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Impact of bariatric surgery on oral health conditions: 6-months cohort study

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Objectives: We evaluate oral health conditions before and after bariatric surgery. **Methods:** The sample was composed of 59 patients who had undergone Roux-en-Y gastric bypass (RYGB). Salivary flow, periodontal pocket depth and dental wear were evaluated before and after 6 months of surgery. Body mass index (BMI), C-reactive protein (CRP) and glucose levels were obtained from the patient's medical files. A *t*-test was used for dependent samples. **Results:** The mean BMI decreased from 49.31 ± 8.76 to 35.52 ± 8.12 kg/m^2 in 6 months after surgery ($P < 0.000$). Before surgery, 67% of patients had high levels of CRP and 38% higher blood glucose levels and after surgery there were significant reductions in these levels ($P < 0.001$). Salivary flow ranged from 0.84 to 0.95 ml/min. There was increased prevalence of periodontal pockets ($P = 0.022$) and mean pocket depth increased to about 0.5 mm ($P < 0.001$). The percentage of surfaces with dental wear in dentine was significantly higher after bariatric surgery ($P = 0.002$), while dental wear in enamel decreased ($P = 0.019$). **Conclusions:** Bariatric surgery may improve systemic conditions. However, it had a negative impact on oral health conditions because of an increase in periodontal disease and dental wear.

Key words: *Bariatric surgery, oral health, periodontal diseases, tooth erosion, obesity, salivary flow*

INTRODUCTION

The nutritional profile of people all over the world has changed[1]. There is a worldwide epidemic of being overweight and obese estimated to involve 1.7 billion people[2]. Obesity causes or exacerbates a large number of health problems, both independently and in association with other diseases (comorbidities)[1]. These diseases may be type 2 diabetes, hypertension, hypoventilation, sleep apnoea, venous stasis, tumour, regenerative joint disease, among others[3].

Often, conventional and less invasive obesity treatments have not had the expected effects on patients with morbid obesity[1]. Bariatric surgery has been found to be the only effective long-term treatment for morbid obesity[4] and it is indicated for patients with body-mass index (BMI) ≥ 40 kg/m^2 or BMI ≥ 35 kg/m^2 in the presence of significant comorbidities[1]. The combination of disabsorptive and restrictive procedures, such as the Roux-en-Y gastric bypass (RYGB) or Fobi–Capella technique is currently one of the most common bariatric surgery techniques, with or without the use of laparoscopy[5]. The number of bariatric surgeries has greatly increased in recent years[3]. The success of this surgery among morbid obese patients has been recognised by the loss of excess weight, control of comorbidities (it reverses, eliminates, or significantly ameliorates type 2 diabetes, hyperlipidaemia, hypertension, heart disease, stroke, obstructive sleep apnoea) and improved postoperative quality of life[6,7].

Therefore, investigation of the oral health status in these patients is important, as obesity is often associated with periodontal disease because it may have some effects on systemic health by affecting host susceptibility to periodontitis owing to inflammatory mediators[8]. Obesity also predisposes the individual to dental wear because of gastro-oesophageal reflux[9], causing enamel surface erosion and anxiety[10], which may cause bruxism (dental attrition)[11].

In view of the increasing prevalence of obesity and the rising number of surgeries to reduce weight, it is necessary to evaluate the oral condition of these

individuals. Considering that bariatric surgery improves the general condition, the question that arises is whether there are changes in oral health conditions after the significant weight loss. The aim of this longitudinal study was to verify periodontal conditions and changes in dental wear after bariatric surgery.

METHODS

Participants

In order to calculate the sample size, we used the following parameters on the basis of a pilot study with 16 patients that had undergone bariatric surgery: standard deviation of the variables of oral conditions, 80% power, 95% confidence interval. The calculation of sample size for the difference between two means was performed using the software GPOWER version 3.1 (Heinrich-Heine-University, Düsseldorf, Germany), the values ranging from 5 to 38 individuals. Thus, we considered the variable that had the largest sample size, which was the variable '% of sites with 4–5 mm pocket', using 2% as a minimum difference to be detected (corresponding to an incidence of three sites). Therefore, we decided to evaluate 90 morbidly obese patients recommended for bariatric surgery (RYGB) for the initial sample, considering the possible losses during this prospective cohort study. They were evaluated at three hospitals in the State of São Paulo-Brazil. Of these, 59 were followed up 6 months after bariatric surgery. The follow-up time of 6 months was determined to represent a period of significant physiological changes after bariatric surgery according to previous studies[12,13]. Individuals with fewer than six teeth, smokers, pregnant women, carriers of infectious diseases and those medicated with anti-inflammatory agents or antibiotics were excluded from the study.

We also evaluated 51 non-obese volunteers to compose the control group. The inclusion criteria were: normal BMI, without systemic disease, similar age range, living in the State of São Paulo, users of the system of public health, as well as the sample of bariatric patients.

Ethical considerations

Participants were informed of the objectives of the study. After obtaining individual approval from each participant, they were asked to sign a written consent form. This study was approved by the Ethics Committees of the three hospitals: Base Hospital of São José do Rio Preto School of Medicine (No. 315/08), 'Hospital das Clinicas' of the Botucatu School of Medicine (No. 468/08) and 'Hospital das Clinicas' of the Ribeirão Preto School of Medicine – University of São Paulo (No. 12384/09). The present research was conducted in full accordance with the World Medical Association Declaration of Helsinki.

Data of patient's medical files

Health information, such as BMI, C-reactive protein (CRP) and glucose levels were obtained from the patient's medical files. The reference values were provided by the hospital laboratories: up to 0.5 mg/dl for the CRP and from 65.0 to 99.0 mg/dl for the glucose.

Oral clinical examination

Only one dentist who had been calibrated at the beginning of the study performed all the examinations. For tooth wear, the coefficient of intra-examiner variation was calculated ($\kappa = 0.82$), obtaining almost perfect concordance. For periodontal evaluation, the mean difference of probing pocket depth, when re-evaluated with six teeth (36 sites) from four patients (total of 144 sites re-evaluated), was calculated with a paired *t*-test, obtaining a difference of 0.01 mm ($P = 0.746$), which indicated intra-examiner concordance. The data were collected at two time-intervals: before and 6 months after bariatric surgery.

Salivary flow was obtained by stimulated saliva collection by chewing a piece of rubber band for 5 minutes and spitting every 1 minute. Salivary flow values were considered low when they were under 1 ml/minute.

A North Carolina periodontal probe was used for the clinical examination of all teeth present, which measured probing pocket depth (PPD), clinical attachment levels (CAL), presence of calculus and bleeding on probing (BOP). The PPD was measured as the distance between the gingival margin and the bottom of the gingival crevice. The CAL was determined by measuring the distance between the cement–enamel junction and the bottom of the gingival crevice. Sites with PPD equal to or greater than 4 mm and with CAL equal to or greater than 3 mm was considered presence of periodontitis. Bleeding on probing indicates the presence of gingivitis.

The occurrence of dental wear was verified using the dental wear index (DWI), which evaluates the prevalence and severity of dental wear on the occlusal/incisal, vestibular and lingual faces of all teeth present in the mouth[14]. The criteria for examination were: 0, normal (no evidence of wear); 1, incipient (tooth wear into enamel); 2, moderate (tooth wear into dentine); 3, severe (tooth wear into pulp); 4, restored (tooth wear leading to restoration); and 9, non-assessed. The surfaces were dried with gauze to facilitate visual diagnosis.

Statistical analysis

Participants' individual characteristics were described using frequency distribution for categorical variables,

as well as median, mean and standard deviation for continuous variables. The Kolmogorov–Smirnov test was performed to analyse the normality of the variables.

The data were analysed using the *t*-test for dependent samples (STATISTICA version 7; Statsoft Inc., Tulsa, OK, USA) for parametric variables and the Wilcoxon test for non-parametric variables – both tests to verify the difference between the two groups (before and after bariatric surgery). The Student *t*-test was used to verify the difference between obese and control. The significance level was set at $P < 0.05$.

RESULTS

Preoperative evaluation: morbidly obese patients

The initial sample composed of 90 morbidly obese patients (mean BMI = 50.41 ± 9.97 kg/m^2); this comprised 74 women (82.2%) and 16 men (17.8%) with a mean age of 38.90 ± 10.13 years. The patients showed increased blood levels for CRP (1.75 ± 1.47 mg/dl) and for glucose (108.02 ± 38.60 mg/dl), which was higher with increasing age ($P < 0.050$). There was a positive correlation ($P < 0.001$) between BMI and CRP levels.

The mean of salivary flow of morbidly obese patients was 0.83 ± 0.57 ml/minute, which was considered low (between 0.7 and 1.0), 40.6% showed hyposalivation (<0.7 ml/minute) and only 32.2% had normal salivary flow.

Periodontal pocket depth and clinical attachment level were 1.86 ± 0.43 mm and 1.97 ± 0.57 mm, respectively, and were higher among diabetic obese patients ($P < 0.001$). Diabetic patients had a higher mean age ($P = 0.001$) and higher proportion of sites with PPD ≥ 4 mm ($P < 0.001$) compared with non-diabetic patients.

The obese patients showed that 22% of teeth had BOP and 21% had dental calculus. Only 10% of patients exhibited a normal periodontal condition and 45% had periodontal pockets ≥4 mm. It was observed that 82.5% of the patients had more than 20 teeth in their mouths. There was no significant difference between CRP and periodontal conditions in the morbidly obese patients.

As regards dental wear, 30% of dental surfaces showed dental wear: 20% in enamel and 10% in dentine. The most affected surface was the occlusal/incisal (79%), followed by buccal (8%) and lingual (13%) surfaces.

The control group comprised 37 women (72.5%) and 14 men (27.5%) with a mean age of 41.68 ± 10.84 years and BMI of 23.45 ± 2.83 kg/m^2. The percentage of teeth with BOP, calculus and number of sites with pocket probing depth ≥4 mm was higher in obese patients ($P < 0.050$), even when the diabetic obese were excluded from the statistical analysis. The highest PPD found was 10 mm in the obese group and 4 mm in the control group. There was a higher prevalence of dental wear in the obese group compared with the control group, but this was not statistically significant. Salivary flow was similar in the two groups (*Table 1*).

Postoperative evaluation: 6 months after bariatric surgery

Of the 90 patients, 70 underwent bariatric surgery. Of these, five died in the first months after surgery, one refused to continue participating in the study, one was not found, one patient was diagnosed with hepatitis and three had not completed 6 months after bariatric surgery up to the time of the present data analysis. Thus, the final sample comprised 59 patients (50 women and 9 men). Data comparing the variable values before and after surgery are shown in *Table 2*.

The BMI decreased significantly ($P < 0.001$), showing a loss of 27% of initial weight.

High serum levels of CRP were observed in 65% of patients before bariatric surgery (>0.50 mg/dl); however, only two patients continued to show high CRP levels 6 months after surgery. Before surgery 36% of patients had high glucose levels (>99 mg/dl) and the percentage decreased to 9% after 6 months of surgery.

There was a slight increase in salivary flow 6 months after surgery, but there was no statistically significant difference. The prevalence of hyposalivation ranged from 40.6% to 38.9% after RYGB. Patients with normal salivary flow increased to 44.1%.

Table 1 Baseline characteristics of obese *versus* control group

Variables	Control Mean ± SD	Obese Mean ± SD	*P*
Age (years)	41.68 ± 10.84	38.41 ± 10.98	0.165
BMI (kg/m^2)	23.45 ± 2.83	46.61 ± 7.94	<0.001*
Teeth (*n*)	26.97 ± 3.86	25.90 ± 6.13	0.321
PPD (mm)	1.83 ± 0.23	1.85 ± 0.45	0.734
CAL(mm)	1.89 ± 0.26	1.93 ± 0.57	0.644
BOP (% teeth)	3.13 ± 5.76	16.4 ± 14.48	<0.001*
Calculus index (%)	13.48 ± 13.43	22.25 ± 18.65	0.012*
Sites with PPD 4–5 mm (%)	0.67 ± 1.17	2.19 ± 3.48	0.006*
Sites with PPD ≥ 6 mm (%)	0.08 ± 0.43	0.51 ± 2.24	0.207
DWI in enamel	16.69 ± 10.90	19.56 ± 8.42	0.175
DWI in dentine	11.94 ± 7.57	11.13 ± 10.41	0.676
Salivary flow (ml/min)	0.93 ± 0.54	0.87 ± 0.54	0.579

*Statistically significant.
BMI, body mass index; PPD, periodontal pocket depth; CAL, clinical attachment level; BOP, bleeding on probing; DWI, dental wear index.

Table 2 Results of paired *t*-test in patients before and after (6 months) bariatric surgery

Variables	Before (n = 59)		After (n = 59)		P
	Mean	SD	Mean	SD	
BMI (kg/m^2)	49.31	8.75	35.52	8.12	<0.000*
CRP (mg/dl)	1.75	1.47	0.49	0.53	<0.000*
Glucose (mg/dl)	108.03	38.60	83.72	14.71	<0.000*
Salivary flow (ml/minute)	0.84	0.53	0.95	0.52	0.105
PPD (mm)	1.86	0.44	2.11	0.38	<0.000*
CAL (mm)	1.96	0.57	2.20	0.49	<0.000*
BOP (%)	22.09	17.19	24.99	19.04	0.218
Calculus index (%)	21.93	20.18	18.56	17.64	0.187
Sites with PPD 4–5 mm (%)	3.03	3.80	4.65	7.41	0.022*
Sites with PPD ≥ 6 mm (%)	0.64	2.02	0.79	1.96	0.131
DWI in enamel	19.80	9.23	17.01	8.65	0.019*
DWI in dentine	9.89	9.18	15.68	10.76	<0.000*
Decayed teeth (n)	0.29	0.79	0.47	1.19	0.296
Number of teeth	25.49	5.78	25.69	5.95	0.176

*Statistically significant.
CRP, C-reactive protein; BMI, body mass index; PPD, periodontal pocket depth; CAL, clinical attachment level; BOP, bleeding on probing; DWI, dental wear index.

Periodontal evaluation showed an increase in the proportion of sites with PPD between 4 mm and 5 mm and the mean PPD increased significantly after bariatric surgery ($P > 0.001$), even among patients without a history of diabetes.

Six months after bariatric surgery, DWI in enamel decreased by 3% while there was an increase of 6% in dentine.

DISCUSSION

Bariatric surgery is usually successful in inducing substantial weight loss in the majority of obese patients, which helps improve their quality of life[1,15]. Moreover, this surgery is able to reduce comorbidities, such as diabetes and hypertension[7]. Type 2 diabetes was resolved or improved in the great majority of patients after bariatric surgery[7]. The improvement in diabetes and the decreased use of medication may have influenced the improvement in salivary flow, whereas hyposalivation has been related to diabetic decompensation and administration of certain drugs[16]. Saliva plays an important role in the maintenance of oral health, as it contains many antimicrobial proteins[17].

Fat tissue secretes pro-inflammatory cytokines and their levels are proportional to BMI and visceral obesity[18]. These substances may enhance periodontal degradation and induce a hyperinflammatory response in periodontal disease[19]. C-reactive protein is a sign of inflammation and bariatric surgery resulted in its reduction, confirming the association between obesity and CRP[20]. In the presence of periodontitis, the levels of inflammatory marker should be high[21,22]; however, the periodontal conditions found in this study were not sufficient to raise the CRP level in patients after bariatric surgery.

Considering that obesity and diabetes are associated with periodontal disease[8], with the significant weight loss and decreased levels of blood glucose, periodontal conditions should show an improvement, but this was not observed in this study. These results were similar to those found in study of Marsicano *et al.*[23], in which the severity of periodontal disease increased 3 months after bariatric surgery. Worsening periodontal condition may be related to some consequence of bariatric surgery, such as nutritional deficiency caused by bypassing the duodenum, resulting in decreased absorption of iron, folate, calcium and vitamins D and B_{12}, which can lead to metabolic bone disease[24,25]. Bone resorption and decreased bone mass was evident 3–6 months after bariatric surgery[26]. Alveolar bone loss was identified by cone beam computed tomography during a follow-up of 2 years in a patient who had undergone bariatric surgery[27].

This study confirms the association between obesity and periodontal disease, as obese patients presented with poor periodontal status in comparison with the non-obese group. The fact that these patients underwent bariatric surgery while they were in an unsatisfactory periodontal condition may be another reason why this oral condition worsened 6 months after surgery. In addition, there was a change in their dietary habits, which included frequent small meals and soft foods that adhered to the tooth surface throughout the day. These frequent and prolonged meal times may have encouraged the proliferation of bacteria that cause oral disease[28].

The enamel wear present before the surgery began to affect the dentine after 6 months. When dental wear involves the dentine it is possible for sensitivity to occur. Hypersensitivity was found in 37% of the patients who had undergone bariatric surgery in the study of Heling *et al.*[29]. This symptom was not investigated in the present study. Worsening dental wear may be attributed to dental attrition caused by anxiety (previously presented in morbidly obese patients), which may have continued to be present after bariatric surgery. Anxiety is one of the most prevalent psychiatric disorders found in pre-bariatric surgery patients and its prevalence did not change after surgery in comparison with baseline values in the study of de Zuaan *et al.*[30].

In most cases of dysfunctional eating habits, such as eating too fast or not chewing food may well cause vomiting and other gastric disorders[6]. Vomiting is a common risk associated with RYGB[6], although the incidence of vomiting is greater after vertical gastroplasty[31]. This factor may contribute to increasing the

severity of dental wear[9]. The acidic challenge leads to loss and softening of the enamel surface and could increase susceptibility to mechanical abrasion effects[32]. The saliva may have an important role in minimising enamel wear following abrasive attack. The buffering capacity of saliva may counteract erosive attacks by reducing enamel loss and softening of the dental surface[33]. Thus, after exposure to acid challenge toothbrushing should be delayed for at least 1 hour[34].

Maintenance of oral health is very important to these patients because in the postoperative period they need to chew well and slowly, and for a long time. In obese subjects nutritional deficiencies are common and these conditions may follow the patient after the bariatric surgery. The degree of malabsorption created by the surgical procedure or the extent of weight loss may require dietary supplementation with multivitamins and minerals[35]. A biochemical assessment is important during preoperative and postoperative periods to prevent or correct nutritional deficiencies and to avoid possible complications. Therefore, attendance by multiprofessional staff is required to minimise the side-effects of RYGB. In addition, these patients should receive nutritional counselling and monitoring, as well as vitamin and mineral supplementation for the prevention and treatment of metabolic consequences arising from bariatric surgery[36,37], and its possible impact on oral health.

There were some limitations in this study because data were prospectively collected and part of the sample may not be followed. These limitations are inherent to any longitudinal cohort study.

Bariatric surgery could improve general conditions, but it had a negative impact on oral health conditions, reflected by the increase in periodontal disease and dental wear. The presence of a dentist in the multidisciplinary team is very important, in order to contribute to the treatment and prevention of oral cavity lesions, and provide benefits to the oral and general health of these patients. Oral health preventive measures should be implemented immediately from the time of the preoperative period to improve postoperative quality of life.

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Conflict of interest

None declared.

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