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REVIEW ARTICLE

Influence of Bariatric Surgery on Salivary Flow: a Systematic Review and Meta-Analysis

Tatyana M. C. P. Farias[1] · Belmiro C. do E. Vasconcelos[2] · Juliana R. SoutoMaior[1] · Cleidiel A. A. Lemos[3] · Sandra L. D. de Moraes[1] · Eduardo P. Pellizzer[3]

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Abstract

Bariatric surgery is the most effective treatment for morbid obesity, but it can cause numerous adverse effects. This systematic review and meta-analysis aimed to evaluate whether bariatric surgery changes patient salivary flow. We searched for articles in the Web of Science, Pubmed/MEDLINE, and Scopus databases using the search terms "oral health AND bariatric surgery OR gastrectomy OR obesity surgery." We recovered 845 articles. After the removal of duplicates and exclusions, eight studies remained. Of them, five showed no significant difference in salivary flow values, two showed an increase in flow rate, and one showed a reduction in flow rate ($p < 0.05$). The results of the included studies showed no significant alteration in salivary flow rate for up to 24 months after bariatric surgery.

Keywords Bariatric surgery · Gastrectomy · Obesity surgery · Oral health; salivary flow

Introduction

The worldwide increase in obesity has caused concern and been the subject of much discussion. According to the World Health Organization, 1.6 million adults are overweight (body mass index [BMI] > 25 kg/m^2) and 400 million are obese (BMI > 30 kg/m^2). The number of individuals with morbid obesity (BMI > 40 kg/m^2) has also increased massively [1].

Obesity is a chronic disease [2] defined as an accumulation of body fat that damages an individual's health [3] or exacerbates other comorbidities [2]. Several studies [1, 4–9] point to bariatric surgery as the most effective treatment for morbid obesity [4] since it generates significant weight loss, reduces the comorbidities associated with obesity, and increases the quality of life of individuals with this disease [10]; it is indicated for patients with a BMI ≥ 40 kg/m^2 [8]. However, this surgical treatment causes anatomical and physiological alterations of the gastrointestinal tract in addition to requiring the patient to change their behaviors and follow up with several health professionals [4]. Bariatric surgery can have numerous adverse effects, such as gastroesophageal reflux, vomiting episodes, malnutrition, nausea, anemia, dehydration, and vitamin and mineral deficiencies [11]. These potential negative effects may lead to oral manifestations such as caries, dental erosion, periodontal disease, changes in salivary flow (SF) rate, and changes in the mucosa [3].

✉ Sandra L. D. de Moraes
sandra.moraes@upe.br

Tatyana M. C. P. Farias
tatyanafariass@gmail.com

Belmiro C. do E. Vasconcelos
belmirovasconcelos@gmail.com

Juliana R. SoutoMaior
julianarsmaior@yahoo.com.br

Cleidiel A. A. Lemos
cleidiel@gmail.com

Eduardo P. Pellizzer
ed.pl@uol.com.br

[1] School of Dentistry, Pernambuco University (UPE), 1650 General Newton Cavalcante Avenue, Camaragibe, PE 54753-020, Brazil

[2] Department of Oral and Maxillofacial Surgery, School of Dentistry, Pernambuco University (UPE), 1650 General Newton Cavalcante Avenue, Camaragibe, PE 54753-020, Brazil

[3] Department of Dental Materials and Prosthodontics, School of Dentistry, São Paulo State University (UNESP), 1193 Jose Bonifacio St, Vila Mendonça, Aracatuba, SP 16015-050, Brazil

Oral manifestations arising from bariatric surgery directly influence patient quality of life because they cause discomfort. However, despite the possible systemic and oral changes, the benefits generated by the surgical procedure are greater than the side effects produced [7].

Saliva plays an important role in the oral cavity since it is essential to oral homeostasis. It has other fundamental functions, such as lubricating the bolus; protecting against viruses and bacteria; buffering, protecting, and repairing the oral mucosa; and re-mineralizing the dentition, which may be a positive long-term factor in the prevention of dental caries [2, 12].

Thus, the objective of this systematic review is to investigate the relationship between bariatric surgery and the possible alterations in SF in morbidly obese individuals undergoing this type of treatment. The null hypothesis is that bariatric surgery does not produce changes in SF.

Methods

Protocol and Registration

The present systematic review was conducted according to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses guidelines and recorded in the International Prospective Register of Systematic Reviews under inscription CDR4201810030.

Eligibility Criteria

The following question was asked according to Population, Intervention, Comparison, Outcome criteria: Do patients undergoing bariatric surgery have altered salivary flow?" According to the established criteria, the population consisted of individuals with morbid obesity. The intervention was in individuals with morbid obesity undergoing bariatric surgery, and the comparison was composed of morbidly obese subjects not submitted to bariatric surgery. The outcome analyzed was the oral health condition (saliva).

Randomized clinical trials as well as prospective, retrospective, longitudinal, cohort, and transverse studies were included, while in situ, in vitro, and animal studies; literature reviews; case reports; and case series were excluded.

Search Methods and Article Selection

The Web of Science, Pubmed/MEDLINE, and Scopus databases were searched using the terms "oral health AND bariatric surgery OR gastrectomy OR obesity surgery." The electronic search was performed through June 2018 without language restrictions.

The electronic selection of articles was performed by two independent authors (T.M.C.P.F. and C.A.A.L.) from title and abstract screenings. Divergences between evaluators were resolved through consensus.

Complementing the searches in the databases, a manual search was conducted in the main journals of interest in the areas of "obesity surgery" and "obesity diseases."

Data Collection

Relevant information was extracted by one author (T.M.C.P.F.) and verified by a second author (C.A.A.L.). The data extracted were author/year, study type, number of patients, mean age, type of bariatric surgery, BMI, sex, evaluation period, and SF values.

Risk of Bias

Article quality was evaluated using the bias risk analysis tool based on the Newcastle-Ottawa scale for non-randomized patients. These tools analyze the risk of bias individually based on sequence generation, allocation concealment, participant blinding, personnel or outcome investigator, incomplete outcome data, selective outcome reporting, and other sources of bias. Risk of bias was classified as low, high, or unclear.

Additional Analyses

Further analyses were performed using the kappa coefficient to determine inter-examiner agreement of the study selection process.

Results

Study Selection

The initial database searches yielded a total of 845 articles, including 228 in Scopus, 468 in Pubmed/Medline, and 158 in Web of Science. After the duplicates were removed, 757 articles remained, of which 17 were selected after title and abstract screening, and 5 were excluded because they did not meet the eligibility criteria. After this step, 12 articles were selected for full-text screening, of which 4 were excluded because they did not present SF values. Thus, eight were ultimately included in the analysis. The reasons for excluding the studies are detailed in Fig. 1. The kappa test was applied to assess inter-examiner agreement in the initial study selection, revealing high levels of agreement: 0.85 for PubMed/MEDLINE, 1.0 for Scopus, and 0.89 for Web of Science.

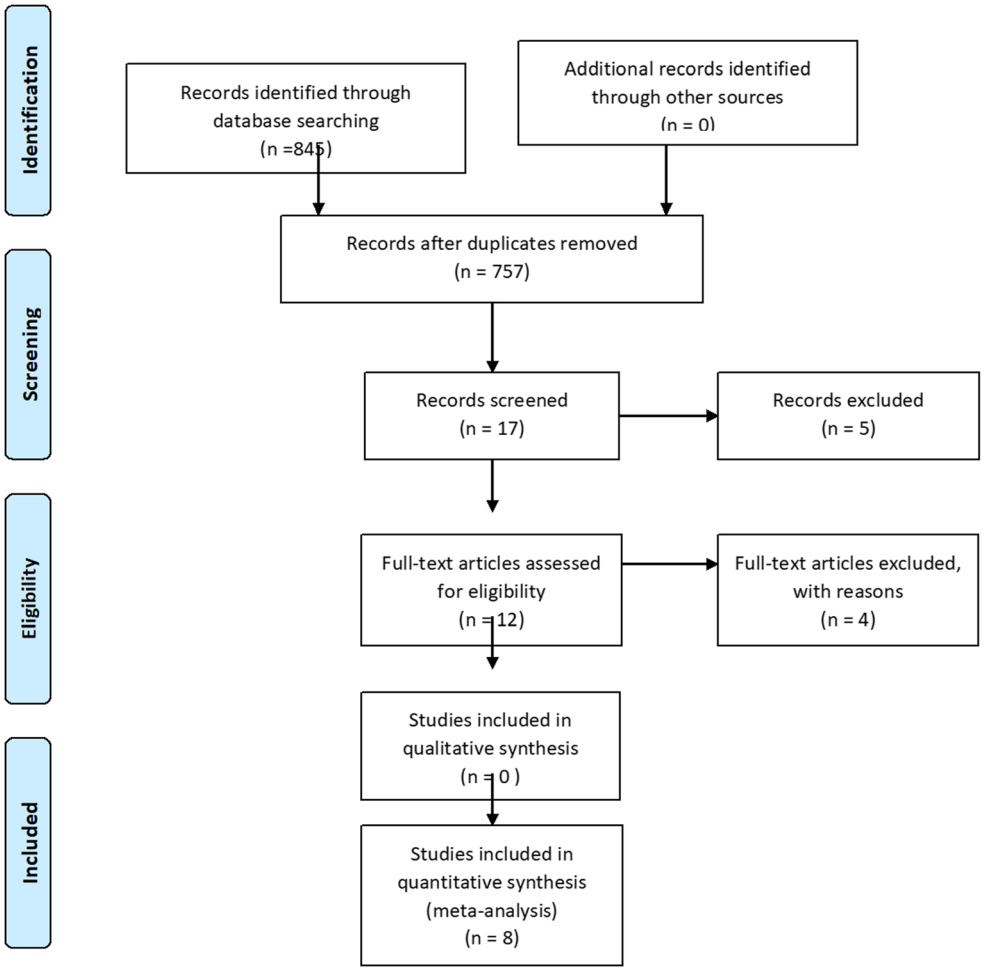

Fig. 1 Flow-chart of literature research

Characteristics of Selected Studies

Detailed data from the eight selected studies are listed in Table 1. A total of 409 individuals aged 26–55 years were evaluated. The maximum follow-up period was 24 months.

Of the eight selected studies, six were longitudinal studies [1, 3, 7, 8, 10, 13], one was cross-sectional [11], and one was a case-control study [14].

Seven studies [3, 7, 8, 10, 11, 13, 14] selected patients who underwent bariatric surgery using the Roux-en-Y gastric bypass method, while only one study—[1] included patients undergoing bariatric surgery using the sleeve gastrectomy laparoscopy method. Six studies [1, 3, 7, 8, 10, 13] had two comparison groups, one prior to surgery (control) and another after surgery (intervention); another divided patients into groups prior to surgery and controls [11]; and one had a case (intervention) group and one control group [14]. All studies considered the sex of the selected patients (total 340 women, 69 men). All studies included in this review showed a higher prevalence of women undergoing bariatric surgeries [1, 3, 7, 8, 10, 11, 13, 14].

One study performed SF measurements before and at 12 and 24 months after bariatric surgery [13]. Three studies obtained flow values before surgery and at 6 months later [3, 8, 10]. One study evaluated SF 24 h after bariatric surgery (baseline) and 6 months later [1]. One study performed SF measurements prior to surgery, 3, and 6 months later [7]. Two studies obtained values of SF, in a period of 16.9 ± 20.7 and 17.7 ± 19.5 months respectively [11, 14].

The eight studies provided data regarding SF level. Of these, six showed a slightly significant increase in values [1, 3, 7, 10, 11, 13], one showed more evident elevation of numbers [7], and one study showed a significant reduction in SF level [14].

Quality and Risk of Bias Assessments

Quality methodological analyses were performed using the Newcastle-Ottawa scale tool for non-Early Career Reviewer studies, which demonstrated a satisfactory level of evidence based on scale criteria. Based on the Newcastle-Ottawa tool, none of the selected studies showed a high risk of bias (< a 6 stars) (Table 2).

Table 1 Characteristics of the analyzed studies

Author/year	Study	Sample size	Group	Gender	Age	Type of BS	BMI	Evaluation period	SF
Marsicano et al. 2011	LS	54	BS ($n = 54$)	44 w 10 m	40.5 ± 9.7 years	RYGB	NR	Preoperatively	0.8 ± 0.5
			AS ($n = 54$)					03 months	0.9 ± 0.5
								06 months	1.1 ± 0.5
Marsicano et al. 2012	CSS	102	ABS ($n = 52$)	39 w 13 m	39.6 ± 9.6	RYGB	NR	16.9 ± 20.7 months	0.65 ± 0.47
			C ($n = 50$)	36 w 14 m	35.5 ± 10.2				0.66 ± 0.49
Netto et al. 2012	LS	26	BS ($n = 26$)	22 w 04 m	39.6 ± 1.93 years	RYGB	120.6 ± 4.30	Preoperatively	0.40 ± 0.02
							74.70 ± 2.17	12 months	1.00 ± 0.07
			AS ($n = 26$)				74.70 ± 2.17	24 months	1.20 ± 0.09
Souza et al. 2013	CCS	62	CG ($n = 31$)	29 w 02 m	41.4 ± 10.0	RYGB	35.0 ± 5.9	17.7 ± 19.5 months	0.50 ± 0.23
			C ($n = 31$)	27 w 04 m	39.5 ± 10.0		47.5 ± 8.9		0.36 ± 0.22
Cardozo et al. 2014	LS	39	BS ($n = 39$)	38 w 01 m	45.7 ± 9.5 years	RYGB	50.7 ± 5.9	Preoperatively	1.06 ± 0.62
			AS ($n = 39$)				37.8 ± 6.6	06 months	1.64 ± 0.99
Moura-Grec et al. 2014	LS	59	BS ($n = 59$)	50 w 09 m	38.41 ± 10.98 years	RYGB	49.31 ± 8.75	Preoperatively	0.84 ± 0.53
			AS ($n = 59$)				35.52 ± 8.12	06 months	0.95 ± 0.52
Hashizume et al. 2015	LS	27	BS ($n = 27$)	26 w 01 m	44.7 ± 7.75 years	RYGB	51.72 ± 4.52	Preoperatively	1.31 ± 0.55
			AS ($n = 27$)				38.02 ± 5.46	06 months	1.47 ± 0.72
Knás et al. 2016	LS	40	BS ($n = 40$)	29 w 11 m	44.1 ± 11.5 years	LSA	44.8 ± 9.2	Baseline	UWS:0.35 ± 0.1 SWS: 0.52 ± 0.1
			AS ($n = 40$)				25.3 ± 1.9	06 months	UWS: 0.47 ± 0.3 SWS: 0.55 ± 0.4

PRP, prospective study; *LS*, longitudinal study; *CSS*, cross-sectional study; *CCS*, case-control study; *ABS*, after bariatric group; *C*, control; *CG*, case group; *RYGB*, roux-en-Y gastric by-pass surgery; *LSA*, laparoscopy sleeve-gastrectomy; *BMI*, body mass index; *SF*, salivary flow; *BS*, before surgery; *AS*, after surgery; *UWS*, unstimulated saliva; *SWS*, stimulated saliva

Meta-Analysis

SF was measured through chewing gum, spitting method, a Dentobuff® kit (Orion Diagnostica, Finland), and storage of saliva in a bottle. No significant statistical difference was observed in the analyzed groups ($p = 0.13$; mean difference, 0.21; confidence interval, − 0.06 to 0.48). The heterogeneity presented a high index (x^2 283.23; $I = 98\%$; $p < 0.00001$), showing that the included studies did not share the same effect size (Fig. 2).

Table 2 NewCastle Otawa Scale

Studies	Selection				Comparability		Outcome			Total
	Exposed Cohort*	Non exposided cohort*	Ascertainment of exposure	Outcome of interest not present at start	Main Factor	Additional Factor	Assessment of outcome	Follow-up long enough*	Adequacy of follow-up	
Netto et al. [13]	0	☆	☆	☆	☆	☆	☆	0	☆	7
Cardozo et al. [10]	0	☆	☆	☆	☆	☆	☆	0	☆	7
Hashizumi et al. [3]	0	☆	☆	☆	☆	☆	☆	0	☆	7
Knás et al. [1]	0	☆	☆	☆	☆	☆	☆	0	☆	7
Marsicano et al. [7]	0	☆	☆	☆	☆	☆	☆	0	☆	7
Marsicano et al. [11]	0	☆	☆	0	☆	☆	☆	0	☆	6
Moura-Grec et al. [8]	0	☆	☆	☆	☆	☆	☆	0	☆	7
Souza et al. [14]	0	☆	☆	☆	☆	☆	☆	0	☆	7

*Five years was considered adequate follow-up period for outcomes

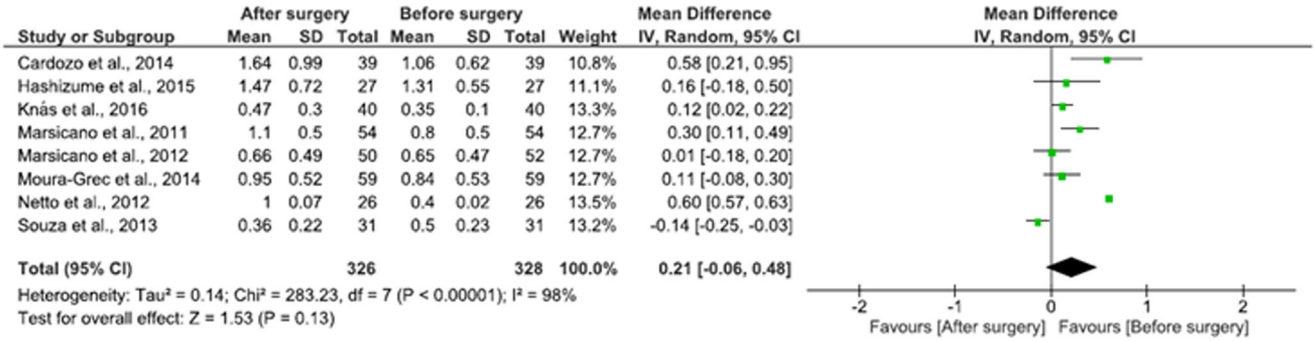

Fig. 2 Meta-analysis for salivary flow level

Discussion

The null hypothesis of the present systematic review and meta-analysis was accepted, as no significant differences in salivary flow values were seen in patients who underwent bariatric surgery. The frequent ingestion of high-dose pharmacological agents for the treatment of obesity-associated comorbidities may adversely affect the regulatory aspects of saliva and cause changes in saliva and salivary fluid composition, making the individual more susceptible to caries, periodontal disease, and dental erosion [15]. On the other hand, the possible weight reduction of morbidly obesity patients after bariatric surgery tends to increase the salivary flow of such individuals [8, 10].

Decreased salivary flow may promote dental erosion [4]. This is a common finding in patients undergoing bariatric surgery because gastric reflux and vomiting are common side effects of the procedure and represent risk factors for erosion due to the dissolution action of acidic pH on dental mineralized tissues [3, 5, 12]. Most of the studies included in this systematic review followed patients undergoing bariatric surgery during a 6-month period. This follow-up period is considered ideal because of the greater chances of the occurrence of possible psychological and physiological changes occurring within this time interval [8, 11, 13]. Marsicano et al. corroborated this assertion when they observed a reduction in the salivary flow rate of patients until 3 months after the surgery, but it was completely restored after 6 months [7].

Post-surgical stress causes temporary damage and organ dysfunction; however after removal of the stressor, the functionality of these affected organs tends to be partially or fully recovered [1]. Knás et al. affirmed that the high intensity oxidative rate may result in failure to repair or replace damaged biomolecules, leading to organ dysfunction [1]. The authors explained that these findings are probably due to the different behavior of the antioxidant barrier, parameters of oxidative stress, and secretory capacity of the submandibular and parotid glands in patients undergoing bariatric surgery. However, the results did not indicate significant differences in the total antioxidant status of the individuals evaluated 24 h and 6 months after surgery.

However, few studies in the literature have correlated the effects of bariatric surgery on patients' oral health. Therefore, it is important to perform new studies with the purpose of identifying how this surgery can affect the oral health of these individuals.

One of the limitations of this systematic review was the high level of heterogeneity of the included studies. Most of the studies were longitudinal and had a follow-up of 6 months, which is considered a safe period of time; however, none were randomized controlled trials. Due to the bias risk analysis, it is important to emphasize that some studies differed in patient follow-up duration and salivary flow measurement methodologies, which may have compromised the results. Thus, it is suggested that new randomized controlled trials be performed to obtain more reliable results.

This review verified that bariatric surgery can bring innumerable benefits to the patient's general health; however, it negatively affects the oral health condition. For this reason, the inclusion of a dentist in the multidisciplinary team to contribute to the treatment, prevent oral cavity lesions, and promote the quality of life for patients before and after surgery is essential [3, 7].

Conclusion

Within the limitations described herein, the findings of this systematic review and meta-analysis suggest that there is no significant change in SF in patients who underwent bariatric surgery and were followed up for up to 24 months.

Compliance with Ethical Standards

Statement of Human and Animal Rights This article does not contain any studies with human participants or animals performed by any of the authors.

Conflict of Interest The authors declare that they have no conflict of interest.

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