

A Narrative Review on Bariatric ERAS

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Rezumat

ERAS în chirurgia bariatrică: un review narativ

Introducere: Chirurgia bariatrică/metabolică (BMS) este cel mai eficient tratament al obezității morbide, în timp ce Enhanced Recovery After Surgery (ERAS) după BMS reprezintă un protocol de îngrijire perioperatorie multimodală conceput pentru a obține recuperarea precoce pentru pacienții obezi, cu caracteristicile lor specifice. Scopul actualei analize narative este de a rezuma și discuta rolul actual, aplicarea și evoluțiile viitoare ale protocoalelor ERAS în domeniul BMS.

Metode: studiile publicate până la 30 iunie 2022, fără restricții privind limba sau perioada de publicare, în Medline și Embase au fost căutate, folosind cuvintele cheie „ERAS” SAU „recuperare îmbunătățită după operație” ȘI „chirurgie bariatrică” SAU „chirurgie metabolică”. Durata postoperatorie a spitalizării LOS, morbiditatea și mortalitatea generală și majoră, ratele de readmisie, greața sau vărsăturile postoperatorii PONV, utilizarea de opioide și antiemetice, costurile spitalicești, ERAS în anumite sisteme medicale, barierele în calea ERAS și evoluțiile viitoare au fost analizate.

Rezultate/Concluzii: Rezultatele au fost prezentate printr-o revizuire narativă a literaturii, folosind tabelări pentru a rezuma rezultatele meta-analizelor și ale RCT: 6 articole care raportează linii-ghid, 5 meta-analize, 9 studii randomizate controlate și 48 de studii observaționale. Protocoalele ERAS sunt fezabile și sigure în contextul BMS și sunt asociate cu reducerea LOS, PONV și a durerii postoperatorii, reducerea consumului de opioide și antiemetice și costuri spitalicești reduse. Mortalitatea postoperatorie și ratele de readmisie sunt similare între pacienții care primesc

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îngrijire standard și pacienții tratați ERAS. Mai mult, creșterea aplicației ERAS poate fi utilă în sistemele medicale afectate de boli infecțioase epidemice și implementate prin progrese tehnologice.

Cuvinte cheie: ERAS, chirurgia bariatrică, review, linii ghid, chirurgie metabolică

Abstract

Introduction: Bariatric/metabolic surgery (BMS) is the most effective treatment of morbid obesity, while Enhanced Recovery After Surgery (ERAS) after BMS represents a multimodal perioperative protocol designed to achieve early recovery for patients with peculiar characteristics. The aim of the current narrative review is to summarize and discuss the current role, the application, and the future developments of ERAS protocols in the field of BMS.

Methods: A literature search for studies published up to June 30, 2022, with no restrictions on language or publication period, was performed on Medline and Embase, using the keywords “ERAS” OR “enhanced recovery after surgery” AND “bariatric surgery” OR “metabolic surgery”. Postoperative length of hospital stay LOS, overall and major morbidity and mortality, readmission rates, postoperative nausea or vomit PONV, opioids and antiemetics use, hospital costs, ERAS in specific health care settings, barriers to ERAS and further developments were analyzed.

Results/Conclusions: The results were presented with a narrative review, using tabulation to summarize the results of meta-analyses and RCTs: 6 articles reporting guidelines, 5 meta-analyses, 9 randomized controlled trials, and 48 observational studies. ERAS protocols are feasible and safe in the setting of BMS, and associated to reduced LOS, PONV and postoperative pain, reduced opioid and antiemetic use and reduced costs. Postoperative mortality and readmission rates are similar between patients receiving standard care and those with ERAS protocols. Furthermore, increase of ERAS application may be useful in health care systems dealing with epidemic infectious diseases and implemented by technological advancements.

Key words: ERAS, bariatric surgery, metabolic surgery, guidelines, narrative review

Introduction

Bariatric/metabolic surgery is the most effective treatment of morbid obesity, guaranteeing a mean total weight loss (TWL) % of 20-30% at 15-20 years follow-up (1-3). Also due to the spread of minimally invasive surgery, bariatric surgery has boomed especially in high-income countries, with 696,191 surgical and endoluminal procedures worldwide performed in 2018 and reported by the International Federation for the Surgery of Obesity and Metabolic Disorders (IFSO), 92.6% of them consisting of primary bariatric/metabolic procedures (4).

Enhanced Recovery After Surgery (ERAS) represents a multimodal perioperative care

pathway or protocol designed to achieve early recovery for patients undergoing major surgery, developed approximately 20 years ago for colorectal surgery (5). The ERAS protocol has been subsequently applied to multiple subspecialties and surgical procedures, including major abdominal surgery (6,7), in the effort to improve a number of outcomes in patients' recovery. The application of ERAS in the field of bariatric/metabolic surgery is considered a challenge as this subset of patients have peculiar characteristics (8-11). The aim of the current narrative review is to summarize and discuss the current role, the application and the future developments of ERAS protocols in the field of surgery for morbid obesity.

Material and Methods

Study Design and Literature Search Strategy

This is a narrative review of literature, based on a literature search for studies published up to June 30, 2022. No restrictions on language or period of publications were applied. Medline and Embase were searched using the keywords “ERAS” OR “enhanced recovery after surgery” AND “bariatric surgery” OR “metabolic surgery”. Additional relevant studies found from the references were also retrieved. The Boolean operator “AND” was used to combine parts of the subject terms and “OR” was used to expand the search. To improve validity of data, we excluded non-peer reviewed articles in preprint databases.

Screening of Articles for Eligibility and Data Extraction

The articles identified from the databases and additional resources were screened for eligibility. First, the title and abstract were screened. The following inclusion criteria were used: (1) studies including patients undergoing bariatric or metabolic surgery; (2) studies using the ERAS protocol to ameliorate patients' outcomes; (3) randomized controlled trials (RCTs), observational studies, case series, retrospective studies, systematic reviews, meta-analyses, editorials. Studies were limited to human participants.

Full articles were retrieved and read in the event of any doubt or uncertainty regarding the content relevance during the abstract screening. After a comprehensive list of abstracts was obtained, the articles were retrieved and reviewed in full text.

Two researchers (NP and GL) independently screened all studies, and the results were collected and reviewed by a third researcher (GS).

The results of the literature were summarized with a narrative review, using tabulation to summarize the results of meta-analyses and RCTs.

Results

Guidelines

Our literature search retrieved 6 articles reporting guidelines in the setting of ERAS and bariatric/metabolic surgery (12–17). The first guidelines were released in 2016 by Thorell et al. (17) on behalf of the enhanced recovery after surgery (ERAS) Society and endorsed by the International Association for Surgical Metabolism and Nutrition (IASMEN). As stated by the authors, recommendations were mostly extrapolated from non-bariatric settings, mainly from colorectal surgery. Strong recommendation statements were formulated about: the need of preoperative patients counseling, smoking cessation at least 4 weeks before surgery, alcohol abstinence (if history of abuse) for at least 2 years, the benefit of preoperative weight loss, the administration of glucocorticoids 90 minutes before induction of anesthesia, a shortened preoperative fasting with clear fluid up to 2 hours before surgery and solids up to 6 hours for non-diabetic obese patients, the administration of maintenance fluid regimens, a multimodal approach to postoperative nausea and vomiting (PONV) prophylaxis, tracheal intubation and lung protective ventilation during anesthesia, the objective qualitative monitoring and full reversal of neuromuscular blockade, the monitoring of anesthetic depth, the use of laparoscopy, the avoidance of postoperative nasogastric tube, the use of multimodal analgesia, the mechanical thromboprophylaxis combined with low molecular weight heparin, an early postoperative nutrition, the postoperative oxygenation, the use of CPAP in patients with BMI > 50 kg/m², severe obstructive sleep apnea syndrome (OSAS) or oxygen saturation ≤ 90% on oxygen supplementation. In 2021 the ERAS society updated the guidelines (12-14). The items that were modified included the alcohol abstinence shifted from 2 years to 1-2 years, the use of glucocorticoids 90 minutes before induction (becoming a weak recommendation), the shortening of preoperative fasting, which was

recommended also to diabetic patients in the absence of gastroparesis, the introduction of the goal of opioid-sparing anesthesia using a multimodal approach, the need to ideally avoid increases in driving pressure resulting from adjustments in positive end-expiratory pressure (PEEP), the need for deep neuromuscular blockade to improve surgical performance, the need for a supervisor senior surgeon during the surgical learning curve phase, the underlining of the association between hospital volume and outcomes, the recommendation to avoid routine use of abdominal surgical drains, the individualization of thromboprophylaxis, which should include mechanical and pharmacological measures, the use of proton pump inhibitor (PPI) for at least 30 days after RYGB and ursodeoxycholic acid for 6 months.

The ERAS society undoubtedly traced a clear and detailed pathway, updated according to a systematic literature review (12). The European Society for Clinical Nutrition and Metabolism (ESPEN) in 2021 released the guidelines for clinical nutrition in surgery, dedicating some paragraphs to bariatric surgery (15). They stated in favor of early oral intake after bariatric surgery and against parenteral nutrition in uncomplicated surgery. In case of complications with relaparotomy these experts advised to consider the use of naso-jejunal tube or jejunostomy for nutritional supplementation. Ten bariatric Canadian centers published a consensus statement in 2020 on the topic (16). Most of their recommendations are in line with the ERAS Society guidelines even if some differences exist. They recommend smoking abstinence for at least 3-6 months prior to surgery; administration of at least 5000 units of unfractionated heparin or low-molecular weight heparin at the time of surgery with no consensus of sequential compression devices; resume of full fluid diet from postoperative day one.

Meta-Analyses

Five meta-analyses were retrieved and included in the present narrative review (18-22). The

characteristics of these studies and the main results are summarized in *Table 1*. All the studies had the LOS as primary outcome. Secondary outcomes included post-operative mortality, complications, readmission rates, costs, PONV, postoperative pain.

The first study was published by Malczak et al. (22) and included a total of 5230 patients in 11 studies. Of them, 3475 underwent laparoscopic Roux en Y gastric bypass (RYGB), laparoscopic sleeve gastrectomy (SG) or biliopancreatic diversion in the setting of ERAS protocols, and the remaining 1755 underwent traditional rehabilitation. A significant decrease of LOS was demonstrated, with mean LOS of 2.8 days in the ERAS group versus 4.6 days in the standard group. No significant differences were retrieved in post-operative complications or costs. In 2017 Singh et al. (21) selected 5 studies including patients who had SG, RYGB or biliopancreatic diversion. Among the included patients, 394 patients entered in the ERAS protocol and 471 received standard care. LOS was significantly shorter in the ERAS group (-1.56 days). Overall and major morbidity and readmission rates were comparable, whereas the rate of minor complications (Clavien Dindo I or II (23)) was higher in the ERAS group. Ahmed et al. (19) reported a meta-analysis including 13 studies and 6172 patients undergoing SG or gastric bypass. Most of them (69%) were treated according to the ERAS protocol and experienced shorter LOS (-1.5 days) than the control group (standard care). Operative time was significantly shorter (19.5 minutes saved) in the ERAS group. Morbidity rate was 5% in both groups without any differences. Also, readmission rates and reinterventions were comparable. A slight non-significant difference in favor of ERAS was noted for costs. Parisi et al. (18) included only RCTs, selecting 5 studies with a total of 610 patients, approximately half (306, 50.2%) in the ERAS group and half (304, 49.8%) in the standard group. Three studies analyzed patients undergoing SG, the remaining RYGB. The authors demonstrated a reduction of postoperative LOS of 0.51 days in patients treated in the ERAS group. PONV

Table 1. Meta-analyses analyzing the role of Enhanced Recovery after Surgery (ERAS) in the setting of bariatric/metabolic surgery

Author, year Number of included studies	Numbers and groups of included patients	Procedures	Primary outcome	Adverse events	Results
Małczak, 2016 11	5230 ERAS=3475 SC=1755	<ul style="list-style-type: none"> • LRYGB • LSG • BPD 	LOS	<ul style="list-style-type: none"> • Bleeding • Anastomotic Leak • Mortality • Readmissions 	Reduced LOS in ERAS's group ($p=0.002$). No significant variations in overall morbidity and specific complications among the two groups.
Singh, 2016 5	865 ERAS=394 SC=471	<ul style="list-style-type: none"> • LRYGB • LSG • BPD 	LOS	<ul style="list-style-type: none"> • Major adverse events (grade ≥ 3 sec Clavien-Dindo) • Minor adverse events (grade < 3 sec Clavien-Dindo) • Anastomotic Leak • Readmissions 	The implementation of ERAS protocol reduced the length of stay by around 1.5 days. No significant increase in the overall or major complications (Clavien–Dindo grade IIIa and higher), anastomotic leak, and readmission rates. Minor complications (Clavien–Dindo grades I and II) significantly higher in the ERAS group.
Ahmed, 2018 13	6172 ERAS=4258 SC=1914	<ul style="list-style-type: none"> • LRYGB • LSG 	LOS	<ul style="list-style-type: none"> • Major adverse events (grade ≥ 3 sec. Clavien-Dindo) • Readmission • Reoperation • Mortality • Costs 	ERAS was associated with a significantly shorter LOS than SC. No significant difference in major complications (Clavien-Dindo \geq grade 3) between the two group with 5% morbidity rates among both ($p=0.70$). No significant difference in terms of readmission and reoperation. Shorter operating duration in patients managed with ERAS protocols, with a statistically significant saving of 19.5 min ($p < 0.01$). No significant difference in the overall mortality rates. ERAS protocols resulted in not statistically significant overall reduction in costs (US\$7891.23 vs 8762.79).
Parisi, 2020 5	610 ERAS=306 SC=304	<ul style="list-style-type: none"> • LRYGB • LSG 	LOS	<ul style="list-style-type: none"> • Major adverse events (grade ≥ 3 sec. Clavien-Dindo) • PONV • Readmission • Intrabdominal bleeding • Mortality • Postoperative pain 	Significant reduction in the LOS by about half a day (MD - 0.51, $P = 0.01$) and of the PONV occurrence (6.4% versus 13.4%) in the ERAS group. No statistically significant differences in terms of overall adverse events, major adverse events, mortality or readmission.
Zhou, 2021 17	8182 4694 ERAS 3218 SC	<ul style="list-style-type: none"> • LRYGB • LSG 	LOS Mortality Postoperative Complications Readmissions Reoperations PONV		No significant differences in operative time, postoperative complications, readmission rates and reoperations. Patients in the ERAS group had significantly lower incidence of PONV (39% versus 52.6%).

were also significantly lower in patients treated within the ERAS pathway. No differences were found in postoperative complications and readmission rates. Data about postoperative pain were not amenable to pooling. The last study (20) by Zhou et al. included 5 RCTs and 12 observational studies, with a total of 4964 patients undergoing bariatric surgery in the ERAS group and 3218 in the standard group. This study did not find any difference between the two groups concerning operative time, postoperative complications, readmission

rates and reoperations. However, patients in the ERAS group had significantly lower incidence of PONV (39% versus 52.6%).

Randomized Controlled Trials

Nine randomized controlled trials were identified (see *Table 2*). Four studies compared standard care versus ERAS recovery pathways in patients undergoing sleeve gastrectomy (24,25) or gastric bypass (26,27). Two articles analyzed nutritional aspects of ERAS in obese

Table 2. Results of randomized controlled trials (RCTs) comparing ERAS pathway versus standard care in bariatric surgery

Author, year	Country	N. of patients	Procedures	Measured Outcomes	Conclusions
Prabhakaran, 2020	India	112	SG ERAS=56 SC=56	<ul style="list-style-type: none"> • LOS • PONV • Post-operative pain • Time for ambulation • 30-day complications • Readmission 	<p>Significantly lower LOS in the ERAS group. ($p=0,003$)</p> <p>Lower pain scores in the ERAS group at 4th hour ($p = 0.003$) and 8th hour ($p = 0.013$)</p> <p>Significantly decreased time for ambulation in the ERAS group</p> <p>Similar complications or 30-day readmission rates</p>
Geubbels, 2018	Germany	220	RYGB ERAS=110 SC=110	<ul style="list-style-type: none"> • Functional hospital stay • LOS • 30-day complications • 30-day mortality • Readmission • Duration of surgery and time spent in the recovery ward 	<p>Lower FHS in the ERAS group (median 20.5 h for conventional versus 17.4 h for ERAS care; $P < 0.001$)</p> <p>Similar LOS ($P = 0.343$)</p> <p>Pain control achieved sooner in the ERAS group (by 1.2 h versus 2.0)</p> <p>PONV achieved earlier in ERAS group</p> <p>Patients in the ERAS group mobilized sooner ($P < 0.001$), and were comfortable with discharge about 3 h earlier ($P < 0.001$)</p> <p>Similar operation time and time in recovery ward</p> <p>No differences in number of complications (Clavien–Dindo grade II or above), grade of complications or readmission.</p>
Ruiz-Tovar, 2018	Spain	180	RYGB ERAS=90 SC=90	<ul style="list-style-type: none"> • Postoperative pain • PONV • 30-day complications • Mortality • LOS • Analytic acute phase reactants 24 hours after surgery 	<p>Lower PONV rates in the ERAS group ($P = .0498$).</p> <p>Similar complication rates</p> <p>No significant difference in terms of reoperations.</p> <p>Lower LOS in the ERAS group ($P < .001$)</p> <p>Lower mean postoperative pain, as measured by VAS 24 hours after surgery, in the ERAS group ($P < .00$)</p> <p>Intraoperative opioid-free analgesia reached in 91.1% of cases in the ERAS group</p> <p>CRP levels, fibrinogen, and white blood cell count were significantly lower in the ERAS group</p>
Lemanu, 2020	New Zealand	116	SG ERAS=40 SC=38 HG=38	<ul style="list-style-type: none"> • LOS • Readmission rates • Postoperative morbidity • Postoperative fatigue • Mean cost for patient 	<p>Lower median hospital stay in the ERAS group.</p> <p>No differences in total, major or technical complication.</p> <p>Lower costs in the ERAS and control versus historical group.</p>

patients (28,29) and the remaining were focused on the use of transversus abdominis plane (TAP) block (30–32). Concerning SG, the first study was published in 2013 by a New Zealand group (24). They randomized 78 patients to ERAS (40) or control (38) and compared these data also with a historical cohort of 38 patients, with no baseline differences among the three groups. They found a significant reduction of LOS in the ERAS group (1 day versus 2 days), without any difference in readmission rates, postoperative complica-

tions and postoperative fatigue. A reduction in the costs was demonstrated for the ERAS and control group compared to the historical cohort. The second RCT was published in 2020 by an Indian institution and included 56 patients in the ERAS group and 56 in the standard pathway (25). The two groups had similar baseline characteristics. The authors demonstrated lower LOS, earlier ambulation, lower pain scores at 4 and 8 hours and reduced need for rescue analgesia in the ERAS group. Two RCTs analyzed the impact of ERAS

programs on gastric bypass. The first one, from a German institution, included 220 patients undergoing RYGB to ERAS (110) or standard care (110). They excluded diabetic patients requiring insulin, concomitant and/or revisional procedures, ASA score over 3. Patients in the ERAS group were treated according to the 2016 guidelines (17). A significant decrease in the functional hospital stay (defined as the time from the end of the surgery until all discharge criteria had been met, including pain controlled with paracetamol and non-steroidal anti-inflammatory drugs, absence of fever and PONV, toleration of a full liquid diet, autonomous mobilization, feeling fit for discharge), earlier toleration of a full liquid diet, earlier mobilization and earlier control of PONV and pain were detected in the ERAS group, whereas total hospital stay was similar. Operation time, number of complications, grade of complications or readmission and quality of life were not significantly different between the two groups. The second trial from Spain included 180 patients, 90 in the ERAS group, 90 in the standard care group (27). Patients with severe underlying cardiovascular diseases, chronic renal failure, hepatic dysfunction, previous foregut surgery or undergoing other bariatric procedures than RYGB were not included. The Spanish national ERAS protocol was followed in the ERAS group. Significant differences in favor of ERAS were detected in the PONV rate (8.9% versus 2.2%, respectively), hospital stay (2.8 versus 1.7 days, respectively), mean postoperative pain and rate of intraoperative opioid free-analgesia.

The remaining RCTs concerned management of analgesia in patients subjected to bariatric surgery within an ERAS program. The first one by Ruiz-Tovar et al. (32) compared laparoscopic-guided TAP block in 140 patients undergoing RYGB with port-site infiltration. The authors demonstrated that laparoscopic TAP-block significantly reduced postoperative pain, opioid needs, and hospital stay, when compared with port-site infiltration with the same anesthetic drug, without increasing operation time. A second RCT by

the same investigators (31) compared patients undergoing postoperative laparoscopic-guided TAP (TAP-lap, 70 patients) and patients not receiving TAP-lap (Control, 70 patients) during OAGB. Multimodal analgesia included preoperative port-site infiltration with Bupivacaine 0.25% in both groups and systemic Acetaminophen. The laparoscopic-guided TAP block group had significantly less postoperative pain and opioid consumption, without increased operative time. A third study (30), from a Canadian institution, was registered and published as study protocol, with the objective of evaluating TAP-lap block, but its results are not yet published.

Observational Studies

Our search identified 48 observational studies investigating the use and results of ERAS protocols in the setting of BMS. Some of them focused on specific patients' population or specific health care settings whereas others reflected the practice of single institutions or multicenter groups. Some of them did not include a control group but only affirmed the feasibility of ERAS protocol in the setting of bariatric surgery reporting low rates of readmissions and complications (33-38). We will summarize these results according to the different outcomes.

Postoperative length of stay

The majority of observational studies report lower postoperative LOS for patients treated within the ERAS protocol compared to patients receiving standard care (8,9,34,35, 39-51). Also the POD 1 discharge rate was higher if the ERAS protocol was applied (39,48) and the extended LOS (defined as LOS ≥ 4 days) reduced (52). Some authors stressed the correlation between high adherence to ERAS items and reduction of LOS (53,54). Only a minority of studies did not report shorter LOS after ERAS implementation (51,55), one of them from a center with traditionally low length of stay even in case of standard postoperative pathway (51).

Overall and major postoperative morbidity

The majority of studies did not report any significant difference in postoperative complication rates (8,40,45,45,48,49,52,55). Some authors observed on the other hand a decrease in postoperative morbidity in the ERAS group. Zhou et al. (39) reported a retrospective series of 435 patients (standard treatment in the first part of the series, application of the ERAS protocol in the second): they showed a drop of postoperative morbidity from 8.6% to 2.1% after implementation of ERAS. Gimeno-Moro and colleagues (57) observed significantly less overall morbidity in the ERAS group (from 21% to 7%), without any difference in severity of complications in a series of 86 patients. Gondal et al. (50) observed lower postoperative morbidity (8.7% versus 4%) in the ERAS group. Malczak et al. (54) observed a diminution in postoperative morbidity but only in patients having a compliance to ERAS items >80%.

Postoperative mortality

All studies reported similar mortality rates among ERAS and standard groups (53). ERAS protocol was never associated to an increase in the risk of postoperative mortality.

Readmission rates

The majority of studies did not report any significant difference in postoperative re-admission rates (8,9,40,41,45,50,53,55). Some authors reported fewer readmissions in the ERAS group. Taylor et al. reported a reduction of re-hospitalizations from 7.94% to 2.86% in their series including 277 patients in the ERAS group and 348 in the standard group (46). Ma et al. (58) reported a 3.74% decline in readmission rates in a monocentric series from a high volume center after ERAS implementation.

Postoperative PONV, opioids and antiemetics use

Adherence to ERAS protocol was associated with a reduction of PONV (59) and opioids use. Sapin et al. (41) and Monte et al. (42) reported

a reduction of opioid morphine milligram equivalent of 61% and 73%, respectively. Other authors reported a reduction of postoperative opioids use (8,45,51,58,59) and narcotics (55). Studies assessing the use of antiemetics reported a reduced percentage of patient receiving these drugs in the ERAS groups (42,51,59).

Hospital costs

Adherence to ERAS protocol was associated with a reduction of costs (43): 155 dollars on average according to the monocentric series by Sapin et al. (41), 2257 dollars according to Taylor et al. (46), 233 dollars in the study by Aktimur et al. (49).

One study analyzed the differences between SG and RYGB in patients treated in accordance with the ERAS protocol, finding higher rate of PONV and longer LOS after SG compared to RYGB, concluding that recovery is longer after SG (60).

ERAS in Specific Health Care Settings

One of the topics about ERAS in the setting of bariatric surgery is its feasibility in different health system and countries. Several authors have reported their experience and the results of the implementation of such programs. In Spain Ruiz-Tovar had reported in 2016 the preliminary experience of ERAS application in 3 centers, including at first 125 patients undergoing RYGB (54.4%) or SG (45.6%) in a pilot study (68). They found compliance of all the items of the ERAS protocol in 78.4% of the patients. The reoperation rate and complications were 4% and 6%, respectively. The mortality rate was 0.8%. The median hospital stay was 2 days with readmission rate of 2.4%. ERAS was considered safe and feasible. A second study by the same group analyzed the data of 233 patients, comparing them to 286 patients receiving standard care (69). The total compliance to protocol increased to 80%, and the ERAS group had less postoperative pain and earlier hospital discharge with similar morbi-mortality and readmission rates. Loots et al. (70) analyzed the feasibility

of ERAS in a South African Teaching Hospital, on a population of 62 patients undergoing SG or RYGB. Outcomes were compared between those who adhered to the perioperative pathway and those who did not. Full adherence was achieved in 53 (85.5%) patients with a mean length of stay (LOS) of 3 ± 0.8 days (significantly lower than 4 ± 3.2 days for patients receiving standard care). Adherence to postoperative follow-up was higher among patients adhering to ERAS protocol. In Italy ERAS was reported in a monocentric series of 202 patients (71), and allowed patients' discharge during the first postoperative day (36.6%) or second POD (77.7%) with a readmission rate of 4.5% and complication rate of 7.4% (Clavien Dindo III-IV=3%). A second Italian study from a high volume institution included 2122 patients (72). The authors demonstrated a minimal adherence rate to the protocol for a single item of 82%. Mortality was null, overall morbidity was 1.8%, readmission and reoperation rate within 30 days was 0.4%. The average LOS was 2.1 days. In the Middle East the ERAS protocol was applied to a cohort of 1602 patients and their results were compared to those of 462 patients undergoing SG or RYGB. Benefits of ERAS consisted in significant reduction of LOS and major complications after SG (whereas the rate was similar after RYGB). However, the control group was operated in the first part of the series (2010-2014) and the ERAS group later (2015-2017), so a learning curve effect could have a role in the different morbidity rates. Gouveia de Oliveira et al. (73) reported the application of ERAS protocol in a philanthropic hospital in Brazil on a population of patients undergoing RYGB or SG. After implementation of ERAS, LOS and total hospitalization costs decreased significantly by 32.5% and 15.2%, respectively (both, $p < 0.05$), compared to the control group, without significant differences in 30-day readmission, complication, or reoperation rates.

Even if ERAS seems to be applicable worldwide, there is still no uniformity among different countries and institutions (53,54,57, 74). An interesting survey (74) collecting data

about nutritional aspects of ERAS showed that significant differences exist in the 5 continents and in different services in the conduct of shortening of preoperative fastening, early postoperative protein supplementation and immediate postoperative diet. There is a large space for implementation and adoption of similar ERAS guidelines worldwide.

Barriers to ERAS

During the implementation efforts for the use of ERAS protocols, some authors focused on the compliance to ERAS [ranging from 42.8% to more than 85% (75)] and barriers to its application (76). In the interesting monocentric series by Jonsson (76) several clinical and operative factors were identified having a role on the achievement of early discharge after SG, including preoperative opioid use, history of psychiatric illness, chronic kidney disease, revisional surgery. On regression modeling, early operating room start time and treated obstructive sleep apnea (OSAS) significantly reduced the LOS, while creatinine >1.5 mg/dL, ejection fraction $< 50\%$, and prolonged operative time increased the LOS. Ehlers et al. (77) in a multicentric survey found a lack of buy-in from team members, availability of specific resources, staffing turnover, and interruption to implementation as barriers to ERAS application, whereas increased communication at all phases and a specific point-person to guide implementation were identified as propulsive factors.

Future Developments

Among the potential future developments, connected surveillance has been proposed (78) as a means to detect complications in discharged patients and increase patients satisfaction. As ERAS protocols are associated with reduction of hospital stay, this tool may be interesting and useful. A preliminary study by Neuberger and colleagues (78) demonstrated that with the use of a specifically developed internet application available 24/7 for the first ten PODs, the healthcare team detected

100% of complications. Implementation of ERAS protocols could also be a very effective means in the future to increase the rationalization of resources and the efficiency of surgical pathways in the hypothesis of a persistent COVID-19 pandemic or other infectious epidemics (44), as it is associated with shorter LOS and faster recovery, with a potential major effect on hospital infection rates.

Conclusions

ERAS protocols are feasible and safe in the setting of bariatric surgery. The most relevant and widely accepted guidelines summarizing the different items to be followed are the ERAS Society guidelines, published in 2016 and updated in 2021 (14,17). The review of the literature shows that the use of ERAS protocols is associated with reduced hospital stay, reduced PONV and postoperative pain, reduced opioid and antiemetic use and reduced costs. Postoperative mortality and readmission rates are similar between patients receiving standard care and patients treated within the ERAS protocol. Most authors showed similar rates of postoperative complications with or without ERAS application even if some researchers observed reduced morbidity in patients treated according to the ERAS principles. ERAS can be applied on patients receiving the most frequently performed bariatric procedures, including SG, RYGB and OAGB, and is feasible in different health care contexts and countries. ERAS principles may be applied also to adolescents and to patients undergoing a revisional bariatric procedure. Considering these data, it seems logical and recommended a large implementation of ERAS in the setting of bariatric surgery in most patients, in the absence of specific contraindications. Furthermore, increase of ERAS application may be useful in health care systems dealing with epidemic infectious diseases and implemented by technological advancements such as connected surveillance.

Conflicts of Interests

The authors report no conflicts of interests

and disclose any commercial interest that they may have in the subject of the study and the source of any financial or material support.

Authors' Contributions

NP & GL data acquisition and curation, methodology, writing the original draft, CEB validation, writing review and & editing, GS project manager, study design, validation, supervision, writing-review & editing.

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