

Reoperations After Bariatric Surgery in 26 Years of Follow-up of the Swedish Obese Subjects Study

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IMPORTANCE Bariatric surgery is an established treatment for obesity, but knowledge on the long-term incidence of revisional surgery is scarce.

OBJECTIVE To determine the incidence and type of revisional surgery after bariatric surgery in 26 years of follow-up of participants in the Swedish Obese Subjects (SOS) study.

DESIGN, SETTING, AND PARTICIPANTS The SOS study is a prospective nonrandomized controlled study comparing bariatric surgery (banding, vertical banded gastroplasty [VBG], and gastric bypass [GBP]) with usual care. The bariatric surgeries in the SOS study were conducted at 25 public surgical departments in Sweden. Men with body mass index values of 34 or higher and women with body mass indexes of 38 or higher were recruited to the surgery group of the SOS study between September 1, 1987, and January 31, 2001, and follow-up continued until December 31, 2014. Data analysis occurred from November 2016 to April 2018.

INTERVENTIONS Banding, VBG, or GBP.

MAIN OUTCOMES AND MEASURES Revisional surgeries, analyzed using data from questionnaires, hospital records, and the Swedish National Patient register through December 31, 2014.

RESULTS A total of 2010 participants underwent surgery. The age range was 37 to 60 years. A total of 376 participants underwent banding (18.7%), while 1365 had VBG (67.9%) and 266 had GBP (13.2%). During a median follow-up of 19 years, 559 participants (27.8%) underwent first-time revisional surgery, including 354 conversions to other bariatric procedures (17.6%), 114 corrective surgeries (5.6%), and 91 reversals to normal anatomy (4.5%). Revisional surgeries (conversions, corrective surgery, and reversals) were common after banding (153 of 376 [40.7%]) and VBG (386 of 1365 [28.3%]) but relatively rare after GBP (20 of 266 [7.5%]). Patients who had banding and VBG primarily underwent conversions to GBP or reversals. Incidence of reversals was 5 times higher after banding than after VBG (40.7% vs 7.5%; unadjusted hazard ratio, 5.19 [95% CI, 3.43-7.87]; $P < .001$). Corrective surgeries were equally common irrespective of the index surgery (72 of 1365 patients who had VBG [5.3%]; 23 of 376 patients who had banding [6.1%]; 19 of 266 patients who had GBP [7.1%]). Revisional surgery indications, including inadequate weight loss, band-associated complications (migration, stenosis, and slippage), staple-line disruptions, and postsurgical morbidity, varied depending on index surgery subgroup. Most corrections occurred within the first 10 years, whereas conversions and reversals occurred over the entire follow-up period.

CONCLUSIONS AND RELEVANCE Corrective surgeries occur mainly within the first 10 years and with similar incidences across all 3 surgical subgroups, but indications varied. Conversions (mainly to GBP) and reversals occurred after many years and were most frequent after banding and VBG, reflecting a higher overall revisional surgery demand after these operations.

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 [Invited Commentary](#)

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The global prevalence of obesity has risen dramatically in recent decades. Worldwide, the number of people who are overweight or have obesity climbed from 857 million in 1980 to 2.1 billion in 2013.¹ Because of the multiple, well-established health risks accompanying excess weight and the absence of efficacious nonsurgical weight loss treatments, bariatric surgery has become increasingly common, especially in patients with severe obesity.² Over the years, several different surgical techniques have also been developed and refined.³ However, revisional surgery as a result of the shortcomings of the initial bariatric procedure appears to be frequent and sometimes includes reversal to normal anatomy.⁴⁻⁶ Previous literature typically covers short-term to intermediate-term (<5 years) follow-up of smaller cohorts, often at a single center (eg, Brethauer et al⁷). Incidence figures also vary widely (inter alia, with respect to type of primary surgical procedure, cohort size, and duration of follow-up). Main indications listed include technical, complication-associated, and weight-associated factors.

The Swedish Obese Subjects (SOS) study is a large prospective cohort study that started in 1987, with 2010 individuals in the surgical group and 2037 matched nonsurgical control participants. The bariatric surgery procedures in the SOS study were banding, vertical banded gastroplasty (VBG), and gastric bypass (GBP). Results from the SOS study have shown that bariatric surgery is associated with reduced long-term mortality⁸ and morbidity,⁹ considerably contributing to the evidence base for the increased use of surgery for morbid obesity.¹⁰ Given the importance of the SOS study, we believe that it could be of interest to describe the patterns (ie, the incidence, timing, and indications) of secondary bariatric interventions, also known as revisional surgeries, in the study. The surgery group of the SOS study is representative of bariatric surgery in the 1990s not only in Sweden but worldwide. In this analysis, we report on revisional surgery in the surgical group of the SOS study up to 26 years after the index procedure.

Methods

The SOS study was previously described.¹¹ In brief, it consists of 4047 individuals aged 37 to 60 years, with body mass indexes (BMIs; calculated as weight in kilograms divided by height in meters squared) of 34 or greater in men and 38 or greater in women, who were enrolled between September 1, 1987, and January 31, 2001. The cohort comprises 2010 individuals who opted for bariatric surgery and 2037 individuals in a matched control group who received usual care (who are not discussed in this article). The choice of bariatric surgery procedure was made by the surgeon based on clinical experience and assessment of the patient in question.

All the regional ethical review boards in Sweden (Gothenburg, Lund, Linköping, Örebro, Karolinska Institute, Uppsala, and Umeå) approved the study protocol. Written or oral informed consent was obtained from all participants.

Revisional Surgeries

Revisional surgeries are classified as conversions, corrections, or reversals, as defined by Brethauer et al.⁷ Conversions are changes to a different type of bariatric procedure; cor-

Key Points

Question What is the long-term incidence of bariatric reoperations in patients who undergo bariatric surgery for morbid obesity?

Findings In this analysis of 2010 patients in the Swedish Obese Subjects study cohort, first-time revisional surgery (conversions, corrections, and reversals) were common after banding operations (40.7%) and vertical banded gastroplasty (28.3%) but relatively rare (7.5%) after gastric bypass operations. Patients who had banding and vertical banded gastroplasty primarily underwent conversion to gastric bypass or reversal, and corrections were equally common (5.3%-7.1%) irrespective of index surgery, but indications differed between groups.

Meaning Revisional surgery is more common after banding and vertical banded gastroplasty than after gastric bypass, involving a higher incidence of conversions and reversals.

rections are the treatment of complications or improvements to the primary (index) surgical procedure; and reversals are operations to restore normal gastrointestinal anatomy. Information on gastric surgical interventions performed during the follow-up period was obtained from hospital medical records and the Swedish National Patient Register, from start of the study in 1987 through December 31, 2014. Data were also collected by means of standardized questionnaires, completed for each patient at each follow-up point. The questionnaires contain information on the type of revisional surgery procedure and postoperative complications.

Statistical Analysis

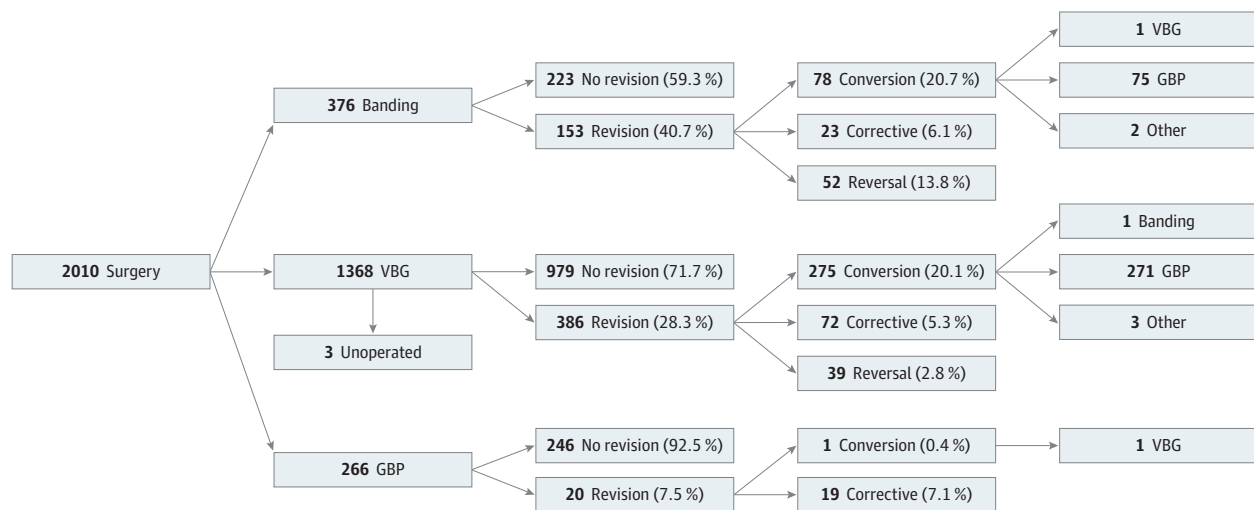
Time to first-time revisional surgery (conversions, corrections, and reversals) was calculated from the date of the primary (index) operation. Patients who died or emigrated before revisional surgery were censored at the corresponding point, and the remainder were censored at the end of follow-up period (December 31, 2014).

Cumulative incidences were calculated with the Kaplan-Meier method. Incidence rates were further calculated and are expressed as a rate per 1000 person-years together with corresponding 95% CIs. Differences in rates of revisional surgery between subgroups (by sex, age, and BMI) were compared with log-rank tests.

Changes in body weight were evaluated among those who did and did not undergo revisional surgery during the follow-up period. Multilevel mixed-effect regression models were used to analyze differences between the groups. The models take into account the repeated measurements of body weight within persons. The differences in body weight trajectories between the groups were evaluated by including an interaction term for follow-up time and group in the models. The results are presented as the value of the χ^2 test.

Statistical analyses were carried out with the Stata statistical package, version 15 (StataCorp LLC). *P* values were 2-sided and a *P* value of less than .05 defined statistical significance. Data analyses were conducted between November 2016 and April 2018.

Figure 1. Overview of SOS Surgery Cohort at Baseline (Index) and First-Time Revisional Surgery Follow-up Status in the Surgery Subgroups



The absolute numbers and percentages of index numbers in subgroups at baseline are shown. Other procedures include sleeve gastrectomy (including gastric plication), duodenal switch (including biliopancreatic diversion), and

jejunoileal bypass. GBP indicates gastric bypass; VBG, vertical banded gastroplasty.

Results

A total of 2010 participants underwent surgery. The age range was 37 to 60 years. In the surgery group of the SOS study, 376 patients underwent banding as an index procedure (18.7% of surgeries), while 1365 underwent VBG (67.9%) and 266 underwent GBP (13.2%). Three individuals recruited to the surgery group never received the planned VBG surgeries, making the total study population in the current analysis 2007 individuals. The SOS surgery group experienced a total of 559 first-time revisional surgeries (27.8% of 2007 patients) during the follow-up period, including 354 conversions (17.6%), 114 corrections (5.6%), and 91 reversals (4.5%; **Figure 1**). The incidence of first-time revisional surgery differed between subgroups stratified by the type of primary (index) surgical procedure, and was highest in the banding subgroup ($n = 153$ [40.7%]), less frequent in the VBG subgroup ($n = 386$; 28.3%), and lowest in the GBP subgroup ($n = 20$ [7.5%]).

Sixty-one patients (3.0%) underwent 2 or more revisional surgeries (eTable 1 in the **Supplement**). The incidence of 2 postindex surgeries was 8.2% in the banding subgroup ($n = 31$ of 376), 2.1% in the VBG subgroup ($n = 28$ of 1365), and 0.8% in the GBP subgroup ($n = 2$ of 266). Four patients (0.2%) had more than 2 postindex surgeries.

Revisional Surgeries in the Banding Subgroup

In the banding subgroup, conversions, corrections, and reversals were performed in 78 patients (20.7%), 23 patients (6.1%), and 52 patients (13.8%), respectively (**Figure 1**). Corrections and reversals were carried out mainly within the first 10 years. In the banding group, 45 of 52 reversals (87%) and all 23 corrections (100%) occurred within the first 10 years. Conversions were mainly to GBP (75 of 78 [96%]; **Figure 1**) and occurred over

the entire follow-up period (**Figure 2A**). There were no mortalities in conjunction with any of these revisional surgeries.

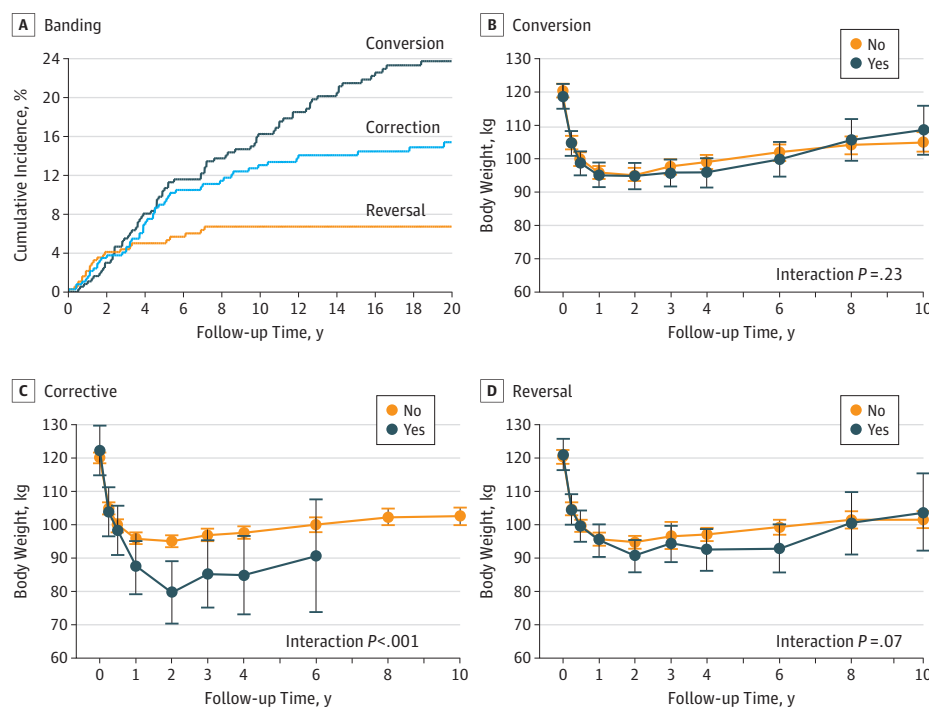
The most common indications for revisional surgery in the banding subgroup were band-associated issues ($n = 44$ [11.7% of the 376 patients in this subgroup]), such as band migration, slippage, and band stenosis. Nausea/vomiting ($n = 36$ [9.6%]), which was often explained by band complications and/or pouch enlargements, and weight-associated factors ($n = 34$ [9.0%]) were also common indications (**Table**). The weight trajectories from index (baseline) surgery up to first-time revisional surgery were similar in patients that underwent conversions and those that did not (**Figure 2B**). For patients who had banding and underwent corrections, the weight loss before surgery was greater in those who underwent reoperation vs in those that were not (**Figure 2C**; interaction $\chi^2 = 26.3$; $P < .001$). Weight trajectories until surgery in patients who underwent reversal were not significantly different from those that did not (**Figure 2D**).

Conversions were almost twice as common in banding patients younger than the median age (47.8 years) vs those older than the median age (rate per 1000 person-years, 17.7 [95% CI, 13.5-23.2] vs 9.2 [95% CI, 6.26-13.5]; $P = .006$; eTable 2 in the **Supplement**) and were numerically (but not significantly) more common in women than in men (rate per 1000 person-years, 15.5 [95% CI, 12.0-19.9] vs 9.5 [95% CI, 6.0-15.1]; $P = .07$; eTable 2 in the **Supplement**). These differences were not associated with baseline BMI values. The incidence of corrections and reversals did not differ significantly across sex, age, or BMI categories (eTables 2-4 in the **Supplement**).

Revisional Surgeries in the VBG Subgroup

In the VBG subgroup, conversions, corrections, and reversals were performed in 275 (20.1%), 72 (5.3%), and 39 (2.8%) of 1365 patients, respectively (**Figure 1**). In this subgroup, most cor-

Figure 2. Cumulative Incidence of First-Time Revisional Surgery and Weight Trajectories in the Banding Subgroup During Follow-up After Study Inclusion, Stratified by Reoperation Status



A, First-time postindex revisional surgery categories (conversion, correction, and reversal) across time. B-D, Weight trajectories by revisional surgery status (conversion, corrective, or reversal). Weights are recorded only up to the time of revisional surgery.

Table. Indications for Revisional Surgery^a

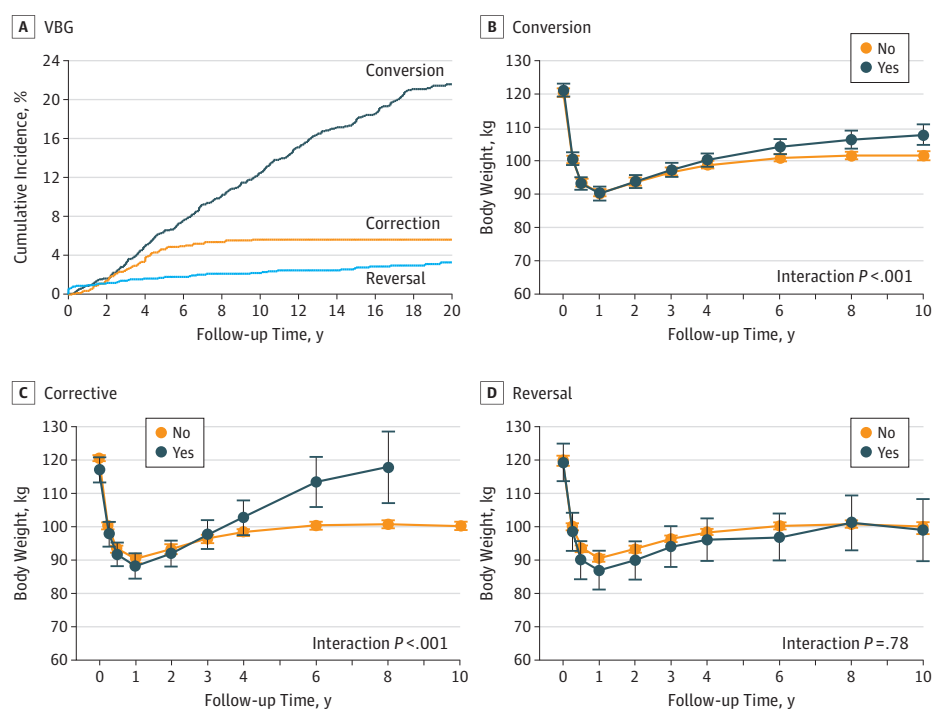
Indication for Revisional Surgery	Patients, No. (%)		
	Banding (n = 376)	Vertical Banded Gastroplasty (n = 1365)	Gastric Bypass (n = 266)
First-time revisional surgeries	153	386	20
Technical characteristics			
Band or collar-associated	44 (11.7)	27 (2.0)	NA
Staple-associated	NA	138 (10.1)	0
Complications			
Infection	8 (2.1)	3 (0.2)	0
Stomasthenosis	14 (3.7)	26 (1.9)	2 (0.8)
Stomadilatation	5 (1.3)	16 (1.2)	0
Pouch enlargement	6 (1.6)	24 (1.8)	1 (0.4)
Nausea/vomiting	36 (9.6)	66 (4.8)	2 (0.8)
Reflux/esophagitis	8 (2.1)	14 (1.0)	10 (3.8)
Weight-associated ^b	34 (9.0)	55 (4.0)	0
Other	15 (4.0)	31 (2.3)	5 (1.9)
Unknown	11 (2.9)	45 (3.3)	0
Total	181 (48.1)	445 (32.6)	20 (7.5)

Abbreviation: NA, not applicable.
^a More than 1 indication may be given for each participant. The total numbers per indication and indication incidence expressed as the number of total patients in the different surgery subgroups are shown.
^b Includes poor weight loss and weight regain.

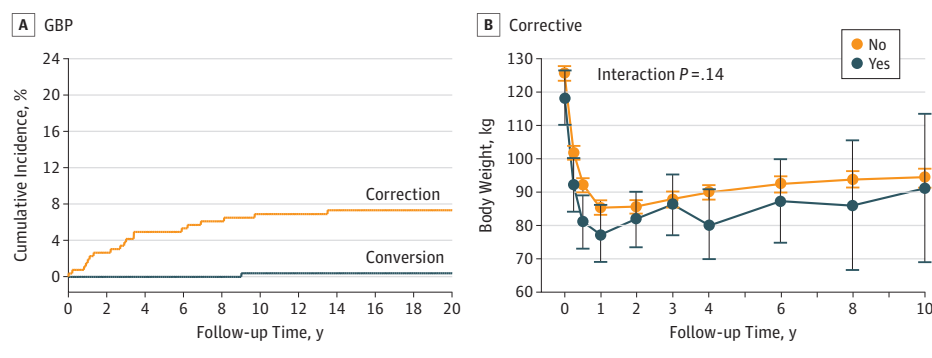
rections were carried out within 8 to 10 years of the index procedure, whereas conversions and reversals took place across the entire follow-up period (Figure 3A). Two patients who had had VBG procedures (0.36% of the 386 patients who had VBG and experienced reoperation) died in conjunction with their conversions to GBP.

The most common indication for revisional surgery in the VBG subgroup was staple-associated disruptions (n = 138 pa-

tients who had VBG [10.1%]), followed by nausea/vomiting (n = 66 [4.8%]; of which several cases were attributed to stenosis and/or migration of the collar), and weight-associated factors (n = 55 [4.0%]; including staple and collar complications) (Table). Weight trajectories in this subgroup differed significantly (Figure 3B; interaction $\chi^2 = 33.3$; interaction $P < .001$) by conversion status, owing to diverging curves beyond the 4-year postindex time point. Weight trajectories in

Figure 3. Cumulative Incidence of First-Time Revisional Surgery and Weight Trajectories in the Vertical Banded Gastroplasty (VBG) Subgroup During Follow-up After Study Inclusion, Stratified by Revisional Surgery Status

A, First-time postindex revisional surgery categories (conversion, corrective, and reversal) across time. B-D, Weight trajectories by reoperation (conversion, corrective, or reversal) status. Weights are recorded only up to the time of revisional surgery. VBG indicates vertical banded gastroplasty.

Figure 4. Cumulative Incidence of First-Time Revisional Surgery and Weight Trajectories in the Gastric Bypass Subgroup During Follow-up After Study Inclusion, Stratified by Revisional Surgery Status

A, First-time postindex revisional surgery categories (correction and conversion) across time; no reversals were performed. B, Weights are recorded only up to the time of revisional (corrective) surgery. No weight trajectories are shown for conversions ($n = 1$). GBP indicates gastric bypass.

patients who underwent VBG index procedures also differed by corrective status (Figure 3C; interaction $\chi^2 = 30.14$; $P < .001$), while there was no significant difference in the weight trajectories by reversal status (Figure 3D).

Conversions in the VBG subgroup were significantly more common in women than men (rate per 1000 person-years, 12.9 [95% CI, 11.3-14.8] vs 9.6 [95% CI, 7.5-12.3]; $P = .04$) and in patients who were younger than vs older than the median age (rate per 1000 person-years, 14.7 [95% CI, 12.7-17.0] vs 8.6 [95% CI, 7.0-10.6]; $P = .001$; eTable 2 in the Supplement) while not significantly different relative to baseline BMI values. Corrections were nearly 4 times more common in women than men (rate per 1000 person-years, 4.3 [95% CI, 3.4-5.4] vs 1.1 [95% CI, 0.5-2.3]; $P = .001$; eTable 3 in the Supplement) but did not differ by age and BMI categories. No significant differences

were found in the incidence of reversals across sex, age, or BMI categories (eTable 4 in the Supplement).

Revisional Surgeries in the GBP Subgroup

In the subgroup who had GBP as the index procedure, conversions and corrections were performed in 1 patient (0.4%) and 19 patients (7.1%), respectively. There were no reversals in this subgroup (Figure 1). Similarly to the banding and VBG subgroups, corrections in the GBP subgroup were done within 10 years of the index procedure in 18 of 19 patients. Conversion to VBG was performed in 1 patient approximately 9 years after the index surgery (Figure 4A). There were no mortalities in conjunction with any of these revisional surgeries.

The most common indications for corrections in the GBP subgroup were reflux-associated and esophagus-associated

complications (Table), and 10 of 20 of the patients who underwent reoperation experienced such problems. Early in the study, 51 of the 266 GBP procedures were constructed with a jejunal loop, while the remaining 215 were with a Roux-en-Y construction. Based on surgical records, 14 of the 19 corrections in the GBP subgroup were revisions of loop-GBP to Roux-en-Y GBP; in 11 of 51 cases (21.5%) these were because of alkaline reflux gastritis and esophagitis treated by a reconstruction to Roux-en-Y through a resection of the afferent limb. The time to correction from loop to Roux-en-Y ranged from approximately 1 to nearly 10 years after index GBP surgery (mean, 3.9 years). Excluding this now-nonexistent reflux issue, revisional surgery in the GBP group was done on 1 patient (1.9%). This conversion was done because of marked blood glucose fluctuations. There was no significant difference in the weight trajectories by corrective surgery status in the GBP subgroup (Figure 4C). The rate of corrections did not differ by sex, age, or BMI categories; patients with baseline BMIs lower than the median had more corrections than those with baseline BMIs higher than the median, but this was not significant (rate per 1000 person-years, 7.3 [95% CI, 3.8-14.1] vs 3.4 [95% CI, 1.9-6.4]; $P = .06$; eTable 3 in the Supplement).

Discussion

In this study, we describe the incidence of, indications for, and time to first-time postindex surgery interventions during 26 years of follow-up in the SOS study surgery group of 2010 individuals. Of all patients in this group, approximately 28% underwent revisional surgery between 1987 and December 31, 2014. However, the reoperation incidence differed between subgroups stratified by the type of surgical procedure used at the study start (index surgery) and was highest in the group that underwent banding (40.7%) and lowest in the group that underwent GBP (7.5%). While the present data are overall consistent with smaller and shorter-term studies, direct comparison is hampered, *inter alia*, by literature that seldom reported first-time revisional surgery separate from a final outcome after either single or multiple revisional surgery interventions.

In the banding subgroup, most first-time revisional surgeries were conversions, followed by reversals and corrections. One of 5 surgeries in this subgroup was converted to a GBP during the period studied, in line with figures reported elsewhere (eg, Brethauer et al⁷). The high long-term need for revisional surgery in the banding subgroup concurs with rates reported in the literature for studies with follow-up periods longer than 5 years,^{7,12-14} and the incidence of complications increases proportionally with time (eg, per Chiapaikoe et al¹⁵). As banding by open (laparotomy) techniques may be more plagued with complications than laparoscopic techniques,¹⁶ the early use of open operation techniques at index surgery in the SOS study may also contribute to the high percentage of revisional surgeries. In accordance with the general view, indications listed for revisional surgery were primarily technical (associated with the band) and frequently coupled with upper gastrointestinal tract symptoms (mainly nausea/vomiting) and/or weight-associated issues. There was no mor-

tality in conjunction with any of the first-time revisional surgeries in this subgroup.

In the VBG subgroup, first-time revisional surgeries were likewise mainly conversions (in every fifth VBG patient, similar to the banding subgroup), followed by corrections and a low percentage (2.9%) of reversals. Overall revisional surgery rates of 10% to 56% in populations that experience VBG have been reported in studies with follow-up period longer than 5 years.⁷ Given the much longer follow-up time in this study, the present value (28.3%) may be considered to be in the lower part of this range. Most of the revisional surgeries in the VBG subgroup were for technical reasons (restapling of disrupted staple lines) and/or nausea/vomiting, consistent with previous studies.^{7,17} Weight loss problems were also common in the patients that underwent VBG, often in combination with staple-line disruptions or band (collar) complications and presenting either as poor weight loss after the index surgery or weight regain after an initial period of weight loss. This agrees with smaller and short-term or medium-term studies,^{7,18,19} as well as with a recent 15-year VBG follow-up study,²⁰ and it may possibly be associated with maladaptive eating after this kind of surgery, as reported by others.^{5,21-23} There were 2 mortalities in conjunction with revisional surgery in the VBG subgroup (approximately 0.5%), both during conversions to GBP. This is similar to safety figures for conversion of VBG to GBP reported elsewhere.²⁴

In the GBP subgroup, only 7.5% of the patients underwent any revisional surgery, and all but 1 were corrections. Only 1 conversion (to VBG, because of marked blood glucose fluctuations) was carried out during the period studied, and no reversals were performed in this subgroup. The greater weight loss after GBP²⁵ is the likely main reason for a lower request for conversions in this subgroup compared with the subgroups that undergo banding and VBG. The dominant reason for corrective revisional surgery was bile reflux (including esophagitis), which occurred only in patients with loop-technique GBP. A total of 14 patients of 51 (28%) who had been operated on with the loop technique underwent reoperation, compared with only 5 of 215 (2.3%) among those having Roux-en-Y GBP at index surgery. This demonstrates the superiority of the Roux-en-Y technique with regard to the need for secondary interventions.

Pattern Commonalities and Differences in Subgroups With Regard to First-Time Revisional Surgery Procedures

These data suggest that, irrespective of index surgery type, most first-time corrections were performed within a 10-year timeframe, whereas conversions and to a certain extent reversals were performed over the entire follow-up period after index surgery. This suggests that complications and technical failures severe enough to necessitate revisional surgery are less prevalent beyond a 10-year timeframe. Notably, however, conversions and reversals in the banding and VBG subgroups are still carried out well beyond 10 years after index surgery. Tentatively, this may reflect dissatisfaction with long-term weight outcomes, which are often cited as a major cause of conversion surgery after restrictive bariatric procedures like banding and VBG.^{18,19} Superficially, weight trajectories in the

SOS material may appear somewhat divergent from this view. However, weight change after index surgery may be either larger (owing to complications like stenosis and nausea/vomiting) or smaller (eg, owing to large stoma or pouches) than expected, thus explaining the high variability in weight trajectories in those undergoing corrective revisional surgery compared to those that do not (eg, in the banding subgroup). Also, the weight difference between those that underwent reoperation and those that did not may be underestimated as a result of early initiation of revisional surgery in patients in need thereof (eg, after staple disruption) to prevent further weight regain.

At the outset of the SOS study in 1987, VBG was the dominating surgical procedure in Sweden and therefore also the most common method in the SOS surgery group. By the end of the 1990s, however, GBP had become the most used technique, and VBG was also essentially abandoned globally²⁶⁻²⁹; this was also shown by the conversion rates of patients who had banding or VBG as the index procedure to GBP seen in our study. The higher incidence of complications in the banding vs VBG subgroup (which was also seen in Sjöström et al²⁵), patient dissatisfaction with weight response, or a planned 2-stage conversion that was not followed through likely contributes to the observed differences in reversal surgery rates between these subgroups.

Finally, analysis of revisional surgery by sex, age, and preoperative BMI values suggests that the typical patient undergoing conversion in the surgery group is female (VBG) and younger (banding and VBG), whereas baseline BMI did not matter. Corrections were more common in women than men in the VBG subgroup, which tentatively concurs with the observation that female patients may be more prone to have staple-line disruption.^{30,31} The incidence of corrections did not significantly differ otherwise across sex, age, or BMI in the surgery subgroups. Reversal surgery was more common at lower BMI in the VBG subgroup, whereas age did not appear to have any

clearcut influence either in the banding or VBG subgroups. Comparative data in the literature are scarce, but male patients tend to be much more content with their bariatric surgery outcome in spite of lesser weight loss and higher complication rates,³² which may potentially be consistent with some of the observations in the SOS surgery cohort.

Limitations

A limitation of this study is that most of the index operations were done with techniques that are now largely abandoned (eg, banding and VBG) in favor of GBP (and recently also gastric sleeve). This notwithstanding, the size of the study and the access to detailed, high-quality, high-resolution prospective data remains a strength for long-term outcome analysis.

Conclusions

This long-term exploration of patients in the SOS study who received primary (index) bariatric surgery between September 1987 and the end of January 2001 shows that, over the entire 26-year follow-up period, more than every fourth individual underwent revisional surgery, with incidence rates being 40.7% in the banding subgroup, 28.3% in the VBG subgroup, and 7.5% in the GBP subgroup. Irrespective of subgroup, most corrective revisional surgeries were carried out within 10 years after index surgery, whereas conversions and reversals also occurred many years thereafter. The main indications for revisional surgery in the banding and VBG subgroups were technical, morbidity associated, and weight associated, whereas bile reflux and esophagitis dominated in the patients who had GBP. It is notable that revisional surgery after banding was in the long term even more common than revisions after VBG, which is nowadays abandoned. In conclusion, our data suggest that banding and VBG are inferior to GBP with regard to the need for revisional surgery overall.

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Critical revision of the manuscript for important intellectual content: All authors.

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