



Effect of revisional bariatric surgery on type 2 diabetes mellitus

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Abstract

Introduction Bariatric and metabolic surgery significantly improves type 2 diabetes mellitus (T2DM). However, a small percentage of patients after bariatric surgery either have persistent hyperglycemia or relapse of their T2DM. These patients are usually medically managed. The aim of this study was to evaluate the effect of revisional surgery on the glycemic status of patients with T2DM who either failed to remit or relapsed after an initial remission following bariatric surgery.

Methods Metabolic parameters and clinical outcomes of 81 patients with persistent or relapsed T2DM after revisional bariatric surgery at an academic center between 2008 and 2017 were studied.

Results The most common types of revisional surgery were pouch and/or stoma revision of Roux-en-Y gastric bypass (RYGB) ($n=22$, 27.2%), conversion of vertical banded gastroplasty (VBG) to RYGB ($n=20$, 24.7%), conversion of adjustable gastric banding (AGB) to RYGB ($n=14$, 17.3%), and conversion of sleeve gastrectomy (SG) to RYGB ($n=13$, 16%). Revision of pouch/stoma after RYGB yielded improvement of T2DM in 50% of patients and remission in 22.7%. Conversion to RYGB yielded improvement of T2DM in 55%, 35.7%, and 30.8% of patients who previously had VBG, AGB, or SG, respectively. Furthermore, conversion of VBG, AGB, and SG to RYGB was associated with diabetes remission rates of 35%, 35.7%, and 23.1%, respectively.

Conclusion Findings of this study, which is the largest series to date, indicate that revisional surgery in patients with persistent or relapsed T2DM after bariatric surgery can significantly improve glucose control and use of diabetes medications. Further clinical and mechanistic studies are needed to better demonstrate the role of revisional bariatric surgery in patients with residual T2DM.

Keywords Revisional bariatric surgery · Diabetes · Roux-en-Y gastric bypass · Sleeve gastrectomy · Vertical band gastroplasty · Adjustable gastric banding

Bariatric surgery is by far the most effective and durable mean to lose weight. It has also been proven to have many metabolic effects. Improvement of type 2 diabetes mellitus (T2DM) is one of the favorable metabolic effects that has gained lots of attention. Many randomized controlled trials with long-term follow-up proved that bariatric surgery to be more effective and durable when compared to medical and lifestyle management of T2DM [1, 2].

Although bariatric surgery is safe, some patients develop complications, regain some weight, or have their diabetes relapse [1]. These consequences occur with different incidences depending on the primary bariatric procedure done [3]. Non-surgical management is often sought first when possible [4]. However, some patients resolve to surgical revision after exhausting all other options. The effect of revisional bariatric surgery on weight loss has been established to be beneficial, although to a lesser extent than primary bariatric surgery [5, 6]. The effect of revisional bariatric surgery on obesity-related metabolic morbidities is less clear.

Diabetes can relapse in patients who have initial remission post primary bariatric surgery. This has been noted to be in the range of 30–50% in long-term follow-up. Although T2DM after relapse is often milder, it still requires medical treatment in many cases. Having said that, the number of medications needed is usually less than the preoperative requirement [1]. Most of these patients continue to be

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managed medically as no guideline exists to guide the management thereafter. Furthermore, it is unclear how revisional bariatric surgery affects T2DM status in patients with relapse after primary bariatric surgery. The aim of this study is to assess the effectiveness of revisional bariatric surgery on residual T2DM.

Methods

This is a retrospective chart review of all patients who underwent a revisional bariatric procedure after a primary bariatric procedure between January 2008 and June 2017 at an academic medical center. All patients 18 years and older with T2DM at time of revisional surgery regardless of the cause for revision were included in the study. Patients with missing baseline or postoperative follow-up data were excluded.

All included patients' charts were reviewed after obtaining approval from the Institutional Review Board. Variables related to patient demographics [age, gender, weight, and body mass index (BMI)], surgery [type of index and revisional surgeries], and T2DM status [fasting blood glucose (FBG), glycated hemoglobin (HbA1c), and insulin and non-insulin diabetes medication use] were extracted from the electronic medical records.

Data values at time of revision, at 1 year after surgery, and at last follow-up were gathered where appropriate. Diabetes remission was defined as HbA1c < 6.5% and FBG < 126 mg/dL off diabetes medications. Diabetes improvement was defined as significant reduction in HbA1c (by > 1%), FBG (by > 25 mg/dL), or reduction in HbA1c and FBG accompanied by decrease in antidiabetic medications requirement. The follow-up period is defined as time between revisional surgery and last blood work done.

Patients included were divided into the following categories by type of index and revision bariatric procedure undergone: vertical banded gastroplasty (VBG) to Roux-en-Y

gastric bypass (RYGB), adjustable gastric banding (AGB) to sleeve gastrectomy (SG), AGB to RYGB, AGB to duodenal switch (DS), SG to RYGB, SG to DS, and revisional surgery for RYGB (revision of pouch and/or stoma).

The Statistical Package for the Social Sciences Ver. 24.0 was used to perform the statistical analysis. Continuous variables were reported as median with interquartile range (IQR) due to non-normally distributed configuration of the data. Categorical variables were reported as frequency with percentage. Significance was measured using non-parametric Wilcoxon signed-rank and chi-square tests for continuous and categorical variables. A *p* value of < 0.05 was considered significant.

Results

We identified a total of 123 patients with residual T2DM at time of revisional bariatric surgery. A total of 42 patients were excluded from the analysis due to missing data rendering the study sample size to 81 patients. The median age at time of revisional surgery was 57 years (46.5–64) with a female predominance of 59 (72.8%).

When categorized by index and revisional procedures, the frequency of type of revision in a descending order was RYGB revisions (*n* = 22; 27.2%), VBG to RYGB (*n* = 20; 24.7%), SG to RYGB (*n* = 13; 16%), AGB to RYGB (*n* = 14; 17.3%), AGB to SG (*n* = 7; 8.6%), SG to DS (*n* = 3; 3.7%), and AGB to DS (*n* = 2; 2.5%). The median overall follow-up was 22 months (IQR 8–39.5). Due to the difference in nature of the different index and preceding revisional procedures, we opted to stratify the results by type of index procedure and revision performed (Tables 1, 2, 3, 4, 5; Fig. 1).

Table 1 Revisional bariatric surgery included by type of index procedure and revision performed

	VBG to RYGB	Conversion from AGB			Conversion from SG		Revision of pouch/stoma after RYGB
		AGB to RYGB	AGB to SG	AGB to DS	SG to RYGB	SG to DS	
Number [<i>n</i> (%)]	20 (24.7)	14 (17.3)	7 (8.6)	2 (2.5)	13 (16)	3 (3.7)	22 (27.2)
Female [<i>n</i> (%)]	14 (70)	9 (64.3)	2 (28.6)	2 (100)	10 (76.9)	3 (100)	19 (86.4)
Age at revision, years, median (IQR)	61 (54.3–66.8)	56 (50.3–62.3)	64 (46–70)	38, 47 ^a	49 (39.5–61.5)	39, 43, 49 ^a	59.5 (46.5–63.5)
Follow-up time after revision, months, median (IQR)	8 (5.3–40.5)	43.5 (12.8–67.3)	38 (8–81)	7, 31 ^a	31 (16–58)	3, 35, 36 ^a	12 (8.5–27.3)
Patients with > 1-year follow-up [<i>n</i> (%)]	7 (35)	13 (92.8)	5 (71.4)	1 (50)	10 (76.9)	2 (66.7)	13 (59.1)

RYGB Roux-en-Y gastric bypass, VBG vertical banding gastroplasty, SG sleeve gastrectomy, AGB adjustable gastric banding, DS duodenal switch, IQR interquartile range

^aValues for individual patients in group

Table 2 Body mass index and weight trends by type of index procedure and revision performed

	VBG to RYGB (<i>n</i> = 20)	Conversion from AGB			Conversion from SG		Revision of pouch/stoma after RYGB (<i>n</i> = 22)
		AGB to RYGB (<i>n</i> = 14)	AGB to SG (<i>n</i> = 7)	AGB to DS (<i>n</i> = 2)	SG to RYGB (<i>n</i> = 13)	SG to DS (<i>n</i> = 3)	
BMI at revision (Kg/m ²), median (IQR)	47.2 (39.9–59.1)	44.2 (39–46.9)	38.5 (33.3– 47.3)	66.6, 81.8 ^a	46.3 (38.2–50.4)	45.4, 55.4, 65.4 ^a	41.2 (33.8–53.1)
BMI at 1 year (Kg/m ²), median (IQR)	32.8 (30.1–42.2)	34.4 (26.9–38.5)	35.6 (29.4–47)	71.5, – ^a	35.8 (31.8–44.3)	35, 41.7, 48.4 ^a	30.4 (28.6–45.6)
<i>p</i> value	0.013	0.03	–	–	0.016	–	0.001
BMI at last fol- low-up (Kg/ m ²), median (IQR)	36.5 (29.3–42.8)	33.2 (30.5–37.3)	37.2 (28.9– 38.8)	46.9, 63.4 ^a	41.5 (28.8–49.3)	35.54, 35.6, 49.7 ^a	30.2 (28.6–46.5)
<i>p</i> value	<0.001	0.001	–	–	0.039	–	<0.001
Weight at revi- sion (Kg), median (IQR)	124.7 (107.2– 149.3)	118.2 (104– 130.7)	118.1 (149– 95.3)	176.2, 237 ^a	125.8 (106.1– 149)	116.2, 137.4, 192.8 ^a	115.8 (86.4– 146.9)
Weight at 1 year (Kg), median (IQR)	85.2 (70.7–96.5)	91.6 (87–99.9)	109.6 (80.6– 153)	207.8, – ^a	109.8 (79.6– 122.9)	88.27, 127, – ^a	88.9 (73.2–136)
<i>p</i> value	0.007	0.003	–	–	0.033	–	0.001
Weight at last follow-up (Kg) median (IQR)	93.3 (77.9–121.7)	89.1 (84.7–93.2)	96.2 (90.2– 124.9)	183.8, 131.9 ^a	114.1 (80.5– 138.3)	88.4, 93.9, 148.3 ^a	86.4 (72.6–133.1)
<i>p</i> value	<0.001	0.001	–	–	0.013	–	<0.001

Statistical comparison was not done if *n* < 10

RYGB Roux-en-Y gastric bypass, VBG vertical banding gastroplasty, SG sleeve gastrectomy, AGB adjustable gastric banding, DS duodenal switch, IQR interquartile range

^aValues for individual patients in group

Conversion of VBG to RYGB (*n* = 20)

A significant reduction in weight and BMI was observed after conversion of VBG to RYGB. The median additional percentage total weight loss (TWL) after revision was 20.5% (IQR 13.5–34.5). The median FBG and HbA1c levels at baseline and at last follow-up were 151.5 and 115 mg/dL (*p* = 0.037), and 7.2% and 6% (*p* = 0.001), respectively. A total of nine patients were on insulin at time of revision which decreased to five after revisional surgery, a 44.4% reduction in insulin users. The median number of diabetes medications also significantly decreased. Furthermore, T2DM remission and improvement rates were 35% and 55%, respectively. The median follow-up in this group was 8 months (IQR 5.3–40.5).

Conversion of AGB

Conversion of AGB to RYGB (*n* = 14)

Significant reduction in body weight was associated with significant improvement of T2DM in this subgroup.

Median additional TWL after revision was 22.4% (IQR 15.1–32.6). The median FBG and HbA1c levels at baseline and at last follow-up were 122.5 and 96.5 mg/dL (*p* = 0.019), and 7.9% and 6.5% (*p* = 0.001), respectively. The median number of non-insulin diabetes medications decreased from 1 to 0 (*p* = 0.059). Diabetes remission and improvement were observed in 71.4% of patients (each outcome in 35.7%). The median length of follow-up in this group was 43.5 months (IQR 12.8–67.3).

Conversion of AGB to SG (*n* = 7)

The median weight and BMI at baseline and at last follow-up were 118.1 and 96.2 kg, and 38.5 and 37.2 kg/m², respectively. Median additional TWL after revision was 13.5% (IQR –1 to 19.1). The median HbA1c level at baseline and at last follow-up was 7.2% (6.7–9.4) and 6.7% (5.9–8.2), respectively. The median length of follow-up in this group was 38 months (IQR 8–81).

Table 3 HbA1c and FBG trend by type of index procedure and revision performed

	VBG to RYGB (<i>n</i> = 20)	Conversion from AGB			Conversion from SG		Revision of pouch/stoma after RYGB (<i>n</i> = 22)
		AGB to RYGB (<i>n</i> = 14)	AGB to SG (<i>n</i> = 7)	AGB to DS (<i>n</i> = 2)	SG to RYGB (<i>n</i> = 13)	SG to DS (<i>n</i> = 3)	
A1C at revision (%), median (IQR)	7.2 (6.2–8.5)	7.9 (6.6–8.5)	7.2 (6.7–9.4)	6, 11.8 ^a	6.4 (6.1–7.3)	5.6, 7.9, 13.1 ^a	6.6 (6.3–8.3)
A1C at 1 year follow-up (%), median (IQR)	6 (5.7–9.6)	6.9 (5.4–7.2)	8 (5.6–10.3)	–	6.7 (5.7–7)	4.7, –, – ^a	6.2 (5.1–6.7)
<i>p</i> value	–	0.028	–	–	0.286	–	0.018
A1C at last follow-up (%), median (IQR)	6 (5.6–6.5)	6.5 (5.9–7.2)	6.7 (5.9–8.2)	5.3, 5.6 ^a	6.8 (5.4–8.1)	5.1, 5.2, 6.3 ^a	5.6 (5.5–6.6)
<i>p</i> value	0.001	0.001	–	–	0.508	–	0.003
FBG at revision, median (IQR)	151.5 (103–196.8)	122.5 (105.5–136)	123.5 (93.5–183.5)	112, 194 ^a	139 (116–184)	102, 112, 144 ^a	140.5 (103.8–184)
FBG at 1 year follow-up, median (IQR)	91 (84–170.5)	103.5 (90.3–135)	189.5 (118.5–241)	–	141.5 (119.3–157)	88, 143, – ^a	130 (100–154.3)
<i>p</i> value	0.500	0.553	–	–	0.161	–	0.093
FBG at last follow-up, median (IQR)	115 (87–140.5)	96.5 (81–118)	150 (97–168)	79, 84 ^a	128 (106.5–187.5)	83, 114, 136 ^a	114 (102.5–141)
<i>p</i> value	0.037	0.019	–	–	0.328	–	0.018

Statistical comparison was not done if *n* < 10

RYGB Roux-en-Y gastric bypass, VBG vertical banding gastroplasty, SG sleeve gastrectomy, AGB adjustable gastric banding, DS duodenal switch, IQR interquartile range

^aValues for individual patients in group

Table 4 Non-Insulin diabetes medication use trend by type of index procedure and revision performed

Non-insulin diabetes medications	VBG to RYGB (<i>n</i> = 20)	Conversion from AGB			Conversion from SG		Revision of pouch/stoma after RYGB (<i>n</i> = 22)
		AGB to RYGB (<i>n</i> = 14)	AGB to SG (<i>n</i> = 7)	AGB to DS (<i>n</i> = 2)	SG to RYGB (<i>n</i> = 13)	SG to DS (<i>n</i> = 3)	
At revision (<i>n</i>), median (IQR)	1 (1–1)	1 (0–1)	1 (1–2)	1, 1 ^a	1 (0–1)	1, 1, 1 ^a	1 (0–1.3)
At 1 year (<i>n</i>), median (IQR)	0 (0–1.5)	0 (0–1)	1 (0.5–2)	–, – ^a	0 (0–1)	0, –, 0 ^a	0 (0–1)
<i>p</i> value	0.180	0.083	–	–	0.317	–	0.014
At last follow-up (<i>n</i>), median (IQR)	0 (0–1)	0 (0–1)	1 (1–1)	0, 0 ^a	0 (0–1)	0, 0, 0 ^a	0 (0–1)
<i>p</i> value	0.001	0.058	–	–	0.102	–	0.022

Statistical comparison was not done if *n* < 10

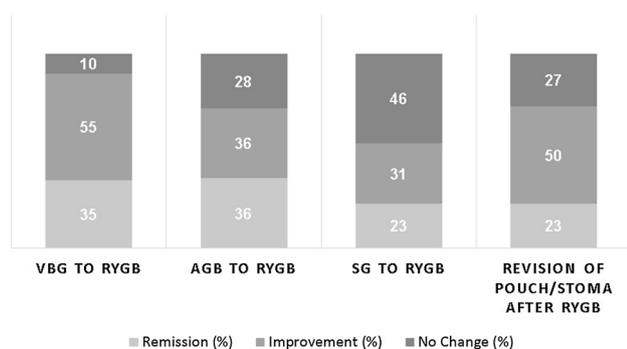
RYGB Roux-en-Y gastric bypass, VBG vertical banding gastroplasty, SG sleeve gastrectomy, AGB adjustable gastric banding, DS duodenal switch, IQR interquartile range

^aValues for individual patients in group

Table 5 Insulin use trend by type of index procedure and revision performed

Insulin use	VGB to RYGB (<i>n</i> = 20)	Conversion from AGB			Conversion from SG		Revision of pouch/stoma after RYGB (<i>n</i> = 22)
		AGB to RYGB (<i>n</i> = 14)	AGB to SG (<i>n</i> = 7)	AGB to DS (<i>n</i> = 2)	SG to RYGB (<i>n</i> = 13)	SG to DS (<i>n</i> = 3)	
At revision (<i>n</i>)	9	9	2	1	8	3	7
At last follow-up (<i>n</i>)	5	7	1	0	6	0	7
Discontinuation of insulin (%)	44.4	22.2	50	100	25	100	0

RYGB Roux-en-Y gastric bypass, VGB vertical banding gastroplasty, SG sleeve gastrectomy, AGB adjustable gastric banding, DS duodenal switch, IQR interquartile range

**Fig. 1** Diabetes status after reoperative bariatric surgery

Conversion of AGB to DS (*n* = 2)

Conversion of AGB to DS was associated with additional weight loss and diabetes improvement in two patients.

Conversions of SG

Conversion of SG to RYGB (*n* = 13)

The median weight and BMI at baseline and at last follow-up were 125.8 and 114.1 kg ($p=0.013$), and 46.3 and 41.5 kg/m² ($p=0.039$), respectively. The median additional TWL after revision was 11.3% (IQR -1 to 17). However, changes in FBG, HbA1c, and diabetes medications were not statistically significant. Two out of eight patients discontinued insulin therapy. Diabetes remission and improvement rates were 23.1% and 30.8%, respectively. The median length of follow-up in this group was 31 months (IQR 16–58).

Conversion of SG to DS (*n* = 3)

Conversion of SG to DS in three patients led to significant weight loss and diabetes improvement.

Revision of pouch/stoma after RYGB (*n* = 22)

Corrective surgery after RYGB significantly decreased excess weight and improved T2DM. The median weight and BMI at baseline and at last follow-up were 115.8 and 86.4 kg ($p<0.001$), and 41.2 and 30.2 kg/m² ($p<0.001$), respectively. Median additional TWL after revision was 14.1% (IQR 5.5–21.3). The median FBG and HbA1c levels at baseline and at last follow-up were 140.5 and 114 mg/dL ($p=0.018$), and 6.6% and 5.6% ($p=0.003$), respectively. Diabetes remission and improvement rates were 22.7% and 50%, respectively. The median number of non-insulin diabetes medications decreased from 1 to 0 ($p=0.022$). The median length of follow-up in this group was 12 months (IQR 8.5–27.3).

Discussion

Primary bariatric surgery is established as a highly effective mean for diabetes remission. This notion has been demonstrated to be true in long-term randomized control trials. However, relapse of T2DM has been shown in studies with long-term follow-up [7, 8]. Predictors of diabetes relapse include severe preoperative diabetes status manifested in poor glycemic control, being on more than two diabetes medications, long history of diabetes, and/or insulin use. Other factors implicated are older age, low excess weight loss, and weight regain [7–11].

Residual diabetes after primary bariatric surgery is currently being managed with diabetes medications, and little is known about the effect of revisional bariatric surgery on persistent diabetes or diabetes relapse. On the contrary, reoperative bariatric surgery is an evidence-based mean for management of complications of primary bariatric surgery. Some of the established indications include procedural side effects such as dysphagia and gastroesophageal reflux disease, and weight recidivism or inadequate weight loss. The scarce patients reported in the literature with residual diabetes

undergoing revisional surgery go through the revision management of complications. A recent review attempted to assess the effect of revisional surgery on T2DM. Our study supports their conclusion that overall improvement of T2DM ranged between 65 and 100% depending on the index and type of reconstruction performed [12].

VBG to RYGB

Problems such as weight regain, band erosion, dysphagia, and staple line failure played a role in marginalizing VBG. Given the anatomical nature of the procedure, the most convenient and common revision is through reconstructing the stomach into a RYGB. In our cohort, this led to a median reduction of 31.4 kg and 10.7 kg/m² in weight and BMI, respectively. Furthermore, a significant reduction was noted in diabetes medication. This confirms findings of other studies, where conversion to RYGB was noted to improve T2DM in the majority of their patients with VBG [13, 14].

AGB revisions

Inadequate weight loss, weight regain, and complications, including band slippage and erosion, are not uncommon after gastric banding [15]. Surgical options include conversion to RYGB, SG, or DS. Regardless of the type of reconstruction performed, further weight reduction is achieved. We noted a remarkable improvement in FBG and HbA1c in patients revised to RYGB. We had small numbers of patients for other conversions. About 65% improvement in T2DM was reported in the literature for conversions to SG and DS [12].

SG revisions

SG has been proven as an effective standalone procedure for weight loss and its metabolic effects. Most patients achieve long-term weight loss and diabetes improvement [16]. Indications for revising a SG include weight recidivism, insufficient weight loss, sleeve stenosis, and gastroesophageal reflux disease. Approximately, 21% of patients had T2DM at the time of revisional surgery, either due to relapse or persistence of T2DM post primary sleeve gastrectomy [12]. Revision options are redo SG, or to convert the SG to either a RYGB or DS. Our cohort has more conversions to RYGB than DS. Further median weight reduction was noted in both revisional groups, which is compatible with reported literature. As for its effect on residual T2DM, our results show clinical remission at a rate of 23.1% and improvement of 30.8% in patients converted to RYGB. However, changes in HbA1c and FBG were not statistically significant. This might be explained by the small sample size that precludes illustration of statistical significance. The reported

improvement in the literature was as high as 62% in patients converted [12].

Revision of pouch/stoma after RYGB

As in the case of SG, a great subset of patients in RYGB achieve significant, durable weight loss on long-term follow-up [1, 17]. However, relapse of T2DM would be as high as 40–50% in long-term follow-up [8]. RYGB revision is indicated for failure to achieve optimum weight loss or in case of weight recidivism. Procedure-specific complications such as refractory marginal ulcers, gastrogastric fistula, or malnutrition are also valid indications for reoperation. Revision of pouch/stoma after RYGB in our cohort produced further significant weight loss and improvement in T2DM control. This concurs with overall 79% improvement of T2DM post-revision reported in the literature [12].

Low prevalence of residual T2DM after prior bariatric surgery makes it difficult to assess the effect of each revision approach on T2DM. With that said, revisional bariatric surgery in our series provided further weight reduction and also diabetes improvement. Most patients in our cohort had an improved medication profile at last follow-up compared to when they presented for revision. Diabetes is a chronic progressive disease. In medical treatment of T2DM, we usually start with prescribing one drug to control blood sugar. If it failed, the next step would be combination of two or more drugs. If it failed to control T2DM, then injectable medication including insulin would be added to the drug list. So, basically we escalate the therapy in chronic diseases including T2DM to effectively control the disease. We can follow the same concept with surgery. If one surgery failed to improve T2DM we can escalate the care and convert to another surgery or do a corrective procedure to improve T2DM. For example, in this study we showed that conversion from restrictive procedures such as AGB or VBG in patients who had persistent T2DM to diversionary procedures such as RYGB, which are associated with significant neurohormonal changes, can significantly improve T2DM. We could also show that corrective surgery after RYGB to revise the size of gastric pouch and stoma can significantly improve the excess weight and T2DM status. Furthermore, reoperative surgery in majority of patients who were on insulin led to discontinuation of insulin.

It is important to emphasize that obesity and T2DM are chronic diseases that would require additional therapy if initial treatment fails. This paradigm is well accepted for many other chronic medical and surgical diseases such as cardiac disease or joint problems. The result of this study showed that persistent T2DM with inadequate weight control can be an indication for revisional bariatric surgery. Unfortunately, many patients and physicians do not consider the option of surgical revision to improve metabolic outcomes.

Furthermore, many insurance providers do not cover reoperative bariatric surgery [18].

This study is the largest cohort assessing the effect of revisional bariatric surgery on T2DM. We acknowledge that the study has limitations. It is a retrospective chart review study. The other limitations include small sample size, short follow-up time, and missing data. Furthermore, since we did not have complications and cost data, we were not able to do risk–benefit and cost-effective analyses to justify revisional bariatric procedures. Performing a subgroup analysis in this study was necessary to identify the effect of each index and revision procedure combination as they would have a different mechanism of action and should not be analyzed together. It would be difficult to prospectively conduct this study in a single institution setting given the low frequency of revisional surgery as well as residual diabetes after primary bariatric procedures. This calls for a collaborative multicenter study to have a sufficiently powered study to assess the effect of various reoperative options on T2DM.

In conclusion, findings of this study would suggest that revisional surgery in patients with persistent or relapsed T2DM after bariatric surgery can significantly improve the glucose control and use of diabetes medication. Further clinical and mechanistic studies are needed to better demonstrate the role of revisional bariatric surgery in patients with residual T2DM.

Compliance with ethical standards

Disclosure Essa M. Aleassa, Monique Hassan, Kellen Hayes, Stacy A. Brethauer, Philip R. Schauer, and Ali Aminian have no conflicts of interest or financial ties to disclose.

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