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ORIGINAL CONTRIBUTIONS

# Protein Intake, Adherence to Vitamin–Mineral Supplementation, and Dumping Syndrome in Patients Undergoing One Anastomosis Gastric Bypass

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## Abstract

**Introduction** One anastomosis gastric bypass (OAGB) is an effective bariatric procedure. However, nutritional deficiencies or dumping syndrome (DS) may occur. The aim of this study was to assess adherence to nutritional recommendations and development of DS in a 3-year OAGB patient follow-up.

**Methods** For 150 OAGB patients, in our center, data were collected through the electronic platform and by an individual telephone interview. The inclusion criterion is OAGB as a primary bariatric procedure, no revisional surgery, or no pregnancy. The adequacy of daily protein intake cutoff was defined as 60 g. Adherence to micronutrient supplementation protocol was considered if a minimum of 5 takes/week were reported. To evaluate the occurrence of DS, the Sigstad score questionnaire was used. For statistical analysis, a significance level less than 5% ($p < 0.05$) was considered.

**Results** A total of 150 patients (80% females), BMI 44.3 ± 21.3 kg/m$^2$, were subjected to the OAGB procedure. Of those, 128 fulfilled the study inclusion criteria. After 3 years, the mean %EBMIL was 78.4 ± 14.4. During the 3-year follow-up, the average protein intake was 60 g/day, and 48% reported an adequate daily protein intake. Adherence to the micronutrient supplementation protocol was reported by 70%. According to the Sigstad score questionnaire, DS was present in 24% of patients.

**Conclusion** A significant part of OAGB patients does not comply with the nutrition prescription assessed, emphasizing the need to improve team/patient communication strategies. Long-term studies are needed to characterize and assess the health impact of protein, vitamin, and mineral malnutrition in patients undergoing OAGB.

**Keywords** Bariatric surgery · One anastomosis gastric bypass · Protein intake · Vitamin–mineral supplementation · Dumping syndrome · Compliance

**Key Points**
- Three-year follow-up, 150 OAGB patients: %EBMIL (78%)
- On average, protein intake: 60 g/day; and adequate daily protein compliance: 48%
- Micronutrient supplementation compliance: 70%
- Dumping syndrome: 24%

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## Introduction

One anastomosis gastric bypass (OAGB) is one of several bariatric surgery (BS) procedures. Patients undergoing BS may develop deficiencies in macronutrients and micronutrients as a result of a reduction of gastric capacity and a decrease in digestion and absorption. Also, symptoms such as nausea or vomiting may contribute to these deficits and induce dehydration [1]. The combination of preoperative nutritional deficits, malabsorption, and decreased intake is predictive for the development of other associated diseases. Energy–protein malnutrition is usually associated with vitamin and mineral deficits. Factors like individual variation in micronutrient absorption, individual needs, or irregular taking of supplements may trigger those deficits [2]. Dumping syndrome (DS) is a common complication in BS. Anatomical modification of the gastrointestinal tract and interference with its innervation causes changes in the mechanism of gastric emptying, triggering a rapid passage of food into the small intestine [3]. The prevalence of these complications may be related to the surgical procedure itself and also the patient's behavior in respect to nutritional recommendations in the postoperative period.

OAGB differs from the classical Roux-en-Y gastric bypass (RYGB) because it combines a long gastric pouch and a jejunal bypass with a wide gastro-jejunostomy using just a single anastomosis [4].

The aim of this study was to assess the protein intake adequacy, the adherence to the vitamin and mineral supplementation protocol, and the prevalence of DS at short/medium-term in patients undergoing OAGB.

## Materials and Methods

### Study Design

This was a retrospective study with relevant data (gender, age, and anthropometric assessments) collected from the electronic multidisciplinary *record system* platform for up to the first 3 years after OAGB. Additionally, an individual telephone interview was performed in order to assess the amount of protein intake and the adherence to the vitamin and mineral supplementation protocol and to determine the prevalence of DS, through the application of the Sigstad questionnaire, a scoring system based on the occurrence of various signs and symptoms where a score $\geq 7$ diagnose DS [5].

### Study Population

In this study, data was collected from 150 patients submitted to laparoscopic OAGB at the Multidisciplinary Department of Bariatric and Metabolic Surgery (MDBMS), at Central Lisbon University Hospital Center, between January 2017 and November 2018. In the same period, 447 patients were submitted to a bariatric and metabolic procedure after a preoperative clinical, nutritional, and psychological evaluation performed by MDBMS.

The inclusion criteria were patients submitted to OAGB as a primary bariatric procedure, acceptance to participate in the study, have not undergone revisional surgery or had not become pregnant since then. A total of 297 patients submitted to a primary bariatric and metabolic procedure other than OAGB or submitted to revisional surgery as well as those women who became pregnant after OAGB were excluded.

Patients interviews were performed in April and May 2019 (i.e., from 6 months to 3 years after OAGB). According to the time interval since OAGB, five groups of patients were considered:

a) patients who underwent OAGB 6 ± 3 months before the interview [6M];
b) patients who underwent OAGB 12 ± 3 months before the interview [12M];
c) patients who underwent OAGB 18 ± 3 months before the interview [18M];
d) patients who underwent OAGB 24 ± 3 or 6 months before the interview [24M]; and
e) patients who underwent OAGB 36 ± 6 months before the interview [36M].

Success for the bariatric procedure was considered when a minimum loss of 50% of the excess body mass index (%EBMIL) has occurred.

The surgical procedure to which patients were subjected followed the operative protocol established at the Multidisciplinary Department of Bariatric and Metabolic Surgery from our hospital.

### Anthropometric Assessments

Body weight was assessed using a Tanita® Scale model SC-330 Body Composition Analyzer (Tanita Europe B.V., Hoofddorp, The Netherlands), with an accuracy of 100 g and a maximum weight of 270 kg. Height was measured using a stadiometer Seca 222® (Seca GmbH & Co, Hamburg, Germany) with a millimetric precision scale (60 to 212 cm).

### Questionnaires

Questionnaires were created and applied through telephone interviews (Table 1). These included quantitative questions in order to estimate daily protein intake and to determine patient adherence to the vitamin and mineral supplement protocol established by the MDBMS. The tool allowed the authors to quantify the daily intake of high biological value protein

**Table 1** Questionnaire

| | |
|---|---|
| Protein intake | |
| Q.1 Daily milk intake (1 unit = 200 ml) | _ unit(s) x 7 g = |
| Q.2 Daily yogurts intake (1 unit = 125-150 ml) | _unit(s) x 5 g = |
| Q.3 Daily ingestion of high protein content yogurts (1 unit =150-170 ml) | _unit(s) x 15 g = |
| Q.4 Daily cheese intake | _unit(s) x _quality g = |
| Q.5 Two times per day intake of meat or fish (1 uni. = 100 g) | _unit(s) x _freq. x 20 g = |
| Q.6 Daily egg intake (1 unit = 55 g) | _unit(s) x 7 g = |
| Daily total | ___ g/day |
| Cheese quality considered: Flemish cheese (slice); Creamy cheese; fresh; cottage; molten cheese; quark; cheese spread | |
| Vitamin and mineral supplementation | |
| Q.7 During the process was it recommended to take vitamin and mineral supplements? | 1. Yes |
| | 2. No |
| | 3. Not sure |
| | 4. Other |
| Q.8 Currently, which supplement do you take? | 1. Bariatric Inspire® |
| | 2. Bariatric Plus® |
| | 3. Barovit® |
| | 4. Fit for Me® |
| | 5. Other |
| | 6. None |
| Q.9 In a week, how many days do you take the supplements correctly? | 1. Always |
| | 2. Almost always |
| | 3. Sometimes |
| | 4. Rarely |
| | 5. Never |
| Always = 7 days/week; Almost always = 5-6 days/week; Sometimes = 3-4 days/week; Rarely = 1-2 days/week. | |
| Sigstad score | |
| Q.10 Pre-shock, shock | + 5 |
| Q.11 “Almost fainting”, syncope, unconsciousness | + 4 |
| Q.12 Desire to lie or sit down | + 4 |
| Q.13 Breathlessness, dyspnea | + 3 |
| Q.14 Weakness, exhaustion | + 3 |
| Q.15 Sleepiness, drowsiness, yawning, apathy, falling asleep | + 3 |
| Q.16 Palpitation | + 3 |
| Q.17 Restlessness | + 2 |
| Q.18 Dizziness | + 2 |
| Q.19 Headache | + 1 |
| Q.20 Feeling of warmth, sweating, pallor, clammy skin | + 1 |
| Q.21 Nausea | + 1 |
| Q.22 Fullness in the abdomen, meteorism | + 1 |
| Q.23 Borborygmia | + 1 |
| Q.24 Eructation | -1 |
| Q.25 Vomiting | - 4 |
| Q.26 Early or latter? | __ |
| Dumping syndrome considered when score ≥ 7 | |

foods and set their adequacy in terms of patients’ needs for protein after surgery. The European Association for the Study of Obesity (EASO) guidelines recommend a minimum daily protein intake of at least 60 g, the reason why this value was considered as a criterion for adequacy of protein intake [6]. To validate this tool, the authors applied it during nutrition

assessments. Besides the identification of the various types of food consumed, the authors also quantified the ingested portions and the consumption frequency. The average protein content of each type of food was estimated and established in daily units.

The criterion of adherence to the vitamin–mineral supplement protocol was defined if patients declare taking it 5 times a week at least. MDBMS protocol recommends 4 distinct types of vitamin–mineral supplements: *Bariatric Inspire* (*Citrus/Morango*)®, *Bariatric Plus*®, *Barovit*®, and *Fit for Me*®. The recommended daily dosage differs depending on the product chosen by the patient. For this reason, the identification of the supplement chosen by the patient was included in the questionnaire.

The presence of symptoms compatible with DS was evaluated through the application of the Sigstad score questionnaire [5]. A score of 7 or above is suggestive of the presence of DS. Whenever this has occurred, the time interval between the meal that triggered the symptoms and their manifestation was recorded in order to define the syndrome as early or late dumping.

### Statistical Analysis

An exploratory analysis of the data was initially performed for all variables. Categorical variables were expressed in frequencies and percentages, and continuous variables through mean and standard deviation (SD) or median and interquartile amplitude (IqA, percentile 25; percentile 75), according to the nature of each variable. The use of parametric or nonparametric tests was established according to previous verification for the normality of the distribution of each variable, graphically verified and through the Shapiro–Wilk test.

Longitudinal analysis of anthropometric assessments and protein nutritional supply was performed using the Friedman test with multiple comparisons. The analysis for the longitudinal evolution of proportions for the classes of categorical variables (adherence to vitamin and mineral supplementation and DS) was performed using the McNemar test.

For comparison of outcomes among several groups (e.g., protein supply among groups of patients according to the time interval after surgery), the Kruskal–Wallis test with multiple comparisons was used.

For the multivariate analysis of factors that may influence adherence to protein nutritional supply, vitamin and mineral supplementation, and development of DS, logistic regression was used by the stepwise forward method.

Initially, the variables with significant association ($p < 0.25$) were identified in the univariable analysis (Mann–Whitney or chi-square test for continuous or discrete variables, respectively). For this study, demographic (age, gender) and clinical/nutritional variables (anthropometric parameters, pre-surgery weight variation, surgical technique, weight variation after surgery, percentual loss of BMI) were used.

For all hypothesis tests, a significance level $\alpha = 0.05$ was considered.

All data were analyzed by SPSS for Windows 22.0® — Statistical Package for the Social Sciences (IBM Corp, IBM SPSS Statistics for Windows, Armonk, NY).

## Results

Between January 2017 and November 2018, 150 patients underwent OAGB as a primary bariatric procedure. Patients submitted to other bariatric procedures or revisional surgery as well as pregnant patients were not included. Their mean age was 49.4 ± 10.5 years old, BMI was 44.3 ± 21.3 kg/m$^2$, and 120 patients (80%) were females.

Table 2 and Fig. 1 display anthropometric data. In the preoperative period (6 months follow-up), a multidisciplinary intervention was performed. The mean percentage of total weight loss (%TWL) was 1.1 ± 6.5, corresponding to a mean percentage of 2.49 ± 16 of excess BMI loss (%EBMIL). Through linear regression analysis, the authors demonstrated that the variation of body weight during the pre-surgery period (%TWL) was related to postoperative success. In fact, for every 1% body weight loss during the preoperative period, an additional loss of about 1 kg of body weight after surgery was observed ($\beta$ = −0.935 (−1.228; −0.642); $p < 0.001$). Percentage of excess BMI loss (%EBMIL) was 66.5 ± 20.4, 83.7 ± 19.7, 87.3 ± 19.5, 87.2 ± 17.1, and 78.4 ± 14.4 at 6M, 12M, 18M, 24M, and 36M, respectively.

A total of 128 agreements for the interview (85.3% of patients) were obtained. The results from the interview questionnaire are shown in Table 3. A variation on the protein daily intake at different moments of the evaluation was observed, and reported protein intake remains close to borderline. Reported higher intake was observed at 6M, where the patient's average intake was 64.6 ± 29.9 g. On the other hand, a mean lower than recommended intake was observed at 36M (55.0 ± 19.2 g). To the question "In the course of the process it was recommended to take vitamin and mineral supplements?" all participants answered affirmatively. However, only 69.6% of patients comply with the recommended protocol (ranging from 59% in 24M to 82% in 36M). Logistic regression analysis reveals that adherence to vitamin and mineral supplementation tends to be higher in those individuals who report an adequate protein intake and vice versa ($\beta$ = 0.015; Exp ($\beta$) = 1.015 [1.000; 1.030]; $p$ = 0.05).

In this study, 24.2% (31 of 128 patients) claim to have experienced at least one of the symptoms described in the

**Table 2** Evolution of anthropometric parameters

| Variables | 6 months before surgery | Surgery | Postoperative assessments | | | | |
|---|---|---|---|---|---|---|---|
| | ($n$ = 150) | ($n$ = 150) | 6M ($n$ = 140) | 12M ($n$ = 100) | 18M ($n$ = 63) | 24M ($n$ = 35) | 36M ($n$ = 10) |
| Weight (kg) | 118.1 ± 21.3 | 116.8 ± 22.3 | 84.9 ± 16.9 | 76.6 ± 15.9 | 73.8 ± 13.6 | 73.6 ± 16.4 | 72.2 ± 8.5 |
| BMI (kg/m$^2$) | 44.3 ± 6.1 | 43.7 ± 6.3 | 31.9 ± 5.2* | 28.8 ± 4.6* | 27.8 ± 3.9* | 27.9 ± 3.8* | 28.4 ± 1.6** |
| Excess body weight (kg) | 51.5 ± 17.6 | 50.1 ± 18.5 | - | - | - | - | - |
| Weight loss (kg) | - | - | 32.1 ± 10.4 | 42.2 ± 14.1*** | 42.7 ± 13.2**** | 43.9 ± 15.3***** | 33.8 ± 14.9 |
| Excess BMI loss (%) | - | 2.5 ± 16.0 | 66.5 ± 20.4* | 83.7 ± 19.7* | 87.3 ± 19.5* | 87.2 ± 17.1* | 78.4 ± 14.4** |

Values expressed in mean ± standard deviation

$p$ value determined by the application of the Wilcoxon signaled posts test for anthropometric variations between the moment of surgery and the moment of evaluation

*$p$ < 0.001, **$p$ = 0.005, ***$p$ = 0.008, ****$p$ = 0.024, *****$p$ value = 0.030

Sigstad score questionnaire. According to the time interval after OAGB, although there was not a statistically significant difference among groups, a higher percentage of patients (34%) have reported symptoms associated with DS at 24M. Among the 31 patients (24.2%) who met the criteria for DS, 19 (14.8%) and 12 (9.4%) reported symptoms for early and late DS, respectively. The manifestation of early symptoms was higher in the 24M group (27% of patients); late symptoms were more frequent at groups 6M and 12M (12% of patients for each group).

## Discussion

This study shows that OAGB is an effective bariatric procedure, in the short/medium term, reaching an average %EBMIL of 78.4 ± 14.4 in those patients who underwent surgery 3 years ago (and ranging from 66.5 ± 20.4% in 6M to 87.3 ± 19.5% in 18M). This finding is consistent with the data described in the literature, supporting the results presented in the YOMEGA study, where %EBMIL in the same period and for the same technique

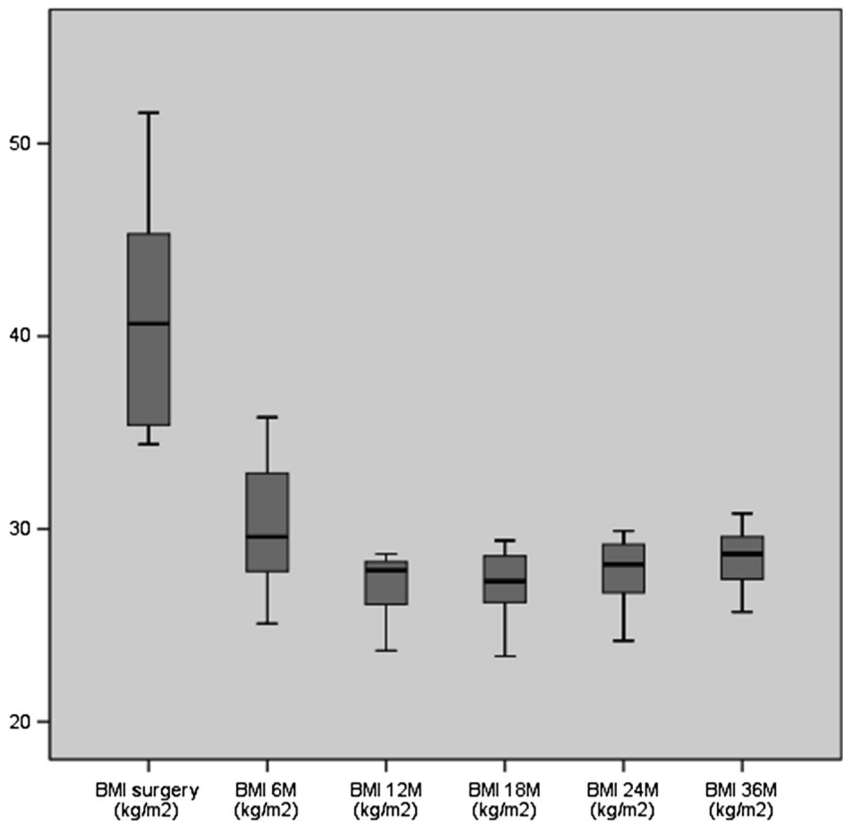


**Fig. 1** BMI variation across groups

**Table 3** Characterization of protein intake, adherence to vitamin and mineral supplementation, and prevalence of dumping syndrome

| Variables | 6M (*n* =41) | 12M (*n* =25) | 18M (*n* =22) | 24M (*n* =29) | 36M (*n* =11) |
|---|---|---|---|---|---|
| Protein intake (g) [¥] | 64.6 ± 29.9 | 56.6 ± 19.6 | 63.0 ± 29.8 | 62.1 ± 29.2 | 55.0 ± 19.2 |
| Adequacy[§] | | | | | |
| Adequate | 51% (*n* = 21) | 44% (*n* = 11) | 50% (*n* = 11) | 52% (*n* = 15) | 45% (*n* = 5) |
| Inadequate | 49% (*n* = 20) | 56% (*n* = 14) | 50% (*n* = 11) | 48% (*n* = 14) | 55% (*n* = 6) |
| Vitamin–mineral supplementation | | | | | |
| None | - | 4% (*n* = 1) | 5% (*n* = 1) | - | - |
| Bariatric Inspire® | 24% (*n* = 10) | 16% (*n* = 4) | 18% (*n* = 4) | 24% (*n* = 7) | 9% (*n* = 1) |
| Bariatric Plus® | 59% (*n* = 24) | 64% (*n* = 16) | 55% (*n* = 12) | 62% (*n* = 18) | 36% (*n* = 4) |
| Barovit® | 2% (*n* = 1) | - | - | - | - |
| Fit for Me® | 15% (*n* = 6) | 16% (*n* = 4) | 23% (*n* = 5) | 14% (*n* = 4) | 55% (*n* = 6) |
| Frequency | | | | | |
| 7 days/week | 49% (*n* = 20) | 48% (*n* = 12) | 55% (*n* = 12) | 34% (*n* = 10) | 64% (*n* = 7) |
| 5–6 days/week | 17% (*n* = 7) | 8% (*n* = 2) | 18% (*n* = 4) | 24% (*n* = 7) | 18% (*n* = 2) |
| 3–4 days/week | 24% (*n* = 10) | 32% (*n* = 8) | 23% (*n* = 5) | 21% (*n* = 6) | 18% (*n* = 2) |
| 1–2 days/week | 10% (*n* = 4) | 4% (*n* = 1) | - | 21% (*n* = 6) | - |
| Never | - | 8% (*n* = 2) | 5% (*n* = 1) | - | - |
| Adherence | | | | | |
| Yes | 66% (*n* = 27) | 64% (*n* = 16) | 77% (*n* = 17) | 59% (*n* = 17) | 82% (*n* = 9) |
| No | 34% (*n* = 14) | 36% (*n* = 9) | 23% (*n* = 5) | 41% (*n* = 12) | 18% (*n* = 2) |
| Dumping syndrome | | | | | |
| No dumping | 78% (*n* = 32) | 68% (*n* = 17) | 86% (*n* = 19) | 66% (*n* = 19) | 91% (*n* = 10) |
| Early dumping | 10% (*n* = 4) | 20% (*n* = 5) | 9% (*n* = 2) | 27% (*n* = 8) | - |
| Late dumping | 12% (*n* = 5) | 12% (*n* = 3) | 5% (*n* = 1) | 7% (*n* = 2) | 9% (*n* = 1) |

[¥] Protein value expressed in mean ± standard deviation

[§] Adequate protein intake when ≥ 60 g/day

was 87.9 ± 23.6 [7]. After 3 years, OAGB seems to demonstrate effective results in body weight loss and maintenance. Our study demonstrates that preoperative weight loss has a predictive value for the success of the surgery. The authors believe that happens because those patients that have shown a greater adherence to the nutritional therapy in the preoperative period of intervention will be those with the best adherence to the nutritional intervention after surgery. Adherence to nutritional therapy is related to better outcomes, and individuals who distance themselves from the recommended treatment tend to have worse results [8]. The degree of nonadherence to the nutritional recommendations of the bariatric population has been reported in the literature and fluctuates substantially across studies (between 3.7 and 63%) [9]. A meta-analysis that included several prospective cohort studies has shown a greater weight loss at 12 and 24 months of the postoperative period in individuals with better follow-up adherence [10]. The reasons for nonadherence to nutritional recommendations reported in the literature are associated with labor difficulties and demotivation, especially when occur weight regain [11]. Moreover, characteristics such as female gender, a younger age, or a higher baseline BMI have also been described in the literature as predictive factors for nonadherence [8, 12, 13].

Hypoproteinemia and muscle mass depletion are common conditions among obese patients subjected to bariatric surgery. Studies have suggested that a daily protein intake equal to or below 60 g is a predictor for fat-free mass loss of at least 10% at 6 months after surgery. However, this was not true for 12 months after surgery, making the first 6 months of the postoperative period the most critical period for action in preventing muscle mass loss [14]. In our study, there were no significant differences in protein intake between time interval groups. However, patients reported an average daily protein intake very close to the minimum of what is recommended (60.3 g/day). There are authors reporting a protein intake lower than the recommended limit (60 g/day) just 1 year after surgery [15, 16]. In our analysis, a deficiency in the mean daily protein intake was also reported at 12M with some amelioration at 18M and 24M and, again, an inappropriate intake at 36M.

Energy–protein malnutrition may be associated with several micronutrient deficits. In addition to the compromised

absorption, the restriction in gastric capacity and subsequently decrease in food intake may lead to this postoperative condition. Iron deficiency and the consequent development of anemia are two of the greatest risks after performing BS. Beyond the malabsorption component of some bariatric techniques, intolerance to some types of food with a high content in this trace element, such as meat, may cause food aversion and, therefore, a decrease in iron supply to the body. Adherence to dietary recommendations in the postoperative period may improve surgical outcomes [17]. However, there are only a few published studies assessing the adherence to those recommendations [17, 18]. In a study of 86 patients undergoing OAGB, Kessler et al. [19] described only 14.5% of adherence to the vitamin and mineral supplementation regimen. The adherence assessment was performed by a nutritional survey performed at 12 and 18 months after bariatric surgery. In our study, for the same time interval, adherence to the protocol was superior, with 64% of patients reporting an appropriate supplementation at 12M and 77% at 18M and with adherence being always above 50% among all-time interval groups. These results are in contrast with other studies that have shown a decrease in adherence to nutritional therapy over time. There are reports of long-term complications, such as nausea, vomiting, or DS, being more frequent in patients who do not comply with nutritional recommendations [20].

Longer biliopancreatic limb in OAGB patients, compared with RYGB patients, seems to concur to nutritional deficiencies [7]. Well-trained and experienced multidisciplinary bariatric teams, adequate evaluation and selection of patients and tailored OAGB, and strong communication strategies regarding nutritional therapy may play a role to mitigate malnutrition events.

Questionnaires based on the most frequent symptomatology described by patients have been used to diagnose DS [21]. In our study, this syndrome was present in 24.2% of patients undergoing OAGB with no significant differences in prevalence between time interval groups. In the YOMEGA study, with the application of the same questionnaire, the prevalence of DS was 14% by the second year after OAGB [7]. For a similar number of patients analyzed in our study, by the second year after OAGB, the authors observed a higher prevalence of DS (34%).

The limitation of this study was the small number of patients in each time interval group that we have considered, especially in 36M (resulting in a nonrepresentative sample for this group). Moreover, data collected from the questionnaire, applied through a telephone interview, depended upon the reliability of the participants' report. Despite the effort to make direct and quantitative questions, a memory error can always be associated with this procedure. Furthermore, protein intake was underestimated as only questions related to foods with high biological value protein content were taken into consideration.

## Conclusion

OAGB is an effective bariatric/metabolic procedure for weight loss. Adequate nutritional therapy compliance is a determinant of treatment success; however, a significant part of these patients do not comply with the nutrition prescription, emphasizing the need to improve communication strategies and a continuous and persistent reinforcement by the multidisciplinary team regarding the nutritional therapy throughout the postsurgical period. Long-term studies are needed to characterize and assess the health impact of protein, vitamin, and mineral malnutrition in patients undergoing OAGB.

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## Declarations

**Ethical Approval** All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

**Informed Consent** Informed consent was obtained from all individual participants included in the study.

**Conflict of Interest** The authors declare no competing interests.

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## Affiliations


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