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Revisional Single-Anastomosis Sleeve Ileal Bypass for Reflux After Sleeve Gastrectomy: Outcomes in 19 Patients with a 19-Patient Sleeve-Only Comparator

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Abstract

Purpose: Post-sleeve gastrectomy (SG) gastroesophageal reflux disease (GERD) may be promoted by a high-pressure sleeve. We evaluated reflux, additional weight loss, and recorded morbidity after revisional single-anastomosis sleeve ileal bypass (SASI), while separately describing weight trajectories after index SG in an SG-only comparator cohort.

Materials and Methods: This retrospective matched-pair study included 38 patients: 19 SG-only patients and 19 patients treated with revisional SASI using a 300-cm common channel. The SG-only comparator cohort was selected using similarity in pre-SG weight, calendar timing of the index SG, and sex as matching criteria. Index SG was performed from 2015 to 2021 and SASI from 2022 to 2023, with follow-up through January 2025. Weight outcomes were assessed after index SG and SASI. RSI, GERD-HRQL, and the GERD-HRQL satisfaction item were evaluated before and 12 months after SASI.

Results: Baseline anthropometry and first-year weight loss after index SG were broadly comparable. In the SASI cohort, median BMI decreased from 34.1 to 28.6 kg/m², cumulative EWL increased from 47.5% to 74.2%, and additional TWL was 19.7% at 12 months (all $P<0.001$; n=18). Median RSI decreased from 7.0 to 3.5 ($P=0.001$), and GERD-HRQL decreased from 12.0 to 1.0 ($P<0.001$). Median operating time was 214 minutes and length of stay was 4 days. Five patients had a recorded postoperative complication; one was Clavien-Dindo grade IIIb.

Conclusion: Revisional SASI was associated with improved reflux outcomes and substantial additional weight loss. A parallel gastroileal outlet may decompress a high-pressure sleeve while preserving pyloroduodenal continuity. Prospective studies with objective reflux testing and standardized safety assessment are required.

Key Points

• The SG-only and SG-to-SASI cohorts had similar baseline anthropometry and broadly comparable weight loss during the first year after index SG.

• At 12 months after SASI, median BMI decreased from 34.1 to 28.6 kg/m² and additional TWL was 19.7%.

• RSI and GERD-HRQL improved significantly after SASI; pressure unloading through a parallel gastroileal outlet is a plausible mechanism.

• The 300-cm common-channel configuration achieved additional weight loss, but recorded morbidity and incomplete safety variables support cautious patient selection and prospective follow-up.

Keywords: single-anastomosis sleeve ileal bypass; sleeve gastrectomy; gastroesophageal reflux disease; revisional metabolic and bariatric surgery; reflux; quality of life

Introduction

Metabolic and bariatric surgery is an established treatment for patients with severe obesity and obesity-related disease (1). Sleeve gastrectomy (SG) remains widely performed because of its technical simplicity and favorable short-term weight outcomes (2). Randomized trials, however, show that long-term reflux outcomes are less favorable after SG than after Roux-en-Y gastric bypass (RYGB) (3, 4).

Post-SG GERD is multifactorial. Loss of the angle of His, disruption of the sling fibers, hiatal hernia, sleeve stenosis or torsion, retained fundus, and impaired gastric emptying may contribute (5-7). A particularly relevant mechanism is conversion of the stomach into a narrow, poorly compliant reservoir in which meal-related intragastric pressure rises can exceed the barrier pressure of the gastroesophageal junction (6). RYGB is therefore the best-established revisional operation for medically refractory GERD after SG, particularly when esophagitis, Barrett esophagus, or major hiatal pathology is present (8, 9). One-anastomosis gastric bypass has also been used, although concerns regarding alkaline reflux remain (10, 11).

SASI bypass combines an existing sleeve with a loop gastroileal anastomosis and preserves passage through the pylorus and duodenum (12-18). The additional gastroileal route may act as a low-resistance outlet, reduce pressure within the residual sleeve, and enhance distal intestinal nutrient exposure. These effects could address both reflux and the need for further weight reduction. However, bile reflux and nutritional complications remain relevant concerns, and outcomes depend on common-channel length and anastomotic configuration (19-23).

This study addressed two prespecified, analytically separate questions. First, reflux symptoms and quality of life were evaluated before and 12 months after revisional SASI. Second, BMI, EWL, and TWL during the first year after index SG were compared between an SG-only cohort and a cohort that later underwent SASI. The SG-only cohort was not used as a reflux control group.

Materials and Methods

Study Design and Cohorts

This retrospective observational matched-pair study used a longitudinal bariatric database and included 38 patients. The SG-only cohort comprised 19 patients who underwent SG and did not undergo SASI during the study period. The SG-to-SASI cohort comprised 19 patients who underwent index SG and later revisional SASI. A 1:1 matched-pair comparison was constructed by selecting SG-only patients with a similar pre-SG weight, a similar calendar timing of the index SG, and similar sex distribution to the SG-to-SASI cohort. The cohorts were kept analytically separate: index-SG weight trajectories were compared between cohorts, whereas reflux, procedural, safety, and post-SASI weight outcomes were evaluated only within the revisional cohort.

Study Setting and Eligibility

The study was conducted at the Department of General, Visceral and Vascular Surgery, University Hospital Jena, Jena, Germany. Index SG procedures were performed between 9

January 2015 and 1 October 2021; revisional SASI procedures were performed between 14 December 2022 and 20 December 2023. Follow-up entries extended to 7 January 2025, and the source workbook was locked on 31 January 2025. All patients treated during the study period who presented with reflux symptoms, had reflux esophagitis and/or a hiatal hernia documented by esophagogastroduodenoscopy, and expressed a desire for additional weight loss were included in the revisional SASI cohort. All 19 revisional patients had GERD documented before SASI in the cleaned reflux dataset; hiatal hernia was documented in 17 (89.5%).

Surgical Technique

All patients underwent SG as the index operation. The sleeve was calibrated over a 36-Fr bougie.

For revisional SASI, the ileocecal valve was identified and the ileum was measured 300 cm proximally. Bowel length was measured in 5-cm increments using corresponding markings on the laparoscopic graspers. A side-to-side gastroileal anastomosis was created using an antecolic ileal loop, leaving a 300-cm common channel. The anastomosis was 4 cm in diameter and was positioned on the gastric sleeve 4 cm proximal to the pylorus. A posterior hiatoplasty was performed with interrupted Ethibond sutures and augmented with an absorbable mesh. The gastroileal anastomosis was tested intraoperatively for leakage using a methylene blue test. The median interval from index SG to SASI was 4.22 years (IQR 2.36-6.22).

Outcomes

BMI, EWL, and TWL were assessed at baseline and 3, 6, 9, and 12 months after index SG. EWL was calculated using the original pre-SG weight and the Broca ideal weight recorded in the database: 100 × (pre-SG weight - follow-up weight)/(pre-SG weight - Broca ideal weight). TWL was calculated as 100 × (pre-SG weight - follow-up weight)/pre-SG weight. Post-SASI weight was assessed immediately before revision and at 3, 6, 9, and 12 months. Additional post-SASI TWL used the pre-SASI weight as the reference, whereas cumulative EWL remained referenced to the original pre-SG weight and Broca ideal weight. Post-SASI BMI was recalculated from recorded weight and height for internal consistency.

Only the SASI cohort contributed reflux and quality-of-life outcomes. The RSI (24), GERD-HRQL score (25), and the GERD-HRQL satisfaction item were recorded before SASI and at 12 months. Lower RSI and GERD-HRQL scores indicate fewer symptoms. The satisfaction item was coded 1=dissatisfied, 2=neutral, and 3=satisfied.

Procedure duration, length of stay, recorded intraoperative and postoperative complications, complication descriptions, and Clavien-Dindo grade were extracted from the source workbook. Micronutrient concentrations before SASI and at 3, 6, 9, and 12 months were classified as deficient when the measured value was below the database-specific lower reference limit. Binary documentation of diarrhea was extracted at 3, 6, 9, 12, and 18 months. The workbook did not permit consistent adjudication of 30-day readmission, reoperation, mortality, or bile reflux.

Statistical Analysis

Continuous variables are reported as median and interquartile range (IQR), and categorical variables as number and percentage. Baseline continuous variables were compared with exact Mann-Whitney U tests; categorical variables were compared with Fisher exact tests when appropriate.

BMI, EWL, and TWL after index SG were analyzed with separate linear mixed-effects models using restricted maximum likelihood. Each model included a patient-level random intercept and fixed effects for cohort, follow-up time, and cohort-by-time interaction. Baseline was displayed descriptively because EWL and TWL were structurally 0 at index SG. Exploratory between-cohort comparisons at individual time points used Mann-Whitney U tests with Benjamini-Hochberg correction. Post-SASI weight, BMI, cumulative EWL, and additional TWL were summarized at each available time point. Paired pre-SASI and 12-month weight, BMI, and cumulative EWL values were compared using Wilcoxon signed-rank tests; no imputation was performed.

Micronutrient deficiencies and diarrhea were summarized descriptively using available-case denominators. Missing values were not imputed. Because diarrhea was not assessed with a standardized frequency or stool-consistency instrument and longitudinal observations were incomplete, no inferential repeated-measures test was performed for diarrhea.

Within the SASI cohort, paired preoperative and 12-month RSI, GERD-HRQL, and GERD-HRQL satisfaction-item values were compared with Wilcoxon signed-rank tests because change scores were non-normally distributed. All tests were two-sided, and $P<0.05$ was considered statistically significant.

Ethics

All procedures involving human participants were conducted in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki Declaration and its later amendments or comparable ethical standards. The study was approved by the Ethics Committee of University Hospital Jena (approval no. 2024-3415-Daten). For this retrospective study, formal informed consent was not required.

Results

Cohort Characteristics

Nineteen patients were included in each cohort. Women represented 89.5% of the SG-only cohort and 100% of the SG-to-SASI cohort. Median age, baseline weight, and baseline BMI at index SG did not differ significantly (Table 1). Hypertension was present in 84.2% of each cohort. Type 2 diabetes was present in 52.6% of the SG-only cohort and 21.1% of the SG-to-SASI cohort. In the revisional cohort, only 3 of 19 patients had GERD documented before index SG, whereas all 19 had GERD documented before SASI.

Weight Trajectories After Index SG

Follow-up availability in the SG-only and SG-to-SASI cohorts was 19/19 and 19/19 at baseline; 13/19 and 15/19 at 3 months; 13/19 and 14/19 at 6 months; 13/19 and 15/19 at 9 months; and 18/19 and 18/19 at 12 months. Both cohorts had substantial reductions in BMI and increases in EWL and TWL during the first year after SG (Table 2; Figs. 3-5). A composite visualization of the separate index-SG and post-SASI phases is provided in Fig. 6. At 12 months, median BMI was 32.5 kg/m² in the SG-only cohort and 32.4 kg/m² in the SG-to-SASI cohort; median EWL was 65.3% and 60.7%, and median TWL was 31.2% and 27.1%, respectively.

Type III fixed-effects tests showed a significant effect of time for BMI, EWL, and TWL (all $P<0.001$) and no overall cohort effect (all $P\geq0.845$). Cohort-by-time interaction was not significant for BMI ($F=2.192$, $P=0.096$) but was significant for EWL ($F=2.897$, $P=0.040$) and TWL ($F=2.841$, $P=0.043$) (Table 4). No Benjamini-Hochberg-adjusted between-cohort comparison at an individual follow-up time was significant. Thus, the interaction terms should not be interpreted as evidence that either cohort had superior index-SG weight loss.

Revisional SASI Procedure and Recorded Safety Outcomes

The median interval between index SG and revisional SASI was 4.22 years (IQR 2.36-6.22). Median age at SASI was 53.9 years (IQR 46.9-61.4). Hiatal hernia was documented in 17 of 19 patients (89.5%); among these patients, median recorded hernia size was 5.0 cm (IQR 4.0-6.0). Median operating time was 214 minutes (IQR 183-247), and median postoperative length of stay was 4 days (IQR 3-13.5) (Table 5).

One intraoperative complication was recorded (iatrogenic small-bowel injury). Five patients had a postoperative complication flag. Recorded events comprised inflammatory deterioration with internal hernia, passage disorder and anastomotic stenosis; abdominal-wall necrosis with prolonged passage disorder; mesenteric bleeding; liver-capsule injury; and one event without a specified description. Three events were coded Clavien-Dindo grade I, one was grade IIIb, and one was not graded. Because timing and intervention fields were incomplete, these data should not be interpreted as a formally adjudicated 30-day complication rate.

Anthropometric Outcomes After Revisional SASI

Post-SASI weight data were available for 18 patients at 3 months, 19 at 6 months, 12 at 9 months, and 18 at 12 months (Table 6; Fig. 6). Median weight decreased from 97.0 kg (IQR 88.0-103.5) before SASI to 76.9 kg (IQR 67.5-84.9) at 12 months. Median BMI decreased from 34.1 kg/m² (IQR 33.0-38.2) to 28.6 kg/m² (IQR 23.3-31.2), and cumulative EWL increased from 47.5% (IQR 38.4-52.5) to 74.2% (IQR 70.6-93.7); paired pre-SASI to 12-month comparisons were significant (all $P<0.001$; n=18). In Fig. 6, the index-SG and post-SASI time axes are displayed as distinct phases; the composite graphic is descriptive and should not be interpreted as a concurrent late post-SG control comparison.

At 12 months, median additional TWL relative to pre-SASI weight was 19.7% (IQR 12.7-31.8). All 18 patients with 12-month data had a lower weight than before SASI; 15 of 18 achieved at least 5% additional TWL and 14 of 18 achieved at least 10%. Because the number of available observations differed across visits, the 9- and 12-month group medians should not be interpreted as paired evidence of weight regain.

Micronutrient Deficiencies and Diarrhea After SASI

Micronutrient laboratory data were incomplete and were therefore analyzed using available-case denominators (Table 7). The most frequent deficiencies after SASI involved vitamin K1, zinc, selenium, and vitamin A. Vitamin K1 deficiency was present in 10/13 patients (76.9%) at 3 months, 12/14 (85.7%) at 6 months, 6/9 (66.7%) at 9 months, and 12/13 (92.3%) at 12 months. Zinc deficiency was documented in 9/14 (64.3%), 9/14 (64.3%), 7/12 (58.3%), and 8/14 (57.1%), respectively. Selenium deficiency declined from 10/16 (62.5%) at 3 months to 3/14 (21.4%) at 12 months, whereas vitamin A deficiency declined from 8/15 (53.3%) to 3/14 (21.4%).

Diarrhea was documented in 10/11 patients (90.9%) with available 3-month data, 9/14 (64.3%) at 6 months, 5/10 (50.0%) at 9 months, 4/11 (36.4%) at 12 months, and 0/7 at 18 months (Table 8). The decreasing proportion suggests postoperative adaptation, but the finding is descriptive because observations were incomplete and no standardized stool-frequency or consistency score was available.

Reflux and Quality of Life After SASI

Paired RSI data were available for 18 patients; paired GERD-HRQL and GERD-HRQL satisfaction data were available for all 19 patients (Table 3; Figs. 1-2). Median RSI decreased from 7.0 (IQR 2.75-19.0) before SASI to 3.5 (IQR 0-6.0) at 12 months ($P=0.001$). Median

GERD-HRQL decreased from 12.0 (IQR 4.0-19.0) to 1.0 (IQR 0-9.0; P<0.001). The satisfaction-item distribution shifted toward higher values (P=0.035).

Discussion

The principal finding is that revisional SASI was associated with substantial improvement in patient-reported reflux symptoms and with clinically relevant additional weight loss at 12 months. RSI and GERD-HRQL decreased significantly, the GERD-HRQL satisfaction distribution improved, median BMI decreased by approximately 5.5 kg/m², and median additional TWL was 19.7%. The two-stage anthropometric pattern is summarized descriptively in Fig. 6. These outcomes were assessed within the revisional cohort; the SG-only cohort did not provide a concurrent reflux or late post-SG control.

Pressure unloading provides a plausible procedure-specific explanation. After SG, a narrow and noncompliant gastric tube can generate high postprandial pressure, increasing the gastroesophageal pressure gradient and promoting reflux (6). SASI adds a parallel gastroileal pathway with lower outflow resistance. Diversion of part of the gastric content through this route may reduce pressure peaks within the sleeve and decrease retrograde flow across the gastroesophageal junction. Functionally, this resembles one important aspect of RYGB: decompression of the high-pressure gastric reservoir. The operations are not anatomically equivalent. SASI preserves the sleeve, pylorus, duodenum, and a portion of the conventional alimentary route, whereas RYGB creates a small pouch and Roux reconstruction. The proposed mechanism was not directly measured in this study and requires confirmation with manometry, pH-impedance, and objective endoscopy.

The 300-cm common channel is relevant to the intended balance between additional weight loss and nutritional safety. SASI increases distal nutrient exposure and may augment GLP-1- and PYY-mediated satiety while adding a controlled bypass component (12-18, 21). In this cohort, cumulative EWL increased from 47.5% before revision to 74.2% at 12 months, while additional TWL reached 19.7%. These findings quantify the renewed weight-loss phase after SASI. The renewed response is consistent with the ileal-brake concept: earlier distal nutrient exposure may stimulate enteroendocrine L cells and reinforce GLP-1/PYY-mediated appetite control. Gut hormones were not measured, so this remains a mechanistic interpretation rather than a demonstrated mediator. Preservation of pyloric and duodenal continuity also maintains conventional endoscopic access. Nevertheless, incomplete laboratory follow-up prevented a robust analysis of micronutrient risk, and the 300-cm configuration should not be interpreted as eliminating malabsorptive complications (20, 21).

The nutritional findings reinforce the need for structured biochemical surveillance after SASI. Deficiencies of vitamin K1, zinc, selenium, and vitamin A were frequent among patients with available measurements, despite recorded supplementation in many patients. These findings should not be interpreted as population incidence estimates because laboratory follow-up was incomplete and supplementation was not standardized in the dataset. The proportion with documented diarrhea decreased over time, reaching 36.4% at 12 months and 0% among seven patients with 18-month documentation, but the absence of standardized stool data limits causal interpretation.

RYGB remains the reference revisional procedure for severe or objectively documented GERD after SG (8, 9). SASI may be considered in selected patients when reflux coexists with recurrent weight gain, suboptimal initial response, or a need for additional metabolic treatment. Unlike RYGB, SASI preserves pyloroduodenal continuity; however, it introduces a gastroileal anastomosis and therefore potential risks of bile exposure, diarrhea, protein-calorie malnutrition, and micronutrient deficiency (18-23). An important nuance is that the median pre-SASI RSI was 7, below the commonly used RSI threshold of 13 (24), indicating

heterogeneous baseline symptom severity. The significant paired improvement should therefore not be interpreted as proof of objective GERD remission; rather, it suggests that clinically meaningful patient-perceived benefit may occur even when baseline symptom scores are modest. The recorded complication burden in this small cohort, including one grade IIIb event, reinforces the need for standardized reporting and structured nutritional surveillance.

This study has several strengths. It uses validated reflux instruments (24, 25), paired outcome assessment, explicit separation of the index-SG and revisional-SASI timelines, and quantified post-SASI weight outcomes. Mixed models retained incomplete longitudinal index-SG observations. Limitations include the retrospective design, small sample, nonrandom comparator selection, absence of a concurrent reflux control, and lack of objective postoperative pH-impedance, manometry, or systematic endoscopy. Post-SASI follow-up was incomplete and available-case medians varied by visit. The source workbook contained inconsistent transcribed BMI values, so post-SASI BMI was recalculated from weight and height. Safety fields did not consistently identify 30-day timing, readmission, reoperation, mortality, bile reflux, or medication discontinuation, and micronutrient data were insufficient for a reliable longitudinal analysis.

Conclusion

Revisional SASI with a 300-cm common channel was associated with significant improvement in RSI and GERD-HRQL and with substantial additional weight loss. A parallel gastroileal outlet may decompress a high-pressure sleeve while preserving pyloroduodenal continuity. Frequent micronutrient deficiencies and early postoperative diarrhea underscore the need for structured, long-term nutritional and gastrointestinal follow-up. Larger prospective comparative studies with objective reflux testing, standardized safety reporting, and protocolized nutritional surveillance are required.

Declarations

Ethics Approval: The study was approved by the Ethics Committee of University Hospital Jena (approval no. 2024-3415-Daten) and was conducted in accordance with the 1964 Helsinki Declaration and its later amendments or comparable ethical standards.

Consent to Participate: For this retrospective study, formal informed consent was not required.

Consent for Publication: Not applicable.

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Competing Interests: The authors declare no competing interests.

Author Contributions: All authors contributed to the study conception and design. Material preparation, data collection, and analysis were performed by the authors. The first draft of the manuscript was written by the first author, and all authors commented on previous versions of the manuscript. All authors read and approved the final manuscript.

Data Availability: The data supporting the findings of this study are not openly available because of their sensitive nature and institutional data-protection requirements. De-identified data may be made available from the corresponding author upon reasonable request and subject to institutional approval.

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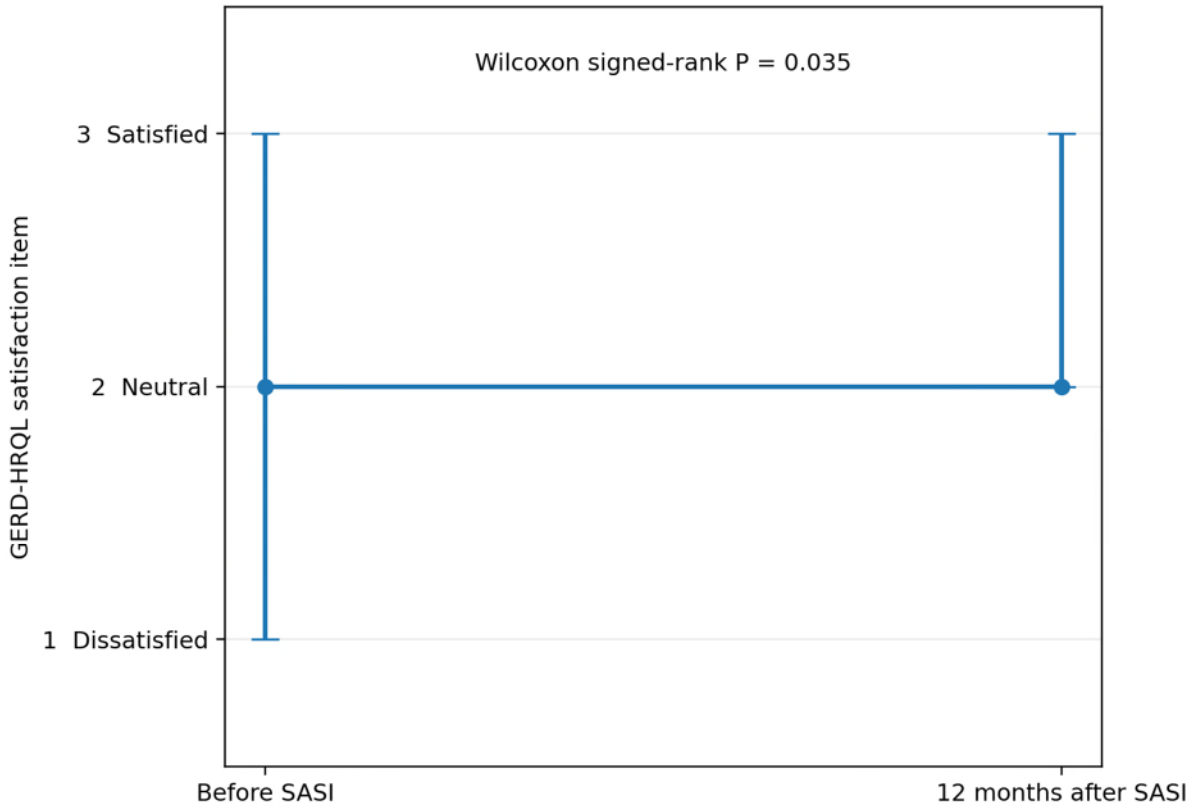


Figure 1. GERD-HRQL satisfaction before and 12 months after revisional SASI. Only the SG-to-SASI cohort is shown. Values are medians with IQR error bars. Higher values indicate greater satisfaction. Wilcoxon signed-rank P=0.035.

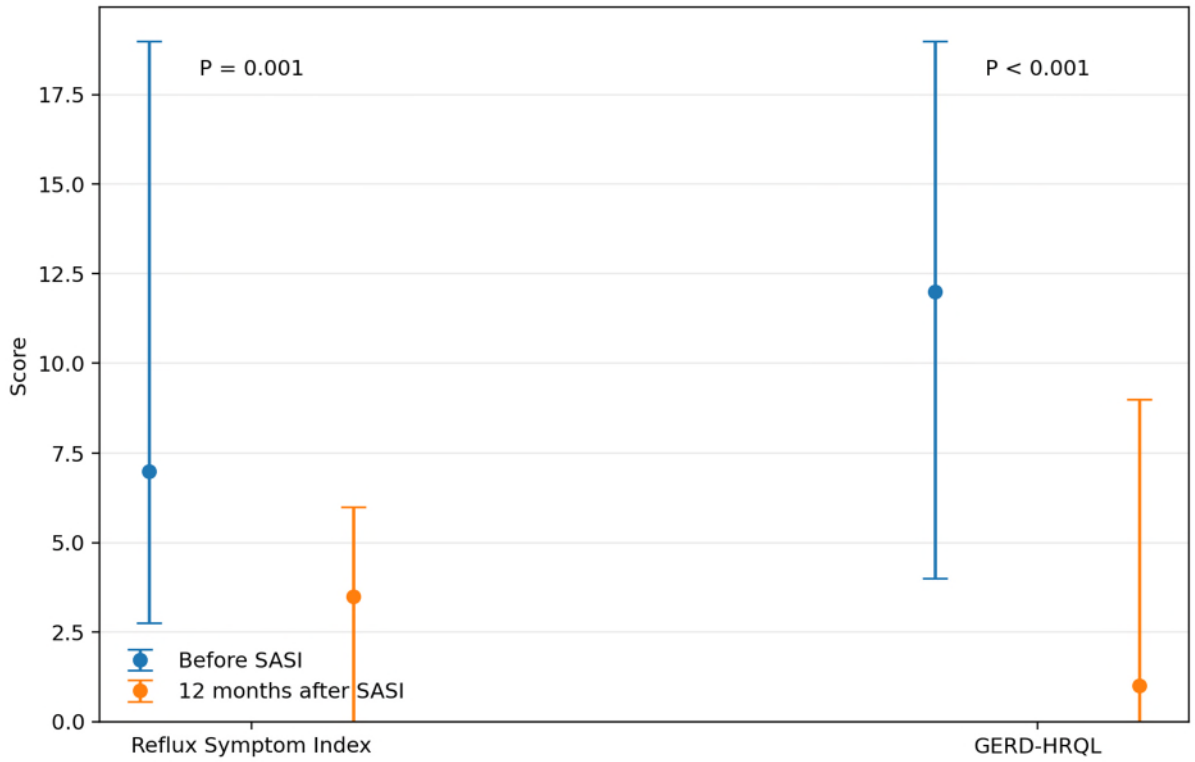


Figure 2. Reflux-related symptoms before and 12 months after revisional SASI. Only the SG-to-SASI cohort is shown. Values are medians with IQR error bars; lower RSI and GERD-HRQL scores indicate fewer symptoms. RSI P=0.001; GERD-HRQL P<0.001.

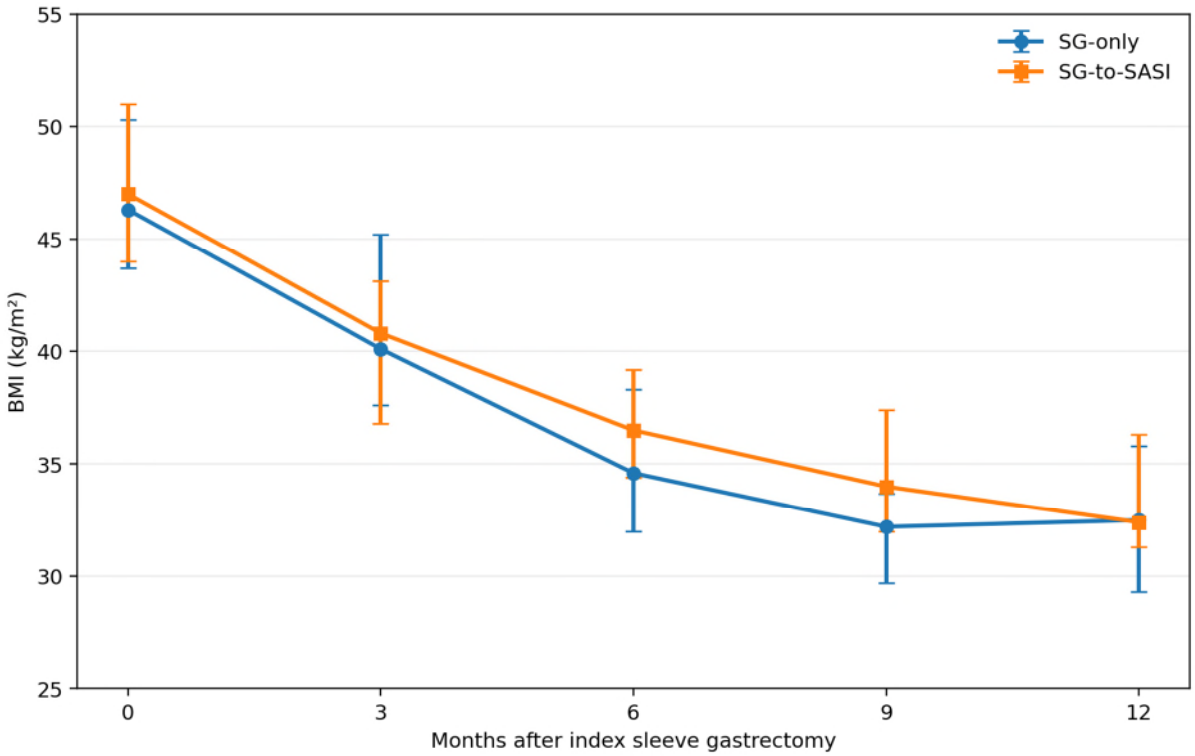


Figure 3. BMI during the first 12 months after index SG. The SG-only cohort and the cohort later revised to SASI are displayed separately. These measurements precede SASI. Points indicate medians and error bars indicate IQRs.

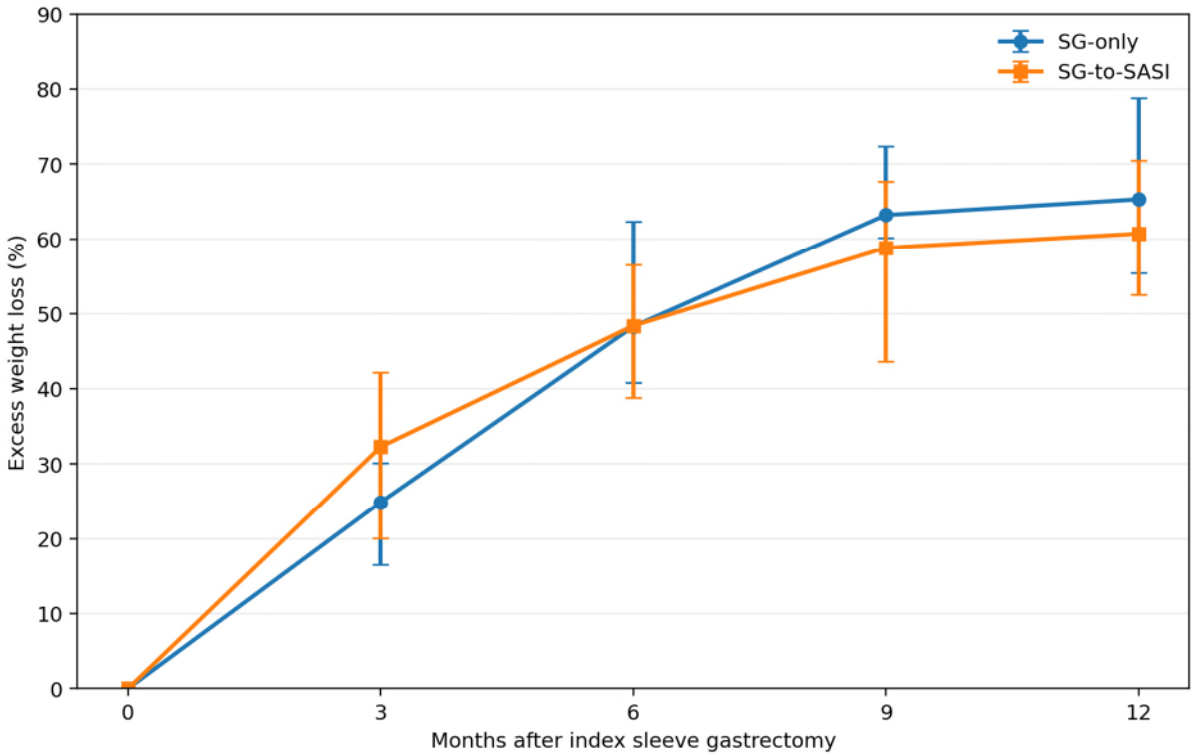


Figure 4. EWL during the first 12 months after index SG. The SG-only cohort and the cohort later revised to SASI are displayed separately. These measurements precede SASI. Points indicate medians and error bars indicate IQRs.

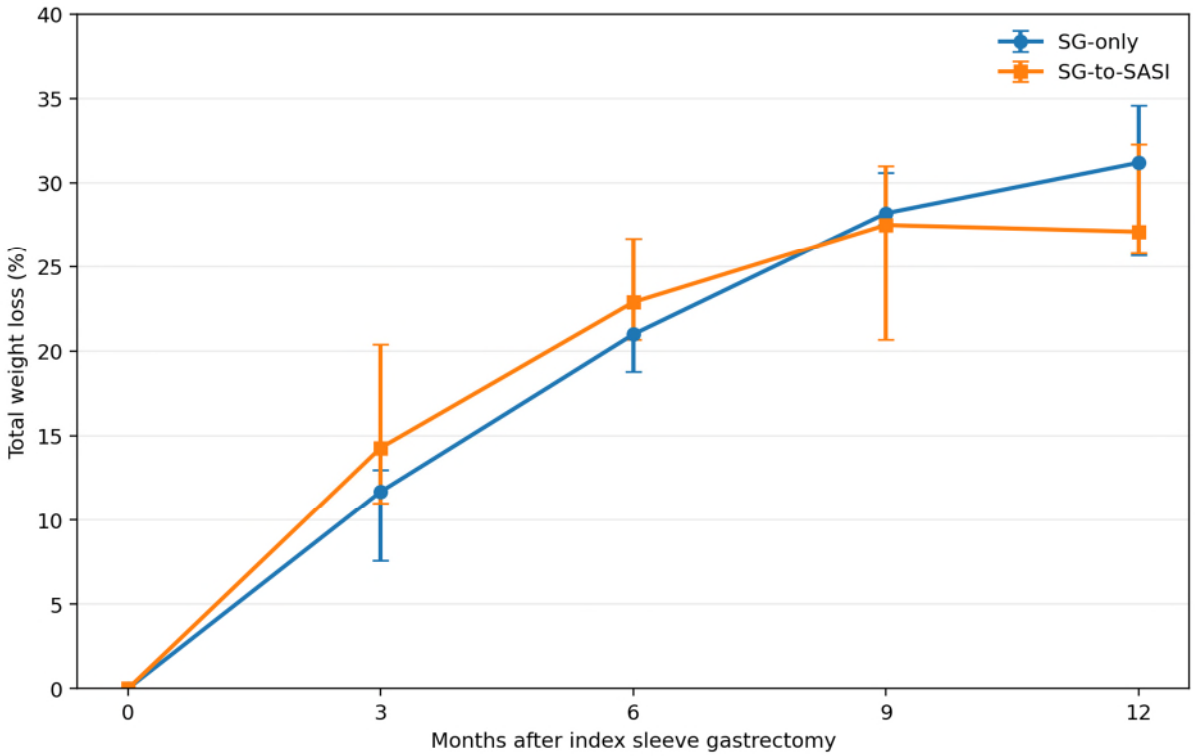


Figure 5. TWL during the first 12 months after index SG. The SG-only cohort and the cohort later revised to SASI are displayed separately. These measurements precede SASI. Points indicate medians and error bars indicate IQRs.

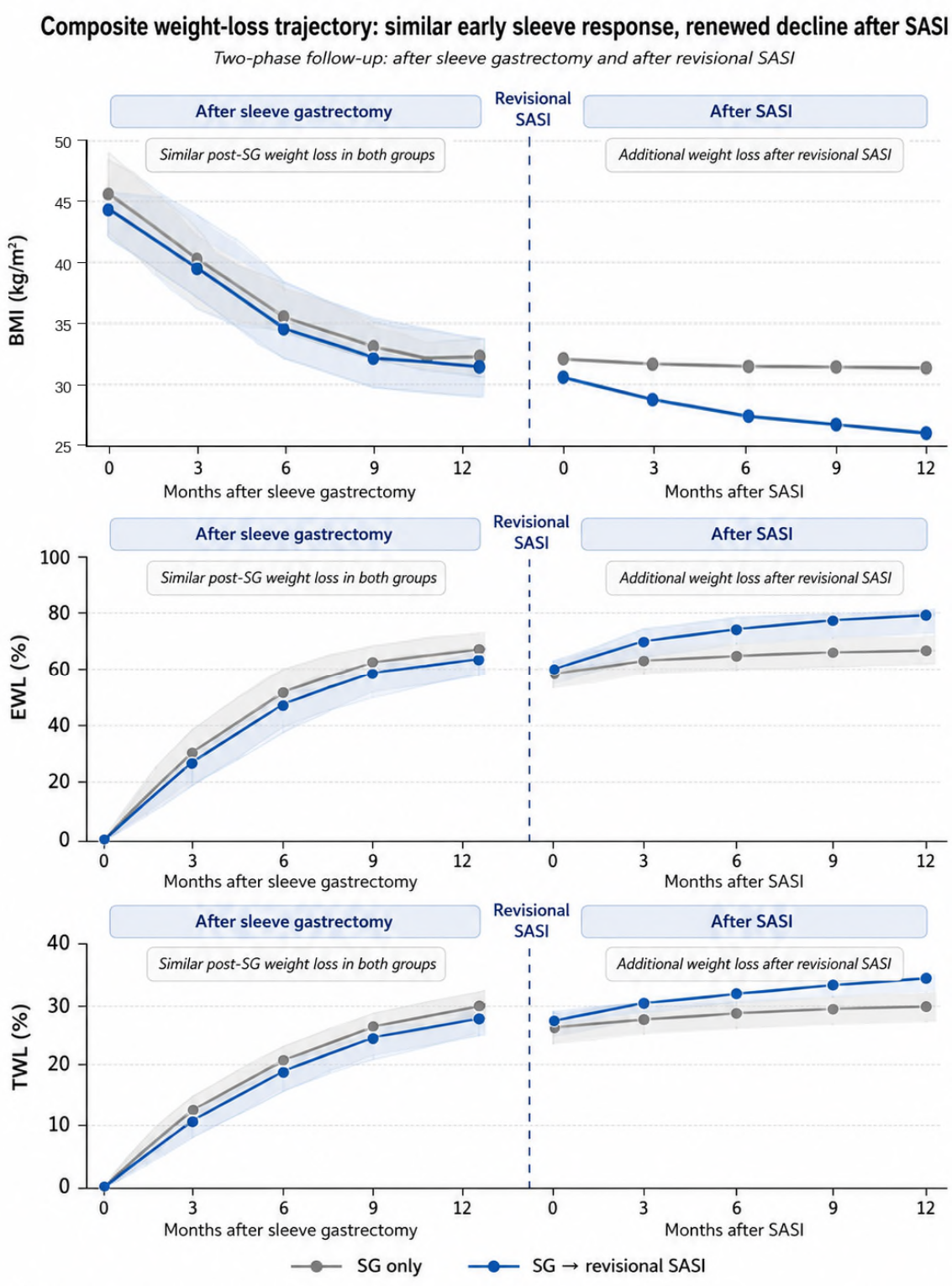


Figure 6. Composite weight-loss trajectory: similar early sleeve response and renewed decline after revisional SASI. Left panels show the index-SG phase and right panels the post-SASI phase. The vertical dashed line separates analytically distinct time axes; the display is descriptive and should not be interpreted as a concurrent late post-SG control comparison. Points are medians and shaded areas are IQRs; the BMI axis is limited to 50 kg/m^2. BMI, body mass index; EWL, excess weight loss; TWL, total weight loss; SG, sleeve gastrectomy; SASI, single-anastomosis sleeve ileal bypass.

Table 1. Baseline characteristics at the time of index sleeve gastrectomy

Characteristic	SG-only (n=19)	SG-to-SASI (n=19)	P value
Female sex	17 (89.5%)	19 (100%)	0.486
Weight, kg	125.0 (117.5-147.5)	133.0 (122.7-141.5)	0.885
BMI, kg/m²	46.29 (43.68-50.26)	47.05 (43.98-51.02)	0.817
Hypertension	16 (84.2%)	16 (84.2%)	1.000
Type 1 diabetes	1 (5.3%)	2 (10.5%)	1.000
Type 2 diabetes	10 (52.6%)	4 (21.1%)	0.091

Values are median (IQR) or n (%). Continuous variables were compared with exact Mann-Whitney U tests; categorical variables were compared with Fisher exact tests. BMI, body mass index; SASI, single-anastomosis sleeve ileal bypass; SG, sleeve gastrectomy.

Table 2. Weight trajectories during the first 12 months after index sleeve gastrectomy

Outcome	Month	SG-only, median (IQR)	n	SG-to-SASI, median (IQR)	n
BMI, kg/m²	0	46.3 (43.7-50.3)	19	47.0 (44.0-51.0)	19
	3	40.1 (37.6-45.2)	13	40.8 (36.8-43.1)	15
	6	34.6 (32.0-38.3)	13	36.5 (34.4-39.2)	14
	9	32.2 (29.7-33.7)	13	34.0 (32.0-37.4)	15
	12	32.5 (29.3-35.8)	18	32.4 (31.3-36.3)	18
EWL, %	0	0.0	19	0.0	19
	3	24.9 (16.5-30.1)	13	32.3 (20.1-42.2)	15
	6	48.3 (40.8-62.3)	13	48.4 (38.8-56.5)	14
	9	63.2 (60.1-72.4)	13	58.8 (43.6-67.7)	15
	12	65.3 (55.4-78.8)	18	60.7 (52.5-70.5)	18
TWL, %	0	0.0	19	0.0	19
	3	11.7 (7.6-13.0)	13	14.3 (11.0-20.4)	15
	6	21.0 (18.8-26.7)	13	22.9 (20.7-26.7)	14
	9	28.2 (27.5-30.6)	13	27.5 (20.7-31.0)	15
	12	31.2 (25.7-34.6)	18	27.1 (25.8-32.3)	18

These measurements precede revisional SASI in both cohorts and are not post-SASI weight outcomes. EWL was referenced to the original pre-SG weight and database-recorded Broca ideal weight. BMI, body mass index; EWL, excess weight loss; IQR, interquartile range; SASI, single-anastomosis sleeve ileal bypass; SG, sleeve gastrectomy; TWL, total weight loss.

Table 3. Reflux and quality-of-life outcomes in the revisional SASI cohort

Outcome	Paired n	Before SASI, median (IQR)	12 months after SASI, median (IQR)	Wilcoxon Z	P value
Reflux Symptom Index 18	18	7.0 (2.75-19.0)	3.5 (0-6.0)	-3.254	0.001
GERD-HRQL	19	12.0 (4.0-19.0)	1.0 (0-9.0)	-3.552	<0.001
GERD-HRQL satisfaction item	19	2.0 (1.0-3.0)	2.0 (2.0-3.0)	-2.104	0.035

Lower RSI and GERD-HRQL scores indicate fewer symptoms. The GERD-HRQL satisfaction item was coded 1=dissatisfied, 2=neutral, and 3=satisfied. GERD-HRQL, Gastroesophageal Reflux Disease Health-Related Quality of Life; IQR, interquartile range; SASI, single-anastomosis sleeve ileal bypass.

Table 4. Type III fixed-effects tests from linear mixed-effects models of index-SG weight trajectories

Outcome	Effect	Numerator df	Denominator df	F	P value
BMI	Cohort	1	33.739	0.039	0.845
BMI	Time	3	77.511	84.010	<0.001
BMI	Cohort × time	3	77.511	2.192	0.096
EWL	Cohort	1	33.473	0.013	0.910
EWL	Time	3	78.459	93.985	<0.001
EWL	Cohort × time	3	78.459	2.897	0.040
TWL	Cohort	1	34.519	0.005	0.945
TWL	Time	3	80.003	94.779	<0.001
TWL	Cohort × time	3	80.003	2.841	0.043

Each model included a patient-level random intercept and fixed effects for cohort, time, and cohort × time. Restricted maximum likelihood was used. BMI, body mass index; df, degrees of freedom; EWL, excess weight loss; SG, sleeve gastrectomy; TWL, total weight loss.

Table 5. Revisional SASI procedural characteristics and recorded safety outcomes

Characteristic	Value
Interval from index SG to SASI, years	4.22 (2.36-6.22)
Age at SASI, years	53.9 (46.9-61.4)
Hiatal hernia documented	17 (89.5%)
Hiatal surface area, cm^2 (n=17)	5.0 (4.0-6.0)
Operating time, min	214 (183-247)
Postoperative length of stay, days	4.0 (3.0-13.5)
Recorded intraoperative complication	1 (5.3%)
Recorded postoperative complication flag	5 (26.3%)
Clavien-Dindo grade I	3 (15.8%)
Clavien-Dindo grade IIIb	1 (5.3%)
Postoperative event without grade	1 (5.3%)

Values are median (IQR) or n (%). The source workbook did not consistently encode 30-day timing, readmission, reoperation, mortality, or bile reflux; the postoperative-complication row therefore represents recorded flags rather than a formally adjudicated 30-day rate. SASI, single-anastomosis sleeve ileal bypass; SG, sleeve gastrectomy.

Table 6. Anthropometric outcomes after revisional SASI

Time after SASI	n	Weight, kg	BMI, kg/m^2	Cumulative EWL, %	Additional
Pre-SASI	19	97.0 (88.0-103.5)	34.1 (33.0-38.2)	47.5 (38.4-52.5)	0.0
3 months	18	88.5 (80.3-94.0)	31.1 (29.8-34.9)	61.5 (52.5-70.0)	10.0 (6.9-13.2)
6 months	19	81.4 (74.7-88.3)	30.1 (26.0-32.4)	72.1 (63.7-80.7)	16.9 (10.4-21.9)
9 months	12	71.0 (67.2-83.0)	25.7 (22.5-29.4)	81.2 (73.9-94.9)	24.7 (15.8-30.9)
12 months	18	76.9 (67.5-84.9)	28.6 (23.3-31.2)	74.2 (70.6-93.7)	19.7 (12.7-31.8)

Values are median (IQR). Post-SASI BMI was recalculated from recorded weight and height. Cumulative EWL was referenced to the original pre-SG weight and the database-recorded Broca ideal weight; additional TWL was referenced to pre-SASI weight. Available-case n varies by visit; the 9- and 12-month medians are therefore not directly paired. Paired pre-SASI versus 12-month comparisons for weight, BMI, and cumulative EWL were all $P<0.001$. BMI, body mass index; EWL, excess weight loss; SASI, single-anastomosis sleeve ileal bypass; SG, sleeve gastrectomy; TWL, total weight loss.

Table 7. Micronutrient deficiencies before and after revisional SASI

Micronutrient	Before SASI	3 months	6 months	9 months	12 months
Vitamin A	1/14 (7.1%)	8/15 (53.3%)	6/14 (42.9%)	6/12 (50.0%)	3/14 (21.4%)
Vitamin B6	2/14 (14.3%)	2/15 (13.3%)	2/14 (14.3%)	2/13 (15.4%)	0/14 (0.0%)
Vitamin B12	1/14 (7.1%)	0/14 (0.0%)	0/14 (0.0%)	1/12 (8.3%)	2/14 (14.3%)
25-hydroxyvitamin D	0/14 (0.0%)	1/15 (6.7%)	0/14 (0.0%)	0/12 (0.0%)	0/14 (0.0%)
Vitamin E	0/14 (0.0%)	1/15 (6.7%)	0/14 (0.0%)	1/11 (9.1%)	0/14 (0.0%)
Selenium	1/14 (7.1%)	10/16 (62.5%)	10/15 (66.7%)	7/13 (53.8%)	3/14 (21.4%)
Zinc	4/14 (28.6%)	9/14 (64.3%)	9/14 (64.3%)	7/12 (58.3%)	8/14 (57.1%)
Vitamin C	10/10 (100.0%)	3/13 (23.1%)	0/13 (0.0%)	0/9 (0.0%)	1/13 (7.7%)

Values are n/N (%) among patients with an available laboratory measurement. Deficiency was defined as a measured concentration below the database-specific lower reference limit, corresponding to a negative deviation variable in the source workbook. Denominators vary because no missing values were imputed. SASI, single-anastomosis sleeve ileal bypass.

Table 8. Documented diarrhea after revisional SASI

Follow-up after SASI	Available observations, N	Diarrhea, n (%)	No diarrhea, n (%)
3 months	11	10 (90.9%)	1 (9.1%)
6 months	14	9 (64.3%)	5 (35.7%)
9 months	10	5 (50.0%)	5 (50.0%)
12 months	11	4 (36.4%)	7 (63.6%)
18 months	7	0 (0.0%)	7 (100.0%)

Values are based on available-case binary documentation in the source workbook. Diarrhea frequency, stool consistency, duration, and treatment response were not recorded using a standardized instrument; no inferential longitudinal test was therefore performed. SASI, single-anastomosis sleeve ileal bypass.