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What is This?

Influence of Roux-en-Y Gastric Bypass Surgery on Vitamin C, Myeloperoxidase, and Oral Clinical Manifestations: A 2-Year Follow-Up Study

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Abstract

Background: Bariatric surgery influences the intake and absorption of nutrients. The serum concentrations of vitamin C, myeloperoxidase (MPO) and oral clinical manifestations were examined in patients two years after Roux-en-Y gastric bypass (RYGB). *Methods:* Clinical prospective-study with control-group (CG; n = 26), assessed only once, and the bariatric-group (BG; n = 26), assessed in the basal period and at 12 and 24 months after surgery. The mean ages in the CG and BG were 37.8 ± 1.51 and 39.6 ± 1.93 years, respectively, and their body mass indices were 22.07 ± 0.29 and 45.62 ± 1.46 kg/m2, respectively. *Results:* At 12 months after surgery, increased episodes of vomiting (P < .001) and dental hypersensitivity (P= .012) were observed, with a reduction in the saliva buffering capacity of 21.3 2.9% (P= .004). At 24 months after RYGB, we detected a significant reduction in serum vitamin C (32.9 ± 5.3%, P < .001) and MPO values were higher than in the basal period (P = .032). With regard to oral hygiene habits, 92.3% of patients reported frequent tooth brushing and 96.1% used fluoride, which were similar across the two years. However, dental hypersensitivity (P = .048) was significantly increased than baseline. *Conclusions:* The results demonstrated that vitamin C deficiency and increased vomiting after RYGB for morbid obesity may contribute to increased periodontal disease. The fact it is impossible to determine which factors (diet, poor compliance with supplementation, vomiting, poor oral hygiene) contributed to the dental problems in these patients is a shortcoming of the report. (*Nutr Clin Pract*. 2012;27:114-121)

Bariatric surgery emerged as a treatment for class III obesity more than 50 years ago, and since then, the number of operations performed has grown steadily.[1] Surgical intervention using Roux-en-Y gastric bypass (RYGB) leads to a significant loss of excess weight.[2] However, it can have a negative impact on the patient's oral health status because gastrointestinal complications, food intolerance, inadequate absorption of nutrients, and/or vitamin supplementation can occur in the postoperative period.[2-4]

Persistent vomiting is also observed in patients who have undergone bariatric surgery, especially with a restrictive procedure.[5] Gastroesophageal reflux and vomiting alter the oral microbiota and pH, producing an acid oral environment, which facilitates dental erosion, hypersensitivity, and the development of carious lesions.[4] Further-more, saliva flow appears to be reduced in obese individuals,[6] which impedes the removal of cariogenic microorganisms from the mouth and affects the processes of dental demineralization and remineralization.[7]

The inadequate absorption of nutrients is among the main postoperative complications of RYGB.[8] Malabsorption, together with limited intake, contributes to a deficiency of

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vitamins, including B_{12}, E, and C.[8,9] As well as causing other problems, a lack of vitamin C can compromise the formation of collagen and subsequent tissue repair in the teeth and gums, triggering bleeding of the gums and altering dental mobility.[10,11] Moreover, several studies have shown that reduced plasma levels of vitamin C contribute to the development of periodontitis by favoring bacterial colonization of the gingival tissue.[12,13]

The fact that obesity is associated with chronic inflammation may also be reflected in oral disease.[14] The greater infiltration of leukocytes and the local release of cytokines in inflamed tissues facilitate the development of periodontal disease, which is also more prevalent in obese patients than in the general population.[14,15] Myeloperoxidase (MPO), an enzyme abundant in the azurophilic granules of neutrophils, can be considered a biomarker of cellular infiltration of the gingival tissue in periodontal disease,[16] and in this context, individuals with periodontal disease exhibit a significant increase in MPO activity.[17]

Because inflammation influences the development of disease in the oral cavity[4] and bariatric surgery alters patient homeostasis, we investigated the influence of RYGB surgery on vitamin C and MPO levels and disease development in the oral cavity.

Materials and Methods

Study Outline

This was a clinical, prospective study (April 2007 to October 2009) carried out at the University Hospital of the Federal University of Santa Catarina (UH-UFSC), Florianópolis, Brazil, after approval was given by the Committee for Ethics in Research With Humans at UFSC (#72/06). The study was registered on the Australian New Zealand Clinical Trials Registry (ACTRN: ACTRN12610000905066) and conformed to the World Medical Association Declaration of Helsinki.[18] All participants signed a term of free and informed consent.

Participants

The control group (CG) was assessed only once, whereas the bariatric group (BG) was assessed in the presurgical period (basal) and at 12 and 24 months after surgery. The CG comprised 26 individuals (4 men and 22 women), with a mean age of 37.9 ± 1.51 years and a body mass index (BMI) of 22.07 ± 0.29 kg/m², and was matched by gender and age to the BG. The inclusion criterion for the CG was normal weight, as defined by the World Health Organization (WHO),[19] and the exclusion criteria for the CG were infection; anemia; cardiovascular or neurological disease; signs or symptoms of inflammation in the gingival tissue; renal insufficiency; diabetes mellitus or glucose intolerance; psychiatric or autoimmune disease; the use of antibiotics, immunosuppressants, antirheumatics, anti-inflammatory drugs, and nutrition and/or hormonal supplements in the 6

months before the study; alcohol dependence; smoking; and current menstruation. The BG sample consisted of 26 patients who had undergone RYGB (4 men and 22 women) with a mean age of 39.6 ± 1.93 years and a BMI of 45.62 ± 1.46 kg/m². The inclusion criteria for the BG were age 20–59 years and BMI ≥40 kg/m² or ≥35 kg/m² with a comorbidity, and the exclusion criteria for the BG were insulin use, immunosuppressant use, anti-inflammatory and/or immunosuppressant therapies, smoking, alcohol dependence, rheumatoid arthritis, autoimmune disease, and/or a major psychiatric disorder.

Assessment of Nutrition Status and Consumption of Vitamin C

The BMI was calculated as the ratio of the weight (kg) to the height squared (m²). The weight and height were first determined using techniques recommended by WHO.[19] The dietary consumption data were acquired by the administration of a validated, semiquantitative food frequency questionnaire.[20] In this evaluation, supplementation with 60 mg/d vitamin C was taken into account (Centrum; Wyeth, São Paulo, SP, Brazil), according to the protocol developed by the UH-UFSC.

Saliva Parameters

This test was performed using the Dentobuff kit (Inodon, Porto Alegre, RS/Brazil). Before sampling, the patients were instructed to avoid eating, drinking, and tooth brushing for 2 hours. During sampling, the patient was instructed to chew a piece of unflavoured paraffin, collecting the saliva in a suitable vessel. Saliva flow was calculated from the volume of saliva produced in 5 minutes and was considered normal at a value ≥1 mL/min. The buffering capacity of the saliva, determined by adding 1.5 mL of saliva to a tube containing a solution of 0.002 N hydrochloric acid and 4 drops of a chromogenic indicator, was classified as follows: low, pH <4.5; intermediate, pH 4.5–5.5; and normal, pH >5.5.

Assessment of Oral Clinical Manifestations and Oral Hygiene Habits

An oral health assessment of each patient was made during an interview conducted by clinically trained interviewers, according to WHO.[21] The structured questions used were validated and presented in Project SB–2003–Ministry of Health (2004),[22] Brazil. The symptoms of oral health assessed before and after surgery were the presence of gingivitis and periodontitis, according to WHO[21] (bleeding of the gums when brushing and/or eating hard, dry foods; pain in the gums; and teeth with altered mobility); nausea; episodes of regurgitation; number of episodes of vomiting per day; tooth pain; and dental hypersensitivity (sensitivity to cold). Oral hygiene habits were assessed as the frequency of tooth brushing, the use of dental floss and fluoride, and dentist visits and their reasons, during the

past 12 months, preceding the interview. The participants did not undergo a clinical periodontal examination.

Vitamin C and MPO Activity

After a 12-hour fast, blood was collected from the intermediate vein of the forearm by trained individuals. The concentration of vitamin C was determined according to the Bessey method[23] (UV–Vis Q-108U spectrophotometer; Quimis Aparelhos Cientificos LTDA, Diadema, SP, Brazil). The results are expressed in mg/dL. MPO was quantified in the serum according to Rao et al,[24] and the optical densities (absorbance at 520 nm) were read on an enzyme-linked immunosorbent assay plate reader (Organon Teknika, Roseland, NJ). The results are expressed in mU/mL.

Statistical Analysis

The data are presented as percentages, means, and standard errors of the means (SEM). The data were analyzed with the χ^2 test, followed by Fisher exact test when appropriate. The Kruskal-Wallis test was followed by the Mann-Whitney test using statistical program Statistical Package for the Social Sciences (SPSS) for Windows, version 16.0 (SPSS, Inc, an IBM Company, Chicago, IL). A value of $P < .05$ was considered statistically significant.

Results

The mean basal weight in the BG was 120.6 ± 4.30 kg, and this was significantly reduced 24 months after surgery to 74.70 ± 2.17 kg ($P < .001$). The basal BMI of 45.62 ± 1.46 kg/m^2 had decreased significantly to 28.57 ± 0.77 kg/m^2 ($P < .001$) at 24 months and, by the end of the study, showed a reduction of $36.50\% \pm 1.97\%$ compared with that at the beginning of the study. A lower intake of vitamin C was observed after surgery compared with that in the basal period, even with supplementation. Vitamin C consumption at 12 months had decreased by $16.46\% \pm 3.32\%$ ($P < .001$), and at 24 months after surgery, it was $13.66\% \pm 9.82\%$ ($P = .005$) lower than in the basal period (Table 1).

The basal serum concentration of vitamin C in the BG was significantly lower ($41.6\% \pm 4.0\%$) than in the CG. There was a significant increase of $208.9\% \pm 25.6\%$ in the serum vitamin C concentration at 12 months ($P < .001$), whereas at 24 months, this parameter had decreased by $32.9\% \pm 5.3\%$ compared with the basal level, despite supplementation ($P < .001$). The basal values for MPO in the BG were higher than in the CG. At 12 months, a reduction of $7.6\% \pm 6.8\%$ ($P = .096$) was seen in MPO activity in the BG, with an increase at 24 months ($23.7\% \pm 9.0\%$, $P = .032$) after surgery compared with the basal level (Table 1).

Saliva flow was significantly reduced in the basal period in the BG compared with that in the CG ($P < .001$). At 24 months after surgery, saliva flow was significantly higher compared with the basal period ($P < .001$). The basal-buffering capacity of saliva in the BG was above the reference value, although it was not significantly different from that of the CG ($P = .090$). At 12 months, this parameter was significantly reduced by $21.3\% \pm 2.9\%$ ($P = .004$) in the BG and was classified as intermediate (Table 1).

The compliance with vitamin C supplementation, clinical manifestations in the oral cavity, and oral hygiene habits assessed in the CG and BG before and after surgery are given in Table 2. Two years after RYGB, the reported compliance with vitamin C supplementation was significantly reduced (12 months = 88.5%, $\chi^2 = 41.241$, $P < .001$ and 24 months = 69.2%, $\chi^2 = 27.529$, $P < .001$). One year after RYGB, there were significantly increased reports of pain and bleeding gums (26.9%, $\chi^2 = 1.038$, $P = .499$), hypersensitive teeth (42.3%, $\chi^2 = 6.256$, $P = .012$), and tooth pain (23.1%, $\chi^2 = 2.641$, $P = .099$). The prevalence of vomiting was 92.3% (n = 24, $\chi^2 = 28.144$, $P < .001$), and the prevalence of vomiting 2 or more times daily was 76.9% ($\chi^2 = 32.500$, $P < .001$) at 1 year after gastric bypass. Vomiting still occurred in 65.4% of patients (n = 17, $\chi^2 = 11.345$, $P = .001$) after 2 years. Only 7.7% (n = 2) of BG individuals did not experience vomiting during any of the postoperative period investigated. Two years after RYGB, the frequencies of nausea, regurgitation, bleeding of the gums, and hypersensitive teeth were 30.8%, 23.1%, 34.6%, and 34.6%, respectively, but these were not significantly different from the basal levels, except for hypersensitive teeth ($\chi^2 = 3.900$, $P = .048$). The presence of teeth with altered mobility was more prevalent at 24 months than at baseline (19.2% and 3.8%, respectively).

The reported oral hygiene habits 2 years after RYGB were similar to the basal levels in terms of the frequency of tooth brushing (92.3%) and the use of fluoride (96.1%), but there was a significant increase in the use of dental floss (69.2%, $\chi^2 = 7.692$, $P = .006$). Visiting the dentist was not reported by 57.7% of the BG, which was significantly different from the rate in the CG ($P < .001$). However, 24 months after surgery, there was an increase in reported visits to the dentist (69.2%, $\chi^2 = 3.820$, $P = .051$) compared with those in the basal period. Oral problems were reported to be the reason for visiting the dentist by 53.8% of BG patients, which was not significantly different from those reported in the basal period (Table 2).

Discussion

The RYGB surgical procedure involves a restrictive technique in which the gastric capacity is reduced, and vomiting is one of the main complications observed at postsurgical follow-up.[3,4,6,25] In this study, the prevalence of vomiting after surgery was markedly elevated compared with that in the basal period. This symptom contributes, in turn, to the development of dental hypersensitivity,[4,26] which was observed at 12 and 24 months after RYGB.

The prolonged acid attacks on the teeth caused by vomiting can be accompanied by changes in the oral buffering

Table 1. Weight, Body Mass Index (BMI), Serum Concentration of Vitamin C, Myeloperoxidase (MPO) Activity, and Saliva Flow and Buffering Capacity in the Control and Bariatric Groups Before and After Roux-en-Y Gastric Bypass

Variables	Control Group (n = 26)	Bariatric Group (n = 26)					
	Mean ± SEM (Median)	Basal, Mean ± SEM (Median)	Basal vs Control, P Value[a]	12 mo, Mean ± SEM (Median)	12 mo vs Basal, P Value[b]	24 mo, Mean ± SEM (Median)	24 mo vs Basal, P Value[c]
Nutrition assessment and consumption of vitamin C							
Weight, kg	60.15 ± 1.59 (59.00)	120.6 ± 4.30 (117.85)	<.001***	75.92 ± 2.32 (75.27)	<.001***	74.70 ± 2.17 (75.15)	<.001***
BMI, kg/m²	22.07 ± 0.29 (22.95)	45.62 ± 1.46 (43.18)	<.001***	38.81 ± 0.75 (27.46)	<.001***	28.57 ± 0.77 (27.15)	<.001***
Vitamin C, mg/d	241.84 ± 12.24 (230.26)	339.93 ± 5.39 (336.72)	<.001***	283.45 ± 11.83 (271.38)	<.001***	294.74 ± 36.69 (248.12)	.005**
Serum concentrations and saliva analysis							
Vitamin C, mg/dL	1.69 ± 0.10 (1.69)	0.62 ± 0.05 (0.58)	<.001***	1.65 ± 0.06 (1.62)	<.001***	0.36 ± 0.12 (0.38)	<.001***
MPO, mU/mL	351.65 ± 37.24 (323.05)	368.53 ± 21.91 (354.35)	.970	317.17 ± 16.58 (315.72)	.096	423.63 ± 18.44 (445.63)	.032*
Saliva flow, mL/min	1.40 ± 0.06 (1.50)	0.40 ± 0.02 (0.40)	<.001***	1.00 ± 0.07 (1.00)	<.001***	1.20 ± 0.09 (1.20)	<.001***
Saliva-buffering capacity	6.20 ± 0.13 (6.50)	6.80 ± 0.91 (6.90)	.090	5.30 ± 0.19 (5.00)	.004**	6.30 ± 0.17 (6.75)	.715

Reference values: Vitamin C^{37} = 0.6–2.0 mg/dL; MPO = the control group acts as the reference for the bariatric group; saliva parameters were determined according to the Dentobuff kit: Saliva flow ≥ 1 mL/min and saliva-buffering capacity pH > 5.5.

[a] P = difference between the control and basal.
[b] P = difference between basal and 12 months
[c] P = difference between basal and 24 months.

Kruskal-Wallis nonparametric test followed by the Mann-Whitney test (*$P < .05$, **$P < .01$, ***$P < .001$).

117

Table 2. Oral Clinical Manifestations in the Control and Bariatric Groups According to Time Since Surgery

	Control Group (n = 26), No. (%)			Bariatric Group (n = 26)				
Variables		Basal, No. (%)	Basal vs Control, $\chi^2\ P^a$	12 mo, No. (%)	12 mo vs Basal, $\chi^2\ P^b$	24 mo, No. (%)	24 mo vs Basal, $\chi^2\ P^c$
Compliance with vitamin C supplementation and oral clinical manifestations							
Compliance with vitamin C supplementation							
Yes	0 (0.0)	0 (0.0)	0.000	23 (88.5)	41.241	18 (69.2)	27.529
No	26 (100.0)	26 (100.0)	1.000	3 (11.5)	<.001***	8 (30.8)	<.001***
Bleeding gums							
Yes	0 (0.0)	4 (15.4)	2.438	7 (26.9)	1.038	9 (34.6)	2.564
No	26 (100.0)	22 (84.6)	.110	19 (73.1)	.499	17 (65.4)	.109
Teeth with altered mobility							
Yes	0 (0.0)	1 (3.8)	0.000	4 (15.4)	1.659	5 (19.2)	0.885
No	26 (100.0)	25 (96.2)	1.000	22 (84.6)	.191	21 (80.8)	.350
Gum pain							
Yes	0 (0.0)	4 (15.4)	2.438	5 (19.2)	0.000	9 (34.6)	2.564
No	26 (100.0)	22 (84.6)	.110	21 (80.8)	1.000	17 (65.4)	.199
Vomiting							
Yes	0 (0.0)	5 (19.2)	3.540	24 (92.3)	28.144	17 (65.4)	11.345
No	26 (100.0)	21 (80.8)	.051	2 (7.7)	<.001***	9 (34.6)	.001***
Frequency of vomiting/d							
Two or more times/d	0 (0.0)	0	Ne	20 (76.9)	32.500	14 (53.8)	19.158
Once a day/never	26 (100.0)	26 (100.0)		6 (23.1)	<.001***	12 (46.1)	<.001***
Nausea							
Yes	3 (11.5)	3 (11.5)	0.000	21 (80.8)	25.071	8 (30.8)	2.882
No	23 (88.5)	23 (88.5)	1.000	5 (19.2)	<.001***	18 (69.2)	.090
Regurgitation							
Yes	3 (11.5)	9 (34.6)	3.900	5 (19.2)	1.564	6 (23.1)	0.843
No	23 (88.5)	17 (65.4)	.048	21 (80.8)	.211	20 (76.9)	.358
Tooth pain							
Yes	0 (0.0)	1 (3.8)	1.020	6 (23.1)	2.641	2 (7.7)	0.000
No	26 (100.0)	25 (96.2)	1.000	20 (76.9)	.099	24 (92.3)	1.000
Hypersensitive teeth							
Yes	2 (7.7)	3 (11.5)	0.148	11 (42.3)	6.256	9 (34.6)	3.900
No	24 (80.8)	23 (88.5)	.703	15 (57.7)	.012*	17 (65.4)	.048*
Assessment of oral hygiene habits							
Use of dental floss							
Two or more times/d	26 (100.0)	8 (30.8)	27.529	9 (34.6)	0.087	18 (69.2)	7.692
Once a day/never	0 (0.0)	18 (69.2)	<.001***	17 (65.4)	.768	8 (30.8)	.006*
Frequency of tooth brushing							
Two or more times/d	26 (100.0)	26 (100.0)	0.000	26 (100.0)	Ne	24 (92.3)	0.000
Once a day/never	0 (0.0)	0 (0.0)	1.000	0 (0.0)		2 (7.7)	1.000
Use of fluoride							
Yes	26 (100.0)	24 (92.3)	0.520	23 (88.5)	0.000	25 (96.1)	0.000
No	0 (0.0)	2 (7.7)	.490	3 (11.5)	1.000	1 (3.8)	1.000
Visiting the dentist							
Yes	26 (100.0)	11 (42.3)	21.081	13 (50.0)	0.310	18 (69.2)	3.820
No	0 (0.0)	15 (57.7)	<.001***	13 (50.0)	.578	8 (30.8)	.051
Reasons for visiting the dentist							
Prevention	26 (100.0)	10 (38.5)	23.111	9 (34.6)	0.083	12 (46.1)	0.315
Oral problems	0 (0.0)	16 (61.5)	<.001***	17 (65.3)	.775	14 (53.8)	.575

χ^2 test followed by Fisher exact test when appropriate (*P < .05, ***P < .001). Ne, no statistic was computed because the variable was a constant.
$^a P$ = difference between the control and basal.
$^b P$ = difference between basal and 12 months
$^c P$ = difference between basal and 24 months.

capacity.[7,27,28] A reduction in the saliva-buffering capacity can then reduce the activity of the enzyme α-amylase, leading to an average reduction of 30%–40% in polysaccharide hydrolysis.[29,30] The association of these events and the preference among individuals undergoing RYGB for foods that are easy to chew, such as those high in carbohydrates and sugars, may have a negative impact on weight loss.[27,31]

The number of patients presenting with hyposalivation was high, although saliva flow normalized after RYGB. Similarly, another study found that as the BMI increased, the saliva flow decreased, and the researchers explained this finding as a consequence of medication[32,33] and the nutrition deficit induced by a diet rich in simple carbohydrates and fat.[11,33]

In the postoperative period, we observed a lower dietary intake of ascorbic acid and inadequate supplementation, especially at 2 years after RYGB, which is supported by other studies.[8,9,34] Of 26 patients evaluated, 3 reported that they had not taken the supplements because they were feeling well, and 5 other patients reported that they kept forgetting to take their supplements on a daily basis. Inflammatory processes and oxidative stress also may contribute to deficiency of vitamins, with an antioxidant function aggravated in the case of obese patients. Moreover, the deficiency of vitamins with an antioxidant function, such as vitamin C, may be an incidental postoperative complication, with the severity being proportional to the extent of the reduction in the area for absorption,[9] but that is not related only to the food intake.[14,34]

Vitamin C deficiency may affect the process of hydroxylation in the formation of hydroxyproline, an integral constituent of collagen, which can manifest as gingival bleeding and edema. However, when this deficiency is more severe, it leads to the loss of dental elements.[13,35,36] In our analysis, the serum concentrations of vitamin C at 24 months were outside the reference range (0.6–2.0 mg/dL),[37] which can result in systemic damage, thereby increasing the fragility of the dental tissue.[36] Linked to this finding, MPO activity and visits to the dentist increased at this time point. Despite the limitations of this study, including the absence of a dental examination at follow-up, we observed a high incidence of vomiting and nausea and low compliance with vitamin C supplementation (30.8% noncompliance in the BG 2 years after RYGB) in this cohort, which may have been associated with the observed low vitamin C and increased MPO. It has also recently been demonstrated that inadequate blood concentrations of vitamin C lead to greater susceptibility to periodontitis, caused mainly by the reduced proliferation of fibroblasts and the lowered resistance of the host.[38] Pussinen et al[35] observed the inverse association between plasma vitamin C concentrations (1.4 ± 1.8 mg/L) and *Porphyromonas gingivalis* antibody levels. Staudte et al[12] found that individuals with mean plasma ascorbic acid levels of 0.47 mg/dL, below the normal range, had increased bleeding scores, which may be related to the role of vitamin C in maintaining the microvasculature structure within the sulcus.

In the present study, the observed weight loss was not reflected in an increase in the concentration of inflammatory markers at 24 months, inconsistent with other studies.[14,39-42] Taking into account this result, it may be relevant to consider the evidence of gingivitis or periodontitis, such as the higher prevalence of bleeding gums and teeth with altered mobility. These findings are consistent with other studies, in which polymorphonuclear infiltration was observed to accompany bleeding gums and periodontal disease, with increased release of MPO and other elements by neutrophil granules.[17,43] Our findings also show that the participants of the BG visited the dentist only when they found any concern for oral problems. However, the oral hygiene reported by the BG was appropriate and similar to those reported by the CG (frequency of tooth brushing and use of fluoride).

The absence of a periodontal clinical examination in this study limited the identification of a cause-effect relationship, and other factors may have been responsible for the changes in the biochemical markers investigated.

RYGB patients must be available periodically before and after surgery to assess their (1) *oral health status*—gingivitis and periodontitis (pain in the gums; bleeding gums when brushing and/or eating hard, dry foods; and teeth with altered mobility), dental caries, saliva pH and saliva flow, dental hypersensitivity (sensitivity to cold), and tooth pain; (2) *compliance with supplementation*—an established form designed to ensure that the patients take the prescribed supplements (eg, vitamin C); and (3) *assessment of the consumption of vitamin C*—consumption of food sources of vitamin C (eg, fruits such as kiwi, orange, mango, lemon, strawberry, watermelon, and tangerine and vegetables such as broccoli, tomatoes, cauliflower, potato, spinach, and cabbage), which, beyond contributing to without disease periodontium, is a potent water-soluble antioxidant.

This is a novelty study to reinforce the importance of dental care for obese patients undergoing gastric bypass surgery because the standards of care for this population in Brazil and other countries, according to the consensus, do not include dentist visits. In fact, visiting the dentist as a preventive measure would benefit oral health and its complications following surgery.

Our results demonstrated that vitamin C deficiency and increased vomiting after gastric bypass for morbid obesity may contribute to increased periodontal disease. The fact that it is impossible to determine which factor or factors (diet, poor compliance with supplementation, vomiting, poor oral hygiene) contributed to the dental problems in these patients is a shortcoming of the report.

Author Contributions

Netto and Moreira had full access to all of the data in the study and take responsibility for the integrity of the data and the accuracy of the data analysis. *Study concept and design:* Netto, Patiño, and Moreira. *Acquisition of data:* Netto, Benincá, and Jordão. *Analysis and interpretation of data:* Netto, Benincá,

Moreira, Jordão, and Fröde. *Drafting of the manuscript:* Netto, Moreira, Patiño, and Fröde. *Critical revision of the manuscript for important intellectual content:* Moreira and Fröde. *Statistical analysis:* Netto and Moreira. *Final approval of the version to be submitted:* Moreira and Fröde. *Obtained funding:* Moreira.

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