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Original article

Esophageal and gastric malignancies after bariatric surgery: a retrospective global study

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Abstract

Background: Bariatric surgery can influence the presentation, diagnosis, and management of gastrointestinal cancers. Esophagogastric (EG) malignancies in patients who have had a prior bariatric procedure have not been fully characterized.

Objective: To characterize EG malignancies after bariatric procedures.

Setting: University Hospital, United Kingdom.

Methods: We performed a retrospective, multicenter observational study of patients with EG malignancies after bariatric surgery to characterize this condition.

Results: This study includes 170 patients from 75 centers in 25 countries who underwent bariatric procedures between 1985 and 2020. At the time of the bariatric procedure, the mean age was 50.2 ± 10 years, and the mean weight 128.8 ± 28.9 kg. Women composed 57.3% (n = 98) of the population. Most (n = 64) patients underwent a Roux-en-Y gastric bypass (RYGB) followed by adjustable gastric band (AGB; n = 46) and sleeve gastrectomy (SG; n = 43). Time to cancer diagnosis after bariatric surgery was 9.5 ± 7.4 years, and mean weight at diagnosis was 87.4 ± 21.9 kg. The time lag was 5.9 ± 4.1 years after SG compared to 9.4 ± 7.1 years after RYGB and 10.5 ± 5.7 years after AGB. One third of patients presented with metastatic disease. The majority of tumors were adenocarcinoma (82.9%). Approximately 1 in 5 patients underwent palliative treatment from the outset. Time from diagnosis to mortality was under 1 year for most patients who died over the intervening period.

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Conclusion: The Oesophago-Gastric Malignancies After Obesity/Bariatric Surgery study presents the largest series to date of patients developing EG malignancies after bariatric surgery and attempts to characterize this condition. (Surg Obes Relat Dis 2022;18:464–472.)

Key words: Bariatric surgery; Esophagogastric cancer; Metabolic surgery; Gastric cancer; Esophageal cancer

Over 1.5 million new cases of esophagogastric (EG) cancers are diagnosed globally per year [1]. Given the anatomical proximity, both esophageal and gastric cancers share several risk factors [2]. Obesity is one such established risk factor and leads to significantly higher cancer-related mortality [3]. The most effective treatment for severe obesity and associated metabolic disorders is bariatric surgery (BS). It has been shown to lead to a reduction in the incidence of many cancers, although understanding of the underlying mechanisms remains limited [4]. EG cancers are particularly interesting as BS can influence their presentation, diagnosis, and treatment. However, the impact of BS on EG cancer has not been fully characterized.

Diagnosis of EG cancer is often delayed by insidious symptoms, but a background of BS can pose additional challenges. Anatomical rearrangement of the gastrointestinal tract in gastric bypass procedures makes it challenging to access the gastric remnant endoscopically, which may lead to delays in cancer diagnosis. Furthermore, iron deficiency anemia—a key clinical indicator of EG cancer—is not uncommon after bariatric procedures and is often treated with iron supplementation in the first instance. Indeed, routine iron supplementation is recommended after most bariatric procedures [5] and could mask cancer-related anemia. Likewise, dysphagia and reflux symptoms could be attributed to BS and delay investigation. However, no robust data currently exist in the literature to suggest that BS leads to delayed presentation of EG cancer.

These anatomical challenges may also complicate the management of EG cancer—in particular, surgery. Excision of up to 80% of the stomach in sleeve gastrectomy (SG) leaves a minimal amount of tissue remaining to prepare a safe gastric conduit after esophageal resection. Similarly, despite the stomach remaining in situ after gastric bypass, the altered small bowel anatomy, division of gastric cardia, and pouch reliance on the left gastric artery can make any further surgery technically demanding and risky. Despite the significant weight loss, BS patients may still suffer from overweight or obesity, adding further technical challenges to tumor resection. It would, therefore, be useful to understand how surgeons are coping with these challenges globally.

Some concern exists over whether bariatric procedures such as SG and one anastomosis gastric bypass (OAGB) predispose patients to EG cancer. There are now several studies citing significantly increased incidence of Barrett's esophagus after SG [6]. Moreover, the academic concern of increased risk of malignancy after OAGB due to bile reflux is a key factor limiting its adoption by the American Society of Metabolic and Bariatric Surgeons [7]. Given the known difficulties in publishing case reports, it would be useful to determine whether many cases of EG cancer after these procedures have been unreported owing to publication bias.

A limited number of case series of EG cancer after BS have been reported. A systematic review published in 2012 identified 33 cases of esophageal and gastric cancers after BS [8]. Musella et al. subsequently identified additional 40 cases published between 2012 and 2018 [8,9]. We believe this was probably a significant underrepresentation of the problem with many cases likely unpublished. Neither of these reviews attempted a detailed characterization of the presentation, management, and prognosis of these cancers, probably constrained by the quality of data in the published reports. We, therefore, conducted a global study, Oesophago-Gastric Malignancies After Obesity Surgery (OGMOS). The OGMOS study aimed to characterize esophageal and gastric malignancies after BS and understand the challenges in their diagnosis and management.

Methods

Study design

We conducted a retrospective, multicenter observational study of patients with EG cancer after BS. The OGMOS study was registered at Whittington Health NHS Trust (Reference: 2020/21-132) as an audit. The data were collected from October 2020 to February 2021. Invitations to collaborate were shared through established social media groups (WhatsApp, LinkedIn, Facebook, Twitter) of healthcare professionals working in the field of BS. Personal networks of authors were used to contact individual clinicians and centers. Study details were also distributed by email to members of the British Obesity and Metabolic Surgery Society, Association of Upper Gastrointestinal Surgery, and the International Federation for the Surgery of Obesity and Metabolic Disorders.

Patient selection

All patients with a diagnosis of a primary esophageal, EG junctional, or gastric (pouch or bypassed) malignancy following a prior bariatric procedure were included irrespective of the time lag between the bariatric procedure and the subsequent diagnosis of EG malignancy. There was no time limit to this retrospective study, and all patients who have

ever undergone a bariatric procedure in the past before developing an EG malignancy were included. Both endoscopic and surgical bariatric procedures were included. Patients with primary malignancy of other anatomical regions or secondary EG malignancy following BS were excluded.

Data submission

Collaborators were required to obtain necessary local approvals for submitting nonidentifiable patient data. Data were submitted through a password-protected database over a secure National Health Service email address. The password was shared separately. Data from all centers were pooled by a single author.

Study outcomes

Data points collected included patient demographics, bariatric procedure type, any revisional surgery performed, time of cancer diagnosis, cancer site and histological classification, management details, and mortality.

Statistical analysis

Descriptive statistics were used. Data were presented as mean ± standard deviation for normally distributed variables or median (interquartile range) for nonparametric variables. Categorical data were summarized by frequency (percentage). Statistical analysis was performed using IBM SPSS Statistics for Windows, Version 27.0 (IBM Corp, Armonk, NY) and Microsoft Excel 365 (Microsoft Corp., Redmond, WA).

Results

Seventy-five centers from 25 countries contributed data (Fig. 1) on 170 patients with EG malignancies after a bariatric procedure. The most common bariatric procedure in this cohort was Roux-en-Y gastric bypass (RYGB) (n = 64), followed by adjustable gastric band (AGB) (n = 46) and SG (n = 43). There were 2 cases of EG cancer following OAGB (n = 2). Fifteen cases of other historical or less commonly performed procedures were also identified, including 1 endoscopic gastric balloon procedure.

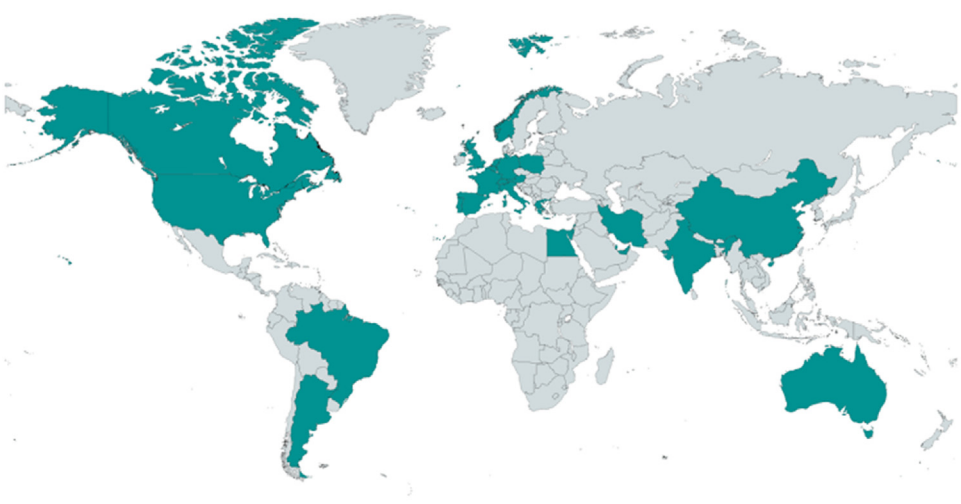
Patient demographics

Mean age at the time of BS was 50.2 ± 10.2 years, and weight was 128.8 ± 28.9 kg. Women composed 57.3% (n = 98) of the total cohort. The majority of patients (n = 147, 86.5%) were of White ethnic origin with the remaining 23 (13.5%) patients from Afro-Caribbean, Asian, Hispanic, or Middle Eastern backgrounds. At the time of the study, patients were a mean of 13.6 ± 7.8 years post–bariatric procedure. Primary procedures were performed between 1985 and 2020. Table 1 provides basic demographic details for the entire cohort and that of patients undergoing different bariatric procedures.

Risk factors

Over half of patients were current (28.2%) or ex-smokers (24.7%). Alcohol intake information was provided for 131 (77.1%) patients with 29% of these reported to be alcohol consumers (Table 1). Overall, 13.5% of patients required daily medication, and 11.8% required intermittent medication for symptomatic relief of gastroesophageal reflux disease, as highlighted in Table 2.

Preoperative esophagogastroduodenoscopy was undertaken in 46.5% of patients. Twenty-four of those who were tested were positive for Helicobacter pylori. Data on the history of Barrett's esophagus was not documented in nearly half of the cases, but of the 89 patients where



COUNTRY	NO. OF CASES
Argentina	6
Australia	11
Austria	2
Belgium	4
Brazil	7
Canada	6
China	1
Egypt	1
France	11
Germany	2
Greece	4
India	1
Iran	1
Israel	2
Italy	12
Netherlands	17
Norway	1
Poland	1
Portugal	1
Qatar	1
Spain	9
Switzerland	10
United Arab Emirates	2
United Kingdom	27
United States	30
TOTAL	170

Fig. 1. Study recruitment sites.

Table 1
Baseline characteristics

	All (n = 170)	RYGB (n = 64)	SG (n = 43)	LAGB (n = 46)	OAGB (n = 2)	Others* (n = 15)
Age, yr	50.2 ± 10.1 (n = 169)	48.5 ± 10.1	51.1 ± 10.3	52.0 ± 9.5 (n = 45)	60.0 ± 1.4	48.7 ± 10.7
Sex						
Male	72 (42.1)	23 (35.9)	19 (44.2)	22 (47.8)	2 (100.0)	6 (40.0)
Female	98 (57.3)	40 (62.5)	24 (55.8)	24 (52.2)	—	9 (19.6)
Not recorded	1 (0.6)	1 (1.6)	—	—	—	—
Ethnicity						
White	147 (86.5)	53 (82.8)	36 (83.7)	43 (93.5)	2 (100.0)	13 (86.7)
Afro-Caribbean	2 (1.2)	1 (1.6)	—	1 (2.2)	—	—
Asian	3 (1.8)	1 (1.6)	1 (2.3)	—	—	1 (6.7)
Hispanic	6 (3.5)	3 (4.7)	3 (7.0)	—	—	-
Middle Eastern	6 (3.5)	2 (3.1)	2 (4.7)	1 (2.2)	—	1 (6.7)
Not recorded	6 (3.5)	4 (6.3)	1 (2.3)	1 (2.2)	—	-
Weight at surgery, kg	128.8 ± 28.9 (n = 138)	128.4 ± 27.1 (n = 50)	126.5 ± 27.5	126.7 ± 29.8 (n = 31)	127.0 ± 24.0	142.9 ± 38.0 (n = 13)
Duration from surgery, yr	13.6 ± 7.8 (n = 168)	14.8 ± 8.3	8.6 ± 4.0 (n = 42)	14.9 ± 6.3 (n = 45)	3.0 ± 0.0	20.3 ± 9.8
Comorbidities						
Type 2 diabetes	58 (34.1)	22 (34.4)	15 (34.9)	15 (32.6)	2 (100.0)	4 (26.7)
Hypertension	75 (44.1)	24 (37.5)	19 (44.2)	22 (47.8)	2 (100.0)	8 (53.3)
OSA	36 (21.2)	16 (25.0)	11 (25.6)	5 (10.9)	2 (100.0)	2 (13.3)
Other	61 (35.9)	28 (43.8)	11 (25.6)	13 (28.3)	1 (50.0)	8 (53.3)
None/not recorded	35 (20.6)	13 (20.3)	6 (14.0)	12 (26.1)	—	4 (26.7)
Smoking status						
Smoker	48 (28.2)	24 (37.5)	13 (30.2)	8 (17.4)	1 (50.0)	2 (13.3)
Ex-smoker	42 (24.7)	13 (20.3)	11 (25.6)	17 (37.0)	—	1 (6.7)
Never smoked	70 (41.2)	25 (39.1)	18 (41.9)	16 (34.8)	1 (50.0)	10 (66.7)
Not recorded	10 (5.9)	2 (3.1)	1 (2.3)	5 (10.9)	—	2 (13.3)
Alcohol consumption						
Consumes alcohol	38 (22.4)	9 (14.0)	10 (23.3)	16 (34.8)	1 (50.0)	2 (13.3)
Does not consume alcohol	93 (54.7)	39 (60.9)	25 (58.1)	18 (39.1)	1 (50.0)	10 (66.7)
Intake not recorded	39 (22.9)	16 (25.0)	8 (18.6)	12 (26.1)	—	3 (20.0)

RYGB = Roux-en-Y gastric bypass; SG = sleeve gastrectomy; OAGB = one anastomosis gastric bypass; LAGB = laparoscopic adjustable gastric band; OSA = obstructive sleep apnea.

Data are given as n (%) or mean ± standard deviation.

* Other procedure types include Mason MacLean vertical banded gastroplasty (n = 6), biliopancreatic diversion (Scopinaro procedure; n = 2), single anastomosis duodeno–ileal bypass with SG (n = 1), duodenal switch (n = 1), banded RYGB (Fobi ring; n=1), gastric balloon (n = 1), SG with loop duodenojejunal bypass (n = 1), silicon ring vertical gastroplasty plus gastric banding (n = 1), and Salmon's technique (vertical banded gastroplasty and horizontal gastric stapling with a Roux-en-Y bypass; n = 1).

this datum was provided, 11 (12.4%) had known Barrett's esophagus.

Personal history of any other malignancies was found in 4.7% of patients and family history of EG malignancy was noted in 7.1% for first-degree relatives and 2.4% for other family members. Forty patients (23.4%) underwent revisional BS before EG cancer diagnosis with secondary procedures (Table 2).

Clinical presentation of EG malignancy

EG cancers were diagnosed at a mean of 9.5 ± 7.4 years (range 1–44 years) from BS, with diagnosis occurring between 2002 and 2021. The mean weight at the time of diagnosis was 87.4 ± 21.9 kg. The time lag was 5.9 ± 4.1 years after SG, compared to 9.4 ± 7.1 years after RYGB, 10.5 ± 5.7 years after AGB, and 2.0 ± 1.4 years after OAGB.

A total of 40 patients (23.4%) had revisional BS before developing malignancy. Of these 7, 5, and 22 patients underwent revisions after RYGB, SG, and laparoscopic adjustable gastric band (LAGB), respectively. Six patients had revisions after other procedures. The time lag from revisional surgery to developing malignancies was 6.1 ± 6.5 years in RYGB patients, 4.8 ± 3.4 years in SG patients, and 4.6 ± 5.0 years in LAGB patients. Patients underwent a variety of revisional procedures for each of these 3 primary procedures.

The location of the malignancy was almost equally distributed between the esophagus, EG junction, and stomach for RYGB and SG groups. However, for AGB and other procedures (* as in Table 2), half of the patients developed esophageal cancer.

In the patients who had RYGB (n = 64), 23.4% were in the esophagus (n = 15), 34.4% in the gastroesophageal junction (GEJ; n = 22), 12.5% in the gastric pouch (n = 8), and 29.7% in the excluded stomach (n = 19). Similarly, in the patients who had SG (n = 43), 25.6% had esophageal cancer (n = 11), 37.2% had at GEJ (n = 16), and

Table 2
Risk factors for gastroesophageal cancer

	All (n = 170)	RYGB (n = 64)	SG (n = 43)	LAGB (n = 46)	OAGB (n = 2)	Others* (n = 15)
Preoperative GORD symptoms						
No/minimal symptoms	108 (63.5)	35 (54.7)	34 (79.1)	32 (69.6)	1 (50.0)	6 (40.0)
Needs intermittent medications	20 (11.8)	9 (14.1)	3 (7.0)	3 (6.5)	1 (50.0)	4 (26.7)
Daily medications	23 (13.5)	11 (17.2)	6 (14.0)	5 (10.9)	—	1 (6.7)
Not recorded	18 (10.6)	8 (12.5)	—	6 (13.0)	—	4 (26.7)
Preoperative endoscopy ≤12 months of primary bariatric surgery						
Yes	79 (46.5)	29 (45.3)	27 (62.8)	17 (37.0)	2 (100.0)	4 (26.7)
No	62 (36.5)	23 (35.9)	15 (34.9)	17 (37.0)	—	7 (46.7)
Not recorded	29 (17.1)	12 (18.5)	1 (2.3)	12 (26.1)	—	4 (26.7)
H. pylori status						
Positive	12 (7.1)	5 (7.8)	5 (11.6)	1 (2.2)	—	1 (6.7)
Negative	49 (28.8)	19 (29.7)	15 (34.9)	13 (28.3)	1 (50.0)	1 (6.7)
Unknown	109 (64.1)	40 (62.5)	23 (53.5)	32 (69.6)	1 (50.0)	13 (86.7)
Barrett's esophagus						
Yes	11 (6.5)	7 (10.9)	2 (4.7)	2 (4.3)	—	—
No	78 (45.9)	22 (34.4)	31 (72.1)	19 (41.3)	1 (50.0)	5 (33.3)
Unknown	81 (47.6)	35 (54.7)	10 (23.3)	25 (54.3)	1 (50.0)	10 (66.7)
History of malignancy						
Yes	8 (4.7)	4 (6.3)	2 (4.7)	2 (4.3)	—	—
No	159 (93.5)	58 (90.6)	41 (95.3)	43 (93.5)	2 (100.0)	15 (100.0)
Unknown	3 (1.8)	2 (3.1)	—	1 (2.2)	—	—
Family history of gastroesophageal malignancy						
Yes (first-degree relative)	12 (7.1)	4 (6.3)	3 (7.0)	5 (10.9)	—	—
Yes (other family member)	4 (2.4)	1 (1.6)	2 (4.7)	—	—	1 (6.7)
No	148 (87.1)	56 (87.5)	37 (86.0)	39 (84.8)	2 (100.0)	14 (93.3)
Not recorded	6 (3.5)	3 (4.7)	1 (2.3)	2 (4.3)	—	—
Revisional bariatric surgery prior to gastroesophageal malignancy						
Yes	40 (23.4)	7 (10.9)	5 (11.6)	22 (47.8)	—	6 (40.0)
Revisional procedure type						
RYGB	9	1	2	5	—	1
SG	5	—	1	4	—	
OAGB	3	—	1	1	—	1
AGB	1	—	—	1	—	
Other	21	6	1	11	—	4

GORD = gastroesophageal reflux disease; RYGB = Roux-en-Y gastric bypass; SG = sleeve gastrectomy; OAGB = one anastomosis gastric bypass; LAGB = laparoscopic adjustable gastric band; OSA = obstructive sleep apnea.

Data are given as n (%) or mean ± standard deviation.

* Other procedure types include Mason MacLean vertical banded gastroplasty (n = 6), biliopancreatic diversion (Scopinaro procedure; n = 2), single anastomosis duodeno–ileal bypass with SG (n = 1), duodenal switch (n = 1), banded RYGB (Fobi ring; n = 1), gastric balloon (n = 1), SG with loop duodenojejunal bypass (n = 1), silicon ring vertical gastroplasty plus gastric banding (n = 1), and Salmon's technique (vertical banded gastroplasty and horizontal gastric stapling with a Roux-en-Y bypass; n = 1).

37.2% in the gastric sleeve (n = 16). In patients with LAGB (n = 46), 50% had esophageal cancer (n = 23), 30.4% had it at the GEJ (n = 14), and 17.4% had in the stomach (n = 8). There was no statistically significant difference between them.

The mean tumor distance from incisors was 33.8 ± 8.7 cm. Nearly 33% (n = 56) of patients presented with metastatic disease at the time of diagnosis. Of this, 43.8% (n = 28/56) had RYGB procedure. Out of 19/28 patients with malignancies in the gastric remnant after RYGB, 13 had metastasis at presentation, and 11 of them died. Table 3 provides data on these for all procedures as well as that for each category.

Histology

Histological analysis revealed that the majority of tumors were adenocarcinoma (82.9%) followed by squamous cell carcinoma (7.1%). Other tumor types included neuroendocrine tumors, lymphoma, gastrointestinal stromal tumors, and small cell carcinoma. The distribution of the histological type of tumors is as shown in Fig. 2.

Management and prognosis

Approximately 1 in 5 patients (n= 33) underwent palliative treatment from the outset. Of the remaining, 20% (n =

Table 3
Features of gastroesophageal cancer

	All (n = 170)	RYGB (n = 64)	SG (n = 43)	LAGB (n = 46)	OAGB (n = 2)	Others* (n = 15)
Time from primary bariatric surgery to gastroesophageal malignancy diagnosis, yr	9.5 ± 7.4 (n = 168)	9.4 ± 7.9	5.9 ± 4.1 (n = 42)	10.5 ± 5.7 (n = 45)	2.0 ± 1.4	17.8 ± 9.7
Anatomical region of malignancy						
Esophageal	57 (33.5)	15 (23.4)	11 (25.6)	23 (50.0)	—	8 (53.3)
Gastroesophageal junction	57 (33.5)	22 (34.4)	16 (37.2)	14 (30.4)	2 (100.0)	3 (20.0)
Gastric pouch	31 (18.2)	8 (12.5)	16 (37.2)	5 (10.9)	—	2 (13.3)
Excluded stomach/gastric remnant	24 (14.1)	19 (29.7)	—	3 (6.5)	—	2 (13.3)
Not recorded	1 (0.6)	—	—	1 (2.2)	—	—
Distance from incisors, cm	33.8 ± 8.7 (n = 86)	35.4 ± 6.8 (n = 29)	34.0 ± 10.7 (n = 18)	33.8 ± 6.6 (n = 29)	42.0 (n = 1)	27.0 ± 13.7 (n = 9)
Weight at diagnosis, kg	87.4 ± 21.9 (n = 166)	85.8 ± 20.3 (n = 63)	87.3 ± 21.6	92.4 ± 23.8 (n = 43)	85.0 ± 0.0	80.1 ± 23.8
Distant metastasis						
Yes	56 (32.9)	28 (43.8)	14 (32.6)	11 (23.9)	1 (50.0)	2 (13.3)
No	109 (64.1)	34 (53.1)	28 (65.1)	33 (71.7)	1 (50.0)	13 (86.7)
Unknown	5 (2.9)	2 (3.1)	1 (2.3)	2 (4.3)	—	—

RYGB = Roux-en-Y gastric bypass; SG = sleeve gastrectomy; OAGB = one anastomosis gastric bypass; LAGB = laparoscopic adjustable gastric band; OSA = obstructive sleep apnea.

Data are given as n (%) or mean ± standard deviation.

* Other procedure types include Mason MacLean vertical banded gastroplasty (n = 6), biliopancreatic diversion (Scopinaro procedure; n = 2), single anastomosis duodeno–ileal bypass with SG (n = 1), duodenal switch (n = 1), banded RYGB (Fobi ring; n = 1), gastric balloon (n = 1), SG with loop duodenojejunal bypass (n = 1), silicon ring vertical gastroplasty plus gastric banding (n = 1), and Salmon's technique (vertical banded gastroplasty and horizontal gastric stapling with a Roux-en-Y bypass; n = 1).

34) underwent surgical resection alone, and 22.4% (n = 38) underwent chemotherapy, radiotherapy, or a combination of both. The distribution of management modalities by procedure type is detailed in Table 4. Endoscopic resection was performed in 8.2% of patients.

All-cause mortality for the whole cohort was 45.9% during the period before data collection. Cancer-specific causes accounted for the majority of deaths and the time from diagnosis to mortality was under 1 year for most patients (Table 4).

Discussion

The OGMOS study presents the largest series to date of patients developing EG malignancies after BS. We have characterized the demographics, presentation, and management of a cohort of 170 patients compared to 73 cases with incomplete characterization reported in 2 systematic reviews on this topic [8,9].

It is hardly surprising that most of the patients in this study had undergone either RYGB (n = 64), AGB (n = 46), or SG (n = 43) as these are the 3 most common procedures performed worldwide [10,11].

However, it is not possible to provide an incidence rate for EG malignancies for each of the procedure types from this study due to its retrospective design and lack of denominator. Also, patients may present with EG cancers to a center different from that performing BS. In fact, many of the patients in this study were submitted by clinicians working in non-BS centers. Indeed, this was not even the aim of this study.

The task is further made difficult by the fact that malignancies for the most part generally take years to develop, and in the global evolution of bariatric procedures, different procedures have had a different time of development and growth curves. To determine precise incidence rates, we will need incidence numbers per year of follow-up for each procedure in a large cohort followed over long periods. In our opinion, such information can only be obtained from well-kept national/international databases or registries. Andalib et al. studied this on a relatively small cohort and failed to show higher rates of esophageal cancer after "reflux-prone" procedures such as SG or duodenal switch in comparison to RYGB at a mean follow-up of 7.6 years after adjusting for confounding variables [12].

At the same time, the mean time lag of 9.5 ± 7.4 years after the bariatric procedures in this study does give an idea regarding the time lag between the procedure and the diagnosis of EG cancer. It is also interesting that the time lag was 5.9 years after SG compared to 9.4 years after RYGB or 10.5 years after AGB. There has been some discussion regarding the need for follow-up endoscopies after certain bariatric procedures. A recent consensus statement on SG suggested that patients should undergo upper gastrointestinal endoscopy every 5 years after SG to screen for Barrett's esophagus [13]. A position statement by International Federation for the Surgery of Obesity and

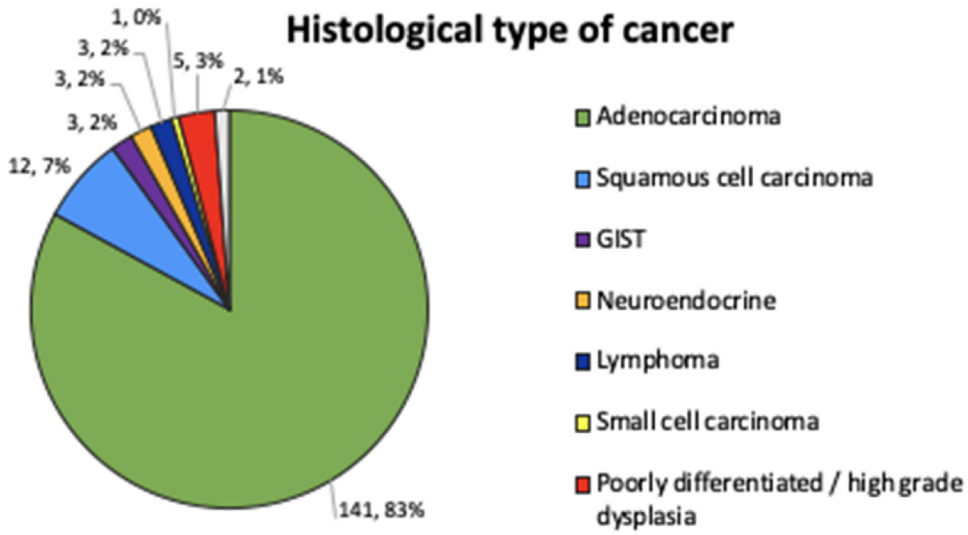


Fig. 2. Histological tumor type distribution. Data are n (%). GIST = gastrointestinal stromal tumor.

Metabolic Disorders on the other hand suggested that patients should undergo routine endoscopy at 1 year and then every 2–3 years after SG and OAGB [14]. Although our study cannot comment on the merit of surveillance endoscopy for individual procedures, it does appear that performing them every 5 years might miss many of these malignancies. There were only 2 malignancies in this study after OAGB with a mean time gap of 2.0 ± 1.4 years. Although the time interval appears shorter than other procedures, no firm conclusions can be drawn regarding the role of OAGB in these malignancies from just 2 patients. We do not know if these patients had metaplastic changes before the surgery. If, however, 2 years was sufficient time for patients to develop malignancies after this procedure, one suspects we would have seen many more malignancies in OAGB patients worldwide. However, the authors would like to caution that these data are not interpreted to quantify the risk of EG malignancy after OAGB. That would indeed need focused studies on a defined cohort over prolonged periods and is beyond the scope of this study.

Both esophageal and gastric malignancies are more common in males in the general population [1]. However, more malignancies occurred in women (57.3%) in our study, which is unsurprising considering women are much more likely to undergo BS [10]. Even more interestingly, the

Table 4
Management and mortality

	All (n = 170)	RYGB (n = 64)	SG (n = 43)	LAGB (n = 46)	OAGB (n = 2)	Others* (n = 15)
Management modality						0
Endoscopic, alone or combination	14 (8.2)	5 (7.8)	4 (9.3)	3 (6.5)	—	2 (13.3)
Surgical, alone	34 (20.0)	7 (10.9)	13 (30.2)	12 (26.1)	—	2 (13.3)
Surgical, combination	47 (27.6)	17 (26.6)	6 (14.0)	18 (39.1)	1 (50.0)	5 (33.3)
Other alone (chemotherapy, radiotherapy, combination)	38 (22.4)	18 (28.1)	10 (23.3)	6 (13.0)	1 (50.0)	3 (20.0)
Palliative	33 (19.4)	14 (21.9)	9 (20.9)	7 (15.2)	—	3 (20.0)
Not recorded	4 (2.4)	3 (4.7)	1 (2.3)	—	—	—
All-cause mortality	78 (45.9)	40 (62.5)	14 (32.6)	18 (39.1)	—	6 (40.0)
Cancer-specific mortality						
Yes	51 (65.4)	22 (55.0)	11 (78.6)	14 (77.8)	—	4 (66.7)
No	13 (16.7)	7 (17.5)	2 (14.3)	2 (11.1)	—	2 (33.3)
Not recorded	14 (17.9)	11 (27.5)	1 (7.1)	2 (11.1)	—	—
Time from diagnosis to mortality, yr	0.83 ± 0.83	0.75 ± 0.81	0.64 ± 0.74	1.17 ± 0.99	—	0.83 ± 0.41

RYGB = Roux-en-Y gastric bypass; SG = sleeve gastrectomy; OAGB = one anastomosis gastric bypass; LAGB = laparoscopic adjustable gastric band; OSA = obstructive sleep apnea.

Data are given as n (%) or mean ± standard deviation.

* Other procedure types include Mason MacLean vertical banded gastroplasty (n = 6), biliopancreatic diversion (Scopinaro procedure; n = 2), single anastomosis duodeno–ileal bypass with SG (n = 1), duodenal switch (n = 1), banded RYGB (Fobi ring; n = 1), gastric balloon (n = 1), SG with loop duodenojejunal bypass (n = 1), silicon ring vertical gastroplasty plus gastric banding (n = 1), and Salmon's technique (vertical banded gastroplasty and horizontal gastric stapling with a Roux-en-Y bypass; n = 1).

mean age of 50.2 ± 10.1 years in this study appears lower than the age group commonly associated with these cancers in the general population [15,16]. To examine an independent effect of bariatric procedures on the incidence of these cancers, we will need to examine a large national database to eliminate the effect of confounders such as obesity, smoking, alcohol use, and other risk factors.

In this context, it is important to note that some studies have reported an increase in alcohol consumption after BS [17]. In our study, alcohol consumption was not recorded in 22.9% of the patients, while 54.7% (n = 93) were reported to be nondrinkers. However, these results should be interpreted with caution because this is a multinational cohort with different lifestyles and cultures.

We found that a large number (32.9%) of the patients had distant metastases at the time of the diagnosis; 43.8% of RYGB patients had distant metastases at presentation compared to 32.6% of SG patients and 23.9% of AGB patients. The lack of endoscopic access to the bypassed stomach may lead to delayed diagnosis of gastric cancers. In our cohort, 42.9% of gastric cancers presented at an advanced stage with distant metastasis, higher than 30.8% reported from U.S. cohorts within the CONCORD-2 study [18]. It is difficult to draw firm conclusions on the prognosis of these cancers from our study. However, it does appear that these cancers are associated with a worse prognosis. BS leads to weight loss and can cause anemia especially if patients are not taking their supplements regularly. We hypothesize that these red flag symptoms could be falsely attributed to BS leading to a delay in the diagnosis. Clinicians should, therefore, have a low threshold for investigating these red flag symptoms especially if they occur after 1 or 2 years following surgery.

Strengths and limitations

This is the largest study to date of EG malignancies after bariatric procedures and attempts to characterize this important condition in terms of patient demographics, presentation, and management. The large number of centers involved from around the world indicates the global relevance of our data. However, the retrospective nature of the study, recall bias, variations in numbers submitted from different countries, and lack of a denominator means that we cannot be certain that our population is representative of the global cohort with this condition. Given the very small numbers of revisional surgeries (n = 5) after SG and the heterogeneous group these patients comprise, it is not possible to make any useful deduction regarding the role of acid reflux in the development of malignancies in these patients. We do not know whether 2 of the patients converted to RYGB were converted for Barrett's esophagus, but the other 3 who had resleeve (n = 2) or OAGB (n = 1) were probably revised for unsatisfactory weight loss. Furthermore, we cannot answer the fundamental question regarding the incidence rates of these cancers after different bariatric procedures as previously explained. The management details of the patients including their surgical details, chemo-radiotherapy, and palliative management would depend on multiple factors that are also not captured in this study. We are also uncertain why only 19.3% of patients were treated palliatively from the outset when 33% had metastatic disease at presentation. It may be because some patients had isolated metastasis that was initially deemed resectable. Despite these limitations, we believe that our study contributes significantly to the limited body of literature on this difficult topic.

Conclusion

The OGMOS study characterizes esophagogastric malignancies after obesity surgery. Among other things, we found that the mean time gap between BS and cancer diagnosis was 9.5 ± 7.4 years. Approximately 83.0% of the tumors were adenocarcinoma, and one third of the patients presented with distant metastasis. One in 5 underwent palliative treatment from the outset, and most deaths occurred within a year of diagnosis.

Disclosures

A. Dayyeh has served as a speaker for Johnson and Johnson, Endogastric Solutions, and Olympus. He is a consultant to Medtronics. R. Zakeri is funded by a Royal College of Surgeons of England Research Fellowship. The other authors report no conflicts of interest.

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Editorial comment

Comment on: Esophageal and gastric malignancies after bariatric surgery: a retrospective global study

We have read with great interest the study from Parmar et al. reporting the thus-far largest study on esophagogastric malignancies after prior obesity surgery. The authors performed a retrospective worldwide not representative survey among bariatric-metabolic and upper gastrointestinal surgeons. Collaborators were reached through