Surgical Endoscopy (2024) 38:2657–2665
https://doi.org/10.1007/s00464-024-10765-3

Single anastomosis duodenal switch versus Roux-en-Y gastric bypass in patients with BMI ≥ 50 kg/m^2: a multi-centered comparative analysis

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Received: 6 December 2023 / Accepted: 21 February 2024 / Published online: 20 March 2024

Abstract

Background Roux-en-Y gastric bypass (RYGB) has consistently demonstrated excellent weight loss and comorbidity resolution. However, outcomes vary based on patient's BMI. Single anastomosis duodeno-ileostomy with sleeve (SADI-S) is a novel procedure with promising short-term results. The long-term outcomes of SADI-S in patients with BMI ≥ 50 kg/m^2 are not well described. We aim to compare the safety and efficacy of SADI-S with RYGB in this patient population.

Methods We performed a multicenter retrospective study of patients with a BMI ≥ 50 kg/m^2 who underwent RYGB or SADI-S between 2008 and 2023. Patient demographics, peri- and post-operative characteristics were collected. Complication rates were reported at 6, 12, 24, and 60 months postoperatively. A multivariate linear regression was used to evaluate and compare weight loss outcomes between both procedures.

Results A total of 968 patients (343 RYGB and 625 SADI-S; 68.3% female, age 42.9 ± 12.1 years; BMI 57.3 ± 6.7 kg/m^2) with a mean follow-up of 3.6 ± 3.6 years were included. Patients who underwent RYGB were older, more likely to be female, and have a higher rate of sleep apnea ($p < 0.001$), hypertension ($p = 0.015$), dyslipidemia ($p < 0.001$), and type 2 diabetes ($p = 0.016$) at baseline. The rate of bariatric surgery-specific complications was lower after SADI-S compared to RYGB. We reported no bariatric surgery related deaths after 1 year following both procedures. SADI-S demonstrated statistically higher and sustained weight loss at each time interval compared to RYGB ($p < 0.001$) even after controlling for multiple confounders. Lastly, the rate of surgical non-responders was lower in the SADI-S cohort.

Conclusions In our cohort, SADI-S was associated with higher and sustained weight-loss results compared to RYGB. Comorbidity resolution was also higher after SADI-S. Both procedures demonstrate a similar safety profile. Further studies are required to validate the long-term safety of SADI-S compared to other bariatric procedures.

Keywords RYGB · SADI-S · Severe obesity · Bariatric surgery · Multicenter study

Metabolic and bariatric surgery (MBS) is widely recognized as the most effective intervention for achieving sustained weight loss in patients with obesity [1]. Among the numerous available options in the current era, Roux-en-Y gastric bypass (RYGB) remains one of the most frequently performed procedures for weight reduction and management of obesity-related medical conditions [2]. In fact, RYGB has consistently demonstrated excellent short-, mid-, and long-term outcomes, along with a favorable safety profile [3, 4]. However, the outcomes of RYGB can vary among patients, depending on certain pre-operative characteristics, such as BMI [5]. Patients with a BMI exceeding 50 kg/m^2 have been reported to experience higher rates of intra- and post-operative complications, increased need for revisional surgery, and lower long-term weight-loss results compared to patients with a lower BMI [6, 7].

Consequently, more novel alternative MBS procedures have been developed and evaluated to optimize surgical outcomes for this specific patient population with a high preoperative BMI. One such alternative, is the single anastomosis

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duodeno-ileostomy with sleeve (SADI-S), a novel bariatric procedure derived from the classic biliopancreatic diversion with duodenal switch (BPD-DS) [8]. Indeed, SADI-S has recently shown remarkable results in terms of both safety and efficacy for patients with obesity, which led to its endorsement by the American Society for Metabolic and Bariatric Surgery (ASMBS) and the International Federation for the Surgery of Obesity (IFSO) in 2020 and 2018, respectively [9].

Despite the promising short- and mid-term results of SADI-S in patients with obesity [10], there remains a scarcity of published literature evaluating its long-term (≥ 5 years) surgical outcomes in patients with a BMI ≥ 50 kg/m^2 and comparing these outcomes with other established bariatric procedures such as RYGB. For this reason, our study aims to comprehensively compare the safety and efficacy of SADI-S and RYGB in the short-, mid-, and long-term for a large cohort of patients with a preoperative BMI ≥ 50 kg/m^2.

Material and methods

Participants

An Institutional Review Board-approved (23-002756) retrospective study of multi-center electronic medical records (EMR) was performed for all adult patients with a preoperative BMI ≥ 50 kg/m^2 who underwent either primary RYGB or SADI-S. All patients who had missing data, no follow-up, performed the operation as a revisional procedure or underwent a concomitant procedure [other than esophagogastroduodenoscopy (EGD)] were excluded from the analysis. Data were collected from January 2008 until September 2023. Patients were included from three different tertiary referral centers for bariatric surgeries to increase generalizability and provide a potential proof of procedure safety.

Our cohort was divided into two groups based on procedure choice: patients who underwent RYGB and those who underwent SADI-S. Data regarding patient demographics and obesity-related medical conditions were collected for both groups at baseline. Patients were followed at 1-,6-, 12-, 24-, and 60-months intervals after surgery. Given that SADI-S is a relatively novel procedure compared to RYGB with a shorter mean follow-up period, we elected to compare surgical outcomes (complication rates and weight loss outcomes) at set time intervals rather than at last follow-up to reduce potential bias related to duration of follow-up. Additionally, we performed a subgroup analysis to compare baseline demographics and presence of obesity-related medical conditions between both procedures for patients with 60 months of follow-up.

Complications were separated into five main groups: symptomatic ulcers, internal hernia, postoperative leak, dumping syndrome, and other complications. Other complications (for both procedures) included early small bowel obstruction, surgical site infections, electrolyte abnormalities with dehydration, and diarrhea/constipation.

Regarding surgical technique, we used a 20-cc pouch, 50–75 cm biliopancreatic limb, and 100–150 cm Roux limb for the RYGB, while we used a 250–300 cm common channel for the SADI-S.

Obesity-related medical conditions and weight-loss outcomes definitions

Medical conditions resolution was defined as, hemoglobin A1c (HbA1c) strictly below 6.5% without anti-diabetic medication use for type 2 diabetes mellitus (T2DM); and discontinuation of CPAP or BiPAP (continuous positive airway pressure, bilevel positive airway pressure) due to improvement in signs and symptoms or after a sleep apnea test for obstructive sleep apnea (OSA). A remission of dyslipidemia (DL) was considered if total cholesterol < 200 mg/dL, triglycerides < 200 mg/dL, and high-density lipoprotein cholesterol > 40 mg/dL in the absence of pharmacological therapy. Hypertension (HTN) remission was defined by a systolic blood pressure < 140 mmHg and a diastolic pressure < 90 mmHg in the absence of antihypertensive treatment. Weight-loss outcomes were reported in %Total weight loss [%TWL = [(pre-operative weight − current weight)/pre-operative weight] × 100]. Lastly, we also aimed to report and compare the rates of 'surgical non-responders' at 1-, and 2-years following both procedures. Therefore, we used the validated definition by Majid et al. which describes 'surgical non-responders' as patients with less than 20% TWL over their entire follow-up period [11].

Endpoints

Our primary objective was to compare the efficacy and safety of SADI-S and RYGB in patients with a BMI ≥ 50 kg/m^2. This included reporting weight loss outcomes as well as post-operative complication rates at different time intervals after both procedures. Secondary outcomes included the comparison of operative time, hospital length of stay, and 1-year mortality rates after MBS for each procedure. Also, we aimed to compare obesity-related medical conditions resolution rates of HTN, OSA, DL, and T2DM between patients who underwent SADI-S and those who had RYGB.

Statistical analysis

Frequencies with percentages were used to describe categorical variables. Means and standard deviations were used for continuous variables. All data was first tested for normality of distribution using Shapiro–Wilk's test, histograms, and

Q–Q plots. Since data was normally distributed, parametric tests were used accordingly. Chi-square test was used for categorical variables and student *T* test was employed for continuous variables. For the primary outcome of weight loss, a multivariable linear regression model was designed to control for the confounding effect of other covariates. Age, sex, BMI, T2DM, and type of procedure were included as covariates into the model a priori based on clinical significance. Multiple models were tested for different time intervals with the same included covariates. %TWL at 6, 12, 24, and 60 months were considered the outcome variable for each model. For other secondary outcomes, univariate analysis was used, specifically, chi-square test was used for categorical outcomes and student *T* test was used for continuous outcomes. A two-sided p value < 0.05 was set for statistical significance. We used version 16 (SAS Institute Inc) of JMP to perform the statistical analysis. This study followed the Strengthening the reporting of cohort studies in surgery (STROCSS) guidelines (supplementary material).

Results

Participants

A total of 986 patients with a known preoperative BMI ≥ 50 kg/m^2, who underwent primary RYGB or SADI-S from 2008 until 2023 were identified. Out of these patients, 18 were excluded as they did not have any follow-up weights or clinical parameters after initial surgery. In our final cohort, 968 patients (343 RYGB and 625 SADI-S; 68.3% female, mean age 42.9 ± 12.1 years; mean pre-operative BMI 57.3 ± 6.7 kg/m^2) with a mean follow-up period of 3.6 ± 3.6 years were analyzed.

SADI-S was the most performed procedure in our cohort (64.6%) followed by RYGB (35.4%). Analysis of patients' baseline demographics demonstrated that patients who underwent RYGB were older and more likely to be female compared to the SADI-S group. Interestingly, pre-operative BMI was statistically similar between the two groups (RYGB 56.8 ± 6.1 kg/m^2, SADI-S 57.8 ± 7.0 kg/m^2; $p = 0.062$) (Table 1). In terms of associated obesity-related medical conditions, OSA was the most prevalent comorbidity in our cohort ($n = 567$, 58.6%). HTN ($n = 491$, 50.7%), DL ($n = 344$, 35.5%), and T2DM ($n = 287$, 29.6%) were also commonly found. Comparison of comorbidity prevalence between the two groups showed that patients who underwent RYGB had a higher rate of OSA ($p < 0.001$), HTN ($p = 0.015$), DL ($p < 0.001$), and T2DM ($p = 0.016$) at baseline compared to the SADI-S cohort (Table 1). Subgroup analysis of patients with 5 years of follow-up (118 RYGB; 60 SADI-S; $n = 178$) demonstrated that age, sex, and BMI were no longer significantly different between both cohorts and that patients undergoing RYGB still had a higher prevalence of OSA and DL at baseline (both $p < 0.001$) (Supplementary Table 1).

Table 1 Preoperative patient demographics and comorbidities

	RYGB $N = 343$	SADI-S $N = 625$	p value
Patient demographics			
Age at procedure, years (SD)	44.9 (13.1)	41.9 (11.4)	< 0.001[a]
Sex, female (%)	256 (74.6)	405 (64.8)	0.002[b]
Preoperative BMI, kg/m^2 (SD)	56.8 (6.1)	57.6 (7.0)	0.062[a]
Preoperative comorbidities			
Sleep apnea (%)	262 (76.4)	305 (48.8)	< 0.001[b]
Hypertension (%)	192 (56.0)	299 (47.8)	0.015[b]
Hyperlipidemia (%)	182 (53.1)	162 (25.9)	< 0.001[b]
Diabetes mellitus (%)	118 (34.4)	169 (27.0)	0.016[b]

Data are presented as mean and standard deviation for continuous variables, and as frequency and percentage for categorical variables

RYGB Roux-en-Y gastric bypass, *SADI-S* single anastomosis duodenal-ileal bypass with sleeve, *BMI* body mass index

[a]Student *t* test

[b]Chi-square test

Peri- and postoperative outcomes

Patients undergoing RYGB had a longer operative time compared to the SADI-S cohort. The mean operative time was 163.6 ± 58.2 min for the RYGB group compared to 112.2 ± 61.9 min for the SADI-S group ($p < 0.001$). Additionally, SADI-S was associated with a shorter hospital stay than RYGB (SADI-S 2.1 ± 1.9 days vs RYGB 2.7 ± 3.1 days; $p = 0.004$).

A total of 45 patients (13.1%) who underwent RYGB experienced a bariatric surgery-related complication during their 5 years follow-up period. Specific complication rates during each time interval are shown in Table 2. Overall post-operative complication rates were 2.9, 2.2, 3.5, 4.6, and 6.8% at 0–1, 1–6, 6–12, 12–24, and 24–60 months intervals respectively following RYGB. These complications included symptomatic ulcers ($n = 20$, 5.8%), anastomotic leaks ($n = 3$, 0.9%), internal hernias ($n = 6$, 1.7%), dumping syndrome ($n = 1$, 0.3%), and other complications ($n = 15$, 4.4%). It is important to note that the majority of these complications were long-term complications, reported after the first 6 months of surgery.

Regarding surgical outcomes following SADI-S, a total of 27 patients (4.3%) reported a post-operative complication during their follow-up. Complications following SADI-S included marginal ulcers ($n = 8$, 1.3%), anastomotic leaks ($n = 5$, 0.8%), internal hernias ($n = 2$, 0.3%), dumping syndrome ($n = 5$, 0.8%), and other complications ($n = 7$, 1.1%).

Table 2 Post-operative complication rates

	RYGB	SADI-S
n	343	625
≤ 30 days		
n	343	625
Overall complications (%)	10 (2.9)	10 (1.6)
1–6 months		
n	317	320
Overall complications (%)	7 (2.2)	8 (2.5)
6–12 months		
n	282	237
Overall complications (%)	10 (3.5)	4 (1.7)
12–24 months		
n	216	148
Overall complications (%)	10 (4.6)	4 (2.7)
24–60 months		
n	118	60
Overall complications (%)	8 (6.8)	3 (5.0)

Data are presented as mean and standard deviation for continuous variables, and as frequency and percentage for categorical variables

RYGB Roux-en-Y gastric bypass, *SADI-S* single anastomosis duodenal-ileal bypass with sleeve

Table 3 Weight-loss outcomes

	RYGB	SADI-S	*p* value
Baseline BMI			
n	343	625	
Mean (SD)	56.8 (6.1)	57.6 (7.0)	0.062[a]
6 months			
n	317	318	
Average BMI (SD)	43.2 (6.4)	42.8 (6.5)	0.475[a]
%TWL (SD)	23.9 (7.1)	26.5 (6.1)	< 0.001[a]
12 months			
n	282	236	
Average BMI (SD)	38.7 (6.4)	36.1 (6.1)	< 0.001[a]
%TWL (SD)	31.9 (8.5)	37.5 (7.5)	< 0.001[a]
24 months			
n	216	148	
Average BMI (SD)	38.5 (6.8)	33.3 (6.9)	< 0.001[a]
%TWL (SD)	31.8 (10.5)	42.4 (10.3)	< 0.001[a]
60 months			
n	118	60	
Average BMI (SD)	41.8 (8.6)	34.3 (7.6)	< 0.001[a]
%TWL (SD)	25.8 (12.6)	40.4 (9.1)	< 0.001[a]

Data are presented as mean and standard deviation for continuous variables, and as frequency and percentage for categorical variables

RYGB Roux-en-Y gastric bypass, *SADI-S* single anastomosis duodenal-ileal bypass with sleeve, *BMI* body mass index, *%TWL* percentage of total weight loss

[a]Student *t* test

Lastly, we also compared the 1-year mortality rate between the two cohorts of patients. We reported no (0%) bariatric surgery related deaths after 1 year following both procedures. The all-cause mortality rates were 0.6% after RYGB and 0.8% after SADI-S ($p = 0.703$).

Weight loss outcomes

Weight loss outcomes were reported in mean BMI and %TWL at 6-, 12-, 24-, and 60-months intervals. Using a univariate analysis, Table 3 demonstrates the statistical superiority of SADI-S in terms of sustained weight loss at each time interval. Indeed, patients who underwent SADI-S had a higher %TWL at 6-months (SADI-S 26.5%, RYGB 23.9%), 12-months (SADI-S 37.5%, RYGB 31.9%), 24-months (SADI-S 42.4%. RYGB 31.8%), and 60-months (SADI-S 40.4%, RYGB 25.8%) after surgery (all $p < 0.001$). After controlling for multiple preoperative confounders, a multivariate linear regression demonstrated that the type of procedure remains statistically significant at each time interval with SADI-S being associated with higher weight loss outcomes after 6, 12, 24, and 60 months of surgery compared to RYGB (Table 4).

Additionally, Fig. 1 highlights the trends in weight loss over a 5-year period. As expected, the most significant weight loss is reached within the first 2 years following both RYGB and SADI-S. However, the weight loss for patients who underwent RYGB starts dipping after the 2-year mark compared to the SADI-S patients who experience a relatively more sustained weight loss up to 5 years (Fig. 1).

At the 1-year follow-up, 22 patients (7.8%, $n = 282$) who underwent RYGB were considered as 'surgical non-responders' compared to 3 patients (1.3%, $n = 236$) from the SADI-S group ($p < 0.001$). Similarly, the rates remained higher for the RYGB group (6.0%, $n = 216$) at the 2-year follow-up compared to the SADI-S cohort (2.0%, n = 148) ($p < 0.001$).

Obesity-related medical conditions resolution

Figure 2 highlights the rates of medical condition resolution following both RYGB and SADI-S. Our results indicate that, apart from OSA, patients who underwent SADI-S had a statistically higher resolution rate of all the evaluated obesity-related medical conditions. Indeed, 80.5% of patients with T2DM experienced remission at last follow-up after SADI-S compared to 37.6% for the RYGB cohort. Similarly, HTN resolution was higher after SADI-S than RYGB (68.3% vs 20.9%). Lastly, SADI-S was also associated with higher DL resolution rates (70.1% vs 29.1%) (all $p < 0.001$).

Table 4 Linear regression analysis of weight loss outcomes

Covariate	Unstandardized coefficient	*p* value[a]
Model 1 (%TWL 6 months)		
Constant	29.3	< 0.001
Age at time of procedure	– 0.93	< 0.001
Sex	1.52	0.009
Preoperative BMI	– 0.8	0.044
T2DM	– 0.67	0.261
Type of procedure	2.44	< 0.001
Model 2 (%TWL 12 months)		
Constant	39.8	< 0.001
Age at time of procedure	– 0.16	< 0.001
Sex	0.59	0.442
Preoperative BMI	– 0.076	0.172
T2DM	– 1.89	0.015
Type of procedure	5.39	< 0.001
Model 2 (%TWL 24 months)		
Constant	20.1	0.001
Age at time of procedure	– 0.062	0.194
Sex	0.566	0.636
Preoperative BMI	0.148	0.099
T2DM	– 3.19	0.007
Type of procedure	9.89	< 0.001
Model 2 (%TWL 60 months)		
Constant	14.2	0.118
Age at time of procedure	0.078	0.306
Sex	– 1.544	0.448
Preoperative BMI	0.004	0.972
T2DM	– 3.174	0.108
Type of procedure	14.2	< 0.001

%TWL percent total weight loss, *BMI* body mass index, *T2DM* type 2 diabetes mellitus

[a]Multivariate linear regression

Discussion

To the extent of our knowledge, this is the largest long-term (≥ 5 years) study examining and comparing surgical outcomes between RYGB and SADI-S in patients with a known preoperative BMI ≥ 50 kg/m^2. In the present cohort, SADI-S was associated with statistically higher weight loss outcomes on the short-, mid-, and long-term compared to RYGB, along with a lower rate of surgical non responders. Additionally, the resolution of obesity-related medical conditions was higher after SADI-S than RYGB for the majority of the evaluated comorbidities. Despite statistical non-significance, patients who underwent SADI-S also experienced fewer post-operative complications compared to the RYGB cohort. Thus, this study highlights the notable results in terms of both safety and efficacy following SADI-S in a specific cohort of patients with a high preoperative BMI.

RYGB has consistently demonstrated excellent efficacy for patients with obesity, irrespective of initial BMI. However, the surgical safety of RYGB for patients with a high preoperative BMI remains a subject of concern and has led to a growing interest in examining other surgical procedures for this specific cohort of patients [12]. Indeed, patients with a BMI exceeding 50 kg/m^2 have demonstrated higher rates of specific long-term complications following RYGB such as marginal ulcers, internal hernias, weight recurrence and inadequate weight loss which typically leads to revisional bariatric surgery [13]. To address these outcomes, multiple recent studies have evaluated the morbidity and mortality associated with other MBS procedures such as the SADI-S [14, 15]. However, these studies essentially reported intra- and early post-operative complications without describing the long-term results of SADI-S. Additionally, the few reports in the literature that describe overall long-term complications following SADI-S fail to categorize patients by subgroups of BMI and to report specific outcomes for each weight subgroup [16]. In a recent meta-analysis by Balamurugan G et al. comparing 5-year outcomes between multiple bariatric procedures (all BMIs included), SADI-S was associated with lower long-term complication rates compared to RYGB [17]. Similarly, other prospective studies and meta-analyses have validated the superior outcomes following SADI-S [8, 18]. Nevertheless, the majority of these reports either included a small sample size, described only short- and mid-term outcomes, or did not take into consideration the patient's initial BMI which might affect surgical outcomes after MBS.

Many reports have identified the most common long-term complications after RYGB [19]. Similar to our findings of 5.8%, marginal ulceration (MU) was found to be the most common long-term complication after RYGB with an incidence varying between 1 and 16% [19]. In case of complicated/symptomatic ulcers, surgical intervention is often required to control the bleeding, repair the perforation, or resect any strictures [20, 21]. While the exact pathophysiology of MU remains unclear, there are several implicated factors that have been identified after RYGB. Early MU, that occurs within the first 3 months, might be a simple component of anastomotic healing [22]. However, the majority of MU develop late after RYGB and can be explained partially by the highly acidic gastric secretions eroding the vulnerable mucosa at the gastrojejunostomy [23]. Other potentially dreadful complications after RYGB include anastomotic leaks seen in 1–5% and internal herniation in 0.7–4.5% of cases [24, 25]. Our results are in accordance with those rates and highlight the relatively high incidence of these complications, which could potentially lead to chronic

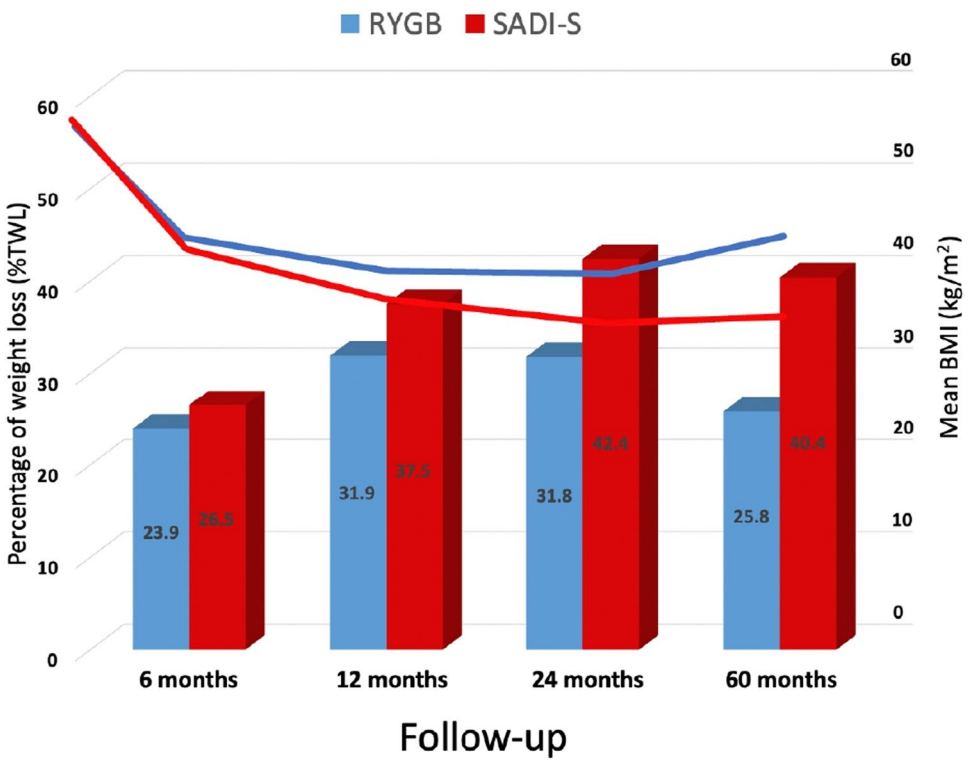

Fig. 1 Long-term weight loss after RYGB and SADI-S. *RYGB* Roux-en-Y gastric bypass, *SADI-S* single anastomosis duodenal-ileal bypass with sleeve gastrectomy

malnutrition and decreased quality of life in patients with very high BMIs.

This in turn, led to the evaluation of SADI-S's safety on the long-term. Despite initial reports describing high complication rates after SADI-S, probably explained by the learning curve and the prolonged operative time [26, 27], current studies confirm that all the above-mentioned complications seem to be lower after SADI-S compared to RYGB. This was also described in our results with SADI-S having lower rates of MU, anastomotic leaks, and internal herniation. In fact, lower rates of MU associated with the pylorus-preserving SADI-S are mainly due to the buffering role of the duodenal Brunner's glands [20]. These glands secrete a mucin-rich alkaline fluid that protects the mucosa from the acidic gastric secretions, thus decreasing the risk of mucosal damage and consequent ulceration [28]. Regarding the lower incidence of internal hernias after SADI-S, this can be explained by the presence of a single anastomosis and avoidance of mesenteric openings as compared to the RYGB [29]. Nevertheless, the main concerns regarding SADI-S were the long-term risks of bile reflux and malnutrition [30]. However, recent studies confirmed the relatively low and comparable incidence of malnutrition with other MBS procedures [31]. Unfortunately, with SADI-S being a novel procedure, there is a scarcity of published literature with prolonged follow-up periods which may introduce some bias when comparing complication rates directly between SADI-S and RYGB. Therefore, further studies are required to truly compare these complication rates after a similar follow-up period.

It is also important to mention the 1-year mortality rates associated with both procedures. Indeed, in our cohort, we reported no bariatric surgery-related deaths and an overall mortality rate of less than 1% for both procedures after 1 year of follow-up. These rates are similar to those described in a recent meta-analysis by Robertson et al. that reports a pooled mortality rate of 0.08% following MBS [32]. Based on these results, both RYGB and SADI-S can be considered safe procedures associated with a low-mortality rate even for patients with high preoperative BMIs.

Given that multiple studies have identified weight-associated issues as primary indications for revisional bariatric surgery, it also becomes essential to optimize weight loss outcomes after primary MBS [33] particularly for patients with an initial BMI ≥ 50 kg/m^2. In fact, there is a negative proportional correlation between preoperative BMI and postoperative weight loss [34]. Our results validate those of many studies that demonstrate the higher weight loss outcomes with SADI-S compared to RYGB [35]. Furthermore, SADI-S is associated with a lower short-, and mid-term rate of surgical non-responders which also highlights the efficacy of this procedure. Lastly, SADI-S also demonstrated a higher overall rate of obesity-related medical conditions resolution [31]. These higher rates can be correlated with the higher weight loss given that %TWL is an independent predictor of remission for multiple comorbidities such as T2DM and

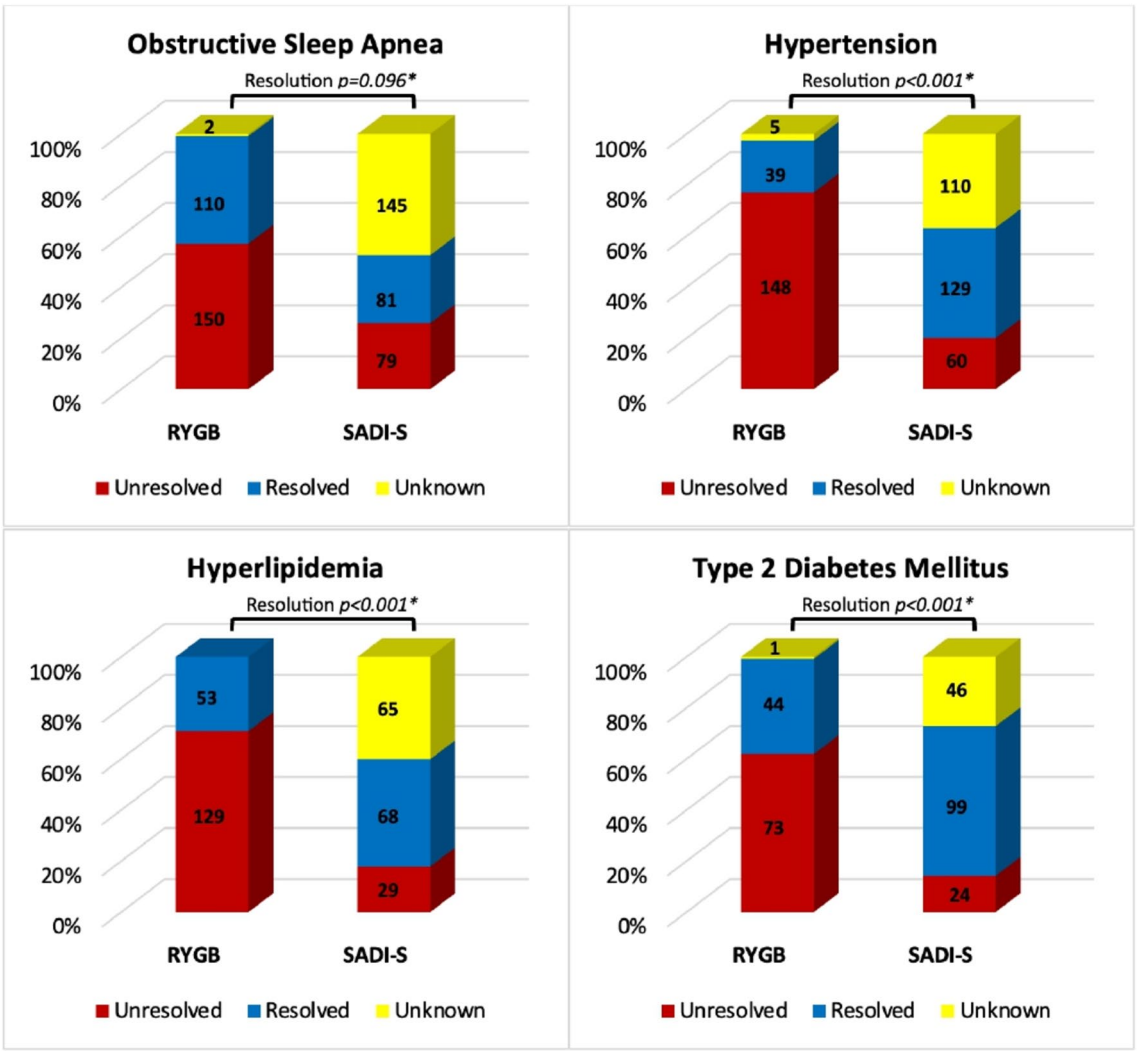

Fig. 2 Obesity-related medical conditions resolution at last follow-up after RYGB and SADI-S. *RYGB* Roux-en-Y gastric bypass, *SADI-S* single anastomosis duodenal-ileal bypass with sleeve gastrectomy. *Resolution rate comparison between both procedures was corrected to the percentage of patients who followed-up

HTN [36]. Also, some studies show that comorbidity resolution is higher after SADI-S compared to RYGB despite similar weight loss [35]. This could imply that the anatomical configuration of the pylorus preserving SADI-S could be a valid alternative explanation to the observed high resolution rate of medical conditions. Therefore, SADI-S emerges as a relatively efficient and safe MBS procedure for patients with obesity and a BMI exceeding 50 kg/m^2.

Strength and limitations

The primary strength of our multi-centered study includes the use of a large sample size to assess and compare the long-term surgical safety and efficacy of two standardized bariatric procedures for a specific subgroup of patients with a high preoperative BMI. However, this study also has several limitations that must be acknowledged. Firstly, this retrospective observational study included two groups of patients with different baseline characteristics which might be a source of selection bias. Patients who underwent RYGB had a higher disease severity and rate of obesity-related medical conditions at baseline, which might affect surgical outcomes comparison between the two procedures. Nevertheless, the most relevant preoperative parameter (BMI) was similar between the two groups at baseline which reduces any potential bias in the subsequent weight loss comparison. Also, due to heterogeneity of data availability from all participating institutions, some variables such as ethnicity and race were not reported and compared between both procedures. Secondly, the average duration of follow-up between both cohorts was not comparable, with RYGB patients having a significantly longer duration of follow-up. This in

turn, limits the direct comparison of specific complication rates between the two groups which was not mentioned in our study. To mediate this limitation and reduce selection bias, we elected to compare overall complication rates at set time intervals. In our study, we also reported a significant difference in follow-up rates after 5 years between both procedures which might have introduced some bias in our long-term analysis. Lastly, despite SADI-S being the more novel procedure, our cohort included a majority of patients who underwent SADI-S compared to RYGB. The inclusion of patients from two leading centers in bariatric surgery with a primary focus on SADI-S might lead to positively skewed results in favor of SADI-S given the surgical expertise in this specific procedure.

Conclusion

In our cohort, SADI-S was associated with higher and sustained short-, mid-, and long-term weight-loss results compared to RYGB for patients with BMI $\geq$ 50 kg/m^2. T2DM, HTN, and DL remission rates were also higher after SADI-S. Both procedures demonstrate a similar safety profile without any reported bariatric surgery-related deaths after 1 year of follow-up. Further studies are required to determine the long-term safety of SADI-S compared to other bariatric procedures.

Supplementary Information The online version contains supplementary material available at https://doi.org/10.1007/s00464-024-10765-3.

Author contributions K.H, A.F.T, D.C, and O.M.G contributed to the conception of the work; K.H, A.S, R.L, and K.A.M contributed to the analysis, interpretation of data for the work, drafting the first manuscript; A.F.T, M.A.J, M.G, M.L.K, D.C, and O.M.G critically reviewed the manuscript. All authors gave approval of the final version to be published.

Declarations

Disclosures Karl Hage, Andre F. Teixeira, Amit Surve, Romulo Lind, Muhammad A. Jawad, Muhammad Ghanem, Kamal Abi Mosleh, Michael L. Kendrick, Daniel Cottam, Omar M. Ghanem have no conflicts of interest or financial ties to disclose.

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