Artículo Original / Original Article

Pre and post-operative anthropometric and laboratory differences of patients submitted to Roux-en-Y gastric bypass and sleeve gastrectomy

Diferencias antropométricas y de laboratorio pre y postoperatorias de pacientes sometidos a bypass gástrico Roux y-in Y gastrectomía vertical

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ABSTRACT

Objective: To evaluate anthropometric and laboratory differences in the pre and postoperative period of patients undergoing gastric bypass surgery (RYGB) and sleeve gastrectomy (SG). **Methods:** Retrospective study, conducted with patients undergoing surgery between 2013-2018, in Northeastern Brazil. The following data were collected by reviewing patient medical records: sociodemographic (sex and age), anthropometric (height, weight and body mass index), clinical (comorbidities and use of multivitamins) laboratory (vitamin D levels – 25OHD and total lymphocyte count - TLC). At the 6 and at 12 months postoperative periods, weight and laboratory data were again collected. Statistical analyses were performed with SPSS 20.0 software, a significance level of 5% was adopted. **Results:** 646 patients were evaluated, with a mean age of 48.0 ± 11.7 years; 78.6% had RYGB and 21.4% SG. Postoperatively, patient weight and BMI decreased, regardless of technique ($p < 0.001$), however, RYGB patients had greater weight loss. All patients had hypovitaminosis D, but SG patients had an increase in 25OHD in the postoperative period ($p < 0.00001$). Regarding TLC, there was a decrease in the postoperative period for both techniques ($p < 0.0001$). **Conclusion:** RYGB patients had higher weight and BMI and greater weight loss. 25OHD was better in the postoperative period for SG patients. There was a reduction in TLC in the postoperative period of all patients.

Keywords: Bariatric surgery; Body mass index; Lymphocyte Count; Vitamin D; Weight Loss.

RESUMEN

Objetivo: Evaluar las diferencias antropométricas y de laboratorio en el período pre y posoperatorio de pacientes sometidos a cirugía de bypass gástrico (BGYR) y gastrectomía en manga (SG). **Métodos:** Estudio retrospectivo, realizado con pacientes sometidos a cirugía entre 2013-2018, en el noreste de Brasil. Los datos se recogieron consultando la historia clínica del paciente: sociodemográficos (sexo y edad), antropométricos (talla, peso e índice de masa corporal), clínicos (comorbilidades y uso de multivitamínicos) y de laboratorio (niveles de vitamina D - 25OHD y total recuento de linfocitos (TLC)). A los 6 y 12 meses del postoperatorio, se recogieron nuevamente los datos de peso y de laboratorio. Los análisis estadísticos se realizaron con el software SPSS 20.0, se adoptó un nivel de significancia del 5%. **Resultados:** Se evaluaron 646 pacientes, con edad media de $48,0 \pm 11,7$ años; El 78,6% se había sometido a RYGB y el 21,4% a SG. En el postoperatorio, el peso y el IMC de los pacientes disminuyeron, independientemente de la técnica ($p < 0,0001$), pero los pacientes sometidos a BGYR tuvieron una mayor pérdida de peso. Todos los pacientes tenían hipovitaminosis D, pero los sometidos a SG tuvieron un aumento de 25OHD en el postoperatorio ($p < 0,0001$). En cuanto a la TLC, hubo una disminución del postoperatorio para ambas técnicas ($p < 0,0001$). **Conclusión:** Los individuos sometidos a RYGB tenían mayor peso e IMC y mayor pérdida de peso. La 25OHD fue mejor en el postoperatorio de SG. Hubo una reducción de la TLC en el postoperatorio de todos los pacientes. **Palabras clave:** Cirugía bariátrica; Índice de masa corporal; Pérdida de peso; Recuento de linfocitos; Vitamina D.

INTRODUCTION

Obesity is defined as the accumulation of body fat and is diagnosed when body mass index (BMI) is greater than or equal to 30 kg/m^2 ¹. According to the World Health Organization (WHO), in 2025, it is estimated that 700 million adults will be obese². In Brazil, its prevalence has increased by 67.8% in thirteen years. In 2006, it was 11.8% and by 2018, it had increased to 19.8%³, making obesity one of the main public health problems today⁴.

This chronic disease is caused by multiple factors, such as genetics, poor eating habits and physical inactivity which can also cause other chronic diseases, such as diabetes, hypertension and cardiovascular disease^{4,5,6}. The treatment of obesity includes changes in lifestyle, pharmacological treatment and, in severe cases, surgical procedure to promote weight loss⁴.

There are several surgical techniques which can be used to promote weight loss in obesity. In general, these restrict food intake, alter hunger and satiety, lead to malabsorption, or involve a combination of these mechanisms⁷. Thus, they result in substantial and sustained weight loss, in decreased cardiovascular risk factors, in diabetes control and in mortality reduction⁴. However, they can generate nutrition and metabolic alterations, such as reduced vitamin D (25OHD) levels and total lymphocyte count (TLC)⁸. TLC is related to immune reserves and is considered a parameter of malnutrition and poor prognosis⁹.

At present, the two most performed surgical techniques in the world are Roux-en-Y gastric bypass (RYGB) and sleeve gastrectomy (SG)¹⁰. But, since 2013, SG is the technique that has been on the rise. This technique is relatively new when compared to other techniques, such as RYGB¹¹. Many studies show that both techniques are safe and effective, although they differ in rates of remission of comorbidities^{12,13}.

In view of the above, the development of studies that compare the two techniques is important not only in relation to weight loss, but also in terms of nutritional

status, considering TLC. Thus, the objective of this study was to evaluate pre and post-operative anthropometric and laboratory differences of patients submitted to RYGB and SG.

METHODS

A retrospective study, conducted from March to December 2018 that included 646 patients submitted to bariatric surgery using RYGB or SG surgery techniques, between 2013 and 2018, in two bariatric surgery services, one public and one private, in Recife, Pernambuco, Northeast Brazil.

Patients of both sexes were included, older than 18 years, who had been operated on and followed up in the preoperative and postoperative periods by the same surgeon. The following were not included: pregnant patients, patients with chronic kidney disease, patients with chronic liver disease and patients with the Human Immunodeficiency Virus, because their condition could interfere with the results.

Data were collected by consulting patient medical records. Preoperative records were searched for the following data: sociodemographic (sex and age), anthropometric (height and weight), clinical (presence of comorbidities and use of multivitamins) and laboratory (25OHD levels and TLC). At the 6 and at 12 months postoperative periods, weight and laboratory data were again collected.

Body mass index (BMI)¹⁴ and excess weight¹⁵ were calculated from anthropometric data. Individuals who had a BMI below 30.0 kg/m^2 were considered 'without obesity'. Those who had a BMI between 30.0 and 34.9 kg/m^2 or a BMI between 35.0 and 39.9 kg/m^2 , or a BMI greater than or equal to 40.0 kg/m^2 were respectively classified as obesity class 1, 2 or 3.

The calculation of weight loss was performed based on the subtraction of the initial weight from the current weight (kg). The percentage of weight loss (%WL) was calculated using the formula: $\%WL = (\text{Weight loss} \times 100) / \text{initial Weight}$. For the calculation of excess weight (EW) and the percentage

of excess weight loss (%EWL) the following equations were used: Excess Weight= Current Weight - Ideal weight, and for %EWL it was considered: %EWL= (100 X WL) / EW¹⁵.

Patients were classified as hypertensive who had systolic blood pressure greater than or equal to 140 mmHg or diastolic pressure greater than or equal to 90 mmHg¹⁶. Patients were considered as having type 2 diabetes when they had fasting glucose greater than 126 mg/dL or glycated hemoglobin greater than or equal to 6.5% or who reported use of hypoglycemic agents⁶. Dyslipidemia was considered when one or more increases in serum lipids were identified¹⁷.

Individuals were considered deficient in 25OHD if values were less than or equal to 20 ng/mL. Those whose 25OHD levels were between 21-29 ng/mL were classified as insufficient and those with 25OHD levels greater than or equal to 30ng/mL were classified as having sufficient 25OHD¹⁸. All patients were instructed to use a multivitamin and mineral (Centrum[®]) for 3 months in the postoperative period and to perform tests every 3 months for 1 year in the first year and then once a year. According to the results of these tests, supplementation was adjusted with the respective micronutrient, as recommended. In case of hypovitaminosis D or hypocalcemia, the patient was instructed to use a dose of 4000 IU/day of vitamin D3 and 1200 mg/day of additional calcium.

TLC was used to classify nutritional status. Based on recommendation of Calixto-Lima et al.¹⁹, TLC greater than 2000 cells/m³ was used as an indicator of normal weight; TLC less than or equal to 2000 cells/m³ was used as an indicator of some degree of malnutrition.

In the preoperative period, patients received multidisciplinary care and were instructed to maintain follow-up in the postoperative period. The surgical procedure of choice depended on numerous individual factors and a decision between doctor and patient.

Statistical analyses were performed with the Statistical Package for the Social Sciences, version 20.0 (SPSS Inc, Chicago, IL, USA). The Kolmogorov–Smirnov test was used to check the normality of the continuous variables. These variables had normal distribution and were expressed as mean and standard deviation. Student's T-test and analysis of variance (ANOVA) for repeated measures, followed by Bonferroni's post-hoc test were used to compare anthropometric and laboratory data in the preoperative and postoperative periods (6 and 12 months after bariatric surgery). The proportions for these were calculated; binomial distribution was close to the normal distribution, at a 95% confidence interval. Pearson's chi-square test was applied to analyze differences between the proportions. A significance level of 5% was adopted.

This study was approved by the Research Ethics Committee (CAAE: 82767618.8.0000.5208), complying with human research rules established by Resolution n. 466/2012 of the National Health Council. In the preoperative period, all patients submitted to bariatric surgery signed a consent form, authorizing the use of data for research.

RESULTS

A total of 646 patients submitted to bariatric surgery were evaluated. Of these, 508 (78.6%) were submitted to RYGB. In this group there were 97 men and 411 women, with mean age of 39.4 ± 9.8 years. Patients submitted to SG were 61 men and 77 women, with a mean age of 48.0 ± 11.7 years. Table 1 shows demographic and clinical variables of the patients evaluated. The differences observed between patients submitted to SG and patients submitted to RYGB were in sex (p<0.001), age (p<0.001) and presence of diabetes (p<0.001).

Table 1. Demographic and clinical variables of sleeve gastrectomy (SG) and roux y-gastric bypass (RYGB) patients. Recife, Pernambuco, Northeast Brazil, 2018.

Variables	Type of bariatric surgery				p [†]
	RYGB (n= 508)		SG (n= 138)		
	n	%	n	%	
Sex					<0.001
Male	97	19.1	61	44.2	
Female	411	80.9	77	55.8	
Age					<0.001
Less than 45 years	362	71.3	50	36.2	
Greater than or equal to 45 years	146	28.7	88	63.8	
Mean ± standard deviation	39.4±9.8		48.0±11.7		
Hypertension*					0.20
Yes	182	58.9	75	65.8	
No	127	41.1	39	34.2	
Diabetes*					<0.001
Yes	92	29.8	72	63.2	
No	217	70.2	42	36.8	
Dyslipidemia*					0.18
Yes	66	21.8	32	28.1	
No	236	78.2	82	71.9	
Preoperative physical activity*					0.81
Yes	16	12.6	4	11.1	
No	111	87.4	32	88.9	
Use of postoperative supplementation*					0.15
Yes	111	87.4	54	63.5	
No	16	12.6	31	36.5	

n - number of participants; 95% CI - 95% confidence interval;

*total n is different according to the number of respondents.

[†]Pearson's chi-square test.

Characterization of nutritional status and 25OHD and TLC levels, before and after surgery, is shown in table 2. Before surgery most individuals were classified as obesity grade II and III and 12 months post-surgery, the majority were not overweight.

Table 3 shows pre and post-surgery anthropometric and laboratory differences of patients submitted to RYGB and SG. In the pre and postoperative periods, weight and average BMI were higher in patients submitted to RYGB than in patients submitted to SG ($p<0.001$). As expected, after surgery, there was a decrease in weight and BMI, regardless of surgical technique used ($p<0.001$) (Table 3).

In the postoperative periods of 6 and 12 months, weight averages were higher in RYGB compared to SG patients. No differences were found in average %EWL between the two techniques. In both techniques, significant %WL and %EWL were observed post-surgery (Table 3).

No difference was observed in 25OHD levels of patients submitted to RYGB before and after surgery. On the other hand, there was an improvement in 25OHD levels of patients submitted to SG at the 6 months postoperative period (25.6 ± 9.9 to 29.3 ± 8.9 ng/mL; $p<0.0001$) that remained at 12 months (29.3 ± 7.6 ng/mL). These patients presented higher 25OHD levels at 6 and 12 months in the postoperative period than RYGB patients ($p<0.0001$) (Table 3).

TLC of patients submitted to either of the procedures decreased in the postoperative period, but there was no difference in TLC at 6 or at 12 months in the postoperative

period and there was no difference in TLC when comparing the two techniques (Table 3).

DISCUSSION

In the present study, most of the individuals submitted to bariatric surgery had grade II or III obesity. One year after the surgical procedure, most patients had a normal weight. Individuals submitted to RYGB had higher weight and BMI averages in both the preoperative and the postoperative periods and higher post-surgical weight loss (%) than SG patients, although both techniques promoted a reduction in weight and BMI. There was an improvement in 25OHD levels of patients submitted to SG at the postoperative period; these patients presented higher 25OHD levels than those submitted to RYGB in the postoperative period. TLC of both types of patients decreased in the postoperative period, but there was no difference in TLC when comparing the two techniques.

A surgical procedure is indicated for severe cases of obesity, such as obesity grade II and III, to promote weight loss²⁰. Among the most developed and proven effective bariatric surgery surgical techniques worldwide are RYGB and SG²¹, which were the techniques chosen for the surgery of the patients in this study. Regardless of the surgical technique used, the surgical procedure promoted weight loss in the individuals studied. However, higher post-surgical weight loss (%) was observed in RYGB compared to SG patients.

Table 2. Pre and post-operative anthropometric and laboratory characteristics of sleeve gastrectomy (SG) and roux y-gastric bypass (RYGB) patients. Recife, Pernambuco, Northeast Brazil, 2018.

Variables	Preoperative				6 months postoperative				12 months postoperative			
	RYGB		SG		RYGB		SG		RYGB		SG	
	N	%	N	%	N	%	n	%	n	%	n	%
Body mass index												
Class III obesity	198	39.0	92	66.7	4	0.8	15	10.9	-	-	3	2.4
Class II obesity	307	60.4	38	27.5	46	9.1	31	22.5	9	2.6	8	6.4
Class I obesity	3	0.6	6	4.3	213	41.9	45	32.6	60	17.4	28	22.4
Without obesity	0	0.0	2	1.4	245	48.2	47	34.1	276	80.0	86	68.8
Vitamin D												
Deficient ²	140	30.0	38	29.5	79	16.7	37	29.4	12	10.3	12	23.5
Insufficient	210	45.1	58	45.0	188	39.8	58	46.0	53	45.3	24	47.1
Sufficient	116	24.9	33	25.6	205	43.4	31	24.6	52	44.4	15	29.4
Preoperative TLC*												
Low ³	172	33.9	52	37.7	208	41.1	69	50.4	122	54.2	59	54.1
Normal	335	66.1	86	62.3	298	58.9	68	59.6	103	45.8	50	45.9

n - number of participants; TLC-total lymphocyte count; *total n is different according to the number of respondents. ¹WHO (1998);

²Holick et al. (2011); Calixto-Lima (2012).

Table 3. Mean $\pm$ standard deviation of weight, body mass index and laboratory data in the preoperative and postoperative periods at 6 and 12 months after bariatric surgery, according to surgery type. Recife, Pernambuco, Northeast Brazil, 2018.

Variables	Preoperative	6 months postoperative	12 months postoperative	p [†]
Weight (kg)				
RYGB	121.2 $\pm$ 26.4 ^a	91.2 $\pm$ 20.1 ^b	79.1 $\pm$ 16.9 ^c	<0.0001
SG	105.9 $\pm$ 13.8 ^d	80.9 $\pm$ 12.0 ^e	73.0 $\pm$ 12.7 ^f	<0.0001
p*	<0.0001	<0.0001	<0.0001	
Weight loss (%)				
RYGB	-	24.7 $\pm$ 8.9 ^a	34.8 $\pm$ 9.7 ^b	<0.0001
SG	-	23.1 $\pm$ 5.7 ^c	31.4 $\pm$ 9.6 ^d	<0.0001
p*	-	0.01	0.0001	
Loss of weight excess (%)				
RYGB	-	64.9 $\pm$ 44.8	88.8 $\pm$ 41.3	<0.0001
SG	-	63.5 $\pm$ 17.0	87.3 $\pm$ 28.7	<0.0001
p*	-	0.57	0.66	
BMI (Kg/m²)				
RYGB	43.5 $\pm$ 6.9 ^a	32.5 $\pm$ 6.2 ^b	28.2 $\pm$ 5.3 ^c	<0.0001
SG	39.5 $\pm$ 3.2 ^d	30.2 $\pm$ 3.2 ^e	27.2 $\pm$ 3.7 ^f	<0.0001
p*	<0.0001	<0.0001	0.02	
Vitamin D (ng/mL)				
RYGB	25.8 $\pm$ 10.9 ^a	25.9 $\pm$ 8.0 ^a	25.7 $\pm$ 7.4 ^a	0.97
SG	25.6 $\pm$ 9.9 ^a	29.3 $\pm$ 8.9 ^b	29.3 $\pm$ 7.6 ^b	<0.0001
p*	0.98	<0.0001	<0.0001	
TLC (cel/m³)				
RYGB	2314 $\pm$ 760 ^a	2055.9 $\pm$ 674 ^b	2058.6 $\pm$ 635 ^b	<0.0001
SG	2223 $\pm$ 43 ^a	2053 $\pm$ 43 ^b	2008 $\pm$ 39 ^b	<0.0001
p*	0.34	0.16	0.51	

n - number of participants; RYGB - Roux-en-Y gastric bypass; SG-Sleeve gastrectomy; BMI-body mass index; TLC total lymphocyte count; [†]ANOVA. Different letters denote statistical difference by Bonferroni's post-hoc test. *Student's test.

Other studies also indicate that RYGB results in greater weight loss compared to SG^{22,23,24,25}. Paterli et al.²³ and Osland et al.²⁴ further suggest that the weight loss promoted by RYGB can be maintained for 2 to 5 years and also promotes remission of diabetes and discontinuation of drugs for the treatment of hypertension and dyslipidemia.

RYGB consists of stapling the stomach, reducing its size to a reservoir of approximately 20-30 mL, in addition to the deviation of intestinal transit in Y^{21,26}. In contrast, SG consists of making a longitudinal division in the stomach and removing 70-80% of it, including the large curvature of the gastric fundus, body and proximal antrum, resulting in a long and narrow stomach^{21,26}.

In both techniques, weight loss occurs mainly through a restrictive mechanism, through early and prolonged satiety, but RYGB is associated with a smaller absorption site^{21,26}, that can favor greater weight loss, as observed in this study.

However, a long-term study is necessary to determine if the differences found in weight loss between the two techniques is a result of the loss of SG effect or if it is related to the difference between the surgical procedures, since intestine exclusion occurs only in RYGB. Thus, RYGB cannot be said to be more indicated than SG for obese individuals. The choice of techniques must be based on a joint decision between doctor and patient, considering risks, benefits, lifestyle and health conditions.

One of the consequences of bariatric surgery is the occurrence of nutritional deficiencies, such as 25OHD deficiency²⁷, which may differ depending on the surgical technique employed²⁸. Nutritional deficiencies can occur even in the preoperative period, according to the study by Sánchez et al.²⁹, which evaluated some micronutrients. The greatest deficiency found was vitamin D, present in 71.7% of the sample. Santos et al.⁸ also showed a high percentage of

hypovitaminosis D, even before surgery (79.1%). As vitamin D is fat soluble, lower levels in obese individuals may be related to absorption by adipose tissue or decreased expression of vitamin D metabolizing enzymes, 25-hydroxylase and 1 α -hydroxylase in cutaneous and visceral adipose tissues³⁰. Decreased sun exposure and inadequate eating habits are also among the risk factors³¹.

In this study, although all patients were instructed to use a multivitamin and mineral supplement, individuals submitted to RYGB had lower levels of 25OHD in the postoperative period than those who were submitted to SG. Chakhtoura et al.³⁰ also compared the two techniques and showed better levels of 25OHD in patients submitted to SG.

This result can be explained by the fact that RYGB causes a reduction in the intestinal surface, while SG is a technique that keeps the biliary, pancreatic and intestinal anatomy intact³². Because it is a fat-soluble substance, 25OHD is absorbed together with fats and is normally secreted by bile secretion and reabsorbed in the small intestine³³. Therefore, patients submitted to RYGB may have impaired absorption of 25OHD of supplementary origin, possibly needing higher doses of the supplement to normalize concentrations of 25OHD.

Nevertheless, other factors such as possible reduction of the exposure to sunlight after surgery, inadequate nutrition, preoperative 25OHD deficiency, and incorrect use of the supplement may have contributed to the lower levels of 25OHD in RYGB patients. Deficiency of bile salts, necessary for 25OHD absorption and intestinal bacterial changes could also contribute to vitamin deficiency in this group³⁴.

Adequate 25OHD levels are essential since 25OHD deficiency is associated with bone complications. It has already been demonstrated that after RYGB there is an increase in bone resorption³⁵ and decrease in bone mineral density with declines in the femur and spine³⁶. Therefore, it is essential to carry out a multiprofessional follow-up in order to identify and correct possible deficiencies and perform individualized nutritional supplementation²⁷.

Regardless of the type of technique used, both surgical procedures led to reductions in TLC. This result shows that the reduction in TLC is associated with weight loss itself and not with the type of technique to which the individual was subjected³⁶. Studies demonstrate that different bariatric surgery procedures lead to a reduction in the content of inflammatory lymphocytes³⁷, by promoting phenotypic changes in lymphocytes, which go from pro inflammatory to anti-inflammatory³⁸.

Since pro-inflammatory lymphocytes are related to systemic and microvascular oxidative stress, while anti-inflammatory lymphocytes have antioxidant capacity, with reduced damage to microvessels³⁹, the reduction in TLC promoted by bariatric surgery could be beneficial. Paradoxically, TLC is considered a good indicator of nutritional status and its reduction is associated with greater risks of infection and malnutrition⁴⁰. Therefore, it is extremely important to develop studies that demonstrate whether the reduction

in TLC in patients after bariatric surgery could have a beneficial regulatory effect or if this reduction would promote complications associated with malnutrition.

One limitation of the study is the absence of data regarding individual nutritional supplementation schemes and the fact that the research was carried out locally, preventing the extrapolation of data.

CONCLUSION

In conclusion, the differences found between RYGB and SG patients were that RYGB patients had higher weight and BMI averages in both the preoperative and postoperative periods and higher weight loss (%) post-surgery compared to SG patients. On the other hand, SG patients had higher 25OHD levels in the postoperative period. In both techniques, there was a reduction in TLC postoperatively, remaining at 6 and 12 months post-surgery.

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