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Original article

Dental outcomes after gastric bypass and sleeve gastrectomy: a register-based study

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Abstract

Background: Bariatric surgery has been shown to cause a negative impact on oral health, as reflected by postsurgical increase of caries-related dental interventions.

Objectives: The aim of this study was to compare dental intervention rates after Roux-en-Y gastric bypass (RYGB) and sleeve gastrectomy (SG).

Setting: Nationwide and register-based (Sweden).

Methods: This 2-staged matched cohort study included all adults who underwent RYGB (n = 26,594) or SG (n = 3416) between 2011 and 2015, registered in the Scandinavian Obesity Surgery Register. Propensity score matching was used to match SG patients to RYGB patients, based on several covariates. The follow-up time was 3 years after surgery. The dental variables were collected from the Dental Health Register, including tooth extractions, restorative interventions (dental fillings), and endodontic interventions (root canal treatment).

Results: In total, 3317 RYGB and 3317 SG patients were included. Both groups showed increased dental event rates postoperatively. RYGB patients had significantly higher event rates compared with SG postoperatively regarding all interventions, restorative and endodontic interventions.

Conclusions: The negative effect on dental outcomes in terms of dental fillings and tooth extractions were higher after RYGB than after SG. The reasons are not clear. More research is needed to replicate these findings, to understand the mechanisms, and further delineate the significance of the surgical method. (Surg Obes Relat Dis 2024;■:1–10.) © 2024 Published by Elsevier Inc. on behalf of American Society for Metabolic and Bariatric Surgery. This is an open access article under the CC BY license (http://creativecommons.org/licenses/by/4.0/).

Keywords: Metabolic surgery; Obesity; Surgery; Dental caries; Oral health; Eating behavior(s); Clinical outcomes; Register-based study

Obesity is a global epidemic. Bariatric surgery limits disease progression of obesity and associated co-morbidities, including type 2 diabetes mellitus, cardiovascular disease, heart failure, cancer, and liver and kidney disease, and the intervention is also associated with a longer life expectancy [1].

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Today, the 2 most common types of bariatric surgery are Roux-en-Y gastric bypass (RYGB) and sleeve gastrectomy (SG). They have been shown as effective and safe approaches to induce sustainable weight loss [1]. However, the surgical intervention might cause a substantial negative impact on oral health [2,3]. We have previously investigated a large cohort who underwent metabolic surgery in Sweden [4]. The surgical cohort had markedly increased intervention rates for dental fillings, root fillings, and tooth extractions postoperatively in comparison to a control cohort. The surgery group had higher intervention rates before surgery compared with control. After index date (surgery) the intervention rates increased by 27%–32% in the surgical cohort, whereas they remained unchanged in the control cohort. Therefore it was considered relevant to investigate if the type of surgery had any impact on these outcomes.

It is recognized that patients referred for bariatric surgery have impaired oral health already before surgery, presumably because of high intake of sucrose and acidic beverages, resulting in increased risk of caries and dental erosion [5–7]. After surgery, the patient is advised to eat several small meals daily and to sip fluids throughout the day [2,8]. Frequent and prolonged mealtimes have an additional negative impact on oral health, increasing the risk of caries [3]. In addition, gastroesophageal reflux disease is considered a risk factor for dental erosion and hypersensitive teeth [9,10]. Previous studies have shown an increase in gastroesophageal reflux disease after SG [11,12].

The aim of the current study was to study if the type of surgery affects dental outcomes in terms of dental fillings, root fillings, and tooth extractions. The hypothesis was that the dental outcomes would be worse after SG, primarily because of acidic reflux.

Materials and methods

This is a register-based, longitudinal, observational cohort study using Swedish national registers. Linkage was performed between the Scandinavian Obesity Surgery Register (SOReg), the Swedish Dental Health Register (DHR), the National Prescribed Drug Register and the Swedish Population Register, using the unique personal identity number assigned to every Swedish resident.

Data sources

Study population

SOReg was used to identify all individuals who had undergone bariatric surgery in Sweden. The registry covers virtually all metabolic surgery procedures in Sweden at present and has been reported to have very high acquisition and internal validity. SOReg includes information such as type of surgery, body weight and body mass index (BMI; preoperative and postoperative), co-morbidities, and postoperative complications [13].

This 2-staged matched-cohort study included all adults (≥20 years) who underwent primary RYGB or SG between July 1, 2011, and December 31, 2015.

Exposure was defined as bariatric surgery in either of 2 groups, RYGB and SG

The covariates age, sex, household (family) disposable income, and educational level were based on individual data from the Total Population Register and Statistics Sweden. Disposable income was categorized into quintiles by individual baseline year, to adjust for inflation. BMI, weight loss, and the presence of diabetes were based on data in SOReg. Data of medication were collected from the National Prescribed Drug Register. All dental variables were collected from the Dental Health Register [14]. The Dental Health Register was established in July 2008 and includes data on dental care provided under the Swedish dental care benefit scheme.

Outcome

The outcomes were tooth extractions (intervention codes 401–406, 409), restorative interventions (dental fillings; intervention codes 701–707), endodontic interventions (root canal treatment; intervention codes 501–522), as well as a summative variable (all interventions; the sum of tooth extractions, and endodontic and restorative interventions).

Follow-up

All individuals were followed in the Dental Health Register from 3 years preoperatively to 3 years postoperatively. Only complete follow-up years were used in the analyses. We chose a 3-year follow-up considering that any dental changes are likely to take time to come into effect; thus, only patients operated up until December 31, 2015, were eligible to allow adequate follow-up. Because RYGB was the predominant procedure during the study period, the number of patients operated with an SG was quite small.

Statistics

To assess differences at baseline, we used independent t tests for continuous data, and χ^2 tests for categorical data (presented as frequencies and percentages). We calculated the propensity weights of RYGB and SG patients based on the baseline age, sex, education, marital status, income level, number of teeth, dental visit rate within 2 years prior to surgery, BMI, xerogenic drugs within the year prior to surgery, and diabetes. Xerogenic drugs were identified based on previous publications, including antidiabetic medication, proton pump inhibitors, antipsychotics, respiratory medication, opioids, and antidepressants [15–17]. For each SG patient, we matched 1 nearest RYGB patient within caliper of .2 × SD of the propensity score [18].

Weighted by the propensity score matching, for each dental outcome, we modeled the event rates before and after the surgery by using Poisson models. The time to surgery was included as splines with 5 knots to smooth the trend over time. To adjust for other factors that can affect dental health, we stratified the sample by diabetes condition, weight loss, and baseline number of teeth, separately. Then the sample within each stratification was weighted again with the same set of baseline characteristics, without the factor used in the stratification. The expected dental event rates after the surgery were calculated by Poisson models. All the analyses were performed using Stata, MP 17.0. The significance level was set to .05.

Ethics

The study was approved by the regional ethical committee in Stockholm (Dnr: 2017/857-32 and amendment 2017/2505-32) and conducted according to the Declaration of Helsinki. The linking of databases was approved and performed by the National Board of Health and Welfare. The study is reported according to the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) statement guidelines [19].

Results

We identified 30,010 patients who met the inclusion criteria, with 26,594 patients receiving RYGB and 3416 receiving SG. During the time period 2011–2015, SG was on the increase, although from very low numbers. In 2011 only .7% and in 2015 28.9% of all bariatric procedures were SG. All included patients had at least 36 months of follow-up in the registries used. The mean age was 41 ± 11 years, the mean BMI was 41.6 ± 5.4 kg/m^2, and 76% were women. The 2 cohorts differed significantly where RYGB patients were in general heavier, had lower education and income, and lower numbers of natural teeth (Supplementary Table 1). The matched RYGB cohort did not differ significantly from the entire RYGB cohort regarding incidence rate ratios for the studied outcomes (Supplementary Table 2).

To account for these potential biases, we used a propensity score matching model where eligible GBP patients were matched 1:1 to SG patients using nearest neighbor matching. In total, 99 SG patients were excluded because of incomplete data, and thus 3317 patients were matched (Fig. 1). The descriptives of the cohorts after propensity score matching are shown in Table 1. The 2 groups were well matched on educational level, income, xerogenic drug consumption, and prevalence of diabetes. As expected, a greater weight loss was observed among the RYGB patients compared to the SG patients at both 1- and 2-year follow-up. The Scandinavian Obesity Surgery Register includes data on 1-, 2-, and 5-year weight loss, and the differences persist over 5 years (data not shown). During follow-up, 34 patients in the RYGB group and 21 patients in the SG group died. They all included risk-time from inclusion until date of death.

During the 36 months of follow-up, the number of all dental interventions and the number of restorations and endodontic interventions (root canal treatment) increased in both groups compared with the preoperative period (Figs. 2–5). The incidence rate ratio for all interventions after versus before surgery was 1.16 (1.07–1.25), and the corresponding numbers for RYGB and SG were 1.18 (1.05–1.33) and 1.13 (1.03–1.25), respectively. Table 2 shows the event rates of the dental interventions. RYGB was associated with higher event rates of restorative (4.99

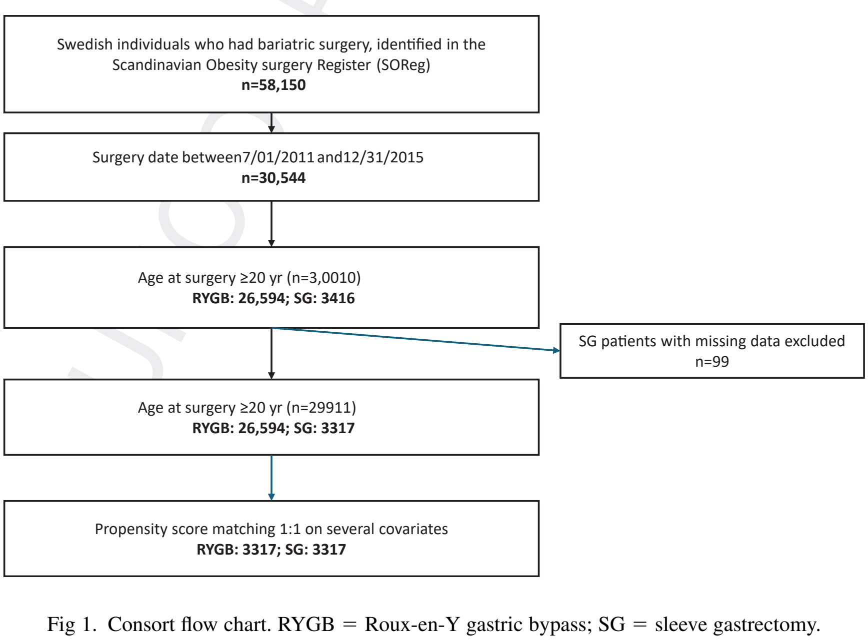

Fig 1. Consort flow chart. RYGB = Roux-en-Y gastric bypass; SG = sleeve gastrectomy.

Table 1
Baseline characteristics of the studied population

Characteristics	RYGB (n = 3317)	SG (n = 3317)	*P* value
Age at surgery, yr, mean (SD)	41.50 (10.61)	41.79 (10.49)	.26
Sex			.93
Female	2660 (80.2)	2663 (80.3)	
Male	657 (19.8)	654 (19.7)	
Year of surgical intervention			<.001
2011	344 (10.4)	23 (.7)	
2012	844 (25.4)	95 (2.9)	
2013	876 (26.4)	444 (13.4)	
2014	690 (20.8)	1082 (32.6)	
2015	563 (17.0)	1673 (50.4)	
Education			.91
≤9 yr	471 (14.2)	459 (13.8)	
10–12 yr	1829 (55.1)	1839 (55.4)	
≥12 yr	1001 (30.2)	1002 (30.2)	
Missing	16 (.5)	17 (.5)	
Marital status			.31
Married/partner	1454 (43.8)	1487 (44.8)	
Single	1324 (39.9)	1265 (38.1)	
Divorced/widow	539 (16.2)	565 (17.0)	
Household income (quintiles)			.94
q1 low	541 (16.3)	548 (16.5)	
q2	593 (17.9)	589 (17.8)	
q3	638 (19.2)	644 (19.4)	
q4	661 (19.9)	680 (20.5)	
q5 high	884 (26.7)	856 (25.8)	
Number of teeth			.90
0–10	22 (.7)	23 (.7)	
11–20	73 (2.2)	64 (1.9)	
21–27	781 (23.5)	781 (23.5)	
≥28	2147 (64.7)	2132 (64.3)	
Missing	294 (8.9)	317 (9.6)	
BMI (baseline), mean (SD)	39.57 (5.94)	39.48 (5.80)	.54
BMI (after 1 yr), mean (SD)	27.13 (4.52)	29.40 (5.17)	<.001
BMI (after 2 yr), mean (SD)	27.05 (4.41)	29.85 (5.47)	<.001
BMI change (after 1 yr), mean (SD)	12.67 (3.88)	10.41 (4.02)	<.001
BMI change (after 2 yr), mean (SD)	12.68 (4.20)	9.75 (4.43)	<.001
EWL (after 1 yr; %), mean (SD)	89.41 (32.12)	71.26 (32.35)	<.001
EWL (after 2 yr; %), mean (SD)	88.96 (31.79)	66.83 (35.10)	<.001
%TWL (after 1 yr) mean (SD)	27.76 (7.72)	22.33 (8.99)	<.001
%TWL (after 2 yr), mean (SD)	27.93 (8.51)	20.98 (10.31)	<.001
No. of dental visits within 2 yr before			.63
None	985 (29.7)	959 (28.9)	
Once	540 (16.3)	535 (16.1)	
Twice	460 (13.9)	496 (15.0)	
Three times and more	1332 (40.2)	1327 (40.0)	
Diabetes medication*			.21
0	2954 (89.1)	2985 (90.0)	
1	363 (10.9)	332 (10.0)	
Proton pump inhibitor medication*			.41
0	3016 (90.9)	3035 (91.5)	
1	301 (9.1)	282 (8.5)	
Antipsychotic medication*			.17
0	3247 (97.9)	3230 (97.4)	
1	70 (2.1)	87 (2.6)	
Respiratory medication*			.21
0	3305 (99.6)	3298 (99.4)	
1	12 (.4)	19 (.6)	
Opioid medication*			.29
0	3026 (91.2)	3050 (92.0)	
1	291 (8.8)	267 (8.0)	

(*continued on next page*)

Table 1 (*continued*)

Characteristics	RYGB (n = 3317)	SG (n = 3317)	*P* value
Antidepressant medication*			.11
0	2688 (81.0)	2636 (79.5)	
1	629 (19.0)	681 (20.5)	

BMI = body mass index; EWL = excess weight loss; RYGB = Roux-en-Y gastric bypass; SG = sleeve gastrectomy; TWL = total weight loss. Unless otherwise noted, values are n (%).

* ATC (Anatomical Therapeutic Chemical) codes for the included medication groups: diabetes: A10; proton pump inhibitor: A02BC; antipsychotics: N05A; respiratory: R06, R03BB; opioids: N02A; antidepressants: N06A.

versus 4.40 events/100 person-months; $P < .05$) and tooth extractions (1.05 versus .91 events/100 person-months; $P < .05$), as well as of all interventions (6.79 versus 6.01 events/100 person-months; $P < .05$), compared to SG.

The effects of the covariates are also presented in Table 2. Throughout, RYGB was associated with higher event rates of dental interventions compared with SG. After both RYGB and SG, previous tooth loss (having <28 teeth) was associated with significantly higher event rates of all types of dental interventions compared with a previous full dentition (≥28 teeth). Within the SG group, weight loss below 20% after surgery was associated with significantly higher event rates of restorative and endodontic interventions, as well as all interventions, compared with weight loss 20% or more (all interventions: 6.94 compared to 5.52 events/100 person-months; $P <$ .05). Within the RYGB group, there was no significant difference of event rates depending on weight loss. In both groups, diabetes was associated with higher event rates (all interventions).

Discussion

The dental interventions increased significantly in both groups after bariatric surgery. The effect was greater among patients operated with RYGB compared with SG, and the event rates of restorative and endodontic interventions were significantly higher after RYGB compared with SG during the follow-up period of 3 years. These results are contrary to our primary hypothesis that the dental outcomes would be worse after SG because of increased prevalence of reflux disease.

Among the variables that we stratified on, the number of teeth seem to be the most prominent driving factor, indicating that poor oral health before surgery results in worse outcome. We conclude that the type of surgery is an important factor for oral conditions among people with similar weight loss.

An SG can introduce reflux symptoms to a previously asymptomatic patient or aggravate existing gastroesophageal reflux disease [11,12]. Gastroesophageal reflux disease

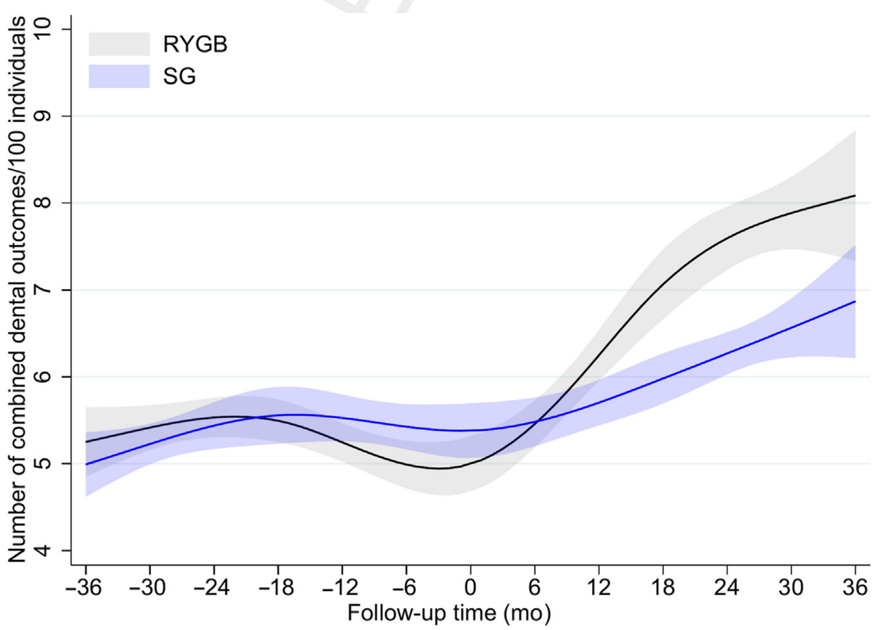

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Fig 2. Event rates of all dental interventions (restorations, extractions, and endodontic interventions/root canal treatment) from Poisson models based on the propensity score–matched samples. RYGB = Roux-en-Y gastric bypass; SG = sleeve gastrectomy.

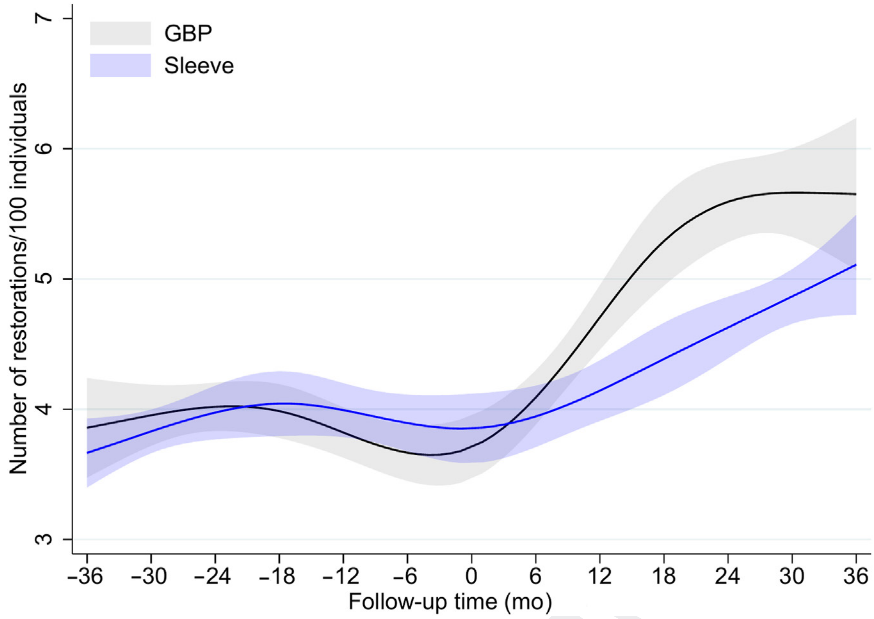

Fig 3. Event rates of restorations from Poisson models based on the propensity score–matched samples. GB = gastric bypass; SG = sleeve gastrectomy.

is recognized to cause several oral disorders, including dental erosions [9]. Thus, oral health in the SG group could be anticipated to deteriorate more than in the RYGB group. However, in the propensity score–matching process, prescription of proton pump inhibitors was one of the matching variables leading to similar prevalence in both groups preoperatively. Because the dental outcomes were worse after RYGB, there are no indications that the effects were mediated by de novo reflux initiated by an SG.

The postsurgical diet instructions are, at least in Sweden, the same for RYGB and SG. Taste and food preferences have been shown to change from fast food and sweets into a healthier diet after bariatric surgery, and these changes correlate with lowered BMI [20,21]. However, some degree

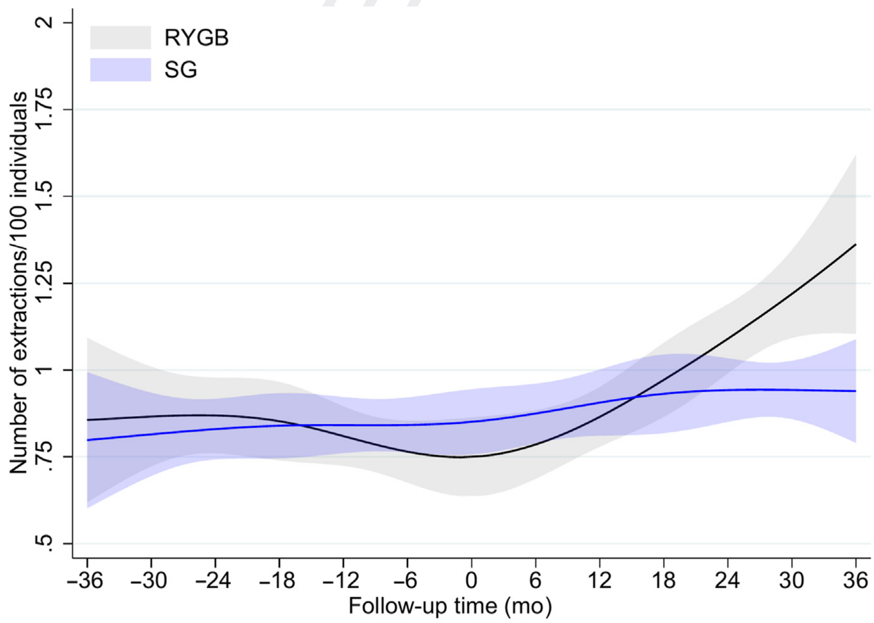

Fig 4. Event rates of extractions from Poisson models based on the propensity score–matched samples. RYGB = Roux-en-Y gastric bypass; SG = sleeve gastrectomy.

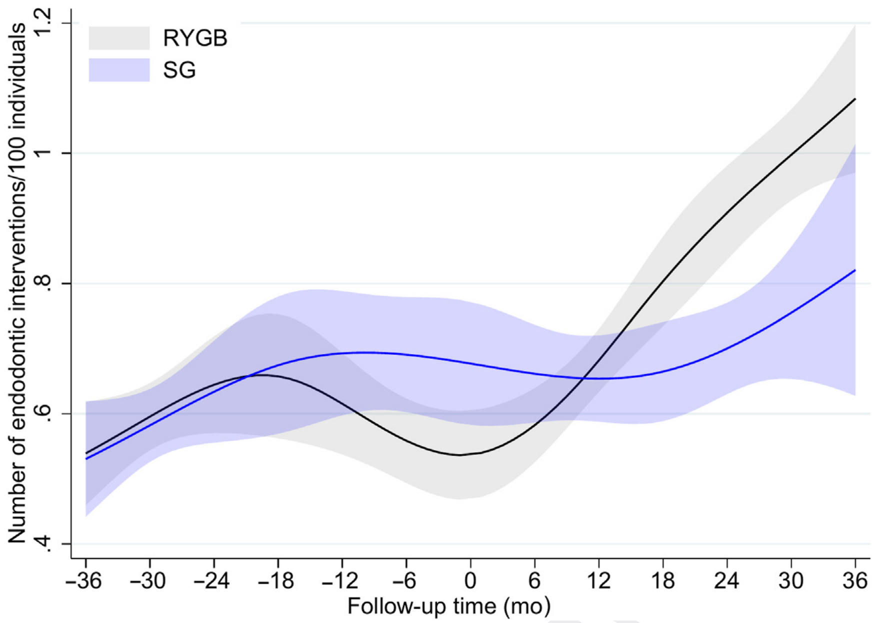

Fig 5. Event rates of endodontic interventions (root canal treatment) from Poisson models based on the propensity score–matched samples. RYGB = Roux-en-Y gastric bypass; SG = sleeve gastrectomy.

of weight regain is common, where about 20%–25% of patients struggle with considerable weight regain after surgery. The diet changes generally fade, or at least become less pronounced with time [21]. Weight regains after surgery may result in frustration, depression, and return to obesity-related behaviors [22]. The risk for impaired oral health is

Table 2
Event rates (95% CIs) of dental interventions after RYGB and SG, respectively*

Oral conditions and diseases after surgery	Restorative interventions	Tooth extractions	Endodontic interventions	All interventions
All				
RYGB	**4.99 (4.82–5.16)**	**1.05 (.98–1.13)**	.75 (.69–.80)	**6.79 (6.58–7.00)**
SG	**4.40 (4.23–4.58)**	**.91 (.84–.98)**	.69 (.63–.75)	**6.01 (5.80–6.22)**
No diabetes				
RYGB	4.69 (4.46–4.91)†	.98 (.89–1.07)†	.76 (.70–.82)	**6.43 (6.18–6.68)**†
SG	4.33 (4.15–4.51)	.86 (.80–.92)†	.68 (.63–.74)	**5.87 (5.67–6.07)**†
Diabetes				
RYGB	5.91 (5.37–6.44)†	1.29 (1.11–1.47)†	.64 (.53–.75)	7.84 (7.21–8.47)†
SG	5.01 (4.40–5.62)	1.32 (.99–1.66)†	.78 (.59–.97)	7.12 (6.31–7.92)†
Number of remaining teeth <28				
RYGB	7.00 (6.59–7.40)†	1.55 (1.35–1.75)†	1.08 (.97–1.19)†	9.63 (9.16–10.10)†
SG	6.23 (5.79–6.67)†	1.52 (1.29–1.75)†	1.04 (.92–1.15)†	8.79 (8.24–9.34)†
Number of remaining teeth ≥28				
RYGB	**4.80 (4.58–5.02)**†	.88 (.80–.95)†	**.80 (.74–.86)**†	**6.48 (6.23–6.73)**†
SG	**4.30 (4.11–4.48)**†	.77 (.71–.84)†	**.64 (.57–.70)**†	**5.71 (5.50–5.92)**†
%TWL <20% after 1 yr				
RYGB	5.44 (4.84–6.04)	.97 (.73–1.21)	.69 (.56–.82)	7.10 (6.40–7.80)
SG	5.17 (4.89–5.46)†	.93 (.81–1.06)	.83 (.74–.92)†	6.94 (6.60–7.27)†
%TWL ≥20% after 1 yr				
RYGB	**4.96 (4.69–5.24)**	1.04 (.95–1.14)	.77 (.68–.85)	**6.77 (6.44–7.11)**
SG	**3.93 (3.71–4.15)**†	.95 (.84–1.05)	.65 (.58–.71)†	**5.52 (5.25–5.80)**†

BMI = body mass index; EWL = excess weight loss; RYGB = Roux-en-Y gastric bypass; SG = sleeve gastrectomy; TWL = total weight loss.
Data are expressed as number of events/100 person-months and 95% CIs. Bold text indicates significant difference between RYGB and SG.
* For each subgroup, the number of events were predicted from Poisson models based on the propensity score–matched samples. The RYGB patients were matched to SG patients on their baseline age, sex, education, marital status, income level, number of teeth, within 2 years dental visit rate prior to surgery, BMI, and diabetes. The covariate being used for stratification was omitted from the matching process.
† Significant difference within group (RYGB or SG) based on covariate.

obvious if eating habits shift back, when combined with snacking/grazing eating behavior. A few studies have addressed differences in eating patterns following the 2 types of surgeries [23–25]. Only minor changes have been reported and it is unlikely that the difference between RYGB and SG observed in this study could be explained by dissimilar eating habits.

The weight loss seen after metabolic surgery is, at least in part, explained by changed secretion patterns of gut hormones. Two anorexigenic gut hormones that have been widely investigated after obesity surgery are GLP-1 and PYY, which are secreted by the enteroendocrine L-cells across the gastrointestinal tract [26]. The postprandial increase in anorexigenic gut hormones after SG is lower than that observed after RYGB [27]. A recent study has shown that the increase in postprandial levels of GLP-1 and PYY are transient after SG, while after RYGB the increase persists beyond 52 weeks [28]. This might explain differences in the weight loss efficacy of the 2 interventions, and the weight regain after SG at long-term follow-up [22]. Receptors of other hormones involved in the gut-brain axis, such as leptin [29] and ghrelin [30] have been demonstrated in the salivary glands, implying an effect of gut hormones on the oral environment. Saliva is of the utmost importance for oral health. A meta-analysis showed no significant alteration in salivary flow rates for up to 24 months after bariatric surgery [31] including series with both RYGB and SG, thus making changes in salivary flow less likely to be the cause of the difference seen in our study.

The anatomic rearrangement after bariatric surgery affects the composition of the intestinal microbiota [32–34] as well as the oral microbiota [35–37]. Studies have shown different bacterial gut composition after GBP compared with SG. The most prevalent oral diseases, dental caries and periodontal diseases, are microbiota-associated diseases. One possible explanation to the different outcomes regarding oral health between RYGB and SG seen in this study could be mediated by differences in the oral microbiota. Further studies are needed in this field.

In the present study, we did not include outcomes related to periodontal health. The rationale was based on the relatively short follow-up time, and also that bariatric surgery was not associated with any increase in periodontal interventions in our previous study [4].

The strengths of the study are the large cohorts, the long follow-up, and the completeness of data. The outcomes used were dental interventions rather than the clinical dental diagnoses. This makes the indications for dental treatment uncertain. The rationale was to obtain as robust outcome variables as possible, and because the interventions are directly linked to the remuneration system, they are considered robust. The structure of the study places some essential limitations on the results. Important clinical information, such as smoking, dietary habits, and oral hygiene routines, is absent in the registries used, possibly resulting in residual confounding. In addition, whether the increase of dental interventions after surgery was caused by new onset of oral disease or preexisting conditions is unclear. Possibly, a more thorough chewing might be necessary postoperatively, stressing preoperative problems previously deferred or that the general behavior of seeking care may be influenced by the surgery itself. However, those possibilities cannot explain the difference seen between the 2 groups. Furthermore, this study was conducted in a Swedish study population. The generalization of the findings can be considered equal to Western contexts, but to some extent circumstances may differ. Another possible limitation is that SG was rarely performed in Sweden, especially early in the time period. There could be a learning curve of the procedure in some institutions. However, SG is technically a much easier procedure to perform compared with RYGB so we believe that any effect would be small. Furthermore, using interventions instead of diagnoses as outcome is considered more robust, but makes it impossible to draw conclusions on the cause of the intervention.

Whether the observed differences between the 2 groups is of any clinical significance could be debated. The risk of any dental intervention was 6.79 events per 100 person-months among RYGB patients compared with 6.01 events per 100 person-months among SG patients. This equates to a risk increase of 13% for RYGB patients. The additional risk increase because of choosing RYGB as surgical technique will further increase the oral health side effects. There are no robust guidelines today for choosing type of bariatric procedure, diabetics being the exception. The findings might be something for the patient to consider when choosing surgical approach. In addition, all surgical candidates would benefit from counseling regarding oral hygiene and caries prevention.

Conclusion

The general finding of the present study is that dental interventions increase after bariatric surgery, indicating impaired oral health. The effect is higher after RYGB compared with SG, with significantly increased intervention rates of restorations and endodontic treatments. We conclude that the type of surgery might be an important factor for oral conditions among people with similar weight loss. The reasons for the observed differences are not clear. More research is needed to replicate these findings, to understand the mechanisms, and further delineate the significance of the surgical method.

Data availability

Data cannot be shared publicly because of patient confidentiality.

Disclosures

The authors have no commercial associations that might be a conflict of interest in relation to this article.

Supplementary data

Supplementary material associated with this article can be found, in the online version, at https://doi.org/10.1016/j.soard.2024.12.001.

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