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ORIGINAL CONTRIBUTIONS

A Prospective Single-Arm Trial of Modified Long Biliopancreatic and Short Alimentary Limbs Roux-En-Y Gastric Bypass in Type 2 Diabetes Patients with Mild Obesity

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Abstract
Background Type-2 diabetes (T2D) patients with body mass index (BMI) below 35 kg/m^2 carry lower remission rates than severely obese T2D individuals submitted to "standard limb lengths" Roux-en-Y gastric bypass (RYGB). Mild-obese patients appear to have more severe forms of T2D, where the mechanisms of glycemic control after a standard-RYGB may be insufficient. The elongation of the biliopancreatic limb may lead to greater stimulation of the distal intestine, alterations in bile acids and intestinal microbiota, among other mechanisms, leading to better metabolic outcomes. The aim of this study is to evaluate the safety and efficacy of the RYGB with a biliopancreatic limb of 200 cm in the control of T2D in patients with BMI 30–35 kg/m^2.
Methods From January 2011 to May 2015, 102 T2D patients with BMI from 30 to 34.9 kg/m^2 underwent laparoscopic RYGB with the biliopancreatic-limb of 200 cm and the alimentary-limb of 50 cm.
Results There were no deaths or reoperations. The mean follow-up was 28.1 months. The mean BMI dropped from 32.5 to 25.1 kg/m^2, while the mean fasting glucose decreased from 182.9 to 89.8 mg/dl and the mean glycated hemoglobin (HbA1c) went from 8.7 to 5.2%. During follow-up, 92.2% had their T2D under complete control (HbA1c < 6%, no anti-diabetic medications), while 7.8% were under partial control. Control of hypertension and dyslipidemia were 89.4 and 85.5%, respectively. No patient developed hypoalbuminemia, and there were mild micronutrient deficiencies.
Conclusions RYGB with long-biliopancreatic and short-alimentary limbs is safe and seems effective in achieving complete control of T2D in patients with BMIs between 30 and 35 kg/m^2.

Keywords Long biliopancreatic limb · Roux-en-Y gastric bypass · Metabolic surgery in mild obesity · Type-2 diabetes

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Introduction

Roux-en-Y gastric bypass (RYGB) is one of the most common bariatric operations performed worldwide, allowing excess weight loss about 65–70% and adequate long-term control of comorbidities, mainly type 2 diabetes (T2D) [1]. Considering patients with BMI greater than 35 kg/m^2, RYGB offers diabetes remission rate around 80% [2]. However, in patients with BMIs below 35 kg/m^2, complete diabetes remission rate published in literature may be lower, generally between 25 and 55% [3–7]. A standard RYGB may be defined as an operation with a small gastric pouch and alimentary limbs measuring from 100 to 150 cm and biliary limbs with 50 to 100 cm. Although there are good results of "conventional standard limbs" RYGB [8] in patients with BMI below 35 kg/m^2, in most of the published studies, standard RYGB has failed to achieve high rates of T2D remission in this lower BMI population. Those different results may be influenced by the selection criteria, time of history of the disease, or the more complex and severe presentation in the lower BMI ranges. It may be possible that this subgroup of patients has a decreased β cell function and a lower degree of insulin resistance [6].

The traditional restriction and malabsorption mechanisms of bariatric surgery do not explain most of the metabolic effects of the procedures [9, 10]. Several other mechanisms have been proposed that may help explaining some weight-independent antidiabetic effects, as intestinal reprogramming and adaptation [11], gut hormones [12], bile acids [13], microbiota [14], and proximal bowel exclusion [15].

Some studies suggested that the elongation of the alimentary limb do not have metabolic implications; thus, enlarging seems to be unnecessary [16]. On the other hand, at least as demonstrated in rodents, enlarging the biliopancreatic limb may lead to better metabolic outcomes in T2D patients, enhancing the mechanisms of improvement after surgery [17].

This is a prospective single-arm study that aims to evaluate the efficacy and safety of the RYGB with a 200-cm-long biliopancreatic limb and an alimentary limb of 50 cm in the control of T2D in patients with BMIs between 30 and 35 kg/m^2. The secondary endpoint is to evaluate the efficacy of this model of RYGB in the control of hypertension and dyslipidemia.

Methods

Among 180 recruited, 102 T2D patients with BMIs between 30 and 34.9 kg/m^2 were included in this prospective single-arm study. All underwent a laparoscopic RYGB with a biliopancreatic limb of 200 cm and an alimentary limb of 50 cm, from January 2011 to May 2015, at the Center for Bariatric and Metabolic Surgery of São Domingos Hospital, in São Luís, Maranhão, Brazil. Other inclusion criteria included at least 2 years of T2D, 18 to 65 years old, fasting C-peptide ≥ 1 ng/ml, and blood tests to rule out autoimmune diabetes. Consolidated Standards of Reporting Trials (CONSORT) diagram is displayed in Fig. 1. This study was approved by the local institutional review board, and all patients signed a written informed con sent when recruited. Retention rate was 100%.

Before the operation, the data collected included: sex, age, weight, height, BMI, time of T2D diagnosis, fasting plasma glucose, glycated hemoglobin (HbA1c), C-peptide, use of anti-diabetic medications and/or insulin, and the presence of comorbidities such as dyslipidemia and hypertension.

Laparoscopic RYGB started with the construction of a small gastric pouch with around 75 ml. The biliopancreatic limb had 200 cm in all cases and the alimentary limb, 50 cm. The gastrojejunal (GJ) anastomosis and the jejunojejunostomy were hand-sewn. The GJ anastomosis was uncalibrated with a mean diameter of 2 cm.

Four surgeons were responsible for conducting the operations, and during the procedures, an assistant was in charge to re-verify the lengths. The alimentary and the biliopancreatic limb measurement were performed employing a 10-cm mark applied in a bowel grasper from its tip. The limb was not overstretched during measurement. Operative time and perioperative complications were noted.

The diagnosis of diabetes was based on the American Diabetes Association criteria [18], while hypertension after the Seventh Report of the Joint National Committee criteria [19]. Dyslipidemia followed the American Heart Association criteria [20].

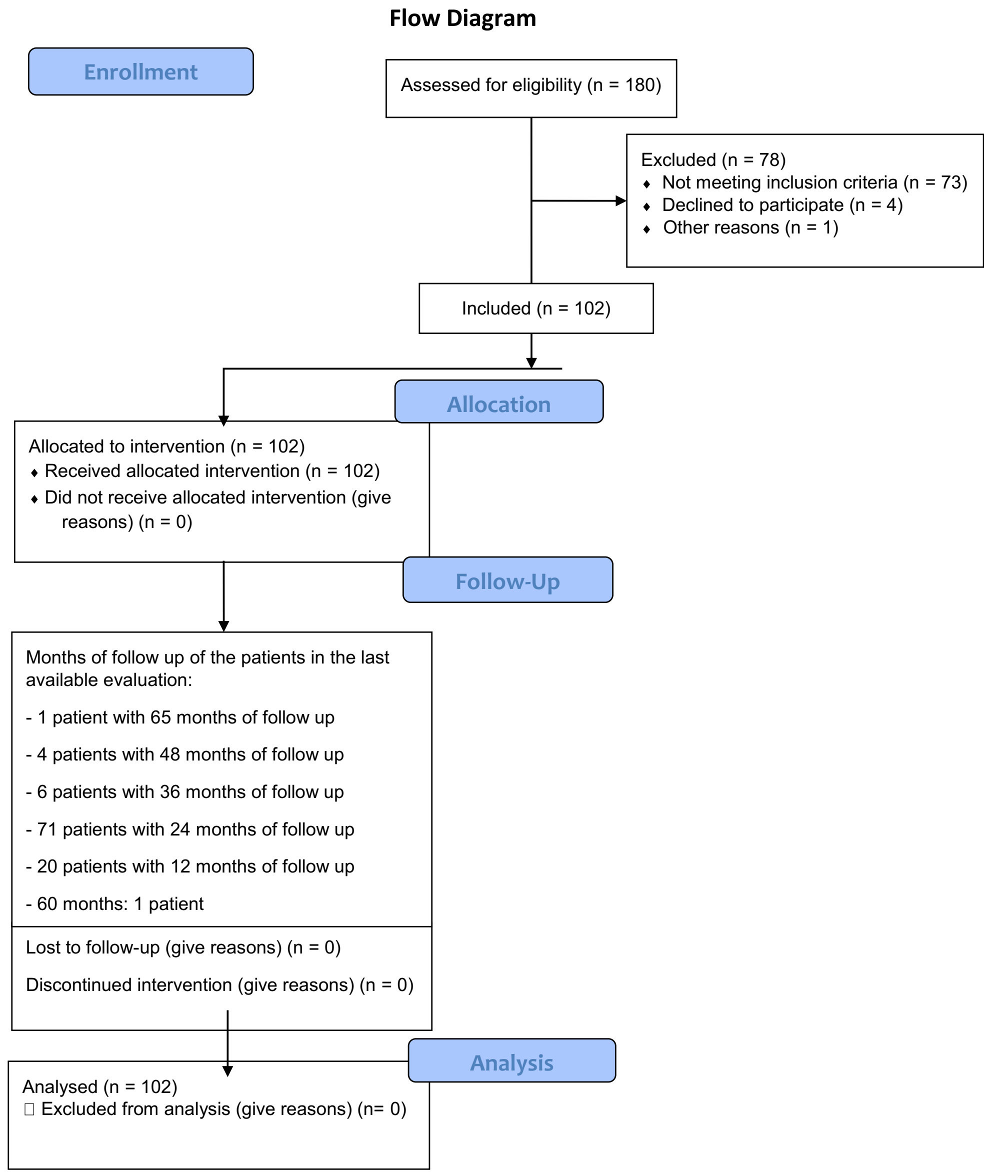
Weight, BMI, fasting plasma glucose, HbA1c, serum albumin, lipid profile, and evaluation for the presence of hypertension were assessed in different time points. Also, patients were asked about their frequency of bowel movements per day.

T2D complete control was considered if the patient achieved HbA1c < 6.0% in the absence of hypoglycemic medications. Partial control was defined when the patient had one of the following conditions: HbA1c between 6.0 and 6.5%, with or without the use of anti-diabetic medications and HbA1c below 6.0% with the use of anti-diabetic medications.

Hypertension control was defined when blood pressure was below 140 × 90 mmHg without medication. Dyslipidemia was considered controlled when low-density lipoprotein (LDL) was below 130 mg/dl, high-density lipoprotein (HDL) was above 40 mg/dl, and triglycerides were below 150 mg/dL, without any pharmacological agent.

Serum albumin level was the criterion chosen to assess nutritional safety. Hypoalbuminemia was defined when serum albumin level was below 3.5 g/dL and was a standard measure in all patients from 1 to 5 years of postoperative follow up. During the first postoperative year, albumin levels were assessed three times and every 12 months afterwards until their latest follow up. Other micronutrients were assessed on baseline as well during follow up, as serum levels of iron, folic acid, ferritin, calcium, and vitamins B12 and D. Zinc, copper and vitamins A, B1, and E were not measured at baseline, only at the follow up. All patients were advised to follow a regular diet, with higher protein intake through food or whey protein supplementation and multivitamins.

Fig. 1 CONSORT (Consolidated Standards Of Reporting Trials)



Fifty-one men and 51 women were operated. The main baseline patient's information are shown in Table 1.

Data were presented as mean (standard deviation (SD)), mean (min-max), mean (95% confidence intervals), or counts (percentage). For continuous variables, Student's *t* test for dependent groups was used to investigate changes from baseline. For dichotomous outcomes, frequencies were compared by McNemar test. A $p < 0.05$ was considered statistically significant. All data analyses were carried out with SPSS version 20.0 (Chicago, IL, USA).

Results

There were no conversions to open surgery, reoperations, or operative mortality. Patients had a mean hospital stay of 2.2 days (2–5 days). The mean operative time was 89 min (68–162 min). There were two (1.9%) major postoperative complications, defined as conditions that required hospital readmission—one acute pulmonary edema and one upper

Table 1 Baseline patient's demographics

Variable	
Gender (male/female)	51 / 51
Mean age (years)	50.8
Mean time of T2D diagnosis (years)	10.4
Insulin use (%)	44 (43.1)
Mean C-peptide (ng/dl)	3.6
Hypertension (%)	57 (55.8)
Dyslipidemia (%)	83 (81.3)

gastrointestinal bleeding that were medically managed. There were three (2.9%) port site infections that were treated in an outpatient basis and considered minor events.

The mean postoperative follow-up was 28.1 ± 8.1 months (12–65 months). The mean frequency of bowel movements per day was 1.8 movements (1–4 movements), with 99% of the patients with a frequency between 1 and 3 movements. Postoperative outcomes are summarized in Table 2. No patient presented hypoalbuminemia up to the longest follow up visit, and micronutrient outcomes compared with baseline information are listed in Table 3.

At the latest follow up, the rate of T2D complete control was 92.2%. The remaining patients were in partial control of the disease. In this follow-up point, hypertension and dyslipidemia control rates were 89.4 and 85.5%, respectively.

The evolution of BMI, fasting plasma glucose, and HbA1c in the first 36 months is shown in Fig. 2.

Table 3 Micronutrients insufficiency at baseline and at the longest follow-up visit

	Baseline outcomes (deficiency)	Longest follow up outcomes (deficiency)
Iron	2/102 (1.9%)	10/102 (9.8%)
Ferritin	1/102 (0.9%)	11/102 (10.8%)
Ionic calcium	3/102 (2.9%)	10/102 (9.8%)
Copper	Non assessed	9/102 (8.8%)
Zinc	Non assessed	14/102 (13.7%)
Vitamin A	Non assessed	6/102 (5.9%)
Vitamin B1	Non assessed	4/102 (3.9%)
Vitamin B12	2/102 (1.9%)	13/102 (12.7%)
Vitamin D	38/102 (37.2%)	49/102 (48%)
Vitamin E	Non assessed	4/102 (3.9%)
Folic acid	1/102 (0.9%)	2/102 (2%)

Discussion

Although RYGB has been performed for decades, there are few studies on the influence of the length of the intestinal limbs over diabetes remission. Kaska et al. compared short and long biliopancreatic limbs (up to 150 cm) and showed a higher rate of complete remission of T2D among patients who underwent an RYGB with longer biliopancreatic limbs [21]. A randomized controlled trial, published in 2008, revealed the superiority in T2D control with longer limbs RYGB [22]. In this trial, both the alimentary and biliopancreatic limbs were enlarged, making it difficult to disclose the primary factor for improvement in the "enlarged limbs" group.

In the current study, figuring a RYGB with a biliopancreatic limb of 200 cm, there was a high glycemic control rate, with more than 92% of patients in complete control of T2D during follow-up. This result is far superior to other RYGB publications on the same BMI range (30 to 35 kg/m^2), where results of complete T2D remission (or complete control) ranged from 25 to 55% [3–7]. Schauer et al. reported HbA1c below 6.0 without diabetes medication in only 22.4% of patients with BMI between 27 and 43, who were submitted to a RYGB with a biliopancreatic limb of 50 cm. It should be noticed that Schauer's randomized controlled trial had a reduced number of patients with BMI below 35 kg/m^2 and had a 5-year follow-up [23].

Several mechanisms have been associated with glycemic control after bariatric/metabolic surgery, including calorie restriction and weight loss, duodenal and proximal bowel exclusion, stimulation of the distal intestine, alteration in bile acids levels and flow, and change of the intestinal microbiota [24]. Greater incretin stimulation [25, 26] after a 200-cm biliopancreatic limb was already reported. The role of the proximal bowel was exhaustively studied in elegant animal models, and apparently, the longer the extent of the duodenal/jejunal exclusion, the greater the effect over insulin sensitivity and intestinal glucose disposal [11, 27]. Beneficial biliary acid alterations and intestinal microbiota changes were associated with a long biliopancreatic limb in a study in rodents [17]. Greater weight loss was also associated with longer biliopancreatic limb [28].

Therefore, of the known mechanisms of glycemic control in bariatric/metabolic surgery, at least five of them (distal/incretin stimulation, proximal bowel exclusion, alterations in bile acids, alterations in microbiota and weight loss) can be optimized with the elongation of the biliopancreatic limb.

Biliopancreatic limbs of 200 cm were also employed by Nora et al. and Lanzarini et al. In the study by Nora et al., 100% of the patients achieved T2D remission after 36 months of follow-up, although the study had only patients with BMI over 35 kg/m^2,

Table 2 Comparison of metabolic outcomes (pre and at the longest follow up)

Variables	Preoperative mean (SD)	Postoperative mean (SD)	*P* value
BMI (kg/m^2)	32.5 ± 1.5	25.1 ± 2.0	< 0.001
Fasting plasma glucose (mg/dL)	182.9 ± 34.8	89.8 ± 7.25	< 0.001
HbA1c (%)	8.7 ± 1.35	5.2 ± 0.53	< 0.001
Hypertension (%)	55.8	5.8	< 0.001
Dyslipidemia (%)	81.3	11.7	< 0.001

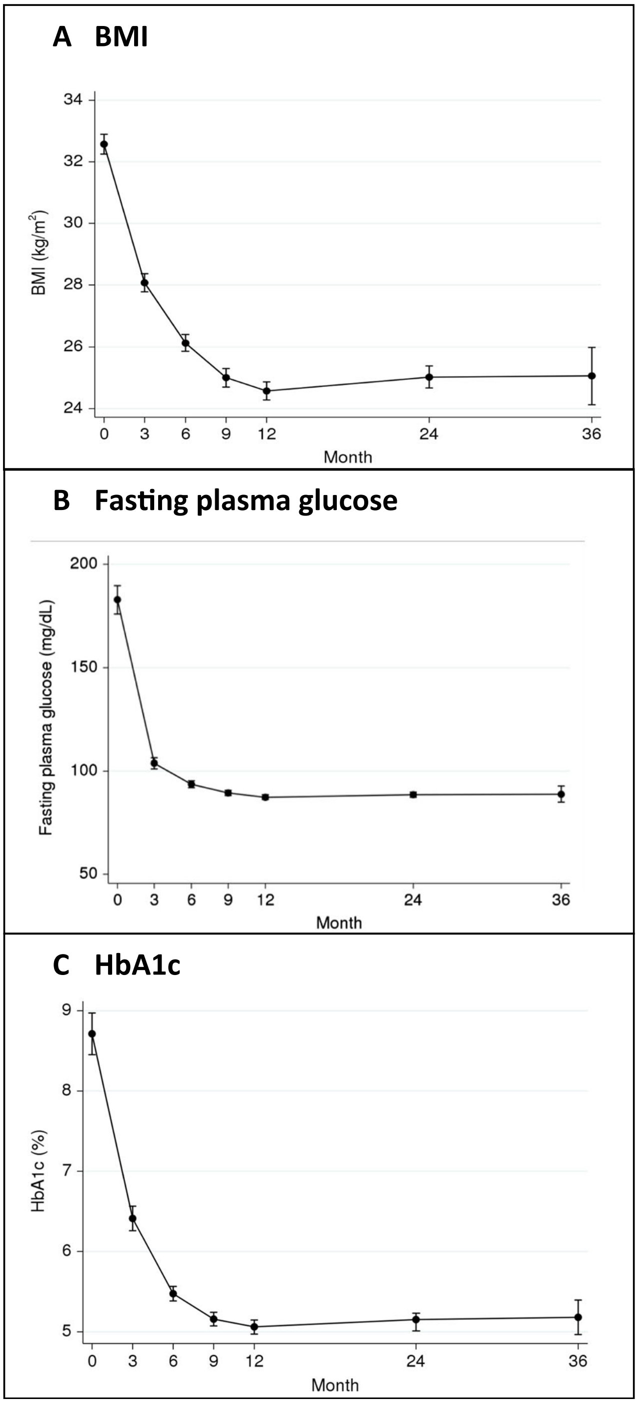


Fig. 2 Evolution of the BMI (**a**). Fasting plasma glucose (**b**). HbA1c (**c**). Results are presented as mean (95% confidence intervals). Estimates are based on 102 participants from baseline to 12 months of follow-up, 82 patients at 24 months, and 11 patients at 36 months

with less severe diabetes and used HbA1c < 6.5% as complete remission criterion [29]. Lanzarini et al., employing analog remission criteria as in the present study, reached 93.6% of complete T2D control in a 36-month follow-up [30], but with a considerably smaller number of patients.

Cohen et al., in 2012, reported that an RYGB with a 100-cm biliopancreatic limb performed in patients with BMI range of 30–35 kg/m^2, achieved 88% of the patients in complete remission in 6 years of follow up [8]. This is comparable with the current study, within the same BMI range, and longer follow-up. But the complete remission criteria used in the study by Cohen et al. was HbA1c < 6.5% without medication, different of the current study's criteria (HbA1c < 6.0% without medication). This fact possibly explains the almost similar results between these two distinct models of RYGB.

Despite the fact that the aim of enlarging the biliopancreatic is to improve the metabolic effect, the exclusion of much of the proximal intestine may potentially increase the risk of nutritional problems. However, the elongation to 200 cm of the biliopancreatic limb was not associated with protein malnutrition, as demonstrated in this study, where none of the patients presented hypoalbuminemia, at least at that time of follow up. The present study also showed mild micronutrient deficiency. To avoid postoperative nutritional problems, the longest possible common limb was left, so a 50-cm Roux limb was used, just enough to prevent significant alkaline reflux. In a study comparing the outcomes of RYGB with long alimentary limb versus long biliopancreatic limb, there was no difference in gastroesophageal reflux disease between groups with a Roux limb of 60 and 150 cm [28]. The length of the biliopancreatic limb seems to be the only variable that translates into significant metabolic improvement. Given the current understanding that malabsorption is not a fundamental mechanism behind the positive metabolic effects after surgery, the elongation of the Roux limb while reducing the common channel achieves limited metabolic outcomes, imposing higher nutritional risks [31–33]. The measurement of the Roux limb of the present study differed from those used in the studies of Nora et al. and Lanzarini et al., who used Roux limbs of 120 and 100 cm, respectively. However, although they have performed longer Roux limbs, and therefore probably shorter common channels, those studies did not report protein malnutrition as well [29, 30].

In addition of being nutritionally safe, the elongation of the biliopancreatic limb to 200 cm does not seem to lead to excessive weight loss. In the current study, the mean BMI has fallen from 32.5 to 25.1 kg/m^2, while in Lanzarini's et al. series, the mean BMI dropped from 33.1 to 24.7 [30]. That reinforces the nutritional safety to recommend metabolic surgery for patients with mild obesity, even being a RYGB with a longer biliopancreatic limb. It is important to highlight that in the present study, a wide uncalibrated gastro-jejunal anastomosis was made, allowing better food adaptation without significant restriction. The aim of this RYGB model with a 200-cm biliopancreatic and 50-cm alimentary limbs is to optimize the metabolic component of the procedure, avoiding mechanical restriction and malabsorption, probably contributing to the non-excessive weight loss.

Despite the longer proximal exclusion in this model of RYGB, the frequency of bowel movements had a mean of 1.8 movements per day, much lower than the mean frequency after malabsorptive procedures, as the biliopancreatic diversions with duodenal switch or Scopinaro's technique, which have a mean frequency of 3.2 and up to 4 movements per day, respectively [34, 35].

Other relevant data were the high control rates of hypertension and dyslipidemia (89.4 and 85%, respectively), better than some reports following conventional RYGB in lower BMIs [23]. Despite the fact that GLP-1 and bile acids seem to influence the regulation of blood pressure and lipid metabolism [36–40], the reasons behind the high remission rates of hypertension and dyslipidemia in this model of RYGB are still to be elucidated.

Although the results of this study are compelling and draw attention to this subject, we acknowledge some limitations: it is a prospective single-arm study with relatively short follow-up, and the long-term durability of the metabolic effect was not assessed in this communication. Randomized controlled trials are necessary to validate the metabolic superiority of the long biliopancreatic and short alimentary limbs RYGB, compared to the conventional model of RYGB and shift the paradigm on the mechanisms involved in this operation.

Conclusion

Long biliopancreatic and short alimentary limbs RYGB is safe and seems effective in achieving complete control of type 2 diabetes in patients with BMI 30 to 35 kg/m^2, as well as control of hypertension and dyslipidemia, without excessive weight loss and malnutrition, in short and midterm follow up. Although not definitive, this unicentric prospective trial stimulates further research on comparing long biliopancreatic and short alimentary RYGB versus "standard" limbs RYGB in a randomized controlled trial.

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Compliance with Ethical Standards

Conflict of Interest The authors declare that they have no conflict of interest.

Ethical Approval IRB approved.

Informed Consent Obtained for every patient.

References

1. Angrisani L, Santonicola A, Iovino P, et al. Bariatric surgery worldwide 2013. Obes Surg. 2015;25(10):1822–32.
2. Buchwald H, Estok R, Fahrbach K, et al. Weight and type 2 diabetes after bariatric surgery: systematic review and meta-analysis. Am J Med. 2009;122(3):248–56.
3. Hsu CC, Almulaifi A, Chen JC, et al. Effect of bariatric surgery vs medical treatment on type 2 diabetes in patients with body mass index lower than 35: five-year outcomes. JAMA Surg. 2015;150(12):1117–24.
4. Xu L, Yin J, Mikami DJ, et al. Effectiveness of laparoscopic roux-en-Y gastric by-pass on obese class I type 2 diabetes mellitus patients. Surg Obes Relat Dis. 2015;11(6):1220–6.
5. Scopinaro N, Adami GF, Papadia FS, et al. Effects of gastric bypass on type 2 diabetes in patients with BMI 30 to 35. Obes Surg. 2014;24(7):1036–43.
6. Lee WJ, Chong K, Chen CY, et al. Diabetes remission and insulin secretion after gastric by-pass in patients with body mass index <35 kg/m2. Obes Surg. 2011;21(7):889–95.
7. Boza C, Valderas P, Daroch DA, et al. Metabolic surgery: roux-en-Y gastric bypass and variables associated with diabetes remission in patients with BMI <35. Obes Surg. 2014;24(8):1391–7.
8. Cohen RV, Pinheiro JC, Schiavon CA, et al. Effects of gastric bypass surgery in patients with type 2 diabetes and only mild obesity. Diabetes Care. 2012;35(7):1420–8.
9. Madan AK, Tichansky DS, Phillips JC. Does pouch size matter? Obes Surg. 2007;17(3):317–20.
10. Odstrcil EA, Martinez JG, Santa Ana CA, et al. The contribution of malabsorption to the reduction in net energy absorption after long-limb roux-en-Y gastric by-pass. Am J Clin Nutr. 2010;92(4):704–13.
11. Saeidi N, Meoli L, Nestoridi E, et al. Reprogramming of intestinal glucose metabolism and glycemic control in rats after gastric by-pass. Science. 2013;341(6144):406–10.
12. Holst JJ, Madsbad S. Mechanisms of surgical control of type 2 diabetes: GLP-1 is key factor. Surg Obes Relat Dis. 2016;12(6):1236–42.
13. Trabelsi MS, Lestavel S, Staels B, et al. Intestinal bile acid receptors are key regulators of glucose homeostasis. Proc Nutr Soc. 2016;16:1–11. [Epub ahead of print]
14. Kaska L, Sledzinski T, Chomiczewska A, et al. Improved glucose metabolism following bariatric surgery is associated with increased circulating bile acid concentrations and remodeling of the gut microbiome. World J Gastroenterol. 2016;22(39):8698–719.
15. Rajagopalan H, Cherrington AD, Thompson CC, et al. Endoscopic duodenal mucosal resurfacing for the treatment of type 2 diabetes: 6-month interim analysis from the first-in-human proof-of-concept study. Diabetes Care. 2016;39(12):2254–61.
16. Müller MK, Räder S, Wildi S, et al. Long-term follow-up of proximal versus distal laparoscopic gastric by-pass for morbid obesity. Br J Surg. 2008;95(11):1375–9.
17. Miyachi T, Nagao M, Shibata C, et al. Biliopancreatic limb plays an important role in metabolic improvement after duodenal-jejunal bypass in a rat model of diabetes. Surgery. 2016;159(5):1360–71.
18. Chamberlain JJ, Rhinehart AS, Shaefer Jr CF, et al. Diagnosis and management of diabetes: synopsis of the 2016 American Diabetes Association Standards of Medical Care in Diabetes. Ann Intern Med. 2016;164(8):542–52.
19. Chobanian AV, Bakris GL, Black HR, et al. Seventh report of the joint national committee on prevention, detection, evaluation, and treatment of high blood pressure. Hypertension. 2003;42(6):1206–52.
20. Stone NJ, Robinson JG, Lichtenstein AH, et al. 2013 ACC/AHA guideline on the treatment of blood cholesterol to reduce atherosclerotic cardiovascular risk in adults: a report of the American College of Cardiology/American Heart Association task force on practice guidelines. J Am Coll Cardiol. 2014; 63 (25 Pt B): 2889-2934
21. Kaska L, Kobiela J, Proczko M, et al. Does the length of the biliary limb influence medium-term laboratory remission of type 2 diabetes mellitus after roux-em-Y gastric by-pass in morbidly obese patients? Wideochir Inne Tech Maloinwazyjne. 2014;9(1):31–9.

22. Pinheiro JS, Schiavon CA, Pereira PB, et al. Long-long limb roux-en-Y gastric by-pass is more efficacious in treatment of type 2 diabetes and lipid disorders in super-obese patients. Surg Obes Relat Dis. 2008;4(4):521–5.
23. Schauer PR, Bhatt DL, Kirwan JP, et al. Bariatric surgery versus intensive medical therapy for diabetes—5-year outcomes. N Engl J Med. 2017;376(7):641–51.
24. Cummings DE. Endocrine mechanisms mediating remission of diabetes after gastric bypass surgery. Int J Obes. 2009;33(Suppl 1):S33–40.
25. Guedes TP, Martins S, Costa M, et al. Detailed characterization of incretin cell distribution along the human small intestine. Surg Obes Relat Dis. 2015;11(6):1323–31.
26. Nergård BJ, Lindqvist A, Gislason HG, et al. Mucosal glucagon-like peptide-1 and glucose-dependent insulinotropic polypeptide cell numbers in the super-obese human foregut after gastric bypass. Surg Obes Relat Dis. 2015;11(6):1237–46.
27. Salinari S, le Roux CW, Bertuzzi A, et al. Duodenal-jejunal bypass and jejunectomy improve insulin sensitivity in Goto-Kakizaki diabetic rats without changes in incretins or insulin secretion. Diabetes. 2014;63(3):1069–78.
28. Nergaard BJ, Leifsson BG, Hedenbro J, et al. Gastric bypass with long alimentary limb or long pancreato-biliary limb—long-term results on weight loss, resolution of co-morbidities and metabolic parameters. Obes Surg. 2014;24(10):1595–602.
29. Nora M, Guimarães M, Almeida R, et al. Metabolic laparoscopic gastric bypass for obese patients with type 2 diabetes. Obes Surg. 2011;21(11):1643–9.
30. Lanzarini E, Csendes A, Gutierrez L, et al. Type 2 diabetes mellitus patients with mild obesity: preliminary results of surgical treatment. Obes Surg. 2013;23(2):234–40.
31. Inabnet WB, Quinn T, Gagner M, et al. Laparoscopic roux-en-Y gastric bypass in patients with BMI <50: a prospective randomized trial comparing short and long limb lenghts. Obes Surg. 2005;15(1):51–7.
32. Kellum JM, Chikunguwo SM, Maher JW, et al. Long-term results of malabsorptive distal roux-en-Y gastric bypass in superobese patients. Surg Obes Relat Dis. 2011;7(2):189–93.
33. Risstad H, Svanevik M, Kristinsson JA, et al. Standard vs distal roux-en-Y gastric bypass in patients with body mass index 50 to 60: a double-blind. Randomized Clinical Trial JAMA Surg. 2016;151(12):1146–55.
34. Marceau P, Biron S, Hould FS, et al. Duodenal switch: long-term results. Obes Surg. 2007;17(11):1421–30.
35. Scopinaro N, Gianetta E, Adami GF, et al. Biliopancreatic diversion for obesity at eighteen years. Surgery. 1996;119(3):261–8.
36. Maiz C, Alvarado J, Quezada N, et al. Bariatric surgery in 1119 patients with preoperative body mass index<35 (kg/m(2)): results at 1 year. Surg Obes Relat Dis. 2015;11(5):1127–32.
37. Wang B, Zhong J, Lin H, et al. Blood pressure-lowering effects of GLP-1 receptor agonists exenatide and liraglutide: a meta-analysis of clinical trials. Diabetes Obes Metab. 2013;15(8):737–49.
38. Katout M, Zhu H, Rutsky J, et al. Effect of GLP-1 mimetics on blood pressure and relationship to weight loss and lowering glycemia: results of a systematic meta-analysis and meta-regression. Am J Hypertens. 2014;27(1):130–9.
39. Dallinga-Thie GM, Nieuwdorp M. GLP-1, an important regulator of intestinal lipid metabolism. Arterioscler Thromb Vasc Biol. 2015;35(5):1048–9.
40. Schonewille M, de Boer JF, Groen AK. Bile salts in control of lipid metabolism. Curr Opin Lipidol. 2016;27(3):295–301.