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ORIGINAL CONTRIBUTIONS

Analysis of the 'Evaluation Indicators' of an Enhanced Recovery After Bariatric Surgery Pathway in the First Six Months After Implementation

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Abstract

The implementation of a clinical pathway in bariatric surgery (BS) might facilitate systemic care. Focusing on enhanced recovery after surgery (ERAS) programs may also improve surgical outcomes depending on the degree of adherence achieved. We hypothesized that the implementation of an ERAS clinical pathway in BS (ERABS) improves clinical outcomes compared to traditional treatment in a tertiary care hospital. The main objective was to assess the degree of adherence to the ERABS program. Secondary objectives were to evaluate compliance with the quality indicators of the Spanish Society for Obesity Surgery (SECO) and overall patients' satisfaction. A retrospective observational study was designed. Data from patients who underwent BS into an ERABS context were reviewed and compared with traditionally treated patients. Process and outcomes indicators adapted from RICA (Recuperación Intensificada en Cirugía Abdominal) pathway, degree of compliance with SECO quality indicators and patients' satisfaction were analyzed. Forty-three patients were included per group. Indicators' compliance rate per patient was 83.23%. Differences were found in postoperative bleeding, immediate morbidity and overall morbidity, but not in severity of complications. No patient felt dissatisfied or unsatisfied. Average compliance with indicators of process and outcome was 90.45%. Overall morbidity in ERABS group did not differ from that recommended by SECO, but traditional group did show significant increase. Adherence was 83.63% and overall incidence of complications was 7%. Our study shows improved clinical outcomes in ERABS group with a high degree of adherence. Quality indicators were met, improving overall morbidity with no difference in the severity of complications.

Keywords ERAS programs · Bariatric surgery · Clinical pathway · Quality indicators · Adherence

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Introduction

Bariatric surgery (BS) is the most effective therapeutic option in morbid obesity [1]. It allows for long-term weight loss, improves associated diseases, and increases life expectancy [2–4].

Given the progression of its prevalence and the indications of bariatric and metabolic surgery in the control of obesity, and also of weight-related diseases, the demand for care is expected to grow.

In view of a specific care that involves a large volume of high-risk patients, and high cost, together with a multidisciplinary approach and a predictable clinical course, the implementation of a clinical pathway might facilitate systemic care [5].

Enhanced recovery after surgery (ERAS) programs integrate multiple multimodal interventions [6] aimed at reducing surgical stress, maintaining physiological function, and facilitating the return to the baseline situation of the operated patient.

The degree of adherence to ERAS programs determines, in part, the improvement of surgical outcomes [7]; however, even a moderate degree of adherence may be difficult to achieve [8]. Scientific publications analyzing implementation are scarce [9]. A degree of adherence lower than 50% has been associated with complication rates of 50%, whereas adherence around 90% relates with complications of less than 20% [10–12].

Specific recommendations on enhanced recovery after bariatric surgery (ERABS) have been extrapolated from colorectal surgery, with specific interventions in accordance with GRADE scores [13].

We hypothesized that the implementation of an ERABS clinical pathway (ERABS-CP) in BS improves clinical outcomes compared to traditional treatment. The main objective of this study was to assess the degree of adherence to an ERABS program in the first 6 months after its introduction. Secondary objectives were to evaluate the degree of compliance with the quality indicators of the Spanish Society for Obesity Surgery (SECO), and overall patient satisfaction.

Materials and Methods

A retrospective observational study was designed. The setting was a public tertiary care reference hospital. Patients undergoing BS in the first 6 months of an ERABS-CP implementation (ERABS surgery group, ESG) were compared with a group of patients scheduled for BS and treated with the traditional clinical pathway (Traditional surgery group, TSG, control group). Consecutive ESG patients operated in a time frame of 6 months in the year 2017 were compared with patients in the TSG operated in the same time frame in the year 2016, and were followed up until day 30 after surgery. The ESG was composed by consecutive adult patients, aged 18 to 60 years, scheduled for BS, as a primary indication or as revision surgery. Patients were recruited from the first 6 months after ERABS-CP implementation. A random, consecutive, 1:1 paired sample was selected to ensure institutional and seasonal comparability. Surgeries were performed by the same surgical team (four surgeons), using the same techniques and spending the same surgical time.

The exclusion criterion was severe obesity-associated comorbidity, scored 4 in the Edmonton Obesity Stage System (EOSS) (Supplementary material Table 1) because an ERABS procedure was not considered feasible due to the high possibility of complications.

Patients with a higher risk of mortality associated with BS scored 4–5 in the Obesity Surgery Mortality Risk Score (OS-MRS) (Supplementary material Table 2), regardless of the score in the EOSS (except EOSS 4), and ASA physical status classifications were admitted as per institutional protocol to the intensive care unit (ICU) during the first 24 h, where the ERABS protocol was initiated. Thus, these patients' data were included in the analysis as well.

The specific procedures of the enhanced recovery program were those of the temporary ERABS matrix from the Spanish Multimodal Rehabilitation Group [14] (Annex Table 8) and of the ERAS Society [13] (Annex Table 9).

To evaluate the degree of adherence to the clinical pathway, 'process indicators' adopted from the RICA [15] pathway were analyzed. We also analyzed the average compliance with the overall 'evaluation indicators' (process and outcome indicators, defined in Supplementary material Table 3). A survey regarding patients' satisfaction was designed (Annex Table 10) and was also adopted from RICA [15].

To compliance with the 'quality indicators' recommended by the SECO (Table 1), the incidence of complications found in both groups was compared with the recommended standards [16]. The SECO upper quality limit was chosen as the reference. The analyzed parameters are summarized in Table 2. The complications are in terms of mortality, overall morbidity, bleeding, major bleeding, leakage, fistula, surgical site infection (SSI), and other postoperative medical or surgical complications, specific to the type of surgical technique. The Clavien–Dindo classification and the Comprehensive Classification Index (CII, see Annexes Table 11 and 12) were used to analyze the differences found (Table 3).

Two independent databases were built in Numbers version 5.3 (Apple Computer Inc., Cupertino, CA, USA). Categorical variables are described as mean frequency or number (*N*) and proportion (%). Continuous variables are described as mean and standard deviation (SD). The Mann–Whitney *U* test was used for comparisons between two continuous variables and the Chi-square test for comparisons between categorical variables. The Binomial test was used for the comparison of a categorical variable with a reference value ('quality indicators'). The data were analyzed using the SPSS 25 (IBM Corporation, Armonk, NY, USA) and STATA 15.1 (Stata Corporation, College Station, Texas, USA) software.

Results

Forty-three patients were included in each group. In both series, patients were mostly women. Otherwise, groups were comparable in terms of age, BMI and EOSS, OS-MRS, and ASA physical status scores (Table 4). Different techniques of bariatric operations have been chosen in our institution for the treatment of obesity and comorbidities.

Compliance with process indicators in the ESG are shown in Table 5. An average compliance rate per patient of 83.23% was achieved. No patient voluntarily dropped out of ERABS-CP. Optimal analgesia (VAS <4) was achieved in 66% of the patients. Data from three patients were excluded from calculation due to perioperative complications not compatible with

Table 1 SECO quality criteria for morbidity and mortality

SECO recommendations	Characteristic		Recommended incidence
Mortality			< 0.5
Morbidity	General		< 10
	PTE		< 1.5
	Fistulas		< 4
	Internal hernias		< 3
	Specific by technique		
	VSG	Leakage	0–3.9
		Stapple suture hemorrhage	0–9
	RYGB		
	Lineal mechanical	Suture dehiscence	0–6.8
		Anastomotic related hemorrhage	1–9.7
	Circular 25 mm	Suture dehiscence	0–6.6
		Anastomotic related hemorrhage	1.6–6.6

Data as (%) of recommended incidence

SECO Sociedad Española de Cirugía de la Obesidad Mórbida y de las Enfermedades Metabólicas (Spanish Society for Morbid Obesity and Metabolic Diseases Surgery), *PTE* pulmonary thromboembolism, *VSG* vertical sleeve gastrectomy, *RYGB* Roux-en-Y gastric bypass

intensified recovery (Table 6). Significant differences were found in postoperative bleeding, immediate morbidity, and overall morbidity, but not in severity of complications as determined by Clavien-Dindo classification [17] (Annex Table 10). The CCI (Annex Table 12) showed that grade II complications (complications that resolved with medical treatment) prevailed in 86% in the whole series. No patient died. No patient rated their perception as dissatisfied or unsatisfied. Fulfillment of the planned length of stay (48–72 h) was accomplished by 88% of the patients (Table 3).

The average compliance with the process and outcome indicators was 90.45%. Overall morbidity in the ESG did not differ from that recommended by SECO, but the TSG did show a significant increase. There was no difference in the incidence of postoperative bleeding, leaks or fistulas between groups and when compared with the recommended values (Table 2).

Univariate analysis results related to morbidity are shown in Table 7. Age (younger) and EOSS (lower score) showed significant (increased) effect on morbidity. BMI, ASA physical status and OS-MRS did not influence morbidity. Adherence to ERABS-CP was 83.63%, and the overall incidence of complications was 7%.

Discussion

ERABS-CP is widely accepted; however, its application is far from established [18] probably due to a lack of robust evidence of its usefulness in patients with high comorbidity and

Table 2 Postoperative complications. Comparison with the quality criteria reference values from SECO

	SECO	ESG	ESG *p* value	TSG	TSG *p* value
Morbidity (general)	10	7	0.51	21	0.02
Hemorrhage	6.6	7	0.91	12	0.18
Major hemorrhage	6.6	2	0.26	7	0.92
VSG leakage	3.9	0	0.26	0	0.26
Mechanical linear RYGB leakage	0.01	0	0.78	0	
Circular RYGB leakage	6.6	0	0.30	2.3	0.26
Fistulas	4	0	0.18	2	0.57

Data as % of SECO recommendations fulfillment

SECO Sociedad Española de Cirugía de la Obesidad Mórbida y de las Enfermedades Metabólicas (Spanish Society for Morbid Obesity and Metabolic Diseases Surgery), *ESG* ERABS surgery group, *TSG* traditional surgery group, *VSG* vertical sleeve gastrectomy, *RYGB* Roux-en-Y gastric bypass

Table 3 Postoperative complications. Result indicators. Comparison between groups

	Total *N*=86	ESG *N*=43	TSG *N*=43	*p* value
Postoperative hemorrhage				0.090
No	80 (93)	42 (98)	38 (88)	
Yes	6 (7)	1 (2)	5 (12)	
Major postoperative hemorrhage				0.31
No	82 (95)	42 (98)	40 (93)	
Yes	4 (5)	1 (2)	3 (7)	
Postoperative fistula				0.31
No	85 (99)	43 (100)	42 (98)	
Yes	1 (1)	0 (0)	1 (2)	
Postoperative leakage				1.00
No	84 (98)	42 (98)	42 (98)	
Yes	2 (2)	1 (2)	1 (2)	
Surgical site infection				0,31
No	85 (99)	42 (98)	43 (100)	
Yes	1 (1)	1 (2)	0 (0)	
Other postoperative surgical morbidity				1,00
No	84 (98)	42 (98)	42 (98)	
Yes	2 (2)	1 (2)	1 (2)	
Medical postoperative morbidity				1.00
No	84 (98)	42 (98)	42 (98)	
Yes	2 (2)	1 (2)	1 (2)	
Immediate morbidity (first 24 h)				0.096
No	79 (93)	41 (98)	38 (88)	
Yes	6 (7)	1 (2)	5 (12)	
Early morbidity (days 2–30)				0.31
No	82 (95)	42 (98)	40 (93)	
Yes	4 (5)	1 (2)	3 (7)	
Delayed morbidity (> day 30)				
No	86 (100)	43 (100)	43 (100)	
Global morbidity				0.062
No	74 (86)	40 (93)	34 (79)	
Yes	12 (14)	3 (7)	9 (21)	
Clavien–Dindo classification grade				0.72
I	1 (8)	0 (0)	1 (11)	
II	8 (67)	2 (67)	6 (67)	
IIIa	1 (8)	0 (0)	1 (11)	
IIIb	2 (17)	1 (33)	1 (11)	
CCI	3 (8.5)	2 (7.4)	5 (9.4)	0.15
Hospital readmission (within 30 days)				0.31
No	82 (95)	42 (98)	40 (93)	
Yes	4 (5)	1 (2)	3 (7)	
Mortality (within 30 days)				
No	86 (100)	43 (100)	43 (100)	
Immediate reoperation (first 24h)				1.00
No	84 (98)	42 (98)	42 (98)	
Yes	2 (2)	1 (2)	1 (2)	
Early reoperation (2-30 days)				0.31
No	85 (99)	43 (100)	42 (98)	

Table 3 (continued)

	Total *N*=86	ESG *N*=43	TSG *N*=43	*p* value
Yes	1 (1)	0 (0)	1 (2)	
No ICU admission in the first 24h in the ward (unforeseen)				
Yes		43 (100)		
Fulfillment of foreseen LOS (48-72h)				
No		5 (12)		
Yes		38 (88)		
Clinical pathway withdrawal				
No		40 (93)		
Yes		3 (7)		
Patient's satisfaction degree				
Satisfied		2 (6)		
Satisfied enough		9 (25)		
Very satisfied		25 (69)		
Optimal satisfaction degree (enough/very satisfied)				
No		2 (6)		
Yes		34 (94)		

Data as mean (SD) and number (%)

Quantitative variables were analyzed with Mann–Whitney *U* test

Qualitative variables were analyzed with Chi-square test

ESG ERABS surgery group, *TSG* traditional surgery group, *CCI* Comprehensive Complication Index, *LOS* length of stay

risk [19, 20]. There is little information about its dissemination in health systems.

It has been proven that ERABS-CP reduces surgical time, postoperative pain, and length of stay (LOS), without differences with traditional approaches in morbidity, specific complications, mortality, reoperation and hospital readmissions [21–30]. A recent metaanalysis claims the need for clinical guidelines with specific evidence in BS [31]. The first review [32] and the first evidence consensus document in ERABS have recently been published [33].

From a general point of view, adherence to the whole ERAS elements gives strength to the method [34, 35], although the impact of individual adherence is still unknown [36].

Our study agrees with those of Pedziwiatr et al. [7], with a high rate of adherence immediately after implantation, being in the high range (70–90%), and considered close to strict adherence (more than 90%) [37]. We also agree on the resulting high intraoperative elements, adherence rates and with the components with worse adherence, these being the postoperative ones (mainly the items scheduled to be applied in the ward) [38, 39]. This weakness might be related to medical needs that require decisions not covered by the ERAS protocol, and not to a true lack of compliance [40]. The adherence to postoperative process indicators in our work was 76%, whereas it was 86.93% and 88% in the preoperative and intraoperative ones respectively.

In relation to the analyzed ERABS process indicators (preoperative assessment and premedication focused on ERABS, preoperative nutritional management, fasting and administration of carbohydrate drinks, antibiotic and thromboembolic prophylaxis, prevention of hypothermia, no placement of abdominal and nasogastric tube drains, laparoscopic surgical

Table 4 Characteristics of the patients

	Total *N*=86	ESG *N*=43	TSG *N*=43	*p* value
Age (years old)	51 (7.4)	52 (6.3)	50 (8.2)	0.22
Sex				0.008
Male	18 (21)	4 (9)	14 (33)	
Female	68 (79)	39 (91)	29 (67)	
BMI (kg/m^2)	46 (6.1)	46 (6.3)	45 (5.8)	0.29
EOSS	2 (0.7)	2 (0.7)	2 (0.7)	0.20
OS-MRS	3 (1.1)	2 (1.2)	3 (1.1)	0.17
ASA physical status	3 (0.3)	3 (0.3)	3 (0.4)	0.29

Data as mean (SD) and number (%)

Quantitative variables were analyzed with Mann–Whitney *U* test

Qualitative variables were analyzed with Chi-square test

ESG ERABS surgery group, *TSG* traditional surgery group, *BMI* body mass index, *EOSS* Edmonton Obesity Staging System, *OS-MRS* Obesity Surgery Mortality Risk Score, *ASA* American Society of Anesthesiologists

Table 5 Degree of adherence to process indicators according to the perioperative period

Perioperative period	Process indicators	Fulfillment (%)	Fulfillment in the perioperative period (%)
Preoperative	Appropriate coverage	98	
	Appropriately indicated procedure	100	
	ERABS preoperative evaluation and information	77	
	Preoperative nutritional management	100	
	Appropriate ERABS premedication	95	
	Carbonated beverages administration	51	86.93
Intraoperative	Thromboembolic prophylaxis	100	
	Antibiotic prophylaxis	100	
	Hypothermia prevention	100	
	No abdominal drains inserted	16	
	No nasogastric tube insertion	100	
	Intraoperative fluids	100	
	Surgical approach	100	88
Postoperative	Optimal analgesia (VAS ≤ 4)	66	
	Early mobilization	86	76

Data as %

ERABS enhanced recovery after bariatric surgery

approach, optimal analgesia and early mobilization) we applied the current recommendations at the time of the study was carried out, these being related as a whole, to greater safety [22], less incidence of complications, earlier recovery [15] and LOS reduction [32].

Recent studies are controversial regarding oral carbohydrate beverages administration [32, 33]. We detected barriers to the implantation of ERABS-CP in the preoperative assessment and premedication items, probably because some patients were assessed before the implantation of the CP and because some of the involved professionals did not acquire enough knowledge of it. This also occurs with abdominal drains placement, possibly due to institutional tradition and to the lack of sensitivity and specificity demonstrated in the detection of anastomotic leaks [41].

Table 6 Reasons for noncompliance and withdrawal from the clinical pathway and its management in ESG

Accidental opening of the small bowel intraoperatively due to adhesion syndrome	Surgical closure Immediate postoperative period in HDU
Leakage of the duodenal stump after SADI-S performed as revision surgery	Urgent surgical intervention in the immediate postoperative period (<24 h)
Early postoperative low gastrointestinal bleeding (2–30 days)	Conservative treatment in hospital ward

HDU high dependence unit, *SADI-S* single anastomosis duodenal–ileal bypass with sleeve

There is evidence of increasing benefits of the laparoscopic technique associated with an ERAS program [42]. In the morbidly obese patient the surgical approach should always be laparoscopic as it reduces the incidence of surgical complications and decreases postoperative pain (high level of evidence, strong recommendation +) [43] provided the surgeons are experts [13].

Evidence-based multimodal anesthesia regimes are recommended [44], opioid reduction and the systematic use of paracetamol and NSAIDs, as well as surgical wound infiltration with local anesthetics, intraperitoneal local anesthetic spraying, abdominal wall nerve blocks or thoracic epidural anesthesia in the case of laparotomy [13]. A pain score rating of 0 to 4 on the visual analog scale (VAS), i.e., moderate pain, is considered acceptable [15, 45]. We did not perform a standardized anesthetic technique, as no specific evidence existed to date on this aspect [13]. All patients received multimodal analgesia based on paracetamol, NSAIDs and surgical wound infiltration with ropivacaine before trocar's placement.

Mobilization is recommended in the first 24 h in morbidly obese patients (high level of evidence, strong recommendation +) and, if possible, in the first 4 h [46]. In this sense, a barrier to implementation is once again apparent in different care settings in the immediate postoperative period, due to the

Table 7 Univariate analysis

	ESG			TSG			Total		
	Morbidity			Morbidity			Morbidity		
	Yes	No	*p* value	Yes	No	*p* value	Yes	No	*p* value
Age (years old)	48 (8.7)	52 (6.2)	0.28	48 (6.6)	50 (8.6)	0.38	48 (6.7)	52 (7.4)	0.05
BMI (kg/m^2)	50 (1.6)	46 (6.4)	0.27	44 (4.5)	45 (6.2)	0.48	45 (4.8)	46 (6.2)	0.99
ASA	3 (0)	2.9 (0.3)	0.63	2.9 (0.3)	2.8 (0.4)	0.79	2.9 (0.3)	2.9 (03)	0.80
EOSS	1 (1)	1.8 (0.6)	0.04	2.1 (0.6)	1.9 (0.8)	0.41	1.8 (0.8)	1.9 (0.7)	0.97
OS-MRS	2.3 (1.2)	2.4 (1.2)	0.95	2.4 (1.1)	2.8 (1.1)	0.43	2.4 (1.1)	2.6 (1.1)	0.65
Surgical technique			0.13			0.82			0.39
RYGB	3 (12)	22 (88)		6 (20)	24 (80)		9 (16)	46 (84)	
SADI-S VSG	0	18 (100)		3 (23)	10 (77)		3 (10)	28 (90)	

Data as mean (SD) and number (%)

ESG ERABS surgery group, *TSG* traditional surgery group, *BMI* body mass index, *EOSS* Edmonton Obesity Staging System, *OS-MRS* Obesity Surgery Mortality Risk Score, *ASA* American Society of Anesthesiologists physical status, *VSG* vertical sleeve gastrectomy, *RYGB* Roux-en-Y gastric bypass, *SADI-S* single anastomosis duodenal–ileal bypass with sleeve

lack of understanding by some of the professionals of the requirements of early mobilization, lack of habit, care pressure, and the shortage of space, as is the case in the ICU.

The SECO carried out a review of a set of parameters as quality indicators of 'good practice' in BS [47]. We analyzed all recommended indicators related to morbidity and mortality (Table 2). There are differences in overall postoperative bleeding, immediate morbidity and overall morbidity, with no differences in the severity of these complications or in the other proposed indicators. When comparing each group with the quality criteria recommended by SECO, no indicator of the ESG differs, but the overall morbidity of the TSG was significantly higher.

In the univariate analysis, two apparently paradoxical results from morbidity were obtained. First, the lower age, the higher morbidity. However, this result did not reach significance, neither statistical nor clinical. Perhaps this would be related to an inadequate sample size for this parameter. Second, in the ESG, the lower the EOSS score, the higher the morbidity. For this result, the chosen surgical technique might be a contributing factor, as it was more conservative in the high-risk patients. Of note, in our study we observed high adherence with a lower than published complications taxes [10–12].

Limitations of the Study

The study was retrospective. A prospective blinded design might offer more consistent results. There were barriers to the implementation of the ERABS-CP due to its recent introduction. We should underline that there was an insufficient level of awareness of the ERABS program among some of the health care workers, and perhaps a lack of confidence and resistance to change due to the weight of institutional tradition. This justifies the need to carry out regular audits to assess the evolution of the adherence over time, as well as to monitor quality indicators, to detect barriers to maintenance, and to assess the success of the measures taken to overcome them. Informative spreading sessions could favor the in-hospital dissemination of CP and its results. Loss of some data and information has been possible as well. Perhaps there is obsolescence or doubtful evidence in some of the ERABS items over time, and this merits future revisions. In addition, similar studies can now be performed using other technical approaches, such as robotic surgery, not currently available at our institution.

Conclusions

The choice of a specific protocol (ERABS-CP) can help to achieve optimal clinical outcomes and fewer complications in bariatric surgery patients. The high degree of adherence to the protocol is associated with these results. On the other hand, the systematic performance of preoperative tests in the bariatric surgery patient does not provide a predictive value in the occurrence of complications; however, an immediate postoperative pathway based on the association of scales and scores (i.e., the protocol) as tools for risk assessment adds safety to the procedures.

Appendix

Annex 1

Table 8 ERABS time matrix

Period	Actions	Responsibility
Before admission	Surgical indication for bariatric or metabolic surgery Multidisciplinary assessment: Endocrinology and Nutrition, Psychiatry, Nursing, Pneumology, Cardiology, Digestive, Radiology, Anesthesiology. - Risk assessment. Specific complementary tests: - SAHS-OHS screening: Stop-Bang Questionnaire. Polysomnography if Stop-Bang >3. Start CPAP-BiPAP 6-12 weeks before surgery - FRT and pneumological evaluation if: Respiratory risk factors, Basal SpO2 <94%, Asthma/COPD not controlled - Cardiological evaluation: EKG 12-lead +/- Echocardiography if: >3 CVRF, abnormal EKG, uncontrolled AHT, congestive heart failure clinic, <4-6METS, suspected evolved SAHS, metabolic syndrome - Information leaflet - Nutritional optimization: - Preoperative weight loss: low-calorie diet with low-calorie and high-protein shakes, 1 month prior to surgery - Preoperative follow-up: - Nursing follow-up and control: control of adherence to the route and explanation of actions to be taken by the patient in the perioperative - Preanesthetic assessment: - Preanesthetic anamnesis - Analysis: blood count, basic biochemistry, hemostasis, nutritional profile - Evaluation of preoperative tests - Anthropometry: BMI, TBW, BWI, LBW, ABW - Airway assessment: predictors of difficult ventilation and intubation - Thromboembolic risk assessment - Risk stratification: ASA, OS-MRS - Respiratory risk assessment - Estimation of postoperative destination	Multi-disciplinary: Surgery Anesthesia Nursing
Perioperative	Immediate preoperative: Fasting for clear liquids 2h and 6h for solids Thromboembolic prophylaxis according to risk: compression stockings, intermittent pneumatic compression stockings, pharmacological prophylaxis according to risk and type of LMWH Do not schedule anxiolytic premedication Carbohydrate drink supplement (12.5 % maltodextrin 200cc) 2h before surgery, if no contraindication Premedication: ATB prophylaxis according to protocol 30-60min before the surgical incision (based on TBW), regurgitation prophylaxis if gastric emptying is delayed (ranitidine + metoclopramide) 1h before surgery	Nursing Anesthesia
Perioperative	Intraoperative: - Fitting of intermittent pneumatic compression devices - Do not anesthetize the patient outside the operating theatre - Safe positioning. Attention to risk factors for rhabdomyolysis - Active heating: thermal blanket, fluid heater - Routine monitoring: Capnography, Central T[a], NMB, BIS, blood glucose - Not routinely indicated: invasive monitoring, central venous catheter - Positive pressure pre-oxygenation (CPAP) - Anesthetic induction in ramp position - Minimize time between induction and IOT - Use of NMB amino steroids as first option (if sugammadex is available) - Lung protective ventilation, PEEP and recruitment manoeuvres - FiO_2 0.6-0.8 - Use of short-term anesthetic agents and multimodal analgesia - Goal-directed hemodynamic optimization with validated devices is recommended. If no such devices are available, restrictive fluid therapy based on IBW is recommended.	Nursing Surgery Anesthesia

Table 8 (continued)

Period	Actions	Responsibility
	- PONV prophylaxis according to the modified Apfel scale - TEA if open surgery. In laparoscopic surgery it is not recommended as a routine procedure. Patients with contraindications for TEA may benefit from bilateral TAP block and/or infiltration of trocars with LA. - The approach should be laparoscopic whenever possible - It is recommended to perform pneumoperitoneum by Veress needle or optical trocar insertion - Vertical sleeve gastrectomy should be calibrated with probes - No NGT (only intraoperative to empty stomach) - Drainage is not recommended on a routine basis	
Perioperative	Immediate postoperative: - Active maintenance of the T[a] - Start of oral tolerance from 6h after surgery - Beginning of mobilization from 6h after surgery - Multimodal analgesia according to intervention Minimize opioids. Assess the use of adjuvants - In patients with SAHS, early implementation of CPAP / BiPAP - Inspiratory incentive - Thromboprophylaxis	Nursing Anesthesia
1st postoperative day (Ward)	- Low-calorie liquid diet according to tolerance - Active mobilisation - Intravenous analgesia - Withdrawal of intravenous fluid therapy if good tolerance - Assess bladder catheter removal (if any) - Assess drainage removal (if any) - Thromboprophylaxis - Respiratory physiotherapy - Surgical wound control and healing - Reserve imaging studies for cases of clinical suspicion of anastomotic leakage	Nursing Surgery
2nd postoperative day and subsequent	- Hypocaloric and hyperproteic total liquid diet - Assess drainage removal if available - Assess home discharge. General criteria for discharge: no surgical complications, no fever, tachycardia or tachypnea, complete ambulation and adequate oral tolerance	Nursing Surgery
At discharge	- Hypocaloric and hyperproteic turmix diet first 1-2 weeks. After that, a shredded diet for 2 weeks. Solid diet after 1-2 months of surgery - Thromboprophylaxis the first 3-4 weeks after surgery - Topical surgical wound care and removal of stitches/staples after 10-12 days in outpatient surgery	Nursing Surgery
Home control after discharge	- Telephone control after discharge - Home support coordinated with primary care	Nursing

ERABS Enhanced Recovery After Bariatric Surgery; *SAHS* sleep apnea-hypopnea syndrome; *OHS* obesity-hypoventilation syndrome; *CPAP* continuous positive airway pressure; *BiPAP* bi-level positive airway pressure; *FRT* Functional respiratory testing; SpO_2 peripheral oxygen saturation; *COPD*: chronic obstructive pulmonary disease; *CVRF* cardiovascular risk factors; *EKG* electrocardiogram; *AHT* arterial hypertension; *METS* metabolic equivalents; *BMI* body mass index; *TBW* total body weight; *IBW* ideal body weight; *LBW* lean body weight; *ABW* adjusted body weight; *ASA* American Society of Anesthesiologists; *OS-MRS* Obesity Surgery Mortality Risk Score; *LMWH* low molecular weight heparin; *ATB* antibiotic; *NMB* neuromuscular blocker; *BIS* bispectral index; *PEEP* positive pressure at the end of the exhalation; *PONV* postoperative nausea and vomiting; *TEA* thoracic epidural anesthesia; *TAP* transversus abdominis muscle plane; *LA* local anesthetic; *NGT* nasogastric tube; *T[a]* temperature

Annex 2

Table 9 Levels of evidence and degrees of recommendation in ERABS

Element	Recommendation	Level of evidence	Degree of recommendation
Preoperative			
Information, education and preoperative advice	Patients should receive preoperative advice	Moderate	Strong
Prehabilitation and exercise	Although pre-habilitation could improve functional recovery, there is insufficient data to recommend it prior to bariatric surgery to reduce complications or hospital stay	Low	Weak
Alcohol and tobacco cessation	- Smoking cessation should be at least 4 weeks before surgery - Patients with a history of alcohol abuse must show at least 2 years of abstinence	- Tobacco: High - Alcohol: Low (only 1 RCT of high quality)	Strong
Preoperative weight loss	Preoperative weight loss should be recommended prior to bariatric surgery. Patients treated with hypoglycemic drugs should be warned of the risk of hypoglycemia	High	Strong
Glucocorticoids	Dexamethasone should be administered 8mg iv, preferably 90min before anesthetic induction, to reduce the incidence of PONV and the inflammatory response	Low (no RCT in bariatric surgery)	Strong
Preoperative fasting	Obese patients should drink clear liquids up to 2 hours and solids up to 6 hours before anesthetic induction. More data are needed in patients with autonomic neuropathy due to the potential risk of aspiration	- Obese without DM: High - Obese plus MD, no neuropathy: Moderate - Obese plus MD plus neuropathy: Low	- Strong - Weak - Weak
Oral carbohydrate loading	Although oral carbohydrate loading in the patient undergoing major abdominal surgery has been associated with metabolic and clinical benefits, more data are needed in the bariatric patient. More data are also needed in the patient with GER, who may have a higher risk of aspiration during anesthetic induction	- Short preoperative fasting (non-DM obese): Low - Obese plus MD plus neuropathy: Moderate - Oral carbohydrate load in obese people: Low	Strong
Intraoperative			
Perioperative fluid management	- Intraoperative fluid overload is not necessary to prevent rhabdomyolysis or to maintain diuresis. Functional parameters such as systolic volume variation facilitate goal-directed fluid therapy and prevent hypotension and excess fluid - Postoperative fluid infusion should be stopped as early as possible, and the enteral route should be preferred	- Maintenance versus liberal regimes: Moderate - Reduction of stress response: Moderate - Open surgery: High - Laparoscopy: Moderate	- Maintenance fluid therapy regimes: Strong
PONV	A multimodal prophylactic approach to PONV should be adopted for all patients	Low	Strong
Standardised anesthetic protocol	The current evidence does not allow recommendations to be made regarding specific anesthetic techniques or agents	Low	Weak
Airway management	- Anesthesiologists should be aware of the specific difficulties of the bariatric airway - Orotracheal intubation remains the benchmark in airway management	- Moderate - Moderate	- Strong - Strong
Mechanical ventilation strategies	- Lung protective ventilation strategies should be employed during scheduled bariatric surgery - Anti-Trendelemburg position, bent hips, beach chair position (especially in the absence of a pneumoperitoneum), improve lung mechanics and gas exchange	- Moderate - Low	- Strong - Weak
Neuromuscular blockade	- Deep NMB facilitates surgery - Ensuring full recovery of the NMB improves patient recovery - Objective qualitative monitoring of the NMB improves patient recovery	- Low - Moderate - Moderate	- Weak - Strong - Strong

Table 9 (continued)

Element	Recommendation	Level of evidence	Degree of recommendation
Monitoring of the anesthetic depth	BIS monitoring should be considered, while ETAG monitoring is not used	High	Strong
Laparoscopy	The laparoscopic technique for bariatric surgery is recommended whenever expert surgeons are available	High	Strong
NGT	The routine one of NGT in the postoperative is not recommended	Low	Strong
Abdominal drains	There is not enough evidence to recommend the routine use of abdominal drains	Low	Weak
Postoperative			
Postoperative analgesia	- Intravenous multimodal drug treatment and infiltration techniques with local anesthetics should be combined	- High	- Strong
	- In laparotomy, thoracic epidural analgesia should be considered	- Very low	- Weak
Thromboprophylaxis	- Thromboprophylaxis should include pharmacological (LMWH) and mechanical measures	- High	- Strong
	- The dosage and duration of treatment with LMWH should be individualized	- Low	- Weak
Early postoperative nutrition	- Protein intake should be monitored. Iron, vitamin B_{12} and calcium supplements are mandatory	- Moderate	- Strong
	- In diabetic patients there must be strict glycemic and lipid control in the postoperative period	- High	- Strong
Postoperative oxygenation	- Non-SAHS obese patients should receive supplementary prophylactic O_2 in a semi-seated position or with headrest elevation in the immediate postoperative period	- Prophylactic O_2 supplements: Low - Postoperative positioning: High	- Strong - Strong
	- Patients with uncomplicated SAHS should receive extra O_2 in a semi-seated position. It should be possible to monitor the increase in apneic episodes. In the presence of signs of respiratory distress, respiratory support with positive pressure should be initiated	- High (14 RCTs and 1 meta-analysis)	- Strong
Non-invasive positive pressure ventilation	- Routine prophylactic postoperative CPAP is not recommended in obese people not diagnosed with SAHS	- Moderate (retrospective data only)	- Weak
	- CPAP treatment should be considered in patients with BMI >50 Kg/m^2 severe SAHS or SpO2 =/< 90 % despite supplemental O2	- Low	- Strong
	- Obese and SAHS patients with home CPAP should use their CPAP device in the immediate postoperative period	- Moderate (retrospective data only)	- Strong
	- Patients with OHS (obesity hypoventilation syndrome) should receive NIMV-BiPAP prophylaxis and monitoring in critical care	- Low	- Strong

ERABS enhanced recovery after bariatric surgery; *RCT* randomized controlled study; *PONV* postoperative nausea and vomiting; *DM* diabetes mellitus; GER gastro-esophageal reflux; *NMB* neuromuscular blocker; *BIS* bispectral index; *ETAG* end tidal anesthetic gas; *NGT* nasogastric tube; *LMWH* low molecular weight heparin; *SAHS* apnea-hypopnea syndrome; *O_2* oxygen; *CPAP* continuous positive airway pressure; *SpO_2* peripheral oxygen saturation; *OHS* obesity-hypoventilation syndrome; *NIMV* non-invasive mechanical ventilation; *BiPAP* bi-level positive airway pressure

Annex 3

Table 10 Satisfaction survey

General information
Age: Gender: Male ☐ Female ☐ Nationality: Spanish ☐ Other ☐
Level of studies: No studies ☐ Primary ☐ Middle ☐ Advanced ☐
Medical data:
Preoperative information
- How would you rate the information you received before the operation from the surgeon?
Very good ☐ Good ☐ Fair ☐ Bad ☐ Very bad ☐
- How would you rate the information you received before the operation from the anesthesiologist?
Very good ☐ Good ☐ Fair ☐ Bad ☐ Very bad ☐
- How would you rate the information you received before the operation from the nursing?
Very good ☐ Good ☐ Fair ☐ Bad ☐ Very bad ☐
Treatment received
- How would you rate the treatment you received from the surgeon?
Very good ☐ Good ☐ Fair ☐ Bad ☐ Very bad ☐
- How would you rate the treatment you received from the anesthesiologist?
Very good ☐ Good ☐ Fair ☐ Bad ☐ Very bad ☐
- How would you rate the treatment you received from nursing?
Very good ☐ Good ☐ Fair ☐ Bad ☐ Very bad ☐
- How would you rate the treatment you received from other health personnel?
Very good ☐ Good ☐ Fair ☐ Bad ☐ Very bad ☐
Installations and equipment
- The operating theatre in which you were operated on and the equipment it had, seemed to you:
Highly suitable ☐ Fairly adequate ☐ Well suited ☐ Poorly suitable ☐ Unsuitable ☐
- The room you stayed in after your stay at ICU was:
Individual ☐ Double ☐ Other ☐
- The room you stayed in after your stay at ICU was:
Highly suitable ☐ Fairly adequate ☐ Well suited ☐ Poorly suitable ☐ Unsuitable ☐

Table 10 (continued)

Pain - What was your pain level after surgery? 0 1 2 3 4 5 6 7 8 9 10 None—Very little———Little————- Quite ———— A lot ———— Too much———Unbearable
Postoperative feeding - Did you have nausea or vomiting after surgery? Yes ☐ No ☐ - When they told you that you had to start drinking, you thought it was: Too early ☐ A little early ☐ On time ☐ Late ☐ Very late ☐
Postoperative mobilization - When they told you that you had to get up on the couch, you thought it was: Too early ☐ A little early ☐ On time ☐ Late ☐ Very late ☐ - When they told you to walk, you thought it was Too early ☐ A little early ☐ On time ☐ Late ☐ Very late ☐
Hospital discharge - How would you rate the information and recommendations you received from the surgeon upon discharge? Very good ☐ Good ☐ Fair ☐ Poor ☐ Very poor ☐ I was not informed ☐ - How would you rate the information and recommendations you received from nursery upon discharge? Very good ☐ Good ☐ Fair ☐ Poor ☐ Very poor ☐ I was not informed ☐ - Did you have to call the contact number they provided? Yes ☐ No ☐ I was not provided ☐

Table 10 (continued)

Professional competence and coordination - In your opinion, the level of professional competence of the surgeon was: Very high ☐ High ☐ Normal ☐ Poor ☐ Very poor ☐ - In your opinion, the level of professional competence of the anesthesiologist was: Very high ☐ High ☐ Normal ☐ Poor ☐ Very poor ☐ - In your opinion, the level of professional competence of nursery was: Very high ☐ High ☐ Normal ☐ Poor ☐ Very poor ☐ - In your opinion, the level of professional competence of other health personnel was: Very high ☐ High ☐ Normal ☐ Poor ☐ Very poor ☐ - Regarding the coordination of members, they were: Very coordinated ☐ Fairly coordinated ☐ Coordinated ☐ Poorly coordinated ☐ Uncoordinated ☐ - If you had to be operated on again, would you choose our unit? Yes ☐ No ☐ - If someone in your family had to undergo surgery for obesity, would you recommend our unit to them? Yes ☐ No ☐
Overall satisfaction - What is your overall satisfaction with the assistance provided? Very satisfied ☐ Fairly satisfied ☐ Satisfied ☐ Poorly satisfied ☐ Unsatisfied☐
Comments: The most positive aspect was: The most negative aspect was: What improvements do you think we could include?

Annex 4

Table 11 Clavien–Dindo classification

Grade	Definition
Grade I	Any deviation from the normal postoperative course without the need for pharmacological treatment or surgical, endoscopic, and radiological interventions Allowed therapeutic regimens are: drugs as antiemetics, antipyretics, analgetics, diuretics, electrolytes, and physiotherapy. This grade also includes wound infections opened at the bedside
Grade II	Requiring pharmacological treatment with drugs other than such allowed for grade I complications Blood transfusions and total parental nutrition are also included
Grade III	Requiring surgical, endoscopic or radiological intervention
Grade IIIa	Intervention not under general anesthesia
Grade IIIb	Intervention under general anesthesia
Grade IV	Life threatening complication (Including CNS complication)* requiring IC/ICU management
Grade IVa	Single organ dysfuction (Including dialysis)
Grade IVb	Multi organ dysfunction
Grade V	Death of patient
Suffix "d"	If the patient suffers from a complication at the time of discharge (see examples in Table 2), the suffix "d" (for "disability") is added to the complication. This label indicates the need for a follow-up to fully evaluate the complication.

*Intraparenchymal cerebral hemorrhage, ischemic stroke, subarachnoid hemorrhage, except transient ischemic stroke.

**CNS* central nervous system, *IC* intermediate care, *ICU* intensive care unit

Annex 5

Table 12 The Comprehensive Complication Index (CCI). From https://www.assessurgery.com/about_cci-calculator/

$$\hat{A}CCI = \frac{\sqrt{(wC_1+wC_2\ldots+wC_x)}}{2}$$

wC=Weight of Complication

	wC	CCI® Single Value
Grade I	300	8.7
Grade II	1750	20.9
Grade IIIa	2750	26.2
Grade IIIb	4550	33.7
Grade IVa	7200	42.4
Grade IVb	8550	46.2

Clavien-Dindo garde V always result in CCI® 100

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Declarations

Statements regarding ethics and consent

This article does not contain any studies with human participants or animals performed by any of the authors. For this type of study, formal consent is not required.

Conflict of Interest CLE declares personal fees from MSD.
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