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ORIGINAL CONTRIBUTIONS

Increase in Protein Intake After 3 Months of RYGB Is an Independent Predictor for the Remission of Obesity in the First Year of Surgery

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Abstract

Introduction Although bariatric surgery promotes dietary changes, many questions regarding their effect on weight loss remain unanswered.

Objective The aim of this study was to evaluate changes in dietary intake and predictive factors of obesity remission in the first 12 months after RYGB.

Methods Fifty-one patients (mean 39.34 ± 9.38 years, 68.7% women) who underwent RYGB were included in this study. Dietary intake was evaluated through a 24-h dietary recall and subsequently classified by NOVA, macronutrients and calories. The predictive factors for obesity remission within 12 months after RYGB were evaluated by Cox regression.

Results At baseline, 62.7% of the patients presented severe obesity; mean excess weight loss was greater than 80% after 1 year of surgery and about 70% of the patients were no longer diagnosed with obesity. An increase in percentage of calories from protein was observed at 3 and 12 months after surgery. The caloric contribution of ultra-processed foods was low at 3 months after surgery while that of unprocessed or minimally processed foods was high at 3 and 12 months after surgery. From the Cox regression analysis, preoperative BMI (HR, 0.78; 95% CI, 0.69–0.88) and age (HR, 0.94; 95% CI, 0.89–0.99) showed an inverse association with obesity remission. Also, Δ protein (at 3 months–baseline) showed a positive association with obesity remission (HR, 1.06; 95% CI, 1.01–1.12).

Conclusion Lower preoperative BMI, lower age, and higher protein intake at 3 months after surgery may favor remission of obesity in up to 12 months compared with baseline.

Keywords Gastric bypass · Food intake · Macronutrients · NOVA · Cox regression

Introduction

Bariatric surgery education focuses on beneficial lifestyle changes in patients with severe obesity, especially regarding eating habits and food choices [1]. These dietary recommendations include macronutrient intake which is generally composed of high-protein and low-fat diet [1, 2]. In the first few months after Roux-en-Y gastric bypass (RYGB), patients tend to prefer natural foods, such as fruits and vegetables, and present reduced consumption of foods rich in sugar and fat, such as sweets, fried foods, fast food, and snacks [1, 3, 4]. This behavior can be related to changes in palate [5], lower tolerance to dense and caloric foods [6], and greater nutritional awareness. Among the existing techniques, RYGB is currently the most performed surgery, being considered a gold standard, as it promotes greater weight loss and maintenance, and has a greater impact on associated comorbidities [7] .

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One of the many contributing factors to obesity is the ingestion of high-calorie foods, rich in sugar and fat, as well as ultra-processed foods. These foods are very palatable, easy to consume, and calorically dense, favoring positive energy balance [8, 9]. The contribution of high-calorie and ultra-processed foods to total daily energy intake can reach up to 30% among Brazilian adults [10]. Studies show that individuals with severe obesity generally consume high-calorie foods, rich in fat and simple carbohydrates and poor in protein, fiber, vitamins, and minerals [11, 12]. However, little is known about the dietary intake and patterns of these individuals after bariatric surgery [4].

The primary goal of bariatric surgery is to offer a solution to obesity and comorbidities; however, the benefits of the surgery depend on several factors [13] and lifestyle changes. The relationship between changes in eating habits and the loss of excess weight after bariatric surgery is underexplored in the literature. Furthermore, studies aimed at quantifying changes in dietary pattern after bariatric surgery and its impact on the remission of obesity are scarce. Based on the aforementioned considerations, the objective of this study was to evaluate changes in dietary intake and factors that predict the remission of obesity in the first year of RYGB.

Methods

This study is an observational, prospective study of patients with severe obesity who underwent RYGB. Fifty-eight (58) adults (20–59 years) of both sexes (68.7% female and 31.3% male) who underwent RYGB surgery for the first time were eligible for the study. The follow-up period of the study was 12 months and data were collected in three phases: preoperative (baseline), 3 months after surgery, and 12 months after surgery. All the patients signed an informed consent form (ICF) accepting to participate in the project. The study was approved by the Ethics and Research Committee (CEP) of the Federal University of Viçosa (no. 1.852.365).

All data were collected during consultation with the researcher, a nutritionist properly trained at the Nutrition Laboratory of the Federal University of Tocantins.

Dietary Intake

Food consumption data was collected through a 24-h dietary recall (24R) applied on 3 non-consecutive days, where the patient reported all foods and beverages consumed the previous day. Data from the 24R was entered into the Brazil Nutri® software [14], and energy and macronutrients were determined according to the Brazilian Nutrition Composition Table for the Family Budget Survey (POF, acronym in Portuguese) developed by the Brazilian Institute of Geography and Statistics (IBGE) [15].

The macronutrients were expressed in percentage and grams, and variation was quantified at 3 and 12 months after surgery in relation to the preoperative period. We evaluated variation (percent) in macronutrient intake expressed as delta (Δ) of protein, carbohydrate, and lipid as follows: Δ = value (percent) at 3 months of RYGB − value (percent) in the preoperative period. Thus, we analyzed variation (percent) in macronutrient intake at 3 months after surgery, a period when dietary changes can be observed.

The foods were also evaluated based on the NOVA classification [16] consisting of 4 food groups: unprocessed or minimally processed, processed, ultra-processed, and culinary ingredient. This food classification was created by Monteiro [17] and considers the level of food processing. Subsequently, the caloric contribution of each group was calculated for the total energy consumed.

Anthropometric and Associated Measurements

Weight was measured with an electronic digital balance (Welmy® brand) whose capacity and precision are 300 kg and 100 g, respectively. Height was measured using an anthropometer with a total length of 2 m coupled to a wall without skirting. Both measurements followed Jellife's protocol [18]. Body mass index (BMI) was calculated using weight and height, and classified according to WHO specifications [19].

The ideal weight of the patients was calculated based on a reference BMI of 24.9 kg/m^2. From this value, excess weight (EW) in kilograms was calculated: pre-weight (kg) − ideal weight (kg). The percentage of excess weight loss (%EWL) was calculated: Absolute weight loss (kg) / EW × 100.

Statistical Analysis

Statistical analysis was performed using Stata software, version 13.0. Numerical variables were expressed as mean and standard deviation, and categorical variables were expressed as relative and absolute frequencies. The normality of the variables was tested by the Shapiro-Wilk test.

In order to compare the difference in the means of the food consumption variables during the three phases (preoperative, 3 months after surgery, and 12 months after surgery), repeated measures ANOVA was performed for the variables with a normal distribution, and for the others, the Friedman test followed by the Wilcoxon test was performed to evaluate the difference between the groups.

Cox regression was performed to evaluate the predictors of obesity remission within 1 year after bariatric surgery. Food consumption variables were analyzed at baseline and Δ 3 months (3-month percentage value − baseline percentage value), in addition to age and preoperative BMI, which were defined a priori based on the literature [1, 20]. The remission of obesity (reduction of BMI to at least 29.9 kg/m^2) according to time was considered a dependent variable. The initial observation period for each subject was defined as the first assessment date (baseline); the final period was defined as the date when the event of interest occurred (remission of obesity) or end of the follow-up period (censoring), 3 and 12 months after surgery. The hazard ratios (HR) and their respective 95% confidence intervals (95% CI) were calculated.

In all analysis, a significance level of 5% ($p < 0.05$) was considered.

Results

The study consisted of 51 patients who underwent Roux-en-Y gastric bypass, with a mean age of 39.34 ± 9.38 years and 68.7% female. At baseline, 62.7% of the patients presented severe obesity (BMI > 40 kg/m^2), and 12 months after the surgery, the mean excess weight loss was greater than 80% and about 70% achieved a remission of obesity (Table 1).

Regarding food consumption, we observed a statistically significant difference among the three phases (baseline, 3 months after surgery, and 12 months after surgery) in relation to energy, carbohydrates (g), proteins (%), and caloric intake from unprocessed or minimally processed foods and processed foods. For ultra-processed foods, we observed differences at 3 and 12 months after surgery in relation to preoperative consumption (Table 2). After surgery, the main ultra-processed foods consumed were cookies and breads, sweetened milk drink (yoghurts and flavored milks), and protein supplements.

A difference in lipid intake (in grams and percent) was observed between the baseline and 3 months after surgery; however, from 3 to 12 months, a significant change was observed only in percentage intake. In this case, there was an increase in lipid intake after 3 months, which approaches the initial value before surgery. A similar pattern was observed for culinary ingredients, a significant intake reduction at 3 months followed by increased intake. For carbohydrate, there was no statistical difference in mean intake among the three phases investigated (Table 2).

In order to evaluate the predictive factors for obesity remission, all food intake variables presented in Table 2 were tested. However, the best model ($R^2 = 0.40$) that explained remission of obesity in the first 12 months after surgery was based on age, BMI, and Δ protein, Δ lipid, and Δ carbohydrate (Table 3). The preoperative BMI presented an inverse association since for every 1 kg/m^2 increase in this parameter, a 22% reduction in the risk of remission of obesity in the first year after bariatric surgery is observed. With regard to age, we also observed an inverse association, where a 1-year increase in age was associated with a 6% reduction in leaving obesity. For variation in protein intake (Δ protein), the association is positive, showing that the 1% increase in its intake at 3 months after surgery in relation to the baseline is associated with a 6% increase in the risk of obesity remission in up to 1 year after RYGB surgery; thus, the higher the protein intake at 3 months in relation to the preoperative period, the greater the risk of obesity remission (Table 3).

Discussion

Bariatric surgery is the most effective treatment of severe obesity [21]; however, several factors may influence its outcome in the first year of surgery [13]. We observed that age, preoperative BMI, and protein consumption significantly interfered with obesity remission in up to 12 months after RYGB. The first year after the surgical procedure is a crucial period to change one's nutritional status since greater weight loss and improvement of comorbidities occur in this period. Furthermore, studies show that weight recovery can begin after 24 months [22].

Table 1 Characteristics of the patients at the baseline, 3 months after, and 12 months after Roux-en-Y gastric bypass

Variables	Baseline (*n* = 51) Mean (SD) or % (*n*)	Three months (*n* = 51) Mean (SD) or % (*n*)	Twelve months (*n* = 50) Mean (SD) or % (*n*)
Weight (kg)	117.1 (19.4)	94.9 (14.5)	77.0 (11.7)
Excess weight (kg)	49.2 (16.3)	36.6 (12.0)	8.8 (10.3)
%TWL	–	18.7 (3.2)	33.1 (6.3)
%EWL	–	47.1 (10.9)	83.7 (19.2)
BMI (kg/m^2)	43.0 (5.7)	34.7 (4.5)	27.6 (5.4)
< 24.9	–	–	20.0% (10)
24.9 ≤ BMI < 30	–	11.8% (6)	48.0% (24)
30 ≤ BMI < 35	–	47.1% (24)	30.0% (15)
35 ≤ BMI < 40	37.3% (19)	27.4% (14)	2.0% (1)
BMI ≥ 40	62.7% (32)	13.7% (7)	–

BMI body mass index, *TWL* total weight loss, *EWL* excess weight loss

Table 2 Food intake according to NOVA and macronutrients at the baseline, 3 months after, and 12 months after Roux-en-Y gastric bypass

Food consumption variables	Baseline ($n = 51$)		Three months ($n = 51$)		Twelve months ($n = 50$)	
	Mean	SD	Mean	SD	Mean	SD
Energy (kcal/day)	2283.2[a]	830.8	1037.6[b]	276.7	1339.6[c]	455.1
Unprocessed or minimally processed foods (kcal)	1253.5[a]	400.7	726.3[b]	185.4	853.5[c]	202.8
Processed foods (kcal)	373.3[a]	357.7	103.9[b]	98.3	221.9[c]	199.6
Ultra-processed foods (kcal)	632.4[a]	615.6	205.2[b]	137.3	248.2[b]	214.2
Processed culinary ingredient (kcal)	24.1[a]	45.2	2.1[b]	5.0	15.9[a]	36.9
Carbohydrate (g)	269.2[a]	107.1	123.7[b]	38.8	157.3[c]	52.0
Carbohydrate (%)	47.7	8.7	47.5	7.9	47.4	7.3
Lipid (g)	84.7[a]	35.7	31.0[b]	12.0	47.2[b]	18.9
Lipid (%)	33.1[a]	5.9	26.7[b]	6.3	31.4[a]	6.2
Protein (g)	102.3[a]	35.0	68.4[b]	18.8	68.6[b]	3.9
Protein (%)	18.4[a]	3.6	26.8[b]	5.7	21.2[c]	3.9

Different superscript letters indicate a statistically significant difference ($p < 0.05$) between the groups. ANOVA test was used for repeated measures with normal distribution and the Friedman and Wilcoxon tests for the others

Age has a direct influence on weight loss after bariatric surgery. Younger patients easily lose weight than older patients due to higher basal metabolism, higher muscle mass, and higher level of physical activity [23].

In addition to age, we observed that for every one unit increase in preoperative BMI, there is a 22% reduction in the risk of obesity remission in up to 1 year after surgery, an indication that lower BMI before surgery increases the likelihood of obesity remission. This result also highlights the role of preoperative period and status in progress after surgery, a period when healthy eating habits as well as weight reduction should be promoted. Weight loss before surgery is recommended as it may help reduce the volume of the liver as well as complications in patients with increased liver and/or fatty liver disease [7].

In relation to dietary changes that interfere with weight loss, protein intake was positively associated with the remission of obesity within 12 months after surgery. The findings corroborate with the study of Kanerva [24] which found that high protein intake 6 months after surgery promotes and maintains long-term weight loss (10 years) regardless of surgical technique, by analyzing 2010 patients who underwent different types of bariatric surgery.

Table 3 Cox regression final model, with hazard ratio and 95% confidence interval for obesity resolution in patients submitted to RYGB after 12 months

Variables	HR	95% CI
Age (years)	0.94	0.89–0.99
Preoperative BMI (kg/m^2)	0.78	0.69–0.88
Preoperative energy (kcal)	0.99	0.99–1.00
Δ Protein (%)	1.06	1.01–1.12
Δ Lipid (%)	0.97	0.92–1.01
Δ Carbohydrate (%)	0.98	0.96–1.01

Δ Protein % protein at 3 months − % protein at baseline; *Δ Lipid* % lipid at 3 months − % lipid at baseline; *Δ Carbohydrate* % carbohydrate at 3 months − % carbohydrate on baseline. *HR* hazard ratio, *95% CI* 95% confidence interval

Protein is one of the most important nutrients required after any bariatric surgery; however, the recommended intake level is a still a debate, with typical values ranging from 60 to 80 g per day or 1.5 g/kg of ideal weight. The American Society of Metabolic and Bariatric Surgery (ASMBS) recommends that post-bariatric surgery patients consume 35% protein, 45% carbohydrates, and 20% fat [7]. Adequate protein intake improves body composition by preserving lean body mass favoring weight loss [25], increasing satiety [26], and preventing sarcopenic obesity.

In this study, protein accounted for 26.8% of total calories consumed at 3 months after surgery and 21.2% at 12 months; mean intake, in grams, was about 68 g at 3 and 12 months. It is important to note that all patients in this study were oriented by a nutritionist and were advised to supplement their diet with protein powders when nutritional recommendations cannot be met through eating only food. Significant changes in the quantity and quality of the patients' diet were observed throughout the follow-up period. Based on the NOVA classification, calories from unprocessed or minimally processed foods increased from 54.9% in the preoperative period to 70% and 63.7% at 3 and 12 months after surgery, respectively. Regarding ultra-processed food intake, we observed a significant decrease, ranging from 27.7% at baseline to 19.7% at 3 months and 18.5% at 12 months post-surgery.

Several studies report changes in dietary pattern after bariatric surgery [1, 2]. The main changes include higher intake of fresh foods, such as fruits and vegetables, and reduced consumption of foods rich in fat and sugar, in addition to a decrease in portion sizes [12, 27], which are attributed to altered food preference [4], dumping syndrome, food intolerance, and awareness of diet quality.

Among the limitations of this study, we highlight possible underestimation or even omission of information regarding actual food intake of the patients which is associated with the data collection instrument employed in the study. In fact, this type of bias is inherent to all dietary assessment instruments. Thus, to minimize this effect, only one duly trained researcher was solely responsible for data collection. The strength of this study is the analytical approach employed, which is an innovation in the studied subject area; thus, the findings can greatly contribute to knowledge on predictive factors of obesity remission.

Conclusion

Patients that undergo RYGB present significant dietary changes (quality and quantity) at 3 and 12 months after surgery. The greatest alteration was found for protein intake where an increase protein intake was associated with an increase in the risk of obesity remission within the first year after surgery. We also found that preoperative BMI and age were inversely associated with the obesity remission in up to 1 year of RYGB. The predictors of obesity remission in up to 12 months were higher protein intake 3 months after surgery compared with baseline, as well as lower age and lower preoperative BMI.

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Author Contributions SLP: Contributed in the design of the study, data collection, analysis and interpretation, manuscript writing, and final version approval.

LLJ and JB: Contributed in the design of the study, analysis and interpretation of the data, critical revision of the manuscript, and approval of the final version.

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Compliance with Ethical Standards

All the patients signed an informed consent form (ICF) accepting to participate in the project. The study was approved by the Ethics and Research Committee (CEP) of the Federal University of Viçosa (no. 1.852.365).

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

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