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Risk of Esophageal and Gastric Cancer After Bariatric Surgery

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Invited Commentary

Supplemental content

IMPORTANCE Bariatric surgery has been associated with a reduced risk of cancer in individuals with obesity. The association of bariatric surgery with esophageal and gastric cancer is still controversial, however.

OBJECTIVE To compare the incidence of esophageal and gastric cancer between patients with obesity who underwent bariatric surgery and those who did not (control group).

DESIGN, SETTING, AND PARTICIPANTS This cohort study obtained data from a national discharge database, including all surgical centers, in France from January 1, 2010, to December 31, 2017. Participants included adults (aged ≥18 years) with severe obesity who underwent bariatric surgery (surgical group) or who did not (control group). Baseline characteristics were balanced between groups using nearest neighbor propensity score matching with a 1:2 ratio. The study was conducted from March 1, 2020, to June 30, 2021.

EXPOSURES Bariatric surgery (adjustable gastric banding, gastric bypass, and sleeve gastrectomy) vs no surgery.

MAIN OUTCOMES AND MEASURES The main outcome was incidence of esophageal and gastric cancer. A secondary outcome was overall in-hospital mortality.

RESULTS A total of 303 709 patients who underwent bariatric surgery (245 819 females [80.9%]; mean [SD] age, 40.2 [11.9] years) were matched 1:2 with 605 140 patients who did not receive surgery (500 929 females [82.8%]; mean [SD] age, 40.4 [12.5] years). After matching, the 2 groups of patients were comparable in terms of age, sex, and comorbidities (standardized mean difference [SD], 0.05 [0.11]), with some differences in body mass index. The mean follow-up time was 5.62 (2.20) years in the control group and 6.06 (2.31) years in the surgical group. A total of 337 patients had esophagogastric cancer: 83 in the surgical group and 254 in the control group. The incidence rates were 6.9 per 100 000 population per year for the control group and 4.9 per 100 000 population per year for the surgical group, resulting in an incidence rate ratio of 1.42 (95% CI, 1.11-1.82; $P = .005$). The hazard ratio (HR) of cancer incidence was significantly in favor of the surgical group (HR, 0.76; 95% CI, 0.59-0.98; $P = .03$). Overall mortality was significantly lower in the surgical group (HR, 0.60; 95% CI, 0.56-0.64; $P < .001$).

CONCLUSIONS AND RELEVANCE In this large, nationwide cohort of patients with severe obesity, bariatric surgery was associated with a significant reduction of esophageal and gastric cancer incidence and overall in-hospital mortality, which suggests that bariatric surgery can be performed as treatment for severe obesity without increasing the risk of esophageal and gastric cancer.

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Obesity and overweight are the most important preventable risk factors for cancer after cigarette smoking.[1] It is estimated that excess body weight is associated with 7.8% of cancer cases and 6.5% of cancer deaths.[1] In particular, excess body weight plays a role in more than 60% of uterine cancers, one-third of liver cancers, about 11% of breast cancers in women, and 5% of colorectal cancers.[1] In total, of an estimated 19.3 million new cases of cancer in 2020 worldwide, 1.5 million cases per year might be attributable to overweight and obesity.[2]

There is increasing evidence of the association of intentional weight loss with reduced risk of developing cancer, and this finding is particularly pertinent to certain cancer types such as breast cancer (after menopause) and endometrial cancer.[3] Bariatric surgery is, at present, the most effective treatment for long-term weight loss.[4,5] Several observational studies have reported that patients undergoing bariatric surgery have a lower risk of cancer than patients with obesity.[6-9]

Nevertheless, some controversy persists surrounding certain types of cancer, esophagogastric neoplasms in particular.[10] Esophageal cancer (adenocarcinoma) and gastric cancer (cardia) are associated with excess body weight, with an estimated relative risk of 4.8 and 1.8, respectively, compared with healthy weight.[11] By surgically inducing weight loss, bariatric surgery could presumably reduce some risk factors implicated in gastroesophageal tumorigenesis. However, bariatric surgery, especially sleeve gastrectomy (SG) and gastric banding, is also associated with an increase in gastroesophageal reflux disease (GERD), whose role in the genesis of gastroesophageal malignant neoplasms has been widely reported.

In the past few years, extensive research has focused on understanding the association of bariatric surgery with GERD. Specifically, SG, the most common bariatric procedure performed worldwide, has raised the greatest concerns.[12] The association of SG with GERD is rather complex and controversial.[13] Yet, there is growing evidence that 25% to 40% of patients who undergo SG develop de novo GERD.[14] It is well established that acid reflux is associated with esophageal injury, which contributes to the development of Barrett esophagus, a precancerous lesion that often precedes esophageal adenocarcinoma.[15] The overall incidence of Barrett esophagus is about 10% of cases after SG (range, 4.8%-18.8%), whereas in the general population, its prevalence is estimated to be between 1% and 2%.[15] Given that the risk of evolution of Barrett esophagus into adenocarcinoma is between 0.3% and 0.5% per year, the potential increase in esophagogastric cancer after bariatric surgery, particularly after SG, is a real concern.

Another drawback of the anatomical modifications induced by bariatric procedures is the risk of bile reflux. The association of Billroth II gastrectomy through bile reflux with an increase in esophagogastric cancer has raised concern about gastric bypass. This topic has been particularly controversial for one-anastomosis gastric bypass, but bile reflux has also been reported after Roux-en-Y gastric bypass.[16] It should be noted that most of the cancers after bypass surgery occur not in the gastric pouch but in the excluded stomach or gastric remnant, as reported by Chemaly et al.[16] Bile reflux and stagnation have been found through scintigraphy studies in the excluded stomach after Roux-en-Y gastric bypass.[17]

However, despite the increase in potential cancer risk factors, case reports are sporadic on esophageal and gastric cancer after bariatric surgery.[18] In a meta-analysis published in 2020, 31 cases of esophageal adenocarcinoma were identified, including 5 cases after SG.[19] A systematic review published in 2021 reported on 17 patients with esophageal cancer after SG.[20] Two large cohorts from North America reported rates of esophageal cancer of 0.08% in 21 people and 0.1% in 8 people at 8 years.[21,22] Moreover, a nationwide study from Sweden reported that in a population of 34 000 patients who had bariatric surgery, the incidence of esophageal cancer (n = 8) was similar to that in nonsurgical patients with obesity.[23] Data on gastric cancer are even more anecdotal, as no estimation of the incidence of this neoplasm after bariatric surgery has been reported.

Hence, little information is available on the incidence of esophagogastric cancer after bariatric surgery in large cohorts. Therefore, using a national administrative database, we performed a study on a nationwide scale comparing the incidence of esophageal and gastric cancer between patients with obesity who underwent bariatric surgery and those who did not (control group).

Key Points

Question Does bariatric surgery increase the risk of esophagogastric cancer?

Findings In this cohort study of 908 849 patients with severe obesity, bariatric surgery was associated with a significant reduction of esophageal and gastric cancer incidence compared with patients who did not undergo bariatric surgery (6.9 vs 4.9 per 100 000 population per year).

Meaning The findings of this study suggest that bariatric surgery can be performed as treatment for severe obesity without increasing the risk of esophageal and gastric cancer.

Methods

Study Design, Setting, and Data Access

Data were extracted from the Programme De Médicalisation des Systèmes d'Information (PMSI), a national discharge database in France. In the PMSI database, each patient is assigned a unique identifier, which remains unchanged over time, thus making linkage between different hospital stays in different hospitals possible. Since the identifier is anonymous, patient informed consent was not required in accordance with Méthodologies de Référence. This retrospective, observational, comparative cohort study complied with Les Méthodologies de Référence,[24] and access to the database was authorized by the National Commission on Informatics and Liberty. We followed the Reporting of Studies Conducted Using Observational Routinely-collected Health Data (RECORD) statement.[25]

The PMSI database collects all data on any hospital stay in France from any public or private health care institution. Discharge reports are mandatory and represent the basis for hospital funding; hence, these data are comprehensive and include all reimbursed surgical activity in the country. The PMSI database has undergone several quality assessments and is widely used for observational research.[26,27]

Participants

We identified all patients with severe obesity who were admitted to a health care institution between January 1, 2010, and December 31, 2017. Obesity was detected in the database through *International Statistical Classification of Diseases and Related Health Problems, Tenth Revision* (*ICD-10*) codes E66x. To identify patients who underwent bariatric surgery, we used the *Classification Commune des Actes Médicaux*, 11th edition, a national standardized classification of surgical, endoscopic, and interventional procedures.[26] For surgical procedures, we included adjustable gastric banding, SG, gastric bypass, and biliopancreatic diversion, regardless of the surgical approach (open or laparoscopic). Thus, we could divide patients with obesity into 2 groups: those who had undergone bariatric surgery (surgical group) and those who had not (control group). We excluded patients who were younger than 18 years, had a history of cancer at baseline, and had been diagnosed with cancer in the 2 years after inclusion, to avoid detection bias (ie, misdiagnosis of cancer in the control group).

According to national guidelines for bariatric surgery, esophagogastroduodenal endoscopy and *Helicobacter pylori* infection eradication are recommended in the preoperative workup for bariatric surgery candidates.[28] This could represent a differential bias with the control group that did not undergo the same explorations. Hence, to account for undiagnosed cancer at baseline, cancer events occurring during the first 2 years of the study were also excluded.

Outcomes

The main outcome was esophagogastroduodenal cancer incidence. Incident cancers were identified through *ICD-10* codes C15 and C16. A secondary outcome was in-hospital mortality, defined as any death occurring during a hospital stay regardless of the cause. We also assessed cancer incidence stratified by bariatric procedure as another secondary outcome.

Patient characteristics were retrieved from the PMSI database: age and sex were stand-alone variables, while body mass index (BMI; calculated as weight in kilograms divided by height in meters squared) and comorbidities were identified through *ICD-10* codes. The French version of the *ICD-10* stratifies the BMI into subcategories: 30 to 40 (moderate to severe obesity), higher than 40 to 50 (morbid obesity), and higher than 50 (extreme obesity). The following comorbidities were coded through the Charlson Comorbidity Index (CCI; the scoring range depends on the version of CCI used): myocardial infarction, congestive heart failure, peripheral vascular disease, cerebrovascular disease, dementia, chronic pulmonary disease, connective tissue disease, ulcer disease, mild liver disease, diabetes, hemiplegia, moderate or severe kidney disease, diabetes with end-organ damage, moderate or severe liver disease, and HIV/AIDS.[29]

Statistical Analysis

Descriptive statistics are presented as number (%) and mean (SD). We applied a 1:2 nearest neighbor propensity score–matched design, which consisted of matching 1 patient receiving bariatric surgery with 2 patients not receiving bariatric surgery based on a propensity score. The propensity score was derived using a logistic regression model using the following pretreatment variables: age, sex, BMI, time of follow-up, smoking status, alcohol-related disorders, and comorbidities according to the CCI. The balance among the covariates of patients was assessed using standardized mean difference (SMD); a difference of 0.10 or lower was considered to be a well-balanced result.[30]

The incidence rates for esophagogastric cancer were calculated using person-time analysis and compared by crude incidence rate ratios (IRRs) between the surgical group and the control group. Moreover, Kaplan-Meier estimates of cumulative incidence rates were calculated using a log-rank test to compare time to first cancer diagnosis between the surgical group and the control group. The same approach was used to compare cumulative cancer incidence among different bariatric procedures and in-hospital mortality. Patient follow-up was censored at December 31, 2019.

Cancer incidence and mortality were assessed using a multivariable Cox proportional hazards regression model (adjusted for age, sex, and comorbidities according to the CCI), providing hazard ratios (HRs) and 95% CIs. The potential confounders were evaluated through backward stepwise selection. To account for potential association between paired outcomes in matched data, sensitivity analyses were conducted using stratified and marginal Cox proportional hazards regression models.

All statistical analyses were performed with R, version 4.0.1 (R Foundation for Statistical Computing).[31] A 2-sided $P = .05$ was considered to be statistically significant. The study was conducted from March 1, 2020, to June 30, 2021.

Results

Between 2010 and 2019, 3 633 019 patients with a diagnosis of obesity were admitted to hospitals in France. Among these patients, we identified 303 709 aged 18 years or older who had undergone bariatric surgery and who had been cancer free for at least 2 years after surgery. These patients represented the surgical group (245 819 females [80.9%], 57 890 males [19.1%]; mean [SD] age, 40.2 [11.9] years) and were matched at a 1:2 ratio with 605 140 patients with obesity who had not undergone bariatric surgery (control group; 500 929 females [82.8%], 104 211 males [17.2%]; mean [SD] age, 40.4 [12.5] years).

Descriptive Data

Patient characteristics at baseline are reported in **Table 1**. After matching, the 2 groups were comparable in terms of sex, age, and CCI (SMD [SD], 0.05 [0.11]), while some differences

Table 1. Baseline Patient Characteristics

Characteristic	Patients, No. (%) Surgical group (n = 303 709)	Control group (n = 605 140)	SMD
Sex			
Female	245 819 (80.9)	500 929 (82.8)	0.048
Male	57 890 (19.1)	104 211 (17.2)	
Age, mean (SD), y	40.2 (11.9)	40.4 (12.5)	0.016
Age, y			
18-29	66 175 (21.8)	138 336 (22.9)	0.089
30-39	82 835 (27.3)	170 763 (28.2)	
40-49	81 660 (26.9)	142 604 (23.6)	
50-59	55 058 (18.1)	110 140 (18.2)	
≥60	17 981 (5.9)	43 297 (7.1)	
BMI			
30-40: Moderate to severe obesity	126 228 (41.6)	404 796 (66.9)	0.527
>40-50: Morbid obesity	152 557 (50.2)	175 201 (29.0)	
>50: Extreme obesity	24 924 (8.2)	25 143 (4.2)	
CCI, mean (SD)	0.52 (1.39)	0.45 (1.37)	0.047
CCI			
0	233 064 (76.7)	485 970 (80.3)	0.093
1-2	56 626 (18.6)	92 051 (15.2)	
3-4	9996 (3.3)	18 777 (3.1)	
>4	4023 (1.3)	8342 (1.4)	
Bariatric procedure			
Adjustable gastric banding	39 453 (13.0)	NA	NA
Biliopancreatic diversion	1157 (0.4)	NA	
Gastric bypass	84 187 (27.7)	NA	
Sleeve gastrectomy	178 912 (58.9)	NA	

Abbreviations: BMI, body mass index (calculated as weight in kilograms divided by height in meters squared); CCI, Charlson Comorbidity Index; NA, not applicable; SMD, standardized mean difference.

persisted for BMI. The surgical group had a higher prevalence of morbid obesity (BMI≥40) than the control group (58.4% vs 33.2%).

Outcome Data

In total, 337 patients had esophagogastric cancers: 83 in the surgical group and 254 in the control group. **Table 2** reports the number of cases for each cancer localization according to *ICD-10* codes. No significant difference was observed between the 2 groups for cancer localization. Gastric cancer was approximately 2-fold more common than esophageal cancer (225 vs 112), and this finding was observed in both groups.

Mean (SD) follow-up time was 5.62 (2.20) years in the control group and 6.06 (2.31) years in the surgical group, ranging from a minimum of 2 years to a maximum of 9.8 years for the surgical group and 9.9 years for the control group. The incidence rates were 6.9 per 100 000 population per year for the control group and 4.9 per 100 000 population per year for the surgical group, with an IRR of 1.42 (95% CI, 1.11-1.82; $P = .005$) (**Table 3**).

In the Kaplan-Meier survival analysis (**Figure 1**), a significant difference was found in the cumulative incidence of esophagogastric cancer among the surgical group and the control group (log-rank test: $\chi^2 = 5.7$ on 1 degree of freedom; $P = .02$). This difference was confirmed in the multivariable Cox proportional hazards regression model, as the HR for bariatric surgery was 0.76 (95% CI, 0.59-0.98; $P = .03$) (eTable 1 in Supplement 1). In sensitivity analyses, stratified and marginal Cox proportional hazards regression models provided results consistent with those of the primary analysis (HR, 0.74 [95% CI, 0.55-0.99] and 0.74 [95% CI, 0.58-0.95]) (eTable 3 in Supplement 1).

Cumulative incidences of esophagogastric cancer by bariatric procedure are displayed in **Figure 2**. Because no events were observed in the surgical group, this procedure was excluded. No statistical difference was observed between the control group and those with different bariatric surgical procedures in the Kaplan-Meier analysis (log-rank test: $\chi^2 = 6.7$ on 3 *df*; $P = .08$). Multivariable Cox proportional hazards regression model did not find significant differences between patients in the control group and those with adjustable gastric banding (HR, 0.84; 95% CI, 0.47-1.51; $P = .56$) and between those in the control group and those with SG (HR, 0.86; 95% CI, 0.63-1.18; $P = .35$). However, the model found a significant decrease in cancer incidence after gastric bypass (HR, 0.62; 95% CI, 0.40-0.95; $P = .02$) (eTable 2 in Supplement 1 for full model). In-hospital mortality was significantly lower in the surgical group than in the control group, with an overall survival

Table 2. Esophagogastric Cancers Identified in Study Population

Cancer type	*ICD-10* code	Overall, No.	Surgical group, No. (%)	Control group, No. (%)	*P* value
Esophageal cancer, total No.		112	26	86	NA
Esophagus					
Cervical part	C150	2 (1.8)	0	2 (2.3)	.42
Thoracic part	C151	4 (3.6)	1 (3.8)	3 (3.5)	
Abdominal part	C152	8 (7.1)	0	8 (9.3)	
Upper third	C153	4 (3.6)	0	4 (4.7)	
Middle third	C154	16 (14.3)	2 (7.7)	14 (16.3)	
Lower third	C155	48 (42.9)	14 (53.8)	34 (39.5)	
Overlapping lesion	C158	4 (3.6)	1 (3.8)	3 (3.5)	
Unspecified	C159	26 (23.2)	8 (30.8)	18 (20.9)	
Gastric cancer, total No.		225	57	168	
Cardia	C160	48 (21.3)	19 (33.3)	29 (17.3)	.10
Fundus of stomach	C161	20 (8.9)	4 (7.0)	16 (9.5)	
Body of stomach	C162	12 (5.3)	2 (3.5)	10 (6.0)	
Gastric antrum	C163	31 (13.8)	6 (10.5)	25 (14.9)	
Pylorus	C164	1 (0.4)	0	1 (0.6)	
Stomach					
Lesser curvature, unspecified	C165	6 (2.7)	1 (1.8)	5 (3.0)	
Greater curvature, unspecified	C166	12 (5.3)	0	12 (7.1)	
Overlapping lesion	C168	5 (2.2)	2 (3.5)	3 (1.8)	
Unspecified	C169	90 (40)	23 (40.4)	67 (39.9)	
Esophagogastric cancer, total No.	C15x-C16x	337	83	254	.18

Abbreviations: *ICD-10*, *International Statistical Classification of Diseases and Related Health Problems, Tenth Revision*; NA, not applicable.

Table 3. Incidence Rate of Esophageal and Gastric Cancer in Study Population

	Overall	Surgical group	Control group	IRR (95% CI)	*P* value
Follow-up, mean (SD), y	5.91 (2.28)	6.06 (2.31)	5.62 (2.20)	NA	NA
Time at risk, person-year	5 372 886	1 705 735	3 667 151	NA	NA
Esophageal cancer events, total No.	112	26	86		
Incidence rate, cases per 100 000 population/y	2.1	1.5	2.3	1.54 (0.99-2.38)	.05
Gastric cancer events, total No.	225	57	168		
Incidence rate, cases per 100 000 population/y	4.2	3.3	4.6	1.37 (1.01-1.85)	.04
Esophagogastric cancer events, total No.	337	83	254		
Incidence rate, cases per 100 000 population/y	6.3	4.9	6.9	1.42 (1.11-1.82)	.005

Abbreviations: IRR, incidence rate ratio; NA, not applicable.

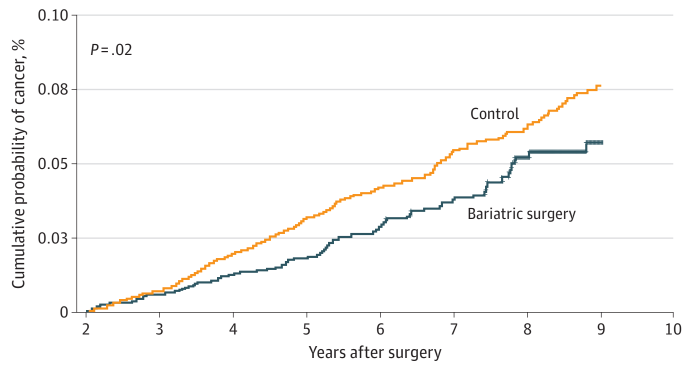
of 99.1% and 98.5%, respectively, at 9 years (log-rank test *P* = .001; HR, 0.60; 95% CI, 0.56-0.64; *P* < .001).

Discussion

This study compared the incidence of esophageal and gastric cancer in patients who underwent bariatric surgery vs nonsurgical controls on a national scale. In a cohort of almost 1 million patients with obesity, we observed a significant decrease in the incidence of esophageal and gastric cancer in the surgical group. No significant difference in this association was observed among those with different bariatric procedures (SG, gastric bypass, and adjustable gastric banding). Mortality also decreased after bariatric surgery.

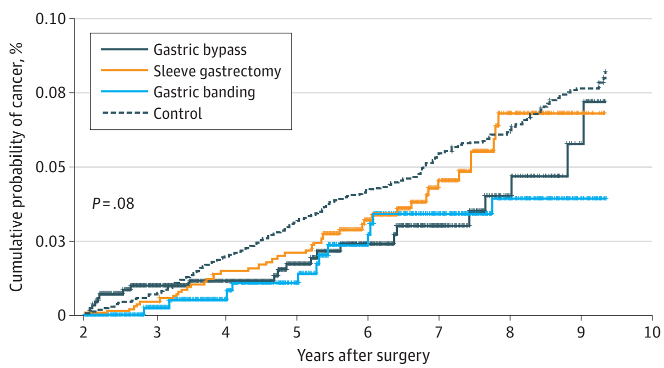
Conflicting data have been reported on the implications of bariatric surgery for the incidence of esophageal and gastric cancer.[32,33] In 2017, a nationwide register-based cohort study from Sweden reported on the incidence of esophageal adenocarcinoma in 2 groups of patients with obesity: patients who received bariatric surgery and those who did not.[23] Compared with the general population, both groups had a high risk of cancer (standardized incidence ratio, 1.6 and 1.9, respectively). The incidence of esophageal adenocarcinoma was lower in patients who had bariatric surgery than in those who did not have surgery, but the difference was not statistically significant.[23] The largest cohort to date on esophageal cancer after bariatric surgery reported 21 cases in 49 000 patients, with a mean follow-up of 5.3 years, representing an incidence of 8.1 cases per 100 000 persons per year.[21] Similarly, a cohort study

Figure 1. Cumulative Incidence of Esophagogastric Cancer by Group



No. at risk								
Control	605 140	530 527	451 518	374 256	298 378	222 953	146 612	74 705
Bariatric surgery	303 709	258 599	210 907	167 159	124 525	85 680	51 551	23 825

Figure 2. Cumulative Incidence of Esophagogastric Cancer by Bariatric Procedure



No. at risk								
Control	605 140	530 527	451 518	374 256	298 378	222 953	146 612	74 705
Gastric banding	39 453	37 847	35 495	32 633	28 365	22 982	16 098	8580
Sleeve gastrectomy	178 912	147 022	114 266	85 586	59 149	37 017	19 816	7780
Gastric bypass	84 187	72 720	60 250	48 153	36 292	25 042	15 096	7072

from Canada identified 8 cases of esophageal adenocarcinoma in a cohort of 5000 patients who underwent bariatric surgery, representing a 0.1% rate at 8 years (incidence, 21 per 100 000 population per year).[22]

Recently, an epidemiological study by Plat and colleagues[34] estimated the expected number of esophageal cancer cases in a bariatric population stratified by age and sex. Among several projections, Plat et al[34] estimated, for instance, that in a cohort of approximately 280 000 patients with bariatric surgery, 33 new cases of esophageal cancer were expected. This result is consistent with findings from the present study and previous cohorts.

A 2021 study by Leslie et al[32] used administrative insurance claims data to compare the incidence of esophageal cancer after SG and gastric bypass in approximately 16 000 patients. Leslie et al[32] reported 73 cases of esophageal cancer, after a mean follow-up of 4.1 years, representing an incidence of 102 per 100 000 population per year. This rate is between 5 and 12 times higher than that previously reported in other studies and approximately 100 times higher than the incidence in the general population.[35] For these reasons, data from this study should be interpreted with caution.

Data on gastric cancer after bariatric surgery are more scarce. A review by Scozzari et al[36] in 2013 identified 22 cases of gastric cancer in patients who underwent bariatric surgery. This study was updated by Musella et al[18] in 2019, and 10 more cases were identified in the literature. Still, none of these studies could establish the incidence of gastric cancer in bariatric surgery recipients. The estimated incidence of new cases of stomach cancer in the general population was 7.2 per 100 000 population per year.[37] We found an incidence rate of 3.3 in the bariatric surgery group and 4.6 in the control group.

Consistent with previous studies, the present study did not find any increase in esophagogastric cancer, suggesting that, on the contrary, bariatric surgery played a role in reduced esophagogastric cancer risk. These findings seem counterintuitive compared with the reports on the postoperative increase in risk factors. The reported occurrence of Barrett esophagus in up to 18.8% of patients with SG is concerning.[15] Still, it should be interpreted with caution, as all reported cases of de novo Barrett esophagus after SG were nondysplastic and had a short segment (<3 cm).[14] Moreover, the definition of Barrett esophagus is not consistent among studies. The American College of Gastroenterology recommends that only segments of salmon-colored mucosa larger than 1-cm long above the gastroesophageal junction with intestinal metaplasia can be considered to be Barrett esophagus.[38,39] Furthermore, since systematic eradication of *H pylori* infection is recommended before bariatric surgery, the decrease in the incidence of gastric cancer in the surgical group could be at least partially explained as a collateral implication of the bariatric surgery program.

Concerning the association of different bariatric procedures with the incidence of esophagogastric cancer, the present study did not find any statistical difference. No study has consistently assessed any difference in the evolution of cancer incidence as a function of the surgical procedure in patients who underwent bariatric surgery. This lack of knowledge needs to be addressed by investigations with larger cohorts. In addition, a decrease in in-hospital mortality was found in the surgical group. This is consistent with a previously published study showing a decrease in long-term mortality in patients who had bariatric surgery.[40]

Overall, we observed a decrease in the incidence of esophagogastric cancer from 6.9 to 4.9 per 100 000 population per year and an improvement in the lifetime survival rate (from 98.5% to 99.1%). It seems that the balance between protective factors (weight loss, metabolic effects, and eradication of *H pylori* infection) and risk factors (GERD and bile reflux) for cancer after bariatric surgery is in favor of protective factors.[41]

Strengths and Limitations

A strength of this study was the use of the PMSI database, which gave access to exhaustive data. In France, it is recommended that an esophagogastroduodenal endoscopy be performed systematically before bariatric surgery in addition to testing for a possible *H pylori* infection and systematic postoperative surveillance, which, to our knowledge, was not described in studies that found an increase in the rate of esophagogastric cancer. We also chose to exclude patients who had cancer within 2 years after surgery because the time frame was too short for esophageal cancer to be associated with bariatric surgery. Consistent with previously published studies,[32] the rate of esophagogastric cancer was low in patients who underwent bariatric surgery.

This study needs to be analyzed in light of several limitations. First, it was a retrospective study that used a prospective database. Second, the histological type of cancer was not reported and was directly associated with different risk factors. Third, the study population was relatively young, with a mean age of 40 years, whereas esophageal cancer is more common in the older adult population. The maximum duration of follow-up in this study was 10 years, with a mean follow-up of 6 years, which may be too short to allow for a large number of esophageal cancers to appear. Finally, the duration of follow-up is a major issue in the analysis of cancer incidence, and our results have to be considered for the time frame of the study. Still, even with a mean follow-up of approximately 6 years, it has to be noted that more than 112 000 persons had at least 9 years of follow-up, which was an unprecedented sample size in the assessment of esophagogastric cancer after bariatric surgery.

Conclusions

In this large, nationwide cohort of patients with severe obesity, bariatric surgery was associated with a significant reduction of esophageal and gastric cancer incidence and overall in-hospital mortality. The findings suggest that bariatric surgery can be performed as treatment for severe obesity without increasing the risk of esophageal and gastric cancer.

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