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Research Article

Early Metabolic Effects of Sleeve Gastrectomy in Patients with Severe Obesity

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Abstract

Obesity is responsible for a series of complications that directly affect the quality and life expectancy of individuals. These patients predispose to the emergence of potentially lethal diseases such as dyslipidemia, cardiovascular disease, type 2 diabetes mellitus, in addition to being an important risk factor for some types of cancer. Currently, it is treated as a pandemic disease, in which the number of cases worldwide and nationally is alarming. Therefore, intervention is necessary in these patients, which may be conservatively or surgically, in which the latter consists of several techniques. In this sense, the present study aimed to evaluate the short-term metabolic results of Laparoscopic Sleeve Gastrectomy in morbidly obese patients. This is a retrospective, descriptive, cross-sectional study, with a quantitative approach based on the analysis of preoperative and postoperative data from 6 to 18 months, covering 35 patients who underwent sleeve gastrectomy in a single institute between the years 2007 and 2013. It was observed that thirty-five patients underwent Sleeve Gastrectomy, 30 women and 5 men, 10 of whom were diabetic and 15 were hypertensive, with a mean collective age of approximately 40 years and a mean body mass index of 43 kg/m^2. Mean HbA1C levels were 7.9 ± 2.8%. The mean body mass index at a mean follow-up of 1 year and 6 months after surgery was 32 ± 4.9 kg/m^2, with a mean HbA1C of 6.1 ± 1%. There was complete resolution of the diabetes condition, and only one patient remained with systemic arterial hypertension and arthralgia. It is concluded that Sleeve Gastrectomy offers good weight loss results, as well as a resolution or improvement of previous comorbidities, in which the issue of diabetes could be more closely monitored. Prospective studies are needed to better compare long-term outcomes.

Keywords: Gastrectomy; Comorbidities; Bariatric Surgery

Abbreviations

ADA: American Diabetes Association; BIGS: Brazilian Institute of Geography and Statistics; BMI: Body Mass Index; BSBMS: Brazilian Society of Bariatric and Metabolic Surgery; CNTD: Chronic Non-Transmissible Disease; DVP: Deep Vein Thrombosis; GERD: Gastroesophageal Reflux Disease; GIP: Glucose-dependent Insulinotropic Polypeptide; GLP-1: Glucagon-like Peptide; HbA1C: Hemoglobin A1C or glycated hemoglobin; OSAS: Obstructive Sleep Apnea Syndrome; PTE: Pulmonary Thromboembolism; SAH: Systemic Arterial Hypertension SG: Sleeve Gastrectomy; SSI: Surgical Site Infection; T2DM: Type 2 Diabetes Mellitus; VTE: Venous Thromboembolism; WHO: World Health Organization; %EWL: Percentage of Excess Weight Loss

Introduction

Obesity is a Chronic Non-Transmissible Disease (CNTD) characterized by excessive accumulation of body fat that is harmful to health, being responsible for a number of complications that directly affect the quality and life expectancy of individuals [1]. Thus, the World Health Organization (WHO) [2]. defines the diagnosis of obesity through the body mass index (BMI) greater than or equal to 30kg/m^2. In this sense, individuals with values above this BMI

predispose to the emergence of potentially lethal diseases such as dyslipidemia, cardiovascular disease, type 2 diabetes mellitus (T2DM), besides being an important risk factor for some types of cancer, such as endometrium, lung and colon, mainly [1].

Moreover, considering the mechanical effect of weight gain in obesity, these individuals may also be susceptible to obstructive sleep apnea syndrome (OSAS), gastroesophageal reflux disease (GERD), arthralgia, among other pathologies. It has a multifactorial etiology, involving environmental factors, as well as factors related to increased caloric intake, reduced physical activity and genetic susceptibility [3].

Currently, this disease has been treated as a pandemic disease, since it affects more than 650 million people worldwide. Restricting to Brazil, the numbers do not get more subtle, since overweight and obesity reached, respectively, 55.4% and 20.3% of adults only in the capitals in the year 2019. Moreover, in the country, the increase in overweight and obesity are evident in all age groups, genders and social classes, especially in the most deprived population [4].

In this context, it is considered as therapeutic modalities for obesity the conservative treatments, such as changes in lifestyle, regular physical activity, dietary re-education and use of medications with disabsorptive, satiety and/or anorexigenic effects, as well as surgical treatments [4]. Although there is weight loss with these conservative measures, only 5 to 10% of this population maintains the loss of excess weight in the long term. In this sense, bariatric surgery may be indicated in patients with BMI greater than 40 kg/m^2 or BMI greater than or equal to 35 kg/m^2 associated with comorbidities, especially when the patient does not respond to other conventional treatments [5].

However, it should be added with the patient in the pre-surgical period, through a multiprofessional team, about the risks of surgery, as well as its benefits. Surgical complications can be defined as any deviation that interferes with the expected recovery. In general, complications of bariatric surgery are associated with the patient's general condition, the magnitude of the procedure, or unimproved surgical technique. They can be classified as major or minor. Major complications are those that require surgical reintervention or increase the length of hospital stay, whereas the minor complications are amenable to outpatient treatment, through minor procedures such as puncture, drainage or dressings [6].

The surgical techniques currently used for bariatric surgery include Gastric Bypass (also called gastroplasty with Roux-en-Y bypass), Sleeve Gastrectomy (SG), Duodenal Switch and Adjustable Gastric Banding. The SG is a technique performed by laparoscopy that has been growing in the country, and its mechanism is considered restrictive and metabolic, in which there is a decrease in the food absorption surface, acceleration of gastric emptying and reduced production of ghrelin, a hormone that stimulates appetite, which is produced mostly in the bottom of the stomach (excised in SG) [7,8].

In this technique, the stomach is transformed into a tube, and its large curvature is removed, starting from 4 to 6 cm from the pylorus to the esophagogastric angle, leaving the new reservoir with a tubular and elongated shape of volume between 150 and 200 ml. It causes a good weight loss when compared to other techniques, besides having a less complex operation because there are no anastomoses, with a shorter surgical time, resulting in fewer early and late complications. It is done mainly for patients who need control of diabetes mellitus, systemic arterial hypertension and dyslipidemias [8,9].

Therefore, the aim of this study was to evaluate the short-term metabolic results of Laparoscopic Vertical Gastrectomy in morbidly obese patients.

Materials and Methods

This work consists of a retrospective, descriptive, cross-sectional study of quantitative approach from the analysis of preoperative and postoperative data from 6 to 18 months, approved by the ethics committee under number 22264313.0.0000.5084. It was performed with surgical data from 2007 to 2013, collected by the CNPQ research group "Study of Morphofunctional Changes of Obesity and Bariatric Surgery" linked to the morphology department of the Federal University of Maranhão, in which 35 patients underwent Laparoscopic Vertical Gastrectomy in the surgery service of the digestive tract of the Progastro Institute, operated in private health units of the city of São Luís - Maranhão, being they UDI, São Domingos and Hospital Centro Médico Maranhense by the same medical team.

Of these, 10 patients were diagnosed with DM2 and were on antidiabetic treatment, with proper diet and exercise. In addition, these patients had preoperative documentation of their hemoglobin A1C (HbA1C) and fasting glucose levels. The indications for surgery for the patients in question are in accordance with the guidelines of the Brazilian Society of Bariatric and Metabolic Surgery (BSBMS)[10] and include BMI ≥ 40 kg/m^2 or BMI ≥ 35 kg/m^2 and one or more obesity-related comorbidities. Demographic and clinical data such as age, sex, BMI, and comorbidities of the patients were collected. These comorbidities included T2DM, systemic arterial hypertension (SAH), arthralgia, and OSAS.

Laboratory data included HbA1C and fasting plasma glucose. Perioperative and postoperative data, including early complications (30 days from surgery), mean time to surgery, days of hospitalization, satisfaction, the percentage of excess weight loss (% EWL), and resolution of comorbidities was collected retrospectively from patient follow-up notes and medical reports. The American Diabetes Association (ADA) [11] definitions of diabetes "remission" was used, wich consists of blood glucose levels below 100 mg/dl and HbA1c below 6.5%, without any medical treatment for T2DM for 3 months. The % EWL was calculated by the standard formula (initial BMI - lowest BMI)/(initial BMI - 25) x 100%.

Data were entered into a digital database that was maintained prospectively. Written informed consent was obtained from all patients prior to surgery. This study was approved by the institutional review board (IRB).

Surgical technique and perioperative care

A prophylactic dose of heparin was administered approximately 2 hours before the incision. The operation was performed under general anesthesia in the supine position with the table in reverse Trendelenburg. Intravenous Cephalosporin was administered 60 minutes before the incision. An orogastric tube was used and the stomach decompressed. A Veress supraumbilical needle was inserted with insufflation of the abdominal cavity at a pressure of 15 mmHg, and five laparoscopic ports were inserted.

The greater curvature of the stomach was mobilized with a Harmonic® (Ethicon Endo-Surgery, Inc.) or Ligasure® (Covidien, Inc.) scalpel. Dissection began 4 centimeters near the pylorus, extending cephalad and taking the adhesions down around the bottom of the stomach. Once mobilized, a bougie was inserted following the minor curvature (bougie size, 32-36 Fr, was the surgeons' preference). Once the bougie tube was in place, sequential shots of the stapler (Covidien tri-stapler or J and J Echelon) were used to section the lateral stomach.

Postoperatively, patients were routinely followed up by their surgeon and a bariatric nutritionist. Patients were instructed to maintain a liquid diet for the first 10 postoperative days and to take multivitamins (B-12, folic acid, calcium, and vitamin D), which were prescribed for all patients. Patients were also encouraged to gradually start physical activity and exercise as soon as possible.

Patients were prescribed proton pump inhibitors and venous thromboembolism (VTE) prophylaxis for six months and three weeks, respectively. Complete blood tests were performed six months and twelve months after the procedure, and every year thereafter.

Statistical analysis

Statistical analysis was performed in IBM SPSS statistics® version 22, with continuous data expressed as mean values with the respective standard deviation. Fischer's test and chi-square test were used for categorical data, and Student's t-test was used for continuous data analysis. All P values were derived from two-tailed tests and a P value of less than 0.05 was considered significant.

Results and Discussion

In the analysis of patients several data were collected for quali-quantitative analysis of the peculiarities of individuals undergoing SG. Regarding demographic data, figure 1 shows the age characteristics of the 35 patients who underwent surgery, in which the mean age was 39.7 years with a variance of 9.5. Still, these same patients had a range of 24 years as a minimum and maximum age of 61 years.

Still on the demographic data we have the analysis of the preoperative BMI, in which, in figure 2, it was estimated with an average of 43 kg/m^2 with a variation of 9 points. The minimum index recorded was 37 kg/m^2, and the maximum was 55 kg/m^2.

Finalizing the demographic data, the gender of the patients was surveyed, in which, in figure 3, there were 30 female patients (86%) and 5 male patients (14%).

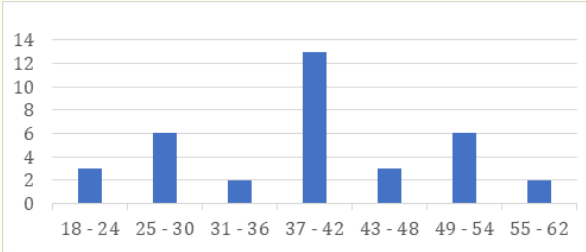

Figure 1: Age of the patients when submitted to the procedure.

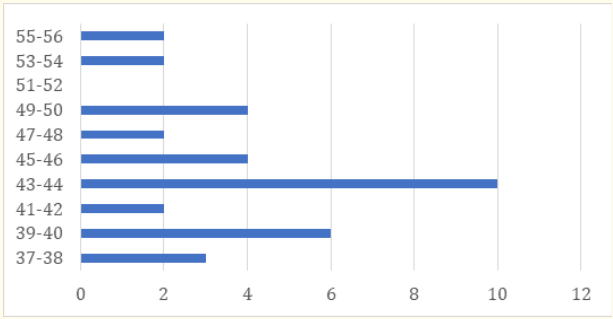

Figure 2: Preoperative BMI.

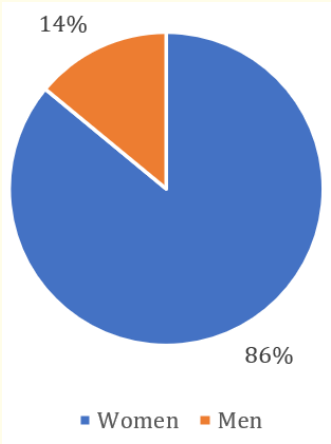

Figure 3: Gender among the operated patients.

Figure 4 shows the relation of comorbidities of the patients in which the data of Systemic Arterial Hypertension, Type 2 Diabetes Mellitus, arthralgias, and Obstructive Sleep Apnea Syndrome were collected. Among the patients who underwent the procedure, about 46% (16 patients) had comorbidities. Figure 4.1 and figure 4.2 show the relation of comorbidities and the percentages of patients with each comorbidity studied, among which SAH accounted for 93.75% (15 patients), DM2 for 62.5% (10 patients), arthralgia for 56.25% (9 patients) and OSAS for 37.5% (6 patients).

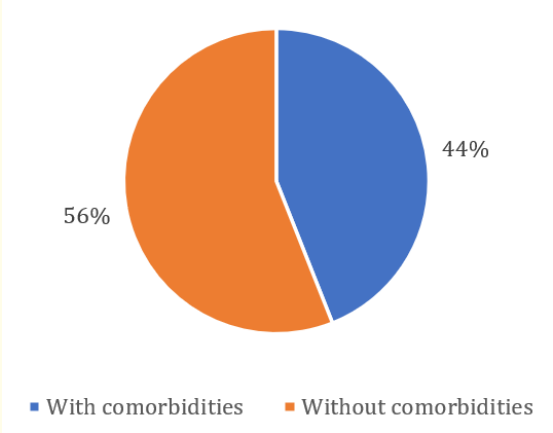

Figure 4: Patients submitted to vertical gastrectomy with or without comorbidities.

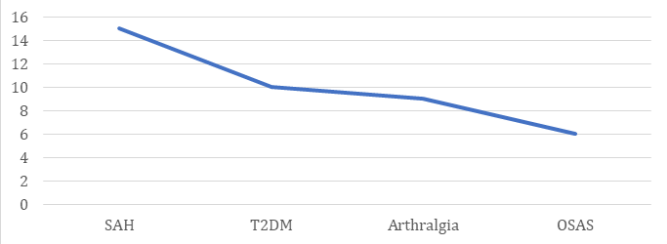

Figure 4.1: Comorbidities of patients undergoing sleeve gastrectomy procedure. Absolute number.
OSAS: Obstructive Sleep Apnea Syndrome; SAH: Systemic Arterial Hypertension; T2DM: Type 2 Diabetes Mellitus.

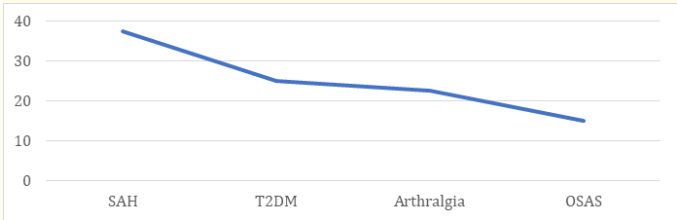

Figure 4.2: Comorbidities of patients undergoing sleeve gastrectomy procedure. Relative number.
OSAS: Obstructive Sleep Apnea Syndrome; SAH: Systemic Arterial Hypertension; T2DM: Type 2 Diabetes Mellitus.

About the surgery, three main points were analyzed in table 1. The first was the average time of surgery, which lasted an average of 96 minutes, with a minimum time of 61 minutes and a maximum of 215 minutes. The hospitalization in days was also evaluated, which on average lasted five days, with a minimum hospitalization of 4 days and a maximum of 41 days. In addition, surgical satisfaction was obtained with an average of 91%.

Time	Mean (minimum - maximum)
Of surgery	96 (61 - 215) minutes
Of hospitalization	5 (4 - 41) days

Table 1: Relation of surgery time and hospitalization for each surgery.

Regarding weight loss in relation to the progression of the surgery, table 2 shows the relation between the pre-surgical period, 6 months after the procedure, 12 months, and 18 months. For this evaluation the BMI was observed, being evaluated the maximum and minimum average. The pre-surgery mean was 43, with the minimum being 37, and the maximum 55. Six months after the procedure it was 38 +/- 9.1, twelve months after 33 +/- 8.2, and eighteen months after 32 +/- 4.9.

BMI	Mean (Minimum - Maximum)
Presurgery	43 (37 - 55)
6 months after surgery	38 (28.9 - 47.1)
12 months after surgery	33 (24.8 - 41.2)
18 months after surgery	32 (27.1 - 36.9)

Table 2: Weight loss on BMI perspective for patients undergoing sleeve gastrectomy.

BMI: Body Mass Index.

Regarding the patients' comorbidities, a great resolution was observed after the surgery, according to table 3. It was observed that of the 15 patients with SAH, only 1 remained with the condition prior to surgery. When related to DM2, only 10 patients had this condition, and total resolution of the diabetics was obtained.

However, in relation to arthralgia, 9 patients had this comorbidity, while only 1 remained with the pathology. In relation to OSAS cases, 6 patients initially presented this syndrome, and after the surgery this quantity was zeroed.

Comorbidity	Before surgery (n)	After surgery (n)
SAH	15	1
T2DM	10	0
Arthralgia	9	1
OSAS	6	0

Table 3: Relation of comorbidities of patients submitted to surgery.

N: Number of Patients, OSAS: Obstructive Sleep Apnea Syndrome; SAH: Systemic Arterial Hypertension; T2DM: Type 2 Diabetes Mellitus

With reference to the cases of complications after vertical gastrectomy surgery, it is observed, through table 4, the division into early phase and late phase. In the early phase, 3 cases of bleeding were obtained, where 2 of them were managed clinically and only 1 underwent splenectomy. Moreover, there was only one surgical site infection (SSI), which also achieved clinical resolution. There were no cases of pulmonary thromboembolism (PTE), deep vein thrombosis (DVT), or fistulae.

Regarding the late phase, also shown in table 4, it was observed that after sleeve gastrectomy, devitaminosis was observed in 5 patients and managed clinically. In addition, there were no cases of internal hernia.

Complications	N	Management
Early		
Bleeding	3	Clinically (2); Splenectomy (1)
SSI	1	Clinically
PTE/DVT	0	-
Fistulae	0	-
Late		
Internal hernia	0	-
Desvitaminosis	5	Clinically

Table 4: Complications after surgery and the type of management addressed.

DVT: Deep Vein Thrombosis; N: Number of Patients; PTE: Pulmonary Thromboembolism

Through the glycated hemoglobin, mentioned in table 5, the 10 diabetic patients who underwent surgery were verified and among them it was possible to observe the relation of type 2 diabetes mellitus preoperatively and after surgery in some periods. Among them, there is initially the pre-surgical, with an average of 7.9% and a variation of about 2.8%. At 6 months after surgery, with 7.3% and a variance of 0.5%. At 12 months, showing 6.6% and a variance of 0.8%. And finally, after 18 months, with the result of 6.1% and a variance of 1%.

Glycated hemoglobin	%
Presurgery	7.9 +- 2.8
6 months after surgery	7.3 +- 0.5
12 months after surgery	6.6 +- 0.8
18 months after surgery	6.1 +- 1%

Table 5: Assessment of type 2 diabetes mellitus.

In this way, with this results, it is known that with the advance in understanding the pathophysiology of obesity and the mechanisms of operation of the various bariatric surgery techniques, some other more modern concepts were added to the classic concepts of gastric restriction and intestinal dysabsorption, such as metabolic changes, neurohormonal signaling, incretin effect, changes in microbiota, bile acid absorption, among others. Thus, it was observed that the techniques of Gastric Bypass and Sleeve Gastrectomy stand out when addressing such concepts [12]. With this, the present study evaluated the early metabolic results of SG in severe obese patients.

In this sense, according to the Brazilian Institute of Geography and Statistics (BIGS) [13], obesity more than doubled in the country in the population aged 20 years or older in 2019, which corroborates with the fact that the patients who sought bariatric service and underwent surgery in our study had a mean age of 39 years, with a variance of 9.5 years. Moreover, according to the National Health Survey, obesity among women in the same age group increased from 14.5% to 30.2% and remained above the male obesity rate, which rose from 9.6% to 22.8%. With this, the majority of patients undergoing bariatric surgery in this study were female (86%), corroborating the findings of several national researches, with a higher prevalence in the age group of 30 to 39 years in both genders [14].

In addition to epidemiological data that prove a growth and prevalence of obesity in women, according to Franco., *et al*. [15], there are also other factors that could explain the predominance of women regarding bariatric surgery, such as personal aesthetic motivations and the stigma of society that cultivates a standard of beauty of thin women and creates an objectification of women.

Moreover, the indications for surgery of the patients in question are in accordance with the guidelines of the BSBMS [10] already mentioned above. Thus, it could be observed that patients had an average BMI around 43 kg/m^2 and 44% had comorbidities, a fact that is not common in the literature, since in most studies the numbers of patients with pathologies exceed those who do not, which can be exemplified in the study conducted in Maceió - AL, where 162 patients underwent bariatric surgery and 73.45% had comorbidities [1].

Regarding the presence of comorbidities, a systematic review conducted by Kelles., *et al*. [16] evaluated data from 3.815 patients who had undergone bariatric surgery, in which stood out the pathologies of hypertension (60.8%), diabetes (22.3%), dyslipidemia (35.3%), arthropathy (33.7%) and obstructive sleep apnea (31.2%). These numbers correlate with the results of the present study, since practically the same diseases affected the patients who underwent SG.

Moreover, Sleeve Gastrectomy complied with what is evidenced in the literature, since this technique is shown as the simplest bariatric surgery in relation to others, which was proven by the time of surgery and hospitalization of patients, which were lower or similar to gastric bypass, for example. Thus, the surgical risk becomes greatly decreased [17].

Moreover, cohort studies, such as Lee., *et al*. [18], who used sleeve gastrectomy in 216 patients and, comparing results, concluded that the technique is able to provide significant weight loss when compared to Roux-en-Y gastric bypass and duodenal switch, prove that this technique still ensures a significant weight loss, even as a minor procedure, which is shown by the % EWL of patients in 18 months of this study. This is probably because it is a restrictive technique, in which there is production of a narrow gastric pouch along the small curvature allowing to promote weight loss, besides reducing appetite by excluding the gastric fundus,

main location of ghrelin-producing cells, peptide known mainly for promoting increased appetite [7,19].

As for the improvement of the comorbidities analyzed, the data are similar to the study by Vargas., *et al.* [20], in which there was resolution or clinical improvement in all the comorbidities investigated. The same can be observed with the patients in the current study, who had total remission of diabetes and obstructive sleep apnea syndrome and partial remission of hypertension and arthralgia, leaving only 1 patient in these last two pathologies. Thus, sleeve gastrectomy proved to be an excellent treatment for obesity-related comorbidities, since it promotes glycemic control, increased pancreatic insulin secretion, improved insulin sensitivity in peripheral tissue, and restores blood pressure levels to normal, besides helping to improve the mechanical factors related to obesity [9].

Added to this, Hora., *et al*. [21] demonstrates through their study that obesity and OSAS are extremely common health problems, characterized by disturbed glucose homeostasis, insulin resistance, as well as hypercholesterolemia and hyperlipidemia. OSAS is strongly associated with visceral adiposity, and both conditions are related to cardiovascular and metabolic complications. Thus, it is observed that with bariatric surgery the patients had total remission of this pathology, which has positive repercussions on these other consequences.

As for postoperative complications, the most common are suture dehiscence, stenosis, fistulas, infections and hemorrhage (more common in the early postoperative period), as well as internal hernia and intestinal obstruction (more common in the late postoperative period), and pulmonary thromboembolism. Thus, the complications observed in patients are consistent with the current literature, since they had cases mainly of bleeding, probably due to the surgical technique, and devitaminosis, something already expected in this surgery, since nutritional deficiencies are common after bariatric surgery, due to gastric reduction, occurring decrease in mechanical digestion and acid secretion, which consequently leads to malabsorption of iron and vitamin B12 [22].

Vitamin B12 deficiency can occur as a result of several factors. As there is a reduction in the gastric production of hydrochloric acid, there is no conversion of pepsinogen into pepsin, which is necessary for the release of vitamin B12 present in proteinic foods. In addition, intrinsic factor is produced by the parietal cells of the stomach. When there is insufficient or no production of intrinsic factor, such as when the gastric compartment is reduced, there is no absorption of vitamin B12 in the distal ileum, leading to pernicious anemia. Low levels of this vitamin can be seen after six months postoperatively, but most often it occurs after a year or more when its storage in the liver is depleted, which was evidenced in our study. For this reason, most patients receive multivitamin complexes for life after surgery, which was encouraged by the acting professionals [1].

Finally, the progression of T2DM was evaluated in the patients for 18 months, and their total remission was verified through the levels of glycated hemoglobin, using the ADA[11] definitions of diabetes "remission", which could be evidenced in the patients in question.

Based on this, it is known that after eating, the process of digestion and absorption of nutrients promotes increased secretion of peptides synthesized by enteroendocrine cells, called incretins, which activate neural circuits, acting in distant organs, including the liver, muscle tissue, adipose tissue, and pancreas, in order to efficiently promote energy storage. These hormones are capable of modulating the response of pancreatic islet cells, increasing insulin secretion and decreasing glucagon secretion. The main incretins produced by the gastrointestinal tract are glucagon-like peptide (GLP-1) and glucose-dependent insulinotropic polypeptide (GIP). Both regulate glucose metabolism by increasing insulin secretion, promoting beta cell growth and enhancing the action of this hormone [7].

With this, it has that the resolution of DM2 after sleeve gastrectomy of the patients in the present study probably has a direct relationship with the changes that occur in these intestinal hormones, pointing to the gastrointestinal anatomy as a primary mediator of the surgical control of this disease. One hypothesis for this involves weight loss, decreased food intake, and accelerated delivery of unabsorbed ingested nutrients to the distal intestine, which would increase the secretion of incretins, which would stimulate insulin secretion, something that still needs to be better elucidated in studies [7,23].

Conclusion

Therefore, this study allowed us to evaluate the short-term metabolic effects of sleeve gastrectomy performed by laparosco-

py, which proved to be very effective in the treatment of morbidly obese patients with previous comorbidities, since it ensured in a short period of time an optimal weight loss, as well as could offer a remission of comorbidities presented by these patients, since they disappeared almost completely in all bariatric patients.

In addition, this work followed more closely the issue of type 2 diabetes mellitus, in which tests were performed for 18 months, which could prove the efficiency of the SG in this pathology with these patients.

Finally, it is important to add the importance of a subsequent follow-up of these data, with the same patients covered in this study, in order to evaluate the metabolic results of the SG in the long term, since all these data have been archived for future studies. Moreover, it would be pertinent to conduct a comparative study in our health centers between sleeve gastrectomy and gastric bypass, since they are the techniques most commonly used in bariatric surgery and most addressed in the literature.

Conflict of Interest

There is no conflict of interest in this study.

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