Original Article

Initial experience with the enhanced recovery after surgery (ERAS) protocols in gynecologic surgery at an urban academic tertiary medical center

Won-Ji Kim[1#^], Joseph J. Noh[1#^], Yu-Jeong Bang[2^], Mi-Yeon Yang[3^], Joo-Hyun Kim[3^], Chun-Ho Park[3^], Hyun-Ju Song[3^], Ji-Min Kim[3^], Chel-Hun Choi[1^], Tae-Joong Kim[1^], Jeong-Won Lee[1^], Byoung-Gie Kim[1^], Jeong-Jin Min[2^], Chung Su Kim[2^], Tae Soo Hahm[2^], Yoo-Young Lee[1^]

[1]Gynecologic Cancer Center, Department of Obstetrics and Gynecology, Samsung Medical Center, Sungkyunkwan University School of Medicine, Seoul, South Korea; [2]Department of Anesthesiology and Pain Medicine, Samsung Medical Center, Sungkyunkwan University School of Medicine, Seoul, South Korea; [3]Gynecologic Cancer Center, Department of Nursing, Samsung Medical Center, Seoul, South Korea

Contributions: (I) Conception and design: YY Lee, TS Hahm; (II) Administrative support: MY Yang, JH Kim, CH Park, HJ Song, JM Kim, YJ Bang, CS Kim, TS Hahm; (III) Provision of study materials or patients: CH Choi, TJ Kim, BG Kim, JW Lee, YY Lee, YJ Bang, JJ Min; (IV) Collection and assembly of data: JJ Noh, WJ Kim; (V) Data analysis and interpretation: JJ Noh, WJ Kim; (VI) Manuscript writing: All authors; (VII) Final approval of manuscript: All authors.

[#]These authors contributed equally to this work.

Correspondence to: Yoo-Young Lee, MD, PhD. Professor, Gynecologic Cancer Center, Department of Obstetrics and Gynecology, Samsung Medical Center, Sungkyunkwan University School of Medicine, 81, Irwon-ro, Gangnam-gu, Seoul 06351, South Korea. Email: yooyoung.lee@samsung.com; Tae Soo Hahm, MD, PhD. Professor, Department of Anesthesiology and Pain Medicine, Samsung Medical Center, Sungkyunkwan University School of Medicine, 81, Irwon-ro, Gangnam-gu, Seoul 06351, South Korea. Email: ts.hahm@samsung.com.

Background: The enhanced recovery after surgery (ERAS) protocols have been consistently associated with improved patient experience and surgical outcomes. Despite the release of ERAS Society guidelines specific to gynecologic oncology, the adoption of ERAS in gynecology on global level has been disappointingly low and some centers have shown minimal improvement in clinical outcomes after adopting ERAS. The aim of this study is to describe the development and early experience of ERAS protocols in gynecologic surgery at an urban academic tertiary medical center.

Methods: This was an observational prospective cohort study. The target patient population included those with low comorbidities who were scheduled to undergo various types of gynecologic surgeries for both benign and malignant diseases between October 2020 and February 2021. Two attending surgeons implemented the protocols for their patients (ERAS cohort) while three attending surgeons maintained the conventional perioperative care for their patients (non-ERAS cohort). Baseline characteristics, surgical outcomes and patients' answers to a 12-question survey were compared. A case-matched comparative analysis was also performed between the ERAS cohort and the historical non-ERAS cohort (those who received the same types of surgical procedures from the two ERAS attending surgeons prior to the implementation of the protocols).

Results: A total of 244 patients were evaluated (122 in the ERAS cohort *vs.* 122 in the non-ERAS cohort). The number of vials of opioid analgesia used during the first two postoperative days was significantly lower whereas the use of nonsteroidal anti-inflammatory drugs (NSAIDs) and acetaminophen was more frequent in

^ ORCID: Won-Ji Kim, 0000-0002-2589-8123; Joseph J. Noh, 0000-0002-3132-8709; Yu Jeong Bang, 0000-0002-2134-9899; Mi-Yeon Yang, 0009-0005-7740-6417; Joo-Hyun Kim, 0000-0001-7259-0108; Chun-Ho Park, 0009-0000-6948-5091; Hyun-Ju Song, 0000-0003-2956-0098; Ji-Min Kim, 0009-0000-7696-7814; Chel-Hun Choi, 0000-0002-0199-6669; Tae-Joong Kim, 0000-0002-9693-9164; Jeong-Won Lee, 0000-0002-6110-4909; Byoung-Gie Kim, 0000-0002-0572-8450; Jeong-Jin Min, 0000-0002-7584-2670; Chung Su Kim, 0000-0002-3488-3206; Tae Soo Hahm, 0009-0008-3678-0885; Yoo-Young Lee, 0000-0001-5902-9877.

the ERAS cohort group. The patients in the ERAS group reported less postoperative pain, feelings of hunger and thirst, and greater amount of exercise postoperatively. These benefits of the ERAS cohort were more pronounced in the patients who underwent laparotomic surgeries than those who underwent laparoscopic surgeries. The case-matched comparative analysis also showed similar results. The length of hospital stay did not differ between those who underwent the ERAS protocols and those who did not.

Conclusions: The results of the study demonstrated the safety, clinical feasibility and benefits of the ERAS protocols for patients undergoing gynecologic surgeries for both benign and malignant indications.

Keywords: Enhanced recovery after surgery (ERAS); gynecology; surgery; perioperative care; patient care bundles

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Introduction

The enhanced recovery after surgery (ERAS), which is also known as fast-track surgery, refers to multimodal interventions to reduce the length of hospital stay and complications through alleviating the surgical stress response that patients experience before, during and after surgical procedures (1). This concept of multimodal approach was first developed in Denmark by colorectal surgeons, and later embraced by other surgical disciplines such as orthopedics, thoracic surgery, urology and gynecology (2). Following the release of ERAS Society guidelines specific to gynecologic oncology (3-6), several studies have demonstrated substantial benefit of ERAS (7,8). Despite these efforts, the adoption of ERAS in gynecology on global level has been disappointingly low and some centers have shown minimal improvement in clinical outcomes after adopting ERAS (9,10).

Herein, we report our experience of adopting the ERAS protocols at an urban tertiary academic medical center, Samsung Medical Center, located in Seoul, South Korea. Our primary aim was to assess the development and early experience of ERAS protocols in gynecologic surgery within real clinical setting, with a focus on improving patient outcomes and experiences. We present this article in accordance with the STROBE reporting checklist (available at https://gs.amegroups.com/article/view/10.21037/gs-23-249/rc).

Highlight box

Key findings

- The enhanced recovery after surgery (ERAS) protocols are feasible and safe in gynecologic surgery.

What is known and what is new?

- Global adoption of ERAS in gynecologic oncology is low, despite proven benefits and specific guidelines. Even after implementation, some centers report minimal improvement in clinical outcomes.
- We demonstrated our clinical experience implementing ERAS protocols at an urban tertiary academic medical center, Samsung Medical Center, in real clinical setting and how they changed the patient care workflow.

What is the implication, and what should change now?

- Our study highlights the ERAS benefits in gynecologic surgery, emphasizing reduced opioid use, postoperative pain, improved exercise, and decreased hunger and thirst. Laparotomic surgeries showed more benefits than laparoscopic, highlighting approach-based variations. Patient feedback underscores the importance of patient-centered care. Customizing ERAS for different surgeries is crucial, and healthcare collaboration is key for enhanced patient care. Further research is needed on short fasting periods' benefits in diverse patient populations.

Methods

This was an observational prospective cohort study of patients undergoing various types of gynecologic surgery for both benign and malignant indications. The present institution employs five gynecologic attending surgeons. Two of the five surgeons introduced the ERAS protocols in October 2020 for their patient care. The other three withheld the implementation of the protocols and adhered to the previously established standard of care. We assessed the clinical outcomes and subjective views from the patients reflected by the pre-made questionnaire between the ERAS cohort *vs.* non-ERAS cohort. We also compared the outcomes of the ERAS cohort against the data from the patients who had received the identical surgical procedures from the same two ERAS surgeons prior to their protocol

adoption (comparison between the ERAS cohort *vs.* non-ERAS historical cohort). The study was conducted in accordance with the Declaration of Helsinki (as revised in 2013). The study was approved by the Institutional Review Board of Samsung Medical Center (No. 2023-11-058). Informed consent was obtained from all individual participants.

Patient selection and data collection

All patients who underwent major abdominal and laparoscopic gynecologic surgery between October 2020 and February 2021 were included. The patients who underwent surgery for vulvar cancer and for emergent conditions were excluded because evidence supporting the benefits of ERAS interventions have not been established in this specific group of patients. Data collected included patients' demographics, co-morbidities (American Society of Anesthesiologists performance score), body mass index (BMI), surgical information, postoperative complications (classified as per Dindo-Clavien surgical complication grading), use of postoperative analgesic medications, and length of hospital stay.

The ERAS team

A core group of gynecologists, anesthesiologists, nurses and mid-level providers across the gynecologic cancer center were identified to participate in the implementation of ERAS. Selection was based on their understanding of ERAS principles, and their willingness and ability to participate in patient care. The team members undertook a consultation process during the protocol development to ensure that the clinical providers were in agreement with all components of the care. Regular communication provided opportunities for feedback and identification of barriers to implementation. Evidence-based interventions reported in the literature were evaluated with existing institutional experience for relevance in gynecologic surgery. Through discussions and consensus building, components of the gynecologic ERAS program were developed. A standardized order set was created within the electronic medical records (EMR) system to facilitate uniform delivery of care. Patient education aids were created, and a questionnaire consisting of 12 items was developed.

Description of intervention: *ERAS protocols*

Specific components of the ERAS program were developed after an extensive review of the current evidence from the literature (11). The components of the ERAS protocols are described in Table S1. Patient education regarding the perioperative process began with the decision to proceed with surgery. All patients attended a pre-admission consultation. After detailed medical history and clinical assessment, patients were provided with verbal and written information relevant to their diagnosis, proposed treatment and perioperative management. This step was to prepare the patient to take an active role in her recovery and set realistic expectations for postoperative care, including duration of stay and postoperative pain control. Patients were provided with a booklet that introduced all members of the perioperative care team and a day-by-day breakdown of what to expect during the hospital stay. Admission one day prior to surgery was made at 5 PM. Mechanical bowel preparation was avoided and preoperative fasting period for solid food was reduced to less than 6 hours before the surgery and clear oral fluids were allowed up until three hours preoperatively (*Figure 1*). Complex carbohydrate loading drinks were used as they have a short stomach transit period due to their relatively low osmolality. Carbohydrate drinks were given 12 hours prior to the surgery and up to three hours before going to the operating room, provided gastric emptying was not impaired. The intervals between each drink were determined according to the patients' scheduled time of operations. An attempt was made to offer minimally-invasive surgery for the majority of cases. Intravenous antibiotics one hour prior to skin incision were administered in order to reduce infection risk. Naso-gastric tubes and abdominal drains were avoided wherever possible. There was no use of pre-medication to anesthesia. Anesthesiologists adopted a consistent protocol in intraoperative management and fluid balance. Postoperative pain management included regular use of acetaminophen and nonsteroidal anti-inflammatory drug (NSAID). Patients were encouraged to have an oral fluid intake and resume carbohydrate drinks 6 hours postoperatively, to facilitate return to normal diet. On the first postoperative day full blood count was checked and intravenous fluids, patient-controlled anesthesia (PCA) and urinary drainage were removed (unless indicated otherwise). The criteria for discharge in the ERAS group included normal or stable hemoglobin levels, tolerable pain with oral analgesia only, tolerance of solid food, being able to ambulate independently and willingness to go home. Where individual patient factors precluded a particular intervention (e.g., previous esophageal surgical history that might

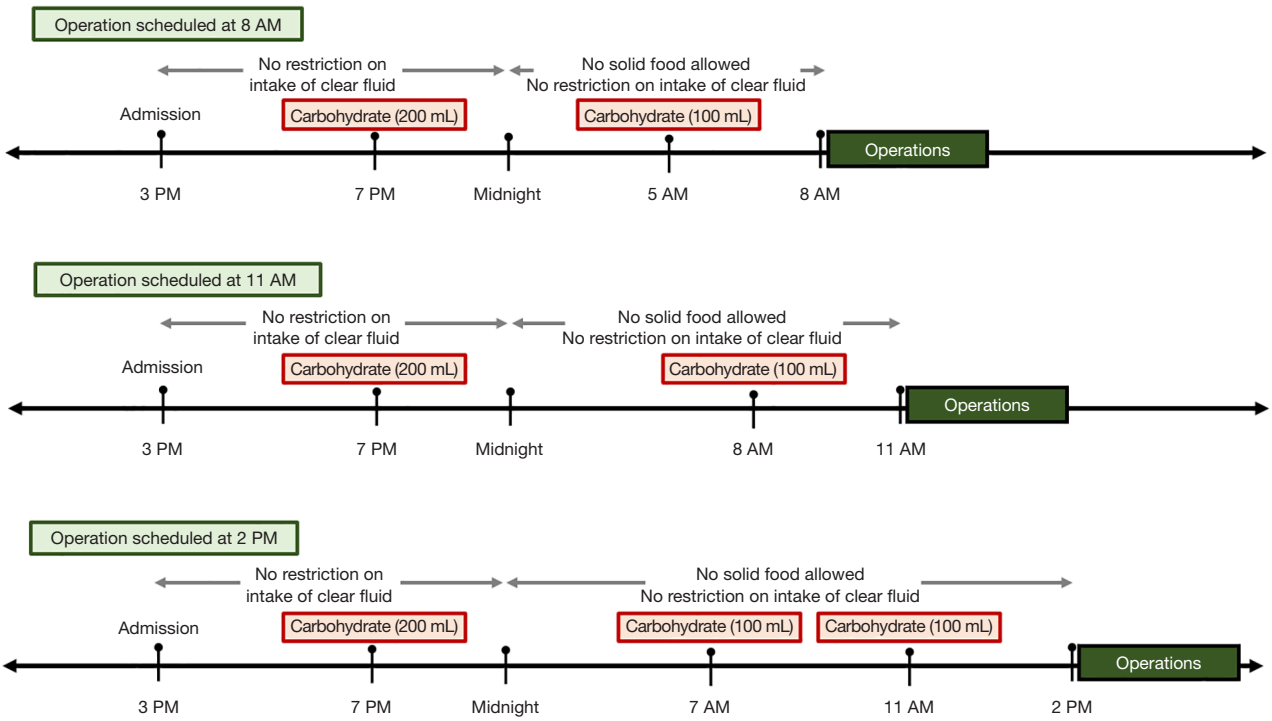

Figure 1 Timeline of preoperative fasting and carbohydrate loading.

increase complication risk in early postoperative diet), the intervention was withheld.

Patient survey questionnaire regarding their perioperative experience

All patients in our study were provided with a booklet explaining specific components of the ERAS protocols on admission. The booklet included a questionnaire with 12 items assessing patients' subjective feelings in regards to specific metrics and their overall satisfaction with the perioperative experience. The items on the questionnaire were adopted from the Patient Reported Outcomes Measurement Information System (PROMIS) (12,13). The original questionnaire was validated by its authors. For example, the patients were asked on a Likert scale how thirsty they felt, how hungry they felt, and how painful they felt perioperatively. They were also asked when they first left their hospital room for ambulation, how many times they chewed gum after surgery, and how many cups of coffee they drank.

Historical comparison group

To correct potential confounding factors, each patient in the ERAS cohort was matched (1:1 ratio) to a patient in the historical non-ERAS cohort using exact matching based on age (within a 5-year age range), surgery type, final diagnosis and disease stage for malignancies [by the FIGO (International Federation of Gynecology and Obstetrics) stage system].

Statistical analysis

Descriptive statistics such as means, standard deviations, medians, and ranges were used as appropriate. The Pearson's Chi-squared test and Fisher's exact test were used to examine associations between the groups for categorical variables. The Wilcoxon rank-sum test and Student's *t*-test were used for continuous variables. A P value lower than 0.05 was considered statistically significant. Data were analyzed with SPSS 22.0 software (SPSS, Inc., Chicago, IL, USA).

Results

Baseline characteristics and operative information

From October 1, 2020 to February 28, 2021, a total of

Table 1 Baseline characteristics of the patients

Characteristics	ERAS (N=122)	Non-ERAS (N=122)	P value
Age (years)	45.8±11.4	43.2±11.2	0.074
Height (cm)	163.5±7.2	162.1±9.0	0.181
Weight (kg)	51.2±7.6	49.8±6.9	0.133
BMI (kg/m^2)	24.5±6.5	25.3±7.2	0.363
Medical comorbidity			
Hypertension	29	25	0.644
Diabetes	17	15	0.850
Dyslipidemia	6	8	0.784
Allergy	8	10	0.807
Previous surgery (including abdominal surgery)	42	36	0.493
Previous abdominal surgery	37	33	0.671
Indication for surgery			
Benign adnexal mass	50	42	0.324
Benign uterine mass[a]	37	48	
Malignancy	35	32	

Data were presented as mean ± standard deviation for continuous data or n for categorical data. [a], the patients who received both uterine and adnexal surgeries were counted as uterine surgery. ERAS, enhanced recovery after surgery; BMI, body mass index.

244 patients were identified who underwent surgical procedures at our institution. Among them, 122 patients received perioperative care with the ERAS components while the other 122 patients received the conventional perioperative care. The baseline characteristics of the patients such as age, BMI, medical comorbidity, history of previous surgery, and indication for surgery were similar between the two groups (*Table 1*). Additionally, the operative information, including the types of surgical approach (laparotomy *vs.* laparoscopy), use of robot-assisted surgery and the extent of surgical procedures showed no significant differences between the two groups. There was no significant difference between the two groups in terms of hemoglobin drop on postoperative day 1 and length of hospital stay (*Table 2*).

Perioperative patients experiences

In general, the patients in the ERAS cohort felt less hunger and thirst before and after surgery, regardless of whether they had laparotomic or laparoscopic procedures (*Table 3*). Another notable finding was that the subjective feelings of pain were significantly lower in the ERAS cohort compared to the non-ERAS cohort. For laparotomic surgery, the mean pain score for ERAS cohort was 6.2±2.9, while it was 7.9±2.1 for non-ERAS cohort (P=0.029). Similar findings were observed for laparoscopic surgery (3.9±2.1 for ERAS cohort *vs.* 5.5±2.3 for non-ERAS cohort, P<0.001). The patients' answers in regards to nausea, and abdominal bloatedness did not differ between the two groups. Nausea, abdominal bloating, and the first gas out time did not differ between the two groups. The ambulation initiation time was also similar, even though the ERAS cohort had been instructed about the importance of early and active ambulation preoperatively. However, the patients in the ERAS group were more satisfied with their fasting time.

Use of postoperative analgesic agents

One of the key elements of the ERAS protocols is postoperative pain management. Among multiple acceptable regimens, we utilized a combination of acetaminophen and NSAID. The patients in the ERAS cohort received 30 mg of intravenous NSAID (ketorolac) immediately after surgery, followed by 1 g of intravenous acetaminophen 4 hours later.

Table 2 Operative information of the patients

Characteristics	ERAS (N=122)	Non-ERAS (N=122)	P value
Type of surgery			0.311
Laparotomy (lower midline incision)	31	27	
Laparotomy (Pfannenstiel's incision)	10	15	
Multi-port laparoscopy	44	39	
Single-port access laparoscopy	11	16	
Multi-port robot-assisted laparoscopy	23	18	
Single-port robot-assisted laparoscopy	0	4	
Others[a]	3	3	
Hysterectomy			0.125
Radical hysterectomy	5	9	
Extrafascial hysterectomy	65	50	
Not done	52	63	
Adnexectomy			0.064
Unilateral cystectomy	32	28	
Bilateral cystectomy	7	12	
Unilateral salpingo-oophorectomy	11	25	
Bilateral salpingo-oophorectomy	55	45	
Not done	17	12	
Pelvic lymph node dissection[b]			0.127
No	90	79	
Yes	32	43	
Paraaortic lymph node dissection[b]			0.301
No	116	112	
Yes	6	10	
Operation time (minutes)			
Laparotomy	160.2±92.1	181.2±95.9	0.082
Laparoscopy	127.5±61.9	135.2±71.2	0.368
Hemoglobin drop on POD 1 (g/dL)			
Laparotomy	1.8±1.3	2.1±1.8	0.137
Laparoscopy	1.2±1.1	1.4±1.3	0.196
Length of hospital stay (days)	2.1±1.4	2.3±1.7	0.317

Data were presented as n for categorical data or mean ± standard deviation for continuous data. [a], others include vaginal surgery, hysteroscopic surgery and wound repair surgery. [b], sentinel lymph node mapping and sampling was counted as no lymph node dissection. ERAS, enhanced recovery after surgery; POD, postoperative day.

Table 3 Results of the patient survey questionnaire

Question items	Laparotomy (N=84)			Laparoscopy (N=160)		
	ERAS (N=41)	Non-ERAS (N=43)	P value	ERAS (N=81)	Non-ERAS (N=79)	P value
On a scale of 0 to 10 (0: not thirsty, 10: very thirsty)						
How thirsty were you during the 6 hours before surgery?	3.4±2.9	4.4±2.2	0.027	3.7±2.5	5.2±2.7	<0.001
How thirsty were you during the 6 hours after surgery?	4.2±2.1	5.2±1.6	0.003	4.5±2.1	6.1±2.4	<0.001
On a scale of 0 to 10 (0: not dry, 10: very dry)						
How dry was your tongue during the 6 hours before surgery?	2.7±1.8	4.5±1.9	0.001	2.6±2.0	3.9±1.7	<0.001
How dry was your tongue during the 6 hours after surgery?	3.2±2.1	4.8±2.6	0.015	2.9±1.8	4.3±2.1	<0.001
On a scale of 0 to 10 (0: not hungry at all, 10: very hungry)						
How hungry were you during the 6 hours before surgery?	4.2±3.1	6.1±2.1	0.021	3.9±2.8	5.8±2.4	<0.001
How hungry were you during the 6 hours after surgery?	5.2±2.7	7.0±2.9	0.025	4.6±2.1	6.5±3.0	<0.001
On a scale of 0 to 10 (0: not nauseous at all, 10: very nauseous)						
How nauseous did you feel after drinking water after surgery?	3.1±2.9	3.3±2.6	0.802	3.9±2.1	3.6±2.4	0.431
How nauseous did you feel after eating soft diet after surgery?	2.0±1.8	2.4±2.5	0.49	2.8±1.7	3.3±3.1	0.223
How nauseous did you feel after eating solid diet after surgery?	2.3±1.9	2.6±2.0	0.585	2.5±2.3	3.0±1.8	0.165
How many rounds of the hospital ward did you walk after surgery?						
On the same day of your surgery	1.4±1.7	0.7±1.1	0.495	6.2±4.5	3.6±3.9	<0.001
A day after your surgery	7.5±7.1	4.3±5.2	0.091	15.2±8.0	5.9±8.0	<0.001
Two days after your surgery	15.0±8.4	9.7±9.2	0.034	14.0±7.7	11.9±8.4	0.126
How many times did you chew a gum after surgery?						
On the same day of your surgery	0.4±0.8	0	N/A	0.2±1.1	0	N/A
A day after your surgery	1.8±2.2	0	N/A	1.3±1.0	0	N/A
Two days after your surgery	2.1±1.6	0	N/A	1.7±0.9	0	N/A
How many cups of coffee did you drink after surgery?						
On the same day of your surgery	0	0	N/A	0	0	N/A
A day after your surgery	0.9±1.8	0.3±1.2	0.202	0.6±1.4	0.5±1.7	0.703
Two days after your surgery	1.3±1.6	1.0±2.1	0.55	0.9±2.1	1.1±1.6	0.538
When did you first pass gas after surgery?			0.425			
In the evening of your surgery	0	1		2	1	0.911
In the morning of the next day of your surgery	2	0		7	9	
In the afternoon of the next day of your surgery	8	4		15	12	
In the morning two days after your surgery	6	4		11	9	
In the afternoon two days after your surgery	15	5		7	5	

Table 3 (*continued*)

Table 3 (*continued*)

Question items	Laparotomy (N=84)			Laparoscopy (N=160)		
	ERAS (N=41)	Non-ERAS (N=43)	P value	ERAS (N=81)	Non-ERAS (N=79)	P value
When did you first leave your hospital room after surgery?			0.07			
In the evening of your surgery	4	1		48	39	0.300
In the morning of the next day of your surgery	20	5		23	19	
In the afternoon of the next day of your surgery	11	11		3	0	
In the morning two days after your surgery	0	1		0	0	
In the afternoon two days after your surgery	0	0		0	0	
On a scale of 0 to 10, how satisfied are you with the fasting time before your surgery?	8.0±2.5	6.8±2.4	0.091	7.8±2.1	7.1±1.9	0.044
On a scale of 0 to 10, how satisfied are you with the fasting time after your surgery?	7.2±2.1	4.8±2.9	<0.001	8.1±1.9	5.5±2.7	<0.001

Data were presented as mean ± standard deviation for continuous data or n for categorical data. ERAS, enhanced recovery after surgery; N/A, not available.

Table 4 Comparison of postoperative pain management

Painkiller	Laparotomy			Laparoscopy		
	ERAS (N=41)	Non-ERAS (N=43)	P value	ERAS (N=81)	Non-ERAS (N=79)	P value
Acetaminophen (vials)	2.7±2.4	0.5±2.1	0.001	1.9±1.1	0.4±1.6	<0.001
NSAID (vials)	3.2±2.4	2.1±1.6	0.081	2.4±2.1	2.8±1.5	0.211
Pethidine (vials)	0.7±0.3	1.7±1.1	<0.001	0.9±1.5	0.5±2.0	0.177
Morphine (vials)	0.6±2.1	1.1±2.3	0.417	0.4±2.0	0.5±0.3	0.702

Data were presented as mean ± standard deviation for continuous data. ERAS, enhanced recovery after surgery; NSAID, nonsteroidal anti-inflammatory drug.

The medications were alternated every 4 hours until the patients resumed their diet, thereby being able to take oral analgesic medications. In contrast, the conventional pain management method in our institution included ketorolac, meperidine, or morphine based on the physician's discretion and patient request (most physicians in the present institution start with NSAID for initial pain management unless contraindicated). This change of postoperative pain management significantly reduced the use of meperidine (*Table 4*).

ERAS patients, especially those who underwent laparotomy, received fewer vials of meperidine during the first two postoperative days (0.7±0.3 vials for ERAS group *vs.* 1.7±1.1 vials for non-ERAS group, P<0.001). The number of vials of NSAID did not differ, but the number of vials of acetaminophen was higher in the ERAS cohort, perhaps due to the already established method of pain management using NSAID.

Results from matched analysis with pre-ERAS historical cohort

A matched analysis on key elements of the ERAS protocols between the ERAS cohort against the non-ERAS historical cohort was performed (*Tables 5*,*6*). The use of meperidine was significantly lower in the ERAS cohort compared to the non-ERAS historical cohort. Furthermore, the length of hospital stay for those who underwent laparotomy was significantly reduced after implementing the ERAS protocols (2.8±1.1 days for the ERAS cohort *vs.* 3.5±1.4 days

Table 5 Comparison of the perioperative management between the ERAS *vs.* historical comparison cohort groups (all surgeries)

Perioperative management	ERAS cohort (N=122)	Historical comparison (N=122)	P value
Use of postoperative drains			
Intraperitoneal drains	60 (49.2)	72 (59.0)	0.123
Foley catheter	75 (61.5)	77 (63.1)	0.792
Nasogastric tube	0	0	N/A
Use of postoperative analgesic agents[a]			
Acetaminophen	2.1±1.8	0.7±0.5	<0.001
NSAID	2.6±2.4	2.1±1.8	0.067
Pethidine	0.8±0.5	2.3±1.9	<0.001
Morphine[b]	0.5±0.7	0.8±1.6	0.059
Length of hospital stays (days)	2.1±1.4	1.9±2.7	0.468

Data were presented as n (%) for categorical data or mean ± standard deviation for continuous data. [a], number of vials prescribed during the first three postoperative days. [b], morphine hydrochloride 10 mg in one vial. ERAS, enhanced recovery after surgery; NSAID, nonsteroidal anti-inflammatory drug; N/A, not available.

Table 6 Comparison of the perioperative management between the ERAS *vs.* historical comparison cohort groups (laparotomic surgeries only)

Perioperative management	ERAS cohort (N=41)	Historical comparison (N=41)	P value
Use of postoperative drains			
Intraperitoneal drains	31 (75.6)	37 (90.2)	0.078
Foley catheter	41 (100.0)	41 (100.0)	>0.999
Nasogastric tube	0	0	N/A
Use of postoperative analgesic agents[a]			
Acetaminophen	2.7±2.4	0.6±0.3	<0.001
NSAID	3.2±2.4	2.0±1.5	0.008
Pethidine	0.7±0.3	3.1±1.7	<0.001
Morphine[b]	0.6±2.1	1.1±0.7	0.152
Length of hospital stays (days)	2.8±1.1	3.5±1.4	0.014

Data were presented as n (%) for categorical data or mean ± standard deviation for continuous data. [a], number of vials prescribed during the first three postoperative days. [b], morphine hydrochloride 10 mg in one vial. ERAS, enhanced recovery after surgery; NSAID, nonsteroidal anti-inflammatory drug.

for the non-ERAS historical cohort, P=0.014).

Discussion

The present study represents that the development and implementation of an ERAS in gynecology at an urban tertiary academic medical center is feasible. We were able to demonstrate a reduction in opioid use for postoperative pain control, greater amount of postoperative ambulation, and a higher satisfaction of the patients in regards to perioperative fasting time. Overall, we did observe benefits of the ERAS protocols on a number of key elements without compromising the safety measures of the conventional perioperative care. However, unlike previous studies, we did not observe earlier return of bowel movement and earlier initiation of ward ambulation. Shorter hospital stay was only observed when comparing patients who underwent laparotomic surgeries by the same surgeon before and after the implementation of ERAS through matched analysis.

The ERAS principles incorporate multiple interventions in patients' care from preoperative assessment to postoperative discharge. This makes it difficult to identify a single or most significant intervention into the success or failure of the program.

Perhaps the greatest change we made by implementing the ERAS protocols in our patient care was the shortening of fasting time and the administration of carbohydrate drinks prior to surgery. There is a substantial amount of data which suggests early feeding decreases risks of infectious complications and duration of hospital stay without increasing rates of ileus or pulmonary complications (14-17). Thus, the advancement to a regular diet is recommended within 24 hours of surgery for gynecologic surgery patients (4). In our practice, patients were allowed to have liquids immediately after surgery and were advanced to a regular diet as tolerated within the first 24 hours. Additionally, the patients were encouraged to chew gum postoperatively based on the evidence that this may accelerate the return of bowel function (18,19). Preoperative administration of oral carbohydrate has also shown a significantly reduced postoperative hospital stay, and a trend towards earlier return of bowel movement when compared with fasting or supplementary water (20). Unfortunately, the present study did not observe earlier recovery of bowel movement. The time of initial flatulence or gas out after surgery did not differ between the ERAS cohort and non-ERAS cohort. This may be partly due to the short period of postoperative hospital stay. The duration of postoperative care at the hospital may not be sufficient to detect the potential benefits of shortened fasting time and earlier return to diet. Indeed, only 59% of the ERAS cohort and 40% of the non-ERAS cohort were able to catch their first flatulence during the hospitalization and answered it on the survey. Others were discharged before the first flatulence occurred. Therefore, it is recommended for future studies to assess the benefits of short fasting period with more objective outcome measures.

Given the recommendations for early feeding, most patients did not require intravenous hydration for longer than 24 hours postoperatively. In addition to intravenous poles limiting patient mobility (21), fluid overload can result in pulmonary edema, increased risk of ileus, and a prolonged duration of stay (22). Our ERAS patients were started on dextrose sodium potassium chloride solution in the immediate postoperative period. Intravenous fluids were discontinued early on the morning of postoperative day 1 in all patients who were tolerating liquids orally. Earlier discontinuation of intravenous fluids, thereby accommodating patient mobility, may have led to the greater amount of ward ambulation seen in the ERAS cohort. The patients who received laparoscopic surgery in the ERAS group performed almost twice as much exercise than the non-ERAS cohort patients both on the same day of their surgery and on the first postoperative day. The amount of exercise for those who received laparotomic surgery was not significantly different between the ERAS and non-ERAS cohorts immediately after surgery, but the patients in the ERAS cohort reported greater amount of ambulation on postoperative day 2.

A previous study reported that the combination of acetaminophen and NSAID is particularly effective and has a great effect than either agent given alone (23). In our practice, patients with acceptable renal and hepatic function were given scheduled NSAID and acetaminophen beginning immediately after surgery. These intravenous administrations of analgesic medication were subsequently transitioned to oral ibuprofen 500 mg every 12 hours. Patients who were unable to receive NSAID for any reason were given tramadol 50 to 100 mg every 8 hours. The routine administration of these agents resulted in less use of meperidine and less subjective feelings of pain as reported on the patient questionnaire. The effectiveness of multimodal opioid-sparing analgesia was attenuated two days after surgery and the pain scores reported by the patients became comparable between the ERAS and non-ERAS groups.

There have been a number of incidences where the execution of the ERAS protocols were faced with problems. Such incidences were due to unexpectedly high complexity of surgery, errors in inter-department communications and patient refusal (Table S2). In some cases, surgical procedures that necessitated postoperative intensive care unit (ICU) admission sometimes prevented the complete adherence to ERAS protocols. The application of ERAS protocols to ovarian cancer patients, in particular, poses unique difficulties. The majority of these patients are diagnosed with advanced-stage disease, requiring complex surgical interventions often involving on-the-spot decision-making. This unpredictability makes it difficult to plan optimal postoperative management in advance. Factors such as extensive and unpredictable surgical procedures, which may include multivisceral resections, and the high risk of postoperative complications, which can lead to poor nutritional status, make implementing ERAS protocols in ovarian cancer patients challenging. Furthermore, it is worth noting that much of the evidence supporting ERAS

guidelines has been derived from observational studies in other surgical disciplines, primarily colorectal surgeries. The medical conditions of ovarian cancer patients can differ significantly from those of colorectal cancer patients, underscoring the importance of scientific evaluation specific to ovarian malignancies. While there is a shortage of clinical trials on ERAS protocols in ovarian cancer patients, existing evidence indicates improved perioperative outcomes (24). Whether these enhanced perioperative outcomes translate into better survival remains an open question, but the current evidence consistently shows the benefits of ERAS protocols. Establishing strong scientific evidence for ERAS protocols in ovarian cancer patients is crucial, as is fostering a collaborative team environment for a multidisciplinary approach and conducting ongoing audits to improve patient care (25). Errors in communications between the surgical team and nursing department once resulted in inappropriate administration of carbohydrate drinks which could not secure three hours of fasting time preoperatively. Good communication and close teamwork with preoperative assessment, anesthesiologists, clinical nurses, and physicians are key factors for the successful implementation of ERAS. In our study, fasting time adherence emerged as a significant barrier, sometimes necessitating surgery postponement; however, recent research suggests that consuming clear fluid within two hours before surgery may pose a manageable challenge, as it falls within the clinically accepted risk margin for regurgitation and aspiration (26).

There are a number of limitations exist in the present study. First, the subjective nature of questionnaire limits its objective interpretation. Second, the comparison between the ERAS cohort and non-ERAS cohort may have bias arising from the fact that the two groups had different attending surgeons. In order to minimize this, we performed matched analysis between the ERAS cohort against the non-ERAS historical cohort. However, this may not have completely eliminated the potential bias. Although numerous data are available that support the benefits of each ERAS protocol component, only a few prospective randomized trials have been conducted so far that assessed the benefits of the bundled ERAS protocols (27). Furthermore, given the positive evidence of the ERAS protocols already established by previous studies, it may not be ethically feasible to perform randomized clinical trials in this setting. In order to compensate this limitation, future studies with rigorous statistical methodologies are recommended with various patient populations.

We observed a high adherence to the program guidelines by the patients despite the fact that the ERAS protocols were relatively new to the patients. The establishment of uniform order sets in our EMR system has also enabled us to run the protocols without major obstacles. Overall, the implementation of ERAS protocols in gynecologic surgery has been successful. It has been well accepted by the healthcare providers and the patients.

Conclusions

Our study demonstrated the safety, clinical feasibility and benefits of the ERAS protocols for patients undergoing gynecologic surgeries for both benign and malignant indications. The advantages of ERAS were more evident in laparotomic surgeries compared to laparoscopic surgeries, suggesting variations based on surgical approach. Customization according to the surgical approach and close teamwork for a multidisciplinary approach are key for improved patient care. Further research is needed on the benefits of shorter fasting periods in diverse patient populations.

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Footnote

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Ethical Statement: The authors are accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved. The study was conducted in accordance with the Declaration of Helsinki (as revised in 2013). The study was approved by Institutional Review Board of Samsung Medical Center (No. 2023-11-058). Informed consent was obtained from all individual participants.

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Supplementary

Table S1 Components of the ERAS protocols adopted

Categories	Components
Preoperative optimization	
Assessment of patients	Screen for chronic conditions. Assessment of weight loss and malnutrition. Cessation of tobacco and alcohol 4–6 weeks prior to surgery. Prescribe nutritional shakes if needed
Patient education about the ERAS bundles	Educate the patients about the purpose of the ERAS bundles. Provide a booklet with explanations on each component of the protocols. Reinforce the patients' role in their own recovery
Shortened fasting time	Reduced fasting time for solid food for 6 hours prior to surgery, and for clear liquids for 3 hours prior to surgery
Carbohydrate loading	Start providing commercialized carbohydrate drinks from the evening before surgery up to until 3 hours prior to the beginning of the surgery
Avoidance of mechanical bowel preparation	Avoid enema for bowel preparation
Intraoperative optimization	
Minimal use of intraperitoneal drains	Avoid using intraperitoneal drains unless necessary
Minimal use of urinary drains	Avoid using urinary drains unless necessary (or unless it is expected for the patient not being able to ambulate for a long period of time)
Postoperative optimization	
Perioperative fluid balance	Avoid fluid overloading by intravenous hydration after surgery. Tolerate without providing additional intravenous fluid up to urine output of 20 mL/h. Provide 300 mL of crystalloid fluid if urine output records less than 20 mL/h
Multimodal analgesia	Administer intravenous NSAID and acetaminophen alternatively every 4 hours after surgery. Administer oral analgesic medication once the patient begins dieting. Avoid administering opioid analgesia unless pain is intolerable by the above regimens
Postoperative antiemetics	Administer intravenous antiemetic medication as the patient is taken to the post-anesthesia care unit from the operation room. Administer another bolus of intravenous antiemetic medication on return to the ward
Early removal of drains	Remove all intraperitoneal drains as soon as conditions allow
Early removal of intravenous lines	Remove all intravenous lines as soon as the patient can tolerate drinking fluid by mouth
Early diet	Resume normal diet as soon as the patient can tolerate
Ileus prevention	Provide the patients with chewing gum and non-sugar coffee. Help the patients on ward ambulation with personal assistant

ERAS, enhanced recovery after surgery.

Table S2 Reasons for discontinuation of the ERAS protocols

Reasons for discontinuation of the ERAS protocols
Exclusion of patients due to pre-existing morbidity (e.g., high-risk of complication with early diet due to previous esophageal surgical history)
Unexpectedly high complexity of surgery
Errors in inter-department communications
Patient refusal

ERAS, enhanced recovery after surgery.

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