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Original

Routine supplementation does not warrant the nutritional status of vitamin D adequate after gastric bypass Roux-en-Y

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Abstract

Bariatric surgery can lead to nutritional deficiencies, including those related to bone loss. The aim of this study was to evaluate serum concentrations of calcium, vitamin D and PTH in obese adults before and six months after gastric bypass surgery in Roux-en-Y (RYGB) and evaluate the doses of calcium and vitamin D supplementation after surgery.

Methods: **Retrospective longitudinal study of adult patients of both sexes undergoing RYGB. We obtained data on weight, height, BMI and serum concentrations of 25-hydroxyvitamin D, ionized calcium and PTH. Following surgery, patients received dietary supplementation daily 500 mg calcium carbonate and 400 IU vitamin D.**

Results: **We studied 56 women and 27 men. Preoperative serum concentrations of vitamin D were inadequate in 45% of women and 37% of men, while in the postoperative period 91% of women and 85% of men had deficiency of this vitamin. No change in serum calcium was found before and after surgery. Serum PTH preoperatively remained adequate in 89% of individuals of both sexes. After surgery serum concentrations remained adequate and 89% women and 83% men evaluated.**

Conclusion: **Obesity appears to be a risk factor for the development of vitamin D. The results show that supplementation routine postoperative was unable to treat and prevent vitamin D deficiency in obese adults undergoing RYGB.**

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RUTINA DE SUPLEMENTACIÓN NO GARANTIZA EL ESTADO NUTRICIONAL DE VITAMINA D ADECUADO PARA BYPASS GÁSTRICO EN Y-DE ROUX

Resumen

La cirugía bariátrica puede llevar deficiencias nutricionales, incluyendo aquellas relacionadas a perdida ósea. El objetivo de este estudio fue avaluar las concentraciones séricas de cálcio, vitamina D y PTH en adultos obesos, antes y seis meses pos cirugía de bypass Gástrico en Y-de-Roux (RYGB) y avaluar las dosis de calcio y vitamina D utilizada después da la cirugía.

Métodos: **Estudio longitudinal retrospectivo con pacientes adultos de ambos sexos que fueron submetidos al RYGB. Fueron obtenidos datos de peso, estatura e IMC y las concentraciones de 25-hidroxivitamina D, calcio iónicos y PTH. Pos cirugía, los pacientes recibieron la suplementación dietética diaria de 500 mg de carbonato de calcio y 400 UI de vitamina D.**

Resultados: **Fueron avaluados 56 mujeres y 27 hombres. El preoperatorio las concentraciones séricas de vitamina D presentaron inadecuadas en 45% de las mujeres y 37% de los hombres, mientras en el periodo posoperatorio 91% de las mujeres y 85% de los hombres presentaron deficiencia de esta vitamina. Ninguna alteración en las concentraciones séricas de calcio fue encontrada antes ni pos la cirugía. Las concentraciones séricas de PTH en el preoperatorio se mantuvieron adecuadas en 89% de los individuos de ambos sexos. Pos la cirugía las concentraciones séricas se mantuvieron adecuadas en 89% y mujeres y 83% de los hombres avaluados.**

Conclusión: **la obesidad puede ser un factor de riesgo para el desarrollo de la deficiencia de vitamina D. Los resultados enseñan que la suplementación fue incapaz de sanar y prevenir la deficiencia de vitamina D en adultos obesos submetidos RYGB.**

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Palabras clave: *Cirugía de bypass gástrico Y-de-Roux. Metabolismo óseo. Calcio. Vitamina D y suplementación.*

Abbreviations

RYGB: Roux-en-Y gastric bypass.
PTH: Parathormone.
BMI: Body mass index.

Introduction

The Roux-en-Y gastric bypass (RYGB) is considered a reference for surgical procedure for weight loss. It consists of a combination of mechanisms that promote weight loss by restricting food-intake capacity by significantly reducing the size of the gastric reservoir associated and limiting the absorptive process[1].

The changes in micronutrient metabolim resulting from the surgical procedure may cause nutritional deficiencies[2], with those that affect vitamin D and calcium metabolism standing out[3]. Even before undergoing surgery, obese patients may already present abnormal levels of serum calcium, vitamin D and parathormone (PTH) levels compared with those who are not obese[4].

There is research showing that the obese have lower levels of vitamin D-25(OH)D[5,6]. This may be due to their seeing less sunlight exposure, being less mobile, the clothing they commonly wear or the greater amounts of vitamin D stored in adipose tissue[7], and inadequate oral intake[8].

Vitamin D is a nutrient essential to calcium and phosphorus homeostasis, and a deficiency leads to a decline in calcium absorption and subsequent rise in PTH levels[9]. According to Bandeira *et al*[10] a subclinical deficiency in the vitamin brings about slight hypocalcaemia, reactive hyperparathyroidism and a loss of bone mass.

Calcium is mainly absorbed in the duodenum and proximal jejunum through an active process mediated by the presence of vitamin D, and the preferential absorption sites are the jejunum and ileum. Nevertheless, besides the hypochlorhydria resulting from the stomach reduction, there is a deviation of the duodenum and 30 to 50 centimeters of jejunum responsible for the lack of digestive enzymes in the remaining jejunum, leading to calcium deficiency[11]. This deficiency can be made worse by lactose intolerance, a common complication to arise from the bariatric surgery, caused by a drop in lactate synthesis[12].

Calcium carbonate has been discussed in clinical practice, owing to the lack of gastric acid needed for optimal absorption[13]. In contrast, calcium citrate used in the same quantities (500 mg plus 125 UI of 25-OH-vit D_3 supplementation daily) has promoted greater increase in calcium levels and reduction of PTH levels[14], suggesting that calcium citrate is more bioavailable after RYGB. Flores *et al*[15] used 1200 mg calcium carbonate plus 800UI vitamin D3 supplementation daily, prescribed when PTH levels were higher than 70 pg/mL. The authors reported that patients have lower absorptive capacity after surgery and, therefore it is necessary to increase vitamin D doses to correct the secondary hyperparathyroidism.

Calcium and vitamin D deficiencies are linked to bone diseases and there is no recommended daily dose for bariatric surgery patients. Therefore, the aim of this study was to research calcium, vitamin D and PTH concentrations in obese adults, both before and six months after Roux-en-Y gastric bypass surgery, and to assess the dose of calcium and vitamin D supplementation used, in an attempt to help prevent and treat those deficiencies.

Methods and materials

A observational longitudinal study was conducted for 83 adult patients of both genders of a BMI ≥ 40 kg/m^2 or a BMI > 35 kg/m^2 with significant comorbidities[16], who underwent Roux-en-Y gastric bypass surgery. We evaluated the patients prior to (T0) and 6 months following the surgical procedure (T1). They were attended to by nutritionists from a multidisciplinary team at a private practice in Rio de Janeiro City. All the patients attended during the study had the same chances of being on the sample group. Patients were excluded if they had undergone prior disabsortive and restrictive surgery, had a prior record of neoplasia, liver disease, disabsortive syndrome, metabolic bone disease, were pregnant or nursing, or taken mineral and vitamin supplementation over the previous six months before entering the study.

Due to the numerous changes in body and hormone composition[17] and the drop in cutaneous vitamin D synthesis[18], this study did not evaluate women past childbearing age (> 49 years) or men over 60.

Following surgery, the patients were provided daily dietary supplementation of 500 mg of calcium carbonate and 400UI of vitamin D for an undetermined length of time.

This study was part of a broader body of research looking into micronutrient nutritional status, including non-retrospective approaches that were approved by the research ethics committee of Clementino Fraga Filho University Hospital and registered under number 011/06.

Laboratorial evaluation

All laboratory analysis was performed at a medical laboratory. The cut-off points we used for PTH, ionic calcium and vitamin D-25(OH)D levels were between 12 and 65 pg/mL via the chemiluminescence immunoassay method[19], between 1 and 1.32 nmol/L using the immunochemiluminometric method[20] and between 15 and 90 ng/mL via the HPLC method[21], respectively.

Anthropometrical evaluation

We performed an anthropometric evaluation on the patients that included taking weight measurements via a Filizola electronic platform scale with a 300 kg

capacity that oscillates by 100 g, while we measured height using a stadiometer fixed to the scale, with the patient standing barefoot, heels together, back erect and extended arms alongside the body[22].

From the weight and height measurements we calculated BMI so as to reach a nutritional diagnosis, dividing body mass (kg) by the square of height (m^2). The cut-off point we used was that established by the WHO[23].

Statistical analysis

We took mean and standard deviation as our quantitative parameters, used the Kolmogorov-Smirnov test to evaluate data distribution normalcy, Student's t-test to assess paired data and the chi-squared test for categorical variables. We analyzed all the data using the SPSS version 13 software package, and $p < 0.05$ was considered statistically significant.

Results

The sample group was composed of 83 patients, of which 56 were women averaged 35 ± 8.86 years of age and with an average BMI of 46 ± 7.56 kg/m^2, and 27 men averaged 40 ± 10.15 years of age and with an average BMI of 43 ± 3.56 kg/m^2. The BMI figures fit the average BMI found in other studies on patients undergoing RYGB[3,9].

During the preoperative period, we found serum vitamin D levels to vary between sexes. Levels were found to be adequate in 55% of the women (14.47 ± 5.60 ng/mL) and in 63% of the men (14.90 ± 5.34 ng/mL). However, during the postoperative period there was a statistically significant drop in serum vitamin D levels for both sexes (p=0.01), with only 9% of the men (10.20 ± 4.68 ng/mL) and 15% of the women (9.69 ± 3.87 ng/mL) found to have adequate levels, suggesting that offered standard dose was not sufficient to correct and/or prevent the worsening of the deficiency.

Both men and women were found to have adequate levels of ionized calcium during both the pre and postoperative stages, with no statistically significant difference between them ($p > 0.05$).

Serum PTH levels during the preoperative stage were found to be 40.30 ±16.48 pg/mL in the women and 43.32 ±16,02 pg/mL in the men, while they were 43.09 ± 18.97 pg/mL and 40.57 ± 18.34 pg/mL during the postoperative stage, respectively. Such figures equate to adequacy for 83% of the women and 89% of the men following surgical intervention. This changes did not differ statistically in both sexes ($p > 0,05$).

Discussion

We found a relevant percentage of vitamin D deficiency during the preoperative period that corresponded to 59% of the sample group. One study comparing obese and healthy individuals showed 26% of the extremely obese patients to have serum levels 25 (OH)D lower than those found in the healthy-patient group[24]. Flancbaum *et al*[25] found deficiency in 37% of the men and 45% of the women they assessed prior to surgery, while Fish[6] *et al* found a prevalence of 84% vitamin D deficiency in preoperative obese patients.

Some authors explain the occurrence of vitamin D deficiency in obese patients as happening because of the large amount of the vitamin captured in adipose tissue, as well as reporting that the obese tend to cover their skin with more clothing and spend less time outside, thus getting less exposure to sunlight than they otherwise would[5,7,18].

During the postoperative period we found 85% of the men and 91% of the women who were evaluated 6 months following surgery to be vitamin D deficient, showing an inability of supplementation protocol to treat and prevent vitamin D deficiency. Gehrer et al[26] found a 22% vitamin D deficiency after a period of 6 months following gastric bypass surgery, even with 300UI vitamin D supplementation every 3 months.

Inadequate intake through food, insufficient supplementation of vitamins and minerals, malabsorption resulting from the surgical procedure and the reduction in fat and fat-soluble vitamins, like vitamin D, can bring about deficiency and consequently harm bone health in gastric bypass patients.

Prisco and Levine[27] evaluated women who had developed osteomalacy and osteoporosis for a period of 9 to 12 months post surgery, during which they found a high prevalence of vitamin D deficiency in every case study. These data back the need for vitamin D supplementation during the preoperative period, as described by Xanthakos and Inge[28], wheredy supplementation with 400 UI of vitamin D was enough to prevent deficiency over the long term. Gasteyger *et al*[29] show that 47% of patients in their database taking 1200mg of calcium and 200UI of vitamin D (corresponding to 100% RDI) required additional doses of 2 nutrients one year after surgery.

The increased levels of PTH may suggest an increase in parathyroid activity immediately following gastric bypass surgery, which results in the skeletal calcium being mobilized and an increase in renal calcium being reabsorbed, thus keeping serum calcium concentrations within a normal range[30].

Following surgery, 14% of the males and 17% of the females were found to have values above the cut-off points. Von Mach[31] did not find a changes in blood PTH concentrations in patients who had underwent bypass surgery. According to Youssef *et al*[32], hyperparathyroidism resulting from calcium deficiency may occur at a later time, around one year after surgery.

We did not find a relationship between PTH and BMI. During the postoperative stage, 7% of the men and 6% of the women were found to have values above the cut-off point. Nor did Snijder *et al*[33] find a positive

correlation between the rise in PTH and excess weight in their study of 443 individuals of both sexes, corroborating our findings. However, Wortsman *et al*[5] and Zemel[34] found associations between obesity and the higher serum PTH levels.

However, the period during which the sample group was observed for this study was only of six months, which could explain the lower frequency of thyroid hormone changes.

Conclusion

Obesity can be considered a risk factor for developing vitamin D deficiency, regardless of gender, and can contribute to the higher prevalence of metabolic bone diseases in patients who have undergone Roux-en-Y gastric bypass surgery.

The results demonstrate that the routine of postoperative supplementation was unable to treat and prevent vitamin D deficiency in obese adults undergoing RYGB. Thus, monitoring of the nutritional status may help in prevention and treatment of deficiency of these micronutrients, and to confirm that supplementation should be individualized according to the degree of disability, aimed at reducing the incidence of bone diseases.

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