Anthropometric measurements, deficiency of vitamin D and calcium in patients in pre- and post-operative bariatric surgery

Medidas antropométricas, deficiência de vitamina D e cálcio em pacientes pré e pós-operatório de cirurgia bariátrica

DOI:10.34117/bjdv6n7-214

Recebimento dos originais: 07/06/2020
Aceitação para publicação: 09/07/2020

Raíssa de Sousa Spíndola
Nutritionist graduated from the Pontifícia Universidade Católica de Goiás
Instituição: Pontifícia Universidade Católica de Goiás
Endereço: Rua 232, número 200, apartamento 104, Setor Leste Universitário, Goiânia - GO, 74605140
e-mail: raissa_spindola@hotmail.com

Lina Monteiro de Castro Lobo
PhD in Ciências da Saúde from the Universidade Federal de Goiás, Nutritionist of Secretaria Municipal de Saúde de Goiânia, Professor of the course of nutrition
Instituição: Pontifícia Universidade Católica de Goiás
Endereço: Rua 401, apto 101, bloco 12, Recanto das praças 1, Setor Negrão de Lima, Goiânia - GO, 74650-340
e-mail: linamonteiro@gmail.com

Adriana Cristina Campos
Nutritionist of Instituto do Rim
Instituição:Hospital Instituto do Rim de Goiânia
Endereço: Av. T-1, Qd.: 39, Lt.: 7/8, Setor Bueno, Goiânia - GO, 74210-098
e-mail: adrianaferreiranutricionista@outlook.com

Leandro Mendonça Pedroso
Digestive System Surgeon and Bariatric Surgeon
Instituição:Hospital Instituto do Rim de Goiânia
Endereço:Av. T-1, Qd.: 39, Lt.: 7/8, Setor Bueno, Goiânia - GO, 74210-098
e-mail: leandropedroso@live.com

Raquel Machado Schincaglia
PhD in Ciências da Saúde from the Universidade Federal de Goiás, Professor of the course of nutrition
Instituição:Pontifícia Universidade Católica de Goiás
Endereço: Rua 227 Viela, Quadra 68, S/N - Setor Leste Universitário, Goiânia - GO, 74605-080
e-mail: raquelms@outlook.com

ABSTRACT

Introduction: Bariatric surgery have been shown as an efficient tool for weight loss, however some nutritional deficiency could be occurred, like vitamin D and calcium. Aim: To evaluate the frequency of serum vitamin D and calcium deficiency, as well as body measurements in patients before and after bariatric surgery. Methodology: Longitudinal study involving patients submitted to Roux-en-Y...
gastric bypass (RYGB) and Sleeve gastrectomy. Anthropometric data and biochemical data were evaluated comparing them to surgical techniques and over time. **Results:** There was no difference in the comparison of weight loss (kg) between techniques after six months of surgery (p=0.151), however, there was a greater total weight loss in patients who underwent RYGB than in those underwent Sleeve gastrectomy (p=0.046) after 12 months after surgery. There was weight loss in percentage in relation to pre-surgery weight and in relation to ideal weight after surgery. No differences were observed in serum vitamin D and calcium concentrations at the beginning and at the end of the study, nor during the post-surgical time (p>0.05). **Conclusion:** Bariatric surgery in both techniques proved to be efficient for continuous body weight loss. No vitamin D and calcium deficiencies were found pre- and post-surgical.

**Keywords:** Obesity, bariatric surgery, vitamin D deficiency, calcium deficiency, anthropometry

**RESUMO**  
**Introdução:** A cirurgia bariátrica tem se mostrado uma ferramenta eficiente para perda de peso, porém podem ocorrer deficiências nutricionais, como vitamina D e cálcio. **Objetivo:** Avaliar a frequência de deficiência de vitamina D e cálcio e medidas corporais em pacientes antes/após a cirurgia bariátrica. **Metodologia:** Estudo longitudinal envolvendo pacientes submetidos a bypass gástrico em Y de Roux (RYGB) e gastrectomia vertical. Dados antropométricos e bioquímicos foram avaliados comparando-os entre as técnicas cirúrgicas e ao longo do tempo. **Resultados:** Não houve diferença na comparação da perda de peso (kg) entre as técnicas após seis meses da cirurgia (p = 0,151), no entanto, houve uma maior perda total de peso nos pacientes submetidos à RYGB do que naqueles submetidos à gastrectomia vertical (p=0,046) após 12 meses após a cirurgia. Houve ponderal em porcentagem em relação ao pré-operatório e em relação ao peso ideal após a cirurgia. Não houve diferenças nas concentrações séricas de vitamina D e cálcio no início e fim do estudo, nem durante o período pós-cirúrgico (p>0,05). **Conclusão:** Cirurgia bariátrica, em ambas as técnicas, se mostrou eficiente para perda ponderal contínua. Não foram encontradas deficiências de vitamina D e cálcio antes e após a cirurgia.

**Palavras-chave:** Obesidade, cirurgia bariátrica, deficiência de vitamina D, deficiência de cálcio, antropometria

**1 INTRODUCTION**

The Associação Brasileira para o Estudo da Obesidade e da Síndrome Metabólica (ABESO) points out that in Brazil more than 50% of the population is in the overweight and obesity range. Obesity is characterized by the excessive accumulation of body fat, which is due to several factors such as genetic, environmental, behavioral and hormonal 1,2.

Obesity can be treated using various approaches such as medical, behavioral and dietary therapies. However, many patients do not adapt to the therapeutic treatments so that they do not respond to it and thus require more effective intervention 3-6.

Bariatric surgery, therefore, is the most commonly used tool, making it the most effective in the treatment and control of morbid obesity, being Roux-en-Y gastric bypass (YRGB) the gold standard alternative for severe obesity 3-5. However, all intervention alternatives should be treated in
a way that meet the individual needs of each patient, since often the most efficient approaches cause vitamin and mineral deficiencies and weight loss 3.

Patients in the postoperative period of bariatric surgery tend to develop nutritional deficiencies of minerals and vitamins. Determinants of these deficiencies are: low dietary intake, low nutrient uptake due to intestinal resection, low fat intake/absorption that interferes with fat-soluble nutrients, inadequate dietary habits, food intolerances, and post-surgical complications such as diarrhea, nausea and vomiting 3,7,9.

However, not only in the postoperative period of bariatric surgery may there be nutritional deficiencies, as commonly in individuals who have not yet undergone the surgical procedure there is development of osteomalacia. This is because vitamin D is responsible for the regulation of calcium and phosphorus metabolism through the intestinal absorption and renal reabsorption systems of these ions, maintaining them in adequate plasma concentrations to ensure suitable mineralization, growth and bone health 9-17.

For the diagnosis of hypovitaminosis D in obese subjects before or after the surgical procedure, it is recommended to verify vitamin D concentrations by calcidiol dosage and not by calcitriol dosage. The justification for this preference is due to the fact that in vitamin D deficiency, there is an increase in parathyroid secretion (PTH), stimulating the kidney to produce more calcitriol and masking the result 11,13,18,19.

Through this perspective, knowing that vitamin D is responsible for the facilitation of calcium absorption that occurs preferably in the proximal duodenum and jejunum, calcium deficiency may be present in these patients. In turn, this calcium deficiency can compromise the proper function of the heart and nervous system and should be monitored and evaluated in these patients 20.

Thus, when considering the importance of assessing nutritional deficiencies in patients undergoing bariatric surgery, as well as the need for early diagnosis of the patients' nutritional status, it is justified to carry out scientific research for this purpose. Therefore, the objective of this study is to evaluate the anthropometric status and frequency of vitamin D and calcium deficiency in patients before and after bariatric surgery.

2 MATERIALS E METHODS
2.1 STUDY DESIGN AND SAMPLE

A retrospective cohort study involving patients who underwent bariatric surgery between January 2010 and December 2015 in two hospitals in a Brazilian capital. Included in the research were medical records of patients over 18 years of age, who possessed health insurance or private health plans, and those who underwent bariatric surgery using the YRGB or Sleeve gastrectomy
technique. Patients with incomplete data and patients submitted to other surgical techniques were excluded from the sample.

2.2 DATA COLLECT

The data collected from the charts were age, sex, marital status, physical activity, physical activity time, smoking habit, and alcohol habit. Pre-surgery, six months and twelve months after surgery, weight, body mass index (BMI), serum vitamin D, serum calcium, use of multivitamin and polimineral supplementation and adherence to the use of supplements were evaluated.

2.2.1 Anthropometric evaluation

The recorded body weight was collected in medical records and measured by a digital anthropometric scale (W-300, Welmy®, São Paulo, Brazil), with a capacity of 300 kg and a 50 g division. The stature collected from the chart was measured by the stadiometer coupled to the scale. After that, the body mass index (BMI) was calculated by dividing the weight in kilograms (kg) by stature squared (m²). For the classification of nutritional status based on BMI, the cut-off points of BMI for obesity, recommended by Renquist (1997), that is, normal (BMI <25.0 kg/m²), overweight (BMI 25.0-27.0 kg/m²), mild obesity (BMI 27.0-30.0 kg/m²), moderate obesity (BMI 30.0-35.0 kg/m²), severe obesity (BMI 35.0-40.0 kg/m²), morbid obesity (BMI 40.0-50.0 kg/m²), super obesity (BMI 50.0-60.0 kg/m²) and super, super obesity (BMI>60 kg/m²). The weight loss was compared to the preoperative weight and to the ideal weight in kilogram or percentual.

2.2.2 Biochemical evaluation

The dosages of the biochemical variables collected in medical records were performed using standardized and routine methods, through venous blood collection, after a 12-hour fast. Vitamin D was classified according to the values defined by the Department of Bone and Mineral Metabolism of the SBEM (2017), being considered adequate values between 30 and 60 ng/ml for risk groups such as pre-bariatric; between 10 and 20 ng/ml considered insufficiency; and less than 10 ng/ml considered deficient. For serum calcium data, values between 8.4 and 10.5 mg/dl were used as cut-off points for normality (not reduced), as were values lower than 8.4 mg/dl.

2.3 DATA ANALYSIS

A descriptive analysis was performed, which for continuous data is presented in mean±standard deviation of the mean and for the categorical ones in absolute and relative frequencies. The Shapiro-Wilk test was used to determine the normality of the continuous data and the absence of normality of
all variables. The Mann-Whitney test was used to compare the surgical type groups and the comparison between six months and twelve months post-surgical. The Kruskall-Wallis test was used to compare pre-surgery, six months and twelve months after surgery. Fisher's exact test was used to test the homogeneity of the groups in relation to the proportions. The analyzes were performed in the STATA version 14.0 program and a significance level of 5% was adopted for all tests.

2.4 ETHICAL ASPECTS

The study was approved by the Research Ethics Committee and authorized the waiver of Free and Informed Consent due to the collection of data in medical records.

3 RESULTS

One hundred thirty-five patients participated in the study, of which 82.2% were females with a mean age of 41.3 years (SD=9.5). More than half of the participating patients had a partner, while nearly 10% had a smoking habit and more than 40% alcoholic habit. Regarding physical activity, 11.1% were active and among these the average practice time was 144.7 minutes/week (SD=40.5). It was observed that the surgical procedure YRGB was the most frequently prescribed being 86.7% of the total surgeries while Sleeve gastrectomy represented 13.3%. When comparing the surgical groups, no differences were observed, except for the gender in which Sleeve gastrectomy type was more common for women (p=0.022) (Table 1).

Table 1. Sociodemographic and behavioral characterization by types of bariatric surgery.

|                          | Total (n=135) | Roux-en-Y gastric bypass (n=117) | Sleeve gastrectomy (n=18) | p-value |
|--------------------------|--------------|----------------------------------|---------------------------|---------|
| **Sex, n(%)**            |              |                                  |                           |         |
| Male                     | 24 (17.8)    | 24 (20.5)                        | 0                         | 0.022*  |
| Female                   | 111 (82.2)   | 93 (79.5)                        | 18 (100.0)                |         |
| **Age (years), mean±SD** | 41.3±9.5     | 41.5±9.7                         | 40.1±8.8                  | 0.525   |
| **Marital status, n(%)** |              |                                  |                           | 0.511*  |
| With partner             | 79 (58.5)    | 68 (58.1)                        | 11 (61.1)                 |         |
| Without partner          | 56 (41.5)    | 49 (41.9)                        | 7 (38.9)                  |         |
| **Smoking habit, n(%)**  |              |                                  |                           | 0.548*  |
| Yes                      | 13 (9.7)     | 11 (9.5)                         | 2 (11.1)                  |         |
| No                       | 121 (90.3)   | 105 (90.5)                       | 16 (88.9)                 |         |
| **Alcohol habit, n(%)**  |              |                                  |                           | 0.591*  |
The mean pre-surgical weight for the total sample studied was 114.9 kg (SD=21.1) and there was a significant reduction over the post-surgical time so that the mean weight at six months was 82.4 Kg (SD=14.87) and at one year 75.3 kg (SD=13.2) (p <0.05) (Figure 1). Also, in relation to weight, it was observed that both techniques promoted significant weight loss in kilos throughout the post-surgical time (p <0.05). It was verified that there was no difference in the comparison of weight loss in kilos between techniques at six months (p=0.151), however, there was a greater weight loss for the YRGB technique compared to Sleeve gastrectomy at twelve months (41.9±17, 0 vs 34.1±8.4, respectively, p=0.046) (Table 2).

Figure 1. Evolution of obese patients before and after bariatric surgery. P-value obtained by Kruskall-Wallis test.

| Physical activity, n(%) | Yes | No |
|-------------------------|-----|----|
|                         | 60(44.8) | 74(55.2) |
| Physical activity time (min/week), mean±SD | 144.7±40.5 | 147.5±44.1 |
|                         | 52(44.8) | 64(55.2) |
|                         | 8(44.4) | 10(55.6) |
|                         | 3(16.7) | 15(83.3) |

Data presented in absolute frequencies (relative frequencies) or mean±standard deviation of the mean. p-value obtained by Fisher’s exact test or the Mann-Whitney test, with a significance level of 5%.
When weight loss was observed in percentage in relation to pre-surgery weight and in relation to ideal weight, significant loss after surgery was observed, but without distinction between surgical procedures. Likewise, it was observed that the BMI that was evaluated continuously or categorized was significantly reduced over time (p <0.05), however, without differences between surgical techniques (p> 0.05) (Table 2).

| Table 2. Anthropometric evaluation in patients submitted to bariatric procedure. |
|---|---|---|---|---|---|---|---|
| | Total | Roux-en-Y gastric bypass | Sleeve gastrectomy |
| | (n=135) | (n=117) | (n=18) |
| Pre | 6 m | 12 m | p | Pre | 6 m | 12 m | p | Pre | 6 m | 12 m | p |
| Weight loss (Kg) | - | 32.7±10 | 40.8±16 | <0.001 | - | 33.3±10 | 41.9±17 | <0.001 | - | 29.2±5.9 | 34.1±8.4 | 0.085* | - | 0.151* | 0.046 |
| Weight loss in comparison to preoperative weight (%) | - | 28.2±6.3 | 34.1±6.7 | <0.001 | - | 28.2±6.3 | 34.3±6.6 | <0.001 | - | 27.8±4.2 | 32.5±7.3 | 0.046* | - | 0.754* | 0.216 |
| Weight loss in comparison to adequate weight (%) | - | 56.6±15.7 | 70.3±23.0 | <0.001 | - | 56.4±16.3 | 70.5±54.2 | <0.001 | - | 58.5±11.3 | 68.4±16.3 | 0.062* | - | 0.554* | 0.751 |
| Body mass index (Kg/m²) | 43.4±6.5 | 31.0±4.8 | 28.4±3.8 | <0.001 | 43.9±6.8 | 31.2±4.6 | 28.6±3.8 | <0.001 | 40.6±3.3 | 29.3±3.0 | 27.4±3.6 | <0.001 | 0.068* | 0.121* | 0.403 |
| Normal | 0 | 5(3.7) | 20(15.2) | 0 | 3(2.6) | 15(13.2) | 0 | 2(11.1) | 5(27.8) | 0 | 3(2.6) | 15(13.2) | 0 | 2(11.1) | 5(27.8) |
In contrast, the biochemical dosages with the post-surgical evolution, it was verified that there was an increase of serum vitamin D concentration in the six months in comparison to the pre-surgery moment and later there was a small decrease, but still remaining above the values pre-surgical (pre: 30.2±9.5; 6m: 34.3±11.1; 12m: 33.5±10.0; p <0.001). The same trend is observed for the YRGB procedure (p <0.001), but not for the Sleeve gastrectomy (p=0.938). There were no significant differences in vitamin D deficiency, insufficiency or adequacy, neither between techniques nor over time (p> 0.05). Regarding calcium, no changes were observed in relation to their serum concentrations and in relation to their classification in non-reduced or reduced (p> 0.05) (Table 3).

|                   | Mild obesity | Moderate obesity | Morbid obesity | Severe Obesity | Overweight | Super obesity | Super, super obesity |
|-------------------|--------------|-----------------|----------------|----------------|------------|---------------|---------------------|
|                   | 1(0.7)       | 41(30.6)        | 2(0.7)         | 37(31.9)       | 4(22.2)    | 4(22.2)       |                     |
|                   | 1(0.9)       | 42(31.8)        | 0              | 38(33.3)       |            |               |                     |
|                   | 0            | 4(26.2)         | 1(5.56)        | 26(22.8)       | 9(50.0)    | 6(33.3)       |                     |
|                   |              | 68(58.1)        | 6(5.2)         | 12(66.7)       | 0          | 0             |                     |
|                   |              | 31(26.5)        | 17(14.7)       | 5(27.8)        | 0          | 0             | 0                   |
|                   |              | 0              | 11(9.5)        | 0              | 3(16.7)    | 3(16.7)       |                     |
|                   |              | 2(1.7)          | 0              | 2(1.7)         | 0          | 0             | 0                   |
|                   |              | 15(11.1)        | 0              | 15(12.8)       | 0          | 0             | 0                   |

Data presented in absolute frequencies (relative frequencies) or mean±standard deviation of the mean. p-value obtained by Fisher's exact test or * Mann-Whitney test or ** Kruskall-Wallis test, with a significance level of 5%.
Regarding the adhesion of the multivitamin and polimineral supplement, it was verified that for the total sample in the twelve months evaluation, 29.3% of the patients did not consume the supplement, whereas in the six-month evaluation, this value was 18.0% (p=0.043). Although there was the same adherence tendency toward the supplement, no differences were observed between surgical techniques (p> 0.05) (Table 3).

| Table 3. Biochemical evaluation and use of multivitamin and polyimineral supplement in patients submitted to bariatric procedure. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Total (n=135) | p | Roux-en-Y gastric bypass (n=117) | p | Sleeve gastrectomy (n=18) | p | p | p |
| | Pre 6 m 12 m | Pre 6 m 12 m | Pre 6 m 12 m |
| **Biochemical evaluation** | | | | | | | | |
| Vitamin D | 30.2±9.5 34.3±11.1 33.47±10.40 | <0.001 ** | 29.46±8.92 34.1±10.96 32.98±9.9 | <0.001 ** | 35.3±1.7 35.7±1.24 36.4±1.31 | 0.938 ** | 0.051 ** | 0.656 ** | 0.228 ** |
| Deficiency | 0 2(1.5) 0 | | 0 2(1.8) 0 | | 0 0 0 0 | | | | |
| Insufficiency | 14(11.0) 8(6.2) 7(5.6) | 0.153 * | 13(11.8) 7(6.2) 6(5.6) | 0.136 * | 1(5.6) 1(5.6) 1(5.9) | 1.000 * | 0.691 * | 1.000 * | 1.000 |
| Adequate | 113(89.0) 120(92.3) 119(94.4) | | 97(88.2) 103(91.9) 102(94.4) | | 17(94.4) 17(94.4) 16(94.1) | | | | |
| Calcium | 9.13±0.7 9.26±0.6 9.17±0.6 | 0.102 * | 9.15±0.5 9.3±0.6 9.2±0.6 | 0.089 * | 8.95±1.5 9.1±0.5 9.2±0.6 | 0.800 ** | 0.445 ** | 0.188 ** | 0.783 ** |
| Not reduced | 129(98.5) 130(98.5) 125(97.7) | 0.803 * | 115(99.1) 114(99.1) 107(97.3) | 0.455 * | 14(93.3) 16(94.1) 18(100.0) | 0.530 * | 0.217 * | 0.242 * | 1.000 * |
4 DISCUSSION

In our study, we could observe that there was a significant reduction of weight in twelve months of postoperative and both techniques promoted efficient weight loss in kilos throughout the post-surgical time. There was no difference in the comparison of weight loss in kilos between techniques at six months, however, there was greater weight loss for the YRGB technique compared to the Sleeve gastrectomy in twelve months. Weight loss as a percentage of preoperative weight and weight in relation to ideal weight was significant after surgery, but without distinction between surgical procedures.

There were no significant differences in vitamin D deficiency, insufficiency or adequacy, neither between techniques nor over time. For calcium, no changes were observed in relation to their serum concentrations and in relation to their classification in non-reduced or reduced. For adherence to the supplement, no differences were observed between surgical techniques.

In the literature, the percentage of excess weight loss (% PEP) of at least 50% and the maintenance of this weight loss in the long term are used to evaluate success in bariatric surgical treatment. Therefore, Novais et al. defined in their study that the groups with % PEP <50% were characterized as...
failure and the groups of ≥50% as success in relation to the weight loss, since after this loss there is a significant improvement of the metabolic state and reduction of risks associated with obesity 21.

In our study we found that there was a higher PEP% in the first six months after surgery, followed by six months of lower loss (Table 2). Likewise, Novais et al. analyzed that the first half was a phase of rapid loss, followed by a slow phase, which lasted from the first to the second year of surgery. From the second year onwards, there may be a weight recovery due to the physiological adaptation of the gastrointestinal tract over time, as well as the absence/difficulty of lifestyle changes 21,22.

Novais et al. also report that the weight loss in kilos presented differences between the pre-surgery weight and the weight at six months postoperatively. After that, the differences were not confirmed, showing that there was weight stabilization without significant recovery between the groups studied 21. In the present study, we verified that weight loss was maintained in kilograms after six months to twelve months of follow-up.

Although weight loss in our study was continuous over twelve months of follow-up, we did not distinguish between surgical techniques. However, in a study that reviewed randomized controlled trials and observational studies, the reduction of BMI was greater for YRGB than the other surgical techniques and similarly it was also observed that the % PEP at twelve months was on average 60% for this same surgical technique 23. Already in a systematic review and meta-analysis, the mean percentage of excess weight loss was 61.6% for YRGB, 43.5 kg for absolute weight loss and a mean BMI reduction of 16.7 kg/m² 24.

In fact, the results on body weight in the short and long term after the procedure are determined by several combined factors, therefore, it is indispensable to know the related factors and to have them monitored in order to confirm the maintenance of the benefits of the surgery, especially in the long term 21. One of these determining factors is food, especially caloric intake, and another is the practice of physical activity. In our study we found that there was a low percentage of individuals who practiced physical activity in the pre-surgical period, and even those who practiced did it for a short time each week. This is possibly justified by the poor functional and mobility capacity that morbidly obese patients experience with weight gain 25,26. On the other hand, there is evidence that in the postoperative period (2-6 years) only 4% of the individuals did not perform any type of regular physical exercise 27, suggesting that the weight loss can motivate practice of physical activity but it can also be a facilitator of the limitations of these patients in relation to mobility.

Although bariatric surgery is of great use in the treatment of obesity, it is worth noting that it has some complications, one of which is the low absorption of vitamins and minerals that can
culminate in nutritional deficiencies. In our study, we observed that for the total sample there was an increase in serum vitamin D concentration in the six months compared to the pre-surgery period, and afterwards there was a small decrease, but still remaining above the pre-surgical values. Apparently, our study differs from others in relation to vitamin D deficiency/insufficiency, since Santos et al. followed by patients with an average of three years postoperatively, finding more significant values of serum vitamin D deficiency in the operated group compared to the control group (56.3% vs 21.1%, p=0.010) \(^{27}\). Regarding the insufficiency, the frequency in our study was around 5% for the patients of the YRGB technique at six and twelve months. In the previously mentioned study, this value was more than 20%, demonstrating that the inadequacy of vitamin D values may arise with the passage of time postoperatively.

On the other hand, the deficiencies are not exclusive in the postoperative period, so that in morbidly obese patients who were candidates for bariatric surgery, calcitriol deficiency was present in 60% of the sample \(^{28}\), whereas in our study no deficiency was found only 11.0% had insufficiency of this vitamin in the pre-surgery, which calls attention to the fact that the higher the BMI, the lower the vitamin D concentrations \(^{28}\).

Interestingly, while it is found that the highest BMI is related to lower vitamin D concentrations, as previously mentioned \(^{28}\), in relation to calcium the higher the concentrations the higher the BMI \(^{29}\). Carlin et al. reported a prevalence of slightly different calcium deficiencies compared to our study (1.5% vs. 0.7%, respectively) \(^{29}\). When evaluating changes in calcium concentrations throughout the postoperative period in the present study, no distinctions were observed. In a cross-sectional, controlled study evaluating adult women submitted to the YRGB three years ago, it was also observed that there was no difference in the serum calcium laboratory parameters of these patients compared to the control group \(^{27}\).

Stein et al. (2014) demonstrated that calcium deficiency was 8.5 to 10.5% in the preoperative period and approximately 10% in the postoperative period, and the risk factors associated with this deficiency were insufficient supplementation of calcium and/or vitamin D, calcium pre-deficiency, vitamin D deficiency, and the techniques Sleeve gastrectomy, YRGB and biliopancreatic deviation with a duodenal switch.

Thus, supplementation is necessary enough to guarantee the nutrient homeostasis of patients who have undergone bariatric procedures. Currently, supplementation of calcium citrate 1000 to 1200mg/day is recommended for patients undergoing obesity surgery \(^{30}\). In our study, we observed that in relation to the adhesion to the multivitamin and polyimineral supplement, for the total sample in the six months evaluation, there was a low percentage of the patients who did not use the supplement, and this value was higher in the evaluation of twelve months post surgical, demonstrating...
that with the passage of time to the adhesion of the supplementation is reduced. In a study on adherence to the use of vitamin supplement was 60.6% considering patients underwent the procedure on average three years ago. In the same study, adherence to calcium supplementation was observed for 70.2% of the patients.27

This low consumption can be justified by the cost of the supplementation treatment associated with the cost of biochemical exams in both the pre and postoperative periods. An average of $35 (equivalent to approximately R $131.25) per month with nutritional supplementation, and $2100 (approximately R $7875.00) per year of exams throughout the follow-up period, reflecting high financial cost capable of adversely affecting adherence, especially in countries where the medicine or financial assistance is not available.31

Another disincentive factor for adherence to supplementation may be related to the large number of capsules to be ingested as evidenced by Gasteyger et al. In that study it was demonstrated that the use of only one capsule per day of standardized multivitamin supplementation was not able to satisfy the need of many patients, making it necessary to use several capsules per day and reducing adherence.31 However, studies show that supplementation recommendations are still scarce and published reports highlight the patient's lack of awareness of the real importance of the need for supplementation.30

We considered as limitations of this study the absence of evaluation of food consumption and especially the consumption of food sources of vitamins D and calcium, however as these were not available data in the medical record, it was not possible to collect them. In addition, the patients' sun exposure time was not evaluated for the same previous reason. We also did not evaluate the dosage and composition of the supplementation, which did not allow us to verify the adequacy of the daily intake of the studied micronutrients. However, in spite of our limitations, we believe that our study presents relevant results for the bariatric surgery public that can assist in the care of these patients, as well as better understand the behavior of weight loss and BMI over twelve months after the procedure.

Thus, it is concluded that bariatric surgery in both surgical techniques promotes continuous body weight loss in twelve months, being greater in the first six months postoperatively. Vitamin D deficiency was not found and only a low frequency was verified for vitamin D deficiency in the presurgery period, with a better result at six months post-surgery in the YRGB technique. No differences were observed in calcium concentrations throughout the postoperative period. In the evaluation of the adhesion of multivitamin and polimineral supplementation, the result was relatively high for the six postoperative months, with reduction in one year postoperative. Thus, the results confirm the need for follow-up, investigation and intervention to avoid nutritional deficiencies and the complications resulting from them.
REFERENCES

1. Quadros MRR, Savaris AL, Da M, Ferreira V, Filho AJB. Intolerância alimentar no pós-operatório de pacientes submetidos à cirurgia bariátrica. Rev Bras Nutr Clínica. 2007;22(1):15–9.

2. IBGE. Pesquisa de Orçamentos Familiares: Antropometria e Estado Nutricional de Crianças, Adolescentes e Adultos no Brasil. Instituto Brasileiro de Geografia e Estatística. 2010.

3. Busetto L, Dixon J, De Luca M, Shikora S, Pories W, Angrisani L. Bariatric surgery in class i obesity: A position statement from the international federation for the surgery of obesity and metabolic disorders (IFSO). Obes Surg. 2014;24(4):487–519.

4. Chopra A, Chao E, Etkin Y, Merklinger L, Lieb J, Delany H. Laparoscopic sleeve gastrectomy for obesity: Can it be considered a definitive procedure? Surg Endosc Other Interv Tech. 2012;26(3):831–7.

5. Shankar P, Boylan M, Sriram K. Micronutrient deficiencies after bariatric surgery. Nutrition. 2010;26(11–12):1031–7.

6. Livingston EH. Obesity and its surgical management. Am J Surg. agosto de 2002;184(2):103–13.

7. Malinowski SS. Nutritional and Metabolic Complications of Bariatric Surgery. Am J Med Sci. 2006;4:219–25.

8. Alvarez-Leite JI. Nutrient deficiencies secondary to bariatric surgery. Curr Opin Clin Nutr Metab Care. 2004;7(5):569–75.

9. Franco E, Torezan G. Revisão das principais deficiências de micronutrientes no pós-operatório do Bypass Gástrico em Y de Roux. :37–42.

10. Castro LCG de. O sistema endocrinológico vitamina D. Arq Bras Endocrinol Metabol. 2011;55(8):566–75.

11. Schalka S, dos Reis VMS. Fator de proteção solar: Significado e controvérsias. An Bras Dermatol. 2011;86(3):507–15.

12. Annerbo M, Hultin H, Stalberg P, Hellman P. Left-shifted relation between calcium and parathyroid hormone in graves’ disease. J Clin Endocrinol Metab. 2014;99(2):545–51.

13. Premaor MO, Furlanetto TW. Hipovitaminose D em adultos: entendendo melhor a
apresentação de uma velha doença. Arq Bras Endocrinol Metabol. 2006;50(1):25–37.

14. Drincic AT, Armas LAG, Van Diest EE, Heaney RP. Volumetric dilution, rather than sequestration best explains the low vitamin D status of obesity. Obesity. 2012;20(7):1444–8.

15. Parikh SJ, Edelman M, Uwaiço GI, Freedman RJ, Semega-Janneh M, Reynolds J, et al. The Relationship between Obesity and Serum 1,25-Dihydroxy Vitamin D Concentrations in Healthy Adults. J Clin Endocrinol Metab. 2004;89(3):1196–9.

16. Compher CW, Badellino KO, Boullata JI. Vitamin D and the bariatric surgical patient: A review. Obes Surg. 2008;18(2):220–4.

17. Maia M, Maeda SS, Marçon C. Correlação entre fotoproteção e concentrações de 25 hidroxi-vitamina D e paratormônio. An Bras Dermatol. 2007;82(3):233–7.

18. Marques CDL, Dantas AT, Fragoso TS, Duarte ALBP. The importance of vitamin D levels in autoimmune diseases. Rev Bras Reumatol. 2010;50(1):67–80.

19. Hossein-nezhad A, Holick MF, Holick MF, Heaney R, Singh RJ, Pettifor JM. Vitamin D for Health: A Global Perspective. Mayo Clin Proc. 2013;88(7):720–55.

20. Bordalo LA, Mourão DM, Bressan J. CIRURGIA BARIÁTRICA Por Que Ocorrem ? 2011;24:1021–8.

21. Novais PFS, Rosera-Júnior I, Leite CVDS, Oliverira MRM DE. Evolução e classificação do peso corporal em relação aos resultados da cirurgia bariátrica – derivação gástrica em Y de Roux Body. Arq Bras Endocrinol Metab. 2010;54(3):303–10.

22. Bond DS, Evans RK, DeMaria EJ, Meador JG, Warren BJ, Shannon KA, et al. A conceptual application of health behavior theory in the design and implementation of a successful surgical weight loss program. Obes Surg. 2004;14(6):849–56.

23. Chang S-H, Stoll CRT, Song J, Varela JE, Eagon CJ, Colditz GA. Bariatric surgery: an updated systematic review and meta-analysis, 2003–2012. JAMA Surg. 2015;149(3):275–87.

24. Buchwald H, Avidor Y, Braunwald E, Jensen MD, Pories W, Fahrbach K, et al. Bariatric Surgery. Abernathy’s Surg Secrets. 2004;292(14):1724–8.

25. Orsi JVDA, Nahas FX, Gomes HC, Andrade CHV DE, Veiga DF, Novo NF, et al. Impacto Da Obesidade Na Capacidade Funcional De Mulheres. Rev Assoc Med Bras. 2008;54(2):106–9.
26. Faintuch J, Souza SAF, Valezi AC, Sant’Anna AF, Gama-Rodrigues JJ. Pulmonary function and aerobic capacity in asymptomatic bariatric candidates with very severe morbid obesity. Rev Hosp Clín Fac Med S Paulo. 2004;59(4):1–6.

27. Santos MTA dos, Souza FIS de, Fonseca FLA, Lazaretti-Castro M, Sarni ROS. Alterações de parâmetros relacionados ao metabolismo ósseo em mulheres submetidas à derivação gástrica em Y de Roux. Arq Bras Endocrinol Metabol. 2012;56(6):376–82.

28. Smaism MF. Association of different body mass index with vitamin D receptor gene in females with deficiency of vitamin D. J Glob Pharma Technol. 2017;9(9):84–93.

29. Carlin AM, Rao DS, Meslemani AM, Genaw JA, Parikh NJ, Levy S, et al. Prevalence of vitamin D depletion among morbidly obese patients seeking gastric bypass surgery. Surg Obes Relat Dis. 2006;2(2):98–103.

30. Stein J, Stier C, Raab H, Weiner R. Review article: The nutritional and pharmacological consequences of obesity surgery. Aliment Pharmacol Ther. 2014;40(6):582–609.

31. Gasteyger C, Suter M, Gaillard RC, Giusti V. Nutritional Deficiencies After Roux-en-Y Gastric Bypass for Morbid Obesity Often Cannot Be Prevented by Standard Multivitamin Supplementation. Am J Clin Nutr. 2008;87:1128–33.