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Deficiencies of protein markers and fat-soluble vitamins at one year after gastric bypass versus duodenoileal bypass in a single anastomosis with gastrectomy (SADI-S)

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Abstract

Aims. To evaluate the impact of bariatric surgery on the patient's long-term nutritional status, comparing two techniques such as Roux-en-Y gastric bypass (RYGB) versus single-anastomosis duodeno-ileal bypass with vertical gastrectomy (SADI-S). Material and methods. A retrospective observational study of patients operated by BGY and SADI-S between 2018 and 2021 in our hospital center was performed. BMI at the time of surgery and at 12 months was recorded. Serum levels of different nutritional markers such as albumin, prealbumin and vitamins A, D, E were analyzed one year after surgery. Results. Patients who underwent SADI-S had a higher BMI than BGY (48.4 vs 45.1 kg/m2) and achieved greater weight loss (18.5 vs 15.0 kg/m2). There are statistically significant differences between all nutritional markers in both groups, except for vitamin D. Serum levels were lower in SADI-S, reaching the deficiency range in the case of vitamin D (95.3% in BGY and 98.5% in SADI-S) and vitamin A (6.3% and 17.8%, respectively). Conclusions. SADI-S allows weight reductions to be achieved with a higher risk of nutritional deficiencies due to the nature of the procedure.

Keywords:

- Obesity
- Bariatric surgery
- SADI-S
- Gastric bypass
- Nutritional deficiencies

Introduction

According to the World Health Organization (WHO), obesity is defined as "a complex chronic disease characterized by an excessive accumulation of fat that can be detrimental to health "[1].

Although not without limitations, the calculation of body mass index (BMI) is considered the most widely accepted tool for determining underweight, normal weight, overweight and obesity in adults[2] (Table 1). It is obtained by dividing weight in kilograms by body surface area in square meters (kg/m2).

BMI < 18'5	Below normal weight
BMI ≥ 18'5 y < 25	Normal weight
BMI ≥ 25 y < 30	Overweight
BMI ≥ 30 y < 35	Obesity grade I
BMI ≥ 35 y < 40	Obesity grade II
BMI ≥ 40	Obesity grade III

Table 1. Classification of Body Mass Index (BMI) in adults according to WHO.
BMI: Body Mass Index.

The impact of obesity on health has been widely studied in the literature; excess body weight from a BMI ≥ 25 kg/m2 onwards entails an increase in overall mortality, cardiovascular mortality and diabetes-related mortality compared to people with a normal body weight[4]. In addition, it predisposes to the development of other comorbidities (insulin resistance, dyslipidemia, nonalcoholic hepatic steatosis, coronary artery disease, atrial fibrillation, acute stroke, obstructive sleep apnea, chronic kidney disease, and depression, among many others). Initial treatment of overweight and obesity includes a combination of hypocaloric diet and aerobic physical exercise. Pharmacological treatment is considered in patients who have not achieved a reduction of at least 5% of body weight after 3-6 months of introducing hygienic-dietary measures. In case of therapeutic failure, the next step involves bariatric surgery, with the incorporation of different techniques that make it possible to achieve significant weight loss by means of restrictive, malabsorptive or mixed mechanisms[5].

Material and methods

We present a retrospective observational study including all patients who underwent bariatric surgery in a third level hospital between the years 2018 and 2021, differentiating the two most frequently used surgical techniques such as gastro-jejunal bypass and SADI-S (Single Anastomosis duodeno-ileal with Sleeve Gastrectomy), obtaining a sample size of 64 and 67 patients respectively.

The indication for bariatric surgery was established according to the following criteria: (1) Patients with BMI ≥ 40 kg/m2, regardless of the presence, absence or severity of possible associated comorbidities. (2) Patients with BMI ≥ 35 kg/m2 with associated comorbidities (arterial hypertension, type 2 diabetes, dyslipidemia, obstructive sleep apnea syndrome).

The choice of one surgical technique or another in our center was established according to a series of individualized criteria, so there was no random selection of the procedure in the cases included in the present study. Those patients with super-obesity (defined as BMI ≥ 55 kg/m2), type 2 diabetes or other associated comorbidities were considered for SADI-S. The remaining patients underwent BGY.

The gastrojejunal bypass (GJB) continues to be the reference technique for the surgical treatment of morbid obesity today[6]. It consists of the creation of a gastric reservoir with a capacity of 15-30 cubic centimeters to which an end of the jejunum is attached to act as a feeding loop, thus allowing caloric intake to be restricted. The acids generated in the gastric remnant are joined to those of the duodenum which, in turn, anastomose with another more distal portion of the jejunum (bilio-pancreatic loop) so that the contents mix with the food coming from the alimentary loop, constituting the common loop where digestion and absorption of most of the nutrients take place[7]. In short, this is a mixed technique that allows weight loss through a fundamentally restrictive mechanism, although there is also a certain component of malabsorption.

SADI-S (Single Anastomosis Duodeno-ileal Bypass with Sleeve Gastrectomy) is a novel and effective technique that aims to reduce the complexity and complications associated with BGY due to the need to perform a double anastomosis. In 2020, the American Society for Metabolic and Bariatric Surgery (ASMBS) considered SADI-S as a suitable technique as a first choice and also as a revision surgery[8]. It consists of the creation of a gastric sleeve, sectioning the first portion of the duodenum, which will subsequently be anastomosed with the small intestine at a distance of about 250 centimeters from the ileocecal valve, thus forming the common loop that allows receiving the bilio-pancreatic fluid afferents, so that there is only a single anastomosis. In this case, the malabsorptive mechanism predominates over the restrictive one.

The aim of the study was to measure the weight loss achieved after both procedures and to assess whether there is a significant impact on the nutritional status of the patients, as well as the need for supplementation after surgery. For this purpose, the medical records of all cases were reviewed and the following parameters were recorded: (1) BMI before surgery (2) BMI 12 months after the procedure (3) BMI lost in absolute values (4). Serum levels of albumin, prealbumin and vitamins A, D and E 12 months after surgery. The reference values used were those used by the Clinical Analysis Service of our hospital (Table 2), with deficiency being understood as a value below the laboratory reference values.

PARAMETER	REFERENCE VALUES
Albumin (g/dl)	3,8-5,1
Prealbumin (mg/dl)	10-40
Vitamin A (µg/dl)	30-80
Vitamin E (µg/dl)	500-1800
25-OH-vitamin D (ng/ml)	20-50

Table 2. Reference values used in the interpretation of analytical parameters.

Numerical variables were described using the median and interquartile range (IQR).

The nonparametric Mann-Whitney U test was used for statistical analysis since most of the variables did not fit the normal distribution using the Kolmogorov-Smirnov test.

Results

patients undergoing BGY had a mean age of 49.3 ± 10.2 years when included in the surgical waiting list and 60.9% were women. They started from a mean BMI of 45.1 ± 5.1 kg/m2 at the time of surgery. At 12-month follow-up from the procedure, a mean of 30.1 ± 4.4 kg/m2 was recorded, which represented a loss of 15 kg/m2 in absolute terms (Table 3). Comparatively, the patients selected for SADI-S had similar characteristics in terms of mean age (52.8 ± 9.1 years) and gender distribution (62.7% women). However, it should be noted that they started from a higher mean BMI as part of the selection criteria for the technique (48.4 ± 4.9 kg/m2) and that greater weight loss was achieved compared to the first group (mean BMI of 29.9 ± 5.1 kg/m2 with a loss of 18.5 ± 5.8 kg/m2; p-value < 0.001).

	GJB	SADI-S
AGE Median [IR]	47,5 [15]	54,0 [15]
GENDER N (%) Male Female	 25 (39,1) 39 (60,9)	 25 (37,3) 42 (62,7)
Previous BMI (kg/m²) Median [IR]	44,0 [9]	48,0 [7]
BMI at 12 months (kg/m²) Median [IR]	29,0 [5]	29,0 [5,5]
IMC lost (kg/m²) Median [IR]	14,5 [6,8]	19,0 [6]

Table 3. Distribution of the variables age, sex, pre- and post-surgery BMI and BMI loss 12 months after the procedure for both surgical techniques

GJB: gastrojejunal bypass. SADI-S: single-anastomosis duodenal crossover. BMI: body mass index. IR: interquartile range (IQR).

As shown in Table 4, all protein markers and fat-soluble vitamins, with the exception of vitamin D, show statistically significant differences, with deficits being higher in patients treated with SADIS than in those treated with BGY.

Vitamin D deficiency was detected in a high percentage of patients (82.4% in BGY and 79.91% in SADI-S; p<0.001), being the most frequent nutritional deficit for both groups and requiring additional supplementation in practically all of them (95.3% in BGY and 98.5% of cases in SADI-S). This supplementation was mainly through the administration of calcifediol monohydrate at a monthly dose of 0.266 mg as a single dose and adjusted according to subsequent controls.

Vitamin A deficiency is the second most frequent for both groups. However, patients undergoing SADIS had significantly lower vitamin A levels compared to patients undergoing BGY, reaching the deficiency range in 17.8% and 6.7% of cases, respectively. Consequently, the former group required supplementation in a percentage equivalent to the former by means of a combination of vitamin A (retinol palmitate) and vitamin E (dl-alpha-tocopheryl acetate) in a single daily dose. It should be noted that, after surgery, practically all patients began to receive supplementation with multivitamin complexes.

	GJB	SADI-S	P-VALUE
ALBMIN (g/dl) Median [IR]	4,3 [0,4]	4,2 [0,4]	<0,001
PREALBUMIN (mg/dl) Median [IR]	22,0 [5,8]	19,5 [6,7]	0,008
VITAMIN A (µg/dl) Median [IR]	49,0 [22]	42,0 [18]	<0,001
VITAMIN E (µg/dl) Median [IR]	1135,0 [298]	1110,0 [306]	0,002
VITAMIN D (ng/ml) Median [IR]	23,5 [10]	22,0 [17]	0,772

Table 4. Quantification of protein markers and fat-soluble vitamins 12 months after the procedure.

GJB: gastrojejunal bypass. SADI-S: single anastomosis duodeno-ileal bypass with vertical gastrectomy. IR: IR: interquartile range

Discussion

The analysis of protein markers and fat-soluble vitamins carried out in the present study seems to indicate that, due to their surgical technique and because they present a greater malabsorption component, patients undergoing SADI-S have lower plasma concentrations compared to RYGB in the

analyzed values. This malabsorption leads to the appearance of diarrhea and the risk of protein-calorie malnutrition along with severe deficiencies of micronutrients, including fat-soluble vitamins[9].

Considering the above, both techniques directly affect the processes of digestion and absorption of nutrients, vitamins and other trace elements. The absorption of fat-soluble vitamins (A, D, E and K) occurs fundamentally at the level of the jejunum and ileum, so their deficiency is a frequent complication after bariatric surgery, especially in the case of techniques with a greater malabsorptive component, as in the case of SADI-S[10].

According to the American Society of Metabolic and Bariatric Surgery (ASMBS), the estimated weight loss in SADI-S is around 40% of total body weight two years after surgery, although this percentage seems to depend fundamentally on the size of the gastric sleeve and the length of the common loop. A length of less than 300 centimeters leads to a high risk of malnutrition by considerably reducing the absorptive surface area[11]. All these factors could justify the differences observed between the two groups of patients.

As limitations of the study, it should be pointed out that, in practically all the patients, we do not have the values of the nutritional parameters before surgery because they are not included in the usual analytical determinations.

It is also necessary to take into account that the vitamin D deficiency recorded in both groups should not be attributed exclusively to the surgical procedure itself. Other factors are involved in this deficiency that could have a greater specific weight, among which is a lower exposure of the general population to ultraviolet sunlight (typical of the geographical region where the study was carried out), which leads to a reduction in the cutaneous synthesis of cholecalciferol, this being the most important source for generating vitamin D3.

Conclusions

Taking into account the results of this study, the patients who underwent SADI-S presented greater nutritional deficits 12 months after the intervention than the patients who underwent gastric bypass.

In the case of vitamin D, there are no statistically significant differences between both groups of patients, being the nutritional deficit more frequent. In this sense, annual controls of all these parameters are necessary to ensure a correct nutritional status.

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