Initial result of unselective implementation of enhanced recovery after surgery in a low-volume bariatric unit: a feasibility and safety study

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Abstract

Background The feasibility and safety of unselectively applying an enhanced recovery after surgery (ERAS) protocol in a low-volume bariatric unit were determined.

Material and methods We retrospectively reviewed all patients undergoing bariatric surgeries under a single surgeon between January 2015 and December 2018. Our ERAS protocol initiated in January 2017 with all patients enrolled unselectively. For those receiving non-primary procedures or with BMI < 32.5 kg/m² were excluded from this analysis. Demographic features and all 30-day outcome measures, including operation time, length of stay (LOS), ER visits, readmissions, reoperations were collected and compared between the ERAS (2017–2018) and control (2015–2016) groups.

Results One hundred eighty-four consecutive patients underwent bariatric surgeries during the study period. Of those fulfilling the inclusion criteria, 62 (40.8%) were treated before and 90 (59.2%) were treated after ERAS implementation. No differences in baseline demographics were found between the groups except ERAS group had more Roux-en-Y gastric bypass procedures (58.9% vs. 12.9%). A markedly reduced operation time (101 min vs. 147 min; $p < 0.001$) and shortened LOS (2.6 days vs. 3.3 days; $p < 0.001$) were observed, with significantly more ERAS patients achieving POD1 discharge (45.6% vs. 1.6%; $p < 0.001$). There were no significant differences in terms of ER visits (2.2% vs. 8%), readmissions (1.1% vs. 4.8%) or total complication rates between the groups (5.5% vs. 9.7%).

Conclusion Unselective ERAS implementation in low-volume units is feasible and safe, with significantly reduced operation times and a shortened LOS without increased complications.

Background

While obesity is being recognized as a global epidemic [1], the commensurate rising prevalence of obesity and multiple comorbidities, such as hypertension (HTN), type II diabetes mellitus (DM), obstructive sleep apnea (OSA), dyslipidemia, etc., resulting in mounting pressure to offer proper treatment for this worldwide health hazard [2]. Interventions such as diet, exercise and intensive medical therapy generally fail to achieve durable effectiveness [3]. Instead, bariatric surgeries currently serve as a standard solution to settle this problem because of their well-recognized long-term effectiveness for weight reduction and comorbidity remission [4]. However, to widespread introduction of such a relatively complex treatment is not without risks [5]. Conventionally, cumulative surgical experience or high-volume practice generally yields superior outcomes [6]. However, it takes a long time to build up adequate experience and achieve this goal. Therefore, for low-volume practices, it is important to utilize alternative measures that are able to maintain safety profiles and facilitate quality improvement.

Clinical pathways such as enhanced recovery after surgery (ERAS) concept and alike, which consists of multimodal recommendations, has successfully been shown to be a valuable modality to attenuate perioperative stress and achieve faster convalescence for various surgical disciplines [7]. Systemic reviews and meta-analyses demonstrate that ERAS concepts could optimize perioperative care with

improved results for bariatric surgeries [8]. Only technique proficiency is generally believed to be a prerequisite to conduct such a practice [9]. In addition, there are no clear patient selection or exclusion criteria. For instance, individuals with an age beyond the regular limits (e.g., < 18 or > 60 years); super obese ; American Society of Anesthesiologists (ASA) class > 3 [10]; organ failure such as chronic kidney disease (CKD) or congestive heart failure (CHF), etc. [11], are traditionally deemed unsuitable for ERAS enrollment. In contrast, other clinicians have considered that the presence of multiple comorbidities should not preclude patients from benefiting from such protocols [12]. In summary, because of the aforementioned factors, the literature remains scarce with respect to the feasibility and results to conduct such a plan in a low-volume practice. The purpose of this study was to verify whether ERAS can be safely performed in a low volume program and provided with additional quality improvement. By means of an unselective approach, our goal was to increase its generalizability.

Methods

Data were retrieved retrospectively from a prospectively maintained database between January 2015 and December 2018 and all procedures performed in this study were in accordance with the ethical standards in the 1964 Declaration of Helsinki and its later amendments. The local institutional review board approved this study. The requirement to obtain formal consent was waived for this kind of study. All patients met the regional criteria [13] and were enrolled unselectively. Those who underwent non-primary surgery or for metabolic purpose that had a body mass index (BMI) of < 32.5 kg/m² were excluded from this analysis. The periods analyzed were two years before and after the implementation of the ERAS protocol. Patients were stratified into control (2015–2016) or ERAS groups (2017–2018) based on case sequence. Preoperative routine evaluations included blood tests, chest radiographs, electrocardiograms, echocardiograms, abdominal ultrasound and upper gastrointestinal endoscopy.

Eras Protocol

A pragmatic ERAS protocol in accordance with the available guidelines at that time that utilized basic and essential changes was fully initiated in January 2017 [14]. Interventions consisted of proper preoperative education and preparations, intraoperative care, and early ambulation and oral intake postoperatively. Table 1 highlights the differences between this protocol and the previous standard of care. Before admission, patients underwent thorough instruction with emphasis on clear expectations and goals in addition to general information regarding the risks and benefits of the surgery as per surgical consent. Premedication was also provided for ERAS patients. Both groups received thromboprophylaxis according to the individual risk profile. Routine nasogastric tube, abdominal drainage, or urinary catheter placement were discontinued after ERAS implementation.

Table 1
Highlighted differences comparing the ERAS protocol to standard care

Phase of care	ERAS	Standard care
Preadmission education	expectations and goals	routine surgical consent
Medications scheduled Premedication	LMW heparin PPI and IV acetaminophen	LMW heparin
During the operation Anesthesia	intermittent pneumatic compression device no Foley catheter no abdominal drain PONV prophylaxis TAP block elimination of opioid use muscle tension monitoring reversal with Sugammadex	intermittent pneumatic compression device routine Foley catheterization and abdominal drainage standard anesthesia
Postoperative Medications scheduled On demand	PPI, metoclopramide Dynastat, ondansetron IV acetaminophen	PPI, metoclopramide
Patient care	head elevated 45 degrees lung recruitment therapy avoidance of fluid overloading rigorous early ambulation routine lab survey on POD1	head elevated 45 degrees lung recruitment therapy liberal use of IV fluids urinary catheter and abdominal drain removed on POD1 or POD2 routine lab survey on POD1
Diet	clear liquids on POD1	clear liquids on POD1 after a swallow test

ERAS, enhanced recovery after surgery; LMW, low molecular weight

PPI, proton pump inhibitor; IV, intravenous;

PONV, postoperative nausea vomiting; TAP, transversus abdominis plane;

Lab, laboratory; POD, postoperative day

Phase of care	ERAS	Standard care
Discharge if criteria met	granted on POD1 or POD2	no such regulations
ERAS, enhanced recovery after surgery; LMW, low molecular weight		
PPI, proton pump inhibitor; IV, intravenous;		
PONV, postoperative nausea vomiting; TAP, transversus abdominis plane;		
Lab, laboratory; POD, postoperative day		

Anesthesia

A standard regimen for general anesthesia was given after full preoxygenation in the ramped position. In the interim, positive end-expiratory pressure was utilized to prevent the formation of atelectasis, with concerted efforts focused on maintaining normothermia, euglycemia, and euvoemia. Apart from standard care, bolus dexamethasone (10 mg) and droperidol (0.625 mg) were introduced for postoperative nausea and vomiting (PONV) prophylaxis in the ERAS group. As per the multimodal analgesic regimen, a particular emphasis was placed on the total elimination of opioid medication and its equivalent usage under the aid of laparoscopically guided transversus abdominis plane (TAP) block. Additionally, an optimal muscle tension monitor (train of four) was utilized to facilitate deep neuromuscular blockage plus sugammadex (2–4 mg/kg) administration for its reversal. Postoperatively, ERAS patients treated with routine and on-demand multimodal analgesics and antiemetic agents (i.e., Dynastat, acetaminophen, ondansetron). The clinical pathway included avoidance of fluid overload (< 2L/day) and rigorous early ambulation.

Liquid diet was commenced on the first postoperative day in the ERAS group with no further need for a swallow study. Discharge criteria included no surgical complications, no fever, stationary hemodynamic parameters, a negative routine laboratory survey, tolerable oral fluid intake and no need for further IV analgesics; this status was granted on POD1 or POD2 in the ERAS group. Each patient received a printed instructional handout when discharged.

Surgical Technique

All surgical procedures were conducted laparoscopically with procedure selection conducted through a shared decision-making process. Roux-en-Y gastric bypass (RYGB) was performed by constructing a 30-mL vertical gastric pouch over a 32 Fr. calibrating tube, followed by an average 100-cm antecolic alimentary, 100-cm biliary limb; linear stapled gastrojejunostomy, jejunio-jejunostomy and suture closure of mesenteric defects via non-absorbable suture.

For one-anastomosis gastric bypass (OAGB), the technique involved first stapling via Crow's foot and subsequent multiple firings alongside a Fr. 32 calibration tube with stapled gastrojejunostomy. The

average length of the biliary limb was 200 cm. Laparoscopic sleeve gastrectomy (SG) involved multiple firings of the proper linear stapler 4–6 cm from the pylorus along a Fr. 32 calibration tube.

Data Collection And Statistical Analysis

Demographic features, including age, gender, BMI, type of operation and history of common comorbid conditions, e.g., HTN, DM, and dyslipidemia, together with all relevant outcome measures, including operating times, length of stay (LOS), emergency room (ER) visits, readmissions, reoperations, and any 30-day complications, such as unplanned procedures/interventions and mortality, were collected and analyzed between groups. Prolonged stay was defined as an LOS over 3 days. Any adverse events including outside facility ER visits were obtained by inquiring directly from all our patients. Postoperative thirty-day complications were recorded and graded according to the Clavien–Dindo classification (CD) [15], and CD grade $\geq$ IIIa was considered a major complication. Statistical analyses were performed using Statistical Package for the Social Sciences software version 20.0 (SPSS, Inc., Chicago, Illinois, USA). Data are reported as the mean $\pm$ standard deviation (SD) or as counts and percentages when appropriate. Chi-square tests or Fisher's exact tests were used to compare two categorical variables. Tests for statistical significance were two-sided with a level of significance of 0.05.

Results

From Jan 2015 to Dec 2018, a total of one hundred and eighty-four consecutive patients underwent bariatric surgery at our hospital. In the ERAS group, 26 patients receiving metabolic surgery with BMI $< 32.5 \text{ kg/m}^2$ and another four patients who underwent revision surgeries were excluded. Among the control group, two patients for metabolic purpose with BMI $< 32.5 \text{ kg/m}^2$ were excluded, leaving a total of 152 patients enrolled in this study. Of these patients, 90 (59.2%) were in the ERAS group, and 62 (40.8%) were in the control group.

Patient characteristics are outlined in Table 2. No significant differences were found between patients who underwent surgery before and after implementation of the ERAS protocol with respect to age (38.7 ± 11.2 yrs. vs. 39.4 ± 11.3 yrs.; $p = 0.707$), female gender (30 (48.4%) vs. 45 (50%); $p = 0.847$), preoperative BMI ($41.2 \pm 7.8 \text{ kg/m}^2$ vs. $39.6 \pm 7.6 \text{ kg/m}^2$; $p = 0.209$) or incidence of common comorbidities such as DM, HTN, and dyslipidemia. RYGB accounted for fewer operations in the control group (8 (12.9%) and 53 (58.9%), respectively), whereas OAGB was more often performed (53 (85.5%) vs. 36 (40%); $p < 0.001$). There were four concomitant procedures in the ERAS group, including two with partial gastrectomy for benign lesions and two with fundus resection for obscured surgical fields, while none of these procedures were performed in the control group. However, this difference was not statistically significant ($p = 0.095$).

Table 2
Characteristics of patients before and after the ERAS protocol

Variables	ERAS (N = 90)	control (N = 62)	p-value
Type of procedures, n (%)	53 (58.9)	8 (12.9)	< 0.001 [‡]
RYGB	36 (40.0)	53 (85.5)	
OAGB	1 (1.10)	1 (1.60)	
SG			
Age (years), range	39.4 ± 11.3 (19–74)	38.7 ± 11.2 (21–64)	0.707
Female gender, n (%)	45 (50)	30 (48.4)	0.847
BMI (kg/m ²), range	39.6 ± 7.6 (32.5–73.7)	41.2 ± 7.8 (32.5–64.1)	0.209
Comorbidity, n (%)			
Diabetes mellitus	27 (30.0)	20 (32.3)	0.764
Hypertension	40 (44.4)	27 (43.5)	0.913
Dyslipidemia	52 (57.8)	33 (53.2)	0.576
Concomitant procedure, n (%)	4 (4.40)	0	0.095
Partial gastrectomy	2		
Fundus resection	2		
ERAS, enhanced recovery after surgery; RYGB, Roux-en-Y gastric bypass			
OAGB, one-anastomosis gastric bypass; SG, sleeve gastrectomy			
BMI, body mass index			
Data are expressed as the means ± standard deviation (range) or as numbers and percentages			

The mean operation time was significantly reduced (101 ± 42.2 min vs. 147 ± 40.2 min; $p < 0.001$), and the LOS was markedly shortened in the ERAS group compared to the control group (2.6 ± 0.7 days vs. 3.3 ± 0.8 days; $p < 0.001$), as shown in Table 3. Forty-one out of ninety patients (45.6%) in the ERAS group were successfully discharged on POD1 compared with a meager one out of 62 patients (1.6%) in the control group ($p < 0.001$). Fewer patients in the ERAS group had an LOS more than 3 days (6 (6.7%) vs. 13 (20.1%); $p = 0.013$). Moreover, there was a trend of reduction in 30-day ER visits (2 (2.2%) vs. 5 (8%); $p = 0.093$), readmissions (1 (1.1%) vs. 3 (4.8%); $p = 0.161$), overall complications (5 (5.5%) vs. 6 (9.7%); $p =$

0.360), and unplanned procedures or interventions (1 (1.1%) vs. 2 (3.2%); $p = 0.360$) in the ERAS group, although none of these differences reached statistical significance. The incidence of major (CD $\geq$ IIIa) (1 (1.1%) vs. 2 (3.2%); $p = 0.360$) or minor (4 (4.4%) vs. 4 (6.4%); $p = 0.343$) complications was not different between the groups. There was no anastomotic leakage, open conversion or mortality reported in either group throughout the study.

Table 3
Surgical perspectives and outcomes

Variables	ERAS (N = 90)	control (N = 62)	P-value
OP time (minutes)	101 $\pm$ 42.2	147 $\pm$ 40.2	< 0.001 ¹
LOS (days), range	2.6 $\pm$ 0.7 (1–5)	3.3 $\pm$ 0.8 (2–6)	< 0.001 ¹
POD1 discharge, n (%)	41 (45.6)	1 (1.6)	< 0.001 ¹
LOS > 3 days, n (%)	6 (6.7)	13 (20.1)	0.013 ¹
30-day ER visits, n (%)	2 (2.2)	5 (8)	0.093
30-day readmissions, n (%)	1 (1.1)	3 (4.8)	0.161
30-day complications, n (%)	5 (5.5)	6 (9.7)	0.360
Major (CD $\geq$ IIIa) ¹ , n (%)	1 (1.1)	2 (3.2)	0.360
Minor, n (%)	4 (4.4)	4 (6.4)	0.343
Unplanned procedures or interventions, n (%)	1 (1.1)	2 (3.2)	0.360
30-day Reoperations	0	0	
30-day Mortality	0	0	
ERAS, enhanced recovery after surgery; OP, operation; LOS, length of stay			
POD, postoperative day; ER, emergency room;			
¹ Clavien–Dindo classification [15]			

Five patients in the ERAS group experienced 30-day complications, with details described in Table 4. Of these, four minor complications were identified, including a patient with focal abdominal wall hematoma. Two other patients visited the ER after discharge; one for self-limited abdominal pain and another patient with hematemesis who visited the ER at an outside hospital and was arranged to be readmitted. The fourth patient had gastrointestinal (GI) bleeding that required a total of 4 days of in-hospital observation. Last, one particular patient who had to abort the index operation due to an obscured surgical field was

classified as having major complications. This specific patient underwent a second surgical attempt four months later uneventfully after vigorous diet control.

Table 4
Details of 30-day complications and reinterventions

Clavien– Dindo classification	ERAS n = 5	control n = 6	complications reported	treated by
Grade I		1	transient liver dysfunction	supportive treatment
	1		abdominal wall hematoma	supportive treatment
		1	fever	ER; medical treatment
	1	1	abdominal pain	ER / ER; medical treatment
Grade II		1	nausea/vomiting	ER; readmission for hydration
	1		hematemesis	ER; readmission for medical treatment
	1		GI bleeding	LOS 4 days; medical treatment (no transfusion)
Grade IIIa		1	intra-abdominal hematoma	ER; readmission for image guide drainage
Grade IIIb (major)		1	anastomosis stenosis	ER; readmission for dilatation under general anesthesia
	1		aborted index operation	reoperation 4 months later
ERAS, enhanced recovery after surgery; ER, emergency room; GI, gastrointestinal				
LOS, length of stay				

In the control group, six patients experienced complications. Among these were four minor complications, including one case of transient liver dysfunction. The other three patients visited the ER, with one presenting mild fever and another reporting self-limited abdominal pain. The third patient had PONV and was readmitted for hydration. Two major complications was identified, namely, one patient was readmitted through the ER for an intra-abdominal hematoma that required image-guided drainage;

another patient of anastomosis stenosis that required readmission via the ER for balloon dilatation under general anesthesia, which comprised the second unplanned intervention.

Discussion

Our analysis demonstrates that unselective implementation of ERAS protocol can be safe in a low volume unit and realize its advantage by a marked decrease in operation time, shortened LOS and with more patients securely discharge on POD1 without an increase in complications.

Since the concept of a multimodal approach to control postoperative pathophysiology and improve recovery was first introduced in 1997 [16], relevant protocols have evolved. The rationale is to hasten convalescence by reducing perioperative stress. From then onwards, guidelines have been established regarding recommendations for integral ERAS components in bariatric field [14]. Recently, several systemic reviews and meta-analyses have demonstrated the superiority of enhanced recovery protocols in terms of carrying out more efficient surgical procedures, lessening the length of hospitalization and effectively reducing overall morbidities compared with standard care [8, 17, 18]. That being said, to generally implement the ERAS regimen remains questionable since this approach is not without risks [9, 19]. For instance, Rebibo et al. reported a cohort with a 40% increase in the readmission rate (from 4–5.6%; $p < 0.01$) [20]. Others observed an increase in the ER visit rate as a result of shortening the target LOS [21]. Using the Metabolic and Bariatric Surgery Accreditation and Quality Improvement Program data set, Inaba et al. found a significantly higher morbidity (3.76% vs. 1.54%) and mortality rate (0.94% vs. 0.05%) when comparing same-day discharge to POD1 discharge after RYGB [22]. In another review from a large prospective database, Morton et al. discovered that an LOS of ≤ 1 day was associated with a significantly increased risk of 30-day mortality (OR 2.02) and a trend toward an increased risk of serious complications for RYGB patients [23]. In fact, the reasons to suggest ERAS be implemented under the setting of specialized high-volume centers reside in that mastered surgical technique beforehand is frequently deemed a prerequisite to conduct these projects safely [9]. For example, McCarty et al. proposed that 84% of patients can be discharged within 23 hours postoperatively with a readmission rate as low as 1.7% for 2000 consecutive RYGB patients [24]. Similarly, based on a single high-volume center, Jacobsen et al. published an ERAS cohort of 2000 consecutive RYGB cases with a significantly shortened hospital stay (from 3 days to 2 days), an early complication rate as low as 2.8% and a readmission rate of only 1.9% [25]. In this regard, it seems reckless to conduct ERAS in a non-accredited low volume unit with fewer than 50 perennial cases. By looking at our two-year results before ERAS inception with mean operative time plateaued at 147 min, LOS stabilized around 3.3 days and no conversions or mortality reported; we believe a safety standard had been reached despite there were no objective criteria to gauge readiness.

Unlike our study background, a vast accumulating experience can usually be found when referring to preceding research that has been conducted with low case numbers. Hahl et al. analyzed data from 318 out of 514 patients who underwent RYGB during a 4-year period with excellent results showing a mean LOS of only 1.3 days and 83% of patients discharged on POD1 [26]. Notably, their accumulative

experience at that time was already far more than five hundred cases. Similar to our study, Awad et al. introduce a series of 226 cases that comprised various bariatric procedures. With a low 30-day complication rate of only 4.4% and a readmission rate of 2.7% [12]; however, this particular study were conducted at a regional high-volume tertiary referral center, wherein they already had a vast prior experience of more than 2000 RYGB procedures. Therefore, whether these superior outcomes result from specific ERAS programs or merely reflect clinician proficiency remains unclear. Some other studies were notably undertaken via independent patient-selection or procedure-selection process. Such as Sasse et al. presented a 38 RYGB case series with a 100% POD1 discharge rate and a low 30-day complication rate of only 2.6% [27]. However, their study group represented fewer than 3% of their total RYGB cases during that period as a result of stringent patient selection. Likewise, Fares et al. accomplished a high POD1 discharge rate of up to 94.8% from a consecutive 96 RYGB case series in a small, teaching community hospital with only 5.2% complications [28]. Nevertheless, the study group comprised 55% of patients selected from a total caseload of 173. Lam et al. reported their recent work which yielding remarkable results in terms of 83.1% of patients achieving POD1 discharge with a 1.5% readmission rate whereas they selected 130 out of 240 total cases in their research, and all subjects were receiving SG [29]. Even so, there was no coherent criterion for subject selection and risk stratification among these studies. Although individuals bearing high-risk profiles are consistently deemed unsuitable for enrollment [10, 11, 20], other studies have demonstrated that quality improvement can be attained for some of these vulnerable groups with preserved safety profiles [30]. As a result, our series comprised various susceptible groups; for example, 5 (5.6%) patients were aged > 65 yrs. (range, 65–74 yrs.), 4 (4.4%) patients had a BMI of > 50 kg/m² (range, 52.5–73.7 kg/m²), and two other patients had a wheelchair-bound status. Notwithstanding, except for a 67-year-old male patient who experienced an abdominal wall hematoma, none of these susceptible patients experienced 30-day complications. Compared to an LOS ranging from 1 day to 2.9 days, readmission rates between 1.7% and 8.1%, early complication rates between 2.8% and 18.3%, and mortality rates of up to 0.7% across former, high-volume studies [12, 24–26, 30], a total LOS of 2.6 days, readmission rate of 1.1% and a total complication rate of 5.5% was accomplished in our series and fall in line with these valuable large studies. Notably, an early hospital discharge (POD1) was possible in 45.6% of our ERAS patients, which is an inferior result if compared with those of the preceding larger series with POD1 discharge rates ranging from 60–84% [24, 26, 30]. Addressing the implementation process, Bamgbade et al. demonstrated that POD1 discharge rates increased from 5–65% over time as their study matured [30]. Barreca et al. also referred a significantly enhanced POD1 discharge rate from 1.6–39.7% after RYGB during a two-year study [31]. Under such circumstances, the overall improvement of the POD1 discharge rate from 1.6–45.6% as the study progressed can be taken as obvious progress and coherent with above studies.

On the other hand, a noticeable tendency toward an increase in adverse outcomes was found in several studies that were specifically endorsed with an unselective approach. For example, Geubbels et al. followed a cohort of 360 unselected RYGB patients and found an increasing early complication rate (from 17.3–18.3%) and an increasing readmission rate (from 4.8–8.1%) after ERAS conduction [32]. Similarly, Mannaerts et al. reported a significantly higher minor complication rate (20.7% vs. 16.1%, $P =$

0.013) and a higher ER visit rate (16.8% vs. 12.5%, $p = 0.015$) [33]. Unlike the aforementioned studies, a tendency of decreasing 30-day ER visits (2 (2.2%) vs. 5 (8%)), readmissions (1 (1.1%) vs. 3 (4.8%)), 30-day complication rates (5 (5.5%) vs. 6 (9.7%)), and unplanned procedures or interventions (1 (1.1%) vs. 2 (3.2%)) was found via our ERAS regimen despite none of these values reaching statistical significance. Comparing patients discharged on POD1 with those discharged later, there was no statistically significant increase in ER visits (1/41 (2.4%) vs. 1/49 (2%)), readmissions (1 /41 (2.4%) vs. 0) or overall complication rates (1/41 (2.4%) vs. 4/49 (8.2%)). Therefore, our initial result did not come at the expense of patient safety.

Regarding patients that failed discharge planning, systematic review reported that the most common postoperative reasons were complications such as abdominal pain, nausea, vomiting, bleeding, and atelectasis [19]. Other factors such as preoperative opioid use, history of psychiatric illness, depression/anxiety, OSA, CKD, and CHF served as additional barriers that hindered expeditious discharge [11]. In our series, six patients (6.7%) stayed more than three days (LOS > 3). Except for one patient who experienced GI bleeding that required extending the index LOS to 4 days, none of our patients who failed planned discharge had complications as the cause. Compared to prior larger studies in which 6.4% of subjects ended up with a prolonged LOS [32], the present investigation demonstrated acceptable compliance with the current ERAS program.

It is clear that a major difference in procedures was noted between groups, with significantly more patients who underwent RYGB in the ERAS group. The reason was attributed to the growing concern regarding long-term sequelae, such as anemia and bile reflux after OAGB, as the study progressed [34–36]. Thereafter, we modified our approach to preferably suggesting RYGB for younger patients (< 40 yrs.) and those with gastroesophageal reflux disease or DM despite the lack of established guidelines to support such practice. Apart from this approach, there are likely many factors uncontrolled in a before-and-after study as systemic reviews have generally revealed heterogeneity and methodological bias among many preceding ERAS studies [18]. Since there were no distinctive advantages regarding safety profiles in the comparison of RYGB to OAGB [37] and there were no differences in other demographic features, we believed that comparing results between groups was viable. Our study shows that ERAS can be safely performed unselectively under low-volume setting and provided with beneficial effects usually reported from high-volume, specialized centers.

Limitations

Our analysis has several limitations that should be taken into consideration.

First, inherent to its retrospective nature, quality measures such as pain score, nausea episodes, etc., cannot be thoroughly collected. In addition, we report only 30-day morbidities, thus leaving long-term complications unreported. However, the strengths of this study reside in the efforts to capture of all complications since no patients dropped out within 30 days postoperatively.

Second, the marked improvement can be interpreted to be caused by the increase in expertise rather than the positive impact of the ERAS protocol. Nevertheless, like all preceding studies conducted across two time frames, it is hard to total eliminate time bias. Having said that, consider current study was based on such a small sample size within a short period and comprised only a single surgeon's work; we believe biases from major technique progress and flaws of individual practice can be avoided.

Conclusion

Our study verifies the safety and feasibility of conducting the ERAS protocol over a wide spectrum of patients in the context of mixed procedures under a low volume setting. Given the small study population, more relevant data and follow-up are required to elucidate the continual beneficial effect and long-term results.

List Of Abbreviations

ERAS, enhanced recovery after surgery; LOS, length of stay; HTN, hypertension; DM, diabetes mellitus; OSA, obstructive sleep apnea; ASA, American Society of Anesthesiologists; CKD, chronic kidney diseases; CHF, congestive heart failure; BMI, body mass index; PONV, postoperative nausea and vomiting; TAP, transversus abdominis plane; RYGB, Roux-en Y gastric bypass; OAGB, one anastomosis gastric bypass; SG, laparoscopic sleeve gastrectomy; LOS, length of stay; ER, emergency room; CD, Clavien-Dindo classification; SD, standard deviation; GI, gastrointestinal

Declarations

Ethical approval and consent to participate

All procedures performed in studies involving human participants were in accordance with the ethical standards of institutional and/or national research committees and with the 1964 Declaration of Helsinki and its later amendments or comparable ethical standards. The research project was approved by local Institutional Review Board. Informed consent was waived because no data regarding the cases were disclosed.

Consent for publication

Written informed consent for publication was waived because no clinical details and/or clinical images regarding the cases were disclosed.

Availability of data and materials

The datasets generated during and/or analyzed during the current study are not publicly available due to restrictions from local Institutional Review Board but are available from the corresponding author on reasonable request and with permission from the local Institutional Review Board.

Competing interests

The authors declare that they have no competing interests.

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Authors' contributions

HC designed the study, performed the surgical procedures, followed the patients, and participated in the data analysis and writing of the manuscript. WK contributed to the data analysis. YC, AC and YT participated in patient anesthesia. The authors read and approved the final manuscript.

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Not applicable

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