Short-term Postoperative Outcomes Before and After the Establishment of the Siriraj Upper Gastrointestinal Cancer Center: A Propensity Score Matched Analysis

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ABSTRACT

Objective: To evaluate short-term postoperative outcomes compared between before and 1 year after the establishment of the Siriraj Upper Gastrointestinal Cancer Center (UGICC).

Methods: Medical records of 211 adenocarcinoma of stomach (GC) and esophagogastric junction (AEG) patients who underwent radical gastrectomy at Siriraj Hospital during January 2012-September 2018 were reviewed (before UGICC; B-UGICC). Data of 40 patients operated upon during October 2018-September 2019 were prospectively collected after the establishment of UGICC (A-UGICC). Propensity score (PPS) matched analysis was conducted, and short-term outcomes were compared. Enhanced Recovery After Surgery (ERAS) protocol was applied to some patients in A-UGICC. Results of conventional care (CC) were compared with ERAS protocol.

Results: PPS matched 78 patients (13 AEG, 65 GC) in B-UGICC, and 40 patients (6 AEG, 34 GC) in A-UGICC. Median postoperative length of stay (POS) was significantly shorter in A-UGICC than in B-UGICC; however, complications and time to oral diet tolerability were not significantly different between groups. In A-UGICC, median POS and time to toleration of oral diet were significantly shorter among 15 ERAS patients than among 25 CC patients. Intestinal recovery and time to ambulation trended to be earlier in ERAS. Regarding the ERAS outcomes, 103 CC and 15 ERAS patients were matched to 36 non-ERAS and 13 ERAS patients. Median time to toleration of oral water, liquid diet, and solid diet was significantly shorter in ERAS than in CC (all $P<0.001$). Median POS was significantly shorter in ERAS ($P<0.001$). Postoperative complications were non-significantly different between ERAS and CC. There was no mortality in this study.

Conclusion: UGICC with multidisciplinary team approach and application of ERAS protocol contributed to improvement of postoperative short-term outcomes.

Keywords: Gastric cancer; esophagogastric junction; gastrectomy; multidisciplinary team; centralization; Enhanced Recovery After Surgery (ERAS) (Siriraj Med J 2020; 72: 321-329)

INTRODUCTION

Gastric cancer is one of the cancers that is often diagnosed as late-stage at presentation. Radical surgical resection with systemic chemotherapy is a mainstay of treatment.[1-4] Radical surgical resection should be considered among those regarded as being fit for surgery.[5,6] An

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experienced multidisciplinary team is needed from the time of diagnosis to encourage, educate, and care for these patients.[7-9] Previous meta-analysis demonstrated the effect of a high volume center on postoperative mortality.[10] High volume center appeared to associate with more radical surgery and lymph node dissection, and this resulted in better overall survival.[11,12] In Thailand, the first Upper Gastrointestinal Cancer Center (UGICC) was established at the Faculty of Medicine Siriraj Hospital, Mahidol University in November 2017. The aim of the Siriraj UGICC is to be a center of excellence in esophageal and gastric cancer treatment and care. Our multidisciplinary team, which includes surgeons, medical oncologists, radiation oncologists, anesthesiologists, nutritionists, physical therapists, nurses, and researchers, was organized to provide intensive perioperative and surgical care. Since October 2018, which is when surgical and perioperative protocols were refined and fully implemented, esophageal and gastric cancer patients at Siriraj Hospital have been treated and cared for by this specialized multidisciplinary team.

Several studies have recently published the results of Enhanced Recovery After Surgery (ERAS) protocol for perioperative care in gastric surgery.[13,14] Significantly earlier recovery of intestinal function and shorter hospital length of stay were observed in ERAS patients.[15,16] A reduction in total medical costs was also found in patients that received ERAS protocol.[17] However, no statistically significant difference in postoperative morbidities was found in ERAS patients when compared to those who received conventional treatment.[18-20] These studies suggest the safety and efficacy of ERAS when applied to gastric cancer patients undergoing gastric surgery. Accordingly, the ERAS protocol was adopted and integrated into the Siriraj UGICC perioperative care protocol.

The primary aim of this study was to evaluate short-term postoperative outcomes compared between before and 1 year after the establishment of the Siriraj UGICC. The secondary objective was to compare short-term postoperative outcomes between patients who received ERAS and patients who received conventional care (CC).

MATERIALS AND METHODS

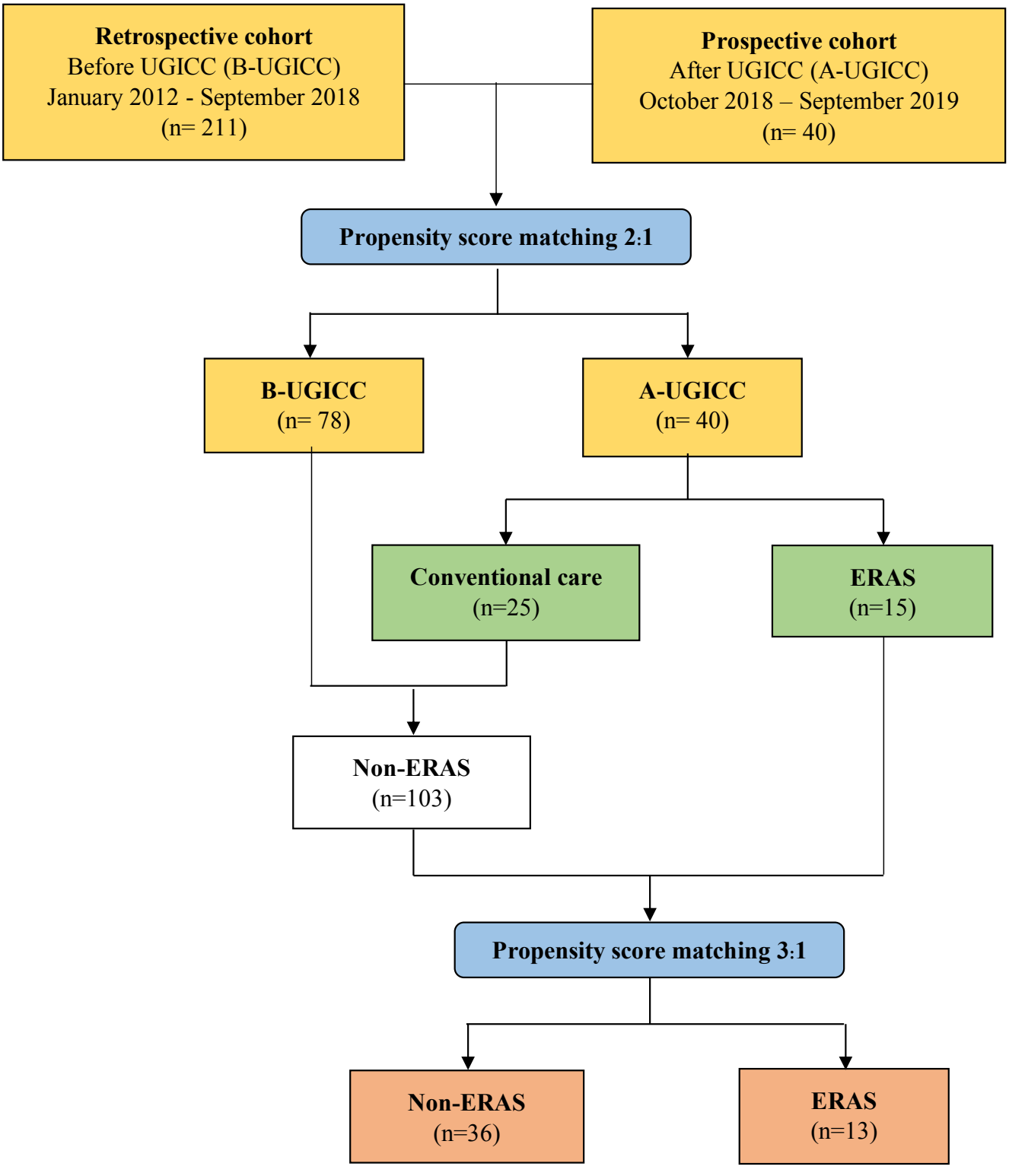
Patients

The medical records of 211 patients with adenocarcinoma of stomach or esophagogastric junction (Siewert type II and III) during January 2012 to September 2018 who underwent curative gastrectomy according to Japanese gastric cancer treatment guidelines[21,22] at Department of Surgery, Faculty of Medicine Siriraj Hospital were reviewed and classified as the *before UGICC group* (B-UGICC). Data of 40 new patients who underwent surgery for the same conditions during October 2018 to September 2019 were prospectively collected following the protocol record form of the Siriraj UGICC, and those patients were classified as the *after UGICC group* (A-UGICC). Propensity score matched analysis (approximately 2:1) with a caliper width of 0.2 using gender, age, American Society of Anesthesiology (ASA) grade, tumor location, operative approach, and extent of operation was conducted to compare between B-UGICC and A-UGICC groups, and to reduce selection bias. After establishment of the Siriraj UGICC, the ERAS protocol was applied in some patients who underwent upper gastrointestinal procedures whereas some patients received traditional care. Perioperative ERAS or conventional care protocols were applied depending on the patient-doctor discussion. Postoperative recovery and complications were compared between 25 patients who received conventional care and 15 patients who received ERAS protocol. Moreover, the short-term outcomes were compared between those in the B-UGICC and A-UGICC groups who received conventional care (non-ERAS group) and patients who received the ERAS protocol in the A-UGICC group (ERAS group) after propensity score matching (approximately 3:1) (Diagram 1).

Preoperative clinicopathological characteristics of patients, including age, gender, ASA grade, tumor location, operative approach and extent of resection were reviewed and recorded. Extent of gastric resection and lymphadenectomy were performed in accordance with Japanese gastric cancer treatment guidelines.[21,22] In this study, extended gastrectomy was defined as transabdominal gastrectomy with combined adjacent organ resection. Esophagogastrectomy was defined as a transthoracic esophagogastrectomy for adenocarcinoma of esophagogastric junction.

Perioperative protocols included preoperative clinical evaluation and laboratory investigations. Anesthesiologist was consulted to evaluate for patients at high risk for anesthesia. Nutritional status was assessed and improved to achieve the energy and protein requirements. Smoking and alcohol were strictly prohibited for at least 2-4 weeks before surgery. For patients receiving the ERAS protocol, breathing exercise and chest physical therapy were emphasized before admission. Clear liquid oral diet was allowed until 3 hours before surgery. Risk of postoperative nausea and vomiting was assessed and prevented. Postoperative pain was controlled by multimodal strategies. Early removal of all catheters and early ambulation were promoted. Oral fluid was started on the first day after surgery, and then soft diet was introduced on postoperative day 3

Diagram 1. Patients and propensity score matching for comparison.



Abbreviations: UGICC, Upper Gastrointestinal Cancer Center; ERAS, Enhanced Recovery After Surgery group

if tolerable. Patients were discharged as soon as they satisfied the discharge criteria.

This study was approved by the Institutional Review Board of the Faculty of Medicine Siriraj Hospital, Mahidol University, Bangkok, Thailand (Si 119/2019).

Outcome measurements

The primary objective was to determine differences in short-term postoperative outcomes between before and after UGICC establishment. Study parameters were timing of intestinal function recovery, timing of ability to tolerate oral intake, postoperative complications and severity classified by Clavien-Dindo classification[23], postoperative length of hospital stay (POS), and postoperative mortality. In this study, we defined intestinal function recovery as time to first flatus and defecation. Severe complication was classified as a grade III and greater according to Clavien-Dindo classification. The secondary objective was to evaluate the benefits of the ERAS protocol compared to that of conventional care.

Statistical methods

All statistical analyses were performed using SPSS statistical software version 23.0 for Windows (SPSS, Inc., Chicago, IL, USA). Descriptive statistics were used to characterize patients before and after the establishment of the Siriraj UGICC. Categorical variables were analyzed using chi-square test or Fisher's exact test, and continuous variables were compared using Student's *t*-test or Mann Whitney U test. Data are presented as number or number and percentage for categorical data, and as mean ± standard deviation (SD) for normally distributed continuous data (SD) or median and interquartile range for non-normally distributed continuous data. Propensity score match analysis was performed by PS matching for SPSS version 23.0. All statistical results were considered significant when the *P*-value was less than 0.05.

RESULTS

Demographic data

Two hundred and eleven patients in the B-UGICC group underwent curative gastrectomy. In the A-UGICC group, 40 new patients were prospectively recruited. There was no significant difference in age, gender, ASA grade, tumor location, or operative approach between groups. Most patients in the B-UGICC group underwent radical extended gastrectomy (86 of 211 patients, 40.8%), whereas radical total gastrectomy was the most common procedure in the A-UGICC group (18 of 40 patients, 45.0%). The extent of gastric resection was significantly different between groups (*P*=0.005). Propensity score matched 78 B-UGICC patients and 40 A-UGICC patients (Table 1). Propensity score match analysis revealed no statistically significant differences in any patient clinical characteristics or surgical procedures between groups. There were 19 patients with adenocarcinoma of the esophagogastric junction (13 in B-UGICC, 6 in A-UGICC), and 99 gastric cancer (65 in B-UGICC, 34 in A-UGICC) patients.

Therapeutic outcomes before and after establishment of the Siriraj UGICC

Of the 118 patients who underwent radical gastrectomy, there was no in-hospital or 30-day postoperative mortality in either group. The incidence of postoperative complications was 30 of 78 patients (38.5%) in B-UGICC, and 19 of 40 patients (47.5%) in A-UGICC. The morbidity rate was not significantly different between groups (*P*=0.628). Two patients (2.6%) in the B-UGICC group suffered from severe postoperative complications. In both cases, intra-abdominal collections, classified as grade IIIa, were successfully treated with non-operative management. In the A-UGICC group, one patient (2.5%) had postoperative bleeding at the esophagojejunostomy anastomosis, but this bleeding was observed to have spontaneously stopped at the time of endoscopy. This bleeding event was classified as grade IIIa. There was no significant difference between groups relative to postoperative time to tolerate oral intake. Median postoperative length of stay was longer in the B-UGICC group than in A-UGICC group (10 days vs. 9 days, respectively; P=0.026) (Table 2).

Impact of the ERAS protocol

Analysis of short-term outcomes compared between the conventional and ERAS protocols in the A-UGICC group is shown in Table 3. Median time to toleration of oral water, liquid diet, and solid diet was significantly shorter in ERAS patients than in CC patients (all *P*<0.001). Recovery of intestinal functions and time to mobilization and ambulation showed a non-significant trend toward being earlier in the ERAS group than in the CC group. Postoperative length of hospital stay was significantly shorter in the ERAS group (5 days vs. 10 days, respectively; *P*<0.001). The postoperative complication rate was not significantly different between ERAS and conventional care (53.3% vs. 44.0%, respectively; *P*=0.570).

To assure the benefit of the ERAS protocol beyond conventional perioperative care, we rearranged previously matched patients. Patients who received conventional care (78 patients in the B-UGICC group, and 25 patients that received the CC protocol in the A-UGICC group) were grouped into the non-ERAS group, and 15 patients who

received the ERAS protocol in the A-UGICC group were assigned to the ERAS group. Propensity score analysis (approximately 3:1) was performed and the patients were matched. Thirty-six patients in the non-ERAS group and 13 patients in the ERAS group were matched (Table 4). The results of that analysis were concordant with those of the previous analysis of ERAS in A-UGICC group. Specifically, significantly earlier time to toleration of oral intake (all $P<0.001$) and shorter postoperative length of stay ($P<0.001$) were observed in the ERAS group. Incidence of postoperative complication in ERAS was higher than in non-ERAS; however, the difference was not statistically significant (61.5% vs. 36.1%, respectively; $P=0.124$). No severe complication was observed in the ERAS group.

TABLE 1. Demographic and clinical characteristics compared between groups before and after propensity score matching.

Characteristics	Before propensity score matching			After propensity score matching		
	B-UGICC (n=211)	A-UGICC (n=40)	*P*-value	B-UGICC (n=78)	A-UGICC (n=40)	*P*-value
Gender, n			0.387			0.847
Male	118	19		39	19	
Female	93	21		39	21	
Age, mean±SD	62.8±14.0	61.6±15.3	0.490	62.9±13.5	61.6±15.3	0.253
ASA grade, n			0.709			0.673
0 – 2	149	27		56	27	
3 – 5	62	13		22	13	
Tumor location, n			0.821			1.000
AEG	38	6		13	6	
GC	173	34		65	34	
Operative approach, n			0.842			0.899
Transthoracic	10	1		4	1	
Open	173	32		59	32	
Laparoscopic	20	5		10	5	
Robotic-assisted	8	2		5	2	
Extent of operation, n			***0.005***			0.437
Proximal gastrectomy	2	0		2	0	
Distal gastrectomy	72	14		32	14	
Total gastrectomy	41	18		23	18	
Extended gastrectomy	86	7		17	7	
Esophagogastrectomy	10	1		4	1	
CRS with HIPEC, n	7	3	0.201	4	3	0.688

A *P*-value<0.05 indicates statistical significance

Abbreviations: AEG, adenocarcinoma of esophagogastric junction; ASA, American Society of Anesthesiologists physical status classification; A-UGICC, after establishment of the Upper Gastrointestinal Cancer Center; B-UGICC, before establishment of the Upper Gastrointestinal Cancer Center; CRS with HIPEC, cytoreductive surgery with hyperthermic intraperitoneal chemotherapy; GC, gastric cancer; SD, standard deviation

TABLE 2. Short-term postoperative outcomes compared between before and after establishment of the Siriraj UGICC.

Postoperative outcomes	B-UGICC (n=78)	A-UGICC (n=40)	*P*-value
Oral intake (days), median (interquartile range)			
Water	4 (3-7)	4 (1.25-7)	0.825
Liquid	5 (4-9)	6 (2.5-8)	0.321
Solid	7 (5-10)	7 (4.25-9)	0.466
Complications, n (%)			0.628
No	48 (61.5)	21 (52.5)	
Mild (grade I-II)	28 (35.9)	18 (45)	
Severe (grade III-IV)	2 (2.6)	1 (2.5)	
Mortality, n (%)	0	0	N/A
Length of stay (days), median (interquartile range)			
Total length of stay	12 (9-16.25)	10 (7-14)	***0.023***
Postoperative length of stay	10 (8-14)	9 (6.25-11)	***0.026***

A *P*-value<0.05 indicates statistical significance

Abbreviations: A-UGICC, after establishment of the Upper Gastrointestinal Cancer Center; B-UGICC, before establishment of the Upper Gastrointestinal Cancer Center; N/A, not applicable

TABLE 3. Outcomes of treatment compared between protocols after establishment of the Siriraj UGICC.

Postoperative outcomes	Conventional care (n=25)	ERAS (n=15)	*P*-value
Oral intake (days), median (interquartile range)			
Water	7 (4.5-8)	1 (1-3)	***<0.001***
Liquid	7 (6-8.5)	2 (2-4)	***<0.001***
Solid	8 (7-10)	3 (3-5)	***<0.001***
Intestinal recovery (hours), median (interquartile range)			
Time to flatus	72 (55-86.5)	60 (24-86)	0.189
Time to defecation	96 (70-125.5)	88 (64-119)	0.401
Ambulation (hours), median (interquartile range)			
Time to in bed mobilization	28 (17-65.25)	22 (16-26)	0.442
Time to out of bed ambulation	63.5 (32.25-82.5)	44 (21-96)	0.682
Complications, n (%)			0.570
No	14 (56)	7 (46.7)	
Mild (grade I-II)	10 (40)	8 (53.3)	
Severe (grade III-IV)	1 (4)	0	
Mortality, n (%)	0	0	N/A
Length of stay (days), median (interquartile range)			
Total length of stay	13 (10.5-15.5)	6 (6-8)	***<0.001***
Postoperative length of stay	10 (9-12.5)	5 (5-7)	***<0.001***

A *P*-value<0.05 indicates statistical significance

Abbreviations: UGICC, Upper Gastrointestinal Cancer Center; ERAS, Enhanced Recovery After Surgery protocol; N/A, not applicable

TABLE 4. Outcomes of treatment compared between patients that did and that did not receive ERAS protocol after propensity score matching (approximately 3:1).

Postoperative outcomes	Non-ERAS (n=36)	ERAS (n=13)	*P*-value
Oral intake (days), median (interquartile range)			
Water	4 (3-7)	1 (1-2)	***<0.001***
Liquid	5.5 (4-8.75)	2 (2-3)	***<0.001***
Solid	7 (6-10)	3 (3-4.5)	***<0.001***
Complications, n (%)			0.124
No	23 (63.9)	5 (38.5)	
Mild (grade I-II)	11 (30.6)	8 (61.5)	
Severe (grade III-IV)	2 (5.6)	0	
Mortality, n (%)	0	0	N/A
Length of stay (days), median (interquartile range)			
Total length of stay	11.5 (9-14.75)	6 (6-7)	***<0.001***
Postoperative length of stay	10 (8-13)	5 (5-6.5)	***<0.001***

A *P*-value<0.05 indicates statistical significance
Abbreviations: ERAS, Enhanced Recovery After Surgery protocol; N/A, not applicable

DISCUSSION

Centralization is now recognized as a factor that improves postoperative mortality and treatment outcomes. High-volume centers and centers of excellence that specialize in certain types of cancer seem to have better short- and long-term survival outcomes. Nimptsch U, *et al.*[24] reported national hospital discharge data after complex gastric surgery in Germany. They found surgery in very high-volume hospitals (50 operations per year) to be associated with lower in-hospital mortality compared to treatment in very low-volume hospitals (5 surgeries per year) (10.6% vs. 12.0%, respectively). For cancer surgery, very high-volume hospitals (34 resections per year) had lower in-hospital mortality than that in very low volume hospitals (3 resections per year) (6.3% vs. 7.7% respectively). Iwatsuki M, *et al.*[25] analyzed the results of distal gastrectomy for gastric cancer from the National Clinical Database of Japan. Operative mortality was significantly higher in low-volume hospitals (1-22 cases per year) than in medium-volume (23-51 cases per year) and high-volume (52-404 cases per year) hospitals (1.9% vs. 1.0% vs. 0.5%, respectively; *P*<0.001). van Putten M, *et al.*[11] reported the short-and long-term outcomes before and after centralization of gastric cancer surgery in the Netherlands. The 30-day postoperative mortality rate was 6.5% before, and 4.1% after centralization (*P*=0.004). The 2-year overall survival rate was also improved from before to after centralization (55.4% vs. 58.5%, respectively; *P*=0.031). Hospital volume could have an impact on postoperative outcomes, and that centralization was associated with improved survival in the developed countries. However, data specific to the development and effectiveness of specialized esophageal and gastric cancer centers in developing countries is scarce. To the best of our knowledge, this is the first data of postoperative outcomes reported from the upper gastrointestinal cancer center in Thailand.

The Siriraj Upper Gastrointestinal Cancer Center was established in November 2017. To the best of our knowledge, this is the first specialized upper gastrointestinal cancer center organized by a multidisciplinary team in Thailand. The aim of the Siriraj UGICC is to be a center of excellence in esophageal and gastric cancer services. This center also aims to be a training center for medical personnel in all aspects of patient care for these two types of cancer. Research to identify ways to improve treatment and patient care is also an important component of the mission of the Siriraj UGICC. We arranged a multidisciplinary discussion to decide upon a pattern of perioperative and surgical care. Since this center's founding, management practices and clinical protocols have become more systematic and efficient. In the initial

period, ERAS protocol could be completely implemented for patients because of a strong multidisciplinary team. A prospectively maintained database is regularly reviewed and updated, and the quality of the documentation is more reliable to study and analyze.

This study reports short-term postoperative outcomes after radical gastrectomy compared between before and after the establishment of a UGICC. We applied propensity score matched analysis to reduce selection bias and improve the quality of comparison. Although our patients were treated by the same group of surgeons and the same surgical standard according to Japanese gastric cancer treatment guidelines, perioperative care was adjusted and refined by the multidisciplinary team after UGICC establishment. Patient recovery demonstrated a non-significant trend toward improvement in the A-UGICC group compared to the B-UGICC group; however, length of hospital stay was statistically significantly improved after the establishment of the Siriraj UGICC. The ERAS protocol is a strategy that can be applied during the perioperative and intraoperative period. Since the ERAS protocol is a new care strategy for esophageal and gastric cancer patients at our center and its reported superior postoperative results have never been proven at our hospital, it was applied in only some selected patients. Although the number of ERAS patients in our study was comparatively low, the postoperative short-term outcomes were promising. Significant improvement in patient recovery and length of hospital stay was clearly shown. In contrast, severe postoperative morbidity and mortality rates were not significantly increased. The identified safety and recovery benefits of the ERAS protocol suggest its benefit in other types of surgical patients in the future. After the Siriraj UGICC was established, the incidence of postoperative complications and mortality was not different from the pre-UGICC period. However and importantly, it should be noted that there was no postoperative mortality in this study. The high incidence of minor postoperative complications might be the result of better data collection.

Some limitations of this study have to be addressed. First, our data was derived from a single super-tertiary center in Thailand, which makes this a single-center study. Moreover, our center, which is a national super-tertiary referral center, is routinely referred complex cases that cannot be managed at a lower level center. This limitation suggests that our findings may not be generalizable to all other care settings. Second, the size of our study population was relatively small; however, the number of patients that undergo radical gastrectomy is generally quite low. In an attempt to mitigate this limitation and improve the quality of our analysis, we employed the use of propensity score matching to reduce selection bias and improve the quality of our comparisons. Further study is needed to compare the cost of treatment between pre- and post-UGICC, and to investigate the long-term outcomes of these patients.

In conclusion, Siriraj Upper Gastrointestinal Cancer Center aims to improve the quality of esophageal and gastric cancer care. This is the first specialized center organized by a multidisciplinary team in Thailand. High surgical standard and appropriate in-house perioperative protocol had significant positive impact on postoperative short-term outcomes. Multidisciplinary team in UGICC with the application of the ERAS protocol contributed to significant improvement in timing of ability to tolerate oral intake and postoperative length of hospital stay.

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REFERENCES

1. Songun I, Putter H, Kranenbarg EM, Sasako M, van de Velde CJ. Surgical treatment of gastric cancer: 15-year follow-up results of the randomised nationwide Dutch D1D2 trial. Lancet Oncol 2010;11(5):439-49.
2. Mocellin S, McCulloch P, Kazi H, Gama-Rodrigues JJ, Yuan Y, Nitti D. Extent of lymph node dissection for adenocarcinoma of the stomach. Cochrane Database Syst Rev 2015(8):CD001964.
3. Cunningham D, Allum WH, Stenning SP, Thompson JN, Van de Velde CJ, Nicolson M, et al. Perioperative chemotherapy versus surgery alone for resectable gastroesophageal cancer. N Engl J Med 2006;355(1):11-20.
4. Ychou M, Boige V, Pignon JP, Conroy T, Bouche O, Lebreton G, et al. Perioperative chemotherapy compared with surgery alone for resectable gastroesophageal adenocarcinoma: an FNCLCC and FFCD multicenter phase III trial. J Clin Oncol 2011;29(13):1715-21.
5. Parakonthun T, Nampoolsuksan C, Swangsri J, Yiengpruksawan A, Methasate A. Retrospective Analysis of the Outcomes in Elderly Patients with Adenocarcinoma of the Stomach and Esophagogastric Junction Following Three Different Treatments. Siriraj Medical Journal. 2019;71(6):449-57.
6. Parakonthun T, Parichardsombat N, Paredes HSR, Phalanusittheph C, Taweerutchana V, Trakarnsanga A, et al. Significance of Microscopic Residual Tumor in Adenocarcinoma of Stomach and Esophagogastric Junction after Gastrectomy with D2 Lymphadenectomy. Siriraj Medical Journal 2018;70(2):95-102.

7. Tegels JJ, De Maat MF, Hulsewe KW, Hoofwijk AG, Stoot JH. Improving the outcomes in gastric cancer surgery. World J Gastroenterol 2014;20(38):13692-704.
8. Mortensen K, Nilsson M, Slim K, Schafer M, Mariette C, Braga M, et al. Consensus guidelines for enhanced recovery after gastrectomy: Enhanced Recovery After Surgery (ERAS(R)) Society recommendations. Br J Surg 2014;101(10):1209-29.
9. Lau CS, Chamberlain RS. Enhanced Recovery After Surgery Programs Improve Patient Outcomes and Recovery: A Meta-analysis. World J Surg 2017;41(4):899-913.
10. Gruen RL, Pitt V, Green S, Parkhill A, Campbell D, Jolley D. The effect of provider case volume on cancer mortality: systematic review and meta-analysis. CA Cancer J Clin 2009;59(3):192-211.
11. van Putten M, Nelen SD, Lemmens V, Stoot J, Hartgrink HH, Gisbertz SS, et al. Overall survival before and after centralization of gastric cancer surgery in the Netherlands. Br J Surg 2018;105(13):1807-15.
12. Pasquer A, Renaud F, Hec F, Gandon A, Vanderbeken M, Drubay V, et al. Is Centralization Needed for Esophageal and Gastric Cancer Patients With Low Operative Risk?: A Nationwide Study. Ann Surg 2016;264(5):823-30.
13. Yamagata Y, Yoshikawa T, Yura M, Otsuki S, Morita S, Katai H, et al. Current status of the "enhanced recovery after surgery" program in gastric cancer surgery. Ann Gastroenterol Surg 2019;3(3):231-8.
14. Aoyama T, Yoshikawa T, Sato T, Hayashi T, Yamada T, Ogata T, et al. Equivalent feasibility and safety of perioperative care by ERAS in open and laparoscopy-assisted distal gastrectomy for gastric cancer: a single-institution ancillary study using the patient cohort enrolled in the JCOG0912 phase III trial. Gastric Cancer 2019;22(3):617-23.
15. Wee IJY, Syn NL, Shabbir A, Kim G, So JBY. Enhanced recovery versus conventional care in gastric cancer surgery: a meta-analysis of randomized and non-randomized controlled trials. Gastric Cancer 2019;22(3):423-34.
16. Tweed T, van Eijden Y, Tegels J, Brenkman H, Ruurda J, van Hillegersberg R, et al. Safety and efficacy of early oral feeding for enhanced recovery following gastrectomy for gastric cancer: A systematic review. Surg Oncol 2019;28:88-95.
17. Wang LH, Zhu RF, Gao C, Wang SL, Shen LZ. Application of enhanced recovery after gastric cancer surgery: An updated meta-analysis. World J Gastroenterol 2018;24(14):1562-78.
18. Li MZ, Wu WH, Li L, Zhou XF, Zhu HL, Li JF, et al. Is ERAS effective and safe in laparoscopic gastrectomy for gastric carcinoma? A meta-analysis. World J Surg Oncol 2018;16(1):17.
19. Kang SH, Lee Y, Min SH, Park YS, Ahn SH, Park DJ, et al. Multimodal Enhanced Recovery After Surgery (ERAS) Program is the Optimal Perioperative Care in Patients Undergoing Totally Laparoscopic Distal Gastrectomy for Gastric Cancer: A Prospective, Randomized, Clinical Trial. Ann Surg Oncol 2018;25(11):3231-8.
20. Ding J, Sun B, Song P, Liu S, Chen H, Feng M, et al. The application of enhanced recovery after surgery (ERAS)/fast-track surgery in gastrectomy for gastric cancer: a systematic review and meta-analysis. Oncotarget 2017;8(43):75699-711.
21. Japanese Gastric Cancer A. Japanese gastric cancer treatment guidelines 2014 (ver. 4). Gastric Cancer 2017;20(1):1-19.
22. Japanese Gastric Cancer A. Japanese gastric cancer treatment guidelines 2010 (ver. 3). Gastric Cancer 2011;14(2):113-23.
23. Dindo D, Demartines N, Clavien PA. Classification of surgical complications: a new proposal with evaluation in a cohort of 6336 patients and results of a survey. Ann Surg 2004;240(2):205-13.
24. Nimptsch U, Haist T, Gockel I, Mansky T, Lorenz D. Complex gastric surgery in Germany-is centralization beneficial? Observational study using national hospital discharge data. Langenbecks Arch Surg 2019;404(1):93-101.
25. Iwatsuki M, Yamamoto H, Miyata H, Kakeji Y, Yoshida K, Konno H, et al. Effect of hospital and surgeon volume on postoperative outcomes after distal gastrectomy for gastric cancer based on data from 145,523 Japanese patients collected from a nationwide web-based data entry system. Gastric Cancer 2019;22(1):190-201.