Obesity Surgery (2024) 34:2634–2649
https://doi.org/10.1007/s11695-024-07240-2

REVIEW

Remnant Gastrectomy and Gastric Bypass: A Systematic Review of Indications and Outcomes of Resectional Gastric Bypass

Shahab Shahabi Shahmiri[1,2] · Erfan Sheikhbahaei[3,4] · Amirhossein Davarpanah Jazi[3] · Hamidreza Zefreh[4] · Wah Yang[5,6] · Rohollah Valizadeh[7] · Rui Ribeiro[8] · Mohammad Kermansaravi[1,2]

Received: 13 March 2024 / Revised: 9 April 2024 / Accepted: 16 April 2024 / Published online: 13 May 2024

Abstract

Background In this systematic review, we aim to evaluate the reasons and outcomes behind remnant gastrectomy with or after gastric bypass procedures.

Results A total of 66 studies examining 1918 patients were included in this study with 70% of female predominance. Twenty studies reported RGB on 1751 patients and 46 studies reported remnant gastrectomy after gastric bypass in 167 patients. The most common etiology of RGB was related to the in situ remnant stomach neoplasia in 10 studies on 981 patients; mostly for preventive intentions in high prevalence areas. Remnant gastrectomy after gastric bypass was performed to treat a complication such as GGF, retrograde bile reflux gastritis, cancer mostly adenocarcinoma. Studies revealed that RGB has similar weight loss in comparison to standard Roux-en-Y gastric bypass.

Keywords Gastric bypass · Remnant gastrectomy · Metabolic surgery · Weight loss surgery · Resectional gastric bypass

Introduction

The Roux-en-Y gastric bypass (RYGB) and one anastomosis gastric bypass (OAGB) are the two most commonly performed metabolic and bariatric surgical (MBS) procedures worldwide. In both of these techniques, the stomach is divided into a pouch and a remnant section [1–4]. Although upper endoscopy may visualize the gastric pouch, gastrojejunal anastomosis (GJA), and the non-diverted part of the small intestine, diagnosing and treating diseases in the gastric remnant are challenging and represent a significant limitation.

Problems of in situ remnant stomach may be categorized as perioperative and late complications [5–7]. Hemorrhage from sutures, staple lines or anastomosis, staple line dehiscence/leakage, and acute dilatation of gastric remnant are among the events that happen early in the postoperative

Key Points
- RGB is indicated when there is a risk of gastric malignancy in remnant.
- Fear of remnant stomach-related complications is another reason for RGB.
- RGB has a comparable weight loss similar to RYGB.
- Gastrogastric fistula, bleeding, ulcer, and neoplasia were reasons of secondary RGB.

✉ Amirhossein Davarpanah Jazi
davarpanahjazi@gmail.com

1 Department of Surgery, Division of Minimally Invasive and Bariatric Surgery, School of Medicine, Rasool-e Akram University Hospital, Iran University of Medical Sciences, Tehran, Iran

2 Center of Excellence of European Branch of International Federation for Surgery of Obesity, Hazrat-e Rasool University Hospital, Tehran, Iran

3 Minimally Invasive and Bariatric Surgery Research Center of Rasool-e Akram University Hospital, Iran University of Medical Sciences, Manaouri St., Niyayesh St., Sattar Khan St., Tehran, Iran

4 Minimally Invasive Surgery and Obesity Research Center, School of Medicine, Alzahra University Hospital, Isfahan University of Medical Sciences, Isfahan, Iran

5 Department of Metabolic and Bariatric Surgery, The First Affiliated Hospital of Jinan University, Guangzhou, China

6 The State Key Laboratory of Pharmaceutical Biotechnology, LKS Faculty of Medicine, The University of Hong Kong, Hong Kong, China

7 Urmia University of Medical Sciences, Urmia, Iran

8 Hospital Lusiadas Amadora Metabolic Surgery Unit and General Surgery Department Coordinator, Amadora, Portugal

course, and gastroduodenal bleeding/perforation, gastrogastric fistula (GGF), late gastric remnant dilatation, and malignancy occur later [5–8]. Gastric remnant resection is one of the available approaches for overcoming these problems. Furthermore, it was hypothesized that gastric bypass with concomitant resection of the remnant stomach or the so-called resectional gastric bypass (RGB) might have an additional positive effect on weight loss and may perform as the primary bariatric approach for patients with severe obesity and in cases who are at high risk for developing problems in excluded remnant stomach such as malignancy or there is a fear of postoperative complications such as GGF, ulcer, bleeding, or perforation [5–14]. However, the reasons, outcomes, and complications of excising the remnant stomach in MBS candidate concomitant with their initial RYGB/OAGB or after a complication are not clear. Thus, in this systematic review, we aim to investigate the indications of remnant gastrectomy in addition to gastric bypass.

Methods and Materials

The Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) has been used to report the findings of this study [15], and the protocol of this review has been registered in the Prospective Register of Systematic Reviews (PROSPERO) database and received the code. This work has been reported in line with PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) and AMSTAR [16] (Assessing the methodological quality of systematic reviews) Guidelines.

Search and Screening

PubMed, Scopus, Embase, Web of Science, and Cochrane were reviewed for articles published by the end of Dec 2020, and the search was updated twice in May and Dec 2023. The keywords searched were "remnant gastrectomy," "resectional bypass," "resectional gastric bypass," "RGB," "bariatric surgery," "obesity surgery," "weight loss," "OAGB," "MGB," "MGB/OAGB," "RYGB," "Roux-en-Y gastric bypass," "one anastomosis gastric bypass," "mini gastric bypass," or a combination of them in the title, abstract, or keywords. The included articles' references and citations were manually reviewed for additional relevant papers. Duplication and conference presentations were removed, and the Covidence website was used to help two authors organize the screening process independently, and another author resolved the conflict. Authors of published congress presentations were contacted through email for their full-text articles. Non-English manuscripts were translated section by section using Google Translate. Inclusion criteria were all observational studies, including case reports, case series, and prospective and retrospective studies on total, subtotal, or partial remnant gastrectomy with or after gastric bypass procedures. Exclusion criteria were studies with wedge resection of the remnant stomach, fundectomy, unclear surgical procedures or results, and animal studies. Studies that have been conducted and published from the same center or might have investigated the same population are separated.

Data Extraction

The data of included studies (first author's name, year of publication, design of study, sample size, age, gender, BMI before MBS, RYGB, or OAGB procedure for MBS, primary or secondary resectional gastric bypass, the type and reason of remnant gastrectomy, BMI at the time of remnant gastrectomy, time interval between MBS and remnant gastrectomy in case of secondary resectional gastric bypass, follow-up period after surgery, and BMI after remnant gastrectomy, any mentioned postoperative complications) extracted by the same two authors and checked by the other author. The difference observed in any step was resolved by another investigator independent of the other three. Primary remnant gastrectomy concomitant with the gastric bypass or RGB was defined when remnant gastrectomy was performed with a gastric bypass procedure (either RYGB or OAGB) and named secondary when a problem in the remnant stomach or a complication of RYGB/OAGB needed remnant gastrectomy as its treatment some months after the initial operation.

Results

A total of 66 studies examining 1918 patients were included in this study (Fig. 1); 20 studies reported simultaneous gastric bypass with remnant gastrectomy on 1751 patients, and 46 studies reported reoperation for remnant gastrectomy after gastric bypass in 167 patients. Characteristics of the included studies with their reported data are presented in Table 1 (simultaneous) and Table 2 (reoperation). Included patients aged 15–70 years, and the female gender was 70% of the included population.

Indications

Simultaneous

RGB was directly related to stomach neoplasia in 10 studies on 981 patients. Among them, four studies from areas with a high prevalence of stomach malignancy (South America,

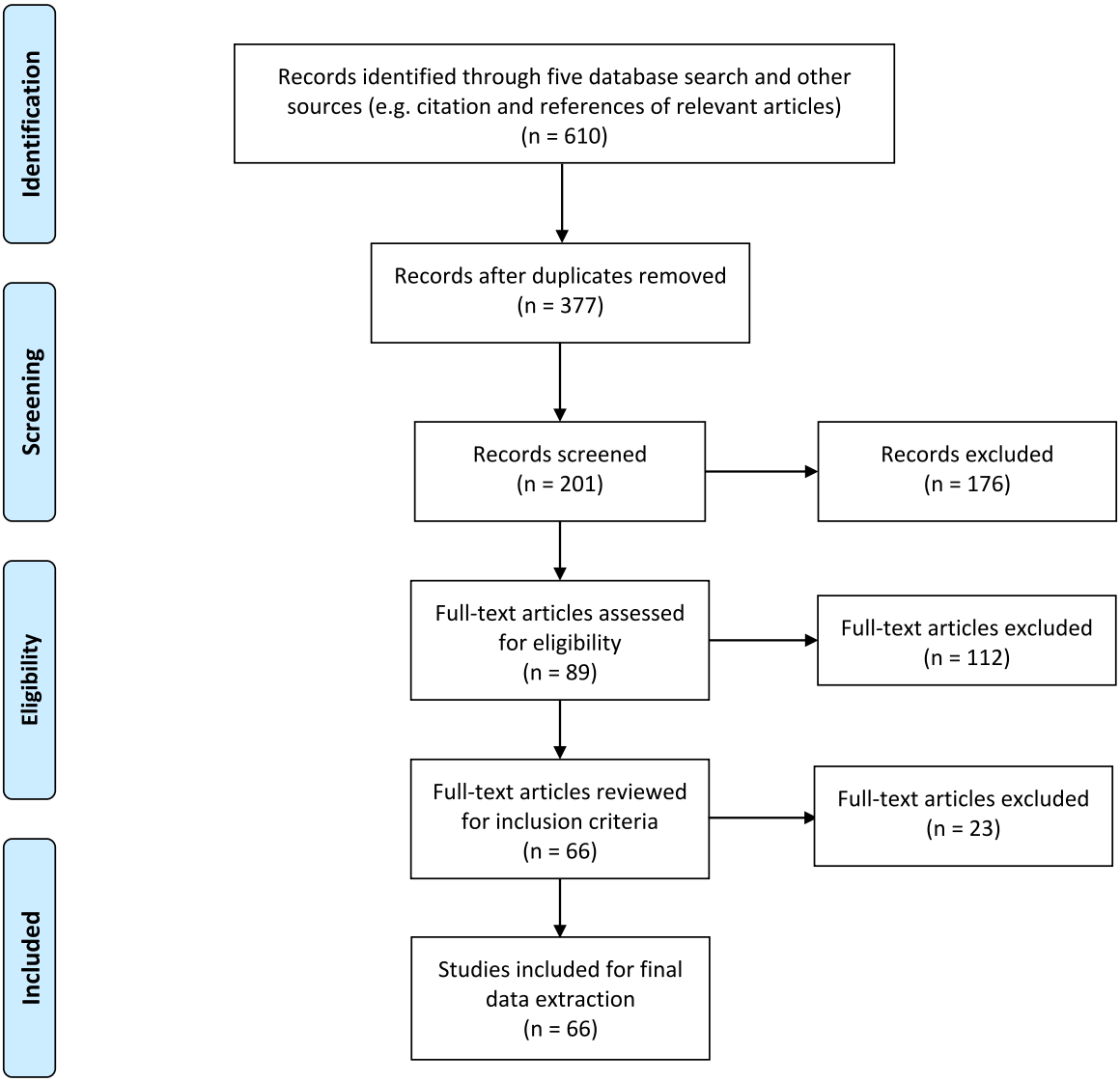

Fig. 1 PRISMA flow chart of the study

such as Chile, and East Asia, such as South Korea) performed remnant gastrectomy on 548 patients for preventive reasons, speculating that remnant stomach will become out-reached by routine upper endoscopy and postoperative surveillance is complicated in this situation. One study with 427 patients was about to find any incidental pathological findings in extracted specimens after MBS. The reported pathologic findings in gastric remnant were chronic or active gastritis in 66, fundic gland polyps in seven, intestinal metaplasia (IM) in three, gastric ulcer in two, lymphoid aggregate in two, diverticulum in one, a developmental cyst in one, and leiomyoma in one. Five case reports on six patients mentioned the reason for RGB was related to IM of the stomach in two patients, an incidental 4.5 cm exophytic gastrointestinal stromal tumor (GIST) on greater curvature, an 8 cm lymphoma, and two small duodenal neuroendocrine tumors.

Six studies with 607 patients performed RGB as the primary MBS approach to evaluate a new surgical technique for weight loss in patients with severe obesity and to overcome the potential problems of the in situ remnant stomach that may face afterward, including fistula, bleeding, ulcer, and neoplasia. RGB was used as a revisional option after a failed prior MBS approach (i.e., having weight problems or intractable symptoms after restrictive approaches) for 86 patients of three articles. GERD was mentioned in two studies with 75 patients, which used RGB for treating both severe obesity and preoperative GERD with IM of the esophagus (i.e.,

Table 1 Characteristic of studies performed remnant gastrectomy simultaneous with the gastric bypass (resectional gastric bypass)

First author	Study type	Year	*N*	Gender	Age	Baseline BMI	Reason of remnant resection	Secondary BMI	Hospital stay (day)
Voellinger [17]	CR	2002	1	F	46	47	Intestinal metaplasia	NR	3
Tartamella [18]	CR	2017	1	M	55	63	Intestinal metaplasia	EWL: 43%	8
Leuratti [19]	CR	2013	2	F	46/60	NR	Incidental GIST/ Significant stomach distortion because of the previous band erosion and insufficient blood supply to remnant stomach	NR	NR
Braghetto [12]	PS	2012	21	12 M	53.2	41.5 ± 4.3	GERD + BE	25.7 ± 1.3 after 1 year, EWL: 91.6%	NR
	PS	2012	39	16F	45.7	39.5 3.4	GERD + BE	31.3 ± 2.4, EWL: 82.9%	NR
Csendes [6]	PS	2005	400	311F	38.5 (15–70)	46 (36–64)	New technique and preventing possible complications	198–33.5 115–27.7 55–27.6 14–27.7	7
Ghanem [20]	CR	2017	1	F	48	38	Severe bleeding (Lynch syndrome)	NR	3
Martin [5]	CC	2004	27	26F	45.8 ± 8.9	42 ± 8.9	Revision due to weight regain or intractable bariatric-related symptoms	28.4	6.5
	CC	2004	54	50F	42.5 ± 10.8	44.8 ± 5.8	Control group for new technique and preventing possible complications	28.1	4.5
Csendes [21]	PS	2006	15	10F	47.6	42.1	Intestinal metaplasia of lower esophagus (BE = 12) or cardia (n = 3) and low-grade dysplasia	28.1 (at 24-month)	NR
Park [22]	RS	2014	16	F	41 (25–58)	36.9 (26.4–51.6)	Prevention of carcinoma	24.5 (18.3–29.0)	4 (2–7)
Jain [23]	CR	2021	2	F/M	45/55	45.7/42.2	Duodenal neuroendocrine tumors	EWL: 55/62%	5/4
Braghetto [11]	PS	2018	400	288F	34.4 ± 8.9	38.5 ± 4.4	Prevention of carcinoma	1y: 25.3 ± 2.7 (23.1–30.5), 3y: 26.2 ± 3.7 (23.4–29.5), 5y:29.8 ± 4.9 (24.9–33.8)	3
Sohn [24]	RS	2008	427	380F	41.7	43	Identify potential incidental pathologic findings from the excised stomach	NR	NR
Cho [9]	RS	2023	20	10F	41 ± 13.8	39.6 ± 6.6	Prevention of carcinoma	NR	NR

Table 1 (continued)

First author	Study type	Year	*N*	Gender	Age	Baseline BMI	Reason of remnant resection	Secondary BMI	Hospital stay (day)
Curry [7]	PS	1998	47	41F	40.5	49	New technique and preventing possible complications	NR	NR
	PS	1998	26	24F	45.6	44.3	Revision due to failure of weight Loss or weight regain after prior procedure	NR	NR
	PS	1998	12	NR	NR	NR	chronic protein malnutrition, refractory marginal ulcer, band erosion, or other severe pouch dysfunction	NR	NR
Quesada [25]	CR	2007	1	M	53	60	Lymphoma	33.5	4
Braghetto [26]	RS	2011	112	NR	39.4 ± 10.7	40.5 ± 6.9 (32.9–50.3)	Prevention of carcinoma	3-month: 30.4 6-month: 27.5 12-month: 24.6	5.8 ± 0.97 (4–45)
Armstrong [27]	RS	2000	27	26F	34	50.4	Weight loss	33.5	7.4
Brounts [28]	RS	2009	27	13F	34.2	40.6	Weight control	25.6	NR
See [14]	RS	2002	52	42F	43.5 ± 12.9 (24–66)	46.7 ± 7.1 (37–66)	Weight control	NR	5
Noun* [29]	RS	2018	21	11F	39.6 ± 12.2	42.9 ± 6.5	Revision due to weight regain after failed prior procedure	NR	2

*All the articles performed RYGB except this one

Barret's esophagus, BE). Finally, one reported case with GI bleeding due to Lynch syndrome and gastric polyp and another due to significant stomach distortion because of the previous band erosion and insufficient blood supply to the remnant stomach needed RGB for definite treatment.

Reoperation

The mean interval between the initial MBS procedure and remnant gastrectomy in the reoperation group was 77 months (with a median of 43 months). Remnant gastrectomy after primary gastric bypass was performed for these causes from the highest to lowest reported rate among the included studies: GGF was the main initial reason for remnant gastrectomy from 11 studies with 93 patients (56%). A mean interval of 32 months (with a median of 23 months) was observed between gastric bypass and remnant gastrectomy for GGF. Insufficient weight loss/weight regain (IWL/WR), bleeding, marginal ulcer (MU), GJA problems, or being significantly and continuously symptomatic (pain and vomiting) were accompanying problems of the GGF that made surgeons reoperate the patients. Retrograde bile reflux to the remnant stomach and symptomatic gastritis was reported by one study with 19 patients to be the reason for their remnant gastrectomy after RYGB. There were 13 studies with 19 patients who developed neoplasia after gastric bypass. Gastric adenocarcinoma with 11 patients was the most reported, GIST with three, and lymphoma with one was the other. There is one study reporting four cases with pancreaticoduodenal cancers (one patient for each of islet cell, acinar, and adenocarcinoma of pancreas and one duodenal ampullary malignancy) treated with remnant gastrectomy ± Whipple procedure. The reason for the remnant gastrectomy was massive, intractable bleeding in 11 studies with 14 cases. The source of bleeding was from gastric ulcer in the six studies with nine patients, duodenal ulcer in two, one due to MU, one from GGF without any other pathology neither in pouch nor in remnant, and one from polypoid mass, which was later found to be due to the Cronkhite-Canada syndrome. MU was the reason for remnant gastrectomy in two studies with 13 patients; nine of them had concomitant GGF, and one of them was refractory to both medical and surgical treatments and remnant gastrectomy was inevitable. Peritonitis due to perforation of the remnant stomach and proceeding gastrectomy were reported in nine patients of eight studies. The reasons for perforation were related to peptic ulcer

Table 2 Characteristic of studies performed remnant gastrectomy after gastric bypass (reoperation or secondary resectional gastric bypass)

First author	Study type	Year	N	Gender	Age	Baseline BMI	Interval	Reason of resection	Secondary BMI	Follow-up	Hospital stay (day)
Puri [30]	CR	2012	1	F	52	NR	6 months	Bleeding from GU		6 months	
Papasavas [31]	CR	2003	1	F	35	45	6 months	Perforation due to GU	nr + L48	38 months	5
Mozzi [32]	CR	2008	1	M	22	36	28 days	Bleeding from GU	24	8 months	29
Rycx [33]	CR	2021	1	F	49	37	3 months	Perforation due to necrosis of stomach	NR	NR	14
Pang [34]	CR	2017	1	F	39	NR	2 years	Bleeding due to MU and GGF	NR	NR	2
Iranmanesh [35]	RAPD	2020	1	M	40	42.7	13 years	Remnant Necrosis	N/A	N/A	4
Chahine [36]	CS	2018	9	6F	38.5 (27–48)	41.3 (38–46)	40.5 months (24–72)	GGF	28.8 (27–31)	29.5 (20–36)	N/A
Suri [37]	CR	2019	1	F	67	NR	14 years	Bleeding from splenic pseudo aneurysm due to NSAIDs-induced GU	NR	NR	NR
Gys [38]	CR	2017	1	M	57	NR	5 years	Massive refractory intraluminal bleeding from a polypoid mass due to Cronkhite–Canada syndrome		5 years	Nr
Ivancez [39]	CR	2014	1	F	59	50	2 years	Bleeding from NSAIDs-induce DU		2 years	Nr
Arshava [40]	CR	2006	2	M	36/54	NR	3 years/2 month	Perforation and bleeding due to NSAIDs-induced PUD/Necrosis of unknown exact etiology		6 months	nr/3 m
Spires [41]	CR	1987	1	M	48	NR	4 years	Bleeding from DU	NR	NR	NR
Abellan [42]	CR	2013	1	F	53	52	4 years	GIST	50	NR	Nr
DeRoover [43]	CR	2006	1	M	66	44	3 years	Perforation/peritonitis due to lymphoma	nr	10 months	Nr
Escalona [44]	CR	2005	1	F	51	42	8 years	Adenocarcinoma	27	8 months	8
Khitin [45]	CR	2003	1	F	57	NR	22 years	Adenocarcinoma	nr	NR	4

Table 2 (continued)

First author	Study type	Year	N	Gender	Age	Baseline BMI	Interval	Reason of resection	Secondary BMI	Follow-up	Hospital stay (day)
Lord [46]	CR	1997	1	F	71	45	12 years	Adenocarcinoma	nr	3 months	Nr
Watkins [47]	CR	2007	1	M	44	50.6	18 years	Adenocarcinoma	23.7	8 months	Nr
Swain [48]	RS	2010	6	F	59.5	NR	9.6 year	3 cases of adenocarcinoma in stomach and pancreatic head, a case of islet cell, acinar carcinoma at the head of pancreas and ampullary tumor on duodenum	Nr	2.4 year	Nr
La Vella [49]	RS	2017	19	F	41	BMI before RYGB: 51.7 and BMI after RYGB: 28.5	4.4 year	Bile reflux gastritis	28.5	79 months	2.7
Campos [50]	RS	2015	5	NR	NR	NR	31 months	GGF		39.7	Nr
Steinemann [51]	CR	2011	1	M	50	45	13 months	Refractory MU	nr	9 months	Nr
Ryzhov [52]	CR	2020	1	M	50	47	6 years	Bleeding from GU	NR	3 month	9d
Tan* [53]	CR	2020	1	F	42	NR	NR	Intussusception			Nr
Rodrigues Gaspar [54]	CR	2020	2	M	44/47	53.3/42.4	3 years/18 month	GGF	26.1/37.1	6 month/24 month	6
Minyoung Cho [10]	RS	2007	15	14F	44.1	52.2	23 months	GGF	32.4	30 months	4.73
Chinelli [55]	MM	2022	1	M	52	49	2 years	GGF	nr	2 years	
Lundberg [56]	CR	2018	1	F	57	NR	15 years	GGF	nr		Nr
Chau [57]	RS	2014	12	NR	NR	NR	43 months	MU with nine GGF		35 months	Nr
Corcelles [58]	RS	2015	7	NR	NR	NR	6.4 ± 3.8 years	GGF			
Salimath [59]	RS	2009	22	NR	NR	NR	9 months	GGF		4 months	Nr
Rizk [60]	CR	2020	1	NR	51	NR	3 years	GGF and visualized the tip of a Faucher tube fixed in the blind pouch and an erosive ulceration on the gastrojejunal anastomosis. Multiple biopsies showed a low-grade dysplasia in the remnant stomach	36	6 months	2

Table 2 (continued)

First author	Study type	Year	N	Gender	Age	Baseline BMI	Interval	Reason of resection	Secondary BMI	Follow-up	Hospital stay (day)
O'brien [61]	CC	2013	7	F	36.7 ± 10.2	51.7 ± 14.2	NA	GGF	34.6 ± 7.2	4.1 ± 4 month (2–13)	Na
Nascimento [62]	CR	2020	1	F	48	NR	2 years	GIST	NA	12 months	NA
Pandya [63]	CR	2023	1	F	53	NR	13 years	GIST	NA	NA	NA
Patrascu [64]	CR	2018	1	F	52	45	7 years	Bleeding from GU	21.9	2 months	13
Abdelsattar [65]	CR	2019	1	F	46	NR	14 years	Bleeding from GGF	N/A	6 weeks	N/A
AlZarooni* [66]	CR	2020	1	F	32	NR	5 years	Remnant perforation due to Peterson's internal hernia	N/A	N/A	4 days
Braley[67]	CS	2002	4	3F	32/38/42/33	NR	15.5 years (13–17)	Bleeding due to GU	N/A	9–24 months	N/R (9 days in one case)
Ferreira* [68]	CR	2022	1	M	53	19.3	3.5 years	Perforation due to proximity to MU	18	2 y	6
Do [69]	CR	2016	1	F	63	NR	10 years	Necrosis and perforation maybe due to jejunojejunal anastomotic stenosis		1 months	3
Tinoco [70]	CR	2015	1	F	56	NR	10 years	Adenocarcinoma	25	1 year	Nr
Magge [71]	CR	2015	2	M/NR	69/NR	NR	28/25 year	Adenocarcinoma		6 m/nr	
Raijman [72]	CR	1991	1	F	38	NR	5 years	Adenocarcinoma		3 months	Nr
Haenen [73]	CR	2016	1	F	53	40	7 years	Adenocarcinoma (Linitis Plastica)		nr	Nr
Tucker [74]	RS	2007	17/7	14 M/7f	42/42	49.7/NR	24.9 m/93.6 m	GGF	NR/NR	NR	7.5

*All of the article are about the resectional after RYGB except this one

diseases (PUD) in two patients, proximity of remnant stomach to MU after OAGB and gastric lymphoma each in one patient, and necrosis mostly related to ischemic dilatation due to increased intraluminal pressure-induced by Peterson's internal hernia, jejunojejunal anastomosis stricture, gastric outlet obstruction by blood clot, or being unknown and justified by the previous manipulation on normal anatomy of vessels, embolic events, or hypercoagulable state. Finally, one report found gastroduodenal intussusception of gastric remnants after OAGB.

Outcomes and Complications

Pooled data of reported BMI 6 months and 1 year after RGB had a range of 27.54–33.2 kg/m^2 and 24.69–28.5 kg/m^2, respectively, and for %EWL at 6-month and 1-year follow-up, they reported 46–59.8% and 71–97%, respectively.

Regardless of death due to cancers, four deaths were reported with causes related to infection/sepsis/organ failure in three and pulmonary thromboembolism in one patient. The detected source of infection was an anastomotic leak and pneumonia in each patient. The remaining one had prolonged hyperthermia and cardiovascular failure after that. The rates of other reported complications are in Table 3.

Discussion

There are many reasons through the literature that made surgeons remove the stomach concomitant with the RYGB/OAGB (either as primary MBS to the GI anatomy or revision to another approach) or after a period from the original procedure due to the occurrence of a problem.

Indications

Simultaneous

Malignancy The risk of neoplasia was the main reason for resecting the remnant stomach concomitant with a standard RYGB/OAGB. RGB had been performed for preventive causes when surgeons were highly suspicious of developing gastric cancer in the future, mostly for patients living in areas with a high prevalence of gastric cancer, such as in East Asia (South Korea) and Central and South America (Chile) [6, 9, 11, 12, 22] and curiosity on what may have found on specimens extracting from 427 patients [24]. However, there is no strong evidence that MBS, mostly gastric bypass, increases the risk of future gastric cancers in predisposed patients, such as those living in areas with a high prevalence [6, 10–12, 22], positive family history, or a high-risk pathology that may advance to malignancy (e.g., IM, dysplasia, adenomatous polyps, and Menetrier's disease) [44]; the remanent stomach is going to be out-reached by standard upper endoscopy after surgery, and therefore, it is better to exclude this part from the system [6, 7, 10–12, 22]. Although these investigations advocated their hypothesis without increased burden, acceptable weight loss, and similar predictable postoperative complications in comparison to SG/RYGB (except for a significant change in serum level of vitamin B_{12}) [9], other surgeons did not dare to pose such an unknown high-risk procedure to their patient in other parts of the world. Regardless of omitting the remnant stomach from the system, there is still a risk of malignancy in the gastric pouch or at the GJA. However, these parts are easily accessible through upper endoscopy. The remaining uninvestigated point is the risk of malignancy after RGB and its comparison to RYGB to evaluate whether RGB prevents cancer much more than RYGB.

Another aspect of this problem is that obesity and gastritis with mucosal atrophy due to chronic inflammation by *Helicobacter pylori* (HP) or autoimmune condition are among the risk factors for developing pathologic changes that transform the normal gastric histology to the IM. Without proper treatment, IM may progress to dysplasia and, eventually, the most common type of gastric malignancy, adenocarcinoma. IM was reported to be the main intention of RGB in 2 patients of 2 included articles and was incidentally found in only three specimens of Sohn et al. and 8.9–10.5% of Braghetto et al. evaluations [11, 12, 17, 18, 21, 24, 26]; definite gastric cancer was not found in any of the previous investigations. Similar to patients who are categorized as high-risk for developing gastric cancer in the future, with gastric bypass, most of the stomach is not easily accessible by upper endoscopy. Therefore, remnant gastrectomy is a reasonable option in these cases for both therapeutic and preventive intentions [6, 22]. Gastritis (either acute, chronic, atrophic, or lymphoid), gastric polyps, and ulcers are other reported pathologies in the remnant stomach that were found incidentally in Sohn et al. and Braghetto et al. histologic reports of the extracted stomach and may have been found in populations with severe obesity similar to normal populations [11, 24]. Gastritis or gastric ulcers regress significantly with effective acid-reducing agents such as PPI. However, unless there is IM, dysplasia, or early stages of adenocarcinoma in taken biopsies, there is no need to perform RGB to prevent gastric adenocarcinoma. There are several types of gastric polyps, and unless they are symptomatic (e.g., severe abdominal pain, bleeding, perforation), large enough, or at high risk of transforming into cancerous lesions (e.g., in hyperplastic and adenomatous types), excision is not indicated.

Incidental findings of GIST, neuroendocrine tumor in the duodenum, and lymphoma were other reasons for RGB in relation to neoplasia. GISTs with local restriction to

Table 3 Reported complications after resectional gastric bypass (both primary and secondary)

Prevalence	Morbidity	*n* of Study	Rate (%) [Range reported in studies]
< 1%	Pneumonia	5	12 (0.19) [0.89–8.3]
	Greater omentum necrosis with abscess	1	1 (0.25)
	Proximal segment of jejunal loop necrosis	1	1 (0.25)
	Small bowel injury	2	2 (0.44) [0.25–1.85]
	Intraoperative abscess	2	2 (0.48) [0.25–8.3]
	Porto-mesenteric thrombosis	1	2 (0.5)
	Duodenal leak*	5	7 (0.51) [0.25–2.56]
	Hemoperitoneum	6	7 (0.72) [0.25–12.5]
	Splenic injury	5	6 (0.92) [0.25–4.1]
	Sub-hepatic abscess	1	1 (0.89)
	Intestinal obstruction	6	11 (0.96) [0.25–8.33]
	Wound dehiscence	3	5 (0.98) [0.25–3.8]
1–5%	Gastric retention	1	4 (1)
	Suture line bleeding	3	6 (1.11) [0.75–4.1]
	Anastomotic Stricture	1	1(1.17)
	Pleural effusion	1	1 (1.17)
	Subphrenic collection	3	7 (1.17) [0.89–1.25]
	Anastomotic suture line bleeding	2	5 (1.21) [1–8.3]
	Gastric suture leak	3	3 (1.77) [0.89–20]
	Atelectasis	1	2 (1.78)
	Perioperative myocardial infarction	1	1 (1.92)
	Internal hernia	4	10 (2.19) [1.75–50]
	Pulmonary thromboembolism	2	3 (2.18) [1.17–3.84]
	Dysphagia	1	1 (2.56)
	Anastomotic leak	6	16 (2.63) [1.17–7.40]
	Vessel injury	3	5 (3.12) [1.92–3.7]
	Urinary tract infection/retention	4	5 (3.12) [1.85–7.4]
	Clostridium difficile colitis	2	3 (3.79) [3.7–3.8]
	Stricture/ileus	3	4 (3.96) [1.85–7.4]
	Surgical site infection	7	12 (4.5) [3.7–8.3]
5–10%	Diarrhea/dumping	4	13 (5.09) [1.08–33.3]
	Gastric bleeding	2	2 (5.4) [4.76–6.25]
	Ventral hernia	6	25 (7.73) [3.7–10.3]
> 10%	Seroma	5	26 (11.81) [7.4–15.3]
	Iron and Vitamin Deficiency**	4	58 (23.01) [20–33.3]
	Wound complication	1	13 (25)
	Marginal Ulcer	1	4 (25)
	Nausea and abdominal cramp/pain	3	12 (31.57) [14.3–58.3]

*Timing of duodenal leak was not defined in one, two occurred early, and four detected late in the postoperative course

**One study reported anemia, one mentioned iron deficiency anemia, one study just declared vitamin deficiency, and one study reported iron (oral and parental) and Vitamin B_{12} supplementation

stomach larger than 2 cm (and in some cases > 1 cm due to the risk of metastasis) or symptomatic types (i.e., with mass effect or mucosal ulcer) are removed surgically [75] with adequate margin. If anatomically applicable, for a patient with GIST and severe obesity, sleeve gastrectomy (SG) is an excellent option to capture the tumor along with the resected stomach in case of no contraindications of SG [19, 75, 76]. Otherwise, RYGB with wedge resection of the tumor is recommended [76]; remnant gastrectomy is for when we cannot have a negative microscopic margin with standard RYGB + wedge resection of the tumor [19, 75, 76], or it is surgically challenging for the surgeon and performing an RGB is more accessible with lower risk. Duodenal neuroendocrine tumor and gastric lymphoma were reported

in two case reports, and we think the same surgical principle applies to these tumors as well. However, the role of preoperative upper endoscopy in inspecting gastric mucosa shines in this scenario [19, 25, 75, 76]. Indeed, in the report by Quesada et al., lymphoma was not identified in the preoperative upper endoscopy and was then found during the surgery by full visualization of the stomach from an external view. The same experience was reported in many GIST cases, especially when the tumor was growing away from the gastric mucosa (exophytic), necessitating surgeons to inspect the stomach externally during the operation before firing the staples [19, 25, 75, 76].

Avoiding Future Remnant Problems and Weight Troubles Failure of previous approach based on weight (IWL/WR) mostly after restrictive approaches (e.g., vertical banded gastroplasty, SG, gastric banding, and horizontal banded gastroplasty) was one of the main reasons for RGB in Curry, Martin, and Noun et al. studies [5, 7, 29]. Although RGB is not a common decision for conversion after a variety of failed primary MBS [77], their comparison with primary RGB or SG [5, 7, 9] supports this idea that besides some predictable challenges, RGB is reliable, safe, and applicable after failed primary MBS or even in a special situation as the main gastric bypass approach to eliminate both severe obesity and the future development of potential complications in the remnant stomach (e.g., fistula, ulcer, gastric dilatation, staple line disruption, hemorrhage, or late malignancy) or to resolve a symptomatic problem of restrictive MBS approach (e.g., dysphagia) [5–7, 11, 14, 26–28] with comparable weight loss not more than what is expected and with the same profile of complications as the standard RYGB has [5, 7, 9, 11, 14, 26–28].

GERD Csendes et al., on 15 patients with BE, revealed that RGB is an excellent anti-reflux procedure for patients with severe obesity and BE + IM of the cardia [13]. However, the need for more evidence on this subject made Braghetto et al. conduct a three-arm study [12]. They implied RGB is the choice for patients with severe obesity and preoperative GERD + BE without the need for fundoplication in comparison to the other two approaches, in which one of them had fundoplication, vagotomy, distal gastrectomy + RY gastrojejunostomy (FVDGRYGJ, removing 60% of the stomach vs. 95% in RGB). The prior method had the exact resolution of GERD + BE but with lower weight loss and different postoperative complication profiles not discussed by the authors [12]. The observed difference in weight loss could be justified by the amount of resected stomach and their difference in choosing the alimentary RY limb (130–150 cm in RGB vs. 60–70 cm in the other). Regarding their postoperative complications, dysphagia in the FVDGRYGJ group could relate to fundoplication, and diarrhea/dumping may be explained by the size of the gastric pouch and limb length discrepancies.

Reoperation

Remnant gastrectomy in previously bypassed patients was mainly indicated to treat a postoperative complication either directly or indirectly associated with the gastric bypass procedure. GGF, GERD, MU, neoplasia, bleeding, and perforation are among the highest reported indications of secondary RGB and other rare causes limited to case reports such as necrosis and intussusception of the remnant stomach to duodenum after OAGB.

GGF The pathway between the gastric pouch and remnant, called GGF, may develop due to various initiators, mainly leak and inflammation from the staple line, and may complicate 1–6% of the cases after RYGB [36, 55]. GGF with the presenting symptom of abdominal pain or vomiting may be the sole problem [74] or be associated with MU, as reported in a different study found together in 16–75% of the cases and other accompanying problems such as bleeding from the fistula [65] or ulcer [34, 57], food intolerance [74], perforation/peritonitis, GJA stenosis [74], or IWL/WR [10, 36, 50, 60, 74]. At first, for small GGF, conservative management constituting PPI, sucralfate, HP eradication if positive, and cessation of NSAIDs and smoking are recommended [10, 59, 74]. In the next step, multiple endoscopic attempts (e.g., glue, clip, or stent placement) may be tested because they are safe, non-invasive, and buy some time to decide what to do next as Campos et al. and other surgeons have recommended [50, 54]. However, they are unacceptable for large tracts due to the high failure rate [36]. Therefore, surgical intervention is the most definite option when the patient is unresponsive to medical/endoscopic treatments with intractable symptoms [10, 50, 59, 74, 78]. GGF surgical intervention has been mentioned to have two types based on the distance between GJA and opening of GGF into the gastric pouch [36], patient symptoms or accompanied problem (e.g., bleeding, MU, or WR) [34, 57, 65], and surgeon preference such as a compromised optimal surgical view by the local inflammation and adhesions [10, 36, 50, 54, 55, 58, 74]. Fistula tract resection with perseveration of GJA by resecting a part of the gastric pouch and remnant stomach or en bloc resection of GGF and GJA with re-do of the GJA are the two proposed methods [10, 36]. Although the amount of remnant resection is different between studies and depends on various factors, it seems the earlier approach with remnant gastrectomy in which a part or nearly all of the source of acid production is deleted is more favorable [10, 54, 57, 59, 74] due to fear of future development of MU, GGF recurrence, and some severe complications [58, 60] unless recreation of the gastric pouch and revision of the GJA is needed such as in enlarged

pouch, stenosis of the GJA, and intractable MU or its associated problems [57, 58, 60]. The interruption in weight loss or WR after surgery is due to the dual route of food pathway and impaired balance between gut hormones, all reversible after GGF repair and restoring the body to what it was after bypass surgery [61]. The bleeding and MU are associated with long-term exposure of gastric pouch and GJA to the acid produced in the remnant stomach brought by GGF and the presence of the remnant stomach itself having G-cells, the origin of gastrin, which stimulates acid production by parietal cells. Therefore, GGF repair with remnant gastrectomy diminishes the main source of acid production and relieves the MU and bleeding [34, 57].

Bile Reflux Gastritis Bile reflux is not a severe concern after OAGB [79]. However, intractable abdominal pain due to bile reflux gastritis of the remnant stomach is a rare complication not have been evaluated thoroughly. La Vella et al. [49] study estimated this problem to be near 2.7%. Although all of their patients were under PPIs, they performed remnant gastrectomy without testing other potential medical treatments such as ursodeoxycholic acid or prokinetics. Therefore, RGB for this scenario needs justification and further investigation.

Neoplasia There are few gastric and pancreaticoduodenal neoplasms after gastric bypass [48, 62]. Gastric cancers were adenocarcinoma [11, 47, 70–73], GIST [42, 62, 63], and lymphoma [43]; adenocarcinoma was reported the most [11, 47, 62, 70–73]. Patients of this group were diagnosed due to the appearance of symptoms such as abdominal pain, dysphagia, vomiting, bleeding, iron deficiency anemia, further weight loss after plateau, or they may remain asymptomatic for an extended period [42, 48] and stay undiagnosed till some severe symptoms appear (e.g., perforation or obstruction) [43]. On the other hand, negligence of symptoms and misinterpretation of common post-bariatric problems and being out-reach by the standard evaluations made these tumors diagnosed at more advanced stages [42–44, 47, 70–73]. Although there is speculation that the incidence of GIST is higher in the bariatric population than in ordinary people [75], lymphoma does not seem to have a direct strong association with obesity [43]. Indeed, HP and chronic mucosal inflammation due to duodenal reflux after gastric bypass may have a role in lymphocyte infiltration and, therefore, gastric stump and distal gastric lymphoma development [43]. However, obesity has an association with IM and gastric adenocarcinoma as it is an independent factor [44].

Instead, although there are large studies indicating cancer development decrease in the MBS group [62] and there is a long period between surgery and detecting cancer, indicating a low probability of a direct causal relationship [46, 70], whether the incidence of IM and gastric cancer will increase by MBS especially after gastric bypass is a debated area. Regardless of the HP, the excluded part does not have close contact with carcinogenic materials in food; however, it has continuous exposure to an acidic environment without food and sometimes duodenopancreaticobiliary contents (i.e., bile reflux), which has shown to be carcinogenic for stomach [44, 45]. Inevitably, remnant gastrectomy is the treatment of choice for gastric adenocarcinoma, GIST, and lymphoma in the excluded stomach [42, 43, 47, 62, 63, 71–73]; indeed, it has a preventive aim for IM to cease its progression to dysplasia.

Bleeding Another rare but life-threatening challenge after gastric bypass is gastrointestinal bleeding with an incidence rate of less than 1% to nearly 5% [30], which, after complete evaluations, may turn out to be from the remnant stomach and its proceeding part, duodenum [39, 41, 67]. PUD with a spectrum of pathologic changes in the stomach (i.e., gastritis and gastric ulcer) or duodenum due to NSAID consumption, HP infection, or unknown causes were the source of bleeding in most cases [30, 32, 37, 39, 40, 52, 64, 67]. Furthermore, bleeding could be associated with mass [20, 38], GGF [65], MU [34], or even some rare cases such as erosion of gastric remnant fundus with the diaphragmatic vessel [76], splenic pseudoaneurysm [37], or perforation/peritonitis [31, 40]. Upper endoscopy is recommended as the first diagnostic approach [30]. However, push or double-balloon enteroscopy is the final preferred approach to inspect the duodenum and remnant stomach after being unremarkable. Bleeding due to PUD is reasonably managed with blood transfusion if indicated, high doses of PPI, antibiotics for HP eradication if positive, and cessation of NSAIDs consumption and smoking [67], which are also the routine first-line treatments for MU and GGF [34]. Although most surgeons advise stepwise management [64] and the nonoperative approach was successful in some cases [80], being resistant to medical and endoscopic treatments (such as electrocautery and clip), recurrence, perforation, producing instability of hemodynamics, or having accompanying problems such as malignancy, MU, or GGF, made surgeon remove the remaining part of the stomach for definite treatment and patient survival [30, 32, 34, 37, 39, 40, 52, 65, 80].

Peritonitis Peritonitis due to perforation was only reported in a few case reports. It was related to (1) NSAIDs or HP-induced PUD, (2) MU, (3) ischemia and necrosis of remnant stomach induced by increased intra-luminal pressure due to jejunojejunal anastomotic stricture, small bowel obstruction because of internal hernia, remnant outlet obstruction by accumulation of blood clots due to bleeding or cancer, and (3) unknown in some situations [33, 35, 37, 40, 66–69, 80]. Before reaching the acute abdomen, most patients may have had other symptoms (abdominal pain ± tenderness, dizziness, lightheadedness, fatigue, dyspnea), but ignorance or underestimation by both surgeon and patient

may lead to perforation [31]. Abdominal pain is the presenting symptom with the highest prevalence, which could be misdiagnosed and misinterpreted as one of the common problems after MBS. Regardless of asymptomatic scenarios, surgeons should alert their patients regarding these gastrointestinal symptoms and encourage them to seek medical professionals. Surgeons should comprehensively investigate patients presenting with these symptoms to roll out serious causes. Finally, a high suspicion level is required to detect these diseases at the beginning of their development. However, general postoperative recommendations such as avoiding smoking and chronic use of NSAIDs and empirical PPI after complete evaluations could be a reasonable approach for most patients to prevent the development of ulcers or slow their progression. Ulcer-induced perforations may be treated with patch-repair [35]; however, remnant gastrectomy was performed for cases with failure or medical/endoscopic treatments, diminished optimal view for other procedures [68], instability of hemodynamics [31], and irreversible ischemia/necrosis of a substantial segment of the remnant stomach [33, 40].

MU The pathophysiology of MU after gastric bypass is unclear; the proximity of gastric tissue to the intestinal mucosa and the disruption of the mucosal protection mechanism could explain it. MU may occur as a sole problem after surgery, presenting with abdominal pain, or be associated with GGF [34, 57, 58]. Symptoms of MU have a wide range and could cause GJA stricture and obstruction, bleeding, and perforation [34, 68]. As long as MU is highly related to an acidic environment without proper mucosal protection, medical treatment tries to address these points [51]. However, in case of persistence, bleeding, stricture, or perforation, a revision to the GJA and en bloc resection of the affected area with a new pouch creation is the recommended surgical approach [34, 57]. Remnant gastrectomy has been mostly performed for cases with additional problems of MU, such as GGF [10, 57, 58] or unresponsiveness to prior medical and surgical management [34, 57, 68]. Indeed rare, two cases had their remnant stomach removed due to intractable MU, one with resistance to all of the medical and surgical actions [51] and the other had a perforation of the remnant stomach due to proximity to ulcer and inflamed area [68]. Most studies did not report the number and reason behind remnant gastrectomy of MU with vs. without accompanying problems such as GGF, which needs further investigation.

Outcomes and Complications

In contrast to indications of RGB, data regarding the postoperative complications and outcomes of RGB and its comparison to SG and standard RYGB/OAGB is scarce; one explanation is that simultaneous remnant gastrectomy with gastric bypass is not a standard procedure and few surgeons have to perform it for mostly preventive intentions and to evaluate whether this approach would help their patients. On the other hand, remnant gastrectomy after gastric bypass had to be performed for the final treatment of some complications. Previous investigations advocate that remnant gastrectomy with or after gastric bypass does not affect the amount of weight loss compared to standard RYGB or SG [9]. It indicates that weight loss after RYGB or RGB is related to the size of the gastric pouch, length of limbs, and patient adherence to postoperative recommendations regarding eating habits and exercise [5–7, 9, 11, 12, 22]. The pooled postoperative data of %EWL or ΔBMI indicates that they are within the expected range at 6 and 12 months after either primary or secondary RGB [5, 6, 12, 22]. Indeed, it facilitates weight loss in those who had failed prior operations or WR due to problems such as GGF [5, 9, 29, 36, 50, 60, 61]. Previously known concerns about standard RYGB apply too after RGB but with permanent elimination of the potential risks that may occur after primary gastric bypass relating to the remnant stomach, such as staple line disruption or enlargement of the residual stomach, and eventual future development of remnant gastric neoplasia or its potential for acid production as in MU, GGF, and bleeding. Post-gastric bypass problems, which led the surgeons to perform a reoperation and conduct remnant gastrectomy, had a 100% success rate without direct mortality, and none of the problems recurred after secondary RGB. Regardless of the surgical challenge, longer operation time, more intraoperative bleeding, and risks of iatrogenic injuries to the vessels (e.g., hemoperitoneum, hepatic and phrenic veins, and short gastric artery) and organs (e.g., spleen and small bowel), RGB is different from standard RYGB in terms of necessitating an experienced surgical team in gastrectomy. Despite their rarity, duodenal stump leak, stricture, hemorrhage from different sites, leak from anastomosis, collection (e.g., in subphrenic or subhepatic regions), intra-abdominal abscess, occasional nausea, post-prandial pain or diarrhea/dumping syndrome, ventral hernia (mainly after open surgery), obstruction (either due to internal hernia or adhesion bands), and wound problems (e.g., seroma, superficial infection, dehiscence, and necrosis mainly after open operations) are some of the reported complications after RGB, which were predictable similar to any other operation [11, 12, 21, 22, 49, 57]. Other postoperative complications (e.g., *Clostridium difficile* colitis, perioperative myocardial infarction, urinary tract infection/retention, ileus, thrombosis, atelectasis, and pneumonia) are a risk of any significant procedure and seem they have no association with remnant gastrectomy. However, iron deficiency anemia and vitamin B_{12} deficiency are predictable after remnant gastrectomy due to the elimination of acid and intrinsic factor secretion from parietal cells [10, 22, 57]. However, both of these conditions are rare; our body has a large reserve of them, and they can easily be diagnosed with a complete blood count test and will be managed with iron and B_{12} supplements (either oral or parental) [10, 22, 57]. The comparison of RGB vs. SG in the Cho et al. study only revealed lower levels of vitamin B_{12} and, therefore, a higher supplementation

rate [9]. Finally, RGB is a permanent act, omitting the chance to reverse the operation [81]; although uncommon, it may be used for cases with severe malnutrition, such as low albumin level, BMI < 18 kg/m^2, or acute liver failure [81].

Conclusion

Remnant gastrectomy concomitant with gastric bypass has been mostly performed in areas with a high prevalence of gastric cancer because of being out-reach by upper endoscopy and hard to detect; therefore, it is better to eliminate the risk. Regardless of the gastric cancer, failure of other approaches, occurrence of post-bariatric intractable symptoms, GERD, and avoiding problems that may occur due to in-site remnant stomach mainly relating to its potential for acid production such as fistula, ulcer, gastric dilatation, staple line disruption, or hemorrhage were other reasons that made surgeon to perform the RGB for patients with severe obesity. Remnant gastrectomy after gastric bypass was performed to treat post-bariatric complications such as fistula, MU, bleeding, peritonitis, and neoplasia with a near 100% resolution rate and no recurrence. Rather than some unique complications relating to remnant gastrectomy, such as duodenal stump leak and anemia (either due to iron deficiency or vitamin B_{12}), RGB has the same range of weight reduction in comparison to standard RYGB or SG; indeed, it helps lose weight in those who had IWL/WR or diminish intractable symptoms due to failed prior procedures.

Supplementary Information The online version contains supplementary material available at https://doi.org/10.1007/s11695-024-07240-2.

Acknowledgements We express our gratitude toward Alireza Pouramini and Mahyaar Omouri for their help and support through this project.

Declarations

Competing Interests The authors declare no competing interests.

References

1. Mahmoudieh M, Keleidari B, Hadipour P, et al. Comparative effectiveness of Roux-en-Y gastric bypass vs. one anastomosis gastric bypass on kidney function. Obes Surg. 2021;31:2464–70. https://doi.org/10.1007/s11695-021-05295-z
2. Mahmoudieh M, Keleidari B, Salimi M, et al. The two different biliopancreatic limb lengths for Roux-en-Y gastric bypass. Obes Med. 2019;16:100146.
3. Mahmoudieh M, Keleidari B, Afshin N, et al. The early results of the laparoscopic mini-gastric bypass/one anastomosis gastric bypass on patients with different body mass index. J Obes. 2020;1. https://doi.org/10.1155/2020/7572153
4. Keleidari B, Mahmoudieh M, Kafi S, et al. Which one is better for non-alcoholic fatty liver disease, the Roux-en-Y gastric bypass or one anastomosis gastric bypass? A paired liver biopsy report. Obes Med. 2020;18:100205.
5. Martin MJ, Mullenix PS, Steele SR, et al. A case-match analysis of failed prior bariatric procedures converted to resectional gastric bypass. Am J Surg. 2004;666–71. https://doi.org/10.1016/j.amjsurg.2004.02.002
6. Csendes A, Burdiles P, Papapietro K, et al. Results of gastric bypass plus resection of the distal excluded gastric segment in patients with morbid obesity. J Gastrointest Surg. 2005;9:121–31.
7. Curry TK, Carter PL, Porter CA, et al. Resectional gastric bypass is a new alternative in morbid obesity. Am J Surg. 1998;175(5):367–70.
8. Mala T. The gastric remnant in Roux-en-Y gastric bypass challenges and possibilities. J Clin Gastroenterol. 2016 Aug 1;50(7)527–31. https://doi.org/10.1097/MCG.0000000000000550
9. Cho YS, Park JH, Kim JS, et al. Clinical outcomes of resectional Roux-en-Y gastric bypass, compared to sleeve gastrectomy for severe obesity. Obes Surg. 2023;33:1338–46.
10. Cho M, Kaidar-Person O, Szomstein S, et al. Laparoscopic remnant gastrectomy: a novel approach to gastrogastric fistula after Roux-en-Y gastric bypass for morbid obesity. J Am Coll Surg. 2007;204:617–24.
11. Braghetto I, Martinez G, Korn O, et al. Laparoscopic subtotal gastrectomy in morbid obese patients: a valid option to laparoscopic gastric bypass in particular circumstances (prospective study). Surg Today. 2018;48:558–65.
12. Braghetto I, Korn O, Csendes A, et al. Laparoscopic treatment of obese patients with gastroesophageal reflux disease and Barrett's esophagus: a prospective study. Obes Surg. 2012;22:764–72.
13. Csendes A, Burgos AM, Braghetto I. Classification and management of leaks after gastric bypass for patients with morbid obesity: a prospective study of 60 patients. Obes Surg. 2012;22:855–62.
14. See C, Carter PL, Elliott D, Mullenix P, Eggebroten W, Porter C, Watts D. An institutional experience with laparoscopic gastric bypass complications seen in the first year compared with open gastric bypass complications during the same period. Am J Surg. 2002 May 1;183(5):533–8. https://doi.org/10.1016/S0002-9610(02)00829-2
15. Page MJ, McKenzie JE, Bossuyt PM, et al. The PRISMA 2020 statement: an updated guideline for reporting systematic reviews. Int J Surg. 2021;88:105906.
16. Shea BJ, Grimshaw JM, Wells GA, et al. Development of AMSTAR: a measurement tool to assess the methodological quality of systematic reviews. BMC Med Res Methodol. 2007;7–1. https://doi.org/10.1186/1471-2288-7-10
17. Voellinger DC, Inabnet WB. Laparoscopic Roux-en-Y gastric bypass with remnant gastrectomy for focal intestinal metaplasia of the gastric antrum. Obes Surg. 2002;12:695–8. https://doi.org/10.1381/096089202321019710
18. Tartamella F, Petracca G, Romboli A, et al. Laparoscopic gastric bypass with remnant gastrectomy in a super-super obese patient with gastric metaplasia: a surgical hazard? Acta Biomed. 2017;88:496–500.
19. Leuratti L, Alfa-Wali M, Bonanomi G. Intraoperative findings during a gastric bypass necessitating the removal of the gastric remnant. to proceed or not with the elective plan? Surg Obes Relat Dis. 2013;9:e69–71. https://doi.org/10.1016/j.soard.2013.02.011
20. Ghanem M, Teixeira AF, Jawad MA. Resection of the excluded stomach due to severe bleeding immediately after Roux-en-Y gastric bypass in a patient with Lynch syndrome: a case report. Surg Obes Relat Dis. 2017;13:e21–3.

21. Csendes A, Burgos AM, Smok G, et al. Effect of gastric bypass on Barrett's esophagus and intestinal metaplasia of the cardia in patients with morbid obesity. J Gastrointest Surg. 2006;10:259–64.
22. Park JY, Kim YJ. Laparoscopic resectional gastric bypass: initial experience in morbidly obese Korean patients. Surg Today. 2015;45:1032–9.
23. Jain N et al. Duodenal neuroendocrine tumours in morbidly obese: Amalgamated strategy to optimise outcome. Journal of Minimal Access Surgery. 2021:17(2):249–2. https://doi.org/10.4103/jmas.JMAS_77_20
24. Sohn VY, Arthurs ZM, Martin MJ, et al. Incidental pathologic findings in open resectional gastric bypass specimens with routine cholecystectomy and appendectomy. Surg Obes Relat Dis. 2008;4:608–11.
25. Quesada BM, Roff HE, Chiappetta Porras LT. Intraoperative finding of a gastric lymphoma during gastric bypass surgery. Obes Surg. 2007;17:847–8.
26. Braghetto I, Csendes A, Korn O, et al. Laparoscopic resectional gastric bypass in patients with morbid obesity: experience on 112 consecutive patients. J Gastrointest Surg. 2011;15:71–80.
27. Armstrong PJ, Chung MH, Holeman VR. The Gary P. Wratten surgical symposium resectional gastric bypass in the bariatric surgery practice of a small community hospital. Curr Surg. 1999 Sep 1;56(7–8):435–7. https://doi.org/10.1016/S0149-7944(99)00154-3
28. Brounts LR, Lesperance K, Lehmann R, et al. Resectional gastric bypass outcomes in active duty soldiers: a retrospective review. Surg Obes Relat Dis. 2009;5:657–61.
29. Noun R, Slim R, Chakhtoura G, et al. Resectional one anastomosis gastric bypass/mini gastric bypass as a novel option for revision of restrictive procedures: Preliminary results. J Obes. 2018;2018. https://doi.org/10.1155/2018/4049136
30. Puri V, Alagappan A, Rubin M, et al. Management of bleeding from gastric remnant after Roux-en-Y gastric bypass. Surg Obes Relat Dis. 2012;8. https://doi.org/10.1016/j.soard.2010.08.015
31. Papasavas PK, Yeaney WW, Caushaj PF, Keenan RJ, Landreneau RJ, Gagné DJ. Perforation in the bypassed stomach following laparoscopic Roux-en-Y gastric bypass. Obes Surg. 2003 Oct 1;13(5):797–9.
32. Mozzi E, Lattuada E, Zappa MA, et al. Failure of gastric bypass following several gastrointestinal hemorrhages. Obes Surg. 2010;20:523–5.
33. Rycx A, Maes H, Van Nieuwenhove Y. A rare complication of laparoscopic Roux-en-Y gastric bypass: case report of gastric remnant necrosis. Acta Chir Belg. 2023;123:62–4.
34. Pang AJ, Hagen J. Laparoscopic approach to a bleeding marginal ulcer fistulized to the gastric remnant in a patient post Roux-en-Y gastric bypass. Surg Obes Relat Dis. 2017;13:1451–2.
35. Iranmanesh P, Manisundaran NV, Bajwa KS, et al. Management of acute gastric remnant complications after Roux-en-Y gastric bypass: a single-center case series. Obes Surg. 2020;30:2637–41.
36. Chahine E, Kassir R, Dirani M, et al. Surgical management of gastrogastric fistula after Roux-en-Y gastric bypass: 10-year experience. Obes Surg. 2018;28:939–44.
37. Suri K, Tran K, Whang G. Gastric remnant perforation in a gastric bypass patient secondary to splenic artery pseudoaneurysm: radiologic-surgical correlation. Clin Imaging. 2019;54:159–62.
38. Gys B, Mertens J, Ruppert M, et al. Cronkhite-Canada syndrome causing pouch outlet obstruction 5 years after roux-en-y gastric bypass. Acta Chir Belg. 2019;119:56–8.
39. Ivanecz A. Life threatening bleeding from duodenal ulcer after Roux-en-Y gastric bypass: case report and review of the literature. World J Gastrointest Endosc. 2014;6:625.
40. Arshava EV, Mitchell C, Thomsen T, et al. Delayed perforation of the defunctionalized stomach after Roux-en-Y gastric bypass surgery. Surg Obes Relat Dis. 2006;2:472–6.
41. Spires WV., Morris DM. Bleeding duodenal ulcer after gastric bypass procedure for obesity. South Med J. 1987;80:1325–6. https://doi.org/10.1097/00007611-198710000-00033
42. Abellán I, Ruíz De Angulo D, Parrilla P. Incidental gastric gastrointestinal stromal tumor (GIST) in the excluded stomach after Roux-en-Y gastric bypass: a case report and review of the literature. Surg Obes Relat Dis. 2014;10. https://doi.org/10.1016/j.soard.2013.07.006
43. De Roover A, Detry O, De Leval L, et al. Report of two cases of gastric cancer after bariatric surgery: lymphoma of the bypassed stomach after Roux-en-Y gastric bypass and gastrointestinal stromal tumor (GIST) after vertical banded gastroplasty. Obes Surg. 2006;16:928–31.
44. Escalona A, Guzmán S, Ibáñez L, et al. Gastric cancer after Roux-en-Y gastric bypass. Obes Surg. 2005;15:423–7.
45. Khitin L, Roses RE, Birkett DH. Cancer in the gastric remnant after gastric bypass: a case report. Curr Surg. 2003;60:521–3.
46. Lord RV, Edwards PD, Coleman MJ. Case report gastric cancer in the bypassed segment after operation for morbid obesity. Aust N Z J Surg. 1997;67(8):580–2. https://doi.org/10.1111/j.1445-2197.1997.tb02047.x
47. Watkins BJ, Blackmun S, Kuehner ME. Gastric adenocarcinoma after Roux-en-Y gastric bypass: access and evaluation of excluded stomach. Surg Obes Relat Dis. 2007;3:644–7.
48. Swain JM, Adams RB, Farnell MB, et al. Gastric and pancreatoduodenal resection for malignant lesions after previous gastric bypass-diagnosis and methods of reconstruction. Surg Obes Relat Dis. 2010;6:670–5.
49. La Vella E, Yarbrough D. Bile reflux gastritis of the remnant stomach following Roux-en-Y gastric bypass: a newly recognized etiology of chronic abdominal pain successfully treated with remnant gastrectomy. Surg Obes Relat Dis. 2016;12:S56.
50. Campos J, Neto MG, Martins J, et al. Endoscopic, conservative, and surgical treatment of the gastrogastric fistula: the efficacy of a stepwise approach and its long-term results. Bariatr Surg Pract Patient Care. 2015;10:62–7.
51. Steinemann DC, Schiesser M, Clavien PA et al. Laparoscopic gastric pouch and remnant resection: a novel approach to refractory anastomotic ulcers after Roux-en-Y Gastric Bypass: Case report. BMC Surg 11, 2011;33. https://doi.org/10.1186/1471-2482-11-33
52. Ryzhov MK, Zubeev PS, Grekova NS, et al. Case of successful treatment of chronic gastric remnant haemorrhagic ulcer after Roux-en-Y gastric bypass. Obe Metab. 2020;17:88–92.
53. Tan WH, Eckhouse SR, Dimou F. Intussusception of the gastric remnant following laparoscopic one-anastomosis gastric bypass. Obes Surg. 2020;30:1586–8. https://doi.org/10.1007/s11695-020-04441-3
54. Gaspar JRR, Marques P, Mesquita I, et al. Laparoscopic treatment of a gastro-gastric fistula after Roux-en-Y gastric bypass—report of two cases. J Surg Case Rep. 2020;2020. https://doi.org/10.1093/jscr/rjaa478
55. Chinelli J, Hernández G, Rodríguez G. Gastro-gastric fistula: late complication after Roux-en-Y gastric bypass. Obes Surg. 2022;32:2490–1.
56. Lundberg P, El Chaar M. Laparoscopic excision of anastomotic stricture and remnant gastrectomy with conversion to esophagojejunostomy. Surg Obes Relat Dis. 2018;14:S80.
57. Chau E, Youn H, Ren-Fielding CJ, et al. Surgical management and outcomes of patients with marginal ulcer after Roux-en-Y gastric bypass. Surg Obes Relat Dis. 2015;11:1071–5.
58. Corcelles R, Jamal MH, Daigle CR, et al. Surgical management of gastrogastric fistula. Surg Obes Relat Dis. 2015;11:1227–32.
59. Salimath J, Rosenthal RJ, Szomstein S. Laparoscopic remnant gastrectomy as a novel approach for treatment of gastrogastric fistula. Surg Endosc. 2009;23:2591–5.

60. Rizk S, El Hajj MW, Assaker N, et al. Case report about the management of a late Gastro-Gastric Fistula after Laparoscopic Gastric Bypass, with the finding of an unexpected foreign body. Int J Surg Case Rep. 2020;67:117–9.
61. O'Brien CS, Wang G, McGinty J, et al. Effects of gastrogastric fistula repair on weight loss and gut hormone levels. Obes Surg. 2013;23:1294–301.
62. Nascimento WA, Macedo CES, Santa-Cruz F, et al. Gastrointestinal stromal tumor of the excluded stomach after Roux-en-Y gastric bypass: a case report and literature review. Int J Surg Case Rep. 2020;74:196–200.
63. Pandya SR, Kenney LM, Hughes MS. Gastrointestinal stromal tumor in the excluded gastric remnant after Roux-en-Y gastric bypass. Am Surg. 2023;89:3311–2. https://doi.org/10.1177/00031348231160839
64. Patrascu S, Ponz CB, Ananin SF, et al. A delayed acute complication of bariatric surgery: gastric remnant haemorrhagic ulcer after Roux-en-Y gastric bypass. J Minim Access Surg. 2018;14(1):68–70. https://doi.org/10.4103/jmas.JMAS_148_16
65. Abdelsattar JM, McCulloch IL, Abunnaja S. Emergency laparoscopic partial resection of the excluded stomach and gastric pouch in a gastric bypass patient with acute gastrogastric fistula bleeding. Surg Obes Relat Dis. Elsevier Inc. 2020;445–6. https://doi.org/10.1016/j.soard.2019.11.016
66. AlZarooni N, Abou Hussein B, Al Marzouqi O, et al. Gastric remnant perforation caused by Peterson's hernia following one anastomosis gastric bypass: a rare complication. Obes Surg. 2020;30:3229–32. https://doi.org/10.1007/s11695-020-04524-1
67. Braley SC, Nguyen NT, Wolfe BM. Late gastrointestinal hemorrhage after gastric bypass. Obes Surg. 2002;12:404–7.
68. Ferreira AJ, Amado F, Trindade C, et al. Anastomotic gastrojejunal ulcer following one anastomosis gastric bypass (OAGB): laparoscopic conversion to resectional Roux-en-Y gastric bypass (R-RYGB). Obes Surg. 2022;4115–6. https://doi.org/10.1007/s11695-022-06312-5
69. Do PH, Kang YS, Cahill P. Gastric infarction following gastric bypass surgery. J Radiol Case Rep. 2016;10:16–22.
70. Tinoco A, Gottardi LF, Boechat ED. Gastric cancer in the excluded stomach 10 years after gastric bypass. Case Rep Surg. 2015;2015:1–3.
71. Magge D, Holtzman MP. Gastric adenocarcinoma in patients with Roux-en-Y gastric bypass: a case series. Surg Obes Relat Dis. 2015;11:e35–8.
72. Raijman, Isaac; Strother, S. Vance Donegan, William L. Gastric cancer after gastric bypass for obesity: case report. J Clin Gastroenterol. 1991;13(2):191–7. https://journals.lww.com/jcge/fulltext/1991/04000/gastric_cancer_after_gastric_bypass_for_obesity_.15.aspx
73. Haenen FW, Gys B, Moreels T, et al. Linitis plastica of the bypassed stomach 7 years after Roux-en-Y gastric bypass: a case report. Acta Chir Belg. 2017;117:391–3.
74. Tucker ON, Szomstein S, Rosenthal RJ. Surgical management of gastro-gastric fistula after divided laparoscopic Roux-en-Y gastric bypass for morbid obesity. J Gastrointest Surg. 2007;11:1673–9.
75. Chiappetta S, Theodoridou S, Stier C, et al. Incidental finding of GIST during obesity surgery. Obes Surg. 2015;25:579–83.
76. Sánchez Antúnez DJ, Fernández NC, Serrano JO. Unusual case of upper gastrointestinal bleeding after laparoscopic gastric bypass: erosion of gastric remnant involving a diaphragmatic vessel. Surg Obes Relat Dis. 2011;7:328–9.
77. Zefreh H, Amani-Beni R, Sheikhbahaei E, et al. What about my weight? Insufficient weight loss or weight regain after bariatric metabolic surgery. Int J Endocrinol Metab. 2023;21. https://doi.org/10.5812/ijem-136329
78. Shahabi, Shahab, et al. Resection of gastric fistula and conversion to rygb for gastro pleural fistula after laparoscopic sleeve gastrectomy—a video report. Obes Surg. 2023;33(9):2951–3. https://doi.org/10.1007/s11695-023-06723-y
79. De Luca M, Piatto G, Merola G, et al. IFSO update position statement on one anastomosis gastric bypass (OAGB). Obes Surg. 2021;31:3251–8. https://doi.org/10.1007/s11695-021-05413-x
80. Papasavas PK, Caushaj PF, McCormick JT, et al. Laparoscopic management of complications following laparoscopic Roux-en-Y gastric bypass for morbid obesity. Surg Endosc Other Interv Tech. 2003;17:610–4.
81. Keleidari B, Mahmoudieh M, Shahabi S, et al. Reversing one-anastomosis gastric bypass surgery due to severe and refractory hypoalbuminemia. World J Surg. 2020;44:1200–8. https://doi.org/10.1007/s00268-019-05290-7