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SURGERY FOR OBESITY AND RELATED DISEASES

ASMBS Guidelines/Statements

American Society for Metabolic and Bariatric Surgery position statement on one-anastomosis gastric bypass

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Abstract The following position statement is issued by the American Society for Metabolic and Bariatric Surgery in response to inquiries made to the society by patients, physicians, society members, hospitals, health insurance payors, and others regarding one-anastomosis gastric bypass as a treatment for obesity and metabolic disease. This statement is based on current clinical knowledge, expert opinion, and published peer-reviewed scientific evidence available at this time. The statement may be revised in the future as more information becomes available. (Surg Obes Relat Dis 2024;20:319–335.) © 2024 American Society for Metabolic and Bariatric Surgery. Published by Elsevier Inc. All rights reserved.

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In 2018, the American Society for Metabolic and Bariatric Surgery (ASMBS) published a review of the literature on one-anastomosis gastric bypass (OAGB) [1]. At that time, there was a lack of data on long-term outcomes [1]. Since that review, a number of recent publications have provided additional information regarding OAGB outcomes, culminating in its endorsement by the ASMBS in May 2022. This position statement summarizes the current outcomes of OAGB and updates the ASMBS 2018 review.

Although the procedure makes up a small proportion of bariatric operations performed in the United States, many surgeons outside of the United States have adopted the procedure because of its favorable outcomes and relative simplicity, as OAGB requires only a single anastomosis, in contrast to the Roux-en-Y gastric bypass (RYGB) procedure, which requires two. OAGB has gained popularity during the past decade to become the third most-performed bariatric procedure worldwide [2].

OAGB differs from the historical "loop" gastric bypass that was introduced by Edward E. Mason in 1967. The latter was abandoned because the short, horizontally oriented gastric pouch with a loop gastrojejunostomy resulted in an unfavorably high rate of bile reflux esophagitis [3]. Current techniques of OAGB consist of a long, narrow gastric pouch based on the lesser curve and a linear anastomosis between the gastric pouch and a loop of jejunum 150–200 cm from the ligament of Treitz [4]. Carbajo et al. described a slight technical variation consisting of a latero-lateral gastrojejunostomy that was designed to minimize bile reflux (Fig. 1)

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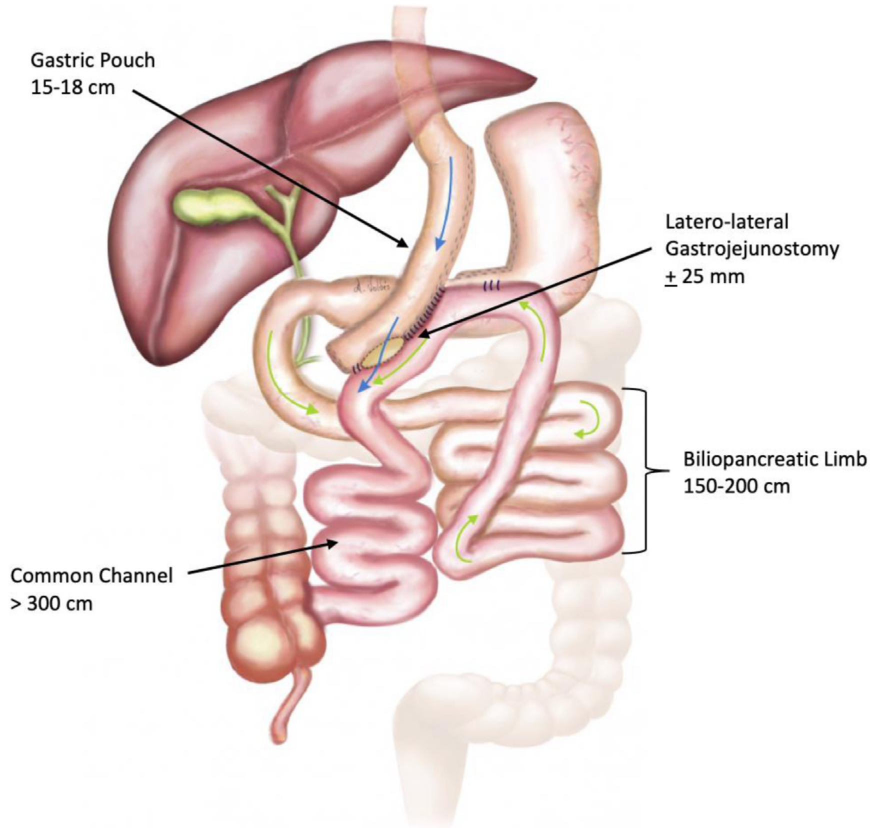

Fig. 1. One-anastomosis gastric bypass. The long gastric pouch is created by dividing the stomach horizontally 2–3 cm distal to the incisura (i.e., crow's foot) and vertically to the left of the angle of His. A wide latero-lateral gastrojejunostomy is completed with an antecolic loop of jejunum 150–200 cm from the ligament of Treitz. The afferent loop is sutured to the gastric pouch staple line above the anastomosis, and the apex of the loop is sutured to the bypassed stomach to divert the flow of bile away from the gastric pouch (diagram by Dr. Arturo Valdes Alvarez of Mexico).

[5]. They called the operation "bypass gastrico de una anastomosis" in Spanish, which translates to "one-anastomosis gastric bypass" in English.

Clinical outcomes of OAGB

In general, studies of OAGB have shown a short operative time and low complication rate, comparable to other common bariatric procedures, with excellent weight loss and resolution of obesity-related co-morbidities [5–8]. A few randomized controlled trials (RCTs) that compare OAGB to sleeve gastrectomy (SG) or RYGB have been published (Table 1). Retrospective case series with short-term (1–3 yr) and mid-term (3–5 yr) follow-up make up the bulk of published outcomes of OAGB, and these have been the subject of systematic reviews and meta-analyses (Table 2). Additionally, several studies with long-term outcomes, beyond 5 years, are now available (Table 3). The existing literature on OAGB is heterogenous regarding the risk of bile reflux esophagitis and malnutrition; this heterogeneity may be related to the variation in the biliopancreatic limb (BPL) length reported in the literature. Since most of the peer-reviewed published information on OAGB is derived from retrospective data and a few RCTs, long-term follow-up of current trials and additional well-designed RCTs to compare OAGB with other established bariatric procedures are encouraged. In 2019, the French Health authority, Haute Autoritè de Santè, did not approve the OAGB because a review of studies could not confirm the superiority or the noninferiority of OAGB compared with RYGB. However, Haute Autoritè de Santè recommended multicenter RCTs to assess the efficacy and safety of OAGB and long-term reporting of outcomes beyond 5 years. The published results of OAGB on weight loss, metabolic disease, complications, and gastroesophageal reflux disease (GERD) of acid or bile are reviewed here in detail.

Weight loss after OAGB

Excellent early weight loss after OAGB has been reported. Multiple prospective cohort studies have reported that OAGB resulted in 69%–93% mean excess weight loss percentage (%EWL) with up to 5-year follow-up [8–14]. Beyond 5 years, a mean %EWL range from 66% to 90%

Table 1
Randomized control trials of OAGB versus RYGB or SG

First author (year) Country	Sample size	Follow-up	Mean BMI (kg/m^2)	Weight loss %EWL	Co-morbidity resolution	Complications (expressed as mean rate)
Lee (2005) [27] Taiwan	40 OAGB 40 RYGB	2 yr (100% follow-up)	44.8 ± 8.8 OAGB 43.8 ± 4.8 RYGB	64.4 ± 8.8 OAGB 59.2 ± 15.1 RYGB At 2 yr	Resolution of T2D and metabolic syndrome were similar	No mortality in either group. Operative morbidity, including leak rate, was higher in the RYGB group (20% versus 7.5%, $P = .05$). Late complications rate was the same (7.5%) with no reoperation.
Robert (2019) [28] France (multisite YOMEGA trial)	117 OAGB 117 RYGB	2 yr	43.8 ± 6.1 OAGB 43.9 ± 5.1 RYGB	%EBMIL 88 ± 24 OAGB 86 ± 23 RYGB ($P = .0024$)	At 2-yr follow-up for patients with T2D: significant improvement in mean HbA1C after OAGB versus RYGB (2.3 ± 1.6 versus 1.3 ± 1, $P = .025$). Complete remission of 60% in OAGB versus 38% in RYGB.	66 serious adverse events (24 in RYGB versus 42 in OAGB, $P = .042$), of which 9 (21.4%) were nutritional complications in OAGB versus none in RYGB. Marginal ulcer: 5 (8%) in RYGB versus 2 (5%) in OAGB. Reflux: 3 (7%) in OAGB. Esophagitis: 2 (3%) in RYGB versus 6 (10%) in OAGB. Metaplasia in 1 OAGB. Bowel obstruction: 3 (13%) in RYGB versus 1 (2%) in OAGB.
Lee (2014) [35] Taiwan	30 OAGB 30 SG	5 yr (80% follow-up rate)	30.2 ± 2.2 OAGB 31 ± 2.8 SG (BMI within 25–35 kg/m^2)	%TWL was similar 23 ± 6 OAGB 20 ± 5 SG ($P > .05$)	100% of patients with preoperative HbA1C >7.5%; 60% in the OAGB group achieved HbA1C ≤6.5% versus 30% in the SG group	OAGB: 1 (4.2%) marginal ulcer and 1 (4.2%) conversion to RYGB for intractable bile reflux. SG: 4 (16%) conversion to RYGB, one for intractable reflux with esophagitis, 3 for diabetes and inadequate weight loss.
Jain (2021) [34] India	101 OAGB 100 SG (At 5-yr follow-up n = 73 OAGB n = 71 SG)	5 yr	45.3 ± 8.2 OAGB 44.9 ± 7.9 SG	Similar weight loss at 1 and 3 yr, but different at 5 yr: 65 ± 14 OAGB 56 ± 27 SG ($P = .0099$)	Similar T2D improvement or remission at 1 and 3 yr, but different at 5 yr: 85% for OAGB versus 57% for SG ($P = .0227$)	Marginal ulcer: 2 (2%) early and 5 (6.8%) late in OAGB. Anemia: 7 (9.5%) in OAGB versus 4 (5.6%) in SG. GERD: 3 (4.1%) in OAGB versus 4 (5.6%) in SG. Hypoalbuminemia: 6 (8.2%) in OAGB versus 3 (4.2%) in SG. One (1.4%) SG revised to OAGB for weight regain.

OAGB = one-anastomosis gastric bypass; RYGB = Roux-en-Y gastric bypass; SG = sleeve gastrectomy; BMI = body mass index; EWL = excess weight loss; T2D = type 2 diabetes; EBMIL = excess BMI loss; TWL = total weight loss; GERD = gastroesophageal reflux disease.

Table 2
Meta-analyses and systematic reviews of OAGB and comparative studies

First author (year) Country	Publication dates	Study type	Sample size	Follow-up	Mean BMI (kg/m^2)	Weight loss %EWL	Co-morbidity resolution	*Complications (expressed as mean rate)*
Parmar (2018) [20] United Kingdom	1995–2018	Meta-analysis 22 studies	12,807	6 mo to 12 yr (median, 2 yr)	46.6 (26–88)	72.6% at 1 yr 78.2% at 2 yr 76.6% at 5 yr	T2D 83.7% HTN 66.94% GERD 82.2%	Mortality .1%, early complication 4.67%, leak .96%, marginal ulcer 2.7%, anemia 7%, GERD 2.08%, malnutrition .71% (0%–3.8%)
Magouliotis (2019) [31] Greece	2001–2019	16 studies (11 included in meta-analysis [quantitative analysis]; 16 included in systematic review [qualitative analysis])	12,445 total 7944 OAGB 4501 RYGB	1–5 yr	–	Greater %EWL for OAGB at 1, 2, and 5 yr (weighted mean difference –6.02, –7.33, –12.82; P = .0007)	OAGB resulted in greater remission of T2D; HTN remission was comparable	Incidences of leaks, marginal ulcer, dumping syndrome, revisions, and mortality were similar. The incidence of malnutrition was higher in OAGB, whereas the incidences of internal hernia and bowel obstruction were greater in RYGB.
Magouliotis (2017) [36] Greece	2001–2017	17 studies (10 included in meta-analysis [quantitative analysis]; 17 included in systematic review [qualitative analysis])	6761 total 5536 OAGB 1225 laparoscopic SG	1–2 yr	–	Greater %EWL for OAGB at 1 yr (weighted mean difference, –6.52); similar weight loss at 2 yr	OAGB resulted in greater remission of T2D, HTN, and dyslipidemia	Incidences of leaks, intra-abdominal bleeding, and anemia were similar. Incidences of marginal ulcer and malnutrition were greater in OAGB. Incidences of reflux, revisions, and mortality were significantly higher in SG.

OAGB = one-anastomosis gastric bypass; BMI = body mass index; EWL = excess weight loss; T2D = type 2 diabetes; HTN = hypertension; GERD = gastroesophageal reflux disease; RYGB = Roux-en-Y gastric bypass; SG = sleeve gastrectomy.

Table 3
Cohort studies reporting mid- to long-term outcomes of OAGB

First author (year)	Country	OAGB, n	Follow-up	Female sex	Mean BMI (kg/m^2)	Weight loss %EWL	T2D resolution	Complications	
								Early	Late
Almuhanna (2021) [19]	Taiwan	2223	15 yr	1522 (70%)	40.2 ± 11.9	65.1 ± 35.6	66.7% at 15 yr	19 leaks, 1 bleed, 2 loop stenoses, 5 other major complications	113 (5.1%) revision surgeries (51 for malnutrition, 24 for weight regain, 22 for esophagitis), <1% bile reflux
Carandina (2021) [21]	France	385	10 yr	319 (89%)	44.3 ± 6.7	64.1 ± 24.6	90%	9 (2.3%) total, including 4 pouch leaks, 2 bleeds, 3 obstructions	17.1% (2.3% malnutrition, 2.7% anemia, 9.8% bile reflux, 5.7% required revision, 4.9% marginal ulcer)
Liagre (2021) [22]	France	115	8 yr	101 (94%)	43.2 ± 5.8	84.8 ± 27.1	36.4%	1 (.9%) intra-abdominal abscess without leak, 1 (.9%) pneumonia	6 (5.2%) converted to RYGB for intractable reflux, 6.5% esophagitis but no Barrett, 8.9% diarrhea
Rheinwalt (2020) [47]	Germany	324	3 yr	242 (75%)	53.7 ± 6.5	36.2 ± 9.2 % TWL	79% at 3 yr	4.63% intraoperative complications	4% malnutrition; 3.5% reflux; 3% marginal ulcer
Scavone (2020) [44]	Italy	953	5 yr	684 (72%)	49.4 (range, 34.7–67.7)	68.8	91.4%	15 (1.5%) early complications, .5% bleed, .5% leak, .1% PE, .1% death	16 (1.6%) late complications, .3% excess weight loss, .4% gastrogastric fistula, .1% small bowel obstruction, .1% perianastomotic abscess
Hussain (2019) [13]	United Kingdom	519	3 yr	358 (68%)	48 ± 8	89% at 1 yr 77% at 3 yr	70% at 3 yr	Marginal ulcer 1.52%, afferent loop obstruction .75%, bleed .37%	2 (.37%) incidences of intractable diarrhea, 1 (.18%) bile reflux, 1 (.18%) GJ stenosis, 1 (.18%) excess weight loss
Alkhalifah (2018) [49]	Taiwan	1731	15 yr	1212 (70%)	40.4 ± 7.7	84.5 ± 35.2	77.6% at 10 yr	30 (1.7%) 30-d serious complications; 29 leaks mostly early in the experience	2.5% malnutrition, 70 (4%) revisions (43 for malnutrition, 9 for weight regain, 14 for intolerance)
Carbajo (2017) [7]	Spain	1200	6–12 yr	744 (62%)	46 (range, 33–86)	77 at 6 yr 70 at 12 yr	94%	4 (.3%) conversions, 16 reoperations (1.3%)	2 (.16%) deaths, 2% bile reflux, .5% marginal ulcer, 14 (1.1%) incidences of protein malnutrition
Taha (2017) [74]	Egypt	1520	3 yr	953 (63%)	46.8 ± 6.6	80.2 ± 5.9	84.1%	7 (.5%) PEs, 1 (.1%) leak, 17 (1.1%) bleeds, 1 (.1%) death	3.1% anemia, 1.2% intractable reflux, .2% marginal ulcer, 1.2% weight gain, .2% excessive weight loss
Chevallier (2015) [16]	France	1000	7 yr	712 (71%)	Median BMI, 45.7	71.6 ± 27 %EBMIL	85.7%	Minor 3.5%, major .3%, leak .5% (3 anastomoses, 2 remnants)	Mortality .2%, marginal ulcer 2%, malnutrition .2%, revision .9%
Kular (2014) [38]	India	1054	6 yr	712 (68%)	43.2 ± 7.4	85%	93.2%	Major complication 1.3%, leak .2%, bleed .1%, minor complication 4.6%	5 (.6%) marginal ulcers, 18 (2%) biliary refluxes, 68 (7.6%) incidences of anemia, 1 (.1%) incidence of hypoalbuminemia

(*continued on next page*)

Table 3 (*continued*)

First author (year)	Country	OAGB, n	Follow-up	Female sex	Mean BMI (kg/m^2)	Weight loss %EWL	T2D resolution	Complications	
								Early	Late
Musella (2014) [17]	Italy	974	5 yr	499 (51%)	48 ± 4.58	81.5 ± 5.0	84.4%	10 (1%) leaks, 34 (3.5%) bleeds, 2 (2%) PEs, 2 (2%) deaths, 5 (5%) perforations	14 (1.7%) marginal ulcers, 44 (5.3%) incidences of anemia, 1 (.1%) incidence of malnutrition, .2% early and .8% late revision
Noun (2012) [18]	Lebanon	1000	5 yr	664 (64%)	42.5 ± 6.39	68.6 ± 21.9	85% at 1 yr	7 (.7%) leaks, 20 (2%) bleeds, 1 (.1%) VTE, 6 (.6%) reoperations	4 biliary refluxes, 6 marginal ulcers, 4 incidences of excess weight loss, 33 incisional hernias
Rutledge (2005) [42]	United States	2410	5 yr	2049 (85%)	46 ± 7 (34–74)	80% at 1 yr	83%	142 (5.9%) early complications, .08% death, 1.08% leak, .12% wound infection	4 (.17%) late deaths, 97 (4%) marginal ulcers, 110 (5%) incidences of iron deficiency anemia, 31 (1%) were revised for excessive weight loss

OAGB = one-anastomosis gastric bypass; BMI = body mass index; EWL = excess weight loss; T2D = type 2 diabetes; RYGB = Roux-en-Y gastric bypass; TWL = total weight loss; GJ = gastrojejunal; PE = pulmonary embolism; EBMIL = excess BMI loss; VTE = venous thromboembolism.

has been reported [7,8,15–19]. A systematic review of 22 articles with 12,807 patients found that at 12, 24, 60, and 60+ months, the average %EWL was 73%, 78%, 77%, and 76%, respectively [20].

In the long term, OAGB has been reported to have a sustained effect on weight. Carbajo et al. studied 1200 patients who underwent either primary or revisional OAGB and reported a mean %EWL of 75% at 12 years [7]. A 20-year retrospective review by Almuhanna et al. included 2223 patients who underwent OAGB; 1117 patients were followed to 5 years, 570 patients to 10 years, and 226 patients to 15 years after surgery [19]. At 5, 10, and 15 years after surgery, the mean total weight loss percentage (%TWL) was 32%, 30%, and 30%, respectively, and the mean corresponding %EWL was 77%, 68%, and 66%, respectively [19]. Another study with long-term outcomes reported on 385 patients with a mean follow-up of over 10 years; it compared OAGB as a primary procedure to OAGB as a revisional procedure [21]. For the overall cohort, the %TWL was 33% ± 11% (mean ± standard deviation), and the %EWL was 64% ± 25% after 10 years. Forty-three percent of patients achieved %EWL >75%, while 29% of the patients had a %EWL <50% [21]. Weight loss was similar between primary OAGB and revisional OAGB [21].

For patients at the upper part of the body mass index (BMI) spectrum, OAGB has been reported to result in excellent short- and mid-term weight loss. In a retrospective study of 245 patients with BMI >50 kg/m^2 who underwent OAGB with a BPL length of 150 cm, the %TWL was 43% ± 9% and the %EWL was 80% ± 16% at 24 months. At 60 months, %TWL was 42% ± 10% and %EWL was 78% ± 18% [22]. Another study compared the outcomes of 150 OAGB patients to 93 SG patients with BMI ≥60 kg/m^2; the mean %TWL at 12, 24, and 36 months after the operation was 36%, 42%, and 43%, respectively, after OAGB versus 29%, 32%, and 32%, respectively, after SG and was statistically higher for OAGB at every point in time [23]. The correlating mean BMI loss percentage (%BMIL) was 23%, 27%, and 27%, respectively, after OAGB versus 19%, 22%, and 22%, respectively, after SG [24]. One drawback to this study was short-term follow-up; <25% of patients achieved follow-up to 36 months. Mean operative time was significantly shorter for OAGB than SG (81 versus 92 min, $P < .001$) [24]. Madhok et al. focused on patients with BMI ≥60 kg/m^2 and compared 19 OAGB patients to 56 SG patients [24]. OAGB resulted in greater mean %EWL than SG at 2 years (66% versus 38%, $P < .001$) [25]. There was no mortality or major complication in either group. Parmar et al. also studied 19 OAGB patients with BMI ≥60 kg/m^2 and reported a mean %EWL of 70% at 2 years versus 57% in 47 RYGB patients ($P < .001$) [25]. The corresponding mean %TWL was 44% for OAGB versus 33% for RYGB after 2 years. The OAGB group had a significantly higher initial weight and BMI. There was no mortality or major complication in either group [25].

The effects of OAGB in patients with lower BMI (≤35 kg/m^2) have also been studied [8]. A systematic review of 376 patients with a mean starting BMI of 29 kg/m^2 found that OAGB resulted in a mean BMI of 24 kg/m^2 at 12-month follow-up [26]. Of note, the average BPL length was 120 cm for these patients. The authors concluded that OAGB is a safe option for patients with a BMI ≤35 kg/m^2 seeking effective metabolic outcomes, such as remission of type 2 diabetes (T2D).

Comparative trials of OAGB and RYGB

Several RCTs have compared the early results of OAGB to RYGB (Table 1). Lee et al. randomized 40 patients to OAGB with a BPL length of 200 cm and compared them to 40 patients randomized to RYGB [27]. After 1 year, the OAGB group had 6% greater reduction in mean % EWL than the RYGB group (65% ± 10% versus 59% ± 16%; P = .025). The difference became nonsignificant after 2 years (OAGB 64% ± 8% versus RYGB 59% ± 15%, $P >$ .05). The French multicenter YOMEGA trial randomized 129 patients to OAGB and another 124 patients to RYGB [28]. The excess BMI loss percentage (%EBMIL) was 88% ± 24% for OAGB versus 86% ± 23% for RYGB after 2 years (P = .0024). The authors concluded that OAGB was noninferior to RYGB [28]. This trial has recently completed a 5-year follow-up per-protocol analysis of 82 participants (69.5%) with RYGB and 75 participants (65.8%) with OAGB [29]. At 5 years, mean %EBMIL was 76% ± 26.2% for OAGB versus 72.7% ± 29.9% for RYGB (P = .46), and weight regain was similar in both groups (10.5% ± 13.1% for OAGB versus 9.6% ± 10.1% for RYGB, P = .9) [29].

Comparisons of OAGB to RYGB have also been the subject of systematic reviews (Table 2). A systematic review and meta-analysis of RCTs by Jia et al. compared the effectiveness and safety of OAGB to RYGB. Quality of evidence was evaluated, and out of 206 reports, only 3 trials with a total of 733 patients were included in the analysis. OAGB was associated with better %EBMIL at 2 years (mean difference 10%; 95% confidence interval [CI], 3%–17%), but the strength of this finding was deemed to be low because of variability in the reported BPL length for OAGB. They concluded that the added OAGB weight loss benefit appeared to be confined to the extended-length BPL but not to the standard-length BPL [30]. Finally, a review of the literature and a meta-analysis comparing OAGB to RYGB by Magouliotis et al. included 16 studies in the qualitative analysis, 11 studies in the quantitative meta-analysis, and 12,445 patients. The weighted mean difference in % EWL after 1, 2, and 5 years was greater in the OAGB group (a difference of 6%, 7%, and 13%, respectively; P = .0007), although BPL length was not taken in consideration in this analysis [31].

Comparative trials of OAGB and SG

OAGB has also been compared to SG in 2 RCTs with 1, 3, and 5-year follow-up [32–35]. The first compared 101 OAGB patients to 100 SG patients and showed a statistically similar %EWL at 1 year of 67% ± 11% for OAGB versus 64% ± 13% for SG ($P >$ .05) [32]. The same group reported a mean %EWL at 3 years of 66% for OAGB versus 61% for SG, which was statistically insignificant [33]. Interestingly, at 5 years, mean %EWL differences became statistically significant at 65% ± 14% for OAGB versus 56% ± 27% for SG (P = .0099) [34]. Weight loss, co-morbidity resolution, and improvement in quality of life at 5 years after surgery were significantly higher in the OAGB group compared to SG at 5 years [34]. The second trial randomized 60 patients with diabetes and mild obesity (BMI 25–35 kg/m^2) to OAGB or SG, with 30 patients in each arm of the trial. Although the mean %TWL was similar in both groups (23% ± 6% for OAGB versus 20% ± 5% for SG, $P >$ .05) at 5 years, OAGB resulted in better glycemic control than SG [35]. A systematic review and meta-analysis review of OAGB versus SG included 17 studies, incorporating 6761 patients, and showed better weight loss, better remission of co-morbidities, shorter mean hospital stay, and lower mortality in the OAGB group, while the incidence of leaks and intra-abdominal bleeding was similar [36].

Most of the peer-reviewed published information on OAGB is derived from retrospective data; published RCTs are scarce. Therefore, long-term follow-up of current trials and additional well-designed RCTs to compare OAGB with other established bariatric procedures are encouraged.

OAGB technique: the effect of BPL length and gastrojejunostomy size on weight loss

The impact of variations in the length of the BPL or the size of the gastrojejunostomy on OAGB weight loss has been studied. Boyle and Mahawar compared the weight loss and nutritional outcomes of a cohort of 343 patients, of whom 225 patient had a BPL length of 200 cm and 118 had a BPL length of 150 cm [10]. At 18-month follow-up, the %EWL was 75% ± 20% versus 74% ± 22% (P = .67), respectively, and no significant difference in nutritional deficiencies was found. The impact of gastrojejunostomy size on weight loss has also been studied. Elgeidie et al. randomized 83 patients to either a narrow gastrojejunostomy of 30 mm or a wide gastrojejunostomy of 45 mm [9]. The surgical technique was otherwise standardized with a BPL length of 200 cm and a bougie size of 36 French. Narrow gastrojejunostomy resulted in better %EWL at 6 months (53% ± 10% versus 43% ± 7%, $P <$ .05), but this effect dissipated at 12 months (mean %EWL 67% ± 8% versus 65% ± 9%, $P >$ .05) and at 24 months (mean %EWL 75% ± 12% versus 75% ± 13%, $P >$ .05).

Metabolic benefits of OAGB

OAGB is a restrictive procedure with a malabsorptive component and has hormonal effects that are similar to other metabolic procedures, such as RYGB and SG. Short- and mid-term cohort studies and randomized trials have highlighted the effect of OAGB on metabolic syndrome and obesity-related co-morbidities.

A number of studies have shown that the metabolic effect of OAGB on T2D is on par or superior to RYGB, as remission rates ≥80% have been reported in large prospective studies [13,17,37–41]. The remission rate of T2D 6 years after OAGB was reported to be 83% in a cohort of 2410 patients [42] and as high as 93% in a cohort of 1054 patients [31]. OAGB was also effective in patients with lower BMIs, as one study reported 53% T2D remission at 7 years after surgery for 128 patients with BMI 25–35 kg/m^2 [8]. The YOMEGA randomized trial showed a significantly greater decrease in mean HbA1C after OAGB compared with RYGB (2.3% ± 1.6% versus 1.3% ± 1%, P = .025) at 2-year follow-up for patients with T2D [28]. However, the HbA1C levels were nearly similar in both groups at 5 years (OAGB 6.0% ± .89% versus RYGB 6.5% ± 1.44%, P = .94), as were the remission rates for T2D (OAGB 58.3% versus RYGB 53.3%, P = .79) [29]. In a retrospective study of 3252 patients in 8 European centers, 313 of whom had T2D, OAGB resulted in significantly higher remission rates of T2D at 1 year after surgery compared to SG (85% versus 61%, $P < .001$) [43].

RCTs comparing the effects OAGB to SG on diabetes have shown mixed results. Seetharamaiah et al. showed better initial improvement or remission of T2D after 3 months (65% after OAGB versus 38% after SG, P = .008); however, the difference between the 2 groups was not significant at 12 months (84% after OAGB versus 77% after SG, P = .12) [32]. In a follow-up study reporting the outcomes at 3 years, the authors did not find a significant difference in the rates of T2D improvement or remission between OAGB and SG (89% versus 82%, P = .38) [33]. With longer-term follow-up to 5 years, the same study found a significant difference in T2D improvement or remission of 85% for OAGB versus 57% for SG (P = .0227) [34].

Additional long-term data on T2D outcomes after OAGB has been published. In a 20-year retrospective review of 2223 patients who underwent OAGB, including 739 patients with T2D, the mean HbA1C before operation was 8.9% ± 1.6% (range, 6%–11%). Complete remission of T2D (HbA1C <6.0%) was achieved in 67% of the patients after 5 years, while another 10% achieved partial remission. At 10 and 15 years, 74% and 67% of those who followed up remained in complete remission of T2D [19]. Lee et al. compared the effects of OAGB and SG on a cohort of patients with established T2D diagnosis for at least 6 months, HbA1C ≥7.5%, c-peptide ≥1ng/mL, and a BMI of 25-35 kg/m^2 [35]. Sixty percent of patients in the OAGB group achieved HbA1C ≤6.5% compared with 30% in the SG group at 5-year follow-up [35]. Higher incretin effect was noted in the OAGB group [35].

Diabetes remission after OAGB has also been the subject of systematic reviews. The systematic review and meta-analysis of RCTs by Jia et al. that compared OAGB with RYGB showed a higher remission rate of T2D for OAGB (risk ratio 1.13; 95% CI, 1.01–1.27) and no statistically significant difference in adverse events [30]. In a review of the literature and a meta-analysis by Magouliotis et al. that included 12,445 patients and compared OAGB to RYGB, T2D remission was greater in the OAGB group (odds ratio .41; 95% CI, .25–.69; P = .0006), while the resolution of hypertension and dyslipidemia was similar between OAGB and RYGB [31].

Many studies have reported the impact of OAGB on metabolic and weight-related co-morbidities other than T2D as secondary endpoints. A positive effect of OAGB on dyslipidemia, hypertension, obstructive sleep apnea, GERD, joint pain/osteoarthritis, renal insufficiency, and polycystic ovarian syndrome has been extensively reported [7,13,20,41,44–52]. Additional long-term results are needed to better define the durability of the metabolic effects of OAGB.

Complications of OAGB

Reported early complications of OAGB are similar to RYGB and SG, including nausea/vomiting, anastomotic leak, hemorrhage, wound infection, and death. A systematic review of 12,807 OAGB patients showed a mortality rate of .1%, leak rate of 1%, marginal ulcer rate of 2.7%, and malnutrition rate of .7% [20]. A large retrospective review of 1054 patients by Kular et al. reported a 4.6% minor early complication rate, mainly due to nausea/vomiting, a 1.3% major early complication rate, a .1% leak rate, a .3% bleed rate, and a .17% risk of death [38]. Another retrospective review of 2410 patients reported an overall complication rate of 5.9%, including a .08% mortality rate and a 1.1% leak rate [42]. In a multi-institutional survey on 2678 patients with mid-term follow-up, intraoperative and early complication rates were .5% and 3.1% respectively; the late complication rate was 10.1%, and the mortality rate was .1% [53].

Long-term complications after OAGB include marginal ulceration, bile reflux, steatorrhea, malabsorption, protein calorie malnutrition, excessive weight loss, gastro-gastric fistula, and internal herniation. Marginal ulcer rates after OAGB have been reported to range from .5% to 8%, and ulcers are mostly associated with smoking [13,21,26,41,54,55]. The rate of internal hernia and bowel obstruction has been reported to be lower for OAGB compared to RYGB (.1% in a large multi-institutional study) but as high as 2.4% in a smaller study of patients with BMI >50 kg/m^2 [22,37,53]. A retrospective study of 385 patients with at least 10 years' follow-up after OAGB reported that although early complications occurred in 2.3% of patients, the overall rate of late complications was much higher at 17.1%. These included marginal ulcers in 19 patients (5%), malnutrition requiring hospitalization in 9 patients (2%), bile reflux in 38 patients (10%), and severe anemia requiring intravenous iron supplementation in 5 patients (3%) [21]. In the meta-analysis by Magouliotis et al. comparing OAGB to RYGB, OAGB was associated with shorter mean operative time but comparable hospital length of stay [31]. The incidence of leaks, marginal ulcer, dumping syndrome, bowel obstruction, revisions, and mortality was similar between the 2 approaches [31]. The incidence of internal hernia and bowel obstruction was greater in the RYGB group, while the incidence of malnutrition was higher after OAGB [31].

Iron deficiency anemia is one of the most common complications after OAGB and has been reported to range from 5% to 10% [15,54,56,57]. Malabsorption, protein-calorie malnutrition, and excessive weight loss have also been reported after OAGB, especially in patients with a BPL length >250 cm [53,58]. A 200-cm BPL length of OAGB is longer than the standard 50–100-cm RYGB BPL length, which some believe may lead to better weight loss but at the expense of a higher risk of malnutrition, including micronutrient deficiencies [58]. Other potential factors that may exacerbate the risk of micronutrient deficiencies after OAGB include a vegetarian diet, diabetic nephropathy, and alcoholic/nonalcoholic liver disease [59]. The YOMEGA multicenter randomized trial found that OAGB was associated with higher rates of nutritional complications when compared with RYGB (21% versus 0%, P = .0034) at 2 years after surgery [28]. However, the nutritional risks and diarrhea seem to improve with time, and there were no significant differences in albumin, prealbumin, hemoglobin, ferritin, vitamin D, vitamin B1, or vitamin B12 levels between the 2 groups at 5 years [29]. The number of patients in the OAGB group who had >4 stools/day was slightly higher than in the RYGB group (11.3% versus 8.2%, P = .57) [29]. One retrospective comparison of OAGB and RYGB reported higher rates of malnutrition and anemia but similar rates of overall surgical revision [41]. Another retrospective series found no difference in malnutrition between OAGB and RYGB (.9% versus .2%, P = .132) [37]. In the long term, a 20-year retrospective review reported on 2223 patients who underwent OAGB and found that although weight loss and antimetabolic effects remained excellent through the follow-up period, a significant malnutrition effect was observed over time. A total of 113 patients (5%) needed revision surgery at follow-up due to malnutrition (51 patients), weight regain (24 patients), acid or bile reflux (22 patients), marginal ulcer (8 patients), ileus (3 patients), or other causes (5 patients). At 15 years, the overall revision rate after OAGB was 12% [19]. The overall conversion rate from OAGB to RYGB for GERD, esophagitis, and malnutrition was 7.9% at 5 years after surgery in the YOMEGA trial [29].

Severe malnutrition following OAGB may require surgical revision or reversal [60–62]. The reported incidence of OAGB revision for malnutrition varies from .3% to 3.7% [19,53,60,62,63]. Depending on the type of revision, surgical modification of OAGB may be associated with significant rates of complications, reported to be as high as 41% [60,61]. In a 10-year retrospective review, Genser et al. reported reversal of OAGB for severe malnutrition in 26 of 2934 patients, and the reversals had a morbidity rate of 31% [60]. Another report found the complication rate associated with conversion of 17 patients from OAGB to RYGB was 41%, but no mortality was reported [61]. Revision of BPL length, reversal of OAGB to normal anatomy, and conversion to RYGB have all been reported to address malnutrition successfully [53,60,61]. A survey focused on revisions after OAGB at 23 Italian bariatric centers of excellence and included 8676 primary OAGB procedures with a follow-up of 62 ± 52 months, with a 55% response rate [64]. In this study, a total of 181 patients (2%) underwent revisional surgery: 82 (.9%) for intractable GERD, 42 (.5%) for weight regain, 16 (.2%) for excess weight loss and malnutrition, 12 (.1%) for marginal ulcer perforation, 10 (.1%) for gastrogastric fistula, and 20 (.2%) for other reasons [64]. The most common revisional procedure was conversion to RYGB (109; 54%), followed by BPL elongation (19; 9%) and reversal (19; 9%) [64].

OAGB and the risk of bile reflux

The potential for problematic bile reflux into the gastric pouch or lower esophagus, created by the loop reconstruction of OAGB, has been a major concern. Such reflux can cause symptoms like heartburn or epigastric pain, inflammation in the esophagus or gastric pouch, or even malignant transformation. These concerns are mainly based on historical experiences with Billroth II reconstruction and Mason's loop gastric bypass procedure. The proponents of OAGB argue that modern techniques are not comparable to these historical procedures, maintaining that the creation of a narrow and long gastric pouch reduces the risk of bile reflux [6,20,53,55]. This risk may be lowered further by Carbajo et al.'s modification [7]. In fact, Carbajo et al. performed 24-hour pH testing and endoscopic examination at 12 and 18 months after OAGB to study reflux in their first 20 patients and reported normal results [7]. Mid-term studies have shown that the rate of symptomatic GERD after OAGB in a long pouch is low, ranging from .5% to 2% [17,38,55]. A multi-institutional review of 2678 OAGB patients showed that postoperative GERD was predicted by 2 factors: preexisting GERD or a gastric pouch shorter than 9 cm [53]. In a systematic review including 12,807 patients, a postoperative GERD rate of 2% was reported [20].

Despite the low rate of GERD in these reports, there is concern that GERD after OAGB may be underestimated or underreported in the literature [65–69]. The reported incidence of bile reflux ranges widely from .9% to 30% [7,15,17,30,45,56–60,69]. At the high end of these reports, Shenouda et al. used endoscopy before and after OAGB and reported increased bilirubin in gastric aspirates and bile gastritis in 6 of 20 (30%) patients [65]. A study of 11 patients who underwent 24-hour pH testing before and 12 months after OAGB demonstrated that the total number of acid reflux episodes decreased, while the total number of nonacid reflux episodes increased [66]. The DeMeester score increased in 4 patients with preoperative GERD, and 2 (29%) patients developed de novo GERD [66]. Five patients without GERD prior to OAGB had no GERD afterward [66]. The incidence of de novo GERD after 200 OAGB was 19.3%, and there was a strong correlation between GERD and hiatal hernia (P = .012) [69].

The YOMEGA randomized trial found that at 2 years after surgery, bile was present in 16% of gastric pouches after OAGB versus none in RYGB [28]. On endoscopy, 10% of patients with OAGB had esophagitis versus 3% in the RYGB group [28]. At 2 years after surgery, 5.6% of participants with OAGB reported clinical GERD versus 1.4% of participants with RYGB (P = .15). However, more patients reported GERD symptoms most of the time or always (OAGB 40.9% versus RYGB 18.4%, P = .03), and daily proton pump inhibitor (PPI) use was high in both groups (OAGB 42% versus RYGB 24.7%, P = .026) at 5-year follow-up [29]. Thirty-two individuals with OAGB and 27 with RYGB underwent upper endoscopy and biopsy at 5 years after surgery. Two OAGB individuals had Barrett esophagus and 3 individuals had bile in the stomach versus none in the RYGB group. Anastomotic ulcer was present in 3 individuals with OAGB versus 2 individuals with RYGB. Gastritis was present in 5 individuals with OAGB versus 4 with RYGB. One participant with OAGB had gastric metaplasia without dysplasia. These differences were not statistically significant, but 5 patients underwent conversion from OAGB to RYGB for Barrett esophagus (n = 2), anastomotic ulcer (n = 1), gastritis (n = 1), and gastric metaplasia (n = 1) at 5 years after surgery [29].

By contrast, Tolone et al. studied 15 asymptomatic individuals for the effects of OAGB on esophageal motor function and gastroesophageal reflux with endoscopy, high-resolution impedance manometry, and 24-hour pH-impedance monitoring before and 1 year after OAGB. A group of patients with obesity who underwent SG served as a comparison group. In contrast to SG, OAGB did not compromise lower esophageal sphincter function and did not increase gastroesophageal reflux (as measured by pH-impedance monitoring) or esophagitis (as seen on endoscopy). The number of acid reflux episodes, esophageal acid exposure time, and the DeMeester score decreased significantly after OAGB [70]. In another study, Saarinen et al. utilized bile reflux scintigraphy after OAGB to show that transient bile reflux into the gastric pouch was common, but reflux into the esophagus was not [71]. In a prospective randomized trial, Musella et al. evaluated esophagogastric reflux in the first year after OAGB (n = 28) and SG (n = 30) using high-resolution impedance manometry, pH monitoring, endoscopy, and a validated GERD questionnaire. There were no differences in demographics, questionnaire scores, esophageal acid exposure, esophagitis, or other manometric and pH data at baseline for both groups. After surgery, there was a significant increase in esophageal acid exposure and Los Angeles grade B and C esophagitis at 12 months after SG, whereas after OAGB, esophageal acid exposure decreased, and esophagitis improved [72].

Most recently, Eldredge et al. compared the incidence of bile reflux through tailored biliary scintigraphy and upper gastrointestinal endoscopy with biopsy and aspiration of gastric fluid in participants who underwent OAGB (20 patients), SG (15 patients), or RYGB (23 patients) [73]. Reflux symptom assessment and upper endoscopy and biliary scintigraphy were performed prior to surgery and at 6 months postoperatively. Gastric bile reflux was identified by biliary scintigraphy in 14 OAGB patients (70%), 1 RYGB patient (5%), and 4 SG patients (31%). Only 1 OAGB patient demonstrated esophageal bile reflux, but this patient had no esophagitis. De novo macro- or microscopic gastritis or esophagitis developed in 11 OAGB patients (58%), 8 SG patients (57%), and 7 RYGB patients (30%), and 13 patients had worsened reflux symptoms after surgery (OAGB 4, SG 7, RYGB 2). There was no statistical association between scintigraphic esophageal bile reflux and de novo gastroesophagitis or reflux symptoms. The authors concluded that despite frequent gastric bile reflux after OAGB, esophageal bile reflux was rare [73].

Many authors report that GERD after OAGB can be successfully treated with medications such as PPIs [7,16,20]. However, those with intractable bile reflux may require surgical intervention. Taha et al. reported severe reflux in 18 of 1520 OAGB patients, of whom 15 were effectively treated with PPIs. The other 3 patients underwent Braun anastomosis (jejunojejunostomy at 70–80 cm distal to the gastrojejunostomy) [74]. A retrospective review of 2780 patients reported that 32 (1.2%) patients required conversion to RYGB for bile reflux and 94% achieved symptom relief [75]. Another study reported the rate of OAGB conversion to RYGB for recalcitrant reflux was 1.2% [22]. A retrospective review of 1000 patients reported that 7 patients required conversion to RYGB for intractable reflux, and 2 patients were converted to RYGB for persistent marginal ulcer [16]. Finally, in a multi-institutional survey including 2678 participants, Musella et al. reported 1.1% conversion to RYGB for bile reflux [53].

While the effect of OAGB on bile reflux may be far from settled, an expert panel of 57 surgeons from 24 countries used a modified Delphi consensus on patient selection for OAGB and concluded that although OAGB can be a suitable procedure in patients with large hiatal hernia, it should not be offered to patients with grade C or D esophagitis or Barrett metaplasia [76].

OAGB and the risk of esophagogastric cancer

The greatest concern with OAGB is the possible increased risk of gastric or esophageal carcinoma due to bile exposure to the gastric and esophageal mucosa. Much of the evidence for carcinogenic effect of bile on the gastric and esophageal mucosa is derived from in vitro and animal studies [55]. There have been reports of gastric body carcinoma after Billroth II reconstruction, an operation that creates a larger pouch than OAGB; however, these reports were prior to understanding the carcinogenic role of *Helicobacter pylori* infection and the importance of its eradication in peptic ulcer disease [53]. Despite the large number of Mason loop gastric bypass procedures performed historically, there has been only 1 case report of gastric cancer 26 years after that procedure [77]. With regard to OAGB-associated cancers, there have been only a few case reports. Wu et al. reported one case of gastric cancer after OAGB, but this was found in the gastric remnant [78]. Another 2 reported cases of adenocarcinoma of the distal esophagus or esophagogastric junction after OAGB were diagnosed 2 years after surgery. One patient had known Los Angeles grade C esophagitis before surgery, while the other did not have a preoperative endoscopy and, therefore, did not have a malignancy ruled out before surgery [79]. The short time between OAGB and cancer diagnosis in these 2 cases makes bile reflux a less likely culprit for the development of malignancy.

Despite the theoretical concern for the development of cancers in the gastric pouch or distal esophagus from the carcinogenic effects of bile exposure after OAGB, systematic reviews of actual cancer cases after OAGB have not validated this concern. A systematic review of esophagogastric cancers following bariatric procedures identified 33 cases, of which 11 were esophageal and 22 gastric in origin [80]. The review identified 4 cases of gastric cancer after OAGB—one was the former report by Wu et al. and another was performed in 1980, most likely a Mason loop bypass. In the other 2 cases, the cancer occurred in the gastric remnant. The review identified 14 esophagogastric cancers after RYGB, with 5 localized in the excluded stomach. The final 15 malignancies were reported following laparoscopic adjustable gastric banding (LAGB), vertical banded gastroplasty (VBG), or SG [80]. Another systematic review and a meta-analysis of all the reported cases of gastroesophageal cancer following RYGB or OAGB identified 50 cases in the literature and 2 cases reported by the authors [81]. Notably, 61% (27/44) of the cancers after RYGB developed in the gastric pouch, whereas only 38% (3/8) of the cancers after OAGB developed in the gastric pouch [81]. Hence the published literature to date has not shown that OAGB carries additional cancer risk from bile reflux specifically. Nonetheless, surveillance of bile reflux, especially in symptomatic patients, must be strongly considered, and the possible long-term impact of bile reflux should be part of the deliberation when considering OAGB in younger patients.

OAGB as a revision procedure

As OAGB has gained popularity in various parts of the world, it has also developed into a popular option for the revision of other failed primary bariatric surgeries, especially restrictive-only procedures. OAGB may provide a malabsorption component in addition to restriction, and some believe this component aids in weight loss for patients with weight recurrence after VBG, LAGB, or SG. Some authors have advocated for OAGB as the preferred revision approach due to its safety and the simplicity of a single anastomosis [82–85].

There are multiple series of revisions to OAGB reported in the literature, most with a small number of patients (range, 21–81) and short- to mid-term follow-up (6–60 months) [57,78,83–89]. Bruzzi et al. published 5-year follow-up results on a retrospective series of 30 revisional OAGB procedures after earlier restrictive procedures (22 LAGB, 4 VBG, and 4 SG) and compared them to 96 primary OAGB procedures [82]. The most common indications for revision were initial weight loss nonresponse or weight recurrence (66%), GERD (13%), dysphagia (10%), and gastric prolapse after LAGB (10%). They used a 200-cm BPL length. The major early complication rate was 6.6%, and there was no reported mortality. There was no significant difference in complication rates between the primary and revision groups. Two revision patients required conversion to RYGB due to severe bile reflux. The %EBMIL at 60 months in the revision group was 66% ± 22%. At 5 years, no differences were found between the 2 groups in terms of weight loss, co-morbidity resolution, morbidity, or mortality. The quality-of-life score was lower after revision to OAGB compared to primary OAGB [82]. One of the largest series of revision to OAGB was a single surgeon experience with 77 patients with weight nonresponse after SG [88]. Revision consisted of a laparoscopic vertical resleeve during gastric pouch creation and a 150-cm BPL. The complication rate was 3.9%, with a zero 90-day mortality. The follow-up rate was 91% at 1 year and 72% at 2 years, with a reported mean %EWL of 74% and 79%, respectively. At 5-year follow-up, 7 patients had new-onset GERD, 2 of whom were refractory to medical management and required conversion to RYGB [88]. Another study included 55 patients with SG who underwent OAGB (34 patients) or RYGB (21 patients) for either weight recurrence/nonresponse (67%) or intractable GERD (33%) [89]. While early complication rates were similar, mean %TWL was 16% ± 8% for OAGB versus 10% ± 8% for RYGB (P = .0132) at 12 months [89]. Finally, Almalki et al. reported a series of 116 patients who underwent revision surgery after VBG (81 patients) and LAGB (35 patients) to OAGB (81 patients) and RYGB (35 patients) [57]. Indications for revision included weight recurrence (51%), initial weight nonresponse (31%), and intolerance (18%). The authors reported a major complication rate of 11% for OAGB and 9% for RYGB ($P = .946$). The anastomotic leak rate was 6% for OAGB and 3% for RYGB. One patient died after OAGB. At 1-year follow-up, weight loss was better for OAGB compared with RYGB (mean %EWL 77% versus 33%, $P = .001$). The 5-year reported mean %EWL was 73% for OAGB and 59% for RYGB ($P = .516$) [57].

OAGB as a revisional procedure after restrictive bariatric surgeries has been the subject of meta-analysis. One study included 26 studies and a total of 1771 patients [90]. The mean initial BMI was 45 kg/m^2, which decreased to 32, 31, and 30 kg/m^2 at 1, 3, and 5 years, respectively, after revision. The remission rate of T2D following revision to OAGB was 65%, 65%, and 78% after 1, 3, and 5 years, respectively. The remission or improvement rate for GERD was 82%; however, 7% of patients developed de novo GERD following OAGB. Anastomotic leak was the most common major complication (1.6%), followed by bleeding (1.2%). The most common BPL length was 200 cm in 9 studies, with a range of 150–350 cm in other studies [90]. In summary, the literature supports the use of OAGB as a revisional option after prior bariatric procedures.

OAGB technique and the effect of BPL length

OAGB consists of a long, narrow gastric pouch based on the lesser curve that has the approximate diameter of the esophagus. This pouch is created around a luminal tube, typically 36–38 French, around which the stomach is divided horizontally 1–2 cm distal to the crow's foot and then extended vertically to the angle of His. Usually, a 30- to 45-mm linear-stapled anastomosis is then created between the gastric pouch and a loop of jejunum 150–250 cm from the ligament of Treitz in an antecolic, antegastric fashion [3]. In 2005, Carbajo et al. published a slight technical variation consisting of a latero-lateral gastrojejunostomy designed to avoid gastroesophageal bile reflux and a BPL length of 200 cm [5]. One technical advantage of the loop configuration of OAGB over RYGB is that it eliminates the need for a second jejunojejunal anastomosis, and this reduces operative time [20]. Furthermore, a longer gastric pouch creates less tension when creating the gastrojejunal anastomosis compared to RYGB.

Theoretically, BPL length may impact overall weight loss, co-morbidity resolution, and the risk of malnutrition. Several mechanisms may explain the relationship between longer BPL length and greater weight loss after OAGB. First, distal delivery of nutrients and bile stimulate the L cells of the ileum to increase incretin hormones such as GLP-1 [91–93]. Second, long BPL leads to higher systemic levels of bile acids, which in turn increase the metabolic rate and result in greater weight loss and better glucose homeostasis [91–93]. Finally, long BPL has favorable effects on the gut microbiome [91–93]. Currently, no universal optimal BPL length for OAGB has been established [11,94,95], although most studies report a BPL length of 150–200 cm.

OAGB has a longer BPL than RYGB, but whether this is an important determinant of weight loss is debatable. Several RCTs and cohort studies comparing OAGB to RYGB have shown that OAGB resulted in better weight loss and co-morbidity resolution than RYGB [25,37,47,57]. On the other hand, the YOMEGA multicenter randomized trial showed that OAGB with a 200-cm BPL led to similar %EBMIL at 2- and 5-year follow-up but more nutritional deficiencies at 2 years compared to RYGB with 150-cm Roux limb and 50-cm BPL [28,29]. The nutritional deficiencies and diarrhea associated with OAGB seem to improve with time at 5 years after surgery, but 40.9% suffered from GERD versus 18.4% with RYGB, and the conversion rate to RYGB was 7.9% [29].

The optimal BPL length in OAGB remains an open question, as there is no agreement in the published literature. Boyle et al. reported that weight loss outcomes were similar for BPL lengths of 150 cm and 200 cm [10]. Carbajo et al. used a BPL length of 200 cm in the first 209 patients undergoing OAGB, but to obtain better weight loss, they switched to a BPL length of approximately half the total small bowel length (TBL) (250–350 cm) in the subsequent 1200 cases [4,7]. More recently, this group studied the ideal BPL length to produce optimum weight loss with a low risk of malnutrition and advocated for measuring the TBL [96]. They found that a common limb length to TBL ratio of .4 produced optimal results [96]. Other investigators have also experimented with BPL length. Komaei et al. reported that bypassing 40% of TBL was superior to a fixed BPL length of 200 cm [97]. Some authors recommend varying the BPL length based on the patient's BMI and whether the operation is primary or a revision after previous bariatric surgery; these authors used a BPL length ranging from 150 to 300 cm [7,19,41,98,99]. Finally, in an RCT of 60 patients, Nabil et al. measured the TBL and compared the outcomes of OAGB with a BPL length of 200 cm (conventional) versus the anastomosis created at 400 cm from the ileocecal valve (distal) [100]. There was no loss to follow-up, and the 2 groups were comparable in initial TBL, %EWL, and complete resolution of co-morbidities up to 12 months. The ratio of the BPL length to TBL was significantly higher in the distal group ($P < .001$), but this did not correlate with %EWL. The levels of hemoglobin, cholesterol, triglycerides, iron, and albumin were significantly lower, and the level of parathormone hormone was higher in the distal group. The quality-of-life score was significantly higher in the conventional group during follow-up. The authors concluded that a BPL length >200 cm does not improve weight loss or co-morbidity resolution. They also recommended measurement of TBL to avoid excessive small bowel shortening, which might increase the risk of nutritional deficiencies [100]. In summary, there is no consensus in the published literature on the optimal BPL length for OAGB.

Risks of OAGB include severe nutritional complications, including protein-calorie malnutrition, liver failure, or even death. Bétry et al. found that of the 12 patients who were referred to the clinical nutrition intensive care unit of their university hospital after bariatric surgery, over half (7 patients) had undergone OAGB versus 2 patients after RYGB, 2 after SG, and 1 after LAGB [101]. Several authors have reported that a BPL ≥200 cm was associated with a higher rate of protein-calorie malnutrition, liver failure, death, or the need for revision [62,101–108]. On the other hand, a study of 155 patients with 3 BPL lengths (150, 200, and 250 cm) and at least 3-year follow-up reported that although the folic acid level was significantly lower for the longest BPL length, there were no differences for vitamins D, A, E, B12, or iron, and no patient developed severe protein-calorie malnutrition [109]. Some authors advocate for a BPL length of 150 cm, arguing that this length results in excellent weight loss and a very low risk of nutritional complications [10,104,107,110–114]. This appears to be the case even in patients with a BMI >50 kg/m^2, with a reported mean %TWL of 42% and mean %EWL of 78% 5 years after surgery [22].

Rather than using a set BPL length for all comers, some investigators have tailored the BPL length to patient preoperative weight or the presence of metabolic disease. A retrospective study of 101 patients evaluated the effect of BP lengths of 150, 180, and 250 cm on outcomes 1 year after OAGB [110]. Patients with higher BMIs, uncontrolled T2D, or hypertension were given longer BPL lengths, while younger patients, female patients of childbearing age, and patients on a vegetarian diet were given a shorter BPL length. Those with BPL lengths of 180 and 250 cm had significantly greater %TWL than those with BPL lengths of 150 cm. However, the longer BPL groups also had greater risk of malnutrition, and there were no significant differences in the resolution rates of T2D and hypertension among the 3 groups. The authors concluded that a 150-cm BPL was associated with minimal nutritional complications and good results, while a 180-cm BPL can be used in the superobese. They cautioned against a 250-cm BPL, as it resulted in significant nutritional deficiencies [110]. Another study evaluated the effects of BPL lengths 150, 180, and 200 cm on weight loss, resolution of co-morbidity, and nutritional deficiencies in 180 patients at 2 years after OAGB [111]. The follow-up rate was 95% at 1 year and 87% at 2 years after surgery. There was no statistically significant difference in %EWL, %TWL, and resolution rates of T2D and hypertension among the groups. Iron and ferritin deficiencies were significantly greater in those with a BPL length of 200 cm than in those with a BLP length of 150 cm. The authors supported the use of a BPL length of 150–180 cm, which was effective for weight loss and carried a low risk of malnutrition [111]. In another retrospective study of 632 patients, the BPL length was tailored to BMI and consisted of 150, 180, and 200 cm [113]. After adjustment for preoperative BMI, longer BPL lengths were not associated with higher BMI loss at 1 and 3 years. There was also no difference in remission rates of co-morbidities [113]. Finally, in a retrospective review of 101 patients who underwent tailored OAGB with a BPL length of 150 and 180 cm based on BMI, the 2 groups did not show any difference in the number of patients achieving >50% EWL or >20% TWL, but the longer BPL resulted in lower mean serum iron levels [114]. Taken in sum, these studies have shown that longer BPL length does not predictably improve weight loss but may add to the risk of nutritional deficiencies.

One area of active investigation is the relationship of TBL, BPL length, and outcomes. The TBL can vary widely from patient to patient; 3 different studies have reported a TBL mean ± standard deviation of 531 ± 105 cm, 690 ± 94 cm, and 506 ± 105 cm [115–117]. Given that some bariatric patients in any cohort will inevitably have a shorter TBL due to random chance, a standardized longer BPL length may lead to too short of a common channel length for these patients. Skandaros reported achievement of good weight loss and remission of hypertension and diabetes at 24 months after OAGB when using a long BPL length of 250 cm in patients with a BMI >50 kg/m^2 and a TBL >600 cm. However, hemoglobin, iron, calcium, albumin, and vitamin D levels showed a significant decrease, and parathyroid hormone levels showed a significant increase [118]. In a 20-year retrospective review by Almuhanna et al. that included 2223 patients with OAGB, the technique, including BPL length, changed with time. In the last period of the study (2016–2020), the entire length of the small bowel was measured, and the common channel length was kept to at least 400 cm to potentially reduce the incidence of protein-calorie deficiency [19]. At this point in time, there is no consensus in the literature on the minimum TBL required to avoid nutrient deficiencies. Some authors advise measuring the entire small bowel during OAGB to ensure an adequately long common limb.

Summary

The growing adoption of OAGB outside the United States during the past decade has resulted in a number of publications exploring early, mid-, and long-term results. OAGB results in effective weight loss at 5 years and beyond that is comparable to RYGB or SG, with some studies demonstrating better results. The short- and mid-term metabolic effect of OAGB, including remission and improvement in T2D, is also comparable to RYGB and SG. Available evidence also has shown that OAGB is effective as a revision option after restrictive operations such as LAGB, VBG, and SG.

OAGB has a relatively short operative time, low early and late complication rates, and a very low mortality rate that is on par with SG and RYGB. Because of the loop construction, the long-term effect of bile reflux remains a concern. Creation of an appropriately long gastric pouch and the Carbajo modification may mitigate some of the risk of esophageal bile reflux. Another concern is malnutrition and nutrient deficiencies; the malabsorptive nature of OAGB may lead to these deficiencies, and the risk may be directly related to the length of the BPL and the resultant common channel length. Although the best BPL length has not been established, the risk of nutritional deficiency has been reported to be very low with a BPL length of 150 cm and may increase with longer BPL lengths, especially a BPL length >200 cm. As such, it is necessary to provide long-term follow-up for patients who have undergone OAGB in order to monitor nutritional status and survey for symptomatic bile reflux.

The ASMBS endorses OAGB as a metabolic and bariatric procedure. The ASMBS will continue to monitor and evaluate emerging data on this procedure and, when appropriate, will issue an update to the position statement.

Disclosures

The authors have no commercial associations that might be a conflict of interest in relation to this article.

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