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Outcomes of bariatric surgery for patients with prevalent inflammatory bowel disease: A nationwide registry-based cohort study

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ABSTRACT

Background: Obesity is becoming more prevalent in patients with inflammatory bowel disease. Although bariatric surgery is an effective treatment for obesity, questions remain regarding its safety and effectiveness for patients with inflammatory bowel disease. The aim of this study was to evaluate the safety and effectiveness of bariatric surgery in patients with inflammatory bowel disease.

Method: This registry-based, propensity-matched cohort study included all patients who had primary Roux-en-Y gastric bypass or sleeve gastrectomy in Sweden from January 2007 to June 2020 who had an inflammatory bowel disease diagnosis and matched control patients without an inflammatory bowel disease diagnosis. The study included data from the Scandinavian Obesity Surgery Registry, the National Patient Register, the Swedish Prescribed Drugs Register, the Total Population Register, and the Education Register from Statistics Sweden.

Results: In total, 71,093 patients who underwent bariatric surgery, including 194 with Crohn's disease and 306 with ulcerative colitis, were 1:5 matched to non–inflammatory bowel disease control patients. The patients with Crohn's disease had a higher readmission rate within 30 days (10.7% vs 6.1%, odds ratio = 1.84, 95% confidence interval 1.02–3.31) than the control patients, with no significant difference between the surgical methods. The patients with ulcerative colitis had a higher risk for serious postoperative complications after Roux-en-Y gastric bypass (8.0% vs 3.7%, odds ratio = 2.64, 95% confidence interval 1.15–6.05) but not after sleeve gastrectomy compared to control patients (0.8% vs 2.3%). No difference was observed in postoperative weight loss or postoperative health-related quality of life.

Conclusion: Sleeve gastrectomy appears to be a safe and effective treatment for obesity in patients with inflammatory bowel disease, whereas Roux-en-Y gastric bypass was associated with a higher risk for postoperative complications in patients with ulcerative colitis.

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Introduction

Over the last decades, the rising prevalence of obesity has been paralleled by an increased prevalence of inflammatory bowel disease (IBD).[1] Compared to patients without obesity, patients with IBD and obesity may not respond as well to medical therapy; thus, they may require higher doses of administered drugs, may have a shorter duration from diagnosis to the first surgery, and may suffer more complications when undergoing surgery.[2,3]

Although previous studies report conflicting results, more recent studies suggest that there may be an association between the 2 most common bariatric surgical procedures (ie, Roux-en-Y

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gastric bypass [RYGB] and sleeve gastrectomy [SG]) and new onset of IBD.[4,5] In addition, there has been a concern that patients with obesity and IBD are more susceptible to complications when undergoing bariatric surgery, and many surgeons consider Crohn's disease (CD) a contraindication for bariatric surgery.[6] Previous studies evaluating the safety and effectiveness of bariatric surgery in patients with IBD suggest that it may be safe, but the studies are relatively small.[7,8] A recent study from France reported low complication rates in a national cohort of patients who mainly underwent SG,[9] but there is still a paucity of matched studies reporting on the safety and effectiveness of RYGB. The aim of this study was to evaluate the safety and effectiveness of RYGB and SG in a nationwide cohort of patients with prevalent CD or ulcerative colitis (UC).

Methods

This observational, matched cohort study was based on data from the Scandinavian Obesity Surgery Registry (SOReg), a national research and quality register that started in 2007, covering virtually all bariatric surgical procedures in Sweden. The register is continuously validated, and registrations have been shown to have very high validity.[10] By using the national identification numbers (unique to all Swedish citizens),[11] the SOReg database is linked to the National Patient Register (NPR) for inpatient and outpatient care,[12] as well as to the Swedish Prescribed Drugs Register,[13] the Swedish Cause of Death Registry, Total Population Registry, and the Education Register from Statistics Sweden for individual information on the level of highest education.[14] The NPR attained national coverage in 1987, covering nearly 100% of all hospital admissions in publicly funded health care (in Sweden, private specialized care centers represent a very small proportion of care centers), whereas the outpatient component started in 2001 and covers approximately 95% of the outpatient visits in specialized health care.[12] The Swedish Prescribed Drug Register was established in 2005 and includes all dispensed drugs classified according to the World Health Organization Anatomical Therapeutic Chemical classification system.[13]

Inclusion and exclusion

Although there were no mandatory national eligibility criteria for bariatric surgery in Sweden during the study period, most regions in Sweden considered a slightly more liberal approach compared to the National Institutes of Health criteria from 1991,[15] with body mass index (BMI) $\geq$35 kg/m^2 with or without comorbidities as the eligibility criteria.

Patients aged $\geq$18 years at the time of surgery who had a primary SG or RYGB from January 1, 2007 until June 30, 2020, were assessed for inclusion in the study.

Definitions

Comorbidity was defined as an obesity-related condition defined in the SOReg as a condition requiring an active pharmacological intervention (type 2 diabetes, dyslipidemia, hypertension) or continuous positive airway pressure treatment (sleep apnea). Previous bowel surgery was defined as previous abdominal surgery with resection of the small bowel or colon, strictureplasty, or construction of a stoma. Information on inflammatory bowel disease was evaluated using combined data from the SOReg and NPR. Inflammatory bowel disease was considered in patients with (1) at least 2 relevant preoperative International Classification of Disease version 10 (ICD-10: K50, K51, K52.3) codes in the National Patient Register, of which at least 1 should be specified as CD or UC; (2) one preoperative relevant ICD-10 code and an ICD-10 code for CD or UC at the time of surgery; or (3) a preoperative registered diagnosis of CD or UC in the SOReg. Patients with 1 diagnosis of colitis (K50–52) and who did not meet the inclusion criteria were excluded from the study.[16,17]

Matching

The matching was conducted as a propensity score match with a generalized linear model, which included age, sex, preoperative BMI, surgical center, surgical access, year of surgery, hypertension, diabetes, sleep apnea, and dyslipidemia, stratified by surgical method.

Endpoints

The main outcome was serious postoperative complications within 30 days of surgery. A serious postoperative complication was defined as a complication graded $\geq$3b on the Clavien–Dindo scale as registered in the SOReg (ie, a complication requiring an intervention under general anesthesia, single or multiorgan failure or mortality).[18] The secondary outcomes were the occurrence of any postoperative complication within 30 days of surgery (defined as a complication requiring a prolonged hospital stay, readmission, or intervention, thus deviating from a normal postoperative course), postoperative weight loss, measured as a percentage total weight loss (100 $\times$ weight loss / preoperative weight), excess BMI loss (100 $\times$ [initial BMI $-$ postoperative BMI] / [initial BMI $-$ 25]), BMI loss in accordance with current recommendations,[19] and health-related quality of life (HRQoL). Health-related quality of life was estimated using the physical and mental components summary score using the global Short Form-36 (SF-36) scale,[20] as well as the disease-specific Obesity-related Problems (OP) scale.[21] Hospital admission from Day 30 until 1 year after surgery was based on combined data from SOReg and the National Patient Register. Additional operations for any cause and bariatric surgical complications during this period were based on data from the SOReg.

Statistics

Continuous variables assuming a normal distribution are presented as the mean $\pm$ standard deviation (SD) or as the medians with interquartile range (IQR) when not assuming a normal distribution. Categorical variables are presented as numbers (n) and proportions (%). Differences in proportions were evaluated with conditional logistic regression or Fisher exact test. Continuous variables were evaluated using a linear mixed-effect model, HRQoL outcomes were evaluated using the linear quantile mixed-effects model, using restricted maximum likelihood estimation with conditional analysis for matching, and these models included surgical method, sex, age, comorbidities, level of education, BMI and smoking at baseline. The linear mixed model was tested for interactions, if present, which were included in the model. The odds ratio (OR), mean difference, and median difference (MdD) are presented as measures of association. Due to multiple calculations of secondary endpoints, the Bonferroni–Holm method was used to adjust for multiple comparisons.[22] Missing data were handled by multiple imputations, and 5 imputed data sets were used for all descriptive and inferential analyses according to Rubin's rule.[23]

SPSS version 25 (IBM SPSS, Inc, Armonk, NY), R version 4.0.0 (R Foundation for Statistical Computing, Vienna, Austria), and Stata version 17.0 (StataCorp, LLC, College Station, TX) were used for statistical analyses.

Table I
Baseline characteristics and surgical procedures

	IBD	Control group	Standardized difference
Number of individuals, *n*	500	2,500	
Age, y, mean ± SD	42.7 ± 10.3	42.9 ± 10.7	0.02
Body mass index, kg/m^2, mean ± SD	41.1 ± 5.7	41.2 ± 6.3	0.02
Sex			
Women, *n* (%)	400 (80.0%)	2,024 (81.0%)	0.03
Men, *n* (%)	100 (20.0%)	476 (19.0%)	0.03
Metabolic comorbidities			
Diabetes, *n* (%)	76 (15.2%)	369 (14.8%)	0.01
Dyslipidemia, *n* (%)	55 (11.0%)	278 (11.0%)	0
Hypertension, *n* (%)	143 (27.8%)	695 (27.8%)	0
Sleep apnea, *n* (%)	63 (12.6%)	308 (12.3%)	0.01
Ulcerative colitis, *n* (%)	306 (61.2%)	0 (0.0%)	
Crohn disease, *n* (%)	194 (38.8%)	0 (0.0%)	
Operation			
Gastric bypass, *n* (%)	241 (48.2%)	1,205 (48.2%)	0
Sleeve gastrectomy, *n* (%)	259 (51.8%)	1,295 (51.8%)	0
Surgical access			
Laparoscopic, *n* (%)	484 (96.8%)	2,419 (96.8%)	0
Open, *n* (%)	14 (2.8%)	68 (2.7%)	0.01
Converted to open, *n* (%)	2 (0.4%)	13 (0.5%)	0.01
Previous bowel surgery	41 (8.2%)	15 (0.6%)	

Baseline characteristics after propensity score matching.
IBD, inflammatory bowel disease; *SD*, standard deviation.

Ethics

The study was approved by the Swedish Ethical Review Authority (Ref: 2020-02808) and was conducted in accordance with the standards of the 1964 Helsinki Declaration and its later amendments.

Results

During the study period, 71,093 patients with a primary SG or RYGB procedure were identified. A specific diagnosis of inflammatory bowel disease was identified in 500 patients, including 194 patients diagnosed with CD and 306 patients diagnosed with UC. Some 2,226 patients had a preoperative unspecified diagnosis of small bowel inflammation and were excluded from the study. Before matching, the patients with IBD were older, had a slightly lower BMI and a larger female predominance, and had higher rates of associated comorbidities. Also, they more commonly underwent an SG procedure (Supplementary Table S1). The matching procedure generated 2 groups without significant differences in the baseline characteristics (Table I).

A total of 104 patients with IBD (20.8%) had a registered dispensed prescription of medications for their IBD within 12 months before surgery. More patients with UC received treatment the year before surgery ($n = 73$, 23.9%) than those with CD ($n = 31$, 16.0%). The most common treatment was aminosalicylic acid or salazopyrine ($n = 85$, 17.0%), followed by systemic corticosteroid treatment ($n = 34$, 6.8%), local corticosteroid treatment ($n = 27$, 5.4%), thiopurine ($n = 23$, 4.6%), tumor necrosis factor–alpha inhibitors ($n = 5$, 1.0%), methotrexate ($n = 5$, 1.0%), and other immunomodulating drugs ($n = 2$, 0.4%).

Surgical data and safety outcomes

SG ($n = 119$) was more often the treatment of choice for the patients with CD compared to RYGB ($n = 75$), whereas RYGB ($n = 166$) was slightly more common for the patients with UC compared to SG ($n = 140$). During the operation, adhesiolysis for more than 10 minutes was reported for 8 patients (3.3%) with IBD compared to 21 controls (1.7%) during RYGB and for 7 patients (2.7%) with IBD compared to 32 controls (2.5%) during SG.

No significant difference in operation time or length of hospital stay was observed for either of the study groups (Tables II and III).

Data from 30-day follow-up visits were available after RYGB for 74 patients with CD (99%) and 163 patients with UC (98%), with 365 (97%) and 812 (98%) in the corresponding control groups. Thirty-day follow-up data after SG were available for 116 patients (98%) with CD and 132 patients (94%) with UC, with 570 (96%) and 682 (97%) in the corresponding control groups. A postoperative complication was seen in 50 (10.3%) IBD patients vs 193 (7.9%) control patients (10.3%; OR 1.33, 95% CI 0.96–1.85, $P = .087$), with serious complications for 14 (3.3%) vs 58 (2.7%), respectively (OR 1.22, 95% CI 0.67–2.21, $P = .510$). Readmission was registered for 48 patients with IBD (10.0%, OR 1.58, 95% CI 1.13–2.22, $P = .008$) and 159 (7.2%) control patients).

CD

Readmission within 30 days from surgery occurred more often for the patients with CD than for the control patients ($n = 19$, 10.7% vs 54, 6.1%; OR = 1.84, 95% CI 1.02–3.31, $P = .040$). When stratified by surgical method, no difference was seen in overall complications or early postoperative readmissions, but bleeding occurred more commonly in the patients with CD after RYGB than in the matched control patients. Hospital admission from day 30 until 1 year after surgery was more common after RYGB but not after SG (Table II).

UC

Readmission within 30 days occurred in 29 patients with UC (11.1%; OR 1.46, 95% CI 0.95–2.26, $P = .085$) and 105 control patients (7.9%). A higher risk for serious postoperative complications, specifically leak/intraabdominal infection, was observed after RYGB compared to the matched control patients (Table III).

Table II
Surgical outcomes for patients with CD, stratified by surgical method

	Gastric bypass				Sleeve gastrectomy			
	CD	Control group	Effect size (95% CI), *P* value	*P* value	CD	Control group	Effect size (95% CI), *P* value	*P* value
Operation time	73.3 ± 34.7	76.4 ± 40.0	Med = −2.61 (−12.27 to 7.05)	.597	51.5 ± 24.3	50.1 ± 24.3	Med = 0.75 (−3.55 to 5.06)	.731
Length of stay	2 (1–2)	2 (1–2)	Mdd = −0.05 (−0.84 to 0.73)	.891	1 (1–2)	1 (1–2)	Mdd = 0.14 (−0.35 to 0.63)	.579
Readmission with 30 d	11 (16.4%)	30 (9.4%)	OR = 1.96 (0.88–4.41)	.102	8 (7.2%)	24 (4.3%)	OR = 1.76 (0.74–4.16)	.201
Postoperative complication	9 (12.2%)	28 (7.7%)	OR = 1.72 (0.76–3.89)	.196	8 (6.9%)	39 (6.8%)	OR = 1.09 (0.49–2.42)	.840
Leak/deep intraabdominal infection†	0 (0.0%)	5 (1.4%)	NA		1 (0.9%)	7 (1.2%)	OR = 0.63 (0.08–5.27)	.672
Bleeding†	4 (5.4%)	4 (1.1%)	OR = 5.20 (1.15–23.52)	.308*	1 (0.9%)	9 (1.6%)	OR = 0.61 (0.07–5.10)	.650
Wound complications†	2 (2.7%)	7 (1.9%)	OR = 1.50 (0.27–8.40)	.647	1 (0.9%)	10 (1.8%)	OR = 0.90 (0.09–8.60)	.925
Bowel obstruction/ stricture/ileus†	0 (0.0%)	4 (1.1%)	NA		2 (1.7%)	3 (0.5%)	OR = 4.17 (0.45–38.5)	.208
Marginal ulcer†	1 (1.4%)	0 (0.0%)	NA		0 (0.0%)	0 (0.0%)	NA	
Cardiovascular complication†	0 (0.0%)	3 (0.8%)	NA		0 (0.0%)	0 (0.0%)	NA	
Pulmonary complication†	0 (0.0%)	3 (0.8%)	NA		0 (0.0%)	2 (0.4%)	NA	
Urinary tract infection†	0 (0.0%)	0 (0.0%)	NA		0 (0.0%)	2 (0.4%)	NA	
Venous thrombosis†	0 (0.0%)	1 (0.3%)	NA		0 (0.0%)	0 (0.0%)	NA	
Pain†	1 (1.4%)	4 (1.1%)	OR = 2.13 (0.19–23.96)	.539	2 (1.7%)	2 (0.4%)	OR = 6.65 (0.49–89.49)	.153
Malnutrition/dehydration†	1 (1.4%)	1 (0.3%)	NA		1 (0.9%)	5 (0.9%)	OR = 1.36 (0.11–16.12)	.808
Other complication†	3 (4.1%)	7 (1.9%)	OR = 2.13 (0.54–8.45)	.280	2 (1.7%)	3 (0.5%)	NA	
Serious postoperative complication‡	2 (3.5%)	6 (2.3%)	OR = 1.17 (0.21–6.39)	.859	2 (1.8%)	14 (2.5%)	OR = 0.80 (0.17–3.73)	.774
Complications at 1 y								
Hospital admission	28 (37.8%)	79 (21.7%)	OR = 2.18 (1.27–3.74)	.015*	25 (23.4%)	93 (17.4%)	OR = 1.51 (0.90–2.54)	.117
Additional surgery	11 (16.2%)	29 (8.7%)	OR = 1.91 (0.88–4.19)	.103	8 (8.6%)	40 (8.6%)	OR = 0.98 (0.43–2.24)	.967
Complications	2 (2.9%)	14 (4.1%)	OR = 0.64 (0.14–2.99)	.575	3 (3.2%)	23 (4.9%)	OR = 0.67 (0.19–2.40)	.542
Postoperative weight loss at 1 y								
% excess BMI loss	84.3 ± 24.5	83.2 ± 24.9	Med = 0.97 (−5.12– to 7.06)	.755	72.1 ± 25.0	72.4 ± 30.5	Med = 0.13 (−5.71 to 5.96)	.966
% TWL	31.3 ± 8.3	31.3 ± 7.9	Med = 0.02 (−20.4 to 2.00)	.984	26.9 ± 9.4	25.7 ± 8.8	Med = 1.27 (−0.68 to 3.23)	.201
BMI loss	12.8 ± 3.9	13.1 ± 3.9	Med = −0.29 (−1.29 to 0.70)	.563	11.2 ± 4.8	10.6 ± 4.2	Med = 0.66 (−0.30 to 1.62)	.177
Postoperative weight loss at 2 y								
% excess BMI loss	89.8 ± 22.4	84.2 ± 22.1	Med = 5.38 (−1.17 to 11.93)	.107	67.9 ± 27.4	66.4 ± 32.1	Med = 0.77 (−7.66 to 9.20)	.858
% TWL	33.1 ± 8.8	32.5 ± 8.3	Med = 0.66 (−1.86 to 3.19)	.607	25.4 ± 8.8	23.8 ± 10.2	Med = 1.77 (−1.08 to 4.61)	.224
BMI loss	13.3 ± 3.9	13.7 ± 4.4	Med = 0.39 (−0.92 to 1.69)	.563	10.7 ± 4.3	9.8 ± 4.7	Med = 1.00 (−0.31 to 2.30)	.136

CD, Crohn's disease; *BMI*, body mass index; *NA*, not available; *TWL*, total weight loss; *OR*, odds ratio; *Med*, median; *Mdd*, median difference, *CI*, confidence interval.
* Adjusted using Bonferroni-Holm method.
† Each patient who suffer from a complication can have more than 1 specific complication.
‡ Analyzed for patients and control patients operated from 2010.

Weight loss

CD

For CD, information on weight was available at 1 year after surgery for 67/75 patients (89%) vs 328/366 control patients (90%) who had reached 1-year follow-up time after RYGB, with corresponding 2-year follow-up of 46/71 (65%) and 231/348 (66%), respectively.

After SG, information on weight was available for 91/109 (83%) patients who had reached the 1-year follow-up time vs 457/558 (82%) control patients, with corresponding follow-up at 2 years of 51/95 (54%) vs 299/477 (63%), respectively. No significant difference in weight loss was detected 1 or 2 years after surgery for any of the groups (Table II).

UC

For UC, information on weight was available at 1 year after surgery for 144/163 (88%) vs 731/816 (90%) control patients who had reached 1-year follow-up time after RYGB, with corresponding 2-year follow-up at 112/159 (70%) vs 537/799 (67%).

After SG, information on weight was available for 104/133 vs 552/661 control patients who had reached a 1-year follow-up time, with corresponding follow-up at 2 years of 59/113 (52%) vs 368/587 (63%), respectively. No significant difference in weight loss was detected 1 or 2 years after surgery for any of the groups (Table III).

HRQoL

Data for HRQoL are registered in the SOReg with some delay and are not registered by all surgical centers at all times. Follow-up data for HRQoL were available at 1 year for 1,457/2,441 (60%) patients and at 2 years for 933/2,244 (42%) patients after surgery.

A lower physical component score was reported at baseline for the patients with CD (MdD 2.92, 95% CI 0.90–4.92, $P = .005$) as well as the patients with UC (MdD 3.33, 95% CI 0.65–6.01, $P = .005$). After surgery, no difference was observed in either the OP score or the mental or physical components of the SF-36/RAND (Tables IV-VII).

Discussion

In this propensity score-matched cohort study, bariatric surgery for patients with inflammatory bowel disease was generally safe and effective. However, when stratified by the type of inflammatory bowel disease and surgical method, RYGB in patients with UC was associated with a higher risk for postoperative complications, including serious postoperative complications, mainly in the form of leaks. Readmission rates were higher among patients with CD. Sleeve gastrectomy was not associated with any statistically significant difference in safety and effectiveness in patients with CD or UC compared to control patients.

Table III
Surgical outcomes for patients with ulcerative colitis, stratified by surgical method

	Gastric bypass				Sleeve gastrectomy			
	UC	Control group	Effect size (95% CI), *P* value	*P* value	UC	Control group	Effect size (95% CI), *P* value	*P* value
Operation time	76.9 ± 37.7	71.7 ± 35.6	Med = 5.33 (−0.12 to 10.79)	.055	55.9 ± 31.2	51.8 ± 32.5	Med = 3.91 (−1.41 to 9.23)	.150
Length of stay	2 (1–2)	2 (1–2)	Mdd = 0.17 (−3.40 to 3.74)	.925	2 (1–2)	1 (1–2)	Mdd = 0.19 (−0.64 to 1.02)	.646
Readmission with 30 days	23 (17.0%)	75 (11.2%)	OR = 1.63 (0.96–2.79)	.072	6 (4.8%)	30 (4.5%)	OR = 1.27 (0.50–3.25)	.613
Postoperative complication	25 (15.3%)	88 (10.8%)	OR = 1.53 (0.93–2.52)	.094	8 (6.1%)	38 (5.6%)	OR = 1.15 (0.51–2.58)	.743
Leak/deep intraabdominal infection[†]	10 (6.1%)	21 (2.6%)	OR = 2.45 (1.09–5.50)	.330[*]	0 (0.0%)	7 (1.0%)	NA	
Bleeding[†]	6 (3.7%)	17 (2.1%)	OR = 1.71 (0.63–4.70)	.294	2 (1.5%)	11 (1.6%)	OR = 0.84 (0.18–4.02)	.831
Wound complications[†]	4 (2.5%)	16 (2.0%)	OR = 1.23 (0.38–3.92)	.732	1 (0.8%)	6 (0.9%)	OR = 0.89 (0.10–8.39)	.921
Bowel obstruction/ stricture/ileus[†]	4 (2.5%)	16 (2.0%)	OR = 1.56 (0.47–5.17)	.464	0 (0.0%)	2 (0.3%)	NA	
Marginal ulcer[†]	1 (0.6%)	5 (0.6%)	OR = 1.03 (0.11–9.73)	.981	0 (0.0%)	0 (0.0%)	NA	
Cardiovascular complication[†]	0 (0.0%)	2 (0.2%)	NA		0 (0.0%)	1 (0.1%)	NA	
Pulmonary complication[†]	4 (2.5%)	5 (0.6%)	OR = 6.37 (0.69–58.57)	.101	0 (0.0%)	2 (0.3%)	NA	
Urinary tract infection[†]	1 (0.6%)	3 (0.4%)	OR = 1.61 (0.11–22.17)	.719	0 (0.0%)	3 (0.4%)	NA	
Venous thrombosis[†]	0 (0.0%)	1 (0.1%)	NA		0 (0.0%)	2 (0.3%)	NA	
Pain[†]	1 (0.6%)	5 (0.6%)	OR = 1.12 (0.09–13.39)	.931	3 (2.3%)	4 (0.6%)	OR = 2.51 (0.43–14.77)	.308
Malnutrition/dehydration[†]	2 (1.2%)	5 (0.6%)	OR = 7.17 (0.57–89.79)	.126	2 (1.5%)	5 (0.7%)	OR = 4.16 (0.50–34.48)	.186
Other complication[†]	1 (0.6%)	9 (1.1%)	OR = 0.55 (0.07–4.62)	.582	1 (0.8%)	6 (0.9%)	OR = 0.82 (0.09–7.84)	.866
Serious postoperative complication[‡]	10 (8.6%)	22 (3.8%)	OR = 2.64 (1.15–6.05)	.022	0 (0.0%)	16 (2.4%)	NA	
Complications at 1 year								
Hospital admission	40 (24.8%)	187 (23.0%)	OR = 1.06 (0.71–1.58)	.774	19 (19.0%)	100 (15.6%)	OR = 1.27 (0.77–2.10)	.347
Additional surgery	18 (12.2%)	72 (9.8%)	OR = 1.31 (0.75–2.31)	.347	7 (6.6%)	50 (8.9%)	OR = 0.63 (0.27–1.46)	.283
Complications	11 (7.3%)	61 (8.1%)	OR = 0.91 (0.46–1.81)	.794	4 (3.8%)	23 (4.1%)	OR = 0.89 (0.27–2.99)	.857
Postoperative weight-loss at 1 year								
% excess BMI loss	86.9 ± 25.0	84.8 ± 25.2	Med = −0.33 (−4.64 to 3.99	.881	70.4 ± 22.8	76.2 ± 31.4	Med = −4.40 (−9.77 to 1.68)	.166
% TWL	31.9 ± 6.9	31.6 ± 7.9	Med = 0.02 (−1.34 to 1.38)	.973	26.1 ± 7.5	26.6 ± 8.8	Med = −0.18 (−2.00 to 1.64)	.846
BMI loss	13.1 ± 3.4	13.1 ± 3.8	Med = 0.18 (−0.48 to 0.83	.596	10.8 ± 3.9	10.9 ± 4.5	Med = 0.03 (−0.88 to 0.94)	.942
Postoperative weight loss at 2 years								
% excess BMI loss	82.7 ± 27.5	84.7 ± 26.7	Med = −1.75 (−7.21 to 3.70)	.529	71.6 ± 24.1	68.8 ± 28.7	Med = 2.48 (−5.12 to 10.08)	.523
% TWL	31.7 ± 9.2	31.9 ± 9.3	Med = −0.19 (−2.04 to 1.67)	.844	26.3 ± 9.2	25.6 ± 10.6	Med = 0.68 (−2.17 to 3.52)	.641
BMI loss	13.5 ± 4.6	13.2 ± 4.4	Med = 0.29 (−0.59 to 1.16)	.519	10.7 ± 4.4	10.7 ± 5.1	Med = −0.07 (−1.42 to 1.27)	.914

BMI, body mass index; *TWL*, total weight loss; *UC*, ulcerative colitis; *CI*, confidence interval; *Med*, median; *Mdd*, median difference; *OR*, odds ratio; *NA*, not available.
[*] Adjusted using Bonferroni-Holm method.
[†] Each patient with a complication can have more than one specific complication.
[‡] Analyzed for patients and control patients operated from 2010.

Table IV
Health-related quality of life for patients with CD undergoing gastric bypass

	CD		Control group		Median difference (95% CI)	*P* value[†]
	N[*]	Median (IQR)	*N*[*]	Median (IQR)		
OP score, baseline	49	75.0 (54.2–83.3)	265	70.8 (50.0–83.3)	5.02 (−1.66 to 11.70)	.141
OP, 1 y	37	8.3 (0.0–22.9)	206	8.3 (0.00–33.3)	−4.68 (−11.92 to 2.55)	.205
Op, 2 y	21	8.3 (0.0–37.5)	140	8.5 (0.00–33.3)	−0.45 (−5.80 to 6.63)	.896
SF-36/RAND						
Mental component, baseline	49	49.3 (39.1–55.7)	260	46.9 (35.2–54.8)	0.79 (−2.71 to 4.29)	.657
Mental component, 1 y	37	54.7 (42.5–56.8)	205	52.5 (45.4–56.3)	0.23 (−3.32 to 3.78)	.900
Mental component, 2 y	21	53.4 (37.5–56.9)	141	52.3 (42.9–56.1)	1.23 (−4.87 to 7.32)	.693
Physical component, baseline	49	32.4 (24.8–43.9)	259	38.1 (28.1–44.8)	−2.24 (−5.43 to 0.95)	.169
Physical component, 1 y	37	49.8 (43.3–56.5)	204	54.6 (47.3–57.1)	−1.52 (−4.10 to 3.80)	.940
Physical component, 2 y	21	46.7 (35.8–56.1)	141	54.0 (50.0–57.2)	−8.08 (−47.69 to 31.52)	.689

CD, Crohn's disease; *OP*, Obesity-related Problems scale; *SF-36/RAND*, short-form 36; *IQR*, interquartile range; *CI*, confidence interval.
[*] Number of correctly filled out evaluations.
[†] Linear quantile mixed-effects model, adjusted for smoking. Missing values in smoking were handled using multiple imputation method.

The general safety of modern bariatric surgery in patients with CD supports the results of a meta-analysis, which included 10 studies with a total of 168 patients and a more recent French study of 85 patients.[7,8] The relative safety of these procedures for patients with IBD was also reported in 2 larger database studies.[24,25] Higher complication rates have been reported for patients with UC, and Garg also reported higher complication rates with RYGB than with SG.[7] In our study, the risk for postoperative complications was increased by 53% in patients with UC who underwent RYGB, with a marked increase in the risk for serious postoperative complications equivalent to 1 additional serious postoperative complication in every 23 patients with UC, compared to the matched control patients without IBD. Although previous major abdominal surgical procedures could account for some of this risk, the high proportion

Table V
Health-related quality of life for patients with CD undergoing sleeve gastrectomy

	CD		Control group		Median difference (95% CI)	*P* value[†]
	N[*]	Median (IQR)	*N*[*]	Median (IQR)		
OP score, baseline	78	75.0 (53.2–87.5)	371	70.8 (50.0–83.3)	1.44 (−4.19 to 7.07)	.616
OP, 1 y	46	16.7 (0.0–37.5)	245	12.5 (0.00–33.3)	2.46 (−6.06 to 10.97)	.570
OP, 2 y	22	16.7 (6.2–27.1)	136	16.7 (0.00–37.5)	−8.37 (−38.02 to 21.28)	.580
SF-36/rand						
Mental component, baseline	77	46.7 (36.6–55.4)	365	46.2 (35.8–53.7)	0.69 (−2.01 to 3.39)	.616
Mental component, 1 y	46	52.6 (43.6–55.7)	237	52.3 (41.5–55.9)	−0.75 (−7.94 to 6.45)	.838
Mental component, 2 y	19	53.3 (46.0–55.5)	135	49.9 (34.3–54.7)	6.54 (−7.80 to 20.89)	.371
Physical component, baseline	77	35.2 (26.1–43.3)	364	39.4 (29.2–47.7)	−3.33 (−6.01 to −0.65)	.015
Physical component, 1 y	46	50.0 (39.8–55.3)	237	53.8 (47.2–57.0)	−2.13 (−5.77 to 1.51)	.252
Physical component, 2 y	19	49.4 (30.0–56.2)	135	52.4 (44.8–57.3)	−0.99 (−6.97 to 4.99)	.745

CD, Crohn's disease; *OP*, Obesity-related Problems scale; *SF-36/RAND*, short-form 36; *CI*, confidence interval; *IQR*, interquartile range.
[*] Number of correctly filled out evaluations.
[†] Linear quantile mixed-effects model, adjusted for smoking. Missing values in smoking were handled using multiple imputation method.

Table VI
Health-related quality of life for patients with ulcerative colitis undergoing gastric bypass

	UC		Control group		Median difference (95% CI)	*P* value[†]
	N[*]	*Median (IQR)*	*N*[*]	*Median (IQR)*		
OP score, baseline	123	70.8 (50.0–87.5)	590	70.8 (45.8–85.7)	2.61 (−2.07 to 7.28)	.275
OP, 1 y	92	10.4 (0.0–27.7)	471	12.5 (0.00–29.2)	−0.26 (−4.80 to 4.28)	.911
OP, 2 y	72	14.6 (0.0–29.2)	325	12.5 (0.00–33.3)	2.93 (−7.02 to 12.89)	.563
SF-36/rand						
Mental component, baseline	124	46.4 (34.7–52.8)	585	47.4 (35.7–54.7)	−1.07 (−3.32 to 1.18)	.351
Mental component, 1 y	90	52.8 (42.5–56.2)	463	53.4 (44.6–56.5)	−1.69 (−4.36 to 0.98)	.214
Mental component, 2 y	73	51.3 (40.7–55.6)	321	51.8 (39.2–56.0)	−0.89 (−4.34 to 2.57)	.614
Physical component, baseline	124	36.1 (29.1–43.0)	585	38.0 (29.1–46.0)	−1.67 (−3.53 to 0.19)	.078
Physical component, 1 y	90	53.8 (46.1–56.0)	461	53.4 (46.3–57.2)	−1.31 (−3.39 to 0.76)	.216
Physical component, 2 y	73	51.8 (44.9–56.3)	321	53.5 (46.4–57.1)	−1.50 (−4.43 to 1.43)	.316

OP, Obesity-related Problems scale; *SF-36/RAND*, short-form 36; *UC*, ulcerative colitis; *CI*, confidence interval; *IQR*, interquartile range.
[*] Number of correctly filled out evaluations.
[†] Linear quantile mixed-effects model, adjusted for smoking. Missing values in smoking were handled using multiple imputation method.

Table VII
Health-related quality of life for patients with ulcerative colitis undergoing sleeve gastrectomy

	UC		Control group		Median difference (95% CI)	*P* value[†]
	N[*]	Median (IQR)	*N*[*]	Median (IQR)		
OP score, baseline	97	70.8 (46.7–89.0)	450	70.8 (50.0–83.3)	0.98 (−4.80–6.77)	.740
OP, 1 y	57	16.7 (0.0–35.4)	303	12.5 (0.00–33.3)	2.21 (−4.81–9.24)	.537
OP, 2 y	23	16.7 (0.0–54.2)	194	12.5 (0.00–37.5)	13.40 (−0.50–27.29)	.059
SF-36/rand						
Mental component, baseline	95	46.8 (36.0–53.9)	448	46.7 (35.9–53.6)	0.81 (−1.92 to 3.55)	.561
Mental component, 1 y	57	52.8 (40.7–55.4)	298	52.5 (43.8–56.5)	−2.14 (−5.71 to 1.43)	.240
Mental component, 2 y	23	48.6 (27.8–54.4)	191	51.0 (40.9–55.6)	−10.74 (−32.09 to 10.61)	.324
Physical component, baseline	95	36.5 (26.7–45.3)	447	40.0 (30.3–47.1)	−2.48 (−4.74 to −0.22)	.032
Physical component, 1 y	57	52.7 (46.7–56.5)	298	52.5 (45.9–56.4)	1.08 (−1.86 to 4.02)	.472
Physical component, 2 y	23	53.1 (41.3–57.3)	191	52.5 (43.6–56.2)	−1.52 (−5.97 to 2.93)	.503

OP, Obesity-related Problems scale; *SF-36/RAND*, short-form 36; *UC*, ulcerative colitis; *IQR*, interquartile range; *CI*, confidence interval.
[*] Number of correctly filled out evaluations.
[†] Linear quantile mixed-effects model, adjusted for smoking. Missing values in smoking were handled using multiple imputation method.

of completed laparoscopic procedures in the present study suggests that other factors account for the main part of this increase in risk. Although the association with specific postoperative complications should be viewed with caution due to the high numbers of calculations, an increased risk for bleeding (in CD) and leaks (in UC) was seen, but despite the relatively high number of patients, no difference in other specific complications was seen. Generally, although these 2 complications represent 2 of the most common postoperative complications after RYGB surgery,[26] chronic inflammation and the handling of the small bowel and its associated mesentery, as well as the construction of anastomosis [27] in combination with immunosuppressive drugs, may likely contribute.[28] The relative safety of SG among patients with IBD is supported by a recent study by Corbiére et al, who did not see any increase in serious postoperative or surgical complications in a cohort that consisted mainly of patients who underwent SG.[9]

The effectiveness was similar for patients with IBD and the control patients, irrespective of the underlying IBD subtype and type of surgery. Health-related quality of life improved in all groups and across all subtypes of IBD. Patients with IBD generally reported

lower physical component scores before surgery (with statistical significance only for the SG group), but this difference largely disappeared after surgery. Higher postoperative weight loss has been associated with better postoperative HRQoL in the obesity-specific and physical domains of HRQoL.[29,30] Thus, given the similar weight-loss results in the cases and controls, similar effects on these domains were expected.

Although the RYGB appears to be slightly more effective in terms of weight-loss results among patients with IBD, the higher complication rates for patients with UC, in combination with a reported nonnegligible risk for the development of primary sclerosing cholangitis,[31,32] SG may be considered the method of choice for patients with UC. For CD without gastric engagement, the results are less clear. However, with the potential of inflammatory bowel disease involving parts of the small bowel, including a nonnegligible risk for involvement of the upper parts of the gastrointestinal tract in combination with a higher absolute number of complications, SG may be considered a better treatment option for CD, particularly for younger patients who may have a higher risk of disease progression and a need for abdominal surgery.[33,34] Although further studies are necessary to evaluate IBD-related outcomes, a higher hospital admission rate was seen among patients with CD during the first year after RYGB but not after SG.

Study limitations

Despite the strengths of this study, which included a nationwide cohort of patients with data from sources of high quality, some limitations must be acknowledged. First, the study was not adequately powered to evaluate the association between different pharmacological treatments and postoperative complications. Many of these treatments are known to influence postoperative complication rates and may thus contribute to a higher risk for postoperative complications. However, with most patients in the present study not receiving active treatment at the time of surgery, it is unlikely that this factor is the only explanation for the differences between the cases and controls. In a supplementary analysis, in which the patients were stratified by immunosuppressive treatment, similar increases in the absolute number of postoperative complications were seen among patients who received active treatment and those who did not. However, higher rates of serious complications were observed among patients with active treatment (Supplementary Table S3). Furthermore, despite the well-matched groups, the study remains an observational study, and, as such, we cannot rule out residual unbalance of factors not matched for. Therefore, the study could not evaluate causation. In addition, compared to the previously described population with IBD in Sweden, there appears to have been a selection toward patients with milder disease, suggesting that the results presented cannot be considered representative of patients with more severe disease.[35] Finally, a high proportion of patients did not report HRQoL. Although this is in line with previous reports, a previous evaluation on the same data source reported only small differences between responders and nonresponders, suggesting that there was acceptable generalizability of this outcome to the Swedish population.[36]

In this study, only bariatric surgical outcomes were evaluated. Further studies are needed to evaluate the impact on IBD-related outcomes.[7]

In conclusion, SG appears to be a safe and effective treatment for obesity in patients with IBD, whereas RYGB was associated with a higher risk for postoperative complications in patients with UC. Further studies are needed to evaluate how IBD-specific outcomes are affected by bariatric surgery.

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Conflict of interest/Disclosure

C.E. received grant support/lecture fee/advisory board from Takeda, Janssen Cliag, Pfizer, and Abbvie. DB has received fees for lectures and participation on advisory boards from Janssen, Bristol Myer Squibb, Pharmacosmos, and Sandoz regarding topics unrelated to the present study. O.O has been Principal Investigator on projects at Karolinska Institutet financed by grants from Janssen, Takeda, AbbVie, Pfizer, and Ferring and also reports grants from Pfizer, AbbVie, Galapagos, and Janssen in the context of national safety monitoring programs. None of those studies have any relation to the present study. Karolinska Institutet has also received fees for lectures and participation on advisory boards held by O.O. from Janssen, Ferring, Takeda, Bristol Myer Squibb, Galapagos, and Pfizer regarding topics not related to the present study. E.S. received lecturing fees from Johnson & Johnson Medical.

Supplementary materials

Supplementary materials associated with this article can be found in the online version, at [https://doi.org/10.1016/j.surg.2023.04.059].

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