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Original article

Outcomes of laparoscopic sleeve gastrectomy with and without antrectomy in severely obese subjects. Evidence from randomized controlled trials

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Abstract

Background: Laparoscopic sleeve gastrectomy (SG) has been proven safe and effective in achieving weight loss. However, the distance from the pylorus where resection should begin has been debated.
Objectives: To compare the clinical outcomes of laparoscopic SG with antrum resection (AR) versus preservation (AP) for bariatric purposes by conducting a meta-analysis of randomized controlled trials (RCT).
Setting: Academic hospital, United States.
Methods: PubMed and Cochrane Library were queried for RCTs from establishment to August 2020. The following key search terms were used: "sleeve gastrectomy" AND ("antrectomy" OR "antrum") AND ("randomized" OR "random"). The following data were extracted: author, publication year, country, sample size, follow-up duration, and clinical outcomes, including weight-related: excess weight loss (EWL), total weight loss (TWL), body mass index (BMI), operation time, length of hospital stay, complication rates, and resolution of obesity-related comorbidities.
Results: A total of 9 unique RCTs including 492 AR and 385 AP patients were screened and included in the final quantitative analysis. Patients who underwent SG with AR showed higher EWL and TWL at 6 months (EWL: $P < .001$; TWL: $P = .006$), and 1 year (EWL: $P = .013$; $P < .001$) postoperatively. The BMI was also lower in the AR group 3 months ($P = .013$) and 6 months ($P = .003$) postoperatively. However, the EWL and BMI at 2 years were comparable between both groups ($P = .222$ and $P = .908$, respectively). No statistical significance was observed in terms of operating time, staple line disruption, bleeding, complications with a Clavien-Dindo Grade >III, resolution of comorbidities (hypertension, diabetes, hyperlipidemia, arthritis/back pain), and de novo gastroesophageal reflux disease ($P > .05$). AP was associated with a slightly shorter postoperative hospital stay (4.0 versus 3.1 days, $P = .039$).
Conclusion: Laparoscopic SG with AR is associated with superior weight loss in the short-term compared with AP. However, mid-term follow-up beyond 1 year showed no significant differences in BMI or incidence of de novo gastroesophageal reflux disease. (Surg Obes Relat Dis 2022;18:404–412.)

Key words: Sleeve gastrectomy; Antrectomy; Antrum resection; Antrum preservation

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Bariatric surgery is a well-recognized, safe, effective, and durable treatment modality for severe obesity [1,2]. While several surgical procedures are available, sleeve gastrectomy (SG) has become the most popular bariatric intervention. In a recent poll from the International Federation for the Surgery of Obesity and Metabolic Disorder Survey, 45.9% of procedures were SG among 579,517 bariatric interventions performed worldwide [3]. Robust evidence has demonstrated that SG is not only effective in attaining weight loss but also in achieving resolution of obesity-related comorbidities, such as cardiovascular disease, diabetes, chronic renal disease, and arthritis [4–8]. From a surgical perspective, however, technical consensus has not been reached on certain procedural aspects, such as ideal bougie size, if staple line reinforcement is required, and indications for this procedure in patients with previous history of gastroesophageal reflux disease (GERD) [9]. In terms of whether antrectomy should be performed on a routine basis, some surgeons recommend a closer distance from the pylorus to start the resection (antrum resection [AR]) to achieve smaller gastric volume and thus more evident therapeutic effect, while others adopt a rather conservative approach, starting gastric resection from a farther distance (antrum preservation [AP]) from the pylorus. Those supporting a conservative approach claim that a more aggressive resection is associated with decreased gastric motility and increased gastric secretion, leading to GERD in the distal esophagus [10]. Several randomized controlled trials (RCTs) have been published with conflicting conclusions, which may be related to underpowering. Based on the Bariatric Metabolic Surgery Standardization World Consensus Meeting, a range of 2–6 cm is an acceptable antrectomy distance from the pylorus [11]. In the present study, a systematic review and meta-analysis of RCTs is performed, aiming to compare the clinical outcomes of patients who underwent SG with AR and AP for bariatric purposes.

Methods

The present meta-analysis is exempt from institutional review board approval because no human subject was involved, and it complies with the Preferred Reporting Items for Systematic Reviews and Meta-analysis Statement (PRISMA) [12].

Search strategy and selection criteria

PubMed and Cochrane Library were queried for articles published up to August 2020. The following keywords were used: “sleeve gastrectomy” AND (“antrectomy” OR “antrum”) AND (“randomized” OR “random”).

The following major criteria were adopted:

1. Patients underwent laparoscopic SG for bariatric purposes
2. Comparative groups of antrectomy starting from <3 cm versus >5 cm
3. Post-operative follow-up data were available
4. RCT only

The following exclusion criteria were adopted:

1. Abstracts without full texts, oral presentations, posters
2. Studies that contain patient samples published in multiple papers
3. Sample size <5
4. Non-RCT

Studies were screened following the flow diagram as depicted in Fig. 1. Quality assessment was performed with the Cochrane Collaboration’s tool for assessing risk of bias in randomized trials (Table 1). The following data were extracted: author, publication year, country, sample size, follow-up duration, and clinical outcomes. Primary clinical outcomes are weight-related: excess weight loss (EWL), total weight loss (TWL), and body mass index (BMI). Secondary outcomes include operation time, length of hospital stay, complication rates, and resolution of obesity-related comorbidities. Obesity-related comorbidities included hypertension (HTN), hyperlipidemia (HLD), type 2 diabetes (T2D), obstructive sleep apnea (OSA), and joint pain/arthritis. GERD, surgery-related bleeding, and leak rates were also retrieved.

Endnote X8 (Clarivate Analytics, Philadelphia, Pennsylvania) was used to remove duplicates. Studies were initially screened based on titles and abstracts, followed by full-text evaluation of remaining studies. Selected studies were eventually subjected to quantitative analysis.

Statistical analysis

Statistical analyses were performed with STATA 15.1 (STATA Corp., College Station, TX, USA). Meta-analysis was performed with the *metan* function. Standard mean difference (SMD) was used to evaluate continuous variables using mean, standard deviation, and sample size in both comparative groups. Odds ratio (OR) was used to analyze binary outcomes. Both were reported in 95% confidence interval (Cl). A forest plot was generated to aim visualization. A random-effect model was implemented regardless of heterogeneity (I^2). Funnel plots and Egger’s test were used to assess publication bias. $P < .05$ was considered statistically significant.

Results

Baseline characteristics

Among 18 research results, review/meta-analysis (n = 1) and irrelevant studies (n = 4) were excluded. Upon full-text

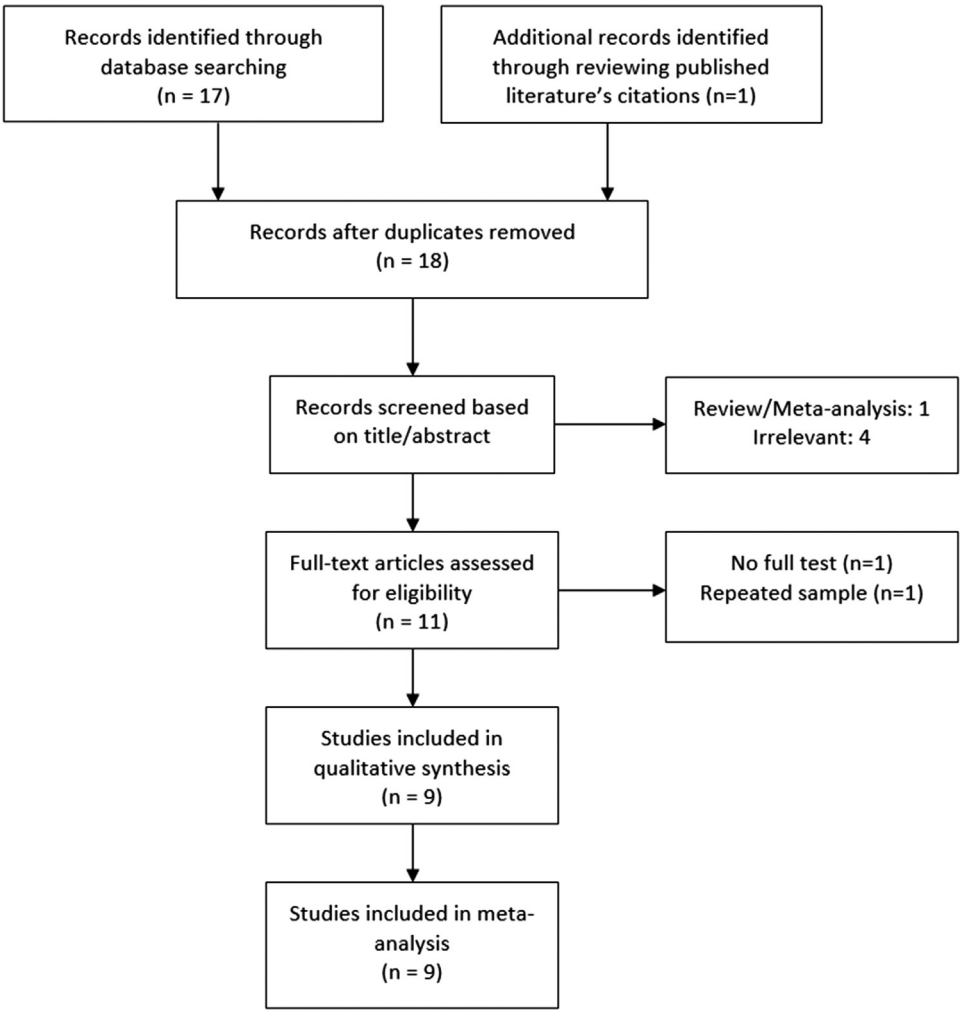

Fig 1. Flow diagram showing the screening process.

evaluation, 1 study was excluded because it was a conference abstract. Two studies contained overlapping patient samples, so the study reporting fewer outcome variables was excluded. Nine published RCTs were identified after literature screening [5,13–20]. A total of 492 and 385 bariatric patients received laparoscopic SG with AR and AP, respectively (Table 2, Fig. 2). Intraoperative leak test was performed in 6 of 7 studies. Most authors defined AR as a distance of 2 cm from the pylorus and AP as a distance of 6 cm (7/9). Oversewing or reinforcement of the staple line

Table 1
The Cochrane Collaboration's tool for assessing risk of bias in randomized trials

Study	Selection bias		Performance bias	Detection bias	Attrition bias	Reporting bias	Other bias	Total
	Random sequence generation	Allocation concealment	Blinding of participants and personnel	Blinding of outcome assessment	Incomplete outcome data	Selective reporting		Low on risk of bias
Omarov 2019	Low	High	High	High	Low	Low	Low	4/7
Pizza 2020	Low	High	High	High	Low	Low	Low	4/7
Garay 2017	Low	Low	High	High	Low	Low	Low	5/7
Nocca 2020	Low	High	High	High	Low	Low	Low	4/7
Abdallah 2014	Low	High	High	Low	Low	Low	Low	5/7
Khalifa 2019	Low	High	High	High	Low	Low	Low	4/7
Pereferrer 2016	Low	High	High	Low	Low	Low	Low	5/7
ElGeidie 2015	Low	High	High	High	Low	Low	Low	4/7
Michalsky 2013	High	High	High	High	Low	Low	Low	3/7

Table 2
Baseline characteristics of included studies

Author/Year	Region	Sample size	Age	M:F	Baseline BMI	Distance	Staple line	Bougie size	Follow-up
Omarov 2019	Turkey	AR 66 AP 57	40.7 41.0	32: 91	NR	2 cm 6 cm	Leak test, reinforced: Per-strips buttressing (Synovis, St. Paul, MN, USA), omentoplasty	32 Fr 36 Fr	24 mo
Pizza 2020	Italy	AR 75 AP 75	32.2 34.2	54: 94	43 44	2 cm 6 cm	Leak test, reinforced: Medtronic Tri-Staple SIGNA (Medtronic Inc., Dublin, Ireland) + GORE SEAMGUARD (WL Gore & Associates, Inc, Flagstaff, AZ)	36 Fr	24 mo
Garay 2017	Spain	AR 12 AP 13	56.6 49.2	8: 17	43.0 45.3	2 cm 5 cm	Leak test, reinforced: GORE SEAMGUARD	33 Fr 42 Fr	12 mo
Nocca 2020	France	AR 141 AP 138	39.9 42.1	35: 224	42.4 42.4	2 cm 6 cm	NR	NR	
Abdallah 2014	Egypt	AR 52 AP 53	NR	36: 79	51.8 51.6	2 cm 6 cm	Leak test, no oversewing	38 Fr	24 mo
Khalifa 2019	Egypt	AR 25 AP 25	35.1 33.1	17: 33	59.5 58.4	2 cm 6 cm	NR	38 Fr	6 mo
Pereferrer 2016	Spain	AR 30 AP 30	51.3 50.5	17: 43	51.0 51.3	3 cm 8 cm	Leak test, reinforcement: GORE SEAMGUARD	38 Fr	12 mo
ElGeidie 2015	Egypt	AR 55 AP 58	37 35	35: 78	45.1 44.6	2 cm 6 cm	No intraoperative leak test, no reinforcement	38 Fr	12 mo
Michalsky 2013	Czech	AR 6 AP 6	45 43	NR	41.9 41	2 cm 6 cm	Leak test. No reinforcement	36 Fr	12 mo
Total		AR 492 AP 385		234: 659					

M = male; F = female; BMI = body mass index; AR = antral resection; AP = antral preservation; NR = not reported.

was routinely performed in 4/7 studies, while 1 group also implemented omentoplasty during surgeries (1/7). A bougie of 38Fr was the most commonly used (5/8). The length of follow-up duration ranged from 6–24 months.

EWL

The EWL between AR and AP was analyzed at 6 months, 1 year, and 2 years (Fig. 3). The EWL was statistically significantly higher in the AR group at 6 months (SMD: .588 [95% CI: .33–.845], $P < .001$; 237 versus 240 patients) and 1 year (SMD: .28 [95% CI: .01–.55], $P = .04$; 356 versus 346 patients), but not at 2 years (SMD: .509 [95% CI: –.308 to 1.325], $P = .222$; 127 versus 128 patients). No publication was suggested by funnel plots and Egger's tests at 6 months and 1 year (Fig. 4).

TWL

TWL at 6 months and 1 years between AR and AP was analyzed (Fig. 5). Two studies reported TWL at 6 months, whereas 3 studies were included at 1-year meta-analysis.

Fig 2. Proportion of patients from each study for the 2 groups (antral preservation [AP] and antral resection [AR]).

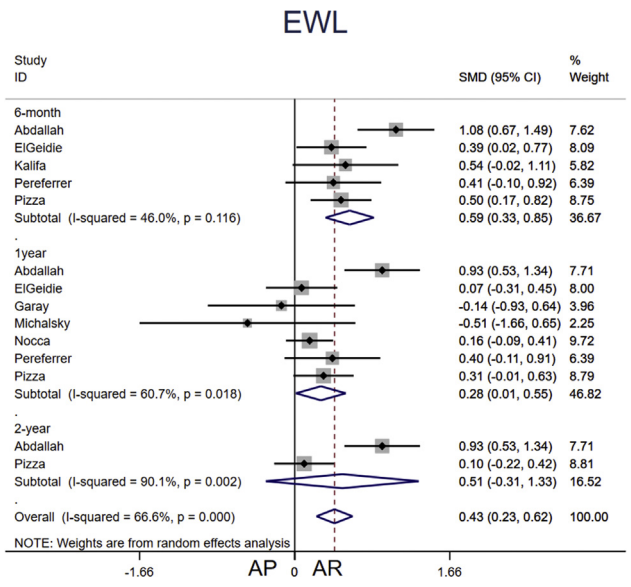

Fig 3. Excess weight loss (EWL) of patients with sleeve gastrectomy with antrum resection (AR) and preservation (AP) at 6 months, 1 year, and 2 years. SMD = standardized mean difference.

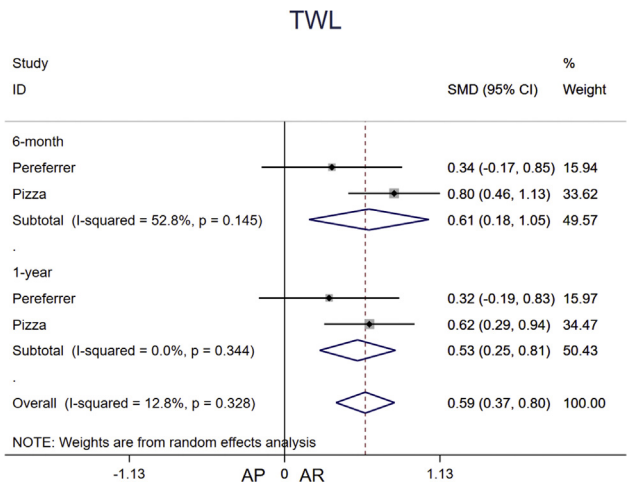

Fig 5. Total weight loss (TWL) of patients with sleeve gastrectomy with antrum resection (AR) and preservation (AP) at 6 months and 1 year. SMD = standardized mean difference.

In both follow-up time points, significantly higher TWL was observed in the AR group: SMD = .61 (95% CI: .18–1.05), $P = .006$ (105 versus 105 patients) and .59 (95% CI: .37–.80), $P < .001$ (135 versus 135 patients), respectively.

BMI

The BMIs at baseline and follow-up were pooled: 41.2 versus 45.9 (287 versus 281 patients [5,15,16,18–21]), 37.5 versus 34.7 (183 versus 174 patients [5,15,18–20]), 37.5 versus 31.7 (251 versus 244 patients [5,15,16,19,20]), 30.8 versus 28.8 (259 versus 252 patients [15,16,18–21]), and 24.2 versus 24.1 (141 versus 132 patients [15,19]) for AR versus AP groups at baseline, 3-month, 6-month, 1-year, and 2-year time points, respectively (Fig. 6). The SMD was .087 (95% CI: –.094–.269), -.44 (95% CI: –.79 to .09), -.63 (95% CI: –1.03 to -.22), –.447 (–.915 to –.020), and .03 (95% CI: –.55 to .62) at baseline, 3-month, 6-month, 1-year, and 2-year time points, respectively. No statistical significance was observed between AR and AP groups at baseline ($P = .344$). AR showed significantly lower BMI than AP at 3 months ($P = .013$) and 6 months ($P = .003$) but not 1 year ($P = .061$) and 2 years ($P = .908$) follow-up between the 2 groups.

Operative time

Five studies compared the length of surgery between AR and AP groups [15–17,19,22]. The average time of AR and AP was 85.9 versus 83.6 minutes, respectively ($P = .225$).

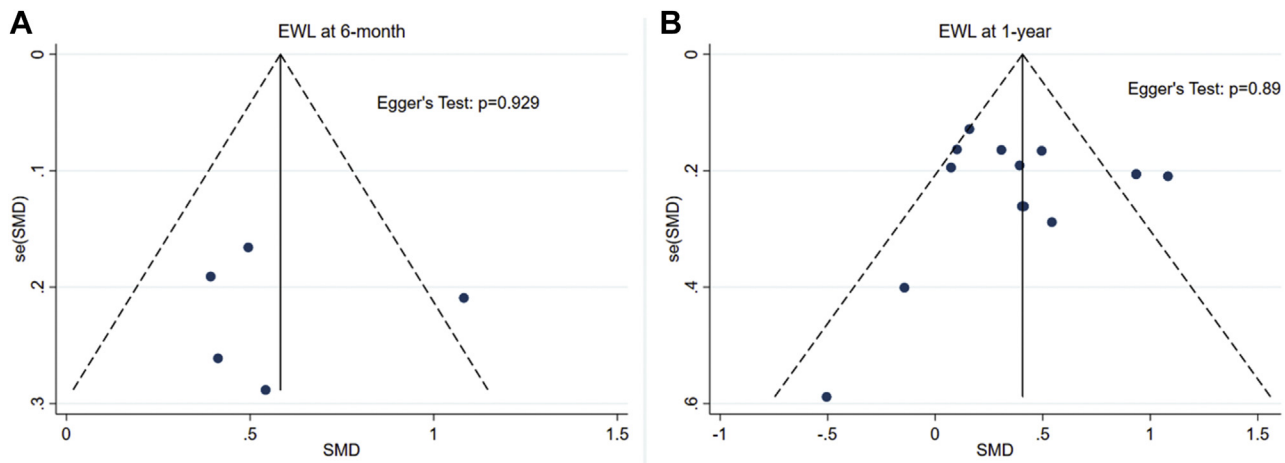

Fig 4. Funnel-plot evaluating publication bias of excessive weight loss (EWL) at 6 months and 1 year.

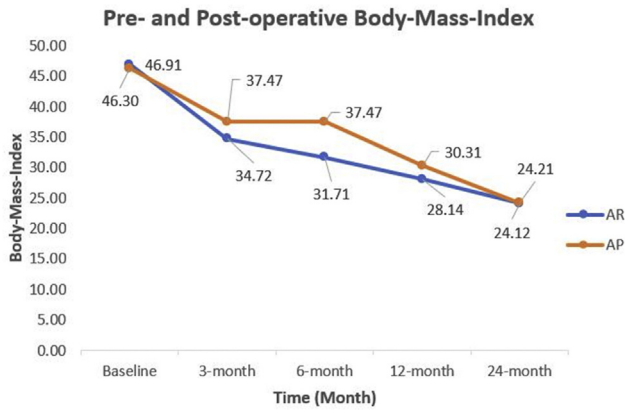

Fig 6. BMI at baseline and postoperative follow-up of patients with sleeve gastrectomy with antrum resection (AR) and preservation (AP).

Length of hospitalization

Four studies reported the length of postsurgical hospital stay [16,17,19,22]. The average length of stay of patients who received SG with AR was significantly longer than their AP counterparts: 4.0 vs 3.1 days ($P = .039$).

Complication rate

The pooled rate staple line disruption (SLD) was 2.26% versus 1.50% in the AR and AP groups, respectively ($P = .130$) [14,16,17,19,21,22]. The risk of surgery-related bleeding was also similar between the 2 groups with a pooled rate of 3.79% versus 7.04% ($P = .130$) [14,16,22]. The rate of complications with a Clavien-Dindo Grade >III of AR and AP groups was 5.77% versus 5.61% ($P = .955$), respectively [16,17,22]. No stricture was observed.

Resolution of comorbidities

Among patients who had SG with AR, 18 of 23 (73.9%), 64 of 86 (74.4%), 28 of 35 (82.9%), 17 of 38 (44.7%), and 27 of 46 (58.7%) had resolution of their baseline T2D [15–17,22], HTN [15–17,22], OSA [16,17,22], arthritis/joint pain [16,17,22], and HLD [16,17], respectively. By contrast, the rate of resolution of these comorbidities in the AP groups were 17 of 29 (58.6%), 52 of 75 (69.3%), 28 of 43 (65.1%), 21 of 42 (50.0%), and 17 of 48 (35.4%), respectively (Table 3). No statistical significance was observed between the 2 groups (T2D $P = .453$, HTN $P = .785$, OSA $P = .085$, joint pain/arthritis $P = .534$, and HLD $P = .076$).

Discussion

As a standalone bariatric procedure, SG induces weight loss through gastric restriction, gastric motility change, and hormonal modulation [23]. Proponents of a closer resection distance from the pylorus aim to increase the restrictive component of the operation, achieving more prominent weight loss-related benefit [24]. Based on the present meta-analysis, patients who underwent AR experienced significantly more EWL and TWL at 6 months and 1 year than their AP counterparts after SG. Accordingly, the BMI of the AR group was also lower at 3 months and 6 months postoperatively. However, such clinical benefits observed among AR patients lost statistical significance at 1- and 2-year follow-up, in terms of EWL and BMI. Weight regain after SG was routinely observed in clinical practice, which could be attributed to hormonal compensation, behavior changes, and possibly remnant dilation, if not technical failures [25–27]. The weight loss advantages from the additional antrectomy observed in early follow-up could be undermined by these aforementioned factors over time.

Table 3
Meta-analyses of secondary outcomes including operation time, length of hospital stay, resolution of comorbidities, and surgical complication rate

	AR (ratio or mean)	AP (ratio or mean)	OR or SMD	*P* value	I^2	Number of studies
Operation time	85.9 min	83.6 min	0.11 (-0.05-0.28)	.225	0.0%	5
Hospital stay	4.0 d	3.1 d	0.21 (0.01-0.41)	.039	0.0%	4
Resolution of comorbidities						
T2D	17/23 (73.9%)	17/29 (58.6%)	1.63 (0.45-5.89)	.453	0.0%	4
HTN	64/86 (74.4%)	52/75 (69.3%)	1.11 (0.51-2.43)	.785	0.0%	4
OSA	28/35 (82.9%)	28/43 (65.1%)	2.58 (0.87-7.62)	.086	0.0%	3
Joint pain/Arthritis	17/38 (44.7%)	21/42 (50.0%)	0.74 (0.29-1. 91)	.534	0.0%	3
HLD	27/46 (58.7%)	17/48 (35.4%)	2.75 (0.90-8.40)	.076	31.7%	2
Complication						
SLD	8/354 (2.26%)	5/334 (1.50%)	1.41 (0.49-4.08)	.524	0.0%	6
Bleeding	8/211 (3.79%)	14/199 (7.04%)	0.48 (0.19-1.24)	.130	0.0%	4
Clavien-Dindo grade >III	6/104 (5.77%)	6/107 (5.61%)	1.03 (0.32-3.33)	.955	0.0%	2
De novo GERD	23/100 (23.0%)	13/92 (14.1%)	1.44 (0.52-4.00)	.486	0.0	4

AR = antral resection; AP = antral preservation; OR = odds ratio; SMD = standardized mean difference; I^2 = heterogeneity; T2D = type 2 diabetes; HTN = hypertension; OSA = obstructive sleep apnea; HLD = hyperlipidemia; SLD = staple-line disruption; GERD = gastroesophageal reflux.

It has been universally acknowledged that SG reduces obesity-related comorbidities [4–6]. The present study also aimed to investigate whether SG with AR and AP resulted in different degrees of resolution of these comorbidities. Despite the initial weight-loss benefit among AR patients, no statistical significance was observed in the resolution rates of HTN, T2D, OSA, arthritis/back pain, and HLD between the 2 groups. However, such results should be interpreted with caveats, as only a small number of included studies reported these outcomes, leading to underpowering.

Conservative surgeons are in favor of a more proximal resection from the pylorus because AP maintains gastric contractility, promoting gastric emptying and decreasing the incidence of GERD [28]. Yet, the methods of measuring gastric motility and gastric reflux were less consistent among studies. Only 2 studies implemented computed tomography (CT) scintigraphy to monitor gastric emptying [13,21]. Whereas Garay et al. observed a significant increase of gastric motility only in the AP group postoperatively, Vives et al. showed an opposite observation, but they also demonstrated that the effect of SG on gastric motility was undermined by patient's diabetes status, suggesting additional factors that might influence gastric emptying [13,21]. In terms of symptomatic GERD, Pizza et al. measured the GERD-HRQL score of patients who underwent SG with and without antrectomy, suggesting a higher degree of GERD symptoms among the AR group by 12-month follow-up [15]. This finding was also correlated with increased esophagitis on upper endoscopy, as well as symptoms of food intolerance. Further, Al Khalif et al. also reported more persistent episodes of vomiting associated with AR patients (36% versus 8%, $P = .004$) [5]. Due to the heterogeneity in gastric motility and reflux measurement among published studies, the present meta-analysis pooled de novo GERD only. Although the pooled de novo GERD rate was higher in the AR group (23.0% versus 14.1%), such difference was not statistically significant ($P = .486$). Based on available evidence, AR starting <3 cm from the pylorus did not result in a higher risk of GERD compared with resection at >5 cm. Indeed, postoperative GERD among patients with obesity undergoing SG could be multi-factorial. While weight loss and reduced gastric volume decrease acid secretion and gastric pressure, the lower esophageal sphincter tone could be compromised and the changes in gastric motility could potentiate the reflux [29]. The effects of antrectomy on gastric emptying and reflux symptoms warrant further prospective investigation.

Increased nausea and vomiting may also contribute to the observed short-term increase in weight loss. Although included individual studies adopted different measurements during follow-ups, which could not be pooled as part of the meta-analysis, nausea and vomiting were noted to be higher among patients allocated to the AR group. According to Abdallah et al., the number of patients with persistent nausea and vomiting beyond 1-month post-op was 13.5% (7/52) and 5.7% (3/53) in AR and AP groups, respectively [17]. Likewise, Nocca et al. also noted symptoms of nausea and vomiting were present in 27 of 141 (19.1%) patients who received AR, compared with 17 of 138 (12.3%) from the AP group, though the rate of gastric stenosis was equally low (1.4% [2/141] versus 1.4% [2/138]) [14]. Yet, these symptoms appear to mitigate over time. According to ElGeidie et al., the increased nausea and vomiting among patients who received AR were more pronounced immediately postoperatively and resolved at 12-month follow-up [16]. In the study of Pizza et al., symptomatic patients from AR and AP were 11.7% (11/75) versus 4.0% (3/75), 9.3% (7/75) versus 2.7% (2/75), 8.0% (6/75) versus 2.7% (2/75), and 2.7% (2/75) versus 1.3% (1/75) at 3, 6, 12, and 24 months, respectively [15]. Interestingly, the present meta-analysis also suggested a longer hospital stay after LSG with AR (4.0 versus 3.1 days, $P = .039$), which might also relate to postoperative nausea, vomiting, and dehydration, if not surgical pain.

One of the concerns regarding AP is the increased incidence of SLD, resulting from a longer staple line and increased intraluminal pressure from the smaller gastric volume and impaired gastric motility [30–32]. Based on data from 6 studies, the SLD rate among AR patients was comparable to that of their AP counterparts (2.26% versus 1.50%, $P = .524$). Additionally, surgically related bleeding incidence and complications with Clavien-Dindo Grade >III were not significantly different between the 2 groups.

While the operation time was similar, the length of hospital stay was significantly longer in the AR group than the AP group (4.0 versus 3.1 d, $P = .039$). Previous retrospective studies suggested various predictors of longer hospital stay in SG patients, such as low oral fluid intake, postoperative high intravenous fluid administration, institutional experience, and routine upper gastrointestinal swallow test [33,34]. Other factors affecting length of stay among bariatric surgery patients include longer operating time, diabetes status, chronic obstructive pulmonary disease, hypoalbuminemia, increased BMI, renal insufficiency, and anemia [35]. In the present meta-analysis, RCTs were conducted with proper randomization and similar baseline patient-specific parameters. Based on a retrospective study comparing SL using a larger and smaller bougie, patients in the latter group had more postoperative nausea and higher ondansetron use [36], and RCTs have shown AP is associated with better food tolerance [22]. The prolonged hospital stay could be related to operating parameters and poorer postoperative oral tolerance requiring more fluid resuscitation among AR patients. Nonetheless, these speculations should be verified in future RCTs.

The present study should be interpreted with several caveats. We should keep in mind that only RCTs were included, and the number of studies with long-term

follow-up beyond 1 year is limited. In addition, weight loss outcomes at 2-year follow-up were based on only 2 studies. The lack of statistical significance could result from underpowering, and studies with long-term data beyond 5 years are warranted to justify either technique. Another important limitation of this study is that the definition of AR vs AP was not exactly consistent among authors. While most authors adopted the 2 cm versus 6 cm from the pylorus, Pereferrer and Garay used 3 cm versus 8 cm and 2 cm versus 5 cm, respectively. The clinical significance of the 2 cm between the 3 cm allocated to the AR and the 5 cm in the AP groups might not be as significant as the 4 cm between 2 cm versus 6 cm. Additional limitations are technical variations among authors that should not be neglected. The volume of the residual gastric remnant is 3-dimensional, so it not only depends on the distance from the pylorus but also, for example, the size of the bougie used, which varied among authors. For example, given the same distance from the pylorus, antrectomy of a narrow versus a wide antrum would yield different volume. The use of a calibration tube with volumetric measurements may further elucidate the role of resection distance from the pylorus versus antrectomy volume in weight loss [14]. In addition, reinforcement of the staple line and omentoplasty, and intraoperative leak test, could potentially influence complication rate and operative time [37]. Last but not the least, all included RCTs were conducted in Europe, Africa, and Asia. Whether these conclusions also hold true in patients in North America is unknown.

Conclusion

Laparoscopic SG with and without antrectomy are equally effective in achieving weight loss and remission of comorbid illnesses without significant difference in the risk of de novo GERD. The initial significant weight loss effect observed in AR patients was undermined beyond 1 year follow-up. Both procedures had similar rates of SLD and bleeding. The resolution of obesity-related comorbidities such as T2D, HTN, HLD, OSA, and arthritis/joint pain was also comparable between the 2 groups. Larger randomized cohorts with better defined anatomical landmarks and long-term follow-up are needed to justify either surgical technique.

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