Research Article

Pamukkale Medical Journal
doi:https://dx.doi.org/10.31362/patd.1376207

Impact of laparoscopic sleeve gastrectomy on periodontal status in obese patients

Obez hastalarda laparoskopik tüp mide ameliyatının periodontal duruma etkisi

Aysan Lektemür Alpan, Gizem Torumtay Cin, Muhammed Raşid Aykota

Posted date:15.10.2023 Acceptance date:28.11.2023

Abstract

Purpose: This study aimed to determine the effects of laparoscopic sleeve gastrectomy surgery on clinical periodontal parameters at 6 months in the postoperative period.

Materials and methods: Fifty-four obese patients with periodontitis between 18 and 70 years of age were evaluated for obesity-related parameters and periodontal status before and 6 months after bariatric surgery. Correlations of the changes in periodontal parameters and the total weight loss and body mass index (BMI) loss at 6 months after bariatric surgery were determined with Spearman correlation analysis. *P*<0.05 was considered as the statistical significance value.

Results: Significant improvements were achieved at 6-month follow-up compared to baseline in BMI values and several systemic health-related serum biomarkers such as C-reactive protein, high-density lipoprotein, low-density lipoprotein, and albumin levels. Periodontal parameters; plaque index (*p*=0.000), gingival index (*p*=0.004), and bleeding on probing (*p*=0.007) were decreased significantly at 6 months after surgery. However, no significant changes in probing depth and clinical attachment level values were observed. The changes in plaque index values were positively correlated with the percent of total weight loss (r=0.301, *p*=0.027). Also, there was a positive significant correlation between the changes in the percent of bleeding on probing levels and the percent of total weight loss and the percent excess BMI loss (r=0.637, *p*=0.000 and r=0.370, *p*=0.006 respectively).

Conclusion: Laparoscopic sleeve gastrectomy surgery resulted in a reduction in periodontal inflammation in parallel with the decrease in BMI levels and obesity-related biochemical markers during the 6-month follow-up period.

Keywords: Bariatric surgery, body mass index, obesity, periodontitis, prospective studies.

Lektemur Alpan A, Torumtay Cin G, Aykota MR. Impact of laparoscopic sleeve gastrectomy on periodontal status in obese patients. Pam Med J 2024;17:205-212.

Öz

Amaç: Bu çalışmada, laparoskopik tüp mide ameliyatının operasyon sonrası 6. ayda klinik periodontal parametreler üzerindeki etkilerinin belirlenmesi amaçlandı.

Gereç ve yöntem: Yaşları 18 ile 70 arasında değişen, periodontitisli 54 obez hasta, obezite ile ilişkili parametreler ve bariatrik cerrahi öncesi ve sonrasındaki periodontal durumları açısından değerlendirildi. Obezite cerrahisi sonrası 6. ayda periodontal parametrelerdeki değişiklikler ile toplam kilo kaybı ve vücut kitle indeksi (VKİ) kaybı arasındaki korelasyonlar Spearman korelasyon analizi ile belirlendi. *P*<0,05 istatistiksel anlamlılık değeri olarak kabul edildi.

Bulgular: 6 aylık takipte VKİ değerlerinde ve C-reaktif protein, yüksek yoğunluklu lipoprotein, düşük yoğunluklu lipoprotein ve albümin seviyeleri gibi sistemik sağlıkla ilgili çeşitli serum biyobelirteçlerinde başlangıca kıyasla önemli iyileşmeler elde edildi. Plak indeksi (*p*=0,000), gingival indeks (*p*=0,004) ve sondlamada kanama (*p*=0,007) gibi periodontal paramatreler ameliyattan 6 ay sonra anlamlı derecede azaldı. Ancak sondlama derinliği ve klinik ataçman seviyesi değerlerinde anlamlı bir değişiklik gözlenmedi. Plak indeksi değerlerindeki değişiklikler toplam kilo kaybı yüzdesi ile pozitif korelasyon gösterdi (r=0,301, *p*=0,027). Ayrıca sondlamada kanama yüzdesindeki değişiklikler ile toplam kilo kaybı yüzdesi ve aşırı VKİ kaybı yüzdesi arasında pozitif anlamlı bir korelasyon tespit edildi (sırasıyla r=0,637, *p*=0,000 ve r=0,370, *p*=0,006).

Sonuç: Laparoskopik tüp mide ameliyatı, 6 aylık takip döneminde VKİ seviyelerinde ve obezite ile ilişkili biyokimyasal belirteçlerde azalmaya paralel olarak periodontal inflamasyonda da azalma sağlamıştır.

Anahtar kelimeler: Bariatrik cerrahi, vücut kitle indeksi, obezite, periodontitis, prospektif çalışmalar.

Lektemür Alpan A, Torumtay Cin G, Aykota MR. Obez hastalarda laparoskopik tüp mide ameliyatının periodontal duruma etkisi. Pam Tıp Derg 2024;17:205-212.

Aysan Lektemür Alpan, Assoc. Prof. Department of Periodontology, Faculty of Dentistry, Pamukkale University, Denizli, Türkiye, e-mail: ysnlpn@gmail.com (https://orcid.org/0000-0002-5939-4783) (Corresponding Author)

Gizem Torumtay Cin, Asst. Prof. Department of Periodontology, Faculty of Dentistry, Pamukkale University, Denizli, Türkiye, e-mail: gyaprak_dt@hotmail.com (https://orcid.org/0000-0002-5362-4146)

Muhammed Raşid Aykota, Assoc. Prof. Department of General Surgery, Tekden Hospital, Denizli, Türkiye, e-mail: muhammedaykota@hotmail.com (https://orcid.org/0000-0003-1862-6186)

Introduction

Obesity is a condition that is a significant global health concern with increasing prevalence rates [1] characterized by excess body fat. Body Mass Index (BMI) which is used to define obesity of 30 or higher is considered indicative of obesity [2]. Obesity is related to many health risks and can have a significant impact on a person's overall well-being. The pathogenesis of type 2 diabetes mellitus (T2DM), cancer, cardiovascular disease, and osteoporosis is linked with obesity [3, 4].

Periodontitis is a chronic inflammatory oral disease that involves a complex interplay between oral bacteria and the person's immune response, resulting in the irreversible destruction of the periodontium [5]. The 2017 periodontal disease classification of the link between these two conditions underscores the idea of comorbidity, where the presence of obesity increases the risk and severity of periodontitis [6]. The relationship between obesity and periodontitis is multifaceted and can involve various mechanisms, including inflammation, altered immune response, and systemic factors [7, 8].

Bariatric surgery (BS), is a set of surgical procedures performed to help individuals with severe obesity lose weight by reducing their BMI. The principal types of BS are laparoscopic sleeve gastrectomy (LSG), adjustable gastric band, biliopancreatic diversion with duodenal switch, and Roux-en-Y Gastric Bypass (RYGB) [9]. LSG is a procedure that allows the stomach to be turned into a narrow tube or sleeve by completely removing the fundus part of the stomach with a vertical incision along the larger curvature (outer curve) of the stomach [10]. LSG has an additional benefit beyond its restrictive effect. It reduces the production of an appetite-stimulating hormone called ghrelin produced in the fundus of the stomach and plays a role in regulating hunger [11]. Research related to the effects of BS on periodontal conditions has produced conflicting results [12-16]. While some studies have stated that BS has a negative effect on periodontal status [12, 13], others have emphasized that the periodontal condition becomes better [15]. Therefore, our study aims to evaluate the 6-month changes in periodontal parameters in obese individuals undergoing LSG. Our study hypothesizes that obesity decreases due to weight loss after LSG and this may lead to improvement in periodontal parameters at the follow-up at 6 months.

Materials and methods

Study population

This prospective observational study evaluated a total of 54 obese patients diagnosed with periodontitis (AAP/EPF classification) [17] who were being monitored in the obesity clinic at the Faculty of Medicine in Pamukkale University and eligible for LSG surgery, during the preoperative and 6-month postoperative period. The indication for BS was made by the experienced bariatric surgeon (MRA) if a patient had a BMI >40 kg/m^2 or BMI >35 kg/m^2 and obesity-related comorbidity [18].

The ethical approval was obtained from the Ethics Committee of the Faculty of Medicine at Pamukkale University with the protocol number 2018/19 and was carried out by the Declaration of Helsinki. Each participant was asked to provide written informed consent. Patients were excluded if they were <18 or >70 years of age, pregnant, underwent periodontal treatment within a 6-month period, and had <15 teeth. After detailed periodontal examination, individuals who underwent sleeve gastrectomy surgery were followed up for a 6-month period after the operation.

Demographic and metabolic variables

Demographic characteristics such as age, sex, education level, and smoking habits were collected from each subject at the baseline of the study. Participants' medical conditions were determined from their medical records. The history of hypertension (systolic blood pressure (SBP) ≥140 mmHg or diastolic blood pressure (DBP) ≥90 mmHg or receiving treatment for hypertension), dyslipidemia (high-density lipoprotein level (HDL): female, <50 mg/dL and males, <40 mg/dL; triglyceride level ≥150 mg/dL or receiving treatment for dyslipidemia) and diabetes (fasting plasma glucose ≥126 mg/dl or receiving treatment for diabetes) was defined according to the related criteria. C reactive protein (CRP), HDL, low-

density lipoprotein (LDL), triglyceride, albumin, glycated hemoglobin (HBA1c) levels, aspartate transaminase (AST), alanine transaminase (ALT) and gamma-glutamyl transpeptidase (GGT), levels were recorded at baseline and 6 months after surgery.

BMI was calculated by taking the weight, in kilograms divided by the height in meters squared. According to the Edmonton Obesity Staging System, participants were categorized according to BMI, such as obesity class I (30 to 34.9), obesity class II (35 to 39.9), obesity class III (≥40) [19]. Weight was measured at baseline and 6th month after the surgery. The percentage of original weight loss and the percent excess BMI loss (EBMIL%) were calculated [20].

Periodontal examinations

Full-mouth periodontal measurements of the patients were made by the same clinician. Intra-examiner calibration was calculated with the Intraclass Correlation Coefficient. The intra-examiner ICC values were 0.90 (PD) and 0.88 (CAL). The number of existing teeth in the patients was recorded. Plaque index (PI) [21], gingival index (GI) [22], the presence of bleeding on probing (BOP) [23], probing depth (PD), and clinical attachment level (CAL) were measured using the Williams periodontal probe (Hu-Friedy, Chicago IL). PD and CAL were calculated at six surfaces per tooth, whereas PI and GI were evaluated at four surfaces per tooth. The periodontitis severity of patients was determined based on the Classification of Periodontal and Peri-Implant Diseases and Conditions stated in the 2017 World Workshop.

Sample size calculation

Power analysis was performed to calculate the sample size of the study. Sample size was calculated using the G*Power statistical program for α=0.05 and d=0.4. The analyses revealed that a total of 52 subjects achieved a power of 80% with 95% confidence.

Statistical analyses

The data were analyzed using a statistical program (SPSS 21 Inc., Chicago, IL). Continuous variables were presented as mean ± standard deviation and categorical variables as numbers and percentages. Kolmogorov-Smirnov test was used to detect data's normality. Wilcoxon test was applied to compare the differences in metabolic and periodontal parameters at baseline and 6 months postoperatively. Spearmen correlation analysis was applied to investigate the associations between periodontal changes within a 6-month period and total weight loss and BMI loss. The statistical significance value was considered as $p<0.05$.

Results

A total of 54 patients who indicated to undergo LSG surgery completed the study throughout the 6-month follow-up period. The baseline demographic characteristics of the study population were presented (Table 1). The majority of patients were female (66.7%), and the mean age of the study population was 41.1±8.89. The prevalence of obesity level III was observed in 68.5% of all participants. While stage 2 periodontitis was diagnosed in 40.7% of participants, the percentage of stage 3 periodontitis was 29.6%.

The metabolic and periodontal parameters were compared between the preoperative period of sleeve gastrectomy and post-operative 6th months after the surgery and were indicated in Table 2. BMI values, CRP, HDL, LDL, and albumin levels were significantly decreased 6 months later compared to the baseline. Regarding periodontal parameters, while there were no significant changes in PD and CAL measurements, PI, GI, and BOP% levels significantly decreased in the 6th month.

The correlations between changes in periodontal parameters, the percent of total weight loss, and the percent excess BMI loss in the 6-month post-operative period of sleeve gastrectomy were shown in Table 3. A positive significant correlation was observed between the changes in PI and the percent of total weight loss (r=0.301, p=0.027). Also, the changes in BOP% levels showed a positive significant correlation both with the percent of total weight loss and the percent excess BMI loss (r=0.637, p=0.000 and r=0.370, p=0.006 respectively).

Table 1. Demographic characteristics of the study population

Baseline characteristics	Number (n)	Percent (%)
Age (mean ± SD)	41.1±8.89	
Sex		
Female	36	66.7
Male	18	33.3
Education level		
Elementary	6	11.1
High school	24	44.4
Collage and PhD	24	44.4
Smoking status		
Smoker	22	40.7
Non-smoker	32	59.3
Obesity level		
II (35 to 39.9)	17	31.5
III (≥40)	37	68.5
The number of present teeth (mean ± SD)	25.17±3.48	
Periodontitis severity		
Stage I	16	29.6
Stage II	22	40.7
Stage III	16	29.6
Presence of hypertension	21	38.9
Presence of diabetes mellitus	22	40.7
Presence of dyslipidaemia	18	33.3

Table 2. Metabolic and periodontal parameters of sleeve gastrectomy patients before and 6 months after the surgery

Metabolic Parameter	Pre-op	Post-op	*p* value
BMI kg/m^2	41.58±5.25	32.15±4.38	**0.000**
CRP (mg/L)	7.54±6.21	3.91±3.94	**0.048**
AST (U/L)	23.30±15.03	20±8.38	0.661
ALT (U/L)	23.59±14.25	22.63±11.77	0.201
GGT (U/L)	27.44±16.37	25.50±14.28	0.067
HDL (mg/dL)	46.24±10.14	47.97±9.43	**0.003**
LDL (mg/dL)	116.65±26.08	111.72±24.86	**0.022**
Triglyceride (mg/dL)	135.20±55.9	128.22±42.03	0.112
Albumin (g/L)	44.88±6.61	41.69±3.44	**0.000**
HBA1c (%)	6.22±0.76	6.10±0.54	0.063
Periodontal Parameter			
PI	1.27±0.57	1.07±0.41	**0.000**
GI	1.37±0.49	1.33±0.44	**0.004**
BOP (%)	76.80±15.80	74.93±14.81	**0.007**
PD	2.67±0.85	2.65±0.84	0.104
CAL	3.16±1.02	3.16±1.02	0.482

BMI: body mass index, CRP: C-reactive protein, AST: aspartate transaminase, ALT: alanine transaminase
GGT: gamma-glutamyl transpeptidase, HDL: high-density lipoprotein, LDL: low-density lipoprotein, HBA1c: glycated haemoglobin
PI: plaque index, GI: gingival index, BOP: bleeding on probing, PD: probing depth, CAL: clinical attachment level
All variables did not present normal distribution (Kolmogorov-Smirnov test $p<0.001$)
Wilcoxon test, Statistically significant differences are indicated in bold ($p<0.05$ and $p<0.001$)

Table 3. Correlations of the changes in periodontal parameters and the total weight loss and BMI loss at 6 months after bariatric surgery

Periodontal variables	Total weight loss (%)	The percent excess BMI loss (% EBMIL)
PI		
p	0.027	0.057
r	0.301*	0.261
GI		
p	0.797	0.845
r	0.036	-0.027
BOP (%)		
p	0.000	0.006
r	0.637**	0.370**
PD		
p	0.355	0.924
r	0.128	0.013
CAL		
p	0.487	0.187
r	0.097	0.182

PI: plaque index, GI: gingival index, BOP: bleeding on probing, PD: probing depth, CAL: clinical attachment level
p: *p* value, r: correlation coefficient value, * statistical significance at $p<0.05$,** statistical significance at $p<0.001$

Discussion

Obesity and periodontitis are prevalent and significant health issues that affect populations worldwide [24]. Both conditions are associated with low-grade inflammation and can have systemic effects on overall health. Additionally, there is emerging evidence suggesting a bidirectional relationship between obesity and periodontitis, meaning that obesity can increase the risk of periodontitis, and periodontal inflammation can contribute to obesity-related complications [7, 25].

LSG is primarily viewed as a restrictive weight loss procedure, but it has also been found to have significant benefits in treating metabolic derangements and improving metabolic health, beyond its role in achieving weight loss [26]. LSG can have a significant and often more effective impact on the management and treatment of T2DM and its associated complications when compared to the best available medical therapies [26].

CRP is an acute-phase reactant, which is a protein produced by the liver in response to various inflammatory signals, including interleukin-6 (IL-6). CRP is a sensitive inflammation marker in the body, and its levels can increase rapidly in response to inflammation or tissue damage [27]. Increased CRP levels have been associated with central obesity, which, in turn, is related to various health concerns, including atherosclerosis and other macrovascular disorders [28]. Also, many systematic reviews indicated elevated CRP levels in patients with periodontitis [29]. During the 6-month observation period of our study, it was observed that serum CRP levels decreased to almost half of the baseline levels. This decrease in CRP levels indicates that systemic inflammation has decreased. The decrease in circulating CRP levels may have led to improvements in periodontal inflammation.

Dyslipidemia refers to a group of lipid metabolism disorders characterized by abnormalities in the levels of various lipids in the blood, particularly lipoproteins such as high levels of total cholesterol, triglycerides, LDL, and decreased levels of HDL [30]. The suggestion of a two-way relationship between dyslipidemia and periodontal disease highlights the potential bidirectional influence of these two conditions on each other [31]. Possible mechanisms play roles such as a direct effect of oral bacteria or an indirect effect on the elevation of pro-inflammatory mediators, promoting lipolysis and the subsequent elevation of circulating TG and consequently the development of atherosclerotic cardiovascular diseases [32, 33]. In our study, an increase in HDL levels and a decrease in LDL and triglyceride levels were observed in the patients. This result may be another factor that

causes a decrease in periodontal inflammation and an improvement in periodontal parameters. According to our findings, LSG caused a reduction in BMI resulting in a decrease in PI, GI, and BOP which represents periodontal inflammation. Furthermore, no changes were observed in CAL and PD. Consistent with our study, BMI, PI, BOP, and PD were found to decrease significantly according to the results of the 1-year follow-up cohort study. As a difference, the decrease in PD levels was not significant in our study. The reason for this may be that the 6-month follow-up period is not sufficient for PD reduction [34]. In contrast with our study results; de Moura Grec et al. [13] observed an improvement in clinical systemic conditions 6 months after BS, nevertheless, PD and CAL increased after surgery significantly compared to baseline. They associated this situation with nutritional deficiencies caused by bariatric surgery, changes in eating habits, or inadequate periodontal status of the patients before surgery. According to the results of a study, a decrease in BMI caused an increase in BOP for 12 months. The authors stated that at least 2 years are required after surgery for the stabilization of physiological processes and inflammatory profile, and that the nutritional imbalance that occurs after the surgical process may cause this result. Additionally, unlike our study, this study focused on patients who had laparoscopic RYGB. Postoperative recovery of these patients develops differently from LSG. In concordance with our study Jaiswal et al. [15] found a significant decrease in bleeding score, plaque, and gingival index as a result of 6-month follow-up of patients with BS, they did not find a significant change in PD and CAL levels.

Ghrelin is a peptide hormone and has roles in various physiological processes, including growth hormone secretion regulation, energy metabolism, and food intake [35]. With the help of LSG, the fundus region of the stomach, that is, the area where the ghrelin hormone is predominantly secreted, is removed LSG provides a decrease in ghrelin concentrations [36] compared to other restrictive techniques [37] or RYGB [38]. Two different forms of ghrelin (des-acylated ghrelin and acylated ghrelin), have been studied for their distinct roles in these processes [35]. Serum total ghrelin concentration was positively correlated with pro-inflammatory cytokines such as tumor necrosis factor-alpha (TNF-α) and IL-6 [39]. Total and acylated ghrelin levels in serum were elevated in chronic periodontitis patients [40]. The levels of ghrelin in gingival crevicular fluid in patients with both periodontitis and T2DM, ghrelin levels in GCF were higher compared to periodontally healthy individuals with T2DM [41]. The observation that levels of TNF-α and IL-6, tend to decrease at 6 months after BS [42]. The increase in circulating levels of adiponectin is known to have anti-inflammatory and insulin-sensitizing properties that have been demonstrated after BS [43]. The observed decrease in GI and BOP may be due to a decrease in inflammatory cytokines and decreased ghrelin concentration after LSG. The acknowledgment of the inability to determine which specific factor or factors contributed to the improvements in periodontal status following LSG is an important limitation of the present study. This limitation underscores the complexity of the interactions between systemic health, lifestyle, and oral health.

The reduction of body fat causes a decrease in systemic inflammation and a decrease in the progression of all diseases linked to obesity (hypertension, diabetes, cardiovascular diseases). According to our findings in this present study, a reduction in BMI led to a decrease in periodontal inflammation but no changes were observed in terms of CAL.

Conflict of interest: No conflict of interest was declared by the authors.

References

1. Blüher M. Obesity: global epidemiology and pathogenesis. Nat Rev Endocrinol 2019;15:288-298. https://doi.org/10.1038/s41574-019-0176-8
2. Who. Obesity and overweight. Available at: https://www.who.int/news-room/fact-sheets/detail/obesity-and-overweight. Accessed October 16, 2023
3. Kim CM, Lee S, Hwang W, et al. Obesity and periodontitis: a systematic review and updated meta-analysis. Front Endocrinol (Lausanne) 2022;13:999455. https://doi.org/10.3389/fendo.2022.999455
4. Kopelman PG. Obesity as a medical problem. Nature 2000;404:635-643. https://doi.org/10.1038/35007508
5. Kwon T, Lamster IB, Levin L. Current concepts in the management of periodontitis. Int Dent J 2021;71:462-476. https://doi.org/10.1111/idj.12630

6. Albandar JM, Susin C, Hughes FJ. Manifestations of systemic diseases and conditions that affect the periodontal attachment apparatus: case definitions and diagnostic considerations. J Clin Periodontol 2018;45:171-189. https://doi.org/10.1111/jcpe.12947
7. Jepsen S, Suvan J, Deschner J. The association of periodontal diseases with metabolic syndrome and obesity. Periodontol 2000 2020;83:125-153. https://doi.org/10.1111/prd.12326
8. Ganesan SM, Vazana S, Stuhr S. Waistline to the gumline: relationship between obesity and periodontal disease-biological and management considerations. Periodontol 2000 2021;87:299-314. https://doi.org/10.1111/prd.12390
9. Buchwald H, Williams SE. Bariatric surgery worldwide 2003. Obes Surg 2004;14:1157-1164. https://doi.org/10.1381/0960892042387057
10. Popescu AL, Ionita Radu F, Jinga M, Gavrila AI, Savulescu FA, Fierbinteanu Braticevici C. Laparoscopic sleeve gastrectomy and gastroesophageal reflux. Rom J Intern Med 2018;56:227-232. https://doi.org/10.2478/rjim-2018-0019
11. Langer FB, Reza Hoda MA, Bohdjalian A, et al. Sleeve gastrectomy and gastric banding: effects on plasma ghrelin levels. Obes Surg 2005;15:1024-1029. https://doi.org/10.1381/0960892054621125
12. Marsicano JA, Sales Peres A, Ceneviva R, de C Sales Peres SH. Evaluation of oral health status and salivary flow rate in obese patients after bariatric surgery. Eur J Dent 2012;6:191-197.
13. de Moura Grec PG, Yamashita JM, Marsicano JA, et al. Impact of bariatric surgery on oral health conditions: 6-months cohort study. Int Dent J 2014;64:144-149. https://doi.org/10.1111/idj.12090
14. de Carvalho Sales HC, de Carvolho Sales Peres M, Ceneviva R, Bernabe E. Weight loss after bariatric surgery and periodontal changes: a 12-month prospective study. Surg Obes Relat Dis 2017;13:637-642. https://doi.org/10.1016/j.soard.2016.08.007
15. Jaiswal GR, Jain VK, Dhodapkar SV, et al. Impact of bariatric surgery and diet modification on periodontal status: a six month cohort study. J Clin Diagn Res 2015;9:43-45. https://doi.org/10.7860/JCDR/2015/14663.6489
16. Weinberg G, Bilder L, Horwitz J, et al. Oral health status of patients before and after bariatric surgery. Dentistry Oral Health Care 2018;1:1-8.
17. Tonetti MS, Greenwell H, Kornman KS. Staging and grading of periodontitis: framework and proposal of a new classification and case definition. J Periodontol 2018;89:159-172. https://doi.org/10.1002/JPER.18-0006
18. Mechanick JI, Apovian C, Brethauer S, et al. Clinical practice guidelines for the perioperative nutrition, metabolic, and nonsurgical support of patients undergoing bariatric procedures - 2019 update: cosponsored by American association of clinical endocrinologists/American college of endocrinology, the obesity society, American society for metabolic & bariatric surgery, obesity medicine association, and American society of anesthesiologists - executive summary. Endocr Pract 2019;25:1346-1359. https://doi.org/10.4158/GL-2019-0406
19. WHO. The World Health Organization warns of the rising threat of heart disease and stroke as overweight and obesity rapidly increase. Available at: https://www.cmaj.ca/content/cmaj/suppl/2020/07/27/192.31.E875.DC2/191707-guide-1-at.pdf. Accessed October 16, 2023
20. Deitel M, Greenstein RJ. Recommendations for reporting weight loss. Obes Surg 2003;13:159-160. https://doi.org/10.1381/096089203764467117
21. Silness J, Loe H. Periodontal disease in pregnancy. II. correlation between oral hygiene and periodontal condition. acta odontol scand 1964;22:121-135. https://doi.org/10.3109/00016356408993968
22. Loe H, Silness J. Periodontal disease in pregnancy. I. prevalence and severity. Acta Odontol Scand 1963;21:533-551. https://doi.org/10.3109/00016356309011240
23. Ainamo J, Bay I. Problems and proposals for recording gingivitis and plaque. Int Dent J 1975;25:229-235.
24. Linden GJ, Lyons A, Scannapieco FA. Periodontal systemic associations: review of the evidence. J Clin Periodontol 2013;40:8-19. https://doi.org/10.1111/jcpe.12064
25. Zhao P, Xu A, Leung WK. Obesity, bone loss, and periodontitis: the interlink. Biomolecules 2022;12:865. https://doi.org/10.3390/biom12070865
26. Hayes K, Eid G. Laparoscopic sleeve gastrectomy: surgical technique and perioperative care. Surg Clin North Am 2016;96:763-771. https://doi.org/10.1016/j.suc.2016.03.015
27. Ridker PM, Morrow DA. C-reactive protein, inflammation, and coronary risk. Cardiol Clin 2003;21:315-325. https://doi.org/10.1016/s0733-8651(03)00079-1
28. Chen JY, Chou CH, Tsai WC, et al. Effects of increased systemic inflammation and central obesity on arterial stiffness in patients with nonalcoholic fatty liver disease. J Am Soc Hypertens 2012;6:253-260. https://doi.org/10.1016/j.jash.2012.04.003
29. Paraskevas S, Huizinga JD, Loos BG. A systematic review and meta-analyses on C-reactive protein in relation to periodontitis. J Clin Periodontol 2008;35:277-290. https://doi.org/10.1111/j.1600-051X.2007.01173.x

30. Lee JB, Yi HY, Bae KH. The association between periodontitis and dyslipidemia based on the Fourth Korea National Health and Nutrition Examination Survey. J Clin Periodontol 2013;40:437-442. https://doi.org/10.1111/jcpe.12095
31. Awartani F, Atassi F. Evaluation of periodontal status in subjects with hyperlipidemia. J Contemp Dent Pract 2010;11:33-40.
32. Schenkein HA, Papapanou PN, Genco R, Sanz M. Mechanisms underlying the association between periodontitis and atherosclerotic disease. Periodontol 2020;83:90-106. https://doi.org/10.1111/prd.12304
33. Gomes Filho IS, Freitas TOB, da Cruz SS, et al. Periodontitis in individuals with few remaining teeth and a high gingival bleeding index increases the probability of dyslipidemia. J Periodontol 2023. https://doi.org/10.1002/JPER.23-0091
34. Arboleda S, Pianeta R, Vargas M, Lafaurie GI, Aldana Parra F, Chaux CF. Impact of bariatric surgery on periodontal status in an obese cohort at one year of follow-up. Med Int (Lond) 2021;1:4. https://doi.org/10.3892/mi.2021.4
35. Kojima M, Kangawa K. Ghrelin: structure and function. Physiol Rev 2005;85:495-522. https://doi.org/10.1152/physrev.00012.2004
36. Goitein D, Lederfein D, Tzioni R, Berkenstadt H, Venturero M, Rubin M. Mapping of ghrelin gene expression and cell distribution in the stomach of morbidly obese patients --a possible guide for efficient sleeve gastrectomy construction. Obes Surg 2012;22:617-622. https://doi.org/10.1007/s11695-011-0585-9
37. Wang Y, Liu J. Plasma ghrelin modulation in gastric band operation and sleeve gastrectomy. Obes Surg 2009;19:357-362. https://doi.org/10.1007/s11695-008-9688-3
38. Peterli R, Steinert RE, Woelnerhanssen B, et al. Metabolic and hormonal changes after laparoscopic Roux-en-Y gastric bypass and sleeve gastrectomy: a randomized, prospective trial. Obes Surg 2012;22:740-748. https://doi.org/10.1007/s11695-012-0622-3
39. Mafra D, Farage NE, Lobo JC, et al. Relationship between total ghrelin and inflammation in hemodialysis patients. Peptides 2011;32:358-361. https://doi.org/10.1016/j.peptides.2010.11.023
40. Yilmaz G, Kirzioglu FY, Doguc DK, Kocak H, Orhan H. Ghrelin levels in chronic periodontitis patients. Odontology 2014;102:59-67. https://doi.org/10.1007/s10266-012-0100-3
41. Mohamed HG, Idris SB, Mustafa M, et al. Impact of chronic periodontitis on levels of glucoregulatory biomarkers in gingival crevicular fluid of adults with and without Type 2 Diabetes. PLoS One 2015;10:e0127660. https://doi.org/10.1371/journal.pone.0127660
42. Miller GD, Nicklas BJ, Fernandez A. Serial changes in inflammatory biomarkers after Roux-en-Y gastric bypass surgery. Surg Obes Relat Dis 2011;7:618-624. https://doi.org/10.1016/j.soard.2011.03.006
43. Illan Gomez F, Gonzalvez Ortega M, Orea Soler I, et al. Obesity and inflammation: change in adiponectin, C-reactive protein, tumour necrosis factor-alpha and interleukin-6 after bariatric surgery. Obes Surg 2012;22:950-955. https://doi.org/10.1007/s11695-012-0643-y

Consent of publication: Additional informed consent was obtained from all individual participants for whom identifying information is included in this article.

Acknowledgments: The authors would like to thank participants in this study.

Ethics committee approval: Permission was obtained from Pamukkale University Non-Interventional Clinical Research Ethics Committee dated 2018 and numbered 19 for the study.

Author contributions

A.L.A. was responsible for drafting the manuscript. A.L.A., G.T.C. and M.R.A. were responsible for Data collection and Interpretation and for drafting the manuscript. A.L.A. was responsible for conceptualization, funding acquisition, design of the study, supervision, and drafting of the manuscript. M.R.A. was responsible for surgical intervention. A.L.A. and G.T.C. were responsible for data analysis and interpretation. All authors reviewed the article critically for important intellectual content and approved the final version to be submitted.