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BRIEF COMMUNICATION

# Experience with an Enhanced Recovery After Surgery (ERAS) Program for Bariatric Surgery: Comparison of MGB and LSG in 374 Patients

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**Abstract**
*Background* Strategic multidisciplinary protocols for "enhanced recovery after surgery" (ERAS) have demonstrated reductions in length of hospital stay (LOS), morbidity, and costs in conjunction with bariatric procedures.
*Methods* We prospectively investigated the effectiveness and safety of an ERAS protocol with laparoscopic omega loop gastric bypass ("mini" gastric bypass, MGB) and LSG in morbidly obese patients.
*Results* Average LOS was 1.24 days (range 1-14); 86.1% discharged on day 1; 96.9% by day 2, a value comparable or better than that of other ERAS studies vs standard care according to meta-analysis. Complications 2.9%; readmission 2.1%; reintervention 1.3%.
*Conclusion* The program was equally safe with both procedures. Postoperative antithrombotic heparin does not appear necessary in low-risk patients. Bariatric surgical ERAS programs are evolving and not yet standardized.

**Keywords** Bariatric surgery · Laparoscopic · Enhanced recovery · ERAS · MGB · LSG

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## Introduction

Bariatric surgery is the most successful treatment for obesity; yet, the perception that it is accompanied by a challenging postoperative course and complicated rehabilitation is a barrier to its greater acceptance by patients and referring physicians [1]. In the last 2 decades, length of hospital stay (LOS), morbidity, and costs have been reduced through multidisciplinary improvements in perioperative methodology, particularly in colorectal and abdominal specializations [2]. Strategically combined, these augmented protocols comprise programs for "enhanced recovery after surgery" (ERAS).

"Fast-track" recovery pathways focus primarily on postoperative protocols and represent a subset of ERAS programs [2]. The ERAS concept, described in 1997 by Kehlet [3], is a comprehensive approach to limiting the pathophysiological strain of surgery through optimization of patient medical status leading up to the procedure; a meticulous approach to operative anesthesia; close consideration of postoperative nutrition, opioid-sparing analgesia, and early mobilization; and attentive follow-up. Several bariatric surgery studies, including one randomized trial, demonstrated faster mobilization, shortened LOS, and decreased costs with ERAS without compromising safety [2, 4–8].

Thorell et al.'s 2016 guidelines for perioperative care in bariatric surgery using ERAS noted that the literature on this subject is sparse, with only a single high evidence-level study [9]. However, Singh et al.'s 2016 meta-analysis of five studies of ERAS protocols with laparoscopic sleeve gastrectomy (LSG), Roux-en-Y gastric bypass (RYGB), and biliopancreatic diversion showed that patients returned to normal activities faster without significantly increased complications and with significantly reduced hospital costs [10]. Similarly, Malczak et al.'s 2017 meta-analysis of 11 comparative studies found that the use of ERAS protocols in bariatric surgery shortened LOS compared to conventional care by a standard mean difference of

−2.39 days ([−3.89, −0.89], $p = 0.002$), with minimal effect on overall morbidity [11].

Drawing on long-term experience in laparoscopic adjustable gastric banding (LAGB), our center performed a feasibility study of LAGB with a protocol for same-day discharge, finding 96.5% of patients successfully ambulatory, and a low readmission rate (3/86, 3.5%). In 2013, we introduced the first outpatient colectomy and, in 2015, reported the associated ERAS program in 20 patients with a LOS <12 h [12]. The current study prospectively investigated the effectiveness and safety of an ERAS protocol for bariatric surgery in morbidly obese patients by comparing laparoscopic omega loop gastric bypass ("mini" gastric bypass, MGB) vs LSG outcomes. To our knowledge, this is the first study of ERAS with MGB. Our ERAS protocol and outcomes with both procedures are presented herein.

## Methods

### Inclusion and Consent

The current prospective comparative cohort study included patients ≥18 years old who met the accepted international criteria for bariatric surgery (i.e., US National Institutes of Health 1991 Guidelines; International Federation for the Surgery of Obesity (IFSO) standards). Although ethics committee approval was not sought for this study, informed consent was obtained from every participant in the series.

### Bariatric ERAS Intervention Protocol

*Presurgical*

During the preoperative consultation with the patient, each step of the clinical pathway was explained in careful detail by the surgeon. The same nurse was designated to follow a particular patient before surgery, in the operating room, and during postoperative consultations. A "passport" was presented to the patient to encourage him/her to be the agent of his /her own well-being, rather than a passive recipient of the protocol.

The day before surgery, the patient was called by a medical secretary and reminded of the fasting recommendations. Patients were reminded to drink one glass of carbohydrate solution (e.g., apple juice) with 1 g paracetamol 2 h prior to admission on the day of surgery.

*Intraoperative*

The MGB and LSG procedures were performed using current, standard laparoscopic surgical techniques [13, 14]. Intraoperatively, anesthesiologists employed protocols for short-acting agents without opioid analgesics and prophylactically administered medications for prevention of pain, nausea, and vomiting. Induction protocol included propofol 3 mg/kg, intravenous remifentanyl, rocuronium 1 mg/kg, dexamethasone 8 mg, and droperidol 1.25 mg, xylocaine 1.5 mg/kg, and ketamine 15 mg with protective ventilation. Anesthesia was maintained with desflurane, remifentanyl, xylocaine IVSE 2 mg/kg/h, and neuromuscular blocking agents that were stopped at the end of the operation.

Ropivacaine infiltration was used at the end of the procedure in all port sites. Neither drains nor nasogastric tubes were used. Only compression socks were used intraoperatively rather than pneumatic stockings.

*Postoperative*

After surgery, patients were supervised in the recovery room for 1 hour. Analgesia was achieved with paracetamol, anti-inflammatories, and acupan. Upon departure from the recovery room, the peripheral intravenous line was closed to facilitate patient movement. Patients were allowed to drink 4 h after surgery and were mobilized by the physiotherapist to walk 4–6 h after surgery.

Prophylactic antithrombotic heparin (low-molecular-weight heparin (LMWH)) was administered systematically to all patients (note: see "Results" for modified LMWH protocol based on mid-study findings).

On the first postoperative day, a blood test was performed to evaluate hemoglobin and C-reactive protein levels. Patients were required to walk back and forth in the hallway independently. No postoperative upper gastrointestinal x-ray was taken. Three-dimensional gastric computer tomography (CT) with air was performed at follow-up month 1.

Prior to leaving the clinic, patients attended a nutritionist-led discharge meeting. The criteria for discharge included freedom from perfusion, full control of pain by oral analgesics, mobilization, ability to take food orally, absence of signs of infection (temperature <38 °C, CRP <150, pulse <120, no tachycardia). Patients were required to formally accept discharge with awareness that rehospitalization was a possibility.

*Follow-Up*

One day after discharge, the service nurse contacted the patient and asked a set of questions regarding pain, nausea, vomiting, and mobility. A house nurse checked blood pressure and pulse rate. Any reading that was out of the reference range for postoperative well-being was reported to the surgical team. All patients were invited to a postoperative follow-up meeting, where a satisfaction survey was completed.

### Statistical Analysis

Between-group differences in continuous variables were analyzed by independent sample *t* test; differences in categorical

**Table 1** Preoperative patient characteristics and postoperative outcomes for patients undergoing mini gastric bypass (MGB) vs laparoscopic sleeve gastrectomy (LSG) with an "enhanced recovery after surgery" (ERAS) program

| Variable | MGB ($n$ = 222) | LSG ($n$ = 152) | $p$ value |
|---|---|---|---|
| Preoperative | | | |
| Female, $n$ (%) | 202 (91.0) | 120 (78.9) | <0.05* |
| Age (years) | 41.5 ± 10.1 (19–68) | 36.9 ± 12.0 (18–67) | <0.05† |
| Height (cm) | 162.9 ± 7.5 (143–189) | 166.5 ± 9.0 (148–195) | <0.05† |
| Absolute weight (kg) | 106.9 ± 17.1 (75–185) | 115.1 ± 19.1 (80–181) | <0.05† |
| Body mass index (kg/m$^2$) | 40.1 ± 5.0 (30–55) | 41.3 ± 4.0 (30–53) | <0.05† |
| Articular disease | 169 (76.1) | 93 (61.6) | <0.05* |
| Hypertension | 39 (17.6) | 26 (17.2) | 1.00* |
| Type 2 diabetes | 18 (8.1) | 7 (4.6) | 0.21* |
| Hyperlipidemia | 31 (14.0) | 26 (17.2) | 0.46* |
| Sleep apnea | 11 (5.0) | 32 (21.5) | <0.05* |
| Operative | | | |
| Mean operative time (min.) | 42.0 ± 12.6 (33.0–58.0) | 31.1 ± 9.3 (26.0–49.0) | 0.08† |
| Length of hospital stay (days) | 1.3 ± 1.2 (1–14) | 1.2. ± 0.5 (1–5) | 0.51† |
| Postoperative | | | |
| Complications | 5 (2.3) | 6 (3.9) | 0.37* |
| Portal vein thrombosis | 0 (0.0) | 3 (2.0) | 0.07* |
| Hemorrhage | 4 (1.8) | 2 (1.3) | 1.00* |
| Leak | 1 (0.5) | 1 (0.7) | 1.00* |
| Reintervention | 3 (1.4) | 2 (1.3) | 1.00* |
| Rehospitalization | 4 (1.8) | 4 (2.6) | 0.72* |

* Fisher's exact test

† Independent samples t test

data were analyzed using Fisher's exact test. Statistical significance was set at $p < 0.05$. All statistical tests were two tailed. Analyses were performed using SPSS software (version 20; IBM, Chicago, IL).

## Results

Between April 2015 and March 2016, 374 patients (86.1% female, mean age 39.6 years [range18–68], mean BMI 40.6 [30–

**Table 2** Preoperative patient characteristics and postoperative outcomes for groups 1 and 2 (with or without systematic thrombophylaxis) in an "enhanced recovery after surgery" (ERAS) program

| Variable | Group 1 ($n$ = 95) | Group 2 ($n$ = 279) | $p$ value |
|---|---|---|---|
| Preoperative | | | |
| Female, $n$ (%) | 83 (87.4) | 239 (85.7) | 0.74* |
| Age (years) | 39.2 ± 10.8 (19–62) | 39.8 ± 11.2 (18–68) | 0.63† |
| Height (cm) | 164.0 ± 8.9 (143–189) | 164.5 ± 8.2 (146–195) | 0.61† |
| Absolute weight (kg) | 107.3 ± 18.0 (78–175) | 111.2 ± 18.4 (75–185) | 0.07† |
| Multiple comorbidities | 73 (76.8) | 189 (67.7) | 0.12* |
| MGB | 60 (63.2) | 162 (58.1) | 0.40* |
| Length of hospital stay (days) | 1.3 ± 0.7 (1–4) | 1.2. ± 1.1 (1–14) | 0.60† |
| Postoperative | | | |
| Complications | 4 (4.2) | 6 (2.2) | 0.28* |
| Portal vein thrombosis | 1 (1.1) | 2 (0.7) | 1.00* |
| Hemorrhage | 2 (2.1) | 4 (1.4) | 0.65* |
| Exploratory laparoscopy | 1 (1.1) | 0 (0.0) | 0.25* |
| Leak | 0 (0.0) | 2 (0.7) | 1.00* |
| Reintervention | 2 (2.1) | 3 (1.1) | 0.61* |
| Rehospitalization | 1 (1.1) | 7 (2.5) | 0.69* |

55]) underwent bariatric surgery with our ERAS protocol. Nearly half (43%) reported having had a previous bariatric procedure: 36% LAGB, 3.7% LSG, and 3.3% vertical banded gastroplasty (VBG). More than 50% presented with multiple comorbidities, including 70.1% with articular disease, 17.4% hypertension, 15.2% hyperlipidemia, 11.5% obstructive sleep apnea (OSA), and 6.7% with type 2 diabetes mellitus (T2DM).

Mean LOS for all operative procedures was 1.24 days (1–14). Specifically, 322 patients (86.1%) were discharged on day 1, and by day 2, 362 patients (96.9%) were discharged. Generally, those hospitalized for two or more days were treated for minor complications. The longer hospital stays (≤14 days) were primarily associated with more severe complications (e.g., hemorrhage, leak). There was no thromboembolic complication, pulmonary embolism, or mortality.

At 1 month, there was 92.5% follow-up; 28 patients (7.5%) failed to attend the first postoperative consultation. Overall patient satisfaction was high: 99.0% (342/346) reported that they "were satisfied with this clinical pathway," and "they would recommend it to others."

Of the 374 patients, 222 (59.4%) underwent MGB and 152 (40.6%) underwent LSG. LSG patients were significantly younger, heavier, and more likely to suffer from OSA. Patients undergoing MGB had significantly more articular disease. However, with respect to operative outcomes with ERAS, there were no statistically significant differences between the two surgical groups (Table 1).

Mean operating time for MGB vs LSG was 42.0 ± 12.6 vs 31.1 ± 9.3 min ($p = 0.08$). Mean LOS for MGB vs LSG patients was 1.3 ± 1.2 vs 1.2. ± 0.5 ($p = 0.51$). Eleven patients (2.9%) experienced significant complications within the first postoperative month and five patients (1.3%) required reintervention. Six patients (1.6%) experienced hemorrhage, four with MGB and two with LSG (1.8 vs 1.3%; $p = 1.00$). Overall, three patients (0.8%) experienced portal vein thrombosis (MGB 0; LSG 3; 0.0 vs 2.0%, $p = 0.07$). This was the only measured outcome where differences in complication rates approached significance; yet, the difference was negligible and likely due to anatomical reasons. Finally, two patients (0.5%) developed leak (MGB 1; LSG 1; 0.5 vs 0.7%; $p = 1.00$).

Three MGB patients (1.4%) and two LSG patients (1.3%) required reintervention ($p = 1.00$). Three who experienced intra-abdominal hemorrhage required reintervention 1 day after primary surgery: two were discharged on day 5 and the third on day 10 following endoscopic treatment. Another patient requiring reintervention underwent exploratory laparoscopy on day 1, but nothing was found. The final reintervention presented 3 days following LSG due to detection of leak and was revised to RYGB.

The post-MGB leak occurred prior to discharge and was treated conservatively with an endoscopic pigtail drain; this patient experienced the longest LOS in the series (14 days). Overall, eight patients (2.1%) were readmitted within the first postoperative month: four MGB, four LSG (1.8 vs 2.6%; $p = 0.72$): three for portal vein thrombosis; two for melena; two for dyspnea, pain, and/or vomiting; and one for leak.

Due to several cases of postoperative hemorrhage early in the series, we altered the anticoagulation protocol. Two patient subgroups were created: group 1 (first 95 patients,, received systematic thromboprophylaxis) and group 2 (subsequent 279 patients, only those with a Caprini [15] score ≥3, received thrombophylaxis). There were no significant differences between groups in LOS, complications, reinterventions, or readmissions (Table 2). Having seen no difference in patient hemorrhages, our ERAS protocol has been modified accordingly so that LMWH is limited to patients with Caprini score ≥3 beginning on postoperative day 1 and continuing through day 10.

## Conclusion

The current ERAS program was equally safe and effective with MGB and LSG, with a mean LOS of 1.24 days, which is better than, but statistically comparable to, the meta-analytic mean of 2.1 LOS obtained for ERAS with bariatric surgery [11]. Further, in our study, 86.0% of patients were discharged on day 1 and 96.9% by day 2. The postoperative complication rate was low (2.9%) with 2.1% readmission and 1.3% reintervention. With operative times of <45 min, postoperative LMWH did not appear necessary in patients with low thromboembolic risk.

ERAS is evolving and not yet standardized for bariatric surgery [9]; therefore, centers may consider excluding high-risk obese patients from ERAS studies until a body of high-level evidence exists.

ERAS programs that result in outcomes comparable to or better than traditional care will reduce LOS, morbidity, and costs. Randomized controlled trial studies of bariatric surgery with ERAS vs conventional protocols are needed.

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**Compliance with Ethical Standards**

**Informed Consent** Informed consent was obtained from all participants.

**Human and Animal Rights** The study was performed in accord with the ethical standards of the Declaration of Helsinki.

**Conflict of Interest** The authors declare that they have no conflict of interest.

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