

Review Article



Gastric Cancer After Bariatric Surgeries

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OPEN ACCESS

Received: Jan 15, 2023

Revised: Jan 23, 2023

Accepted: Jan 23, 2023

Published online: Jan 24, 2023

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Funding

No funding was obtained for this study.

Conflict of Interest

None of the authors have any conflict of interest.

ABSTRACT

Bariatric surgery has been covered by medical insurance in Korea, since January 2019; and its number is steadily increasing. Representative bariatric surgeries include adjustable gastric banding, sleeve gastrectomy, and Roux-en-Y gastric bypass. Each surgical method can be applied according to the patient's condition; however, there are other issues to consider in Korea. Because of the high incidence of gastric cancer in Korea, gastroscopy is recommended every two years after the age of 40. Therefore, it is difficult to perform conventional gastroscopy after Roux-en-Y gastric bypass. In this review, the incidence of gastric cancer after representative bariatric surgery was investigated through a literature review, so that it could be used as a reference for the selection of bariatric surgery in Korea.

Keywords: Bariatric surgery; Roux-en-Y gastric bypass; Gastric cancer

INTRODUCTION

According to the World Health Organization (WHO), approximately 13% of the world's population was reported to be obese (body mass index [BMI] ≥ 30 kg/m²) in 2016. In addition, the prevalence of obesity tripled over the past 40 years from 1975 to 2016 [1]. Among these, bariatric surgery is the only treatment with long-term effects on severe obesity (BMI ≥ 40 kg/m²) [2]. On the other hand, obesity is known to increase the risk of several cancers involving esophagus, stomach, and colon [3-5]. In fact, very few cases of gastric cancer have been found after surgery in patients who have undergone bariatric surgery [6]. However, despite these facts, it cannot be said with certainty that the importance of these cases has diminished. The side effects that occur after bariatric surgery, such as abdominal pain, nausea, vomiting, indigestion, and bloody stools, may lead to both patients and doctors overlooking symptoms that suggest gastric cancer. The fact that it is difficult to evaluate postoperatively with gastroscopy because of anatomical changes in the body provides a suggestion to consider whether the currently performed bariatric surgery techniques are sufficient. Therefore, the authors identified three major bariatric surgical techniques, adjustable gastric banding (AGB), sleeve gastrectomy (SG), and Roux-en-Y gastric bypass (RYGB), through a literature review and identified the limitations of the current bariatric surgery technique and to see if there were any improvements.

Author Contributions

Conceptualization: Park DJ; Data curation: Youk KM; Formal analysis: Youk KM, Park DJ; ; Investigation: Youk KM, Park DJ, Kim J; Methodology: Park DJ; Supervision: Park DJ; Writing - original draft: Youk KM; Writing - review & editing: Park DJ, Kim J, Cho YS.

METHODS

In this review, case reports published in English up to 2022 and review articles on gastric cancer after bariatric surgery in PubMed were included. The search terms included “gastric cancer” or “gastric (adeno)carcinoma”, “stomach cancer” or “stomach (adeno)carcinoma” and “gastric banding” or “banding”, “sleeve gastrectomy” or “sleeve”, “Roux-en-Y gastric bypass”, “gastric bypass”, and “Roux-en-Y bariatric surgery”. Among them, cases other than gastric cancer, such as esophageal cancer, and patients who had undergone surgery other than AGB, SG, and RYGB were excluded. In addition, patients diagnosed with gastric cancer before surgery were excluded.

RESULTS

A total of 51 cases were identified in 49 documents. The cases are summarized in 3 tables according to the surgical technique performed. Authors (year of publication), age and sex of the patient, surgical technique, time to diagnosis after surgery (years), location of cancer, stage, treatment performed, treatment results, and symptoms that the patient complained before diagnosis were included.

Four cancer cases were reported after AGB, 11 after SG, and 36 after RYGB. The average age of the patients at the time of diagnosis was 55.2 years, and in terms of sex, 36 cases (71%) were female, which was approximately twice as many as 15 cases of males. Adenocarcinoma was the most common (41 cases, 82%), and other tumors such as lymphoma and gastrointestinal stromal tumor (GIST) accounted for 10 cases (18%). Of these, 10 cases (20%) had stage 4 cancer at the time of diagnosis, and 8 cases (16%) of early gastric cancer accounted for a small fraction.

1. AGB

For patients who underwent AGB, the average number of years from surgery to diagnosis was 4.4 years (Table 1). In two cases, cancer occurred in the pouch, which is the upper part of the band, and in one case, the cancer occurred in the lesser curvature. Shetty et al. [7] reported diffuse large B-cell lymphoma found in a 67-year-old male; however, the time to diagnosis or the location of the cancer could not be determined.

Table 1. Summary of studies for surgical technique: AGB

Author (year)	Age/ Sex	Operation	Time from surgery to diagnosis	Location	Pathology	Treatment	Treatment results	Symptoms
Hackert et al. (2004) [8]	62/F	AGB	10 years	Pouch	Poorly differentiated adenocarcinoma (pT2b), Stage 4	Near total gastrectomy + adjuvant chemotherapy	No postoperative complications	Epigastric pain
Stroh et al. (2008) [9]	65/F	AGB	2 years 8 months	Pouch	Stage 4	Exploratory laparotomy	Died on fifth postoperative day	Hematemesis
Orlando et al. (2014) [10]	37/F	AGB	6 months	Lesser curvature	Poorly differentiated adenocarcinoma (pT1sN0M0)	Total gastrectomy	Condition was well after 2 years	Incidental finding
Shetty et al. (2020) [7]	67/M	AGB	N/A	N/A	Diffuse large B-cell lymphoma	Chemotherapy		

AGB = adjustable gastric banding, N/A = not applicable; DLBCL = diffuse large B-cell lymphoma.

Table 2. Summary of studies for surgical technique: SG

Author (year)	Age/ Sex	Operation	Time from surgery to diagnosis	Location	Pathology	Treatment	Treatment results	Symptoms
Angrisani et al. (2014) [12]	56/F	SG	4 years	Body & antrum & pylorus	Poorly differentiated adenocarcinoma (pT4aN1)	Total gastrectomy & adjuvant chemoradiotherapy	Disease free after 8 months	Vomiting, dysphagia, epigastric pain, asthenia
Erim et al. (2015) [11]	52/F	SG	4 years	Lesser curvature	Well-differentiated Gastric carcinoid tumor (GCT)	Endoscopic submucosal dissection		Dyspepsia
Masrur et al. (2016) [13]	44/F	SG	9 months	Stomach body	Poorly differentiated adenocarcinoma (pT4bN3a)	Total gastrectomy & adjuvant chemotherapy	Well at 8-month follow-up	Dysphagia
Vladimirov et al. (2017) [14]	47/F	SG	4 years	Antrum	Adenocarcinoma (pT1bN0)	Total gastrectomy	No evidence of recurrent tumor 2 years postoperative	Abdominal pain and back, Pain
Sohn et al. (2017) [15]	46/F	SG	2.5 years	Fundus	Poorly differentiated adenocarcinoma (T3N0M0)	Neoadjuvant chemotherapy & oesophagogastrectomy & adjuvant chemotherapy		Iron deficiency on a routine test
Seki et al. (2018) [16]	64/F	SG	1 year	Antrum	Well differentiated adenocarcinoma (pT1a)	Endoscopic submucosal resection		Routine endoscopy
Yamashita et al. (2019) [17]	42/F	SG	8 years	Pylorus	Poorly differentiated adenocarcinoma (pT4aN0)	Total gastrectomy & adjuvant chemotherapy	Well at 12-month follow-up	Symptoms of GERD
Muamar and Ammori (2020) [18]	26/F	SG	5 years	Antrum	Poorly differentiated adenocarcinoma (pT1N0)	Neoadjuvant chemotherapy & total gastrectomy & adjuvant chemotherapy	Remained disease-free at 3-month of follow-up	Food intolerance, vomiting, epigastric pain, nausea, sweating, vertigo and palpitation
Orellana et al. (2021) [19]	59/M	SG	6 years	Greater curvature	Poorly differentiated adenocarcinoma (pT4aN3bM0)	Total gastrectomy & adjuvant chemotherapy		Epigastric pain, early satiety, dysphagia, postprandial vomiting, weight loss
Li et al. (2021) [20]	45/F	SG	6 years	Antrum	Poorly differentiated adenocarcinoma (pT4aN2M0)	Subtotal gastrectomy & adjuvant chemotherapy	Well after 10 post-operative months	Epigastric pain
Najjari et al. (2021) [21]	36/M	SG	15 months		Linitis plastica (poorly differentiated adenocarcinoma), Stage 4	Palliative chemotherapy	Expired after 6 months	Food intolerance and weight loss

SG = sleeve gastrectomy, GERD = gastroesophageal reflux disease.

2. SG

In the case of SG, the average time from surgery to diagnosis was 4 years (Table 2). Most cases (10 cases) were adenocarcinomas; and Erim et al. [11] reported gastric carcinoid tumors in a 52-year-old woman. A special feature is that compared to other surgical techniques, the first reported year was 2014, which is the latest. This reflects the recent trend that SG has the shortest history in bariatric surgery and is gradually being performed more frequently.

3. RYGB

After RYGB surgery, 36 cases of gastric cancer have been reported (Table 3). The average time from surgery to diagnosis was 9.98 years, which was more than twice that of the other 2 surgical techniques. Of these, 9 (25%) cases of gastric cancer were found in the pouch and 27 (75%) were found in the excluded stomach. The average time to the discovery of cancer in an isolated stomach was 11.5 years, which was more than twice that of the 4.7 years when gastric cancer was discovered in the pouch. This is believed to be related to the difficulty in accessing the isolated stomach with diagnostic instruments, such as conventional gastroscopy, because the path to the separated stomach is very long. As with other surgical techniques, most of the reported cancers were adenocarcinomas; however, two cases of diffuse large B-cell lymphoma, one case of mucosa-associated lymphoid tissue lymphoma, 2 cases of GIST, and one case of mixed adenoneuroendocrine carcinoma were also reported.

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Table 3. Summary of studies for surgical technique: RYGB

Author (year)	Age/ Sex	Operation	Time from surgery to diagnosis	Location	Pathology	Treatment	Treatment results	Symptoms
Rajjman et al. (1991) [22]	38/F	RYGB	5 years	Body	Adenocarcinoma	Distal gastrectomy	Died of progressive cancer 3 months after	Malaise, non-radiating epigastric pain, intermittent low-grade fever, dark stool
Lord et al. (1997) [23]	71/F	RYGB	12 years	Antrum & pylorus	Polypoid adenocarcinoma (pT1bN0M0)	Distal gastrectomy	Stable after 3 months	Anemia
Khitin et al. (2003) [24]	57/F	RYGB	22 years	Excluded stomach	Poorly differentiated adenocarcinoma (pT3N0Mx).	Resection of gastric remnant	Uneventful post-operative period	Epigastric pain and distention
Escalona et al. (2005) [25]	51/F	RYGB	8 years	Pylorus	Moderately differentiated adenocarcinoma (T4N1)	Total gastrectomy	Normal 6 months after surgery	Epigastric pain, Nausea
Trincado et al. (2005) [26]	52/F	AGB → RYGB	5 years	Pouch	Well-differentiated adenocarcinoma (T3N1M0)	Esophagopouchectomy & adjuvant chemoradiotherapy	No recurrence after 12 months	Epigastric pain
de Roover et al. (2006) [27]	66/M	RYGB	3 years	Fundus of excluded stomach	DLBCL	Distal gastrectomy & adjuvant chemoradiotherapy	Complete remission 10 months after	Fever and left shoulder pain
Corsini et al. (2006) [28]	57/M	RYGB	4 years	Antrum of excluded stomach	Poorly differentiated adenocarcinoma	Palliative therapy	Succumbed 3 months after surgery	Abdominal pain and excessive weight loss
Harper et al. (2007) [29]	45/F	RYGB	1 year	Antrum of excluded stomach	Adenocarcinoma stage 4	Decompressive gastrostomy & chemoradiotherapy	Expired 4 months after surgery	Abdominal pain, distension, and constipation with weight loss
Watkins et al. (2007) [30]	44/M	Silastic-banded gastroplasty → RYGB	18 years	Antrum of excluded stomach	Adenocarcinoma (pT2N0M0)	Remnant gastrectomy	Died 26 months after due to recurrence	Upper abdominal pain, emesis, dehydration
Sun et al. (2008) [31]	65/M	RYGB	5 years	Pouch	Poorly differentiated adenocarcinoma, Stage 4	Hospice care	Died 2 months after diagnosis	Dysphagia, heartburn
Swain et al. (2010) [32]	69/M	RYGB	20 years	Pylorus	Adenocarcinoma	Remnant gastrectomy	No recurrence found after 1 year	Abdominal pain
Jawad et al. (2012) [33]	71/F	RYGB	21 years	Excluded stomach	Gastric MALT	Exploratory laparotomy	Showed marked improvement of abdominal symptoms after 2 months	Abdominal pain
Kulaylat et al. (2013) [34]	54/F	RYGB	7 years	Pouch	Adenocarcinoma (T4N1M0)	Total gastrectomy	Recurrence free for 20 months	Dysphagia, weight loss
Menéndez et al. (2013) [35]	51/F	RYGB	3 years	Excluded stomach	Adenocarcinoma (pT4N2Mx), Stage 4	Neoadjuvant chemotherapy & total gastrectomy & adjuvant chemotherapy	No evidence of recurrence 6 months after surgery	Incidentally found after gynecological surgery
Ribeiro et al. (2013) [36]	52/M	RYGB	2 years	Pouch	Undifferentiated adenocarcinoma	Total gastrectomy + adjuvant chemotherapy	Died after 21 months due to recurrence	Dysphagia
Abellán et al. (2014) [4]	60/F	RYGB	7 years	Greater curvature	Serous gastric GIST (T4N0)	Remnant gastrectomy	Condition was well	Incidentally found during work up for cystic teratoma
Courtney et al. (2014) [37]	56/F	RYGB	10 months	Lesser curvature	DLBCL	Chemotherapy		Abdominal pain
Nau et al. (2014) [38]	55/F	RYGB	2 years	Excluded stomach	Linitis plastica (poorly differentiated adenocarcinoma), Stage 4	Referred to oncology department		Epigastric pain, vomiting, and poor oral intake
Midani et al. (2014) [39]	43/F	RYGB	14 years	Excluded stomach	Poorly differentiated adenocarcinoma, Stage 4	Palliative chemotherapy		Severe right lower quadrant abdominal pain, nausea, and anorexia
Magge and Holtzman (2015) [40]	69/M	RYGB	28 years	Excluded stomach	Moderately differentiated adenocarcinoma (pT2N1M0)	Neoadjuvant chemotherapy & subtotal gastrectomy & adjuvant chemotherapy	No recurrence after 6 months	Syncope, abdominal discomfort, nausea, vomiting

(continued to the next page)

Table 3. (Continued) Summary of studies for surgical technique: RYGB

Author (year)	Age/ Sex	Operation	Time from surgery to diagnosis	Location	Pathology	Treatment	Treatment results	Symptoms
Magge and Holtzman (2015) [40]	(N/A)/F	RYGB	25 years	Excluded stomach	Poorly differentiated adenocarcinoma	Subtotal gastrectomy & adjuvant chemoradiotherapy	No recurrence after 3 years	Abdominal distention and weight loss
Tinoco et al. (2015) [41]	56/F	RYGB	10 years	Excluded stomach	Moderately differentiated adenocarcinoma (pT1bN3b)	Total gastrectomy & adjuvant chemotherapy		Severe abdominal pain, distension, flatus expulsion and melena
McFarland et al. (2015) [42]	68/M	RYGB	7 years	Antrum	Extremely well differentiated adenocarcinoma (pT4b)	Gastric cancer was found during autopsy	Expired due to iatrogenic duodenal perforation	Abdominal pain and constipation
Fleetwood et al. (2016) [43]	73/M	Vertical banded gastroplasty → RYGB	-	Pouch	Adenocarcinoma (pT1aNx)	Total gastrectomy	No complication after surgery	Early satiety
D'Antonio et al. (2017) [44]	58/F	RYGB	4 years	Antrum	Intramucosal adenocarcinoma	Laparoscopic trans-gastric resection		Iron deficiency anemia, epigastric pain, outlet obstruction, and abdominal distension
Haenen et al. (2017) [45]	52/F	RYGB	7 years	Excluded stomach	Linitis plastica (poorly differentiated adenocarcinoma)	Chemotherapy	Chemotherapy was ceased due to tumor progression and intolerance	Abdominal cramps, vomiting and abdominal pain
van de Vrande et al. (2017) [46]	69/F	RYGB	2 years	Pouch	Well-differentiated adenocarcinoma (pT1N0)	Esophagopouchectomy & proximal excluded stomach resection	No recurrence after 6 months	Vomiting, dysphagia, and weight loss
Pastorello et al. (2017) [47]	61/M	RYGB	19 months	Pouch	MANEC (pT1bN1M0)	Total gastrectomy + chemotherapy	Recurred after 6 years	Incidentally found during evaluation for incisional hernia
Ahmad et al. (2017) [48]	74/F	RYGB	41 years	Excluded stomach	Poorly differentiated adenocarcinoma	Poor surgical and chemotherapy candidate	Passed away in a hospice	Early satiety, weight loss, abdominal pain
Ali et al. (2018) [49]	40/F	RYGB	13 years	Excluded stomach	Adenocarcinoma, Stage 4	Chemotherapy		Epigastric pain and weight loss
Ali et al. (2018) [49]	50/F	RYGB	6 years	Pylorus	Poorly differentiated adenocarcinoma, Stage 4	Chemotherapy		Epigastric pain, nausea, and recurrent gastrointestinal bleeding
Nascimento et al. (2020) [50]	48/F	RYGB	2 years	Excluded stomach	GIST	Remnant stomach gastrectomy	Presents no signs of recurrence 12 months after	Abdominal pain and distension, asthenia and weight loss
Chen et al. (2020) [51]	68/M	RYGB	5 years	Pouch	Poorly differentiated adenocarcinoma	Chemotherapy + traditional Chinese medicine therapy (refused surgery)	Died after 15 months	Abdominal pain and dysphagia
Schneider et al. (2021) [52]	56/F	AGB → RYGB	16 years	Excluded stomach	Poorly differentiated adenocarcinoma	Neoadjuvant chemotherapy & remnant stomach gastrectomy & adjuvant chemotherapy		Upper abdominal pain, nausea, and diarrhea
Chemaly et al. (2022) [6]	56/M	AGB → RYGB	10 years	Pouch	Moderately differentiated adenocarcinoma (T2N1M0)	Total gastrectomy + adjuvant chemotherapy	Passed away after 19 months due to recurrence	Dysphagia, anorexia, nausea, regurgitation, weight loss
Koyama et al. (2022) [53]	50s/F	RYGB	12 years	Excluded stomach				Anemia, abdominal symptom

RYGB = Roux-en-Y gastric bypass, AGB = adjustable gastric band, DLBCL = diffuse large B-cell lymphoma, MALT = mucosal-associated lymphoid tumor, GIST = gastrointestinal stromal tumor, MANEC = mixed adenoneuroendocrine carcinoma.

In 44 of the 51 cases, the patient complained of symptoms such as abdominal pain, nausea, vomiting, and weight loss. In 6 cases, cancer was discovered incidentally or was found due to an abnormality during regular check-ups. In the remaining one case, no explanation of the patient's symptoms was found in the literature. Because the rate of early gastric cancer

among patients is only 16% and that of stage 4 gastric cancer is rather high (20%), the diagnosis after the onset of symptoms can be considered very late. This suggests that the difficulty of regular check-ups should be considered.

DISCUSSION

To date, 51 gastric cancer cases have been reported to PubMed after bariatric surgery using the three techniques, which is very small compared to the number of bariatric surgeries performed every year [54]. However, considering the history of bariatric surgery, the fact that most cases were reported after the year 2000, especially after 2010, is due to the fact that it was difficult to think of linking bariatric surgery and cancer in the past and the long time until diagnosis after surgery. Consequently, it is believed to have been underreported in academia. Of these, more than 70% (36 cases) were patients who underwent RYGB. However, it should be considered that RYGB has been a standard technique for bariatric surgery for a long time, and the number of operations is higher than that of other techniques. Nevertheless, 75% of the patients who underwent RYGB surgery developed cancer in the isolated stomach, and the time to diagnosis was more than twice that of pouch-detected cases or patients who underwent other surgeries. This can be considered a matter for the operator.

The number of AGB surgeries, which accounted for a large proportion of bariatric surgeries in the past, has decreased significantly, and the current major techniques are SG and RYGB. Although the standard procedure is still RYGB, it has been reported that the control effect of gastroesophageal reflux and type 2 diabetes, which were identified in SG, does not gradually differ from RYGB surgery as the surgical technique is gradually improved [55]. Although the number of gastric cancer cases is very small, once it occurs, considering its severity, it seems to be an essential point to consider when comparing the two procedures. SG, which is superior in regular check-ups after surgery, is expected to replace the current standard technique of RYGB.

Resectional RYGB, a procedure that leaves only the gastric pouch to prevent cancer arising from the separated stomach, may compensate for the weakness of the existing RYGB. However, the reoperation rate of RYGB was 5.9%, which was considerably higher than that of SG (1.8%) [56]. Considering this point, the procedure that eliminates the method of reoperation can be considered troublesome. Midani et al. [39] and Ali et al. [49] performed double-balloon enteroscopy as a regular screening method to detect gastric cancer in patients with deformed anatomical structures of the gastrointestinal tract. A technique that supplements the existing endoscopy can be considered, but it is technically quite difficult and takes a long time to train, and the possibility of gastrointestinal perforation exists [57].

CONCLUSIONS

Gastric cancer can occur after bariatric surgery and has been reported even after RYGB. Compared with AGB and SG, gastric cancer was diagnosed much later in RYGB, and advanced gastric cancer was more common. Therefore, the possibility of gastric cancer should be considered when selecting bariatric surgery in Korea.

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