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Original Research

Robotic-Assisted Laparoscopic Hysterectomy versus Conventional Laparoscopic Hysterectomy for Endometrial Cancer at a Regional Institution: A Retrospective Study

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Abstract

Background: Minimally invasive surgeries, such as laparoscopic and robotic surgeries, have been the main treatment methods for stage I endometrial cancer instead of laparotomy. However, minimally invasive surgeries for malignant tumors have not yet been established in many rural hospitals or hospitals with few gynecologists. This study aimed to investigate whether laparoscopic or robotic surgery for stage I endometrial cancer is more sustainable and useful at a rural hospital where a single non-laparoscopic-specialized surgeon performs oncologic surgery and provides outpatient care. **Methods**: This retrospective case-control study was conducted at our hospital. The study enrolled 65 patients with endometrial cancer who underwent robotic-assisted laparoscopic hysterectomy (RALH) or total laparoscopic hysterectomy (TLH). We compared surgical outcomes such as patient background, operation time, blood loss, and other indices. **Results**: Exactly 34 patients underwent robotic surgery, and 31 underwent laparoscopic surgery. No severe adverse events required reoperation, conversion to laparotomy, or ureteral injury during either operation. The operation time decreased in patients who underwent robotic surgery compared with those who underwent laparoscopic surgery (193 (140–227) *vs.* 253 (219–287) min, $p < 0.001$). In addition, the blood loss volume decreased by half in patients who underwent robotic surgery compared to those who underwent laparoscopic surgery. Significantly more operations were completed by two operators rather than three operators at robotic surgery compared to laparoscopic surgery (59% *vs.* 26%, $p = 0.007$). The hospitalization days were 1.5 days shorter in the robotic surgery group than in the laparoscopic surgery group ($p < 0.001$). Exactly 18 patients underwent robotic surgery with pelvic lymphadenectomy, and 26 underwent laparoscopic surgery with pelvic lymphadenectomy. Patients who underwent robotic surgery required less operation time than those who underwent laparoscopic surgery (226 (199–246) *vs.* 261 (236–287) min, $p = 0.001$). **Conclusions**: In the surgical treatment of stage I endometrial cancer, robotic surgery was associated with a significantly shorter operation time, shorter hospital stay, and no obvious complications. This study proposes that robotic surgery is a promising solution for the sustainable introduction of minimally invasive surgery for stage I endometrial cancer in rural hospitals or hospitals with few gynecologists.

Keywords: laparoscopic hysterectomy; local facility; minimally invasive surgery; pelvic lymphadenectomy; robotic surgery; rural hospital; uterine corpus cancer

1. Introduction

Endometrial cancer is the most common gynecological malignancy, affecting 410,000 people per year worldwide and ranking sixth in the number of malignant tumors in women [1]. In Japan, it is the fifth most common malignancy in women, with 18,000 patients reported annually [2]. It is an important disease with a gradually increasing number of patients [3]. Surgery is the primary treatment for endometrial cancer. Although laparotomy has been used, laparoscopic surgery, and more recently, robotic surgery, is being increasingly performed [4,5]. Regarding minimally invasive surgery for endometrial cancer in Japan, public insurance covered laparoscopic surgery in 2014 and robotic surgery in 2018. Our hospital began introducing robotic surgery in 2019. In a comparison between laparoscopic surgery and robotic surgery, studies have reported that there is no significant difference in surgical outcomes and accuracy of diagnosis and that laparoscopic surgery is superior to robotic surgery in terms of operation time [6–11]. Most of these reports are based on data from facilities with sufficient physicians and equipment due to the short period since the practical application of robotic surgery.

In contrast, our hospital has only one gynecologic oncologist who is not specialized in laparoscopy; this gynecologic oncologist manages almost all patients with malignant tumors as outpatients and performs operations. For minimally invasive surgery for stage I endometrial cancer to be more prevalent as a safer and higher quality treatment in the future, it must be introduced and sustained even in hospitals with few gynecologists or no specialists in minimally

invasive surgery. Therefore, this study aimed to investigate whether robotic or laparoscopic surgery is more useful for sustainable medical treatment at a local facility by comparing the operation time and other indices.

2. Materials and Methods

2.1 Study Design and Statistical Analyses

This retrospective study was reviewed and approved by the Human Ethical Committee of the University of Teikyo Hospital (trial registration number: 20-054). The medical records of 65 female patients who underwent total laparoscopic hysterectomy (TLH) or robotic-assisted laparoscopic hysterectomy (RALH) for endometrial cancer between 2016 and 2022 were reviewed retrospectively. A gynecologic oncologist performed all surgeries with the assistance of other gynecologists. The gynecologic oncologist was originally experienced in laparoscopic surgery but had only performed a few hysterectomy cases and had no technical certification. RALH was performed using a Da Vinci Xi Surgical System (Intuitive Surgical Inc., Sunnyvale, CA, USA). Of the 65 patients, 31 underwent TLH, and 34 underwent RALH. Lymph node dissection was performed in only 44 patients. The omission of lymph node dissection was considered in endometrioid carcinoma G1 or G2 cases with no/minimal myometrial invasion based on magnetic resonance imaging findings.

2.2 Patient Characteristics and Analysis Methods

Patient characteristics were obtained from the medical records. First, to evaluate the effectiveness and outcomes of RALH and TLH, we compared the operation time, blood loss volume, and other patient characteristics using the Student's *t*-test. Second, for a more accurate comparison between RALH and TLH, we selected hysterectomy cases of pelvic lymphadenectomy and compared the operation time, blood loss volume, and other patient characteristics using the Mann–Whitney U test. Results with a p-value of <0.05 were considered statistically significant.

2.3 Surgical Techniques

A single surgeon who was an expert in gynecologic oncology but not an expert in laparoscopy (AT) performed all surgical procedures with assistance from other gynecologists at his hospital who supported the operations.

RALH was performed using the four-arm da Vinci surgical system (Intuitive Surgical, Sunnyvale, CA, USA) with the following characteristics: (1) Five trocars, i.e., an assistant trocar (12 mm), a camera trocar (8 mm), and three trocars for da Vinci (8 mm), were used. (2) The vaginal vault was transvaginally sutured and closed with 0-Vicryl. (3) Maryland Bipolar Forceps, Fenestrated Bipolar Forceps, Cadiere Forceps, and Mega Suturecut needle driver were used. (4) Pelvic lymphadenectomy was performed first, and the resected lymph nodes were collected in two 200-mL MemoBags. (5) Hysterectomy was performed in the same manner as TLH. First, the bilateral fallopian tubes were clipped, and a uterine manipulator was not used. A cylindrical vaginal pipe was inserted for accurate circumferential colpotomy. (6) The specimen was collected transvaginally using an 800-mL MemoBag.

TLH was performed as described previously [12]. The representative characteristics were as follows: (1) Five trocars, i.e., an umbilical trocar (12 mm), three lower abdominal trocars (5 mm), and one additional upper abdominal trocar (5 mm), were used instead of a uterine manipulator. (2) First, the bilateral fallopian tubes were clipped. Then, a cylindrical vaginal pipe was inserted for accurate circumferential colpotomy. (3) Two 200-mL MemoBags for the resected lymph nodes and one 800-mL MemoBag for the resected uterus and bilateral adnexa were used, and the specimens were collected transvaginally.

3. Results

3.1 Patient Characteristics

The median age, body mass index (BMI), and parity of the 65 included patients were 54 (47–61) years, 22.9 (20.1–27.1) kg/m^2, and 1.2 $\pm$ 1.0 (0–3) parity, respectively (Table 1). The overall median operation time was 223 (170–259) min, and the median blood loss volume was 12 (0–100) mL. The median weight of the resected uterus was 122 (94–172) g. Stage I accounted for 92%, stage IA for 80%, and stage IB for 12% of all cases. The histological type was endometrioid carcinoma grade 1 in 83% of all cases and endometrioid carcinoma grade 2 in 9% of all cases.

3.2 Comparison between RALH and TLH

A total of 34 patients underwent RALH, and 31 underwent TLH. No significant difference was noted in the patient background between the two groups. Moreover, no severe adverse events required reoperation, conversion to laparotomy, or ureteral injury during either operation. Comparing the two patient groups, the operation time was decreased in patients who underwent RALH compared with that in those who underwent TLH (193 (140–227) *vs.* 253 (219–287) min, $p < 0.001$) (Table 1). In addition, the blood loss volume decreased by half in patients who underwent RALH compared with those who underwent TLH (3.5 (0–88) *vs.* 51 (0–150) mL, $p = 0.019$). Significantly more operations were completed by two operators rather than three operators at robotic surgery compared to laparoscopic surgery (59% *vs.* 26%, $p = 0.007$). The hospitalization days were shorter in the RALH group compared with the TLH group (5.8 $\pm$ 1.2 *vs.* 7.3 $\pm$ 1.2 days, $p < 0.001$) (Table 2). However, pelvic lymphadenectomy was performed significantly more frequently in the TLH group than in the RALH group (84% *vs.* 53%, $p = 0.007$). Since there was a difference in the rate of pelvic lymphadenectomy between the two groups, we also selected and compared the cases of pelvic lymphadenectomy to further evaluate the difference between RALH and TLH.

Table 1. Patient characteristics.

Characteristic	Median (IQR)/Average ± SD (Min.–Max.), number
Age (years)	54 (47–61), n = 65
Body mass index (kg/m^2)	22.9 (20.1–27.1), n = 65
Parity	1.2 ± 1.0 (0–3), n = 65
Abdominal surgical history	n = 9
Anesthesia time (min)	298 (239–328), n = 65
Operation time (min)	223 (170–259), n = 65
Blood loss (mL)	12 (0–100), n = 65
Weight of the resected uterus (g)	122 (94–172), n = 63
Preoperative Hb level (g/dL)	13.4 (12.8–14.0), n = 65
Postoperative Hb level (g/dL)	11.9 (11.0–12.9), n = 65
Hospitalization days	6.4 ± 1.4 (5–10), n = 65
Type of operation	
Robotic surgery	n = 34
Laparoscopic surgery	n = 31
Pelvic lymphadenectomy	n = 44
Conversion to laparotomy	n = 0
Surgical stage (FIGO 2008)	
IA	n = 52
IB	n = 8
II	n = 1
IIIA	n = 2
IIIB	n = 1
IIIC	n = 1
Histological type	
Endometrioid grade 1	n = 54
Endometrioid grade 2	n = 6
Endometrioid grade 3	n = 1
Serous	n = 1
Mucinous	n = 1
Mixed	n = 2
Adjuvant chemotherapy	n = 8
Postoperative recurrence	n = 3

Representative patient characteristics obtained from medical records are summarized in this table. For each item, we calculated the median with IQRs or averages, standard deviations, minimal and maximal values, and the count data from the medical records. Abbreviations: IQR, Interquartile range; SD, Standard deviation; Min., Minimum; Max., Maximum; FIGO, Federation International of Gynecology and Obstetrics.

3.3 Comparison of Cases of Pelvic Lymphadenectomy between RALH and TLH

Overall, 18 patients underwent RALH with pelvic lymphadenectomy, and 26 underwent TLH with pelvic lymphadenectomy. Comparing the two groups, the operation time was decreased in patients who underwent RALH compared with those who underwent TLH (226 (199–246) *vs*. 261 (236–287) min, $p = 0.001$) (Table 3). RALH appeared to have fewer variations than TLH when the operation time was plotted between RALH and TLH (Fig. 1). The number of resected lymph nodes by RALH was not significantly different from TLH (n = 16 (9–20) *vs*. n = 20 (13–25), $p = 0.252$).

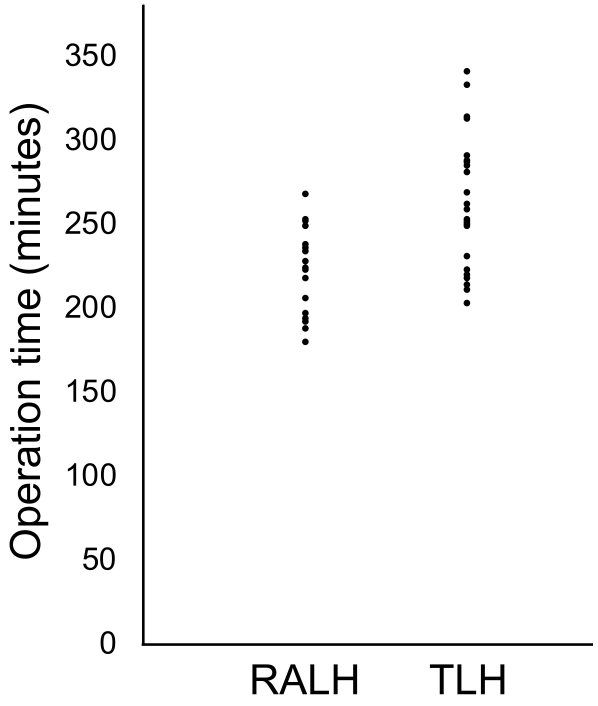

Fig. 1. Graph showing the operation time of robotic and laparoscopic surgery with pelvic lymphadenectomy. The operation time was decreased in patients who underwent RALH compared with those who underwent TLH (226 (199–246) *vs*. 261 (236–287) min, $p = 0.001$). When the operation time was plotted between RALH and TLH, RALH appeared to have fewer variations than TLH. Abbreviations: TLH, total laparoscopic hysterectomy; RALH, robotic-assisted laparoscopic hysterectomy.

4. Discussion

In this retrospective study conducted at our institution, RALH for stage I uterine cancer was performed within a shorter operative time than TLH, with shorter hospitalization days and no obvious complications. In contrast to TLH, RALH was achieved with two operators instead of three. These results indicate that RALH is a sustainable and minimally invasive surgery for stage I uterine cancer.

Minimally invasive surgery has been widely used to treat stage I endometrial cancer, as laparoscopic surgery has advantages in the perioperative course and results in a slight increase in the risk of long-term prognosis compared with laparotomy [13,14]. Subsequently, reports of better short-term results with fewer complications, less blood loss, and fewer cases of conversion to laparotomy in robotic surgery

Table 2. Comparison of indices between robotic and laparoscopic surgery.

Index	Robotic-assisted (n = 34)	Laparoscopic (n = 31)	*p*-value
Age (years)	56 (48–61)	53 (47–61)	0.363
Body mass index (kg/m^2)	23.9 (20.6–26.5)	22.2 (19.4–27.4)	0.512
Parity	1.4 ± 1.0 (0–3)	1.0 ± 1.0 (0–3)	0.119
Abdominal surgical history	n = 4/34	n = 5/31	0.617
Anesthesia time (min)	256 (216–314)	316 (289–347)	<0.001
Operation time (min)	193 (140–227)	253 (219–287)	<0.001
Blood loss (mL)	3.5 (0–88)	51 (0–150)	0.019
Weight of the resected uterus (g)	118.2 (95–167)	122 (90.2–188)	0.701
Preoperative Hb level (g/dL)	13.6 (12.6–14.2)	13.3 (13.0–14.0)	0.907
Postoperative Hb level (g/dL)	12.3 (10.9–13.1)	11.8 (11.0–12.7)	0.639
Operated by only two operators	n = 20/34	n = 8/31	0.007
Hospitalization days	5.7 ± 1.0 (5–9)	7.2 ± 1.2 (5–10)	<0.001
Pelvic lymphadenectomy	n = 18/34	n = 26/31	0.007
Surgical stage (FIGO 2008)			
IA	n = 27/34	n = 25/31	0.903
IB	n = 3/34	n = 5/31	
II–III	n = 4/34	n = 1/31	
Histological type			
Endometrioid grade 1	n = 26/34	n = 28/31	0.141
Endometrioid grade 2	n = 5/34	n = 1/31	
Other	n = 3/34	n = 2/31	
Adjuvant chemotherapy	n = 3/34	n = 5/31	
Postoperative recurrence	n = 2/34	n = 1/31	

A total of 34 patients underwent RALH, and 31 underwent TLH. We compared representative indices between RALH and TLH. For each item, we calculated the median with IQRs or averages, standard deviations, minimal and maximal values, and the count data from the medical records. In this analysis, 7 indices, namely, anesthesia time, operation time, anesthesia-operation time, blood loss, operated by only two operators, hospitalization days, and pelvic lymphadenectomy, were significantly different between the two groups. The *p*-values are shown in this table.

Abbreviation: Hb, Hemoglobin.

Table 3. Comparison of indices between robotic and laparoscopic surgery with pelvic lymphadenectomy.

Index	Robotic-assisted (n = 18)	Laparoscopic (n = 26)	*p*-value
Age (years)	54 (48–60)	53 (47–62)	0.877
Body mass index (kg/m^2)	23.9 (20.6–26.5)	21.8 (19.4–26.8)	0.337
Parity	1.4 ± 1.0 (0–3)	1.0 ± 1.0 (0–3)	0.349
Abdominal surgical history	n = 4/18	n = 2/26	0.693
Anesthesia time (min)	307 (268–324)	324 (299–348)	0.068
Operation time (min)	226 (199–246)	261 (236–287)	0.001
Blood loss (mL)	13.5 (0–106.3)	64 (0–150)	0.455
Weight of the resected uterus (g)	123 (98.3–173)	112.5 (89.4–189.2)	0.722
Number of resected lymph nodes	16 (9–20)	20 (13–25)	0.252
Hospitalization days	5.8 ± 1.2 (5–9)	7.3 ± 1.2 (5–10)	<0.001

A total of 18 patients underwent RALH with pelvic lymphadenectomy, and 26 underwent TLH with pelvic lymphadenectomy. We compared representative indices between RALH and TLH. For each item, we calculated the median with IQRs or averages, standard deviations, minimal and maximal values, and the count data from the medical records. In this analysis, two indices, operation time and hospitalization day, were significantly different between the two groups. The *p*-values are shown in this table.

than in laparoscopic surgery and reports of advantages in obese patients have led to the widespread use of robotic surgery [6–11,15–18]. In this study, no obvious complications or conversions to laparotomy were noted in either

laparoscopic or robotic surgery, and blood loss was lower with RALH. We safely achieved good short-term outcomes, as in previous reports.

Previous reports comparing RALH and TLH have often been "studies of data about RALH introduction by operators familiar with TLH", which may be one reason for the longer operative time with RALH than with TLH [17,18]. However, it was reported that the learning curve was faster with RALH [19], and it was expected that the operative time would be shorter with RALH if the operator were unfamiliar with laparoscopy [20]. The operative time was reduced to approximately 60 min in this study when we introduced RALH at our institution to an operator unfamiliar with TLH and to approximately 40 min for only lymph node dissection cases.

TLH and RALH were performed under conditions wherein the supporters had the experience of TLH and RALH for benign diseases, but the operator performed the procedure for the first time. This environment seemed similar to that of a local hospital, wherein minimally invasive surgery for malignancy was recently introduced. In this institution, we achieved good short-term outcomes for both TLH and RALH, as noted in previous reports [7–11,15,16]. Furthermore, the operative time was reduced to approximately 40 min in the case of lymph node dissection in RALH compared to TLH. In addition, two operators performed 59% of the RALH procedures, indicating that the number of surgeons required for RALH can be reduced. RALH can be performed by two surgeons because the second assistant surgeon for transvaginal manipulation is usually not necessary. Therefore, since fewer surgeons are needed to perform RALH, RALH is an efficient way of treatment. The hospitalization days for RALH were 1.5 days shorter than that for TLH.

There are many facilities with few gynecologic oncologists or surgeons familiar with laparoscopy to promote the use of minimally invasive surgeries for endometrial cancer in the future. Therefore, it is important to report the introduction of minimally invasive surgery for malignancies in such facilities. This study's results show that robotic surgery is a sustainable and useful approach in such facilities.

This study had some limitations. First, the number of cases was small. Since this was a retrospective study conducted at a single institution, confounding factors and selection bias could not be eliminated. Many hospitals, such as ours, should ensure the quality of malignant tumor care with a limited number of gynecologists. In addition, it is not easy for hospitals with only 10–15 cases of stage I endometrial cancer per year to achieve technical improvements through intensive operations, as in high-volume centers. Therefore, we first compared the short-term results of robotic surgery in this environment to verify the sustainability of RALH. Further evidence will be accumulated in the future.

Second, when the RALH and TLH groups were compared, significantly more cases of lymph node dissection were noted in the TLH group than in the RALH group. Since the presence or absence of lymph node dissection may have had a significant impact on the results, we also selected cases of lymph node dissection for comparison to ensure the quality of the results. It has recently been shown that lymph node dissection may not affect the prognosis of stage I endometrial cancer at a low risk of recurrence, which explains the difference in the number of patients with and without lymph node dissection [21]. This policy regarding lymph node dissection has changed after the introduction of RALH, resulting in more cases being omitted in the RALH group. In the future, we would like to consider ways to ensure the quality of treatment with or without dissection, in addition to the introduction of RALH.

Third, we lacked an analysis of the long-term prognosis. The 5-year overall survival rate for early-stage endometrial cancer is 88.7% [22]. It has been 4 years since insurance coverage for robotic surgery began and 3 years since RALH began at our hospital. In this study, there were two cases of recurrences in the RALH group and one in the TLH group. However, follow-up at 10-year intervals should be continued, as another report indicated that patients treated with robotic surgery showed recurrence more frequently and earlier and were more likely to die of cancer than those treated with laparoscopy [23].

Fourth, we could not analyze the benefit of cost. To sustain robotic surgery as a normal treatment for endometrial cancer, the matter of cost also has to be advantageous. Robotic surgery is costly and can be disadvantageous from the perspective of hospital costs.[24] In the future, we need to consider the cost efficacy of RALH for endometrial cancer.

5. Conclusions

In the surgical treatment of stage I endometrial cancer, robotic surgery was associated with a significantly shorter operation time, shorter hospital stay, and no obvious complications. This study proposes that robotic surgery is a promising solution for the sustainable introduction of minimally invasive surgery for stage I endometrial cancer in rural hospitals or hospitals with few gynecologists.

Abbreviations

BMI, body mass index; TLH, total laparoscopic hysterectomy; RALH, robotic-assisted laparoscopic hysterectomy.

Availability of Data and Materials

The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

Author Contributions

DH collected and analyzed the data and wrote the manuscript. WI collected the data. AT and ON supervised the whole study. AT, MH, HT, RM, and AF performed medical care on the subjects. AT determined the methods of the operation and supervised all medical procedures. All authors read and approved the final manuscript.

Ethics Approval and Consent to Participate

This retrospective study was reviewed and approved by the Human Ethical Committee of the University of Teikyo Hospital (trial registration number: 20-054). This retrospective case-control study was conducted at the Department of Obstetrics and Gynecology, University Hospital Mizonokuchi, Teikyo University School of Medicine. Written informed consent was obtained from the patients for the publication of this report.

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Conflict of Interest

The authors declare no conflict of interest.

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