Benign, Premalignant, and Malignant Lesions Encountered in Bariatric Surgery

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ABSTRACT

Background: Obesity is associated with several comorbidities like diabetes, hypertension, hyperlipidemia, and obstructive sleep apnea. It is also well established that obese patients have an increased risk of several types of cancer like kidney, pancreas, endometrial, breast, and others. The bariatric surgeon needs to be aware of the problem of benign tumors and cancer in obese patients as well as the optimal management of these conditions that may be present at the time of evaluation for bariatric surgery, during the surgical procedure, and in the postoperative period.

Database: A PubMed search for the words "cancer" and "bariatric surgery" and subsequent review of the abstracts identified 40 articles concerning cancerous, benign, and premalignant conditions in bariatric surgery patients. Data were then extracted from full-text articles.

Conclusion: Bariatric surgery decreases cancer risk especially in women. RYGB can be an effective treatment for Barrett's esophagus. Patients having esophageal cancer should not undergo bariatric surgery, while those who develop the same postoperatively are usually managed by a combined abdominal and thoracic approach (Ivor Lewis technique). Gastric cancer of the remnant stomach is usually managed by a remnant gastrectomy. A remnant gastrectomy during RYGB would be necessary in conditions that require endoscopic surveillance of the stomach like gastric polyps, intestinal metaplasia, and carcinoid tumors. Sleeve gastrectomy is an excellent option in a patient with GIST or a carcinoid who needs a bariatric operation. Preoperative endoscopy usually does not detect malignant conditions. Postoperative evaluation of the bypassed stomach is possible using various percutaneous and novel endoscopic techniques.

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INTRODUCTION

The epidemic of obesity has rapidly grown over the past decade, though recent data indicate that the prevalence of obesity has stabilized. Over one-third of the population is obese and over two-thirds are either obese or overweight.[1] Obesity is one of the important causes of cancer along with smoking. Obese persons may present with benign tumors, premalignant conditions, and malignant conditions before, during, as well as, after a bariatric procedure and the bariatric surgeon should be aware of the management of such conditions.

We would like to present available data on the gastrointestinal as well as other malignancies and premalignant/benign conditions commonly encountered in the bariatric patient. We present the incidence of these conditions in obese/bariatric surgery patients and the optimal diagnostic methods. Due to the rarity of these cancers and benign conditions in bariatric patients, the available evidence on these conditions is scarce and does not allow one to establish proper guidelines for the management of these conditions. Nevertheless, the data presented here should shed some light on the deviation from the normal line of management that is needed when these conditions are encountered in bariatric patients. Though such knowledge is important for any surgeon, the occurrence of these conditions more commonly in the bariatric population and challenges provided by the altered anatomy due to surgery necessitate a review of these conditions for the sake of bariatric surgeons.

Cancer in general is not an absolute contraindication for bariatric surgery. The exceptions include patients who have such a short life expectancy as to not benefit from the bariatric surgery and a patient diagnosed with esophageal cancer. The major issue in a postgastric bypass patient is the difficulty of access to the bypassed stomach if a pathological condition is suspected after surgery. Hence, several surgeons have altered the surgical technique in the presence of these tumors or premalignant

conditions. The second issue is whether routine preoperative endoscopy has any role in changing the management of these patients. The management of most cancers is also not affected by the bariatric procedure in a postbariatric patient.

METHODS

A PubMed search for the phrase "cancer and "bariatric surgery" was performed without limitation on the year of publication. Studies (40 in number, **Table 1**[3–5,19–21,23–26,28,29,31–42,46–48,52,56,58–60,63,71–73,76,77,81] describing the occurrence and management of various cancers, benign and premalignant conditions, in patients undergoing bariatric surgery were retrieved. These reports accounted for a total of 570 patients. While most were uncontrolled case series and case reports, 3 controlled studies were retrieved. Full texts were reviewed to extract information about the incidence, diagnosis, and management of these conditions in bariatric patients. In addition, a PubMed search for the phrase "endoscopy and bariatric surgery" was made to retrieve original articles dealing with the utility of preoperative endoscopy in bariatric surgery patients, and the incidence of cancer, benign and premalignant conditions, in these patients were extracted from these articles.

Effect of Bariatric Surgery on Cancer Risk Reduction

As mentioned below, obesity has been definitively shown to increase the risk of several cancers and premalignant conditions. The risk of cancer in obesity has been dealt in other reviews.[2]

In the study by Adams et al.[3] it was found that the risk of cancer was reduced by 24% in gastric bypass patients, when compared to obese controls, though this difference was apparent only in women. No decrease was seen in nonobesity related cancers. They reported that to prevent one cancer 71 gastric bypasses would need to be performed. Nevertheless, the risk of no individual cancer was found to be reduced except that of cancer of the uterus and vulva.[3] In the study by Christou et al.[4] it was found that the relative risk of cancer in bariatric surgery patients compared to morbidly obese patients was 0.22. However, this reduced risk was statistically significant for breast cancer and trending for colorectal cancer, and their study was not powered to detect differences in the incidences of all types of cancers.[4] In the study by Sjöstörm et al.[5] bariatric surgery produced an overall decrease in cancer incidence (hazard ratio of 0.67), though this decrease was not found in men. The hazard ratio was unchanged after

excluding cancers presenting during the first 3 y after surgery. In addition, degree of weight change could not be related to treatment effect.[5] In summary, bariatric surgery reduces overall risk of cancer, and this benefit occurs only in women. The risk reduction for individual types of cancers should be determined in future studies with larger sample size.

Barrett's Esophagus

Obesity is associated with an increased incidence of Barrett's esophagus.[6] A BMI $\geq$30 has been found to increase the odds of having Barrett's esophagus by 1.35 times.[7] However, whether the link between excess body weight and Barrett's esophagus is confounded by the presence of GERD is uncertain.[8,9] Currently, there is no evidence that BMI has an influence on the progression to dysplasia.[10] Surter et al.[11] reported an incidence of 1.2% for Barrett's esophagus in morbidly obese patients undergoing endoscopy for reflux symptoms.[11] During routine endoscopy of morbidly obese patients for bariatric surgery, the incidence of Barrett's esophagus has been reported in the range of 1.2% to 3.7%.[12–15] However, in more than 1000 patients referred for gastric banding, no cases of Barrett's esophagus were found on routine endoscopy by Masci et al.[16] though esophagitis and hiatal hernia were found in about 8% and 12% of the cases respectively.[16] After excluding patients who reported GERD symptoms and those who were on therapy for GERD symptoms, women undergoing routine upper endoscopy before bariatric surgery were found to have Barrett's esophagus in 8% of the cases. All patients had short segment BE.[17]

Definitive diagnosis of Barrett's esophagus generally needs a multiple quadrant biopsy at 1-cm intervals. There may be inaccurate recognition of Barrett's in about 9% of cases by endoscopy alone.[18] If the intestinal metaplasia extends more than 2cm to 3cm above the gastroesophageal junction, it is termed long segment Barrett's esophagus; metaplasia extending only 2cm to 3cm above the GE junction is termed short segment Barrett's.

Houghton et al.[19] performed a retrospective review of patients with biopsy proven long segment Barrett's esophagus followed up for more than a year after RYGB. They found that the length of Barrett's was reduced in 4/5 patients and Barrett's disappeared in 2/5 patients after RYGB. Low-grade dysplasia resolved in 1 out of 2 patients who had this preoperatively; degree of dysplasia improved in all 3 who had the same preoperatively.[19]

Table 1.
Studies Included in the Review

Study	Year	Patients with Neoplasia	Learning Points/Findings
Adams [3]	2009	254	Reduced cancer incidence and reduced mortality due to cancer in patients after gastric bypass
Christou [4]	2008	21	Reduced physician/hospital visits for common cancers after bariatric surgery
Sjöström [5]	2009	117	Reduced incidence of first time cancers in women but not in men
Houghton [19]	2008	5	Complete or partial regression of Barrett's in 4/5 patients
Chang [20]	2009	2	Macroscopic resolution of Barrett's after RYGB and gastric band
Balsiger [21]	2000	25	Conversion of VBG to RYGB causes resolution of reflux symptoms and no progression of Barrett's to dysplasia
Melstrom [23]	2008	3	Reported Ivor Lewis technique for esophageal adenocarcinoma and feasibility of transhiatal technique for high grade dysplasia in a patients post RYGB. No recurrence in the patient with dysplasia. Follow-up for the operated cancer pt. not reported.
Kuruba [24]	2009	1	Reported Ivor Lewis technique for esophageal adenocarcinoma. Developed brain mets 1 yr later
Korswagen [25]	2009	1	Symptoms of esophageal cancer can mimic symptoms considered 'normal' in Band patients and high index of suspicion is necessary to detect early stage cancer
Stauffer [26]	2011	1	Symptoms of esophageal cancer can mimic symptoms considered 'normal' in Band patients and high index of suspicion is necessary to detect early stage cancer
Seva-Pereira [28]	2006	1	Early gastric cancer detected pre-operatively. Open subtotal gastrectomy, D2 lymphadenectomy and Roux-en-Y gastric bypass performed. No recurrence and normal weight loss at 6 months
Raijman [29]	1991	1	Remnant cancer treated by distal gastrectomy - patient died of progressive disease 3 years later
Lord [31]	1997	1	Remnant gastrectomy for gastric remnant cancer, patient was well after 3 months
Khitin [32]	2003	1	Resection of distal part of remnant stomach. Long term follow-up not mentioned
Watkins [33]	2007	1	Remnant gastrectomy for gastric remnant cancer, developed extensive metastasis after 1.5 yrs and finally succumbed
Corsini [34]	2006	1	Patient with intestinal metaplasia pre-operatively develops remnant cancer after RYGB. Gastroenterostomy done for palliation
Trincado [35]	2005	1	Pouch cancer after RYGB - Transhiatal esophagopouchectomy performed. No recurrence after 12 months
Babor [36]	2006	1	Pouch cancer in RYGB- total gastrectomy and esophago- jejunostomy performed. No follow-up reported
Chebib [37]	2007	1	Pouch cancer in VBG- total gastrectomy and esophago- jejunostomy performed. No recurrence after 1 yr follow-up
Jain [38]	2003	1	Pouch cancer in VBG-total gastrectomy with esophago-jejunostomy performed. No recurrence after 6 months of follow-up
Papakonstantinou [39]	2002	1	Gastric cancer in VBG - patient required Whipple procedure. Patient expired after 6 months inspite of chemotherapy

Table 1. (continued)
Studies Included in the Review

Study	Year	Patients with Neoplasia	Learning Points/Findings
Sweet [40]	1997	1	Linitis plastica after VBG - total gastrectomy. No follow-up reported
Zirak [41]	2002	1	Pouch cancer after silastic VBG - total gastrectomy performed. No recurrence after 1 year
Sanchez [42]	2005	4	All GIST removed by wedge resection during bariatric surgery. No long term follow-up reported.
Beltran [46]	2010	1	GIST removed during laparoscopic sleeve gastrectomy. No followup reported
Wang [47]	2009	2	GIST removed during laparoscopic sleeve gastrectomy. No recurrence after 1 yr
De Roover [48]	2006	2	Malignant GIST after VBG treated with total gastrectomy. Distal recurrence detected after 3 yrs
Sohn [52]	2008	11	Remnant stomachs analysed - chronic or active gastritis in 66, fundic gland polyps in 7, intestinal metaplasia in 3, gastric ulcers in 2, gastropathy in 2, lymphoid aggregate in 1, diverticulum in 1, a developmental cyst in 1, and leiomyoma in 1.
Crea [59]	2011	7	1.5% incidence of appedicial carcinoids, with 0.6% discovered post-operatively by histopathology. Routine appendectomy or careful inspection of the appendix during surgery was advised. No tumor recurrence after a mean followup of 64 months
Keshishian [56]	2002	3	3 small bowel carconoids, 1 with abdominal metastasis in which the bariatric surgery was postponed. The patient remaiend asymtopmatic 1 yr after RYGB. Patients in whom RYGB was performed with removal of the small bowel carcinoid remained asymptomatic for>8 months
Perryman [81]	2011	1	Sleeve gastrectomy can be used to include the site of the carcinoid. Normalization of chromogranin A and gastrin levels 2 months after surgery
Greenbaum [58]	2005	31	400 patients underwent abdominal exploration during bariatric surgery, 25 pathology were related to the ovary, only 3 findings which would change prognosis
Lopez-Tomassetti Fernandez [60]	2007	1	Carcinoid syndrome may be confused with malabsorptive syndrome
Gagne [70]	2009	58	3.7% incidence of malignancy in their series with 36 present before surgery, 4 detected during pre-op evaluation, 2 suspected during surgery and 16 detected after surgery. Bariatric surgery in general is not contraindicated in the presence of cancer. Treatment of post operative malignancies is not affected by bariatric surgery
Helman [63]	2011	1	Remnant gastrectomy with RYGB done after diagnosis of gastric MALToma. No recurrence after 2 months follow-up
Bardaro [71]	2006	1	RYGB combined with supragastric left adrenalectomy reported. Pt asymptomatic at 6 months follow-up with weight loss as expected
Datta [72]	2010	1	Laparoscopic left adrenalectomy is feasible in antecolic RYGB. Post-operative dexamethasone supression test was normal
Varela [73]	2009	1	Retroperitoneal laparoscopic adrenalectomy in a morbidly obese patient. Asymptomatic with normal BP till 8 mo followup

Table 1. (continued)
Studies Included in the Review

Study	Year	Patients with Neoplasia	Learning Points/Findings
Szymanski [76]	2011	1	Left hepatectomy feasible in a gastric band patient, weight loss with bariatric surgery to decrease steatosis before hepatecotomy should be considered for benign liver tumors
Cáceres [77]	2009	1	RYGB in the presence of a left lobe liver tumor was not possible, liver resection and bariatric surgery was then performed as a single stage procedure
Total Number of Patients		**570**	

Macroscopic resolution of Barrett's esophagus has also been reported after LAGB in a case report (though biopsy revealed rare cells of intestinal metaplasia).[20]

Vertical banded gastroplasty (VBG) is a procedure of the past and is no longer performed, though the bariatric surgeons of today will see patients who underwent a VBG in the past. VBG has been shown to have a very high incidence of gastroesophageal reflux and Barrett's esophagus postoperatively. Of the 24 patients undergoing revisional surgery (VBG to RYGB), esophagitis was found in 58% and Barrett's esophagus was found in 28% of the VBG patients. All patients except one had resolution of reflux symptoms after conversion to RYGB. There was no progression of Barrett's esophagus to dysplasia.[21]

Though RYGB seems to be helpful in the treatment of Barrett's esophagus, well-designed larger studies are needed to confirm this. It is not known whether RYGB or fundoplication would be the preferable operation in such patients.

Esophageal Carcinoma

The link between esophageal adenocarcinoma and obesity has been well established,[22] while there is no increased risk of squamous cell cancer with obesity. Obesity has been shown to increase the odds of esophageal adenocarcinoma by 2.4 in males and 2.1 in females.[22] Obesity was found to further increase the risk of esophageal adenocarcinoma in patients with GERD.[2]

The diagnosis of esophageal adenocarcinoma is a contraindication for bariatric surgery, and esophagectomy should be performed instead. The surgical management of a post-RYGB patient with gastroesophageal junction cancer has been described below.

Even though transhiatal esophagectomy has been performed in a patient with high-grade dysplasia in a Barrett's esophagus,[23] the same has not been reported in post-RYGB patients with esophageal cancer. All cases have reported an abdominal approach to mobilize the pouch followed by right posterolateral thoracotomy to mobilize the esophagus. Via the abdominal approach, the left gastric and short gastric arteries are ligated as they form the blood supply for the gastric pouch. The right gastric and right gastroepiploic arteries are preserved, because they form a major blood supply for the gastric remnant that can be used as a conduit. The Roux limb is cut distal to the pouch with a linear stapler. The Roux-en-Y formation is taken down by anastomosing the distal end of the biliopancreatic limb to the proximal end of the Roux limb. A hand-sewn side-to-side jejunojejunostomy is performed when the biliopancreatic limb was too narrow to permit a stapled anastomosis.[24] The gastric remnant is mobilized and tacked to the hiatus before the abdomen is closed. A right posterolateral thoracotomy is then performed and the esophagus is resected with linear staplers at the level of the azygos vein. Reconstruction is performed by pull up of the gastric remnant with or without jejunal free tissue transfer. Intraoperative frozen section can be used to confirm tumor-free margins. Colonic interposition has not been reported in an RYGB patient. One patient was diagnosed with metastatic cancer,[24] but the follow-up in the other patient was not reported.[23]

Gastrointestinal symptoms are common after bariatric surgery and diagnosis of esophageal cancer may be delayed when such symptoms are not promptly investigated with an upper GI endoscopy.[25,26] There is a report of a patient who developed esophageal adenocarcinoma shortly after placement of a gastric band (2 mo). This further highlights the need for thorough preoperative evaluation of a patient, because the cancer could have been present before surgery.[23]

Gastric Cancer

The risk of gastric cancer has been shown to be increased with obesity in a metaanalysis, though subset analysis did not reveal any increased risk for noncardia cancers in obese patients.[27]

Gastric Cancer Detected Before Bariatric Surgery

There is a case report where early gastric cancer was diagnosed preoperatively by endoscopy. It presented as an ulcer at the incisura angularis, and further evaluation revealed no metastatic disease. A high subtotal gastrectomy (and D2 lymphadenectomy) with RYGB was performed on an oncological basis.[28] The surgical specimen revealed a type IIc early gastric cancer with none of the removed lymph nodes were cancerous. Follow-up for 6 mo revealed no recurrence, and weight loss occurred as expected.

Gastric Remnant Cancer after RYGB

The dilemma facing bariatric surgeons in areas with a higher incidence of gastric cancer is the difficulty involved in evaluating the bypassed stomach if pathology such as cancer is suspected. Hence, these surgeons prefer to perform routine endoscopy to rule out cancer preoperatively, though most published series so far have been unable to detect an incidence of gastric cancer in such routinely performed endoscopic evaluations.

There are 5 case reports of gastric remnant cancer after RYGB, which presented after variable time intervals after RYGB (ranging from 1 to 22 y). Some studies have reported a total gastrectomy and Roux-en-Y esophagojejunostomy as the treatment, whereas in most a resection of only the remnant stomach was performed, leaving the gastric pouch intact.[29–33] This is in line with the current belief that total gastrectomy for gastric cancer offers not survival benefit unless required for an R0 resection. It is important to remove the lymph nodes en bloc along with the specimen. In nonresectable cases, some procedure to drain the remnant stomach is needed if there is a distal obstruction due to the cancer (like a gastrotomy or gastrojejunostomy).[34] Postoperative chemotherapy or radiotherapy can be considered. All cases for which follow-up was reported died due to progressive disease 1.5 y to 3 y later, and hence the extent of surgery in these cases needs to be further investigated.

Cancer of the Gastric Pouch after RYGB

Unlike a cancer of the gastric remnant, cancer in a gastric pouch can be easily detected during an endoscopy. A transhiatal esophago-pouchectomy was performed in one case.[35] An en bloc resection of the tumor and the structures invaded by the tumor, along with an esophagojejunostomy was done in another case where cancer was in the distal aspect of the pouch.[36] We have performed a totally laparoscopic resection of gastric pouch cancer, with removal of a part of a gastric remnant, followed by esophagojejunostomy (http://www.sages.org/video/details.php?id=102476). The first patient[35] had a disease-free survival for 12 mo.

Gastric Cancer after VBG

A few case reports of cancer after VBG have been reported.[37–41] Three cases presented in the pouch, one presented in the distal stomach, and one presented as linitis plastica. In most cases, a total gastrectomy with lymphadenectomy was performed. In one case of gastric cancer in the pylorus infiltrating into the head of pancreas, a Whipple's procedure was performed.[39] Most patients did not have a recurrence for 6 mo to 12 mo.

Surprisingly, no cases of gastric cancer after gastric banding were found in our PubMed search. There have been no reports of cancer after biliopancreatic diversion and sleeve gastrectomy, perhaps due to the relatively smaller number of these procedures performed so far.

Gastrointestinal anatomy is altered by bariatric surgery. Whether the currently performed procedures are sufficient for gastric cancer arising after bariatric surgery is difficult to ascertain due to the lack of long-term follow-up.

Gastrointestinal Stromal Tumor (GIST)

The importance of these tumors for the bariatric surgeon lies in the fact that they are incidentally encountered during a laparoscopic bariatric operation. The incidence of GIST has been suspected to be more in obese patients undergoing bariatric surgery (0.8%) compared to the general population (0.0006 to 0.0015%).[42] They are more likely to be encountered in the older age group (>60 yrs) and have an equal sex distribution.[43,44]

GISTs are likely to be asymptomatic. GISTs are exophytic tumors hence are not usually discovered during an endoscopy. They are also unlikely to be discovered during an ultrasonographic examination (although they can be[13]). Because they are unlikely to be detected during preoperative evaluation, the surgeon must inspect the stomach during laparoscopy for such tumors. For gastric GISTs, most are located in the fundus and cardia, which is in

accordance with the distribution of interstitial cells of Cajal.[45] When a GIST is suspected during a bariatric procedure, a frozen section may be performed to confirm the diagnosis and rule out gastric cancer. If a sleeve gastrectomy is being done, the tumor can be resected along with the specimen if possible, and sleeve gastrectomy is being increasingly recognized as a concomitant treatment option for obesity and GIST.[46,47] In any case, the treatment of choice for GIST is R0 resection (indicating clear margins). Of these tumors, 95% are CD117 positive. The follow-up data are presented in Table 1. GIST has also been reported to present as an outlet obstruction in a VBG pouch,[48] and the patient was treated with total gastrectomy. The surgical specimen revealed a high-risk tumor, and systemic recurrence was detected after 3 y. The follow-up after resection should be based on standard guidelines in the general population, which is a CT scan every 3 mo to 6 mo for 5 y and yearly after that.[48,49] Imatinib should be added if systemic spread is detected.

Intestinal Metaplasia (IM)

Intestinal metaplasia of the stomach is a premalignant condition that can predispose to gastric adenocarcinoma. However, the risk of gastric adenocarcinoma is believed to be much less than the risk of esophageal adenocarcinoma in Barrett's metaplasia. The sequence of progression to cancer occurs in the following way: atrophic gastritis, intestinal metaplasia, dysplasia, intestinal type of gastric cancer. The complete subtype that resembles small bowel mucosa is believed to have a better prognosis compared to the incomplete subtype that resembles colonic mucosa.

The cause of intestinal metaplasia of the cardia is less well established; both gastroesophageal reflux and *H. pylori* are believed to play a role. Distal IM occurs more in high-risk groups that are also at high risk for gastric cancer like Asians, native Americans, and African Americans.[50] The risk factors for the latter include *H. pylori* infection, smoking, and alcohol amongst others.[51] *H. pylori* when found in the presence of IM should be eradicated.

Sohn et al.[52] who examined the distal part of the stomach that was resected routinely during RYGB, found that intestinal metaplasia was present in about 0.7% of the stomachs. De Moura et al.[53] who performed gastric biopsy during endoscopy in 36 patients as demanded by endoscopic findings in a series of 162 patients, found that intestinal metaplasia was present in about 11% of the patients who had a biopsy. Azagury et al.[54] who reviewed 109 asymptomatic patients who had endoscopic biopsies

before bariatric surgery found that intestinal metaplasia constituted about 9% of the lesions found on biopsy.

The management of IM in a bariatric surgery candidate would depend on the risk of progression of IM to gastric cancer. This risk assessment would be important in the case of RYGB due to the difficulty of endoscopic access to the remnant stomach. In the presence of extensive distal IM that is of the incomplete type, it is wise to perform a high subtotal gastrectomy with RYGB,[55] as these lesions require regular endoscopic follow-up owing to their high risk of progression to gastric cancer.

Carcinoid Tumors

These are a type of neuroendocrine tumor; only 4% of such tumors are present in the stomach. They account for 1% of gastric tumors. Carcinoids of the stomach are rarely detected during preoperative endoscopic screening; although most series did not report carcinoids during preoperative endoscopy, one series reported an incidence of 0.6% (duodenal carcinoid)[13] and another reported a 0.3% incidence of gastric carcinoid.[15] Keshishian et al.[56] reported a 1.5% incidence of small bowel carcinoids. Sohn et al.[52] found no pathological evidence of carcinoids on examination of 427 stomach remnants, which were routinely resected during RYGB.

Serum chromogranin A levels can aid in diagnosis. The treatment for a gastric carcinoid depends on the type of lesion. Solitary small tumors (especially type 1 and 2) can be managed by endoscopic resection. Antral resection can be used to control gastrin secretion.

RYGB again presents with the difficulty in endoscopic examination of the remnant stomach. Hence, it would be wise to consider a high subtotal gastrectomy, especially in cases of numerous carcinoids (>5) and type 3 carcinoids.[57] Sleeve gastrectomy can be utilized to completely include the site of the carcinoid in the gastric specimen.

Appendicial carcinoids were found incidentally in 1/400 (0.25%) cases in an American series of patients undergoing gastric bypass[58] and 7/477 cases (1.4%) in patients who underwent routine appendectomy during BPD in an Italian series. In 3 cases of the latter series, the tumor was diagnosed intraoperatively. All were <2cm and no serosal or mesoappendicial involvement was identified, which was also confirmed later from the histological diagnosis. In 2 other cases not identified intraoperatively, the carcinoids were <2cm without lymph node metastasis, whereas in one case a carcinoid was found at the base of the appendix with lymph node metastasis, which required

a right hemicolectomy 1 mo later. Young age, female sex, higher BMI, and the presence of type 2 diabetes mellitus were found to be independent predictors of carcinoid tumor of the appendix.[59] Small bowel carcinoids were resected with adequate margins when found during the bariatric procedure. They also searched for abdominal metastasis and abandoned the bariatric procedure if they were found.[56]

Carcinoid syndrome develops only with liver metastasis but can be confused with dumping syndrome associated with malabsorptive procedures.[60]

Gastric Polyps

Gastric polyps are of various types: fundic, hyperplastic, adenomatous, hamartomatous, and inflammatory fibroid polyps. Only the adenomatous type is a purely premalignant condition, although hyperplastic polyps and hamartomatous polyps are associated with some, but a low risk of gastric cancer. The risk of cancer in fundic and fibroid polyps is very low.

Gastric polyps have been diagnosed at a rate of 0.7% to 5% in various studies. Most studies have failed to mention the type of gastric polyps encountered, although one study mentioned all polyps that were discovered as hyperplastic polyps.[61]

Any polyps found during preoperative endoscopy should be biopsied to rule out cancer and to determine the type of polyp. The difficulty of endoscopic surveillance of the bypassed stomach in the case of adenomatous polyps, hyperplastic polyps and Puetz Jegher's polyps would again necessitate a remnant gastrectomy during RYGB.[13,62]

Gastric Lymphoma

There is a single case report of a patient being diagnosed with gastric MALToma before bariatric surgery. The patient underwent subtotal gastrectomy with Roux-en-Y reconstruction. Gastric MALTomas are usually treated by medical therapy for *H. pylori* eradication or by monoclonal antibody therapy, and in the former instance can be an indication for resection of remnant stomach during a RYGB.[63] A thorough evaluation for systemic disease is essential with abdominal and chest CT scans and bone marrow biopsy. Lymphoma of the gastric remnant presenting with chronic gastrointestinal bleeding has been described[48] and was treated with a distal gastrectomy followed by chemotherapy. Ten-month follow-up revealed clinical and radiologic remission.

The Value of Endoscopy Before Bariatric Surgery in Preventing Morbidity Due to Cancer in Bariatric Surgery Patients

The American Society for Gastrointestinal Endoscopy recommends that preoperative endoscopy may be considered in all patients with or without symptoms, although the level of evidence for screening only the symptomatic patients is higher. The Society also recommends routine screening for *H. pylori* and treatment if positive.[64]

The incidence of Barrett's esophagus in various studies of patients undergoing routine endoscopy before a bariatric procedure has ranged from 0.19% to 3.7%, with a cumulative incidence of 0.93%. Gastric or duodenal polyps have been found to vary in incidence from 0.7% to 5%. A 0.6% incidence of GIST, 0.3% incidence of gastric carcinoid, and 0.6% incidence of duodenal carcinoid were also found.[12,13,54,61,65–69] None of these routine preoperative endoscopies found any cancer.

The incidence of benign/premalignant pathology found on screening endoscopy before bariatric surgery is very low, and cancer is usually not detected during such endoscopy. The only report of preoperatively detected (gastric) cancer was by Seva-Pereira et al.[28] which has been mentioned before. Hence, even though screening endoscopy may alter the surgical management of these patients, further studies are required to assess the cost effectiveness of such screening.

Access to the Bypassed Stomach in RYGB

It is important for the clinician to be aware of ways to access the bypassed stomach if a pathology is suspected in a patient post-RYGB. CT scan after percutaneous injection of contrast is possible, but it does not evaluate the mucosa.[70] Ultrasound guided gastroscopy has been described.[71] Some surgeons advocate the routine placement of a gastrostomy tube with a radio-opaque marker around the gastrostomy site.[72] Retrograde duodenogastroscopy has been described but is technically challenging and is successful only in a small percentage of cases. Newer technologies like the double balloon and the Shapelock technology should further facilitate access to the bypassed stomach.[73,74] With the advancement in technologies to access the bypassed stomach, the surgeon's anxiety about leaving behind an excluded stomach with potential to develop a serious pathology should be greatly decreased.

Nonupper GI Cancers

Lymphomas

Gagne et al.[75] in their large retrospective review reported that lymphomas accounted for 11% of the preoperative incidence of malignant diseases. Splenectomy or radiotherapy when used for the treatment of these conditions can result in abdominal adhesions that can complicate a future bariatric operation. They also found an intraoperative low-grade lymphoma that presented as mesenteric panniculitis. The patient was observed without treatment for 22 mo.[70]

Adrenal Tumors

There are just 2 case reports of adrenal tumors presenting in a bariatric surgery patient. In a report of adrenalectomy during a gastric bypass procedure, the left adrenal was removed by a supra gastric approach by creating a window between the divided pouch and the stomach remnant. The tumor was a nonfunctioning adrenocortical tumor.[76] The anterior approach was found to be feasible in a patient 13 mo postlaparoscopic RYGB who had a functional left adrenal cortical adenoma. It was approached by mobilizing the left colon and retracting the viscera medially.[77] A patient who has undergone bariatric surgery, especially open bariatric surgery, may have dense adhesions that make the anterior approach to adrenalectomy very difficult, in which case the posterior approach would have an advantage. The posterior approach also avoids the hemodynamic consequences of increased abdominal pressure, and the prone position would be better tolerated in the morbidly obese. Higher pressures can also be used in the retroperitoneal laparoscopic technique (25mm Hg), which would facilitate dissection. This was demonstrated in a morbidly obese patient who underwent left retroperitoneal laparoscopic adrenalectomy for a pheochromocytoma.[78] The follow-up information is provided in **Table 1.**

Hepatic Tumors

Liver steatosis, which is widely prevalent in the morbidly obese population, is a challenge for hepatic resection. Patients with at least 30% steatosis have been shown to have an increased risk of morbidity and mortality after surgery compared to patients with <30% steatosis.[79] Bariatric surgery is well known to improve steatosis.[75] However, the additional challenge in a postbariatric patient (especially in a patient with a gastric band) undergoing hepatectomy for left-sided tumors is the presence of dense adhesions at the gastroesophageal junction.[80]

Weight reduction is possible before surgery for benign tumors, and hence such a patient can undergo bariatric surgery first followed by liver resection, although the latter has been found to be technically difficult in the case of a left-sided tumor. In the latter case, an open hepatectomy and RYGB were performed as a single procedure.[81,82] However, weight loss before hepatectomy is usually not an option for malignant tumors.

Insulinoma

Though there are no special points to mention regarding a bariatric patient having insulinoma, this entity assumes importance because other diagnoses in postbariatric patients can be confused with insulinoma. First, late dumping syndrome can present with hypoglycemia >30 min after a meal. This usually responds to conservative measures and octreotide. A patient with dumping syndrome who does not respond to octreotide for 3 mo must be suspected of having either an insulinoma or noninsulinoma pancreatogenous hypoglycemia syndrome (NIPHS-sometimes also called nesidioblastosis). Insulinoma diagnosis should be ruled out by standard imaging techniques, somatostatin scintigraphy, or endoscopic ultrasound. After exclusion of an insulinoma, the diagnosis of NIPHS is possible currently only by invasive techniques, although noninvasive methods like PET with the use of various binding agents may also be useful.[83] Calcium is infused into the pancreatic arteries, and insulin is measured at the confluence of the hepatic veins; increased insulin levels at the latter indicate β cell hyperplasia. In contrast to insulinoma, the appearance of increased insulin from stimulation of multiple segments of pancreatic vascular supply is observed in NIPHS. Medical treatments for NIPHS include the use of diazoxide, octreotide, and calcium channel blockers. Surgical treatment of choice is conversion to a restrictive procedure with or without restoration of gastrointestinal continuity. Pancreatic resection (total or subtotal) is the last resort. The details have been reviewed elsewhere.[84]

Renal Cell Carcinoma

Obese patients have an increased risk of renal cell cancer, and this risk is not eliminated after bariatric surgery.[85] If renal cysts/masses are picked up during a sonogram, a CT scan with contrast is warranted. Another challenge in diagnosis of renal cell cancer in super obese patients is that they do not fit into the CT scanner.

Gagne et al.[70] in their large series of 1500 bariatric patients found that about 8% of the cancers found preoperatively were renal cell cancers (and 1 out of 4 cancers diagnosed

during the screening process). They also found a retroperitoneal mass intraoperatively, but it was investigated with a CT scan after the patient lost weight (6 wk post-RYGB) due to limits of the CT scanner. The patient underwent radical nephrectomy for renal cell cancer and was reported to be disease free for >4yrs. One of 16 cancers diagnosed postoperatively were renal cell cancers.[70] The treatment of renal cell cancer is not affected by bariatric surgery.

Ovarian Abnormalities

Greenbaum,[58] upon exploring the abdomen for abnormalities during open bariatric surgery, found 31 (7.8%) unexpected findings during the bariatric procedure, most of which were ovarian masses (25 in number, 81%). Although most were benign cystic masses, 8 solid tumors were identified, one of them being a carcinoma and another a Sertoli Leydig cell tumor. Bariatric surgery was, however, performed in all cases. Given such a low incidence (1/400 = 0.25%) of cancer, the cost effectiveness of routine abdominal exploration must be further elucidated.[58]

CONCLUSION

Cancer is not a contraindication for bariatric surgery in general. Postoperative management of cancer patients was not affected by the bariatric procedure in all studies. RYGB effectively resolves Barrett's esophagus. Oncologic resection of early gastric cancer with RYGB has been performed. Gastric cancer occurring in the gastric remnant was treated by a distal gastrectomy in most cases. Pouch cancer after RYGB was treated by transhiatal esophagectomy with pouchectomy or en bloc resection with esophagojejunostomy, depending on the location of the tumor and the extent of involvement. Gastrointestinal cancers in gastric band patients may mimic the benign symptoms experienced by these patients necessitating a high index of suspicion. Esophageal adenocarcinoma was treated with the abdominal approach with taking down of the Roux-en-Y formation followed by thoracotomy and esophageal resection, followed by pull up of the stomach remnant in all the studies. Gastrointestinal stromal tumors, gastric polyps, and carcinoids may be encountered by the bariatric surgeon, and difficulty in endoscopic surveillance of the gastric remnant after gastric bypass may necessitate a remnant gastrectomy in these cases. Remnant gastrectomy has also been done in the case of a gastric lymphoma (MALToma). Sleeve gastrectomy is an excellent option for concomitant treatment of GIST or carcinoid and morbid obesity, because it not only allows for complete excision of the lesion but also for postoperative endoscopic surveillance. Novel endoscopic technologies may help evaluate the bypassed stomach. Non-GI tumors may also be encountered by the bariatric surgeon. Bariatric surgery before operating for benign hepatic tumors is a feasible option. A posterior approach for adrenalectomy in a bariatric patient may avoid the adhesions due to a previous bariatric procedure. An insulinoma or the carcinoid syndrome may be confused with dumping syndrome seen in malabsorptive procedures. Diagnostic CT scan presents technical challenges in the morbidly obese patients; they may be able to fit into the scanner just a few weeks after bariatric surgery. Ovarian masses are commonly encountered during surgery in a female bariatric patient, though the discovery of ovarian malignancy during a bariatric operation is unlikely.

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