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Research Article

Laparoscopic Gastric Sleeve and Micronutrients Supplementation: Our Experience

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Background. Laparoscopic gastric sleeve (LGS) has been recently introduced as a stand-alone, restrictive bariatric surgery. Theoretically, LGS attenuates micronutrients deficiencies and associated complications that were typically observed following malabsorptive procedures. The aim of this study was to assess some micronutrients and mineral deficiencies in patients undergoing LGS. *Methods*. In the period between July 2008 and April 2010, 138 obese patients (110 females and 28 males) with mean BMI 44.4 kg/m^2 ± 6.5, mean age 43.9 ± 10.9 years were enrolled and underwent LGS. Patients were followed up with routine laboratory tests and anthropometric measurements and assessed for nutritional status, as regards vitamin B12, folic acid, iron, hemoglobin, calcium, and vitamin D, every three months throughout 12 months. *Results*. 12 months after sleeve, patients did not show iron deficiency and/or anemia; plasma calcium levels were in the normal range without supplementation from the sixth month after the operation. Vitamin B12 and folic acid were adequately supplemented for all the follow-up period. Vitamin D was in suboptimal levels, despite daily multivitamin supplementation. *Conclusion*. In this study, we showed that LGS is an effective surgery for the management of morbid obesity. An adequate supplementation is important to avoid micronutrients deficiencies and greater weight loss does not require higher dosage of multivitamins.

1. Introduction

Obesity, traditionally defined as a body mass index (BMI) above 30 kg/m^2, increases the risk of death from any cause. There is currently a global pandemic of obesity and obesity comorbidities: nearly 75% of Americans have a BMI > 25 kg/m^2 and 1 of 4 children are overweight or heavier [1]. The comorbidities of obesity per se and the atherosclerotic diseases they engender reduce life expectancy of obese, in particular morbidly obese, females by 7 years and males by 9 years [2].

Obese patients have a history of repeated failures after traditional methods of weight loss, such as dieting, exercise, and medications. In this context, the number of obese people who have sought bariatric surgery to treat obesity has increased since this type of surgery has been established as a key to successful weight loss and weight maintenance.

Bariatric surgery, actually considered the highest successful treatment for obesity, requires adherence to special dietary recommendations and adequate vitamins supplementations to insure the achievement of weight loss goals, weight maintenance, and correct nutritional status.

All types of bariatric surgery lead to an important decrease of ingested calories, ranging from 700 to 900 kcal/die, especially during the first six months after the procedure [3]. Micronutrients deficiency is an important complication associated with bariatric surgery with 50% of cases of vitamin deficiency being observed at the end of the first postopesrative year, possibly arising from the substantial decrease of food intake from food intolerance and from dysabsorption [4].

Laparoscopic gastric sleeve (LGS) is a relatively new bariatric procedure. It was initially introduced as either the restrictive component of biliopancreatic diversion with duodenal switch (BPD-DS) or the first step of a staged approach for weight loss. In the latter, superobese patients with increased operative risks undergo LGS to initiate enough weight loss to allow for a second stage gastric bypass or BPD-DS [5]. It has been recently used as a definitive bariatric surgery following reports of significant reduction in body mass index (BMI) and comorbidities [6]. LGS is considered a restrictive bariatric procedure, in which the fundus and the greater curvature of the stomach are removed, leaving a narrow gastric tube or "sleeve." The small intestine is neither bypassed nor removed during this procedure, minimizing the micronutritional deficiencies typically observed after malabsorptive procedures [6, 7].

Objectives of this study are threefold: first, to analyze if the weight loss achieved 12 months after LGS was responsible of important nutritional deficiencies; second, to examine if eventual nutritional deficiencies were related to the entity of weight loss; third, to determine whether constant daily vitamin supplementation would be sufficient to prevent possible vitamin deficiencies in obese patients after LGS.

2. Materials and Methods

In the period between July 2008 and April 2010, 138 obese patients (110 females and 28 males) with mean BMI 44.4 kg/m^2 ± 6.5, mean age 43.9 ± 10.9 years were enrolled and underwent LGS. Patients were followed up with routine laboratory tests and anthropometric measurements and assessed for nutritional status every three months throughout 12 months. All the patients were subdivided into five groups according to BMI: *Group A* with BMI between 32 and 34.9 (7 patients, 6 females and 1 male, mean BMI 32.5 kg/m^2 ± 3.1, mean age 36.7 ± 13.2 years); *Group B* with BMI between 35 and 39.9 (29 patients, 24 females and 5 males, mean BMI 37.8 kg/m^2 ± 1.5, mean age 43.6 ± 10 years); *Group C* with BMI between 40 and 44.9 (40 patients, 29 females and 11 males, mean BMI 42.5 kg/m^2 ± 1.6, mean age 44.4 ± 9.6 years); *Group D* with BMI between 45 and 49.9 (33 patients, 26 females and 7 males, mean BMI 46.8 kg/m^2 ± 1.5, mean age 45.1 ± 12.8 years); *Group E* with BMI ≥ 50 (29 patients, 25 females and 4 males, mean BMI 53.9 kg/m^2 ± 3.2, mean age 43.7 ± 10.8 years). In all the groups, for each patient, Δ weight was defined as the difference between mean weight present at baseline and mean weight detected 12 months after LGS. Then, mean Δ weight values of the five groups were compared with each other.

In addition a nutritional status assessment was detected at each follow-up visit with the blood measurement of haemoglobin, iron, ferritin, calcium, vitamin B12 and folic acid.

All patients were supplemented after LGS administering oral multivitamins in the amount of one tablet per day for the first six months. Each tablet principally contains 2,5 mcg of vitamin B12, 200 mcg of folic acid, 5 mg of iron, 162 mg of calcium, and 5 mcg of vitamin D, in association with other minerals and micronutrients. After this period, oral multivitamins were stopped, and one vial of intramuscular vitamin B12 (1000 mcg per month), oral vitamin D (0.625 mg per month) and one tablet of folic acid (5 mg per day for ten days a month) were administered during all the follow-up period.

The study has been approved by the Institutional Ethical Committee. An informed consent was given by all patients.

2.1. Surgical Technique. LGS was performed according to the technique previously described by Moy et al. [8]. From 2002, technical modifications have been introduced. The technique used in this patient group is described as follows. The patient is positioned in 30° anti-Trendelenburg position with legs abducted. Five trocars are used (4 trocars 12 mm and 1 trocar 5 mm). The skeletonisation of the greater curvature of the stomach started at 6 cm from the pylorus up to the angle of His, using a radiofrequency device. A 48 Fr transoral bougie was positioned from the hiatus to the duodenum along the lesser curvature. The SG was performed using a linear stapler (EndoGIA, US Surgical Norwalk, CT, USA), with 2 sequential 4.8/60 mm green cartridge load firings for the antrum, and 3.5/60 mm blue cartridge for corpus and fundus or Echelon stapler with gold cartridge. The first and second cartridges of stapler are fired using the right hypochondrial trocar and the subsequent through the left subcostal port. A 60 mL capacity gastric pouch was finally obtained. The capacity is measured by the methylene blue dye test.

There is not agreement in the literature about the bougie size and the distance from pylorus where the gastric resection should be initiated. But in our experience, meticulous gastric fundus dissection, accurate placement of the bougie against the lesser curve, and stretching of the gastric walls during the resection are the most important factors in determining the capacity of gastric remnant.

The specimen was extracted directly through the right subcostal trocar site and the trocar sites closed by using the Bercy needle when blade trocar is positioned to avoid trocar site hernia [9].

3. Results

The mean postoperative BMI at 18-month follow-up was markedly decreased in all the groups as expressed in Table 1. Δ weight was higher in patients characterized by a greater BMI at baseline ($P < 0.05$). Furthermore, whereas before surgery the extreme groups A and E differed each other by 21.4 points of BMI, after 18 months this difference was significantly reduced to 13 points. Weight loss was more important in groups with higher BMI before surgery. Otherwise, in patients with lower BMI, Δ weight was 25 Kg in the 12-month follow-up period and patients have never reached an underweight condition. At 12 months of follow-up, plasma values of haemoglobin, iron, ferritin, calcium, vitamin B12, and folic acid were not significantly different from baseline values in all patients (Table 2). Also analyzing group by group (Tables 3, 4, and 5), there were not significant differences of the nutritional parameters between values observed at baseline and the same values detected after surgery. The same vitamin and mineral supplementation ensured a correct nutritional status in all groups, even in patients who loosed 50 kilograms during this period.

Table 1: BMI and weight before and after 12 months.

Group	No patients	BMI before (kg/m^2)	BMI after (kg/m^2)	Weight before	Weight after	Δ weight (Kg)
A	7	32.5 ± 3.1	22.5 ± 3.4	89.8 ± 13.8	62.5 ± 17.5	27.3
B	29	37.8 ± 1.5	26.1 ± 2.4	104.6 ± 11.6	72.8 ± 13.3	31.8
C	40	42.5 ± 1.6	29.0 ± 2.8	118.6 ± 13.4	81.5 ± 11.1	37.1
D	33	46.8 ± 1.5	32.3 ± 4.1	127.8 ± 14.7	89.9 ± 12.9	37.9
E	29	53.9 ± 3.2	35.5 ± 4.5	145.0 ± 16.8	95.9 ± 11.6	49.1

Table 2: Nutritional parameters before and after 12 months in all the patients.

	At baseline	12 months after LGS	*P*
Hb (g/dL)	13.7 ± 1.8	13.1 ± 3.29	Ns
Iron (μg/dL)	78.1 ± 29.0	95.9 ± 36.6	Ns
Vitamin B12 (pg/mL)	495.7 ± 262.5	488.9 ± 229	Ns
Folic Acid (ng/mL)	5.7 ± 2.3	8.7 ± 3.9	Ns
Calcium (mg/dL)	9.2 ± 0.4	9.4 ± 0.5	Ns
Vitamin D (ng/mL)	20.9 ± 7.7	20.4 ± 10.9	Ns

Table 3: Haemoglobin (Hb) and iron before and after surgery.

Group	Hb (gr/dL)		Iron (μg/dL)	
	Baseline	12 months after LGS	Baseline	12 months after LGS
A	12.8 ± 0.8	13.1 ± 1.2	76.9 ± 16	97.2 ± 58.7
B	13.4 ± 1.5	13.0 ± 1.5	67.8 ± 22.9	91.9 ± 38.5
C	13.9 ± 1.1	13.2 ± 1.5	82.4 ± 35.1	87.3 ± 38.0
D	13.2 ± 1.4	13.2 ± 1.1	80.1 ± 27.5	94.8 ± 31.7
E	12.8 ± 2.9	13.8 ± 6.9	64.3 ± 25.5	97.4 ± 36.4

Table 4: Vitamin B12 and folic acid before and after surgery.

Group	Vitamin B12 (pg/mL)		Folic acid (ng/mL)	
	Baseline	12 months after LGS	Baseline	12 months after LGS
A	430 ± 180	459 ± 385.4	6.3 ± 2.2	7.2 ± 3.9
B	387.5 ± 255.7	474 ± 261.9	4 ± 1.9	7.0 ± 2.1
C	510.5 ± 268	364 ± 161.2	7 ± 0.1	6.7 ± 2.6
D	701 ± 258.8	385.3 ± 209.1	6 ± 2.1	8.8 ± 6.0
E	350.7 ± 300.1	411.2 ± 253.4	6.1 ± 3.7	5.7 ± 2.7

Table 5: Calcium and vitamin D before and after surgery.

Group	Calcium (mg/dL)		Vitamin D (ng/mL)	
	Baseline	12 months after LGS	Baseline	12 months after LGS
A	9.2 ± 0.3	9.3 ± 0.5	18.5 ± 3.6	20.6 ± 4.6
B	9.2 ± 0.5	9.1 ± 0.4	17.1 ± 5.4	21.6 ± 5.3
C	9.2 ± 0.4	9.2 ± 0.5	15.9 ± 6.7	21.2 ± 12.1
D	9.3 ± 0.3	9.5 ± 0.5	16.4 ± 0.9	20.4 ± 6.4
E	9.2 ± 0.4	9.3 ± 0.5	16.4 ± 2.3	19.9 ± 5.2

4. Discussion

Micronutrient deficiencies are important complications associated with bariatric surgery, with 50% of reported vitamins deficiencies occurring within the first year of surgery [10]. LGS is gaining popularity among laparoscopic bariatric surgeons. It is easy to perform and results in significant weight loss with a lower mortality than gastric bypass surgery [11]. It has been suggested that LGS has a minimal impact on macronutrients as it does not alter the site of their absorption in the small intestine [12].

Gehrer et al. compared the nutritional deficiencies occurring after LGS and laparoscopic Roux-en-Y gastric bypass (RYGB) and observed nutritional deficiencies in 57% of patients. In particular, after LGS the following deficiencies were observed: folate in 22%, iron 18%, vitamin B12 in 18% [13].

A significant number of patients developed vitamin B12 deficiency after LGS. This complication could be attributed to fundus resection, which is the most abundant part of the stomach with parietal cells that release intrinsic factor essential for vitamin B12 absorption. Also, PPIs (proton pump inhibitors) use might have played an additive role in the development of vitamin B12 deficiency in these patients by reducing acidity as demonstrated by multiple studies in nonbariatric patients [14].

In the present study the initial oral daily administration for the first 6 months and subsequent monthly administration of the intramuscular vitamin B12 are sufficient to prevent the development of vitamin B12 deficiency in our patients. Even in patients with the greater weight loss, the same dose of vitamin maintains adequate levels of vitamin B12.

Folate can be absorbed throughout the intestine, especially in the jejunum, and therefore folate deficiency is less common after LGS, usually resulting from a low intake [15–17]. A very small amount of folate is stored by the body and a constant supply of a diet containing foods that are sources of folic acid is necessary to maintain serum concentrations. The best sources of folate are viscera, beans, and green leafy vegetables.

Some investigators have reported that low folate levels reflect nonadherence to multivitamin supplementation because the amount of supplemented folic acid properly corrects low serum folate levels.

Hakeam et al. reported folate deficiency after surgery and though patients in this study received a daily supplement containing 0.2 mg folic acid following LGS, folate levels deteriorated throughout the study period. Therefore, patients undergoing LGS might require more than the RDA of folic acid to maintain normal folate levels. This could be attributed to the diet changes after surgery [18].

In fact, in our study, patients received daily administration containing 0.2 mg folic acid for 6 months after LGS and 5 mg per day for ten days a month in the subsequent period, maintaining adequate levels of folic acid.

Also, more attention has to be directed to folic acid and vitamin B12 in females planning to get pregnant after LGS, as folic acid and vitamin B12 deficiency during pregnancy in general population has been linked to the increased risk of neonatal neural tube defects.

As regards iron deficiency, Skroubis et al. demonstrated that 1-year postgastric bypass, the percentage of low ferritin and anemia increased from 18% to 32% and from 16.4% to 23%, respectively [19]. Similarly, Vargas-Ruiz et al. showed that the incidence of anemia increased from 10% to 26.6% after 1 year following gastric bypass [12]. Both studies reported that study participants had received a multivitamin, plus minerals. Moreover, each of these studies had included patients with preoperative iron deficiencies, anemia, or both. Therefore, it is important to determine the accurate incidence of iron deficiency prior to surgery in order to exclude anemia caused by surgery.

As regards LGS, Hakeam et al., found a low incidence of iron deficiency (4,9%) and of anemia (1.6%) 12 months after surgery [18].

In this study, we did not observe iron deficiency 12 months after LGS, contrary to what was found in previous reports in which iron deficiency regarded other types of bariatric surgeries. All the patients in our study were given an iron supplementation in a multivitamin formula in amount of 5 mg per day only for the first six months, and patients did not develop an iron deficiency during all the study period. Then, LGS seems not to be responsible for iron deficiency and/or anemia.

Bone metabolism can change during the first year after LGS. Part of this change is explained by the weight loss itself due to the loss of pressure on the weight bearing bones, thus losing a potent stimulant for bone preservation. Furthermore, normal levels of vitamin D are essential for an adequate intestinal calcium uptake. A shortage in vitamin D eventually leads to a negative calcium balance and causes a compensatory rise in PTH to promote bone resorption [20]. Aarts et al. reported normal calcium levels 1 year after LGS, but suboptimal levels of vitamin D, althoughout daily multivitamin supplementation.

In our study, plasma calcium levels remained in the normal range in all the patients, regardless of weight loss degree. Plasma levels of vitamin D were low before surgery in all the groups. They remained under normal range after surgery, despite patients were supplemented for all the follow-up period.

5. Conclusions

In this study, we showed that LGS is an effective surgery for the management of morbid obesity. An adequate supplementation is important to avoid micronutrients deficiencies and greater weight loss does not require higher dosage of multivitamins.

After 1 year, the impact of this bariatric surgery on iron indices was negligible. Therefore, iron supplementation appears unnecessary in nonanemic patients undergoing LGS at least in the interval of 6–12 months after surgery.

Close monitoring of vitamin B12 and folate levels is important and an adequate supplementation is necessary to maintain these parameters in the normal range for all the follow-up period.

Calcium supplementation is important in the first 6 months in the multivitamin formula and it is sufficient to maintain normal plasma values in all the follow-up period.

Vitamin D supplementation of 0.625 mg per month is not sufficient to ensure adequate plasma levels.

In conclusion, we can assert that each bariatric surgical procedure needs to be assessed on the micronutrients to avoid either low or high concentrations in short and long postsurgery followup.

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