Revista Portuguesa
de Endocrinologia, Diabetes e Metabolismo

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Artigo Original

Type 2 Diabetes Remission One Year After Bariatric Surgery: A Comparison Between Sleeve Gastrectomy and Gastric Bypass

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INFORMAÇÃO SOBRE O ARTIGO

Historial do artigo:
Received/ Recebido: 2020-10-19
Accepted/Aceite: 2021-03-16
Publicado / Published: 2021-08-05

Keywords:
Bariatric Surgery;
Diabetes Mellitus, Type 2/surgery;
Gastrectomy;
Gastric Bypass.

A B S T R A C T

Introduction: Laparoscopic Roux-en-Y gastric bypass (LRYGB) is considered the gold standard metabolic surgery. Type 2 diabetes (T2D) remission successfully achieved after laparoscopic sleeve gastrectomy (LSG) suggested that this procedure is not only a restrictive one, but it also has beneficial metabolic effects. The aim of this study was to compare the rate of T2D remission between patients submitted to LRYGB and LSG 1 year after surgery and to evaluate possible predictors of T2D remission.
Methods: A retrospective study including 112 patients with T2D submitted to bariatric surgery in Hospital de Braga from January 2011 to December 2016 was performed. Anthropometric and metabolic parameters were recorded before and 12 months after surgery. T2D remission was defined as glycated hemoglobin (A1c) < 6% and fasting plasma glucose (FPG) < 100 mg/dL without diabetes pharmacological treatment (DPT) at the 1-year post-surgery evaluation. The data was analyzed using the IBM SPSS® software version 25.0 and statistical significance was set at p <0.05.
Results:Twelve months after surgery, there was a reduction in mean body mass index (BMI) (-13.40±4.7 for LSG and -13.55±5.3 for LRYGB, p=0.878), mean FPG and DPT frequencies. Patients submitted to LRYGB presented a greater decrease in plasma fasting insulin and A1c (-0.85 ± 0.9 for LSG and -1.50 ± 1.6 for LRYGB, p=0.039). Patients submitted to LSG presented T2D remission rates similar to those of patients that underwent LRYGB (40% after LSG and 38.6% after LRYGB, p=0.893). Baseline A1c and age at the time of the surgery were predictors of T2D remission.
Conclusion: Younger patients with better T2D control and optimized preoperative glycemic control have better chances to attain T2D remission, independently of the type of surgery.

Palavras-chave:
Cirurgia Bariátrica;
Diabetes Mellitus, Tipo 2/cirurgia;
Gastrectomia;
Bypass Gástrico.

Remissão de Diabetes Tipo 2 Um Ano Após Cirurgia Bariátrica: Uma Comparação entre Gastrectomia Vertical Calibrada e Bypass Gástrico

R E S U M O

Introdução: *Bypass* gástrico em Y-de-Roux (*bypass*) é considerado o *gold-standard* da cirurgia metabólica. O sucesso na remissão da diabetes tipo 2 (DM2) após gastrectomia vertical calibrada (*sleeve*) sugeriu que esta cirurgia não é apenas restritiva, mas também tem efeitos metabólicos benéficos. O objectivo deste estudo foi comparar a eficácia do *bypass* e do *sleeve* na remissão da DM2 um ano após cirurgia e determinar possíveis factores preditores de remissão da DM2.
Métodos: Estudo retrospectivo com 112 doentes com DM2 submetidos a cirurgia bariátrica no Hospital de Braga, de Janeiro de 2011 a Dezembro de 2016. Colheram-se parâmetros antropométricos e metabólicos antes e 12 meses após a cirurgia. A remissão da DM2 foi definida por hemoglobina glicosilada (A1c) < 6% e glicose plasmática em jejum (GJ) < 100 mg/dL sem tratamento para a diabetes (TPD) na reavaliação 1 ano após cirurgia. Os dados foram analisados através do *software* IBM SPSS® versão 25.0 e estabeleceu-se significância estatística para p <0,05.

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https://doi.org/10.26497/ao200059

Resultados: Doze meses depois da cirurgia, verificou-se redução do índice de massa corporal (IMC) (-13,40±4,7 após *sleeve* e -13,55±5,3 após *bypass*, *p*=0,878), GJ e número de doentes sob TPD. Doentes submetidos a *bypass* apresentaram uma maior redução na insulina plasmática em jejum e A1c (-0,85 ± 0,9 após *sleeve* e -1,50 ± 1,6 após *bypass*, *p*=0,039). Doentes submetidos a *sleeve* apresentaram taxas de remissão da DM2 semelhantes às dos doentes submetidos a *bypass* (40% após *sleeve* e 38.6% após *bypass*, *p*=0,893). A A1c inicial e a idade no momento da cirurgia foram preditores de remissão da DM2.

Conclusão: Doentes mais jovens, com DM2 melhor controlada e controlo glicémico pré-operatório optimizado têm maior probabilidade de alcançar remissão de DM2, independentemente do tipo de cirurgia.

Introduction

According to the World Health Organization (WHO), obesity, defined as a BMI ≥30 kg/m^2, is the first pandemic of the 21st century and an often-neglected public health problem. In 2016, more than 1.9 billion adults were overweight and, of these, over 650 million were obese.[1]

Type 2 diabetes (T2D) is one of the many comorbidities associated to obesity, with an incidence that quadrupled in the past three decades, accounting for 90% of all the cases of diabetes in the world. T2D is the ninth major cause of death worldwide and its chronic complications, mainly cardiovascular, are the leading cause of morbidity and mortality in these patients.[2]

Bariatric surgery is a surgical treatment for patients with obesity with a BMI > 40 kg/m^2 or a BMI > 35-40 kg/m^2 with at least one obesity-related comorbidity.[3] Laparoscopic Roux-en-Y gastric bypass (LRYGB) and laparoscopic sleeve gastrectomy (LSG) are the two most popular procedures performed worldwide.[3] LRYGB consists in the creation of a small stomach pouch that is anastomosed to the jejunum through a Roux-en-Y alimentary limb and this anatomical reconfiguration is responsible for malabsorption and consequent weight loss. It also induces neurohormonal alterations with significant positive metabolic effects.[4] Besides LSG's mainly restrictive effects that lead to weight loss, recent data shows that it also induces metabolic improvements.[5] The resulting hormonal changes increase insulin secretion and insulin sensitivity and improve overall glycemic control,[4,6,7] thus, both surgeries seem to be able to improve metabolic control in patients with T2D.[8] Metabolic surgery should be recommended as a treatment option for T2D in patients with BMI ≥ 35 and may be considered for patients with BMI between 30 and 34.9 kg/m^2 who do not achieve durable weight loss and improvement in T2D with nonsurgical treatment.[9] Interestingly, gut hormones follow a distinct profile after a gastric restrictive surgery compared with the one observed with intestinal bypass.[6] Therefore T2D remission rate after LSG has been considered inferior to LRYGB.[4,8,10-12] A systematic review and meta-analysis from 1990 to 2006 reported T2D remission rates from 56.7% to 95.1%, depending on the type of surgery.[10] Some further studies aimed to verify T2D remission rates 1 year after LSG and LRYGB, accordingly to American Diabetes Association (ADA) criteria, and found rates of 50%-66.7% and 74%-87.5%, respectively.[4,13] Recent articles that also used the ADA remission criteria reported remission rates of 35.3% after LSG and 37.1% to 52.5% after LRYGB.[12,14,15] Nevertheless, some authors detected no statistical differences between LSG and LRYGB T2D remission rates and the hypothesis whether LSG might have the same efficacy as LRYGB in inducing T2D remission has been raised.[5,11,13,16-18] Besides the type of surgery, other factors have been suggested as predictors of T2D remission: BMI < 30 kg/m^2, inferior BMI reduction, older age, longer T2D duration, higher preoperative fasting plasma glucose (FPG), higher baseline glycated hemoglobin (A1c), higher baseline waist circumference, higher visceral fat area and preoperative use of insulin are associated to lower T2D remission rates after metabolic surgery.[11-13,18-20] On the contrary, other studies showed that preoperative BMI, age, gender, duration of T2D and BMI variation did not predict T2D remission.[19,20-25]

The aim of this study was to compare T2D remission rates 1 year after LRYGB and LSG. The secondary goal was to evaluate predictive factors of T2D remission after bariatric surgery.

Material and Methods

A retrospective review of our institution's bariatric surgery database and electronic medical record system for patients who underwent bariatric surgery was performed. From January/2011 to December/2016, 112 patients with obesity and T2D underwent bariatric surgery in the Surgery Department of our institution, a tertiary and academic hospital, with a Bariatric Surgery Center. To be eligible for surgery, patients must had met the criteria of European guidelines for obesity surgical treatment: body mass index (BMI) ≥ 40 kg/m^2 or BMI 35–40 kg/m^2 with co-morbidities in which surgically induced weight loss is expected to improve the disorder. To be considered for surgery, patients should have failed to lose weight or to maintain long-term weight loss, despite appropriate surgical and/or non-surgical comprehensive medical care.[26]

Our center has experience in LRYGB and LSG and both surgeries were performed through laparoscopy and following a standard surgical protocol. In LRYGB, the gastric fond is mobilized and the horizontal section line is set at the third gastric vessel of the small curvature. An 11 mm orogastric calibration probe is introduced, constructing the gastric reservoir until the angle of His. The gastro-jejunal anastomosis is set at the first proximal 90 cm. The food duct resulting from the jejuno-jejunal anastomosis has 120 cm. During LSG the surgeon uses an 11 mm orogastric calibration probe to determine the gastric section line, then sectioned with an endoscopic stapler (Endo GIA), resulting in a 100 mL volume stomach, with preservation of the pyloric function.

Prior to hospital discharge, patients received a dietary plan, starting with a high protein, low-fat and soft diet, then gradually progressing to a common meal. Follow-up appointments occurred with nutritionist that evaluated anthropometry and food plan compliance, and with bariatric surgeons, who assessed clinical and biochemical status of the patients at 1 year after surgery. Blood was collected by venipuncture between 8 a.m. and 11 a.m. after an overnight fast. Biochemical parameters were measured using routine techniques. The presence or absence of glucose-lowering medication was collected based upon physician registries.

T2D was defined as FPG ≥126 mg/dL in at least two measurements, A1c ≥6.5% or prescription of any diabetes pharmacological treatment (DPT).[9] To define T2D remission, a modified version of the ADA criteria was used, considering T2D complete remission if A1c < 6% and FPG < 100 mg/dL and the absence of glucose-lowering drugs at the 1-year post-surgery evaluation.[27] Patients included had at least one evaluation of FPG or A1c when T2D remission determination was not possible. The variables test-

ed for predictors of remission were chosen through an exploratory analysis of the differences between T2D remitters and non-remitters. A1c was the selected variable to evaluate T2D control. BMI reduction was calculated through the difference between BMI at 1 year and baseline BMI. There were no patients lost to follow-up.

The collected data was analyzed using the software IBM SPSS® version 25.0 and statistical significance was set at p <0.05. For continuous quantitative variables, the existence of normal distribution was tested through histogram observation and kurtosis and skewness analysis. To describe variables, we used central tendency measures (mean and median) and dispersion measures (standard-deviation and percentiles 25-75) for quantitative variables and absolute numbers and percentages for qualitative variables. To compare continuous variables with normal and non-normal distribution between groups, a T-test for independent variables and a Mann Whitney test were used, respectively. A pairwise T-test and the Wilcoxon test were used, respectively to compare continuous variables with normal and non-normal distribution within groups. To analyze differences between and within groups of categorical variables, the Chi-Square test/Fisher's exact test and McNemar's test test were used, respectively. In the logistic regression model, to assess predictors of T2D remission, a stepwise regression with a backward elimination approach was performed.

This study has been approved by the ethical committee of Hospital de Braga (Ref.ª 91/2019).

Results

Of the 112 patients included in the study, 63 (56.25%) were submitted to LSG and 49 (43.75%) underwent the LRYGB procedure. Two of the patients submitted to LRYGB had previously undergone LSG at 4 and 5 years ago. All patients completed 1 year of follow-up. Table 1 exhibits the patients' characteristics prior to surgery. Patients submitted to LSG had a shorter median T2D duration than patients submitted to LRYGB, higher frequency of treatment with lifestyle measures, as well as a lower prevalence of DPT, both oral antidiabetics (OAD) and insulin therapy (IT). Regarding biochemical parameters, patients submitted to LSG presented baseline lower levels of FPG, FPI and A1c than patients submitted to LRYGB.

Table 1. Characteristics of the population prior to surgery

	LSG (n=63)	LRYGB (n=49)	*p*
Female (n;%)	47; 74.6	39; 79.6	0.535
Age (n;m±SD years)	63; 47.63 ± 11.7	49; 50.29 ± 10.0	0.207
T2D duration (n;md(P25-P75) years)	59; 3.00 (2.0 - 4.0)	49; 5.00 (2.0 - 7.5)	0.018
BMI (n;m±SD kg/m²)	62; 45.51 ± 7.6	49; 43.74 ± 5.8	0.179
FPG (n;m±SD mg/dL)	63; 130.27 ± 38.5	49; 153.45 ± 56.1	0.015
FPI (n;md(P25-P75) uUI/mL)	63; 13.70 (10.1-23.5)	41; 18.50 (11.4-35.5)	0.040
A1c (n;m±SD %)	56; 6.77 ± 1.09	46; 7.43 ± 1.5	0.013
No DPT (n;%)	10; 15.9	2; 4.1	0.045
With DPT (n;%)	53; 84.1	47; 95.9	0.045
Under OAD (n;%)	53; 84.1	47; 95.9	0.045
Under IT (n;%)	3; 4.8	12; 24.5	0.005

LSG=laparoscopic sleeve gastrectomy; LRYGB=laparoscopic Roux-en-Y gastric bypass; T2D=type 2 diabetes; BMI=body mass index; FPG=fasting plasma glucose; FPI=fasting plasma insulin; A1c=glycated hemoglobin; DPT=diabetes pharmacological treatment; OAD=oral antidiabetics; IT=insulin therapy

At 1-year postoperative evaluation, both groups (LSG versus LRYGB) presented statistically significant improvements on BMI (-13.40±4.7 *vs* -13.55±5.3), FPG (-29.69±31.8 *vs* -47.23±53.0), fasting plasma insulin (FPI) (-8.74 (-15.6– (-3.4)) *vs* -18.70 (-30.7– (-10.8))), A1c (-0.85±0.9 *vs* -1.50±1.6), as well as a reduction in the prevalence of DPT (83.6% to 44.3% *vs* 95.8 to 47.9%) (Table 2).

Table 2. Comparison of Body Mass Index, Fasting Plasma Glucose, Fasting Plasma Insulin, glycated hemoglobin and prevalence of Diabetes pharmacological treatment at 0 and 12 months after Laparoscopic Vertical Sleeve Gastrectomy and Laparoscopic Roux-en-Y Gastric Bypass

	LSG		
Variables	**0 months**	**12 months**	***p***
BMI (n;m±SD kg/m²)	59; 45.09 ± 6.8	59; 31.70 ± 5.7	<0.001
FPG (n;m±SD mg/dL)	42; 125.05 ± 34.7	42; 95.36 ± 20.5	<0.001
FPI (n;md(P25-P75) uUI/mL)	39; 14.60 (9.8 – 23.4)	39; 5.12 (4.0 – 8.9)	<0.001
A1c (n;m±SD %)	37; 6.73 ± 1.1	37; 5.88 ± 1.1	<0.001
DPT (n;%)	51; 83.6	27; 44.3	<0.001
	LRYGB		
Variables	**0 months**	**12 months**	***p***
BMI (n;m±SD kg/m²)	47; 43.85 ± 5.9	47; 30.30 ± 3.7	<0.001
FPG (n;m±SD mg/dL)	40; 154.15 ± 52.7	40; 106.93 ± 36.9	<0.001
FPI (n;md(P25-P75) uUI/mL)	27; 24.30 (15.5 – 39.4)	27; 3.72 (2.8 – 8.7)	<0.001
A1c (n;m±SD %)	35; 7.42 ± 1.6	35; 5.92 ± 1.2	<0.001
DPT (n;%)	46; 95.8	23; 47.9	<0.001

LSG=laparoscopic sleeve gastrectomy; LRYGB=laparoscopic Roux-en-Y gastric bypass; BMI=body mass index; FPG=fasting plasma glucose; FPI=fasting plasma insulin; A1c=glycated hemoglobin; DPT=diabetes pharmacological treatment

Nevertheless, patients submitted to LRYGB presented greater reductions in mean FPI and mean A1c comparing with patients submitted to LSG (Table 3).

Table 3. Comparison of Body Mass Index, Fasting Plasma Glucose, Fasting Plasma Insulin, glycated hemoglobin, prevalence of Diabetes pharmacological treatment and Diabetes remission 12 months after Laparoscopic Vertical Sleeve Gastrectomy and Laparoscopic Roux-en-Y Gastric Bypass.

Variables	**12 months after LSG**	**12 months after LRYGB**	***p***
BMI (n;m±SD kg/m²)	59; - 13.40 ± 4.7	47; -13.55 ± 5.3	0.878
FPG (n;m±SD mg/dL)	42; -29.69 ± 31.8	40; -47.23 ± 53.0	0.076
FPI (n;md(P25-P75) uUI/mL)	39; -8.74 (-15.6 – (-3.4))	27; -18.70 (-30.7 – (-10.8))	0.001
A1c (n;m±SD %)	37; -0.85 ± 0.9	35; -1.50 ± 1.6	0.039
DPT (n;%)	27; 44.3	23; 47.9	0.704
Diabetes remission (n;%)	20; 40.0	17; 38.6	0.893

LSG=laparoscopic sleeve gastrectomy; LRYGB=laparoscopic Roux-en-Y gastric bypass; BMI=body mass index; FPG=fasting plasma glucose; FPI=fasting plasma insulin; A1c=glycated hemoglobin; DPT=diabetes pharmacological treatment

Patients submitted to LSG presented similar T2D remission rates to those of patients that underwent LRYGB (40.0% for LSG and 38.6 for LRYGB, *p*=0.893), and there were no differences in the number of patients under DPT at 12 months (44.3% for LSG and 47.9% for LRYGB, *p*=0.704) (Table 3).

Regarding differences between patients that presented or failed to achieve T2D remission at the 1-year postoperative evaluation, the first group was younger, presented lower baseline mean FPG and A1c and had a lower baseline prevalence of DPT and IT. Moreover, after surgery they presented a higher BMI reduction compared to patients that did not achieve T2D remission criteria (Table 4).

Table 4. Type 2 Diabetes remitters and non-remitters' characteristics

Variables	Remitters	Non-remitters	*p*
LSG proportion (n;%)	20; 54.1	30; 52.6	0.893
Female (n;%)	31; 41.9	43; 58.1	0.334
Age (n;m±SD years)	37; 44.59 ± 10.4	57; 52.21 ± 10.7	0.001
T2D duration (n;md(P25-P75) years)	37; 3.00 (1.5 – 5.0)	55; 4.00 (2.0 – 6.0)	0.076
BMI (n;m±SD kg/m²)	37; 44.55 ± 5.9	57; 44.40 ± 7.0	0.913
FPG (n;m±SD mg/dL)	37; 121.54 ± 28.9	57; 156.67 ± 56.1	<0.001
FPI (n;md(P25-P75) uUI/mL)	37; 17.60 (11.8 – 31.5)	49; 13.20 (9.9 – 25.1)	0.220
A1c (n;m±SD %)	36; 6.47 ± 1.1	50; 7.69 ± 1.4	<0.001
DPT (n;%)	29; 34.1	56; 65.9	0.002
IT (n;%)	0; 0	14; 100	0.002
BMI variation (n;m±SD Kg/m²)	37; -15.18 ± 5.0	55; -12.25 ± 4.8	0.006
Diabetes remission (n;%)	20; 40.0	17; 38.6	0.893

LSG=laparoscopic sleeve gastrectomy; T2D=type 2 diabetes; BMI=body mass index; FPG=fasting plasma glucose; FPI=fasting plasma insulin; A1c=glycated hemoglobin; DPT=diabetes pharmacological treatment; IT=insulin therapy

Logistic regression identified baseline A1c and age as predictors of T2D remission (OR=0.386 (95% CI: 0.223-0.668) and OR=0.938 (95% CI: 0.893-0.985), respectively) (Table 5).

Table 5. Predictors of type 2 diabetes remission

Variables	OR	95% CI	*p*
A1c (%)	0.386	0.223 – 0.668	0.001
Age (years)	0.938	0.893 - 0.985	0.011

Logistic regression. Included covariable: BMI variation. OR = odds ratio; 95% CI = 95% confidence interval; A1c=glycated hemoglobin; BMI=body mass index

Discussion

While previously thought to be a restrictive surgery, LSG has also effects in several gut hormones that ultimately promote insulin sensitivity and improve glucose homeostasis.[4,5,7] In fact, in this study patients submitted to both surgeries presented similar frequencies of T2D remission at the 1-year postoperative evaluation. The first studies that compared LSG and LRYGB efficacy in T2D treatment showed that remission occurred later in time and in a lesser magnitude in patients submitted to LSG.[4,6-8,10-13] Authors hypothesized that the procedures differed in the magnitude of hormonal alterations responsible for T2D remission.[6] The Oseberg study, a single-center, triple-blind, randomized controlled trial defined T2D remission as A1c ≤6.0% without the use of DPT at 1 year after surgery and concluded that remission rates were higher after LRYGB than after LSG.[28] On the contrary, a systematic review and meta-analysis from 2007 to 2012 revealed no statistically significant differences in T2D remission between LRYGB and LSG (76% and 68% at 1 year, respectively).[16] Recent studies applying ADA's T2D remission criteria demonstrated that LSG is as effective as LRYGB,5,7,11,13,16-18 with remission rates at 1 year of 37% in patients submitted to LSG and 42% in patients submitted to LRYGB.19 It is important to note that the use of these standardized criteria reduced the remission rates in both procedures.[20] The present study showed that patients submitted to LRYGB and LSG achieved 38.6% and 40.0% T2D remission, respectively, with no significant differences in the rate of T2D remission or in the number of patients under DPT at 12 months. Nevertheless, we must take into account that the baseline characteristics of these patients were different between the group submitted to LSG and LRYGB, as this last presented a higher frequency of patients under DPT and a superior IT prevalence. There were no differences in the reduction of BMI and FPG in both groups, although a significantly greater reduction in FPI and A1c levels was observed in patients submitted to LRYGB. In accordance with our results, SM-BOSS study showed that both procedures allowed significant weight loss at 1 year, without statistical differences.[29] Kashyap *et al*. showed no differences in weight loss between LRYGB and LSG at 4 weeks post-surgery, but FPG and FPI were further reduced with LRYGB. Moreover, it was evidenced that LRYGB was responsible for a greater decrease in insulin resistance, C-peptide level and insulin secretion and an increase in GLP-1 responsiveness to meal.[11] The STAMPEDE (Surgical Treatment and Medications Potentially Eradicate Diabetes Efficiently) study showed that LRYGB was responsible for a greater reduction in BMI, FPG, A1c and DPT compared to LSG. In fact, 28% of patients still needed DPT after LSG, whereas none of the patients was using glucose-lowering drugs 1 year after LRYGB.[17,21] These differences suggest that LRYGB could be superior in improving glycemic control comparing to LSG, and this might be explained by the pattern of hormonal response that seems to be slightly different from the one elicited by LSG. After LRYGB there seems to be a reduced secretion of amylin, cholecystokinin and lower responsiveness to PP, associated to an increase in bile acids. There is also a reduction in ghrelin and an elevation in GLP-1 and PYY.[7,21,30] Moreover, the length of the gastro-intestinal tract bypass has weight loss-independent effects in glycemic control.[31] It has been hypothesized that the rapid metabolic improvement that occurs after LRYGB is one of the key factors affecting T2D remission and latter, the recurrence rates. On the other hand, LSG is responsible for diminishing ghrelin, elevating GLP-1 and PYY and improving responsiveness to glucagon and PP. The lack of interference with amylin and cholecystokinin and the absence of a gastro-intestinal tract bypass may explain the lower remission rates previously reported in patients submitted to LSG.[4,21]

Several predictive factors for T2D remission have been described in literature, such as baseline BMI, age, gender, initial FPG, baseline A1c, BMI postoperative reduction, T2D duration, preoperative treatment with insulin, C-peptide level, type of surgery, baseline waist circumference and visceral fat area.[5,7,10,12,15,19,20,25,32] Higher T2D re-

mission rates have been documented in patients with better glycemic control and younger age, irrespectively of initial BMI and type of surgery.[8,15,19,22,25] Recent studies aimed to verify the efficacy of both procedures in diabetic patients with BMI <35 kg/m² and Panunzi *et al* and Xiao Du *et al* concluded that T2D remission rates were similar in patients with BMI <35 kg/m² and BMI ≥35 kg/m².[22,23] Ramirez et al demonstrated similar improvement in glycemic control 1 year after metabolic surgery, despite different baseline BMI, reinforcing that initial BMI is not a predictor of T2D remission.[19,20,24] The majority of studies have suggested that the type of surgery and gender do not influence T2D remission.[7,19-22,25] Several authors reported that a shorter duration of T2D may independently predict higher T2D remission rates and lower risk of relapse.[7,12,15,20,21,32-34] In a previous study,[7] a strong correlation between BMI reduction and insulin sensitivity improvement was found, with no statistically significant differences between LRYGB and LSG. Although the metabolic alterations responsible for the improvement of glycemic control remain uncertain, the weight reduction and the consequent increase in insulin sensitivity emerge as potential mechanisms.[5,7,19] Whether this effect is exclusively dependent of weight loss is still controversial.[19] On the other hand, some studies reported no influence of BMI variation in T2D remission, in accordance with our study results.[19]

In this study patients that presented T2D remission were younger, had lower A1c, lower FPG, lower prevalence of DPT or IT and experienced a superior BMI reduction at the 1-year postoperative evaluation, compared to patients that failed to achieve T2D remission. Baseline A1c and age emerged as predictors of T2D remission in the logistic regression model. Our results are in accordance with other that evidenced that baseline A1c and age correlate negatively with T2D remission.[8,15,22] There were no differences in mean age between patients submitted to LSG and LRYGB, which may explain the similar T2D remission rates. On the other hand, the fact that patients submitted to LSG had lower baseline A1c might have favored their T2D remission rates.

LSG might be an option to treat patients with obesity and T2D, although LRYGB could cause a greater improvement in glycemic control. Nevertheless, LSG is a simpler technic with lower morbidity and efficacy in weight loss and control of comorbidities such as T2D. It also has other advantages like accessibility to gastrointestinal tract, absence of anastomosis, minimal nutritional deficiencies and better food tolerance and quality of life.[6,38]

Independently of the type of surgery, we conclude that younger patients with better glycemic control will have greater odds of achieving T2D remission. Thus, it is fundamental to optimize preoperative A1c in order to aim for the best results. Regarding age, younger patients may have better odds of having T2D remission, so future studies should focus on what is the best age to have surgery aiming to achieve T2D remission, while minimizing adverse effects from the surgeries.

This study has some limitations that deserve comment. First, it was a retrospective study with an associated bias not susceptible to rule out. Second, the sample size was small, thus it is possible that the power was insufficient to detect differences in some outcomes. Third, there were some missing variables at 0 and/or 12 months. Finally, there were differences in the initial characteristics of the patients submitted to LRYGB versus LSG that could have affected the 1-year post surgery outcomes.

Conclusion

In this study, 1 year after bariatric surgery, patients submitted to LSG and LRYGB presented similar rates of T2D remission. Patients submitted to LSG also presented mean BMI and FPG reductions similar to patients submitted to LRYGB. In our regression model, age and baseline A1c were found to be predictive of T2D remission. Thus, younger patients with better T2D control and optimized preoperative A1c have better chances to attain T2D remission, independently of the type of surgery.

Future studies are necessary to evaluate the duration of T2D remission after metabolic surgery and to explore differences in long-term remission between both surgeries.

Responsabilidades Éticas

Conflitos de Interesse: Os autores declaram a inexistência de conflitos de interesse na realização do presente trabalho.
Fontes de Financiamento: Não existiram fontes externas de financiamento para a realização deste artigo.
Confidencialidade dos Dados: Os autores declaram ter seguido os protocolos da sua instituição acerca da publicação dos dados de doentes.
Proteção de Pessoas e Animais: Os autores declaram que os procedimentos seguidos estavam de acordo com os regulamentos estabelecidos pelos responsáveis da Comissão de Investigação Clínica e Ética e de acordo com a Declaração de Helsínquia de 2013 da Associação Médica Mundial.
Proveniência e Revisão por Pares: Não comissionado; revisão externa por pares.

Ethical Disclosures

Conflicts of interest: The authors have no conflicts of interest to declare.
Financing Support: This work has not received any contribution, grant or scholarship
Confidentiality of Data: The authors declare that they have followed the protocols of their work center on the publication of data from patients.
Protection of Human and Animal Subjects: The authors declare that the procedures were followed according to the regulations established by the Clinical Research and Ethics Committee and to the 2013 Helsinki Declaration of the World Medical Association.
Provenance and Peer Review: Not commissioned; externally peer reviewed.

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