two had depression, one had panic disorder, and one had Hashimoto's disease. In the RH group, two patients had diabetes, one had schizophrenia, and four had hypertension. All patients in both groups received appropriate treatment for complications, which were controlled. In the NSRH group, five patients underwent unilateral nerve-sparing surgery due to preoperative evaluation of tumor invasion and intraoperative findings. Postoperative histopathological examination revealed tumor invasion into the cardinal ligaments in seven patients in the NSRH group and six patients in the RH group; however, in all cases, the resected margins were negative. Pelvic lymph node metastases were pathologically diagnosed in six patients in the NSRH group and nine patients in the RH group. Based on the stage of postoperative pathological diagnosis, 23 patients in the NSRH group and 21 patients in the RH group received postoperative adjuvant therapy. In the NSRH group, 19 patients received chemotherapy and 4 patients received concurrent chemoradiotherapy. In the RH group, 15 patients received chemotherapy, 4 patients received radiotherapy, and 2 patients received concurrent chemoradiotherapy.
In order to evaluate the invasiveness of the surgical procedure, operative time, intraoperative blood loss, and intraoperative complications were compared in both groups. In the NSRH group, the median operative time was 390.0 minutes (range, 253–580 minutes) and the median blood loss was 1,212.0 g (range, 500–3,195 g). In the RH group, the median operative time was 361.5 minutes (range, 255–555 minutes) and the median blood loss was 1,562.5 g (range, 500–4,780 g). No significant difference was observed between the two groups (Table 2), and no intraoperative complications occurred in either the NSRH or the RH group.

To evaluate urinary function, the postoperative micturition desire and the number of days required to establish urination without a catheter were compared between the two groups. As a result of a self-reported subjective survey, 80.6% (25/31) in the NSRH group were aware of urination after removal of the indwelling bladder catheter, while 46.7% (14/30) in the RH group were aware. The median time required to establish urination after removal of the indwelling bladder catheter was 6 days (range, 2–20 days) in the NSRH group and 13.5 days (range, 3–46 days) in the RH group. These results were significantly better in the NSRH group ($p < 0.05$). None of the patients in the NSRH group required self-catheterization at discharge, whereas five patients in the RH group did require it (Table 2). A higher prevalence of dysuria has been observed in patients with diabetes or mental illnesses such as
depression. However, in this study, postoperative urinary function did not differ significantly between patients with these complications and those without complications. The results of five cases where the patient underwent a unilateral nerve-sparing procedure in the NSRH group were analyzed. The median time required to establish urination was 7 days (range, 5–15 days) in those patients. This number was slightly inferior compared to that of the patients who underwent the bilateral nerve-sparing procedure but was significantly better when compared to that of the patients in the RH group. This result is consistent with a previous report that the contractile function of the detrusor muscle of the bladder is maintained if the unilateral nerve preservation is successful.

To assess curability, the local recurrence-free rate, disease-free survival, and overall survival were compared between the two groups. Local recurrence-free rate was observed in 87.1% (27/31) of patients in the NSRH group and 83.3% (25/30) in the RH group. The disease-free survival rate in the NSRH group was 70.0% at 5 years (70.0% at 10 years), while that in the RH group was 68.3% at 5 years (63.1% at 10 years). The overall survival rate was 86.1% in the NSRH group at 5 years (86.1% at 10 years) and 78.2% at 5 years in the RH group (67.9% at 10 years). No differences were observed between the two groups in terms of the local recurrence-free rate, disease-free survival, or overall survival (Fig. 7). The mean follow-up period after treatment was 2,456.3 days (range, 48–4,213 days).
Discussion

RH has been the longstanding standard surgical treatment for cervical cancer worldwide. In Western countries, the resection line of RH is defined according to the classification of Piver, Rutledge, and Smith, while in Japan, it is defined according to Okabayashi. Okabayashi surgery is more radical than Piver type III surgery and usually involves sacrifice of the pelvic plexus. Since the sympathetic and parasympathetic nervous systems throughout the pelvic plexus play a key role in normal urinary function, damage to these autonomic nerves caused by RH is strongly associated with the risk of consequent bladder dysfunction. The importance of carefully identifying and preserving autonomic nerves to minimize bladder dysfunction has recently been emphasized in the practice of RH. Preserving the pelvic autonomic nerves without sacrificing the radicality of RH has been an important issue for gynecological oncologists. Therefore, many studies have been published that include descriptions of nerve-sparing surgical techniques and patient outcomes.

The results of this study showed that, as reported by the authors, our improved nerve-sparing technique resulted in well-preserved bladder function and contributed to maintaining the postoperative quality of life of these patients. However, some patients exhibited insufficient bladder function despite nerve-sparing surgery. Commonly conceivable reasons
may be nerve damage due to surgical procedures unnoticed by the surgeon and non-visible thermal damage from powered devices. In addition, occasional cases had unexpectedly poor bladder function outcomes, despite complete intraoperative progress and careful adherence to nerve-sparing techniques. We consider that in some cases, the preservation rate of the pelvic plexus may be low due to large individual differences in how nerve tracts run, which may cause unexpectedly poor results. It is very difficult to focus on the nerves that are not present as single distinct nerve bundles such as the obturator nerve. The hypogastric nerve runs like a membrane, while multiple thin nerve fibers cross each other as in a mesh. Similarly, the bladder branch diverging from the pelvic plexus also spreads to the bladder as narrow nerve fibers. Most of the bladder branches pass through the posterior layer of the vesicouterine ligament and reach the area in the back of the bladder mainly from the vesicoureteral junction to the bladder neck. However, these nerve tracts show atypical differences in terms of location, e.g., some fibers run along the ureter, some fibers pass through the anterior layer of the vesicouterine ligament that is located further on the ventral side of the typical nerve tract, and some fibers pass through the anterior vaginal wall. Fibers that run in relatively shallow layers must be cut, and in such patients, a reduction in the nerve preservation rate is inevitable. The nerve-sparing technique is not a technique of isolating only nerve fibers, but rather, it is a technique of preserving the lateral parametrium.
and paracolpium, which are expected to contain the majority of nerve fibers. For that reason, it is extremely difficult to achieve 100% complete nerve preservation. We consider that the variability in the results after nerve-sparing surgery is due to such individual differences in nerve tracts. We also consider that in previous reports, the description of nerve-sparing technique was ambiguous and that replication of the technique is sometimes very difficult due to these individual differences in nerve tracts.

The main point of the surgical procedure we propose here is that when the posterior layer of the vesicouterine ligament is dissected, it should not be cut from the outside more than is necessary to avoid damage to the bladder branch that runs in the dorsolateral direction. In addition, the procedure of peeling the pelvic plexus outward after dissecting the uterine branch is stopped at the minimum necessary depth. With the above precautions, it is possible to reduce the risk of damage to the nerve plexus due to the dissection procedure and to avoid nerve damage during hemostasis for bleeding due to vascular damage of the parametrium. There is a concern that these procedures will sacrifice curability because these procedures are clearly limited surgically compared with conventional ones that do not consider nerve preservation. A response to this concern is that nerve-sparing surgery had previously been reported to have no adverse effect on the short-term prognosis of these
patients, but the results of this study have shown that nerve-sparing surgery also has no adverse effect on the long-term prognosis.

As stated above, the nerve-sparing technique is a limited surgery. However, the modification of radical surgery that changes it to a limited surgery presents a conflict. The reason for such an obvious reverse in course is required because radical surgery has been performed as a standard treatment for early-stage cervical cancer, which has remained unchanged for approximately a century. Is highly invasive surgery such as surgery that involves dissection of the pelvic floor really needed in relatively early-stage patients with cervical cancer that has not invaded beyond the cervix? In developed countries today, preoperative staging is performed using various examinations including diagnostic imaging. Specifically, in Japan, both computed tomography and magnetic resonance imaging have become mandatory preoperative examinations. In other words, accurate preoperative diagnosis is now possible compared with the time when RH was first developed. In addition, postoperative adjuvant therapy has also advanced significantly, and some have questioned further whether radical surgery is required for early-stage cervical cancer. Currently, patients with a high risk of relapse are usually treated with additional chemotherapy or radiation therapy or concurrent chemoradiotherapy. In this study, 72.1% of all the patients received adjuvant therapy (55.7% of the patients received chemotherapy and 16.4% of the patients
received either radiotherapy or concurrent chemoradiotherapy). This high rate of additional
treatment may be one of the reasons why the prognosis did not differ between the two
groups. If so, it is questionable whether radical surgery is needed for relatively early invasive
cancers, such as FIGO IB stage cancers. The revision of the FIGO classification in 2018
acknowledged the use of diagnostic imaging, such as computed tomography or magnetic
resonance imaging, to determine the preoperative FIGO classification, as global medical
capabilities have improved. Accordingly, it is necessary to conduct a large-scale
prospective study to reconsider the optimal surgical method based on accurate preoperative
diagnoses.

The results of this study indicate that the nerve-sparing technique is effective for bladder
function preservation and does not adversely affect short-term or long-term
prognosis. However, this study has several limitations. One is that this study is a historical
controlled study. Within the enrollment period, patients in the RH group tended to receive
treatment relatively early, while patients in the NSRH group tended to receive treatment
relatively late. By setting the enrollment period around the transition period of the operative
procedure, patients were almost equally assigned to the two groups. In addition, no
fundamental treatment changes were implemented during this enrollment period except for
the introduction of nerve-sparing techniques. Second, this is a single-center study with a
small sample size. This study evaluated the results of surgical procedures, and the accuracy of the procedures should not vary. At this stage, we consider it appropriate to conduct single-center studies to perform accurate nerve-sparing techniques for all patients. In the future, it will be necessary to perform more extensive research involving multiple surgeons who can perform nerve-sparing surgery with uniformly high quality.

Our findings have shown that NSRH for cervical cancer can maintain satisfactory postoperative bladder function. No difference was observed in local recurrence rates and no adverse effects were seen on the long-term prognosis beyond five years. Therefore, we consider NSRH to be one of the best treatment options for early cervical cancer.

Conflict of Interest

The authors declare no conflicts of interest.
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Figure 1
The step at which the resection of the anterior layer of the vesicouterine ligament was completed.

The left ureter was moved completely and laterally.

Figure 2
A photograph obtained during the resection of the posterior layer of the vesicouterine ligament. Several bladder veins were found in the ligament.

Figure 3
The deep uterine vein was cut distally and lifted toward the uterus. The pelvic nerve plexus was located inside and dorsal to the venous plexus. Intersections formed by the hypogastric nerve and the pelvic splanchnic nerve, which merged around the pelvic plexus, and those of the uterine and bladder branches, which were the branching nerves, were confirmed.
Only the uterine branch was cut from the intersection, and the pelvic plexus was peeled outward with the cut site as the starting point.

The paravesical space and pararectal space were continuous as the lateral vaginal space, and the pelvic nerve plexus was laterally displaced in a plate-like form.

The plate-like tissue, including nerve fibers that were completely separated from the uterus and parametrium, became a T-shape without the uterine branch from the intersection of fibers.

Kaplan-Meier curves are shown. a shows the local recurrence-free rate. b shows the disease-free survival. c shows the overall survival. According to the log-rank test, no significant difference was observed in the curves shown in a, b, and c.
## Table 1

| Patient characteristics | NSRH (n = 31) | RH (n = 30) | p-value |
|-------------------------|--------------|------------|---------|
| Age (years)             | 50.8 ± 10.3  | 49.7 ± 11.3 | 0.682   |
| BMI (kg/m²)             | 22.6 ± 3.0   | 23.1 ± 4.2  | 0.619   |
| FIGO stage (%)          |              |            | 0.742   |
| IA                      | 1 (3.2)      | 0 (0.0)    |         |
| IA2                     | 2 (6.5)      | 0 (0.0)    |         |
| IB1                     | 14 (45.2)    | 15 (50.0)  |         |
| IB2                     | 6 (19.4)     | 4 (13.3)   |         |
| IIA                     | 1 (3.2)      | 1 (3.3)    |         |
| IIB                     | 7 (22.6)     | 9 (30.0)   |         |
| IIIB                    | 0 (0.0)      | 1 (3.3)    |         |
| TNM stage               |              |            |         |
| pT (%)                  |              |            | 0.895   |
| 1a                      | 1 (3.2)      | 0 (0.0)    |         |
| 1a1                     | 1 (3.2)      | 1 (3.3)    |         |
| 1a2                     | 2 (6.5)      | 0 (0.0)    |         |
|                | 1b  | 1b1 | 1b2 | 2a  | 2b  | 3a  | pN (%) | pM (%) | Postop treatment (%) | Histology (%) |
|----------------|-----|-----|-----|-----|-----|-----|--------|--------|----------------------|---------------|
|                | 1 (3.2) | 0 (0.0) | 12 (38.7) | 14 (46.7) | 4 (12.9) | 4 (13.3) | 2 (6.5) | 4 (13.3) | 7 (22.6) | 6 (20.0) | 1 (3.2) | 1 (3.3) | 6 (19.4) | 9 (30.0) | 0.384 | 0 (0) | 0 (0) | N/A | 23 (76.7) | 21 (70.0) | 0.771 | 0.097 |
| Squamous cell carcinoma | 19 (61.3) | 25 (83.3) | 1 (3.2) | 0 (0.0) | 7 (22.6) | 4 (13.3) | 3 (9.7) | 0 (0.0) | 1 (3.2) | 0 (0.0) | 0 (0.0) | 1 (3.3) |
| Adenosquamous carcinoma | 1 (3.2) | 0 (0.0) | 1 (3.2) | 0 (0.0) | 7 (22.6) | 4 (13.3) | 3 (9.7) | 0 (0.0) | 1 (3.2) | 0 (0.0) | 0 (0.0) | 1 (3.3) |
| Mucinous carcinoma | 7 (22.6) | 4 (13.3) | 1 (3.2) | 0 (0.0) | 7 (22.6) | 4 (13.3) | 3 (9.7) | 0 (0.0) | 1 (3.2) | 0 (0.0) | 0 (0.0) | 1 (3.3) |
| Endometrioid carcinoma | 0 (0.0) | 1 (3.3) | 0 (0.0) | 1 (3.3) | 0 (0.0) | 1 (3.3) | 0 (0.0) | 1 (3.3) | 0 (0.0) | 1 (3.3) | 0 (0.0) | 1 (3.3) |
| Serous carcinoma | 0 (0.0) | 1 (3.3) | 0 (0.0) | 1 (3.3) | 0 (0.0) | 1 (3.3) | 0 (0.0) | 1 (3.3) | 0 (0.0) | 1 (3.3) | 0 (0.0) | 1 (3.3) |
| Small cell carcinoma | 0 (0.0) | 1 (3.3) | 0 (0.0) | 1 (3.3) | 0 (0.0) | 1 (3.3) | 0 (0.0) | 1 (3.3) | 0 (0.0) | 1 (3.3) | 0 (0.0) | 1 (3.3) |

Values are number (%) or mean ± standard deviation. BMI, body mass index; TNM stage, the TNM classification of malignant tumors.
established by the Union for International Cancer Control; pT, pN, pM, TNM
classification determined by histopathologic examination of a surgical specimen
Table 2 Results of postoperative urination and invasiveness during surgery

|                                | NSRH (n = 31)          | RH (n = 30)           | p value |
|--------------------------------|------------------------|-----------------------|---------|
| Operative time (min)           | 390.0 [253.0, 580.0]   | 361.5 [255.0, 555.0]  | 0.155   |
| Blood loss (g)                 | 1,212.0 [500.0, 3,195.0] | 1,562.5 [500.0, 4,780.0] | 0.074   |
| Micturition desire (%)         | 25 (80.6)              | 14 (46.7)             | 0.008*  |
| Establishment of urination     | 6.0 [2.0, 20.0]        | 13.5 [3.0, 46.0]      | 0.002*  |
| (days)                         |                        |                       |         |
| Self-catheterization (%)       | 0 (0.0)                | 5 (16.7)              | 0.024*  |

Values are number (%) or median [range]

*p < 0.05