Submitted: 29 May, 2023 Accepted: 27 June, 2023 Published: 15 February, 2024 DOI:10.22514/ejgo.2024.005

ORIGINAL RESEARCH

European Journal of Gynaecological Oncology

Enhanced recovery after single-site robotic staging surgery of endometrial cancer

Sang Hyun Cho[1], Seong Eun Bak[2], Bo Ram Choi[3], Keun Ho Lee[3,*]

[1]Department of Obstetrics and Gynecology, St. Vincent's Hospital, The Catholic University of Korea, 16247 Suwon, Republic of Korea
[2]Department of Obstetrics and Gynecology, Bucheon St. Mary's Hospital, The Catholic University of Korea, 14647 Bucheon, Republic of Korea
[3]Department of Obstetrics and Gynecology, Seoul St. Mary's Hospital, The Catholic University of Korea, 06591 Seoul, Republic of Korea

***Correspondence**
hohoho@catholic.ac.kr
(Keun Ho Lee)

Abstract

This retrospective study aimed to examine the safety and clinical outcomes of enhanced recovery after single-site robotic staging surgery in patients with endometrial cancer. Data were collected from Seoul St. Mary's Hospital's electronic medical records between July 2017 and August 2021. All the included endometrial cancer patients underwent single-site robotic staging surgery followed by enhanced recovery after surgery based on the guidelines for enhanced recovery after surgery society recommendations. The factors assessed were survival outcomes, complications and postoperative adjuvant therapy. Of the 60 patients included in this study, four (6.7%) experienced grade III postoperative complications within 30 days after surgery. Additionally, there were five cases (8.3%) that required a visit to the emergency room and two cases (3.3%) that necessitated readmission. Seventeen patients (28.3%) received postoperative adjuvant therapy, with treatment initiated 8 weeks after staging surgery in 14 patients (23.3%) and over 8 weeks in three patients (5.0%). The follow-up duration averaged 32.0 months (range, 3 to 60 months). No mortality was recorded during the follow-up period after staging surgery. The recurrence rate was 5.0% (n = 3), and the 3-year progression-free survival rate for the endometrioid type was 94.3%. These findings suggest that enhanced recovery after single-site robotic staging surgery is feasible for patients with endometrial cancer, yielding similar clinical outcomes and manageable complications without extending the time to adjuvant therapy initiation. However, further studies are necessary to investigate the long-term survival outcomes associated with enhanced recovery after surgery application.

Keywords

Endometrial cancer; Enhanced recovery; Adjuvant therapy; Robotic; Single-site

1. Introduction

Endometrial cancer is the most commonly diagnosed gynecological cancer in industrialized countries [1, 2]. Staging surgery plays a crucial role in diagnosing and treating this condition, particularly in patients with early-stage disease. Notably, staging surgery is the gold standard for treatment in patients with early stages of endometrial cancer [3]. While laparotomy was previously the primary approach for staging surgery, the advancements in technology and equipment have led to the widespread adoption of minimally invasive surgery, which is now the recommended method according to guidelines [3–7].

Robotic surgery for endometrial cancer has been extensively studied and utilized, with numerous publications on the use of robots in the surgical management of endometrial cancer [8–12]. Robotic surgery offers several advantages compared to open surgery, including faster patient recovery, decreased blood loss, smaller incisions and reduced pain. Additionally, advancements in single-site robotics regarding the use of fewer ports have further enhanced the benefits of robotic surgery [11, 13].

The concept of fast-track recovery after cardiac surgery was first introduced by Engelman in 1994, and the impact of minimally invasive surgery, pain management, early oral feeding and early mobilization following colonic surgery was published by Kehlet in 1995 [14–16]. The enhanced recovery after surgery (ERAS) protocol has been developed to maintain normal physiological conditions during the perioperative period [17]. This protocol offers several advantages, including lower complication rates, reduced readmissions, shorter hospital stays and faster recovery following surgical interventions [18, 19]. In the field of obstetrics and gynecology, guidelines have been established for each patient group to promote early recovery following surgery, following the principles of ERAS [17, 20–23]. However, limited studies have applied the ERAS approach to minimally invasive procedures, such as single-site robotic surgery [24, 25].

Following staging surgery for endometrial cancer, adjuvant therapy such as chemotherapy or radiation therapy is often nec-

essary based on the surgical stage and pathological findings. Delaying the administration of adjuvant therapy can impact the patient's prognosis [26]. Minimally invasive surgery and the implementation of enhanced recovery after surgery have been shown to facilitate rapid postoperative recovery, potentially reducing delays in the initiation of adjuvant treatment [27]. However, there are no studies on the long-term survival outcomes associated with performing minimally invasive surgery and implementing ERAS in patients with endometrial cancer.

This retrospective study aimed to assess the prognosis and safety of enhanced recovery after single-site robotic staging surgery, as well as the timing of postoperative adjuvant therapy initiation, in patients with endometrial cancer.

2. Materials and methods

2.1 Study design

This retrospective study was performed on data obtained from the electronic medical records of Seoul St. Mary's Hospital. A total of 65 patients with endometrial cancer underwent single-site robotic staging surgery between July 2017 and August 2021. The inclusion criteria comprised patients aged 18 or above with a diagnosis of endometrial cancer, encompassing all histotypes and stages, and who underwent single-port robotic staging surgery using the da Vinci Xi® surgical system. Patients who had a concurrent diagnosis of other gynecologic cancers at the time of surgical staging and those who did not have a follow-up assessment within 30 days after staging surgery were excluded from the study. The patients received enhanced recovery after surgery for the staging procedure. The staging surgery involved various procedures, including hysterectomy with salpingectomy, oophorectomy and pelvic/para-aortic lymphadenectomy. The decision to perform lymphadenectomy, lymph node dissection/biopsy, or sentinel lymph node dissection was based on the patients' condition and the surgeon's judgment. In cases where sentinel lymph node mapping using indocyanine green was unsuccessful, a complete lymph node dissection was performed. The enhanced recovery after surgery protocol used in this study was based on the recommendations of the enhanced recovery after surgery society guidelines [13, 14]. Adjuvant therapy was considered based on the guidelines provided by the National Comprehensive Cancer Network, the European Society of Gynaecological Oncology, and the Korean Society of Gynecologic Oncology or through clinical consultations regarding postoperative treatments. Survival outcomes, complications and postoperative adjuvant therapy were analyzed after the enhanced recovery after surgery protocol application. Baseline characteristics of the patients, including age, body mass index, prior abdominal surgeries, menopause status and parity, were collected. Pathological data consisted of the 2019 International Federation of Gynecology and Obstetrics (FIGO) stage, histology, FIGO grade, presence of lymphovascular space invasion, myometrial invasion, cervical stromal invasion and the pathological results of the pelvic and para-aortic lymph nodes. Surgical treatment data encompassed the specific surgical procedures performed, operative time, and transfusion requirements. Complications occurring during the intraoperative and postoperative periods within 30 days after surgery were analyzed. The Clavien-Dindo classification system was employed to grade the severity of complications, ranging from Grade I (requiring no pharmacological treatment) to Grade V (resulting in death) [28]. Additionally, emergency room visits, readmissions, reoperations and mortality rates were assessed within the 30-day postoperative period. Regarding adjuvant treatments, such as radiotherapy, chemotherapy and combined radiotherapy with chemotherapy, the initiation date of adjuvant therapy and the reasons for any delays in its administration were analyzed.

2.2 Enhanced recovery after surgery protocol

Enhanced recovery after surgery protocol elements included education and counseling before and after surgery, no bowel preparation, no patient-controlled analgesia, no fluid overload, minimally invasive surgery, multimodal analgesia, no drainage, short duration of Foley catheter indwelling, prophylactic anti-thrombosis, prophylactic antibiotics, prophylactic anti-emetics after surgery, early oral feeding (starting with sips and gradually progressing to a tolerable diet), encouragement of early mobilization as soon as the patient is capable, and an early hospital discharge.

2.3 Surgical and survival outcomes

Progression-free survival was defined as the time elapsed from the staging surgery for endometrial cancer to either the occurrence of recurrence or the last follow-up. Overall survival was defined as the duration from the date of staging surgery for endometrial cancer to either death or the last follow-up. The collected data encompassed various surgical outcomes, including operative time, estimated blood loss, intraoperative transfusion, postoperative hospital stay, disease recurrence, site of recurrence and the most recent death status. Surgical complications encompassed both intraoperative and postoperative complications related to the staging surgery. The primary endpoints of the study are perioperative complications and the safety of single-site robotic staging, enhanced recovery after surgery, and the timing of postoperative adjuvant therapy initiation in patients with endometrial cancer. The secondary endpoints include progression-free survival and overall survival. Furthermore, the study examined the recurrence rates and sites of recurrence after the surgical staging procedure.

2.4 Statistical analysis

Statistical analysis was performed using SPSS version 24.0 (IBM SPSS Inc., Chicago, IL, USA). Fisher's exact test or the χ^2 test was used to analyze differences in the proportions of variables. In addition, recurrence and survival outcomes were analyzed using the Kaplan-Meier survival curve and log-rank test. Statistical significance was set at $p < 0.05$.

3. Results

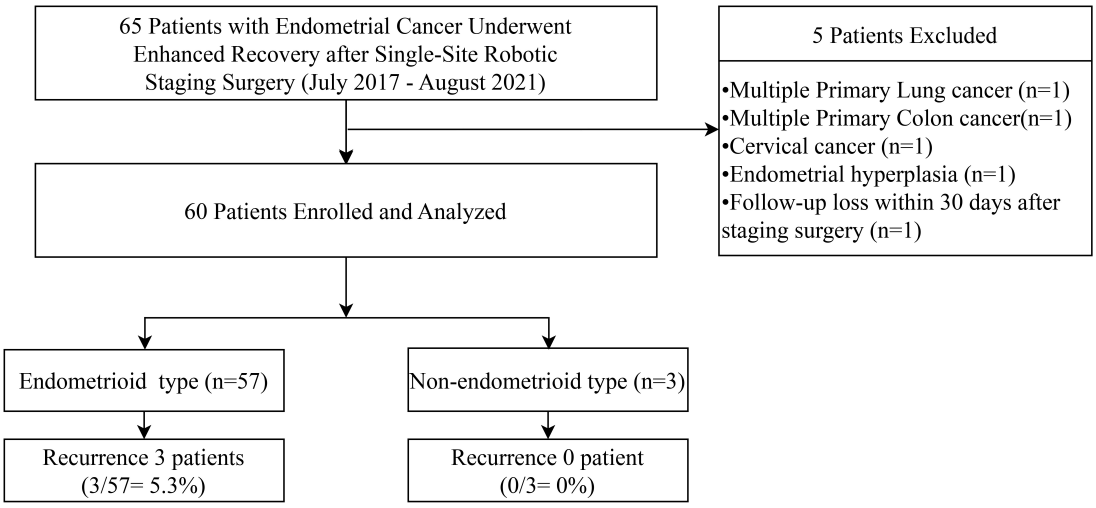

FIGURE 1. Flow chart of the study population.

3.1 Patients' characteristics

A total of 60 patients were enrolled and analyzed (Fig. 1). The patients' baseline characteristics are shown in Table 1. Their median age was 55.0 years, and the median body mass index was 23.7 kg/m^2. Based on the American Society of Anesthesiology (ASA) scores, 20 patients (33.3%) were classified as ASA score I, while 40 patients (66.7%) were classified as ASA score II. Histologically, 57 patients (95%) had endometrioid-type tumors, and 3 patients (5%) had non-endometrioid-type tumors (serous, n = 1; low-grade endometrial stromal sarcoma, n = 1; adenosarcoma, n = 1). The most common FIGO stage was IA (n = 49, 81.7%), and the most common grade was 1 (n = 31, 51.7%). Staging surgery involved hysterectomy in all 60 patients (100%), oophorectomy in 46 patients (76.7%), salpingectomy in all 60 patients (100%), pelvic lymphadenectomy in 56 patients (93.3%), and para-aortic lymphadenectomy in 12 patients (20%).

3.2 Surgical outcomes and enhanced recovery after surgery protocol application

The median duration of follow-up for the patients was 32.0 months, ranging from 3 to 60 months. The median operative time was 155.0 minutes, ranging from 75 to 400 minutes. The estimated blood loss had a median value of 50.0 mL, ranging from 10 to 300 mL. None of the patients required a blood transfusion during the surgery. All patients underwent the enhanced recovery after surgery protocol. Among the patients, two individuals (3.3%) received patient-controlled analgesia, while three patients (5.0%) underwent a spinal block for pain management. Bowel preparation was performed for seven patients (11.7%), and no drainage was utilized after the surgery. Foley catheter indwelling during the surgery was conducted in 38 patients (63.3%), and the catheter was removed within one-day post-surgery. Prophylactic measures for preventing thrombosis included the use of intermittent pneumatic compression in 48 patients (80%) and anti-embolic stockings in eight patients (13.3%). Regarding oral intake, on the day of surgery, 57 patients (95.0%) initiated oral feeding *via* sips and progressed to a tolerable diet. All patients were able to consume regular meals within one day after the surgery. Two patients (3.3%) were discharged on the same day of surgery, while 44 patients (73.3%) were discharged on the first day after the surgery. All patients were discharged within three days after the surgery (Table 2).

3.3 Postoperative treatment and survival outcomes

Adjuvant treatment after staging surgery included radiotherapy, chemotherapy, or radiotherapy with chemotherapy (Table 3). Postoperative adjuvant therapy was administered to 17 patients (28.3%), while radiotherapy was administered to 14 patients (23.3%). Comparatively, adjuvant chemotherapy was administered to only one patient (1.7%), one patient (1.7%) was treated with chemotherapy and radiotherapy, chemotherapy and radiotherapy sandwich treatment was administered to one patient (1.7%), and postoperative adjuvant therapy was initiated 8 weeks after single-site robotic staging surgery in 14 patients (23.3%) and over 8 weeks in three patients (5.0%; traffic accident, n = 1; vaginal stump dehiscence, n = 1; vaginal discharge, n = 1). Notably, among the patients who received chemotherapy as their initial adjuvant therapy, all of them underwent the treatment within 4 weeks after the surgery. This includes one patient (1.7%) who received chemotherapy only and another patient (1.7%) who underwent a sequential treatment of chemotherapy, followed by radiotherapy and then chemotherapy again.

The median duration of follow-up was 32.0 months (ranges 3–60). The recurrence rate was 5.0% (n = 3), with recurrences observed in the lungs (n = 1), the vaginal stump (n = 1), and multiple sites (lungs, mesenteric lymph nodes, psoas muscles, and obturator region) (n = 1) (Table 3). The 1-year and 3-year progression-free survival rates, as estimated by the Kaplan-Meier method, for endometrioid endometrial cancer were 96.4% and 94.3%, respectively (Fig. 2). Throughout the follow-up period after staging surgery, no deaths were reported among the patients; thus, the overall survival rate could not be calculated using Kaplan-Meier estimates.

TABLE 1. Baseline characteristics of the investigated patients with endometrial cancer (n = 60).

Characteristics	Data
Age, median (range)	55.0 (33.0–78.0)
Body mass index, median (range)	23.7 (18.6–36.3)
Previous abdominal surgery, n (%)	
Yes	23 (38.3)
No	37 (61.7)
Parity, n (%)	
Nulliparity	8 (13.3)
Primiparity and Multiparity	52 (86.7)
Menopause	
Yes	36 (60.0)
No	24 (40.0)
ASA score, n (%)	
I	20 (33.3)
II	40 (66.7)
Histology, n (%)	
Endometroid	57 (95.0)
Non-endometrioid	3 (5.0)
Serous	1 (1.7)
Low-grade endometrial stromal sarcoma	1 (1.7)
Adenosarcoma	1 (1.7)
Tumor grade, n (%)	
FIGO grade 1	31 (51.7)
FIGO grade 2	23 (38.3)
FIGO grade 3	4 (6.7)
Not reported	2 (3.3)
FIGO stage, n (%)	
IA	49 (81.7)
IB	5 (8.3)
II	2 (3.3)
IIIA	1 (1.7)
IIIC1	1 (1.7)
IIIC2	2 (3.3)
Staging surgery, n (%)	
Hysterectomy with salpingectomy	60 (100.0)
Oophorectomy	46 (76.7)
Pelvic lymphadenectomy	56 (93.3)
Para-aortic lymphadenectomy	12 (20.0)

ASA: American Society of Anesthesiology; FIGO: International Federation of Gynecology and Obstetrics.

TABLE 2. Surgical outcomes and enhanced recovery after surgery protocol application (n = 60).

Variables	Data
Operative time, median (range)	155.0 (75–400)
Estimated blood loss, median (range)	50.0 (10–300)
Transfusion during operation, n (%)	0
Patient-controlled analgesia, n (%)	
Yes	2 (3.3)
No	55 (91.7)
Spinal block	3 (5.0)
Bowel preparation, n (%)	
Yes	7 (11.7)
No	53 (88.3)
Venous thromboembolism prophylaxis, n (%)	
Intermittent pneumatic compression	48 (80.0)
Anti-embolic stocking	8 (13.3)
Unknown	4 (6.7)
Foley catheter removal, n (%)	
No insertion	1 (1.7)
Operation Room	38 (63.3)
Postoperative day 0	16 (26.7)
Postoperative day 1	3 (5.0)
Unknown	2 (3.3)
Start of diet after surgery (sips of water then tolerable diet), n (%)	
Postoperative day 0	57 (95.0)
Postoperative day 1	2 (3.3)
Unknown	1 (1.7)
Discharge date after surgery, n (%)	
Postoperative day 0	2 (3.3)
Postoperative day 1	44 (73.3)
Postoperative day 2	13 (21.7)
Postoperative day 3	1 (1.7)

TABLE 3. Postoperative adjuvant therapy and recurrence of disease (n = 60).

Variables	Data
Postoperative adjuvant therapy, n (%)	
Radiotherapy only	14 (23.3)
Radiotherapy + Chemotherapy	1 (1.7)
Chemotherapy only	1 (1.7)
Chemotherapy + Radiotherapy + Chemotherapy	1 (1.7)
No treatment	43 (71.7)
The Initiation Time of Postoperative adjuvant therapy, n (%)	
≤8 wk	14 (23.3)
>8 wk	3 (5.0)
Recurrence rate, n (%)	3 (5.0)
Recurrence site, n (%)	
Lung	1 (1.7)
Vaginal stump	1 (1.7)
Multiple sites	1 (1.7)

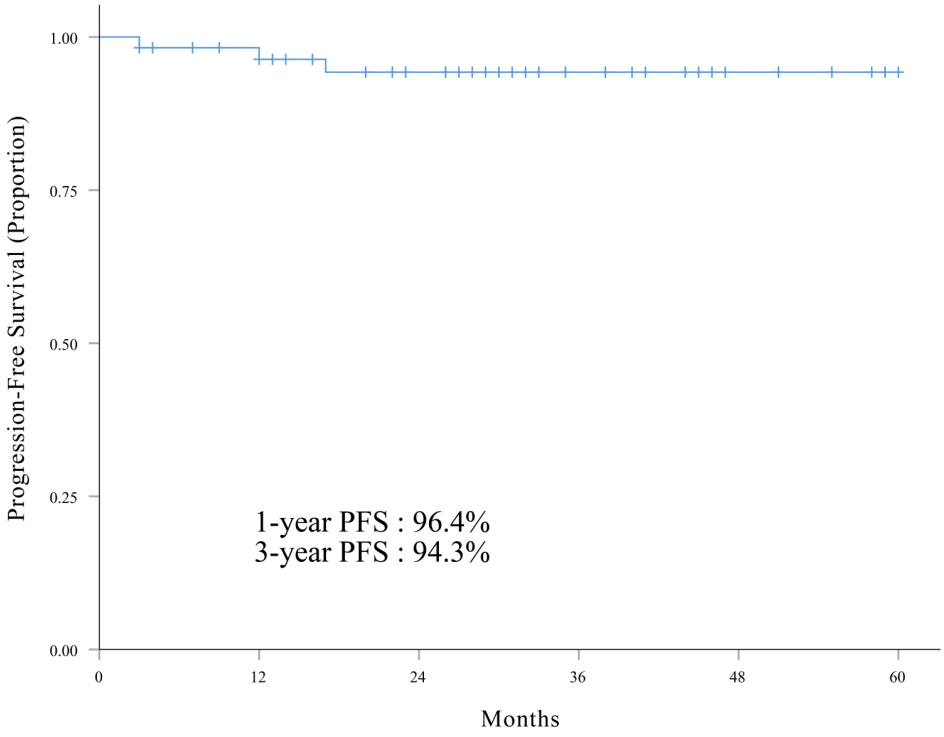

FIGURE 2. Kaplan-Meier curve illustrating the progression-free survival in patients with endometrioid endometrial cancer who underwent enhanced recovery after single-site robotic staging surgery (n = 57, except non-endometrioid type).

TABLE 4. Adverse events (n = 60).

Variables	Grade I†	Grade II†	Grade III†	Grade IV† & V†
Intraoperative complication	0	0	0	0
Postoperative complications within 30 days after surgery	5 (8.3%)	7 (11.7%)	4 (6.7%)	0
Visit to emergency room within 30 days after surgery	2 (3.3%)	3 (5.0%)	0	0
Readmission within 30 days after surgery	0	2 (3.3%)	0	0
Reoperation within 30 days after surgery	0	0	0	0
Death within 30 days after surgery	0	0	0	0

†*Clavien-Dindo classification; Grade I: requiring no pharmacological treatment; Grade II: requiring pharmacological treatment with drugs; Grade III: requiring further intervention; Grade IV: life-threatening; Grade V: death.*

3.4 Adverse events

No intraoperative complications were observed. Postoperative complications were analyzed according to the duration after surgery (Table 4). Within 30 days following the surgery, four patients (6.7%) experienced grade III complications, including vesicovaginal fistula in two patients (3.3%), hydronephrosis in one patient (1.7%), and umbilical hernia in one patient (1.7%). Additionally, there were five cases (8.3%) that required a visit to the emergency room and two cases (3.3%) that necessitated readmission. No reoperations or deaths were reported within the first 30 days after surgery (Table 4). Among the patients who underwent lymphadenectomy, three cases of lymphedema were observed following staging surgery. One case (1.7%) occurred within 30 days, another case (1.7%) within 6 months, and the third case (1.7%) within 12 months' post-surgery.

4. Discussion

This study examined the prognosis and safety of enhanced recovery after single-site robotic staging surgery, as well as the timing of postoperative adjuvant therapy initiation, in patients with endometrial cancer. The findings demonstrated favorable clinical outcomes, manageable complications without any recorded mortality, and timely administration of postoperative adjuvant therapy during the follow-up period after staging surgery.

The enhanced recovery after surgery (ERAS®) society has established comprehensive guidelines for gynecology and oncology, which served as the basis for the implementation of enhanced recovery after surgery in this study [17, 20–23]. The study adhered to these guidelines and incorporated various components of enhanced recovery after surgery. Several studies have also previously analyzed the results of enhanced recovery after surgery application for gynecologic oncologic patients. Bowel preparation before surgery was minimized,

with 88.3% of patients undergoing surgery without the need for an enema. Whenever possible, patients were allowed to have sips of water immediately on the day of surgery, followed by a gradual transition to a tolerable diet. However, in four patients without complications, the intake of liquids was administered before surgery to minimize the duration of preoperative fasting. Multimodal pain control strategies were employed, reducing the need for patient-controlled analgesia. Analgesics were injected as needed when the patient complained of pain and oral analgesics were regularly administered. In certain cases, spinal blocks were utilized, although further research is necessary to explore patient cooperation with anesthesiologists. Prophylactic anti-emetics were administered once after surgery to prevent postoperative nausea and vomiting, with additional doses given as needed. Prophylactic antibiotics were administered within 60 minutes before surgery, and postoperative fluid therapy was carefully managed using starch fluid (500 mL) to minimize fluid volume. Prophylactic antithrombotic measures involved the use of intermittent pneumatic compression devices, with or without anti-embolic stockings. No drainage tubes were inserted during any of the surgeries, and efforts were made to minimize the indwelling duration of Foley catheters. Early mobilization was encouraged whenever possible to facilitate patient recovery.

In a previously reported study, same-day discharge was improved with low perioperative complications by enhanced recovery after minimally invasive gynecologic oncologic surgery [18]. However, previous studies have identified certain risk factors associated with delayed discharge, including age ≥60, frequent use of opioid analgesics, long surgery times and excessive bleeding [29]. Another review article reported that risk factors for prolonged hospitalization included age >70 years, operative start time after 1 PM, operative time >2 hours, and intraoperative complications [30]. In our study, the primary approach was to facilitate early discharge for patients. Although the cause of delayed discharge was not identified in our study, it is noteworthy that two patients were successfully discharged on the same day of surgery. These patients were 52 and 53 years old, and their operative times were 125 and 150 minutes, respectively. The surgeries for the two patients started at 8:25 AM and 8:30 AM, and the estimated blood loss was 10 mL and 100 mL, respectively. The pathology results confirmed the presence of endometrioid-type tumors at FIGO stage IA. These patients demonstrated rapid recovery after surgery, experienced no perioperative complications, and encountered no recurrence without adjuvant therapy. Although these cases represent a small sample size, their early discharge indicates the physiological stability of perioperative patients.

The safety and advantages of laparoscopic surgery compared with laparotomy were confirmed in a prospective study (Gynecologic Oncology Group LAP2 study) [5, 6]. Since then, robotic surgery has been introduced and proven to be safe and advantageous. The evolution of robotic surgery has led to the development of single-site robotic procedures, which involve smaller incisions compared to multiport robotic procedures for endometrial cancer. In a multicentric study of single-site robotic staging surgery in patients with endometrial cancer, the total operative time ranged from 35 to 282 minutes, with a median of 122 minutes. The median estimated blood loss was 50 mL, ranging from 10 to 250 mL. Early postoperative complications were observed in 10 out of 125 patients, including pelvic bleeding (n = 2), wound infection (n = 2), cystitis (n = 2), fever (n = 1), deep vein thrombosis (n = 1), vaginal vault hematoma (n=1), and lower limb neuropathy (n = 1) [31]. These results, particularly the median operative time and estimated blood loss, were similar to those observed in this present study. Importantly, no complications resulting in mortality were observed. Among the grade III complications occurring within 30 days after surgery, one case of vesicovaginal fistula was managed by Foley insertion, and another case was repaired through surgical intervention. Furthermore, one patient with hydronephrosis underwent ureteral stent insertion. Incisional herniation at the umbilicus is a significant complication of single-site surgeries. In a separate study, the incisional hernia rate was reported as 5.5%, with predictive factors including ASA class, diabetes, hypertension, increasing age, and body mass index [32]. n our study, there was only one case of incisional hernia, which was successfully repaired using mesh. However, this case was not associated with any of the predictive factors. Therefore, meticulous attention should be given to the incision site during single-site surgeries to minimize the risk of complications.

In a study that examined thromboembolism following minimally invasive surgery (robotic or laparoscopic) with mechanical prophylaxis, the reported incidence was 0.55% [33]. Although no studies have directly compared robotic surgery and laparoscopy, it is suggested that the increased operative time associated with robotic surgery may contribute to an increased risk of thromboembolic events [34]. In our study, one patient presented with pulmonary thromboembolism within 30 days after surgery, leading to an emergency room visit and subsequent readmission. The patient's condition improved with the administration of oral anticoagulant therapy, and vaginal discharge/bleeding was managed with antibiotics, and during the surgery, the patient had received preventive measures in the form of anti-embolic stockings. There were no specific risk factors, medical history or abnormal findings during the hospitalization period. However, even in the absence of known risk factors, it is crucial to closely monitor patients for thrombotic symptoms and further investigate the occurrence of thrombosis. Thus, additional research is still needed to better understand thrombotic events in the context of robotic surgery for endometrial cancer.

The recurrence rate for endometrial cancer varies depending on the histologic type, with rates of approximately 20% for endometrioid type and 50% for non-endometrioid type, while the 5-year survival rate exceeds 90% [2, 35]. In one study, the 3-year progression-free survival and overall survival rates following robotic staging surgery for endometrial cancer were reported as 92.9% and 93.4%, respectively [12]. The common site of recurrence for distant metastasis is the lung [5, 35]. In our study, the recurrence rate among the patients was 5.0% and the 3-year progression-free survival rate, which are consistent with the findings from previous studies. The recurrent cases observed in our study were classified as endometrioid type grade 2, with FIGO stage IA for vaginal stump metastasis and stages II and IIIA for lung metastasis.

Adjuvant treatments such as radiotherapy, chemotherapy or chemo-radiotherapy are commonly considered following staging surgery for endometrial cancer. However, studies have suggested a poorer prognosis when postoperative adjuvant treatment, including radiotherapy, is delayed for more than 8 weeks. In our study, three patients experienced delayed treatment exceeding 8 weeks. The reasons for the delay were a traffic accident (n = 1), wound complications at the vaginal stump with questionable healing-dehiscence (n = 1), and the need for treatment of watery vaginal discharge (n = 1).

This study possesses several notable strengths. Firstly, it examines the survival and recurrence rates associated with minimally invasive surgery and enhanced recovery after surgery in patients with endometrial cancer. Secondly, it investigates the timing of postoperative adjuvant therapy initiation following enhanced recovery after surgery and single-site robotic staging surgery. However, it is essential to acknowledge the limitations of this study. Firstly, the study sample size was relatively small, as it was based on a retrospective analysis conducted at a single institution. Second, there may exist selection bias, as the analysis relied on data collected from medical records, with a focus on patients who underwent single-site robotic staging surgery. Additionally, there was no control group without enhanced recovery after surgery application in this single-arm study.

5. Conclusions

In conclusion, our study demonstrates that the implementation of enhanced recovery after single-site robotic staging surgery in patients with endometrial cancer is both feasible and associated with positive clinical outcomes. The manageable complications and timely initiation of adjuvant therapy further support the benefits of this approach. However, it is important to note that additional research focusing on the long-term survival outcomes of enhanced recovery after surgery application is necessary to further validate its effectiveness and impact.

AVAILABILITY OF DATA AND MATERIALS

Data are available upon reasonable request.

AUTHOR CONTRIBUTIONS

SHC and KHL—designed the research study; performed the research; analyzed the data; wrote the manuscript. All authors contributed to editorial changes in the manuscript. All authors read and approved the final manuscript.

ETHICS APPROVAL AND CONSENT TO PARTICIPATE

This study was approved by the Institutional Review Board of the Catholic University of Korea, Seoul St. Mary's Hospital (KC22RASI0972). The requirement for informed consent was waived because anonymized data were used.

ACKNOWLEDGMENT

Not applicable.

FUNDING

This research received no external funding.

CONFLICT OF INTEREST

The authors declare no conflict of interest.

REFERENCES

[1] Crosbie EJ, Kitson SJ, McAlpine JN, Mukhopadhyay A, Powell ME, Singh N. Endometrial cancer. The Lancet. 2022; 399: 1412–1428.

[2] Lu KH, Broaddus RR. Endometrial cancer. The New England Journal of Medicine. 2020; 383: 2053–2064.

[3] Koskas M, Amant F, Mirza MR, Creutzberg CL. Cancer of the corpus uteri: 2021 update. International Journal of Gynecology & Obstetrics. 2021; 155: 45–60.

[4] Concin N, Matias-Guiu X, Vergote I, Cibula D, Mirza MR, Marnitz S, *et al*. ESGO/ESTRO/ESP guidelines for the management of patients with endometrial carcinoma. Radiotherapy and Oncology. 2021; 154: 327–353.

[5] Walker JL, Piedmonte MR, Spirtos NM, Eisenkop SM, Schlaerth JB, Mannel RS, *et al*. Recurrence and survival after random assignment to laparoscopy versus laparotomy for comprehensive surgical staging of uterine cancer: gynecologic oncology group LAP2 study. Journal of Clinical Oncology. 2012; 30: 695–700.

[6] Walker JL, Piedmonte MR, Spirtos NM, Eisenkop SM, Schlaerth JB, Mannel RS, *et al*. Laparoscopy compared with laparotomy for comprehensive surgical staging of uterine cancer: gynecologic oncology group study LAP2. Journal of Clinical Oncology. 2009; 27: 5331–5336.

[7] National Comprehensive Cancer Network. Uterine neoplasms (Version 2.2023). 2023. Available at: https://www.nccn.org/professionals/physician_gls/pdf/uterine.pdf (Accessed: 28 April 2023).

[8] Fu H, Zhang J, Zhao S, He N. Survival outcomes of robotic-assisted laparoscopy versus conventional laparoscopy and laparotomy for endometrial cancer: a systematic review and meta-analysis. Gynecologic Oncology. 2023; 174: 55–67.

[9] Kakkos A, Ver Eecke C, Ongaro S, Traen K, Peeters F, Van Trappen P, *et al*. Robot-assisted surgery for women with endometrial cancer: Surgical and oncologic outcomes within a Belgium gynaecological oncology group cohort. European Journal of Surgical Oncology. 2021; 47: 1117–1123.

[10] Eoh K, Nam E, Kim S, Shin M, Kim SJ, Kim J, *et al*. Nationwide comparison of surgical and oncologic outcomes in endometrial cancer patients undergoing robotic, laparoscopic, and open surgery: a population-based cohort study. Cancer Research and Treatment. 2021; 53: 549–557.

[11] Ng JS, Leitao MM, Lim PC, Kim T, Kim SW. Asian society for gynecologic robotic surgery consensus guidelines on robotic surgery in gynecological cancer. Gynecologic Robotic Surgery. 2020; 1: 2–13.

[12] Chambers LM, Carr C, Freeman L, Jernigan AM, Michener CM. Does surgical platform impact recurrence and survival? A study of utilization of multiport, single-port, and robotic-assisted laparoscopy in endometrial cancer surgery. American Journal of Obstetrics and Gynecology. 2019; 221: 243.e1–243.e11.

[13] Corrado G, Mereu L, Bogliolo S, Cela V, Gardella B, Sperduti I, *et al*. Comparison between single-site and multiport robot-assisted hysterectomy in obese patients with endometrial cancer: an Italian multi-institutional study. The International Journal of Medical Robotics and Computer Assisted Surgery. 2020; 16: e2066.

[14] Engelman RM, Rousou JA, Flack JE, Deaton DW, Humphrey CB, Ellison LH, *et al*. Fast-track recovery of the coronary bypass patient. The Annals of Thoracic Surgery. 1994; 58: 1742–1746.

[15] Bardram L, Funch-Jensen P, Jensen P, Crawford ME, Kehlet H. Recovery after laparoscopic colonic surgery with epidural analgesia, and early oral nutrition and mobilisation. The Lancet. 1995; 345: 763–764.
[16] Bisch SP, Nelson G. Outcomes of enhanced recovery after surgery (ERAS) in gynecologic oncology: a review. Current Oncology. 2022; 29: 631–640.
[17] ACOG Committee Opinion No. 750: perioperative pathways: enhanced recovery after surgery. Obstetrics & Gynecology. 2018; 132: e120–e130.
[18] Kim SR, Laframboise S, Nelson G, McCluskey SA, Avery L, Kujbid N, *et al*. Enhanced recovery after minimally invasive gynecologic oncology surgery to improve same day discharge: a quality improvement project. International Journal of Gynecologic Cancer. 2022; 32: 457–465.
[19] Chau JPC, Liu X, Lo SHS, Chien WT, Hui SK, Choi KC, *et al*. Perioperative enhanced recovery programmes for women with gynaecological cancers. Cochrane Database of Systematic Reviews. 2022; 3: CD008239.
[20] Stone R, Carey E, Fader AN, Fitzgerald J, Hammons L, Nensi A, *et al*. Enhanced recovery and surgical optimization protocol for minimally invasive gynecologic surgery: an AAGL white paper. Journal of Minimally Invasive Gynecology. 2021; 28: 179–203.
[21] Nelson G, Bakkum-Gamez J, Kalogera E, Glaser G, Altman A, Meyer LA, *et al*. Guidelines for perioperative care in gynecologic/oncology: enhanced recovery after surgery (ERAS) society recommendations—2019 update. International Journal of Gynecologic Cancer. 2019; 29: 651–668.
[22] Nelson G, Altman AD, Nick A, Meyer LA, Ramirez PT, Achtari C, *et al*. Guidelines for pre- and intra-operative care in gynecologic/oncology surgery: enhanced recovery after surgery (ERAS®) society recommendations—part I. Gynecologic Oncology. 2016; 140: 313–322.
[23] Nelson G, Altman AD, Nick A, Meyer LA, Ramirez PT, Achtari C, *et al*. Guidelines for postoperative care in gynecologic/oncology surgery: enhanced recovery after surgery (ERAS®) society recommendations—part II. Gynecologic Oncology. 2016; 140: 323–332.
[24] Kwak YH, Lee H, Seon K, Lee YJ, Lee YJ, Kim SW. Da vinci sp single-port robotic surgery in gynecologic tumors: single surgeon's initial experience with 100 cases. Yonsei Medical Journal. 2022; 63: 179–186.
[25] Wilson CA, Aminsharifi A, Sawczyn G, Garisto JD, Yau R, Eltemamy M, *et al*. Outpatient extraperitoneal single-port robotic radical prostatectomy. Urology. 2020; 144: 142–146.
[26] Zhu S, Khalil R, Altairy O, Burmeister C, Dimitrova I, Elshaikh M. Increased risk of recurrence in early-stage endometrial carcinoma after delays in adjuvant radiation treatment. International Journal of Gynecologic Cancer. 2021; 31: 73–77.
[27] Tankou JI, Foley O, Falzone M, Kalyanaraman R, Elias KM. Enhanced recovery after surgery protocols improve time to return to intended oncology treatment following interval cytoreductive surgery for advanced gynecologic cancers. International Journal of Gynecologic Cancer. 2021; 31: 1145–1153.
[28] Dindo D, Demartines N, Clavien P. Classification of surgical complications: a new proposal with evaluation in a cohort of 6336 patients and results of a survey. Annals of Surgery. 2004; 240: 205–213.
[29] Tymon-Rosario JR, Miller DT, Novetsky AP, Goldberg GL, Nevadunsky NS, Makhija SK, *et al*. Risk factors associated with delayed discharge following robotic assisted surgery for gynecologic malignancy. Gynecologic Oncology. 2020; 157: 723–728.
[30] Sanabria D, Rodriguez J, Pecci P, Ardila E, Pareja R. Same-day discharge in minimally invasive surgery performed by gynecologic oncologists: a review of patient selection. Journal of Minimally Invasive Gynecology. 2020; 27: 816–825.
[31] Corrado G, Mereu L, Bogliolo S, Cela V, Freschi L, Carlin R, *et al*. Robotic single site staging in endometrial cancer: a multi-institution study. European Journal of Surgical Oncology. 2016; 42: 1506–1511.
[32] Moulton L, Jernigan AM, Carr C, Freeman L, Escobar PF, Michener CM. Single-port laparoscopy in gynecologic oncology: seven years of experience at a single institution. American Journal of Obstetrics and Gynecology. 2017; 217: 610.e1–610.e8.
[33] Freeman AH, Barrie A, Lyon L, Littell RD, Garcia C, Conell C, *et al*. Venous thromboembolism following minimally invasive surgery among women with endometrial cancer. Gynecologic Oncology. 2016; 142: 267–272.
[34] Jorgensen EM, Hur H. Venous thromboembolism in minimally invasive gynecologic surgery: a systematic review. Journal of Minimally Invasive Gynecology. 2019; 26: 186–196.
[35] Kurra V, Krajewski KM, Jagannathan J, Giardino A, Berlin S, Ramaiya N. Typical and atypical metastatic sites of recurrent endometrial carcinoma. Cancer Imaging. 2013; 13: 113–122.

How to cite this article: Sang Hyun Cho, Seong Eun Bak, Bo Ram Choi, Keun Ho Lee. Enhanced recovery after single-site robotic staging surgery of endometrial cancer. European Journal of Gynaecological Oncology. 2024; 45(1): 26-34. doi: 10.22514/ejgo.2024.005.