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RESEARCH ARTICLE

Need for Multivitamin Use in the Postoperative Period of Gastric Bypass

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Abstract
Background Based on the reduced gastric volume and the malabsorption produced by Roux-en-Y gastric bypass (RYGBP) and diet therapy, it is essential in the postoperative period to obtain and maintain an adequate nutritional state, with the aim of preventing malnutrition and seeking a healthy life. It is observed that patients have difficulty in understanding the new food choices that must considered, as they have eating habits that are very divergent from those currently proposed. There is often the need for vitamin and mineral replacement after laboratory tests.
Methods This study calculated and evaluated the 24-h eating records of 210 patients, collected in the course of nutritional visits in follow-ups of the first, third, sixth, ninth, 12th, 18th, and 24th months postoperative.
Results It was possible to observe an increase in the consumption of nutrients in the course of the study period, but it was not regular and significant for all the nutrients. Also, it is noted that the minimal requirements for vitamin A, vitamin C, calcium, iron and B-complex vitamins (except for cyanocobalamin and riboflavin) were not attained. The nutrients in which satisfactory results were obtained were total proteins of high biological value: cyanocobalamin and riboflavin.
Conclusion This study demonstrated the concern for nutrient supplementation in the postoperative period of RYGBP. Thus, the routine use of multivitamins is deemed necessary after the first month postoperatively, with its maintenance preferably for the rest of the patient's life, without abandoning periodic clinical and laboratory follow-up.

Keywords Bariatric surgery · Morbid obesity · Nutritional deficiency · DRI

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Introduction

The preoccupation of healthcare professionals with morbid obesity has grown proportionally with its prevalence in the population worldwide. When clinical methods are shown to be ineffective in the treatment of morbid obesity, surgical treatment is considered, which is growing in demand and which constitutes the major control of this disease [1–4].

For the surgery to produce satisfactory results, it is essential to have solid and continuous clinical-nutritional follow-up. This requires the involvement of the patient who should adhere to the treatment and follow the guidance rendered [5]. Currently, the most variable degrees of medium- and long-term nutritional deficiencies are observed in these patients. This is the greatest concern of the healthcare professionals involved in this treatment [5–19].

The nutritional and medical evaluation and follow-up in the pre- and postoperative period are essential for monitoring these deficiencies [18, 20]. Nutritional deficiencies and alterations most often determined by laboratory tests during the first year after surgery are: hypoalbuminemia, deficiencies in iron, folic acid, and vitamin B12, and anemia [7, 9, 12, 14, 15, 17–21].

Because of the decreased caloric intake of the diet, vitamin/mineral supplementation is indispensable because the patients do not achieve an adequate amount of nutrients based on that recommended by the Dietary References Intake (DRI) [22]. This situation is aggravated by malabsorption, which leads to a low bioavailability when compared to normal individuals [2–5, 8, 9, 12, 15, 16, 19, 20, 23–25].

The routine replacement of nutrients in the postoperative period of bariatric surgery diverges from one team to the other [16, 26, 27]. The aim of this study was to determine the need for multivitamin use after the first 30 days after Roux-en-Y gastric bypass (RYGBP), at treatment centers for obesity surgery, for the purpose of preventing nutritional deficiencies in the most in-depth manner.

Materials and Methods

An observational study was conducted with the collection of data from patients seen at the nutrition outpatient clinic of the Center for Morbid Obesity of Hospital São Lucas da Pontificia Universidade Catolica of Rio Grande do Sul. An analysis was made of the medical charts of 210 patients, selected randomly, in the postoperative period of RYGBP. The nutritional value was calculated from the food intake for 24 h recorded at nutrition consults, which were part of the postoperative protocol at the first, third, sixth, ninth, 12th, 18th, and 24th month. Of these patients, we were able to obtain complete data for the first month in 189 inquiries, the third month 182, the sixth month 158, the ninth month 187, the 12th month 147, the 18th month 164, and the 24th month 193.

The food intake records, mentioned above, were analyzed by the nutrition software Dietwin® Professional 2.0 of Brubins e Dataweb Tecnologia, Brazil [28]. This software carries out, besides other tasks, the nutritional analysis of diets. In analyzing the eating records of the patients, a calculation was made of the percentage of adequate intake of the nutrients studied in relation to the Dietary Reference Intake (DRI) for healthy adults. The DRI utilized corresponds to the age group and sex of each individual studied. The nutrients evaluated in this study were protein, calcium, iron, vitamin A, vitamin C, and B complex vitamins: thiamin—B1; riboflavin—B2; niacin—B3; pantothenic acid—B5; pyridoxine—B6; folic acid—B9, and cyanocobalamin—B12.

After calculating the percentage of adequate intake for each nutrient for each period in relation to the DRI of each of the individuals, a statistical analysis was performed using SPSS (Statistical Package for the Social Sciences) version 10.0. The quantitative variables were expressed as means and standard deviation, and the categorical variables as absolute and relative frequencies.

Analysis of variance (ANOVA) for repeated measures was utilized to compare the percentage of nutrient intake over the 2 years of evaluation. Some variables did not show a normal distribution, but were homoscedastic (equal variances), which validated the model, as homoscedasticity is a more important criterion for the utilization parametric models. ANOVA for repeated measures was complemented by the application of the Bonferroni test.

It was also determined if there was a linear relationship of the percentage of nutrient intake over the course of the 2-year study based on the linear tendency test, which is obtained by ANOVA for repeated measures. Significance was set at the 5% level, where differences were considered statistically significant for values of $p \leq 0.05$.

Results

The sample we have to this study were of 210 patients postoperative and of this 70% were women. The age groups with more occurrences are until 40 years old and the body mass index (BMI) more frequently are between 40 to 44 kg/m^2 or more than 50 kg/m^2 (Table 1).

The study shows an increase in the consumption of nutrients in the course of the period, but it was not regular. Also, it is noted that the minimal requirements for vitamin A, vitamin C, calcium, iron and B-complex vitamins (except for cyanocobalamin and riboflavin) were not attained. The nutrients in which satisfactory results were obtained were total proteins of high biological value, cyanocobalamin, and riboflavin (Table 2).

The analysis of linear relationship of the percentage of nutrient intake over the course of the 2-year study based on

Table 1 Characterization of the sample

Variable	n=210
Male	63 (30%)
Age group[a] (years)	n (%)
≤30	65 (31.0)
31–40	67 (31.9)
41–50	47 (22.4)
>50	31 (14.8)
BMI[b] (kg/m^2)	n(%)
35.0–39.9	33 (15.7)
40.0–44.9	68 (32.4)
45.0–49.9	45 (21.4)
≥50.0	64 (30.5)

[a] Age varied from 12 to 67 years with mean of 36.8 years (SD=10.9).
[b] BMI varied from 35 to 87.3 kg/m^2 with a mean of 46.9 kg/m^2 (SD=7.9).

Table 2 Percentage of nutrient intake according to DRI during the 2-year period following bariatric surgery

Nutrient	Consumption of nutrients post-bariatric surgery (%)							
	1st month	3rd month	6th month	9th month	12th month	18th month	24th month	P*
Ptn (n=146)	75.6^{a}±28.2	93.6^{b}±27.8	99.4^{bc}±36.5	115.1^{d}±44.9	109^{cd}±34.1	131.4^{e}±34.0	146.6^{f}±34.0	<0.001
Ca (n=145)	76.3^{ab}±41.9	83.9^{abc}±40.0	86.9^{bc}v42.9	111.3^{b}±133.1	72.2^{a}±29.9	115.4^{c}±133.1	115.4^{c}±133.1	<0.001
Vitamin B12 (n=141)	128.8^{a}±65.9	148.5^{ab}±66.1	154.0^{ab}±81.6	158.6^{b}±76.7	158.8^{ab}±153.4	210.7^{c}±76.7	225.3^{c}±76.7	<0.001
Iron (n=145)	41.9^{a}±24.3	62.9^{b}±29.1	63.4^{bc}±29.6	75.8^{cd}±38.9	82.1^{d}±41.8	76.0^{cd}±38.9	82.3^{d}±41.8	<0.001
Vitamin B1 (n=145)	32.8^{a}±20.9	43.8^{b}±14.2	48.4^{bc}±16.0	52.7^{c}±18.4	55.6^{cd}±30.5	61.9^{de}±18.4	66.0^{e}±18.4	<0.001
Vitamin B2 (n=139)	80.5^{a}±42.9	98.1^{b}±43.5	95.8^{b}±43.5	105.8^{b}±41.5	108.1^{abc}±121.7	111.2^{c}±41.5	111.9^{c}±41.5	<0.001
Vitamin B3 (n=145)	27.5^{a}±15.7	42.5^{b}±18.7	43.2^{b}±21.2	49.2^{bc}±25.9	52.2^{cd}±26.8	55.5^{d}±25.9	54.0^{cd}±26.8	<0.001
Vitamin B5 (n=145)	65.6^{a}±29.9	83.2^{b}±28.0	83.5^{b}±28.4	97.1^{c}±35.2	79.6^{b}±33.2	101.1^{d}±35.2	80.6^{b}±33.2	<0.001
Vitamin B6 (n=145)	43.1^{a}±28.0	56.4^{b}±23.5	57.0^{b}±23.5	64.0^{bc}±30.3	67.1^{bc}±44.7	67.1^{c}±30.3	90.2^{d}±44.7	<0.001
Vitamin B9 (n=145)	36.8^{a}±20.8	53.9^{b}±25.1	55.0^{b}±28.3	63.5^{b}±33.3	59.6^{b}±34.3	63.6^{b}±33.2	59.6^{b}±34.3	<0.001
Vitamin C (n=137)	62.2^{a}±56.5	69.6^{ab}±48.9	65.9^{a}±54.4	84.5^{ab}±68.0	76.0^{ab}±59.4	91.2^{b}±68.0	83.9^{ab}±59.4	<0.001
Vitamin A (n=141)	49.5^{a}±76.1	88.0^{b}±101.4	57.3^{ab}±85.7	85.1^{b}±92.7	74.5^{ab}±102.8	86.8^{b}±92.7	76.8^{ab}±102.8	<0.001

*Value obtained by Wilk's lambda test of analysis of variance (ANOVA) for repeated measures.
a,b,c,d,e,f: The same letters indicate no significant difference by the Bonferroni test .

the linear tendency test with a IC (Confiance Index) of 95% was shown in all nutrients observed $p<0.001$, except in calcium (Linear Relation Intake=8.62%; $p=0.004$) and vitamin A (Linear Relation Intake=5.04%; $p=0.026$) (Table 3).

Table 3 Analysis of linear relationship of the percentage of nutrient intake over the course of the 2-year study based on the linear tendency test with an IC (Confiance Index) of 95%

	Linear relation (IC 95%)	P
Ptn (n=146)	249.4	$p<0.001$
Ca (n=145)	8.62	$p=0.004$
Vitamin B12 (n=141)	100.96	$p<0.001$
Iron (n=145)	80.81	$p<0.001$
Vitamin B1 (n=145)	207.66	$p<0.001$
Vitamin B2 (n=139)	33.79	$p<0.001$
Vitamin B3 (n=145)	102.79	$p<0.001$
Vitamin B5 (n=145)	23.74	$p<0.001$
Vitamin B6 (n=145)	94.07	$p<0.001$
Vitamin B9 (n=145)	36.16	$p<0.001$
Vitamin C (n=137)	17.59	$p<0.001$
Vitamin A (n=141)	5.04	$p=0.026$

Linear tendency test was obtained by ANOVA for repeated measures.

Discussion

It is estimated that only 57% of the protein ingested is absorbed during the postoperative period by the extent of the intestinal bypass performed in the RYGBP [5, 18, 20, 23]. According to the data obtained in this study, there was an adequate protein intake by the patients in relation to the DRI, but the deficiencies encountered in clinical practice show evidence of an absorptive deficit.

Studies have demonstrated that patients in the postoperative period of bariatric surgery show abnormalities in bone mass, showing hypocalcemia in as many as 15% to 48% of patients [10, 29, 30]. Moreover, the deficient absorption of lipid-soluble vitamins (vitamins A, E, D, and K) aggravate the malabsorption of calcium [5, 6, 10, 19, 25, 29, 30]. The malabsorption of vitamin D interferes in the absorption of calcium and stimulates hyperparathyroidism, which in the long term leads to the occurrence of osteoporosis [11, 29, 31, 32]. In this study, calcium deficiency was observed in the diet, and in clinical practice, the above systemic damage is encountered [10, 24, 29, 31, 32].

Deficient iron intake, demonstrated in this study, explains the frequent treatment of anemia in the postoperative period [7, 9, 18, 19, 23, 25, 33]. This also occurs by the difficulty patients have in eating beef [20, 24, 26, 27, 33].

Vitamin C improves cellular immunity and enhances iron absorption, besides being essential for the synthesis of collagen, adrenal hormones, amines, and carnitine. This vitamin is important, especially for the bariatric patient [34, 35]. Unfortunately, in this study, the daily recommended allowance for vitamin C was not achieved.

Thiamin (vitamin B1) deficiency as a consequence of reduced absorption in the duodenum is caused by the following: decrease in gastric juice production, losing its activity at pH>7; restriction in food intake; and frequency of vomiting. Patients who drink alcoholic beverages frequently show blocked absorption of this vitamin. Replacement of this nutrient becomes necessary not only because the recommended amount by DRI is not reached, but also because of the above factors [6, 13–19, 29, 34–39].

An efficient consumption was demonstrated for riboflavin (vitamin B2), but this vitamin is sensitive to light, ultraviolet rays, the presence of zinc, iron, copper, caffeine, theophyllin, nicotinamide, sodium, tryptophan, urea, and ascorbic acid [34, 35]. As it is a vitamin with many interactions among nutrients, its malabsorption in the postoperative period makes a deficiency plausible.

Niacin (vitamin B3) is involved in supplying cellular energy through its part in the metabolism of macronutrients. There is a tendency toward a deficiency in bariatric surgery [6, 34, 35].

Pantothenic acid (vitamin B5) is sensitive to light, alkaline pH, and its deficiency occurs together with other B complex vitamins. Besides not being ingested in the necessary quantities, in this study, it would still be exposed to the conditions related above [6, 34, 35].

The functional integrity of the brain is dependent of pyridoxine (vitamin B6). The deficiency of this vitamin is exacerbated by the use of antibiotics, antihypertensives and alcoholic beverages, and by alkaline pH [6, 34, 35]. The recommended adequate intake according to DRI standards was not reached satisfactorily in the diet of the patients in this study.

Deoxyribonucleic acid (DNA) and ribonucleic acid (RNA) synthesis depends on the presence of folic acid (vitamin B9) and its absorption is hampered by bariatric surgery [6, 29, 34, 35]. The risk of its shortage is greater as the food intake is not reached.

Cyanocobalamin (vitamin B12) deficiency is normally observed after bariatric surgery. Its absorption in the postoperative period is impaired by the reduced production of intrinsic factor [5, 6, 13–17, 19, 29, 34–36]. Considering the result obtained by the mean intake calculated, we get an erroneous impression of meeting the daily needs of this nutrient. However, patients have deficiency of this nutrient [5, 6, 13–17, 19, 29, 34–36].

After bariatric surgery, there is a substantial deficiency in nutrients, although the findings are expected because of the limitation of food intake and alterations in absorption, which justifies the utilization of nutritional supplements, mainly the use of vitamin and mineral complex, so that a better allowance of these is attained [5–7, 11–19, 23, 26, 27, 29, 34, 35].

The nutrients that reached the recommended levels according to DRI standards in the food eaten by the patients studied, curiously, are those reported frequently in scientific studies as a result of malabsorption caused by the surgery [7, 9, 12, 14, 15, 17–21]. Besides, this study points out the concern for metabolic conditions that ensue when recommended daily intake amounts of nutrients are not met and also when these nutrients absorbed at insufficient rates, which is rarely determined adequately.

Conclusion

This study provides further evidence of the necessity of routine supplementation of vitamins and minerals using multivitamins, starting by the 30th day after bariatric surgery and persisting for the rest of the patient's life. Certainly, this routine does not eliminate the need for complementary supply of some specific nutrients based on periodic clinical and laboratory evaluation, but probably reduces the potential occurrence of deficiencies and also of systemic damage.

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