



Original article

Resolution of diabetes, gastrointestinal symptoms, and self-reported dietary intake after gastric bypass versus sleeve gastrectomy: a randomized study

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Abstract

Background: There is a lack of randomized studies examining diabetes remission and dietary intake between patients undergoing Roux-en-Y gastric bypass (RYGB) versus sleeve gastrectomy (SG).

Objective: To examine longitudinal differences in diabetes resolution, dietary intake, and gastrointestinal (GI) symptoms in patients with obesity and type 2 diabetes (T2D) randomized to either RYGB or SG and according to remission of T2D.

Setting: Four hospitals in Sweden, 2 of which are university hospitals.

Methods: Dietary intake and GI symptoms were calculated from questionnaires and morphometric differences between surgical methods and T2D remission were compared using the Student *t* test, effect size (ES) for parametric parameters, and Mann-Whitney *U* test for nonparametric parameters.

Results: Five years after RYGB or SG there was no significant difference in the rate of remission of T2D between RYGB and SG (43% versus 20%, $P = .176$). RYGB ($n = 19$) patients had greater weight loss than SG patients ($n = 14$) (26.4 [9.5] versus 13.1 [9.6] kg, $P < .001$), despite reporting higher daily caloric intake ($\Delta 669$ kcal, $P = .059$, ES .67) and food weight ($\Delta 1029$ g/d, $P = .003$, ES 1.11). RYGB patients, compared with SG patients, also ate 1 more fruit per day ($P = .023$). Pooled data showed no differences between patients with and without T2D remission regarding weight loss, but those in remission drank more nonalcoholic drinks and milk.

Conclusions: Five years postoperatively, patients randomized to RYGB reported considerably higher food intake compared with SG despite lower body weight. The reason and importance of the higher food intake after RYGB compared with SG needs to be further studied. (Surg Obes Relat Dis 2022; ■:1–9.) © 2022 American Society for Metabolic and Bariatric Surgery. Published by Elsevier Inc. This is an open access article under the CC BY license (<http://creativecommons.org/licenses/by/4.0/>).

Keywords:

Roux-en-Y gastric bypass; Sleeve gastrectomy; Type 2 diabetes; Dietary intake; Remission Induction; Gastrointestinal symptoms

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For 25 years it has been known that bariatric surgery can induce remission of T2D and that surgical methods based on bypassing the proximal small intestine achieve higher remission rates than restrictive methods [1,2]. It has long been thought that the increased incretin hormone release resulting from bypassing the proximal small intestine contributes to the improvements in glucose control [3]. We [4] and others [5] have demonstrated that SG displays similar effects on incretin hormone release and T2D remission [4,6], at least in the short term, although the mechanisms may also in part differ [7]. Current research has shown that it is not only incretins that are the underlying mechanisms for diabetes remission, but also treatment with a preoperative low energy diet which accounted for more than 90% of improvements in health markers (including body weight, blood sugar, and hormone levels) compared with the surgery itself [8]. Furthermore, an interaction between dietary intake, increased bile flow, and the microbiota has also been shown to play a role in diabetes remission [9,10]. Several studies have addressed differences in dietary intake between SG and RYGB [11]. However, in none of these studies was dietary intake compared in patients with T2D.

Therefore, in this study, we aimed to explore differences between RYGB and SG in patients with T2D regarding: (1) energy and macronutrient intake, food choice, meal frequency, and gastrointestinal (GI) symptoms up to five years postoperatively; and (2) dietary intake (carbohydrate intake, energy density, number of meals, and food choices) in relation to diabetes remission 5 years after surgery.

Methods

Patients and remission criteria

These are 5-year results from a randomized controlled trial (RCT) investigating the effects of Roux-en-Y gastric bypass (RYGB) and sleeve gastrectomy (SG) on diabetes remission in patients with obesity [4,12]. The study was registered at [ClinicalTrials.gov](https://clinicaltrials.gov) (identifier: NCT01984762). From March 2012 to September 2015, 815 patients were assessed for eligibility at 4 bariatric centers in Sweden (Sahlgrenska University Hospital [Sahlgrenska and Ostra Hospital] in Gothenburg, Skaraborg Hospital in Skövde, and Ersta Hospital in Stockholm). Six hundred eighty-two patients did not meet inclusion criteria, and 74 patients declined to participate; thus, 60 patients with T2D were included.

The inclusion criteria were body mass index (BMI) of 35 to 50 kg/m², age of 18 to 60 years, and T2D requiring any glucose-lowering pharmacologic medication, not dietary treatment alone. Exclusion criteria were severe gastrointestinal reflux disease (GERD) and inability to understand the Swedish language or to adhere to study instructions. Postoperative adjustments of diabetes medications were handled

by the physician usually in charge of the patient's diabetes treatment and diabetes remission was defined as glycosylated hemoglobin ≤ 42 mmol/mol without any ongoing diabetes medications. Weight and height were recorded with patients wearing only underwear after an overnight fast. All patients were White.

The study was approved by the Regional Ethical Review Board of Gothenburg (study reference number 016-12) and conducted according to the principles of the Helsinki declaration. All patients gave written informed consent.

Randomization procedure

Patients were randomized by the use of computer-generated numbers into RYGB or SG groups stratified for age and sex [4,12].

Surgery and follow-up

All patients underwent a laparoscopic RYGB or SG by experienced bariatric surgeons as described earlier [13]. A dietitian counseled the patients before surgery and after surgery at 6 weeks, 6 months, and 12 months. The usual 2-week preoperative low-energy diet (LED) was omitted in order not to influence preoperative or early postoperative glycemic control. Patients received the same dietary advice regardless of surgical method, including intake of liquid diet for 1 week and thereafter semi-solid food for 3 weeks. Patients were instructed to adhere to a diet rich in protein and vitamin and mineral supplementation were given according to international guidelines [14]. The patients received both written and oral dietary advice individually and in groups before surgery and individually after surgery at 6 weeks, 6 months, 1 year, and 2 years. Patients were advised to high intake of meat, fish, chicken, eggs, and dairy products, or vegetarian options and use LED products or protein drinks during the first months, although we did not define any specific protein target to be reached. The diet was adjusted individually, if necessary, at outpatient visits. Dietary assessment and GI symptoms were evaluated preoperatively and at each follow-up visit 6 weeks and 6, 12, 24, and 60 months after surgery.

Dietary assessment

Dietary data were collected with a semi-quantitative food questionnaire described in detail by Lindroos et al. [15] with a confirmed validity in patients with obesity. The energy intake (EI), macronutrient distribution, and food groups were analyzed. The self-administered dietary questionnaire consists of 51 questions that are answered without oral instructions. The questionnaire covers habitual dietary intake over the past 3 months, with emphasis on portion size and frequencies per day or per week. Reported food amounts were converted into grams, from which daily intake of energy and nutrients were calculated. In addition to total

energy and nutrient intake data, the dietary questionnaire makes it possible to obtain data on 15 different food groups. Nutritional values were obtained from the food database of the National Food Administration, version 04.1.1 (Uppsala, Sweden). A simplified and self-instructing questionnaire describing habitual daily intake occasions and distribution over an ordinary 24-hour period was used to examine daily meal patterns [16,17]. Intake of only beverages (with or without caloric content) were not regarded as a separate meal. Food weight (FW) includes weight of food, milk, alcohol, and energy-containing drinks (soft drinks, fruit syrups, and juice), coffee and plain tea, but excludes water, bottled water, and diet sodas. The energy density was calculated by dividing EI by FW.

Glucose homeostasis

Blood samples were collected for analysis of glycosylated hemoglobin (HbA1C), fasting glucose and insulin, and C-peptide. Homeostasis model assessment of insulin resistance (HOMA-IR), an index for insulin resistance, was calculated using the following formula: homeostasis model assessment of insulin resistance = (insulin [μ IU/mL] x fasting glucose [mmol/L]) / 22.5.

GI symptoms

GI symptoms were measured using the Gastrointestinal Symptom Rating Scale (GSRs) [18,19]. GSRs includes questions about 15 common GI symptoms that are summed into 6 dimensions: abdominal pain, reflux, diarrhea, indigestion, and constipation. The magnitude of the symptoms during the past week is graded on a 7-point Likert scale, in which the highest score denotes the most pronounced symptoms. A mean score (range, 1–7) is calculated for each domain.

Statistics

Differences between surgical methods and T2D remission in BMI, weight loss, energy intake, food weight, energy density, and macronutrients were tested using the Student *t* test. Effect size (ES) was calculated as Cohen's *d* with effects denoted <.2 "trivial", .2 to <.5 "small", .5 to <.8 "moderate," and >.8 "large" [20]. Differences in nonnormally distributed data—glucose homeostasis, alcohol, meal frequency, food group weights, and GI symptoms (GSRs)—were tested using the Mann-Whitney *U* test without calculation of effect sizes. Excess weight was defined as body weight above a BMI of 25 kg/m². Differences in weight (kg) loss were also tested in a general linear model, adjusted for baseline weight. Differences in sex distribution and diabetes remission were calculated by the χ^2 test. The results are presented as mean and standard deviation. Power calculation was performed on the assumption that T2D remission rates were 87% for RYGB and 57% for SG. With type 1 error of .05 and power of .8, 25 patients

were needed in each group. In addition, 5 additional patients were admitted to each group for the expected drop-out, a total of 60 patients were included [12].

Results

Withdrawal

Of the 60 patients included, 22 underwent SG and 26 RYGB. Twelve patients were excluded: 3 patients had verified Barrett's esophagus; 1 patient randomized to SG was operated with RYGB due to a thickened gastric wall caused by antrum gastritis; 1 patient was randomized to RYGB but opted for SG; 1 patient was converted from SG to RYGB due to weight regain; 1 patient was judged to be noncompliant before surgery; and 5 patients chose to drop out (Fig. 1). Dietary data was missing for 4 patients at baseline, 8 at 6 weeks, 9 at 6 months, 7 at 1 year, 8 at 2 years, and 12 at 5 years. The total number of dietary questionnaires answered was 228 of 276 (83 %). The reason for missing data was both technical (error copying questionnaires) and reluctance to answer the dietary questionnaires. The 2 previous reports used intention to treat methodology [4,12], but in this study we chose to use per-protocol analysis because the groups are small, and even small changes can disturb the results of dietary data.

Body weight and diabetes remission

Body weight and BMI did not differ between patients in the RYGB (*n* = 26) and SG (*n* = 22) groups before surgery (Table 1). However, 5 years after surgery, RYGB had a 13.3-kg greater weight loss than SG (*P* < .001). Adjusted for baseline weight, the difference was 12.5 kg (*P* < .001). After 5 years, the T2D remission rate, defined as normoglycemia (HbA1C \leq 42%) without any diabetes medications, did not differ significantly between RYGB and SG (43% versus 20%, *P* = .176). There was no difference in weight loss between patients with or without diabetes remission (92.1 versus 98.3 kg respectively, *P* = .14, adjusted for baseline weight). HbA1C and fasting glucose was significantly lower in patients with diabetes resolution, as expected (*P* < .001). However, there were no differences in fasting insulin, C-peptide, or HOMA-IR (*P* > .05).

Dietary intake

There were no differences in EI, FW, macronutrients, fiber, and meal frequency between groups at baseline and through 2 years (Table 2). Five years postoperatively, mean EI was 669 kcal, higher in RYGB (*P* = .059, ES .67) and FW 1029 g/d higher (*P* = .003, ES 1.11) compared with SG, despite 9.2-kg lower body weight (Tables 1 and 2). Protein intake was 29 g/d higher among those operated with RYGB (*P* = .015, ES .77) and fiber intake was 8 g/d higher after RYGB (*P* = .009, ES .81) compared with SG (Table 2).

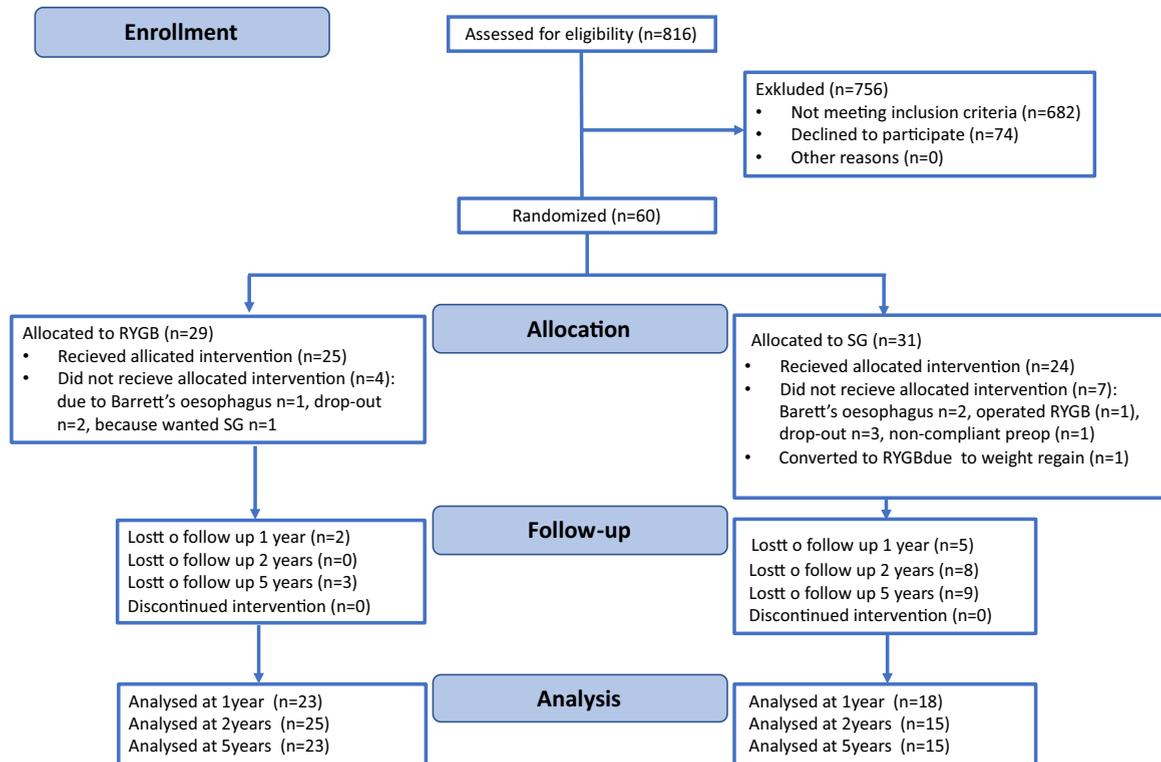


Fig. 1. Flow chart.

There was no statistical difference in self-reported alcohol intake between the 2 groups (Table 2). However, the intake corresponded to 5 standard glasses of alcohol per week for RYGB and 3 for SG. In terms of food choice, the only difference was that intake of fruits was 88 kcal higher in the RYGB patients ($P = .023$) at 5 years (Table 3).

Meal frequency

There were no significant differences in meal frequency between the RYGB and SG patients preoperatively (RYGB 4.3 versus SG 4.7 meals/d, $P = .150$) or 5 years after surgery (RYGB 4.4 versus SG 4.8 meals/d, $P = .319$) (Table 2).

Dietary intake in relation to remission state

On pooled data (for surgical technique), there were no differences in EI, FW, DED, macronutrient intake, or number of meals between those in remission ($n = 12$) and those with T2D ($n = 21$); however, patients in remission drank 49 g more in nonalcoholic drinks ($P = .02$) and 94 g milk per day ($P = .05$) than patients with T2D (Table 4).

GI symptoms

Before surgery, no differences in GI symptoms were reported between the groups ($P > .05$). The RYGB group

reported fewer reflux symptoms than the SG group at 1 year ($P = .013$), a difference that seemed to persist also 5 years postoperatively ($P = .06$) (Table 5). Diarrhea, indigestion, constipation, and abdominal pain did not show any tendencies to differences between the groups at any time after surgery.

Discussion

In this longitudinal study in patients with T2D randomized to either RYGB or SG, we observed a large difference in the reported energy intake and food weight. Those who underwent RYGB reported a ~ 700 kcal higher energy intake and ~ 1000 g higher food weight intake than the SG patients despite a 9.2-kg lower body weight. The difference in reported dietary intake between those who were in remission of T2D showed that patients in remission drank more nonalcoholic drinks and milk. Regarding diabetes remission, we could not see any statistical difference between the surgical methods, but the RYGB patients had significantly lower HbA1C than the SG patients.

El Labban et al. [21] saw that RYGB patients consumed significantly more fruits than SG patients, which is in line with the results of this study. Reported intake of lighter meals also tended to be higher after RYGB although it did not reach statistical significance ($P = .061$). Overs et al. [22] have reported that food tolerance and GI quality of

Table 1
Changes in weight, BMI, glucose homeostasis, and diabetes remission rates 5 years after surgery

Outcome	RYGB	n	SG	n	P value
Baseline data					
Sex (% women)	50	26	46	22	.780*
Age (yr)	49 (9)	26	47 (11)	22	.420 [†]
Body weight (kg)	119.3 (15.2)	26	118.9 (19.6)	22	.925 [†]
BMI (kg/m ²)	39.8 (3.9)	26	40.5 (4.1)	22	.520 [†]
5-yr data					
	n = 23	n	n = 15	n	
Body weight, kg	91.9 (12.8)	19	101.1 (16.1)	14	.077 [†]
BMI, kg/m ²	30.4 (4.1)	19	34.6 (3.7)	14	.005 [†]
TWL, kg	26.4 (9.5)	19	13.1 (9.6)	14	<.001 [†]
TWL, %	22.3 (7.5)	19	11.4 (8.2)	14	<.001 [†]
EWL, %	64.4 (23.6)	19	31.7 (22.9)	14	<.001 [†]
Waist circumference, cm	107 (12)	18	112 (10)	11	.257 [†]
Blood pressure, systolic, mmHg	81 (19)	18	84 (10)	13	.520 [†]
Blood pressure, diastolic, mmHg	140 (13)	18	142 (19)	13	.756 [†]
Glycosylated hemoglobin, mmol/mol	44.2 (11.4)	23	55.9 (19.1)	15	.020 [‡]
Fasting plasma glucose, mmol/L	7.1 (1.8)	23	8.8 (3.8)	15	.101 [‡]
Insulin, mIU/L	11.7 (9.8)	23	14.1 (11.6)	11	.403 [‡]
C-peptide, ng/mL	.89 (.45)	23	1.06 (.33)	11	.114 [‡]
HOMA-IR	3.72 (3.25)	23	5.07 (4.09)	11	.383 [‡]
Glycosylated hemoglobin ≤6.0% (42 mmol/mol), n/n (%)	11/23 (48)		3/15 (20)		.101*
Glycosylated hemoglobin ≤6.0% (42 mmol/mol) and no medication, n/n (%)	10/23 (43)		3/15 (20)		.176*

BMI = body mass index; RYGB = Roux-en-Y gastric bypass; SG = sleeve gastrectomy; TWL = total weight loss; EWL = excess weight loss; WL = weight loss; HOMA-IR = homeostasis model assessment of insulin resistance.

* χ^2 Test.

[†] *t* Test.

[‡] Mann Whitney *U* test.

life 2 to 4 years after surgery are best after SG, followed closely by RYGB. Although we used a different dietary examination methodology and a different questionnaire for GI symptoms, our study did not show worse GI quality of life in those who underwent RYGB. Previous studies have shown that SG is associated with more reflux symptoms than RYGB, which we also found in our present study [18,21]. However, the prevalence of other GI symptoms was similar between the 2 groups. Regarding dietary intake, patients operated by RYGB seem to be able to eat significantly more than the SG patients and still maintain a lower weight 5 years after surgery. Moreover, the increasing amount of food consumed 5 years after RYGB did not result in higher prevalence of abdominal pain or diarrhea. Bjorklund et al. [23] have demonstrated that 1 year after RYGB distention of proximal Roux limb was associated with unspecific sensation of discomfort and pain. It could be that 5 years after RYGB the proximal part of the Roux limb undergoes physiologic changes that make it less sensitive to the distention caused by ingested food. What clinical impact this may have on long-term results should be elucidated in future studies.

There are several factors that could explain the large difference in reported EI, for example, differences in energy

expenditure, body composition, increased malabsorption after gastric bypass, over- or underreporting of dietary intake, or differences in physical activity. The results from different studies have, however, not been able to confirm differences in resting energy expenditure between RYGB and SG [24–27], but these studies were performed up to 2 years after surgery, and our results showed significant differences first at 5 years after surgery. A comparison between RYGB and vertical banded gastroplasty showed that resting energy expenditure was not different, but rather energy expenditure in response to food intake was significantly increased after RYGB [28]. This finding could explain why RYGB patients can eat more, and still lose more weight compared with SG patients. There are, however, also data from animal studies suggesting that RYGB induced a substantial increase in resting energy expenditure compared with SG, the latter after which weight loss primarily resulted from a decrease in food intake [29]. Another explanation could be differences in the effect on body composition with higher proportion of fat mass after SG. In other studies, however, no demonstrable differences in the percentage of fat-free mass between the surgical methods were found [30,31]. There is a lack of balanced studies on fecal energy losses after SG, but 14 months after

Table 2
Differences in dietary intake between surgical methods at baseline and up to 5 years postoperatively

	Baseline	6 wk	6 mo	1 yr	2 yr	5 yr	Between groups at 5 yr <i>P</i> value	Effect size between groups at 5 yr*
RYGB (n)	25	23	22	23	25	22		
SG (n)	19	17	17	18	15	14		
Kcal/d [†]								
RYGB	2813 (1248)	1676 (780)	1835 (798)	1988 (842)	2148 (886)	2633 (1199)	.059	.67
SG	2406 (855)	1669 (705)	1835 (709)	1936 (706)	1928 (382)	1964 (548)		
Kcal/kg/d [†]								
RYGB	23.8 (9.4)	16.7 (8.3)	21.3 (8.3)	22.9 (8.4)	24.9 (9.3)	26.0 (10.1)	.121	.62
SG	20.8 (8.7)	16.3 (7.3)	20.8 (8.0)	22.2 (9.2)	21.5 (6.3)	20.3 (7.2)		
Food weight g/d [†]								
RYGB	2566 (1128)	1937 (818)	1948 (762)	2045 (596)	2288 (785)	2822 (1060)	.003	1.11
SG	2183 (600)	2065 (1023)	1862 (950)	2071 (982)	1884 (586)	1793 (651)		
Dietary energy density [†]								
RYGB	1.14 (.36)	.87 (.17)	.97 (.25)	.97 (.26)	.93 (.20)	.94 (.21)	.052	.80
SG	1.13 (.33)	.84 (.16)	1.05 (.19)	.98 (.18)	1.08 (.27)	1.17 (.37)		
Protein (g) [†]								
RYGB	120 (53)	76 (33)	79 (33)	80 (36)	85 (31)	107 (44)	.015	.77
SG	98 (26)	79 (39)	77 (38)	80 (32)	79 (22)	78 (23)		
Fat (g) [†]								
RYGB	127 (61)	68 (41)	81 (35)	84 (42)	93 (42)	118 (57)	.110	.56
SG	106 (41)	61 (26)	76 (27)	80 (28)	86 (24)	91 (30)		
Carbohydrates (g) [†]								
RYGB	276 (136)	177 (73)	194 (100)	211 (88)	224 (105)	271 (149)	.053	.58
SG	246 (104)	189 (86)	191 (80)	202 (77)	186 (42)	199 (60)		
Fiber (g) [†]								
RYGB	26 (10)	18 (9)	19 (9)	20 (6)	21 (7)	24 (11)	.009	.81
SG	21 (7)	16 (7)	19 (8)	20 (7)	20 (5)	17 (4)		
Alcohol (g) [‡]								
RYGB	5 (6)	2 (4)	3 (4)	4 (5)	5 (6)	8 (9)	.761	NA
SG	5 (5)	2 (3)	5 (6)	6 (8)	7 (8)	5 (6)		
Meal frequency (n/d) [‡]								
RYGB	4.3 (9)	5.7 (1.2)	5.1 (1.2)	4.9 (1.2)	5.2 (1.0)	4.4 (1.1)	.319	NA
SG	4.7 (1.6)	5.1 (1.3)	5.1 (1.1)	5.1 (1.4)	5.1 (1.3)	4.8 (1.5)		

RYGB = Roux-en-Y gastric bypass; SG = sleeve gastrectomy; NA = not applicable.

Data are presented as the mean (standard deviation).

* Effect size <.2 is considered “trivial,” .2 to <.5 “small,” .5 to <.8 “moderate,” and >.8 “large.”

[†] *t* Test.

[‡] Mann-Whitney *U* test.

long-limb gastric bypass, a small study showed that the average net absorption was only 75 kcal lower than before surgery [32]. Malabsorption is most likely minimal after SG and therefore even a minor increase in malabsorption after RYGB could play a part in explaining the discrepancy between the weight decrease and the 700 kcal higher energy intake per day after RYGB compared with SG. Underreporting of dietary intake is correlated to BMI [33], which could be a cause of lower reported energy intake among SG patients who lost less weight than RYGB patients. We did not measure physical activity and can therefore not comment on whether there were any differences between the groups. The results of the present study indicate that there may be long-term and large differences in dietary intake between RYGB and SG that need to be investigated

further. If RYGB leads to a higher energy expenditure than SG, it should lead to an incrementally better weight development, therefore follow-up greater than 5 years after surgery is needed.

Those with and without remission of T2D ate roughly the same 5 years after surgery. One previous study indicated lower intake of sweet drinks by patients with diabetes [34]. We observed a similar trend, although it was not statistically significant. Whether individuals diagnosed with T2D compared with healthy controls have a better diet quality has been measured in 8200 individuals in the National Health and Nutrition Examination Survey study; the Healthy Eating Index, however, did not show any differences between patients with diabetes and healthy controls either on the whole scale or any of the 12 subgroups [35].

Table 3
Energy intake (kcal) from 15 food groups 5 years after gastric bypass or sleeve gastrectomy

Food group (kcal/d)	RYGB n = 22		SG n = 14		P value*
	Mean	SD	Mean	SD	
Cereals	80	89	57	66	.490
Cheese, ham	118	214	30	30	.327
Sandwiches	439	201	358	236	.281
Cooked food	403	174	347	163	.267
Desserts	49	114	44	53	.253
Fast foods	109	116	104	116	.761
Lighter meals	277	456	99	124	.061
Eggs	46	40	66	72	.360
Fruits	155	127	67	44	.023
Alcoholic drinks	71	85	45	53	.737
Nonalcoholic drinks	88	147	38	39	.553
Milk	221	203	199	247	.665
Snacks	227	207	206	138	.911
Chocolate, candies	210	299	206	252	.962
Cakes, cookies	139	164	98	98	.377

RYGB = Roux-en-Y gastric bypass; SG = sleeve gastrectomy.

* Mann-Whitney *U* test.

Strengths

This is, to our knowledge, the first randomized study on patients with T2D undergoing RYGB or SG in which dietary intake was specifically studied. None of the studied

parameters revealed significant differences before surgery, but repeated measurements up to 5 years after surgery show potentially important differences between the surgical methods in terms of reported energy intake and food weight.

Table 4
Differences in dietary intake at 5 years postoperatively according to diabetes remission status and pooled data

	Diabetes remission 5 yr				
	Remission (n = 11)		No remission (n = 20)		P value
	Mean	SD	Mean	SD	
Energy, macronutrients, and number of meals					
Energy (kcal)*	2504	1024	2265	1179	.58
Food weight (g)*	2793	811	2366	1150	.19
Energy density (kcal/g)*	.92	.29	1.02	.22	.26
Protein (g)*	106	37	90	45	.35
Fat (g)*	117	60	99	49	.37
Carbohydrates (g)*	242	114	239	149	.95
Fiber (g)*	21	8	22	11	.77
Alcohol (g)†	8	9	7	7	.89
Number of meals†	4.4	1.3	4.6	1.3	.70
Food group (kcal/d)†					
Cereals	65	95	85	78	.48
Cheese, ham	153	290	52	71	.52
Sandwiches	443	222	391	223	.58
Cooked food	358	103	406	199	.56
Desserts	49	65	41	113	.58
Fast foods	111	102	95	120	.61
Lighter meals	93	113	255	474	.24
Eggs	64	46	50	63	.13
Fruits	106	94	126	130	.86
Alcoholic drinks	70	87	67	72	.95
Nonalcoholic drinks	96	144	47	116	.02
Milk	278	208	184	238	.05
Snacks	241	210	160	82	1.00
Chocolate, candies	218	381	181	184	.86
Cakes, cookies	125	91	126	175	.28

SD = standard deviation.

* *t* Test.

† Mann-Whitney *U* test.

Table 5
Gastrointestinal Symptom Rating Scale by surgical method

	Baseline	6 wk	6 mo	1 yr	2 yr	5 yr	Between groups at 5 yr <i>P</i> value*
RYGB (n)	26	23	23	24	25	16	
SG (n)	22	20	21	20	16	11	
Diarrhea							
RYGB	2.0 (1.5)	1.8 (1.0)	2.0 (1.1)	1.8 (.8)	1.8 (.9)	1.9 (1.1)	.48
SG	2.6 (1.4)	2.6 (1.7)	2.0 (1.0)	2.0 (1.5)	2.1 (1.6)	1.8 (1.5)	
Indigestion							
RYGB	2.3 (1.1)	2.7 (1.2)	3.1 (1.1)	3.1 (1.4)	3.0 (1.4)	2.8 (1.4)	.61
SG	2.6 (1.3)	2.8 (1.3)	2.8 (1.1)	2.8 (1.4)	3.1 (1.3)	3.1 (1.7)	
Obstipation							
RYGB	1.7 (1.0)	2.2 (1.5)	2.2 (1.4)	2.0 (1.4)	2.2 (1.6)	2.1 (1.2)	.40
SG	2.0 (1.0)	2.1 (1.0)	2.0 (.9)	2.0 (1.0)	2.7 (1.2)	1.8 (1.3)	
Reflux							
RYGB	2.1 (1.2)	1.3 (.7)	1.3 (.6)	1.2 (.5) [†]	1.3 (.7)	1.3 (1.0)	.06
SG	2.0 (1.2)	1.5 (.6)	1.6 (.9)	1.9 (1.0)	1.8 (1.1)	2.5 (1.6)	
Abdominal pain							
RYGB	2.0 (1.1)	2.0 (.9)	2.0 (1.1)	1.8 (.8)	1.7 (.7)	2.1 (1.2)	.16
SG	2.0 (1.0)	2.5 (1.1)	2.3 (1.0)	1.8 (.8)	2.3 (.9)	2.7 (1.2)	

RYGB = Roux-en-Y gastric bypass; SG = sleeve gastrectomy.

Higher scores indicate the most pronounced symptoms. Data are presented as the mean (standard deviation).

* Mann-Whitney *U* test.

[†] Significantly different from SG (*P* = .010).

Limitations

Dietary intake is difficult to measure for many reasons. First, there is a risk of underreporting of energy intake and specific food groups, often those that are considered less socially accepted such as soft drinks, fast food, sweets, and alcohol. We chose not to sort under- and overreporters because the number of patients was small and there is no clear definition of weight-reporting bias. Furthermore, in our study the patients were randomized to RYGB and SG which should mean that both groups supposedly would under- or overestimate to the same degree. Secondly, the food intake is very different from person to person regarding energy needs and preferences and therefore entails large between-person variations, which require a large sample to reach sufficient power. Finally, we did not measure physical activity, which could have facilitated a better explanation of the differences in reported energy intake between the groups.

Conclusions

Five years after surgery, patients with T2D randomized to RYGB reported considerably higher food intake compared with those that were randomized to SG, despite having on average 9.2 kilos lower body weight. There were no differences in meal frequency or GI symptoms. The difference in diabetes resolution was 28% in favor of RYGB, which did not reach statistical significance due to the small sample size. Patients in T2D remission ate essentially the same as patients who were not in remission. Future studies are needed to explore what effects the differences on energy and food weight intake have on long-term nutritional status and quality of life.

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