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Original Article

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# Roux-en-Y Gastric Bypass Versus One Anastomosis Gastric Bypass as Revisional Surgery After Failed Sleeve Gastrectomy: A Systematic Review and Meta-analysis

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**Trial Registration**
PROSPERO Identifier: CRD42023474966

## ABSTRACT

**Purpose:** This study aimed to assess the outcomes of revisional procedures, namely Roux-en-Y gastric bypass (RYGB) and one anastomosis gastric bypass (OAGB) following unsuccessful laparoscopic sleeve gastrectomy.
**Materials and Methods:** This systematic review and meta-analysis included 817 patients (404 in OAGB group, 413 in RYGB group) from seven retrospective comparative studies. Data on sample size, demographics, perioperative complications, operative time, pre- and post-revisional body mass index, total weight loss, and global weight loss over follow-up were extracted.
**Results:** The mean operative time was 98.2–201 minutes for RYGB versus 78.7–168 minutes for OAGB. Despite classical RYGB gastric bypass taking longer, mini gastric bypass resulted in greater weight loss than RYGB, with a mean difference of −5.84 (95% confidence interval [CI], −6.74 to −4.94; $P<0.00001$; $I^2=0\%$), greater total weight loss, and a higher diabetes remission rate (odds ratio [OR], 0.32; 95% CI, 0.14 to 0.71). However, OAGB was associated with a significantly higher incidence of postoperative gastroesophageal reflux than RYGB (52 vs. 31: OR, 0.40; 95% CI, 0.24 to 0.67; $P=0.0005$; $I^2=0\%$).
**Conclusion:** OAGB was performed more quickly and boasted greater total weight loss and higher diabetes remission rates compared to RYGB after failed sleeve gastrectomy. However, OAGB also demonstrated a higher incidence of postoperative gastroesophageal reflux disease. Thus, careful patient selection is essential when considering OAGB.

**Trial Registration:** PROSPERO Identifier: CRD42023474966

**Keywords:** Gastric bypass; Roux-en-Y gastric bypass; Metabolic surgery; Surgical revision; Weight reduction

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**Conflict of Interest**
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**Author Contributions**
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# INTRODUCTION

Obesity is a complex and multifaceted disease. Since 1980, the global occurrence of overweight and obesity has increased twofold; approximately one-third of the global population is now categorized as overweight or obese [1]. Bariatric surgery represents the most efficacious intervention for individuals with morbid obesity, as it enables significant and enduring reductions in body weight while ameliorating or resolving comorbidities linked to obesity, ultimately leading to decreased mortality rates [2].

Laparoscopic sleeve gastrectomy (SG) is currently the most widely utilized bariatric procedure owing to its substantial ability to reduce body weight, ameliorate comorbid conditions, and enhance overall well-being [3]. In 2018, it accounted for more than 45% of all reported bariatric procedures to the International Federation for the Surgery of Obesity and Metabolic Disorders. This can be attributed to its favorable safety record, technical feasibility, and consistently successful outcomes [4]. Revisional bariatric procedures are increasingly common. With more primary procedures being performed to manage severe obesity and its complications, 5–8% of these procedures will fail, requiring revisional surgery [5].

However, the literature to date has recognized various reasons for revisional surgery after SG, with the most frequent causes being gastroesophageal reflux disease (GERD) and problems related to weight [6]. In addition to re-sleeving and Roux-en-Y gastric bypass (RYGB), several other surgical procedures are available. RYGB was the preferred surgical intervention in numerous research studies [7]. However, the appropriate revisional bariatric surgery after unsuccessful SG remains debatable [8].

One anastomosis gastric bypass (OAGB) was first introduced by Rutledge as mini gastric bypass in 2001 [9] and modified later to OAGB by Carbajo in 2005 [10]. OAGB seems highly efficient at promoting weight reduction and diminishing comorbidities associated with obesity after the initial bariatric intervention [11]. The popularity of OAGB has increased significantly during the past few years. It is the most common type of bariatric surgery performed worldwide [12] after SG and RYGB. Its advantages include a brief operative period, solitary anastomosis, satisfactory short-term complication rates, and successful weight loss. Furthermore, the outcomes of such procedures are non-inferior to those of revisional RYGB [13]. This study aimed to examine the results of RYGB and OAGB as revision surgeries after unsuccessful SG.

# MATERIALS AND METHODS

## 1. Study design

The present investigation was conducted with the utmost fidelity to a previously established methodology that was collectively assented to by all contributing authors of the research and adhered to the directives outlined in the PRISMA guidelines. A comprehensive exploration of the literature was conducted to ensure a meticulous and thorough analysis (**Fig. 1**).

## 2. Literature search strategy

A comprehensive literature exploration was performed of the PubMed, Scopus (ELSEVIER), and Embase databases using the following terms and Boolean operators: (OAGB OR “single anastomosis gastric bypass” OR “Revisional OAGB” OR “mini gastric bypass” OR “omega

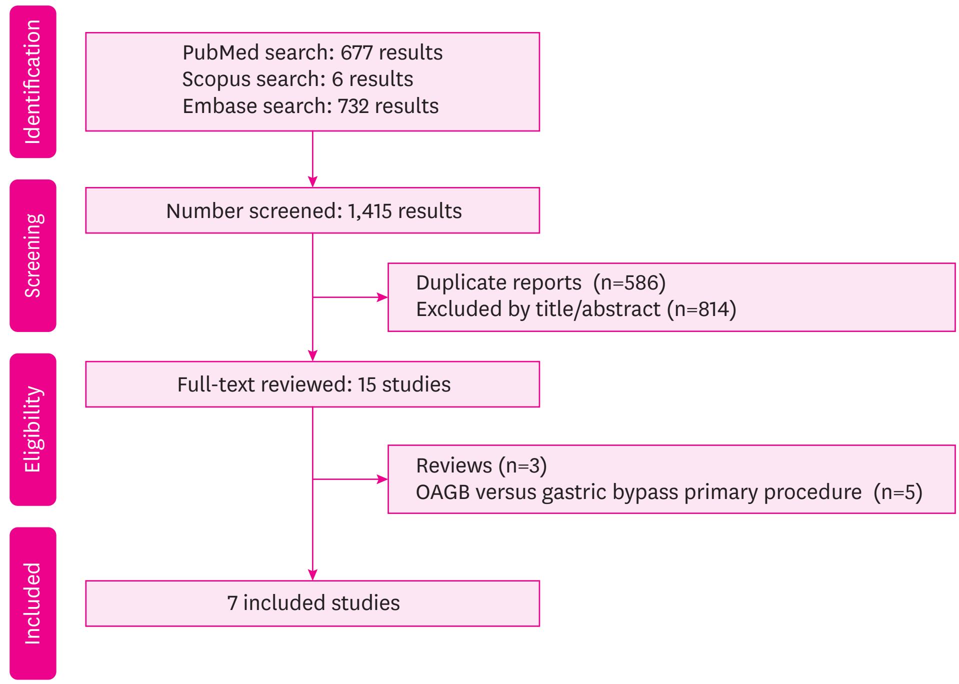


**Fig. 1.** PRISMA flow diagram of study screening and selection process.

loop bypass") AND ("gastric bypass" OR "Roux-en-Y" OR "revisional surgery") AND ("sleeve gastrectomy" OR "failed sleeve gastrectomy").

The inclusion criteria were defined as follows: prospective and retrospective studies comparing RYGB and OAGB after SG; publication in English; and published in 2000–2023. The exclusion criteria were as follows: meeting abstracts, reviews, case reports, and clinical guidelines; and duplicate studies or a lack of sufficient information. Additionally, studies that focused on alternative procedures for revisional surgery after SG were only included if they provided separate data on weight loss outcomes for RYGB and OAGB.

The study was registered in the PROSPERO database (No. CRD42023474966).

### 3. Outcomes

The primary study objective was to determine the percentage of total weight loss (TWL) following the revisional operation. Furthermore, the objective of this study was to evaluate the secondary outcomes, including the overall weight loss (referred to as the global TWL) and diabetes remission and any postoperative complications including GERD, stenosis, and anastomotic ulcer, that may have arisen due to the revisional intervention.

### 4. Data extraction

The participants' demographic information, including sample size for each group, age, sex, preoperative body mass index (BMI), comorbidities, and perioperative outcomes such as operative time, length of hospital stay, leakage, diabetes remission, and GERD, was extracted for each study in the analysis. The data extraction process was performed by 2 investigators (KA and AA), who ensured data validity by reaching consensus through the comparison. For the data analysis, RevMan software (v. 5.3; Cochrane Collaboration, London, UK) was used.

Journal of Metabolic and Bariatric Surgery JMBS

### 5. Statistical analysis

The random-effects model (Mantel-Haenszel statistical method) was employed to calculate the odds ratio (OR) and 95% confidence interval (CI) for the categorical outcomes. The study employed the weighted mean difference (WMD) and its corresponding 95% confidence interval (CI) to assess continuous outcomes. This was accomplished using random-effects models and the inverse variance statistical method.

### 6. Quality and publication bias evaluation

The Newcastle-Ottawa quality assessment scale (score range, 0–9 stars) was used to assess nonrandomized controlled trials. The inclusion criteria involved selecting studies with a methodological quality score of 5 or higher, indicating sufficient quality. The included studies were assessed by 2 investigators (KA and AB), who conducted independent ratings. Consensus was then reached based on their evaluations (**Table 1**) [4,8,13-17].

## RESULTS

### 1. Overview of article selection process

The meta-analysis included seven studies with 404 patients who underwent OAGB and 413 patients who underwent RYGB. These studies were published in 2018–2023 and sourced from various countries, including Germany, Brazil, Poland, Austria, and Egypt (**Table 2**) [4,8,13-17].

**Table 1.** Study quality assessment

| Study | Selection | | Outcome | | | | | | Total |
|---|---|---|---|---|---|---|---|---|---|
| | Exposed cohort | Non-exposed cohort | Ascertainment of exposure | Outcome of interest | Comparability | Assessment of outcome | Length of follow-up | Adequacy of follow-up | |
| Chiappetta et al. [14] | * | * | * | * | ** | * | * | * | 9 |
| Rayman et al. [4] | * | * | * | * | ** | * | * | | 8 |
| Hany et al. [15] | * | * | * | * | ** | | * | * | 8 |
| Rheinwalt et al. [8] | * | * | * | * | ** | | * | * | 8 |
| Dayan et al. [13] | * | * | * | * | ** | | * | * | 8 |
| Felsenreich et al. [16] | * | * | * | * | ** | * | * | * | 9 |
| Wilczyński et al. [17] | * | * | * | * | ** | | * | * | 8 |

**Table 2.** Study characteristics

| Study | Year | Study design | Groups | No. of patients | Female | Age (yr) | BMI, (kg/m$^2$) | Pre-operative GERD |
|---|---|---|---|---|---|---|---|---|
| Chiappetta et al. [14] | 2018 | Retrospective | Single anastomosis | 34 | 23 | 47±11 | 46±8 | 5 |
| | | | Roux-en-Y | 21 | 19 | 46±11 | 37±7 | 13 |
| Rayman et al. [4] | 2020 | Retrospective | Single anastomosis | 144 | 107 | 42±11 | 42±6 | 28 |
| | | | Roux-en-Y | 119 | 84 | 44±12 | 40±5 | 41 |
| Hany et al. [15] | 2022 | Randomized trial | Single anastomosis | 80 | 69 | 43±7 | 45±8 | 33 |
| | | | Roux-en-Y | 80 | 69 | 43±8 | 45±6 | 32 |
| Rheinwalt et al. [8] | 2021 | Retrospective | Single anastomosis | 55 | NA | 42±1 | 46±1 | 4 |
| | | | Roux-en-Y | 68 | NA | 46±1 | 39±1 | 21 |
| Dayan et al. [13] | 2023 | Retrospective | Single anastomosis | 31 | 23 | 44±12 | 40±9 | 22 |
| | | | Roux-en-Y | 47 | 38 | 50±13 | 31±6 | 34 |
| Felsenreich et al. [16] | 2021 | Retrospective | Single anastomosis | 13 | NA | NA | 40±8 | NA |
| | | | Roux-en-Y | 45 | NA | NA | 34±8 | NA |
| Wilczyński et al. [17] | 2022 | Case cohort | Single anastomosis | 47 | 34 | 45±11 | 41±9 | 7 |
| | | | Roux-en-Y | 33 | 27 | 41±11 | 39±7 | 10 |

Data are shown as number or as mean ± standard deviation.
BMI = body mass index, GERD = gastroesophageal reflux disease, NA = not applicable.

Journal of Metabolic and Bariatric Surgery JMBS

| Study or Subgroup | RYGB Mean | RYGB SD | RYGB Total | OAGB Mean | OAGB SD | OAGB Total | Weight | Mean Difference IV, Random, 95% CI |
|---|---|---|---|---|---|---|---|---|
| Chiappetta | 98.2 | 24.3 | 21 | 78.7 | 35.7 | 34 | 22.7% | 19.50 [3.63, 35.37] |
| Hany | 104.9 | 13.7 | 80 | 85.6 | 18.6 | 80 | 37.5% | 19.30 [14.24, 24.36] |
| Rheinwalt | 201 | 6.8 | 68 | 168 | 7.2 | 55 | 39.7% | 33.00 [30.50, 35.50] |
| **Total (95% CI)** | | | **169** | | | **169** | **100.0%** | **24.79 [13.35, 36.22]** |

Heterogeneity: Tau² = 84.03; Chi² = 24.38, df = 2 (P < 0.00001); I² = 92%
Test for overall effect: Z = 4.25 (P < 0.0001)

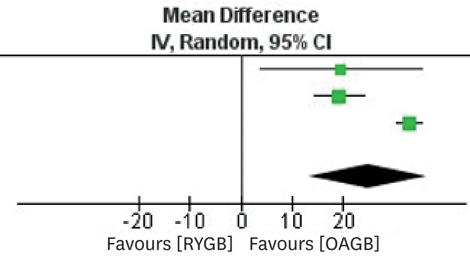


**Fig. 2.** Forest plot of operative time.
RYGB = Roux-en-Y gastric bypass, OAGB = one anastomosis gastric bypass, SD = standard deviation, IV = interval variable, CI = confidence interval.

## 2. Mean operative time

The mean operative time was 98.2–201 minutes in the RYGB group versus 78.7–168 minutes in the OAGB group, showing a significant difference and an absolute mean difference of 24.79 (95% CI, 13.35 to 36.22; P<0.00001; $I^2$=92%) (**Fig. 2**).

## 3. Length of hospital stay

There were 136 patients in the RYGB cohort and 131 patients in the OAGB cohort. Only three of the seven studies discussed the length of hospital stay. The two groups had similar lengths of hospital stays (mean, 5–6 days). The difference from the absolute mean was 0.49 (95% CI, −0.82 to 1.80; P=0.46; $I^2$=69%) and was not statistically significant (**Fig. 3**).

## 4. Diabetes remission

The findings of the analysis demonstrated a significantly greater rate of remission in the OAGB group (n=73; as indicated by an OR of 0.29 [95% CI, 0.11 to 0.79]) versus the RYGB group (n=57). The research encompassed four separate studies, yielding a sample size of 130 patients (**Fig. 4**).

## 5. Total weight loss after revisional surgery

After revisional surgery, TWL was measured in four separate investigations. In contrast to the RYGB group, the OAGB procedure exhibited a more pronounced reduction in body weight, as evidenced by a mean difference of −5.84 (95% CI, −6.74 to −4.94; P<0.00001; $I^2$=0%) (**Fig. 5**).

## 6. Complications

Postoperative leakage was reported by 5 studies, with seven incidences occurring in the RYGB subgroup versus four in the OAGB subgroup. The OR for leak rate was 1.36 (95% CI, 0.41 to 4.52; P=0.61; $I^2$=0%), confirming that leaks were less likely to occur in the OAGB subgroup, although the difference was not statistically significant (**Fig. 6**).

| Study or Subgroup | RYGB Mean | RYGB SD | RYGB Total | OAGB Mean | OAGB SD | OAGB Total | Weight | Mean Difference IV, Random, 95% CI |
|---|---|---|---|---|---|---|---|---|
| Chiappetta | 5 | 0 | 21 | 5 | 0 | 45 | | Not estimable |
| Dayan | 5.2 | 4.1 | 47 | 3.8 | 2.7 | 31 | 35.2% | 1.40 [-0.11, 2.91] |
| Rheinwalt | 6 | 0.6 | 68 | 6 | 0.6 | 55 | 64.8% | 0.00 [-0.21, 0.21] |
| **Total (95% CI)** | | | **136** | | | **131** | **100.0%** | **0.49 [-0.82, 1.80]** |

Heterogeneity: Tau² = 0.68; Chi² = 3.24, df = 1 (P = 0.07); I² = 69%
Test for overall effect: Z = 0.74 (P = 0.46)

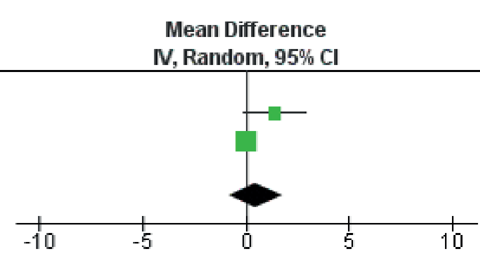


**Fig. 3.** Forest plot of length of stay.
RYGB = Roux-en-Y gastric bypass, OAGB = one anastomosis gastric bypass, SD = standard deviation, IV = interval variable, CI = confidence interval.

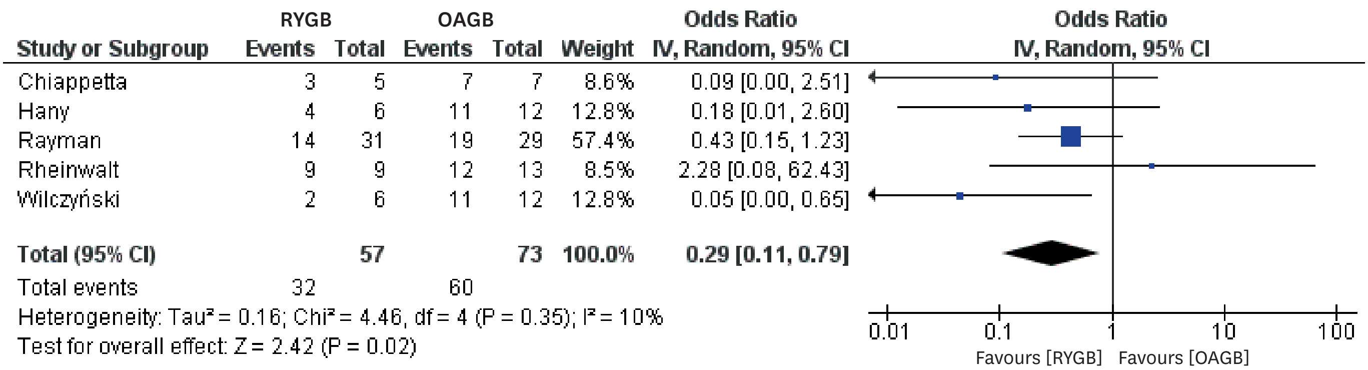


**Fig. 4.** Forest plot for diabetes remission.
RYGB = Roux-en-Y gastric bypass, OAGB = one anastomosis gastric bypass, IV = interval variable, CI = confidence interval.

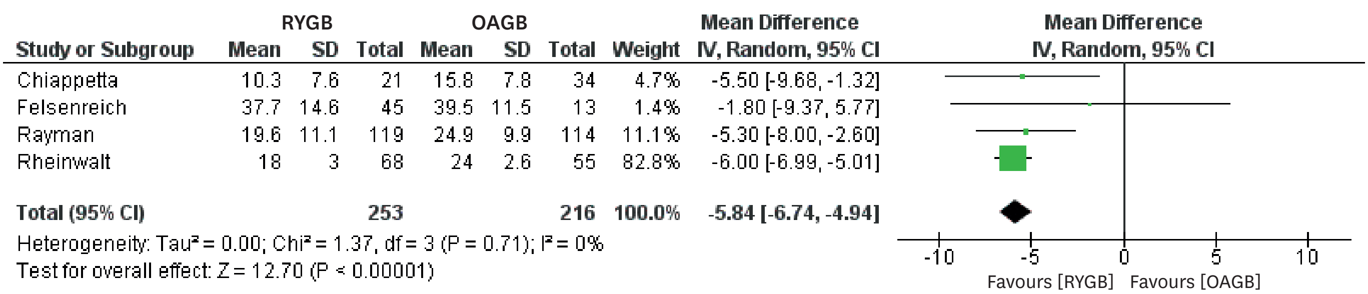


**Fig. 5.** Forest plot of total weight loss.
RYGB = Roux-en-Y gastric bypass, OAGB = one anastomosis gastric bypass, SD = standard deviation, IV = interval variable, CI = confidence interval.

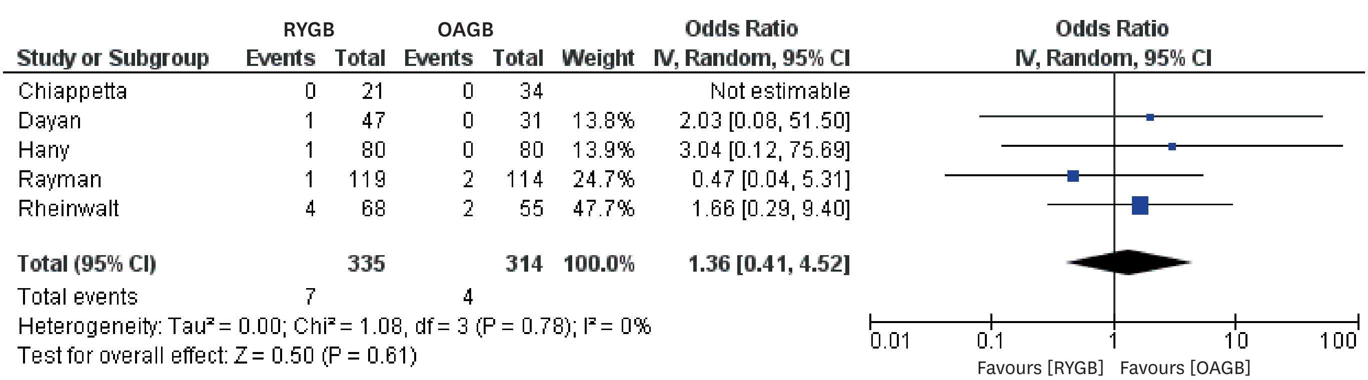


**Fig. 6.** Forest plot of postoperative leak.
RYGB = Roux-en-Y gastric bypass, OAGB = one anastomosis gastric bypass, IV = interval variable, CI = confidence interval.

## 7. Postoperative GERD

The incidence of postoperative GERD was significantly higher in the OAGB subgroup (n=52) than the RYGB subgroup (n=31), resulting in an OR of 0.40 (95% CI, 0.24 to 0.67; P=0.0005; $I^2$=0%) (**Fig. 7**).

## 8. Barrett's esophagus

Barrett's esophagus was mentioned in four studies (n=125 in the RYGB subgroup, n=91 in the OAGB subgroup) with no significant intergroup difference and an OR of 1.17 (95% CI, 0.12 to 11.49; P=0.89; $I^2$=92%) (**Fig. 8**).

| Study or Subgroup | RYGB Events | RYGB Total | OAGB Events | OAGB Total | Weight | Odds Ratio IV, Random, 95% CI |
|---|---|---|---|---|---|---|
| Chiappetta | 1 | 21 | 4 | 34 | 5.3% | 0.38 [0.04, 3.61] |
| Dayan | 4 | 47 | 7 | 31 | 15.5% | 0.32 [0.08, 1.20] |
| Felsenreich | 13 | 45 | 7 | 13 | 17.0% | 0.35 [0.10, 1.24] |
| Hany | 1 | 80 | 2 | 80 | 4.7% | 0.49 [0.04, 5.56] |
| Rayman | 9 | 119 | 25 | 144 | 42.1% | 0.39 [0.17, 0.87] |
| Rheinwalt | 0 | 68 | 1 | 55 | 2.6% | 0.27 [0.01, 6.64] |
| Wilczyński | 3 | 33 | 6 | 47 | 12.7% | 0.68 [0.16, 2.95] |
| **Total (95% CI)** | | **413** | | **404** | **100.0%** | **0.40 [0.24, 0.67]** |
| Total events | 31 | | 52 | | | |

Heterogeneity: Tau² = 0.00; Chi² = 0.77, df = 6 (P = 0.99); I² = 0%
Test for overall effect: Z = 3.46 (P = 0.0005)

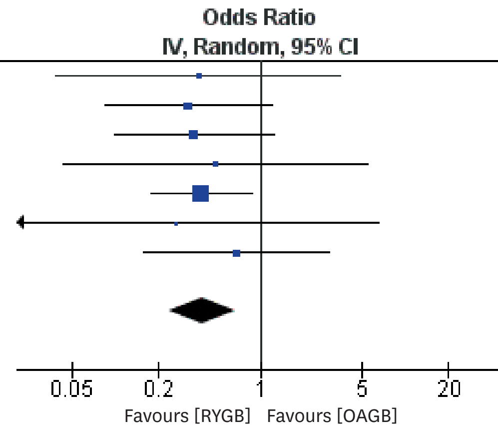


**Fig. 7.** Forest plot of postoperative gastroesophageal reflux disease.
RYGB = Roux-en-Y gastric bypass, OAGB = one anastomosis gastric bypass, IV = interval variable, CI = confidence interval.

| Study or Subgroup | RYGB Events | RYGB Total | OAGB Events | OAGB Total | Weight | Odds Ratio IV, Random, 95% CI |
|---|---|---|---|---|---|---|
| Dayan | 0 | 47 | 0 | 31 | | Not estimable |
| Felsenreich | 4 | 45 | 1 | 13 | 100.0% | 1.17 [0.12, 11.49] |
| Wilczyński | 0 | 33 | 0 | 47 | | Not estimable |
| **Total (95% CI)** | | **125** | | **91** | **100.0%** | **1.17 [0.12, 11.49]** |
| Total events | 4 | | 1 | | | |

Heterogeneity: Not applicable
Test for overall effect: Z = 0.14 (P = 0.89)

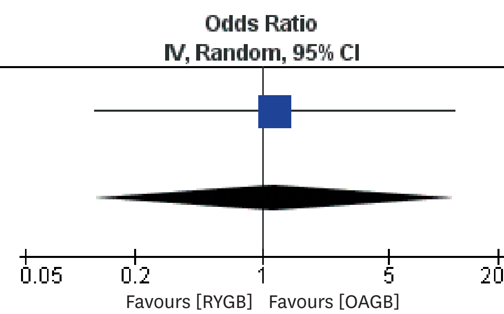


**Fig. 8.** Forest plot of Barrett's esophagus.
RYGB = Roux-en-Y gastric bypass, OAGB = one anastomosis gastric bypass, IV = interval variable, CI = confidence interval

| Study or Subgroup | RYGB Mean | RYGB SD | RYGB Total | OAGB Mean | OAGB SD | OAGB Total | Weight | Mean Difference IV, Random, 95% CI |
|---|---|---|---|---|---|---|---|---|
| Chiappetta | 36 | 10.8 | 21 | 34.7 | 9.3 | 34 | 19.8% | 1.30 [-4.28, 6.88] |
| Dayan | 4.4 | 14.6 | 47 | 22 | 12.9 | 31 | 19.0% | -17.60 [-23.77, -11.43] |
| Felsenreich | 41.5 | 14.1 | 45 | 44.8 | 12.6 | 13 | 16.4% | -3.30 [-11.29, 4.69] |
| Rayman | 27 | 9 | 119 | 32 | 9 | 144 | 23.8% | -5.00 [-7.19, -2.81] |
| Wilczyński | 13.4 | 9.38 | 33 | 25.17 | 11.87 | 47 | 21.1% | -11.77 [-16.43, -7.11] |
| **Total (95% CI)** | | | **265** | | | **269** | **100.0%** | **-7.29 [-12.87, -1.71]** |

Heterogeneity: Tau² = 32.84; Chi² = 27.21, df = 4 (P < 0.0001); I² = 85%
Test for overall effect: Z = 2.56 (P = 0.01)

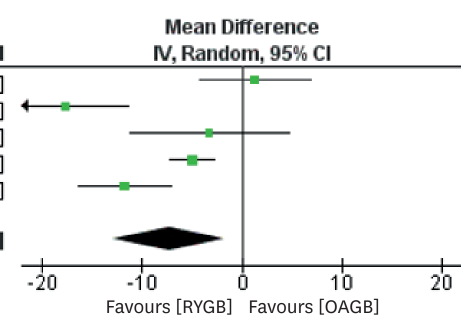


**Fig. 9.** Forest plot of mean difference in global total weight loss.
RYGB = Roux-en-Y gastric bypass, OAGB = one anastomosis gastric bypass, SD = standard deviation, IV = interval variable, CI = confidence interval.

## 9. Global TWL

The global TWL was reported by five studies and showed a significantly greater weight loss in the OAGB versus RYGB subgroup with a mean difference of −7.29 (95% CI, −12.87 to −1.71; P=0.01; $I^2$=85%) (**Fig. 9**).

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## DISCUSSION

This study described a comprehensive meta-analysis of seven distinct studies encompassing 404 patients in the OAGB subgroup and 413 patients in the RYGB subgroup. The studies as mentioned above were published within 2018–2023 and sourced from various countries.

The field of revisional surgery, which pertains to correcting and amending previous bariatric surgical procedures, has experienced rapid growth and development. As of 2015, revisional surgery accounted for 13.6% of all bariatric procedures [18]. The increase in primary surgical interventions, primarily intended for the management of severe obesity and its related complications, has resulted in a failure rate of 5–8% requiring revisional surgery [5].

OAGB and RYGB are surgical interventions used in cases of unsuccessful SG. This study compared the outcomes of these two procedures.

Our research revealed that OAGB resulted in greater TWL than RYGB by a mean of 5.84%. Felsenreich et al. [16] reported the greatest TWL after failed SG for both procedures, while Chiappetta et al. [14] reported the modes in both procedures; these findings are similar to those of Robert et al. in which, at the 2-year follow-up, OAGB was not inferior to RYGB in terms of weight loss or improved metabolic function [19]. The significant malabsorptive effects of OAGB can be attributed to various factors, with one of the most crucial being the length of the biliopancreatic limb. In patients who undergo RYGB, it is recommended that the length of the biliopancreatic limb be 50–150 cm, whereas for OAGB, the length should be 250–350 cm. The duodenum and jejunum play crucial roles in food digestion and absorption. In contrast, the biliopancreatic limb serves as a bypass segment within the small intestine, effectively restricting nutrient absorption. An extended biliopancreatic limb significantly hampers the body's capacity to effectively assimilate nutrients, thereby contributing to the observed malabsorption phenomenon.

In terms of global TWL, which starts from the time of the initial surgery and ends after the revisional surgery, the OAGB subgroup showed greater values than the RYGB subgroup. In contrast to our finding, Dantas et al. [20] showed no significant difference in global TWL between the two procedures after SG. However, this difference can be attributed to many factors, such as the gastric pouch size and starting BMI before the initial operation. At the same time, no one can argue about the power of OAGB in terms of malabsorption, which might be attributed to the longer biliopancreatic limb.

In contrast to our results, the occurrence of GERD is reportedly higher among patients who undergo OAGB versus RYGB. Eskandaros et al. [21] reported using upper endoscopy, 24-hour pH monitoring, and manometry to establish that the 2 procedures yielded similar positive outcomes in mitigating GERD-associated symptoms. Nevertheless, OAGB demonstrates potential as a bariatric procedure that promotes weight loss among individuals who are obese and have mild to moderate GERD, specifically those with up to Los Angeles grade B esophagitis [21]. Thus, despite its comparable efficacy, OAGB has not been widely accepted due to concerns regarding postoperative esophageal biliary reflux.

Saarinen et al. [22] presented a cohort study of nine patients with a preoperative BMI of 43.1 (range, 34.2–54.6) $kg/m^2$. OAGB involved the construction of a gastric tube measuring 15 cm long, which was then connected to the small intestine using a 40-mm stapler. The biliary limb,

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measuring 250–270 cm long, was positioned in an antecolic manner. Hepatobiliary scintigraphy, esophagogastroduodenoscopy, gastric pouch biopsy examination, and the use of a reflux symptom questionnaire (GerdQ) were employed to detect the presence of bile reflux following a 12-month postoperative period. A significant proportion of the study participants, specifically 55.5%, experienced bile reflux. Of them, one required additional surgical intervention.

Both procedures possess significant ability to achieve diabetes remission. This was illustrated in our study and similarly by Magouliotis et al. [23]. In fact, the superiority of OAGB over RYGB in terms of diabetes remission has been demonstrated. This may be attributed to the heightened malabsorptive effect of the OAGB procedure as well as alterations in the gastrointestinal tract microbiome. Nevertheless, it should be noted that OAGB was more closely associated with micronutrient deficiency.

To the best of our understanding, this meta-analysis encompasses the most extensive collection of studies comparing RYGB and OAGB as revision procedures following laparoscopic SG. Nevertheless, the research conducted exhibited certain constraints. First, it included a relatively small sample size and relevant studies were scarce. Second, because of the paucity of studies, we included studies irrespective of differing follow-up durations, which could have impacted our conclusions regarding weight reduction outcomes.

## CONCLUSION

In conclusion, patients who experience weight regain or insufficient weight loss after laparoscopic SG may find conversion procedures advantageous. These procedures are safe and effective at treating weight regain and insufficient weight loss. Compared to RYGB, OAGB yields greater weight loss and is more adept at inducing diabetes remission. However, it also carries a higher risk of GERD.

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