Diabetes, Metabolic Syndrome and Obesity

ORIGINAL RESEARCH

Comparative Study for Safety and Efficacy of OAGB and SADJB-SG: A Retrospective Study

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Purpose: Obesity and related complications are managed by One Anastomosis Gastric Bypass (OAGB) and Single Anastomosis Duodeno-Jejunal Bypass with Sleeve Gastrectomy (SADJB-SG), both of which are adapted from traditional gastric bypass procedures. However, there are no current comparative studies on the safety and efficacy of these two surgical procedures.

Patients and Methods: Preoperative baseline data of patients who had undergone OAGB and SADJB-SG surgeries from June 2019 to June 2021 were retrospectively analyzed at our bariatric facility. Postoperative data, including weight changes, improvement in type 2 diabetes (T2DM), and complication rates were collected over 2 years. This was followed by a comprehensive evaluation of the safety and efficacy of the two surgical procedures.

Results: A total of 63 patients completed the follow-up in this study. At the 24-month follow-up, excess weight loss percentage (EWL %) for the OAGB and SADJB-SG was 73.970±5.005 and 75.652±7.953, respectively (*P-value = 0.310*); total weight loss percentage (TWL%) was 24.006±8.231 and 23.171±6.600, respectively (*P-value = 0.665*). The diabetes remission rates for the two groups were 71.429% and 69.048%, respectively (*P-value = 0.846*). The cost for OAGB was 55088.208±1508.220 yuan, which was significantly lower than the 57538.195±1374.994 yuan for SADJB-SG (*P-value< 0.001*).

Conclusion: The two surgical procedures are reliable in terms of safety and efficacy, and each has distinct advantages. While OAGB has reduced operational expenses, SADJB-SG offers a broader range of applicability.

Keywords: one anastomosis gastric bypass, single anastomosis duodeno-jejunal bypass with sleeve gastrectomy, safety, efficacy

Introduction

The global prevalence rates of obesity have increased in recent years.[1] Obesity is strongly linked to the occurrence of numerous diseases, including type 2 diabetes (T2DM), cardiovascular diseases, and cancer. Obesity and its associated complications were first treated surgically in the early 1950s.[2] Roux-en-Y gastric bypass (RYGB) is considered the gold standard procedure for bariatric surgery.[3] Surgeon Miguel Carbajo performed the One Anastomosis Gastric Bypass (OAGB) for the first time in the early 21st century.[4] OAGB has several advantages, including simplicity, reduced operative time, and a lower risk of intraoperative bleeding and complications.[5–8] Antonio J. Torres proposed the Single Anastomosis Duodeno-Jejunal Bypass with Sleeve Gastrectomy (SADJB-SG), which combines the advantages of SG and RYGB and aims to provide more effective weight loss, and reduce complications.[9–11] Singh and Ser et al discovered that OAGB and SADJB-SG are effective in weight reduction and glycemic control.[10,12] These procedures yield comparable outcomes to traditional surgeries (SG and RYGB) in terms of weight reduction, T2DM symptom relief, glycemic control, and enhancement of quality of life.[10,12–15]

Previous research has primarily compared these two surgical procedures to RYGB. To date, there are relatively few comparative studies on OAGB and SADJB-SG. Pan et al conducted research focusing on the efficacy of OAGB versus

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SADJB-SG in mitigating long-term cardiovascular risks.[16] However, their study's long-term follow-up rate is only about 30%, which may introduce statistical bias and impact the reliability of the conclusions.[17] We collected clinical data from patients who underwent OAGB and SADJB-SG procedures at our bariatric center and conducted a two-year post-operative follow-up. Then, this study provides a multi-dimensional comparison of OAGB and SADJB-SG to further assess their long-term efficacy and safety.

Material and Methods

Selection and Description of Participants

Clinical data from patients who had undergone OAGB and SADJB-SG at our bariatric center from June 2019 to June 2021 were retrospectively analyzed.

Inclusion criteria: (1) a history of OAGB or SADJB-SG (based on Chinese obesity and type 2 diabetes surgical treatment guidelines (2019). RYGB is the gold standard of bypass procedures, as such, we recommend it to patients needing such surgeries. OAGB or SADJB-SG was offered as treatment options for patients concerned about the increased risk of anastomotic leaks due to two anastomoses of RYGB, and those requesting a single-anastomosis procedure during preoperative consultations); (2) no history of abdominal surgery.

Exclusion criteria: (1) incomplete preoperative clinical data; (2) incomplete two-year follow-up data after surgery.

All patients signed informed consent forms. The study adhered to the Declaration of Helsinki. The Ethics Review Board of Capital Medical University Affiliated Beijing Shijitan Hospital approved the study protocol [approval number: sjtkyll-lx-2022(076)]. All the participants provided informed consent for participation in the study.

Surgical Approach

(1) OAGB: Our surgical approach has been described previously.[16] The gastroenterostomy was performed with the intestine positioned 200cm distal to the Treitz ligament.

(2) SADJB-SG: Our surgical approach has been described previously.[16] The gastroenterostomy is performed with the intestine positioned 200cm distal to the Treitz ligament and a sleeve gastrectomy is created over a 36 French Bougie.

All procedures at our center were performed by the same surgeon.

Clinical Data and Postoperative Follow-Up

Preoperative data, including age, gender, waist circumference, hip circumference, waist-hip ratio, height, weight, BMI, duration of T2DM, preoperative fasting blood glucose, preoperative glycated hemoglobin (HbA1c), preoperative fasting C-peptide, and preoperative fasting insulin, were collected retrospectively using the medical records system. Additionally, surgery-related data such as operation time, intraoperative blood loss, postoperative hospital stay, and surgical costs were collected.

Postoperative follow-ups were performed using WeChat and telephone to collect the weight of the patient at 3, 6, 12, and 24 months postoperatively, fasting blood glucose, fasting C-peptide, and fasting insulin. The incidence of post-operative complications was also documented.

Definition of Relevant Indicators

(1) Ideal BMI: The ideal BMI was defined as 23 kg/m², based on Chinese demographic characteristics.[18–21]

(2) EWL% and TWL%: EWL% = (Initial weight - Current weight) / (Initial weight - Ideal weight) × 100; TWL% = (Initial weight - Current weight) / Initial weight × 100

(3) Diagnostic criteria for T2DM: Preoperative HbA1c ≥ 6.5% or a previous definitive diagnosis of T2DM was considered a T2DM diagnosis. HbA1c < 6.0% without using hypoglycemic medications or insulin postoperatively was defined as T2DM remission.[22]

(4) Homa-IR and HOMA-β: HOMA-IR = (Fasting blood glucose × Fasting insulin) / 22; HOMA-β = 20 × Fasting insulin / (Fasting blood glucose - 3.5).

(5) Nausea and vomiting: Nausea and vomiting were defined according to the diagnostic criteria for chronic nausea and vomiting.[23]
(6) Nutritional deficiency: The reference values for fasting serum albumin, calcium, magnesium, folate, and vitamin B12 were 40–55 g/L, 2.1–2.75 mmol/L, 0.66–1.2 mmol/L, 3.1–19.9 ng/mL, and 180–914 pg/mL, respectively. If the value of a nutritional element fell below its lower limit, it was considered deficient in that nutrient.
(7) Anemia: Anemia was defined as hemoglobin levels below 130 g/L in males and below 120 g/L in females.
(8) Functional dyspepsia: This condition was defined as upper abdominal pain/burning, early satiety, and/or postprandial fullness without any other identifiable cause following routine clinical evaluation.[23]
(9) Hypoglycemia and Hypotension: Hypoglycemia was diagnosed when fasting blood glucose levels fell below 3.9 mmol/L for three consecutive readings, or when clinical symptoms such as sweating, dizziness, and blurred vision appeared. Hypotension was diagnosed when systolic blood pressure fell below 90 mmHg or diastolic blood pressure was below 60 mmHg.

Statistical Analysis

All analyses were performed using SPSS 22.0 software. Categorical data, expressed as numbers (percentage), were compared using the chi-square or Fisher's exact test. Normally distributed quantitative data, expressed as mean ± standard deviation, were compared using the Shapiro–Wilk test. The independent-sample *t*-test was applied for between-group comparisons. Non-normally distributed quantitative data, expressed as median (25th percentile, 75th percentile), were compared using non-parametric tests. A two-sided $p\text{-value} < 0.05$ was considered to indicate statistical significance. All figures were plotted by GraphPad Prism.

Results

Patient Demographics and Baseline Characteristics

According to the inclusion and exclusion criteria, a total of 75 participants were included in this study, with 63 ultimately completing the follow-up, resulting in a follow-up rate of 84%. This study comprised 63 patients who met the inclusion and exclusion criteria. Patients were categorized into the OAGB group and SADJB-SG group, with 21 patients and 42 patients, respectively. There were no significant differences in baseline characteristics between the two groups. Table 1 shows detailed baseline characteristics.

Table 1 Patient Characteristics of the Two Groups

	OAGB (N = *21*)	SADJB-SG (*N* = *42*)	$X^2/t/Z$	*P-Value*
Age (year)	44.762±11.068	37.500 (31.000, 47.000)	−1.729[c]	0.084
Gender				
Men	6 (28.571%)	13 (30.952%)	0.038[a]	0.846
Height (cm)	164.048±8.868	167.357±8.700	1.414[c]	0.162
Weight (kg)	87.500 (75.900, 105.000)	94.310±15.071	−0.445[c]	0.657
BMI (kg/m^2)	35.091±6.174	33.574±4.026	−1.022[b]	0.315
Waist Circumference (cm)	110.952±11.369	115.500 (103.000, 120.000)	−0.117[c]	0.907
Hip Circumference (cm)	113.762±10.329	114.952±9.287	0.462[b]	0.646
Waist-Hip Ratio	0.976±0.054	0.972±0.060	−0.230[b]	0.819
Duration of T2DM (years)	8.000 (6.000, 10.000)	7.000 (5.000, 10.000)	−1.324[c]	0.185
FBG (mmol/L)	13.335±2.729	12.558±2.247	−1.203[b]	0.234
HbA1c (%)	9.721±2.438	9.055±1.802	−1.227[b]	0.224
Fasting C-peptide (ng/mL)	2.930±0.738	2.730 (2.280, 3.870)	−0.029[c]	0.977
Fasting Insulin (μU/mL)	17.990±7.571	18.280 (14.690, 21.590)	−0.452[c]	0.651
Homa-IR	10.368±4.571	9.893 (8.289, 12.820)	−0.714[c]	0.475
HOMA-β	40.650±21.713	45.693 (32.011, 59.801)	−0.846[c]	0.398

Notes: [a]x^2-value; [b] t-value; [c] Z-value;
Abbreviations: BMI, Body Mass Index; FBG, Fasting Blood Glucose; HbA1c, Glycated Hemoglobin, Hemoglobin A1c;

Table 2 Trends in Weight Change and Diabetes Improvement of the Two Groups

	OAGB (N = 21)	SADJB-SG (N = 42)	X^2/t/Z	P-Value
Weight loss				
EWL-3 (%)	52.837 (50.757, 54.145)	56.697 (49.717, 59.776)	−0.190[c]	0.850
EWL-6 (%)	66.839±724	67.580±4.215	0.683[b]	0.497
EWL-12 (%)	74.026±4.655	75.345±6.896	0.896[b]	0.374
EWL-24 (%)	73.970±5.005	75.652±7.953	1.024[b]	0.310
TWL-3 (%)	16.836±6.501	16.583±4.849	−0.174[b]	0.863
TWL-6 (%)	21.737±7.540	20.679±5.569	−0.570[b]	0.573
TWL-12 (%)	24.000±8.087	23.103±6.599	−0.471[b]	0.639
TWL-24 (%)	24.006±8.231	23.171±6.600	−0.435[b]	0.665
T2DM Improvement				
T2DM Remission Rate	15 (71.429%)	29 (69.048%)	0.038[a]	0.846
FBG (mmol/L)	5.741±0.482	5.607±1.175	1.000[b]	0.524
HbA1c (%)	5.326±0.470	5.500 (4.700, 6.100)	−1.066[c]	0.286
Fasting C-peptide (ng/mL)	2.109±0.397	1.975 (1.510, 2.770)	−0.146[c]	0.884
Fasting Insulin (μU/mL)	11.181±2.176	12.025±2.719	1.333[b]	0.189
Homa-IR	2.679 (2.343, 3.423)	3.013±0.999	−0.394[c]	0.694
HOMA-β	104.086±31.194	126.372 (82.596, 206.923)	−1.925[c]	0.054

Notes: [a]x^2-value; [b] t-value; [c] Z-value.
Abbreviations: EWL, Excess Weight Loss; TWL, Total Weight Loss; FBG, Fasting Blood Glucose.

Operation Efficacy

Table 2 shows the weight changes in the two groups of patients. Postoperative analysis of EWL% and TWL% at 3 months, 6 months, 12 months, and 24 months between the two groups revealed no significant differences in weight changes between the groups (*P > 0.05*). Figure 1 illustrates the trends of EWL% changes in the two groups, whereas Figure 2 depicts the trends of TWL%.

Table 2 shows the improvement in diabetes in the two patient groups. Comparisons of the pertinent indicators between the two groups yielded *P-values* greater than 0.05, indicating no significant differences in T2DM improvement between the groups.

Surgical Outcomes and Complications

The operation-related indices are shown in Table 3. The two groups were compared in terms of operative time, surgical cost, intraoperative blood loss, and postoperative hospital stay day. The OAGB group had an operative time of 62.429

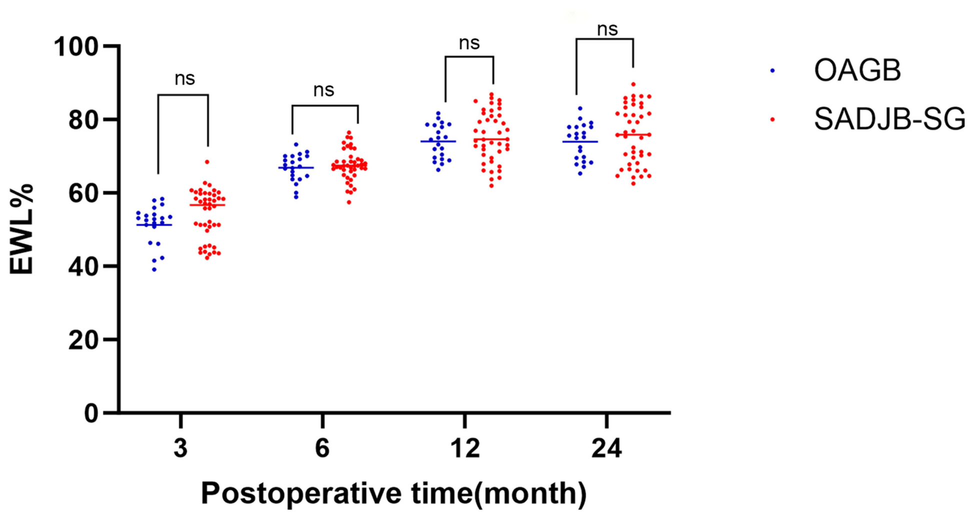

Figure 1 EWL% dynamics trends up to 24 months postoperatively in two groups.

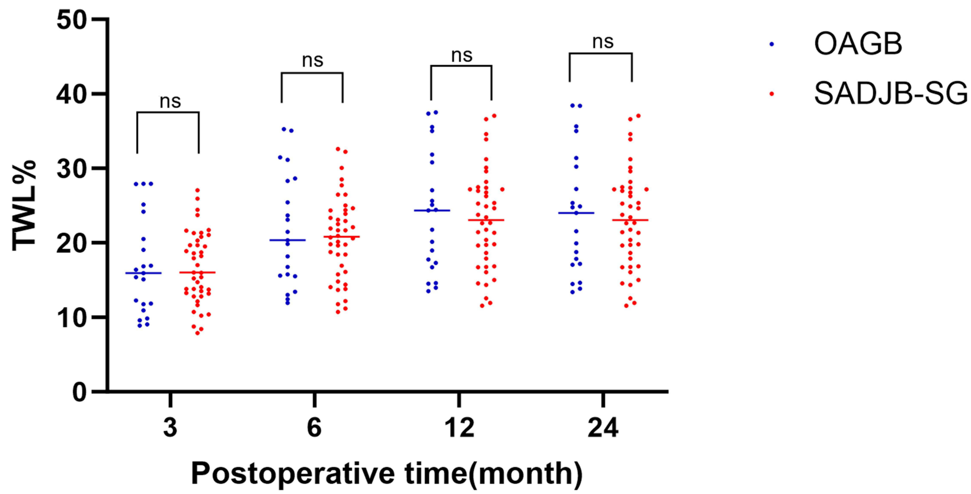

Figure 2 TWL% dynamics trends up to 24 months postoperatively in two groups.

±4.130 min and a surgical cost of 55,088.208±1,508.220 yuan. The SADJB-SG group had an operative time of 118.000 (115.000, 120.000) min and a surgical cost of 57,538.195±1374.995 yuan. The *P-values* were consistently less than 0.05, indicating significant differences in operative time and surgical cost between the two groups. However, intraoperative blood loss and postoperative hospital stay day were not significantly different between the groups ($P > 0.05$).

Moreover, complication rates were compared between the two groups. Neither group of patients experienced early postoperative complications. There were no significant differences in the incidence of complications between the two groups ($P > 0.05$).

Table 3 Operation-Related Indexes and Operative Complications of the Two Groups

	OAGB (N = *21)*	SADJB-SG (N = *42)*	X^2/t/Z	P-Value
Operation-related indexes				
Operative time (min)	62.429±4.130	118.000 (115.000, 120.000)	−6.501[c]	0.000
Surgical cost (yuan)	55088.208±1508.220	57,538.195±1374.994	6.455[b]	0.000
Hospital stay day after surgery (day)	4.238±1.136	3.000 (3.000, 4.000)	−1.599[c]	0.110
Intraoperative blood loss (mL)	6.381±3.514	5.000 (3.000, 8.000)	−1.924[c]	0.054
Operative complications				
Death	0	0	-	-
Leakage	0	0	-	-
Postoperative bleeding	0	0	-	-
Stenosis	0	0	-	-
Nausea and vomiting	10 (47.619%)	17 (40.476%)	0.292[a]	0.589
Hypoproteinemia	5 (23.810%)	11 (26.190%)	0.042[a]	0.838
Anemia	4 (19.048%)	6 (14.286%)	0.015[a]	0.903
Functional dyspepsia	3 (14.286%)	1 (2.381%)	-	0.104
Hypoglycemia	3 (14.286%)	5 (11.905%)	-	1.000
Gallstones	2 (9.524%)	3 (7.143%)	-	1.000
Hypotension	0	1(2.381%)	-	1.000
Hypocalcemia	1 (4.762%)	0	-	0.333
Hypomagnesemia	1 (4.762%)	0	-	0.333
Folate deficiency	0	2 (4.762%)	-	0.548
Vitamin B2 deficiency	0	1 (2.381%)	-	1.000

Notes: [a] x^2-value; [b] t-value; [c] Z-value.

Discussion

Bariatric surgery has evolved over decades. Kremen described the first type of bypass surgery, Jejunoileal Bypass (JIB), in the 1950s.[24,25] Later on, Nicola Scopinaro proposed Biliopancreatic Diversion (BPD) in the 1960s.[26] These two surgical procedures swiftly became outdated due to their complexity, high complication rates, and poor safety profiles.[26] Mason and colleagues first reported the RYGB in the 1960s.[27] With its safety and efficacy, RYGB has become the gold standard procedure for bariatric surgery and remains extensively used today.[27–29] Miguel Carbajo first performed the OAGB in the early 21st century.[30] This procedure requires one anastomosis, making the surgical technique significantly simpler, lowering the difficulty of the operation, and reducing intraoperative risks.[31,32] Antonio J. Torres pioneered the SADJB-SG as laparoscopic procedures advanced.[10,33,34] Unlike other gastric bypass surgeries, this procedure preserves the pylorus, significantly lowering postoperative complications such as reflux and dyspepsia, while also improving postoperative quality of life.[35] With the continuous advancement in bariatric surgery, OAGB and SADJB-SG have received increased attention from bariatric surgeons.[9,36] Emerging evidence indicates that these two surgical procedures can achieve similar results to RYGB in terms of weight reduction and T2DM improvement.[37–39] However, there are currently insufficient comparative studies on the safety and efficacy of these two surgical procedures.

A retrospective analysis was performed to compare the safety and efficacy of the two procedures in weight reduction, T2DM improvement, surgical costs, and surgical risks. Postoperative weight trajectory data over two years were analyzed retrospectively. Our analysis revealed no significant differences in EWL% and TWL% between the two groups at 3, 6, 12, and 24 months postoperatively, indicating that both surgical procedures have comparable efficacy for short-term and long-term weight reduction. OAGB creates a small gastric pouch, whereas SADJB-SG removes a large portion of the stomach and establishes a gastric sleeve. Additionally, both OAGB and SADJB-SG bypass 200 cm of the small intestine, reducing food absorption. Studies have demonstrated that changes in intestinal anatomy might alter the composition of the gut microbiota, potentially influencing food metabolism, energy intake, and weight regulation.[40–42] These two surgical procedures can also alter insulin sensitivity and fat oxidation rates, which promote lipolysis and fat oxidation, lowering fat accumulation and promoting weight loss.[43,44,] In this view, the mechanisms by which these two procedures induce weight loss are comparable from anatomical and physiological perspectives. This similarity might explain why the two groups had no significant differences in short-term and long-term weight loss outcomes.

T2DM improvement was assessed using measurements of fasting blood glucose, glycated hemoglobin, and T2DM remission rates collected 24 months after surgery. Additionally, the levels of insulin and C-peptide were measured and used to calculate the HOMA-IR and HOMA-β and to assess pancreatic function. T2DM remission rates were 71.429% in OAGB patients and 69.048% in SADJB-SG patients 24 months after surgery. A comparative analysis of the remission rates between the two groups showed no significant difference. This finding demonstrates that both surgical procedures effectively improve T2DM, with no significant difference in efficacy. At 24 months postoperatively, both groups had significantly lower levels of fasting blood glucose, glycated hemoglobin, fasting C-peptide, fasting insulin, and insulin resistance index, whereas the insulin sensitivity index increased significantly. The differences in these indicators were not statistically significant, indicating that both surgical procedures effectively improve pancreatic function. The two surgical procedures bypass the duodenum and proximal jejunum, allowing food bolus to reach the distal small intestine faster. This promotes the secretion of glucagon-like peptide-1 (GLP-1) and pancreatic peptide YY (PYY), which aid in appetite control and increase insulin secretion, thereby improving T2DM.[44] In these procedures, the altered intestinal anatomy significantly reduces the contact duration between food and the digestive tract, decreases the interaction time between digestive juices and food, and alters the pH of the distal small intestine. These effects disrupt the habitat of harmful bacteria.[45] Changes in intestinal anatomy may boost the synthesis of short-chain fatty acids (SCFAs) in the gut, which assist in maintaining intestinal microecological balance and promoting the proliferation of beneficial bacteria, improving glucose metabolism and ameliorating T2DM.[46,47] Additionally, the two surgical procedures induce weight loss, which significantly reduces the excessive accumulation of adipose tissue, a primary cause of insulin resistance, resulting in marked improvements in pancreatic function.[48,49] In summary, the two surgical procedures have comparable mechanisms for improving T2DM. This similarity could account for no significant differences in the effectiveness of these procedures in improving T2DM and pancreatic function postoperatively.

Moreover, data on surgery time, surgical costs, postoperative hospital stay day, and intraoperative blood loss were collected to evaluate the operation costs. The safety of the two surgical procedures was assessed based on data on the incidence of early complications (death, leakage, postoperative bleeding, and stenosis) and late complications (nausea and vomiting, hypoproteinemia, anemia, functional dyspepsia, hypoglycemia, gallstones, hypotension, and malnutrition). The results revealed significant differences in surgery time between OAGB and SADJB-SG. The surgery time for OAGB was 62.429 ± 4.130 min, significantly shorter than the 118.000 (115.000, 120.000) min for SADJB-SG ($P = 0.00$). The surgical cost for OAGB was 55,088.208 ± 1508.220 yuan, significantly lower than the 57,538.195 ± 1374.994 yuan for SADJB-SG ($P = 0.00$). SADJB-SG integrates SG with DJB. In contrast to OAGB, which solely requires the construction of a small gastric pouch, SADJB-SG entails the creation of a sleeve gastrectomy, requiring more staple lines, which may explain the higher surgical costs of SADJB-SG over OAGB. Additionally, during sleeve gastrectomy, the seromuscular layer of the anastomosis must be embedded, which might contribute to the lengthier surgery time for SADJB-SG compared with OAGB. There were no significant differences in postoperative hospitalization days or intraoperative blood loss between the two groups. These findings demonstrate that OAGB has lower surgical costs than SADJB-SG.

Of note, neither group experienced early complications postoperatively. The incidence of late complications between the two groups did not differ significantly, indicating that both surgical procedures are equally safe and reliable.

Pan et al highlighted that OAGB and SADJB-SG can continuously improve weight loss outcomes and alleviate obesity-related comorbidities within three years post-surgery, particularly in significantly reducing the incidence of major adverse cardiovascular events (MACE) over 10 years.[16] Their study primarily focused on MACE using the China-PAR model.[50] In contrast, our research focuses on comparing the long-term efficacy and safety of OAGB and SADJB-SG, with particular emphasis on EWL% and TWL%, two key metrics for evaluating the outcomes of bariatric surgery and long-term weight control. Additionally, by conducting a comprehensive comparison of the two procedures from multiple perspectives, we aim to complement Pan et al's findings and enhance the accuracy and reliability of these conclusions in Chinese patients with obesity.

Bile reflux gastritis has been a persistent concern for obesity surgeons for OAGB.[51] The loss of the pyloric structure after OAGB allows bile and pancreatic juices to reflux from the jejunum into the stomach.[52] Studies have indicated that approximately 5% of patients may experience delayed gastric emptying after surgery, which prolongs bile retention duration in the stomach and increases the exposure of the gastric mucosa to bile.[53] Bile reflux can disrupt the gastric acid-base balance, increasing the pH of the stomach contents and weakening the gastric mucosal defense mechanisms. Bile acids and pancreatic enzymes are highly corrosive and irritating. Prolonged exposure to these substances can damage the gastric mucosal barrier, causing inflammation, erosion, and ulceration.[54]

The benefits of OAGB include lower surgical complexity, shorter operation time, and lower surgical costs. On the other hand, SADJB-SG has a dramatically lower incidence of postoperative bile reflux gastritis because the pyloric structure is preserved. Furthermore, because SADJB-SG does not leave a residual stomach pouch, it significantly decreases the risk of malignancy in patients who test positive for *Helicobacter pylori (HP)*. For *HP*-positive patients, SADJB-SG might be the more appropriate surgical option.

This study has some limitations. First, long-term outcomes regarding weight loss and T2DM improvement could not be assessed due to the short follow-up period. Second, the sample size in this study was insufficient, which may lead to skewed results and reduce the reliability of the conclusions. Lastly, this study solely compared the clinical outcomes of the two procedures without exploring the molecular biological mechanisms underlying weight loss and T2DM improvement. As such, future research should focus on the underlying molecular biological mechanisms through which these surgical procedures achieve weight reduction and T2DM improvement.

Conclusion

In conclusion, both OAGB and SADJB-SG are safe surgical procedures, with comparable efficacy in weight loss and T2DM improvement. There are no significant differences in the safety and efficacy between OAGB and SADJB-SG.

OAGB offers distinct advantages to patients seeking lower surgical costs. However, for patients concerned about postoperative bile reflux, SADJB-SG may be a preferable option.

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All authors made significant contributions to the reported work, including conception, study design, execution, data acquisition, analysis and interpretation, or in all these areas. They participated in drafting, revising, or critically reviewing the article, provided final approval for the version to be published, agreed on the journal to which the article was submitted, and are accountable for all aspects of the work.

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Disclosure

The authors report no conflicts of interest in this work.

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