

Impact of bariatric surgery on Eustachian tube function

Original Article

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Abstract

Introduction - Rapid weight loss that occurs in the period after bariatric surgery can lead to a reduction in the adipose tissue that surrounds the cartilaginous portion of the Auditory Tube (AT). It is suggested in the literature that this loss of adipose tissue may correspond to a theoretical risk factor for AT dysfunction, although its real incidence is not known.

Objectives - The objective of this study was to evaluate the relationship between weight loss, 6 months after bariatric surgery, and the incidence of AT dysfunction.

Material and Methods - Prospective cohort study carried out with 50 patients aged 18 years or over and with formal criteria for bariatric surgery: body mass index > 40 kg/m² or > 35 kg/m² presenting related co-morbidities to weight. All patients underwent a complete objective examination, nasal endoscopy, tympanogram, pure tone audiogram, AT function tests and a questionnaire aimed at symptoms of AT dysfunction - Eustachian Tube Dysfunction Questionnaire (ETDQ-7-PT). Regardless of the questionnaire, patients were also asked about 3 symptoms (autophony, ear fullness and feeling their own breath in their ear). Patients were evaluated 1 month before and 6 months after bariatric surgery. Patients with changes in the initial pre-surgical assessment, history of otological/rhinological pathology, previous surgery in these anatomical areas or previous bariatric surgery were excluded.

Results - The average age was 47.3 ± 12.9 years and 82% of patients were female. The average weight loss in the 6th month after bariatric surgery was 41.6 ± 19.2 kg. The incidence of symptoms of autophony, ear fullness and feeling one's own breath in the ear was 22%, 24% and 26%, respectively. The ETDQ-7-PT score, 6 months after surgery, ranged from 7 to 33, with a mean of 12.5 ± 6.9. The magnitude ($p = 0.003$) and velocity ($p = 0.006$) of weight loss were significantly higher in patients with AT dysfunction (ETDQ-7-PT score ≥ 14.5 , $n = 8$, 16%). The distributions by sex, age or smoking did not show statistically significant differences according to the ETDQ-7-PT result ($p > 0.05$).

Conclusions - Bariatric surgery can cause AT dysfunction, with a statistically significant

relationship with the magnitude and speed of weight loss.

Keywords: Auditory Tube; bariatric surgery; obesity; weight loss; autophony.

Introduction

The Eustachian tube (ET) is a dynamic structure that plays a crucial role in equalizing pressure and ventilating the middle ear, clearing mucociliary secretions, and protecting the ear from nasopharyngeal secretions.¹ Its opening is induced by swallowing, yawning, chewing, performing the Valsalva maneuver, and changes in the atmospheric pressure. At rest, the ET remains closed. The opening of the ET is facilitated by the activation of the tensor veli palatini, levator veli palatini, and salpingopharyngeus muscles. Additionally, the closure of the ET is influenced by glands, the pterygoid venous plexus, and adipose tissue that surrounds the cartilaginous portion of the ET,² specifically the adipose tissue located in the anterolateral region of the cartilaginous portion of the ET lumen.²

Patulous ET dysfunction is presumably caused by the loss of tissues surrounding the cartilaginous portion of the ET. This condition has traditionally been associated with pregnancy, use of oral contraceptives, and estrogen therapy.³ It may also arise from atrophy or fibrosis of nasopharyngeal structures due to radiotherapy, poliomyelitis, multiple sclerosis, stroke, adenoidectomy, palate myoclonus, and craniofacial anomalies.⁴ Furthermore, ET dysfunction has been associated with rheumatological diseases, allergic conditions, and gastroesophageal reflux, which can contribute to atrophy of the peritubal tissues.³ It has also been observed in patients who have undergone bariatric surgery, presenting with symptoms such as autophony, aural fullness, or the sensation of feeling one's own breathing in the ear.¹ Autophony is the most frequently reported symptom.³ In approximately 20% of the affected patients, the symptoms persist for more than six months.⁵

The prevalence of obesity has increased rapidly

worldwide, resulting in substantial medical, psychological, and financial consequences.⁶ Bariatric surgery is recognized as an effective therapeutic intervention for clinically severe obesity, with an increasing number of procedures performed in recent years.⁷ On an average, bariatric surgery results in a weight loss of 20–40 kg.⁸ Evidence suggests that the rapid and substantial weight loss observed in these patients may predispose them to ET dysfunction more than the general population.¹

The association between significant weight loss and patulous ET dysfunction was first described in case reports of patients with anorexia nervosa,⁹ supporting the hypothesis that reduced tissue pressure and loss of fat surrounding the cartilaginous portion of the ET underlie the pathophysiology of ET dysfunction. There are few reports correlating ET dysfunction with weight loss following bariatric surgery,¹⁰ and the true incidence remains unclear.

This study aimed to evaluate the relationship between weight loss after bariatric surgery and the incidence of ET dysfunction. Additionally, potential parameters associated with an increased risk of developing ET dysfunction were analyzed.

Materials and methods

This prospective cohort study included 50 patients aged 18 years or older who met the formal criteria for bariatric surgery, defined as a body mass index (BMI) > 40 kg/m² or > 35 kg/m² with weight-related comorbidities. All patients underwent the same type of bariatric procedure, gastric bypass, performed by the same surgical team.

Comprehensive evaluations were conducted one month preoperatively and one, three, and six months postoperatively. These evaluations included a complete physical examination, nasal endoscopy, tympanometry, pure-tone audiometry, and ET function tests. Symptom-specific data were collected using the Eustachian Tube Dysfunction Questionnaire (ETDQ-7-PT), validated and translated into

European Portuguese.¹¹ A score ≥ 14.5 was considered indicative of ET dysfunction, as defined by *McCoud* et al.¹²

Patients were also interviewed about the presence of three symptoms, i.e., autophony, aural fullness, and the sensation of their breathing in the ear. The exclusion criteria were presence of abnormalities in the initial preoperative evaluation, history of otological or rhinological pathology, previous surgery in these anatomical regions, or previous bariatric surgery. The following variables were recorded: age, sex, initial and monthly weight (up to six months), percentage of body fat mass, abdominal and hip circumference, waist-to-hip ratio, and active smoking.

For statistical analysis, participants were divided into two groups based on the presence or absence of ET dysfunction, as determined by their ETDQ-7-PT scores. The magnitude and rate of weight loss were compared between the two groups. The patients were evaluated between January 2022 and November 2023, with all surgeries performed at the São José Local Health Unit (ULSSJ).

The study adhered to the ethical standards of the institutional research committee and the Declaration of Helsinki, and received approval from the ULSSJ Health Ethics Committee (CES 1143/2021), ULSSJ Financial Management and Accounting Department (AGFC 171/2021), and ULSSJ Board of Directors (CA 5890).

Statistical analysis

Categorical variables were analyzed using the Fisher's exact test, while continuous variables were evaluated using either the Student's *t*-test or Mann-Whitney U test. $p < 0.05$ was considered statistically significant. Statistical analyses were performed using SPSS software version 25 (SPSS Inc., Chicago, IL).

Results

The age of the participants ranged between 25 and 64 years, with an average of 47.3 ± 12.9 years. Female patients predominated, comprising 82% of the cohort ($n = 41$). The weight of the participants ranged between

96 and 160 kg, with an average of 110.5 ± 19.2 kg. Height ranged between 151 and 184 cm, with an average of 163.8 ± 6.9 cm. The average BMI was 38.8 ± 3.2 Kg/m². The average body fat percentage was 47.4 ± 3.2 . Abdominal circumference ranged between 102 and 138 cm, with an average of 118.4 ± 12.0 cm. Hip circumference ranged between 121 and 155 cm, with an average of 131.6 ± 10.7 cm. The waist-to-hip ratio varied between 0.8 and 1.1, with an average of 0.89 ± 0.09 . Active smoking was reported by 14% of the participants ($n = 7$) and was continued postoperatively. A summary of the demographic characteristics of the participants before surgery is provided in Table 1.

None of the patients exhibited preoperative abnormalities on nasal endoscopy, tympanometry, pure-tone audiometry, or ET function tests. Additionally, none of the participants had a preoperative ETDQ-7-PT score indicative of ET dysfunction (Table 2). The mean preoperative ETDQ-7-PT score of all participants was 8.2 ± 2.4 .

At six months postoperatively, the participants' weight loss ranged between 33.4 and 56.9 kg, with an average of 41.6 ± 19.2 kg. The ETDQ-7-PT scores at six months postoperatively ranged between 7 and 33, with an average of 12.5 ± 46.9 . Among the 50 participants, 8 (16%)

Table 1
Initial demographic characteristics of the participants

	n = 50
Age, years	47.3 ± 12.9 years
Sex	
Female	41 (82%)
Male	9 (18%)
Weight (Kg)	110.5 ± 19.2
Initial BMI (kg/m ²)	38.8 ± 3.2
Body fat mass (%)	47.4 ± 3.2
Abdominal circumference (cm)	118.4 ± 12.0
Hip circumference (cm)	131.6 ± 10.7
Waist-to-hip ratio	0.89 ± 0.09
Active smoking (%)	7 (14%)

BMI, Body Mass Index.

Table 2

Evaluation of the ETDQ-7-PT scores pre- and postoperatively, according to the presence or absence of ET six months after bariatric surgery (gastric bypass)

	ETDQ-7-PT < 14.5 (n = 42)			ETDQ-7-PT ≥ 14.5 (n = 8)			p**
	Preop	Pósop	p*	Preop	Pósop	p*	
1. Pressure in the ears?	1.2 ± 0.4	1.5 ± 0.5	0.0832	1.3 ± 0.5	3.9 ± 0.6	< 0.0001	< .00001
2. Pain in the ears?	1.2 ± 0.4	1.3 ± 0.5	0.2805	1.1 ± 0.4	2.6 ± 0.5	0.0001	< .00001
3. A feeling that your ears are clogged or "under water?"	1.3 ± 0.4	1.5 ± 0.5	0.0584	1.4 ± 0.5	5.3 ± 0.9	< 0.0001	< .00001
4. Ear symptoms when you have a cold or sinusitis?	1.2 ± 0.4	1.3 ± 0.5	0.0701	1.5 ± 0.8	4.6 ± 1.1	< 0.0001	< .00001
5. Crackling or popping sounds in the ears?	1.1 ± 0.3	1.3 ± 0.4	0.0510	1.1 ± 0.4	2.6 ± 0.9	0.0007	< .00001
6. Ringing in the ears?	1.2 ± 0.4	1.5 ± 0.6	0.0672	1 ± 0	3.4 ± 1.2	< 0.0001	< .00001
7. A feeling that your hearing is muffled?	1.2 ± 0.4	1.4 ± 0.5	0.0596	1 ± 0	5.0 ± 0.8	< 0.0001	< .00001

ETDQ-7-PT, Eustachian Tube Dysfunction Questionnaire; Preop, preoperative; Pósop, postoperative (6 months).

* - comparison of the pre- and postoperative ETDQ-7-PT scores for each question within each group.

** - comparison of the postoperative ETDQ-7-PT scores for each question between the groups.

demonstrated symptoms consistent with ET dysfunction according to the ETDQ-7-PT criteria. In participants without ET dysfunction (n = 42), no statistically significant differences were observed between the preoperative and postoperative periods for any of the seven questions in the ETDQ-7-PT. In contrast, in patients with ET dysfunction (n = 8), the answers for all ETDQ-7-PT questions demonstrated statistically significant differences between the pre- and postoperative periods. At six months postoperatively, the incidence rates of symptoms such as autophony, ear

fullness, and the sensation of one's own breath in the ear were 22% (n = 11), 24% (n = 12), and 26% (n = 13), respectively. Overall, 30.3% (n = 23) of the participants experienced at least one of these symptoms. Notably, all patients diagnosed with ET dysfunction using the ETDQ-7-PT (100%) reported all three symptoms.

Both the magnitude (p = 0.031) and speed (p = 0.006) of weight loss were significantly greater in participants with ET dysfunction. Distributions based on sex, age, or active smoking status did not show statistically

Table 3

Demographic characteristics of the patients at three and six months after bariatric surgery (gastric bypass), categorized by the presence or absence of ET dysfunction

	3 months			6 months		
	ETDQ-7-PT < 14.5 (n = 7)	ETDQ-7-PT ≥ 14.5 (n = 43)	p	ETDQ-7-PT < 14.5 (n = 8)	ETDQ-7-PT ≥ 14.5 (n = 42)	p
Age, years	42.9 ± 11.1	48.3 ± 13.1	0.308	45.0 ± 11.9	48.6 ± 13.0	0.471
Sex						
Female	5 (71.4%)	36 (83.7%)	0.773	6 (75.0%)	35 (83.3%)	0.883
Male	2 (28.6%)	7 (16.3%)		2 (25.0%)	7 (16.7%)	
Total weight loss (kg)	41.4 ± 6.1	20.5 ± 7.6	<0.0001	59.3 ± 4.6	38.2 ± 26.5	0.031
Body fat mass (%)	32.4 ± 4.1	37.2 ± 3.3	0.001	30.4 ± 3.9	33.1 ± 3.4	0.06
Active smoking (%)	1 (14.3%)	6 (14.0%)	0.9691	1 (12.5%)	6 (14.3%)	0.897

ETDQ-7-PT, Eustachian Tube Dysfunction Questionnaire

significant differences according to the ETDQ-7-PT results ($p > 0.05$) (Table 3). Notably, patients with ET dysfunction attained $69.8 \pm 6.1\%$ of their total six-month weight loss within the first three months. This was higher than that ($53.7 \pm 7.6\%$) observed in patients without ET dysfunction during the same period, representing a statistically significance difference ($p < 0.0001$).

Discussion

Few reports in the literature have correlated significant weight loss with the onset of ET dysfunction symptoms, and this is the first study to evaluate this issue in the Portuguese population.

In 1964, based on a series of 15 cases, *Pulec* et al. postulated that the probable etiological basis of abnormal ET patency was weight loss.¹³ In 2009, *Alhammadi* et al. reported the first case of patulous ET dysfunction after Roux-en-Y gastric bypass surgery. The patient was a 44-year-old woman who developed autophony and ear fullness three months post-bariatric surgery, following a weight loss of 20 kg. *Munoz* et al. observed a significant prevalence (21.28%) of patulous ET in 163 patients who underwent bariatric surgery, and identified an association between ET dysfunction and the speed and magnitude of weight loss.³ Conversely, a 2021 study by *Yazici* et al. found that the incidence of ET dysfunction was 10.5% in a population of 76 patients who had undergone bariatric surgery, but reported no correlation with the percentage of weight loss.¹ *Yoshida* et al. showed that in patients with patulous ET, the ET lumen remained chronically open in its cartilaginous portion. Additionally, the surrounding soft tissues, including adipose tissue adjacent to the cartilaginous portion, were reduced in these patients.¹⁴ These findings align with those of *Poe* et al.,^{15,16} who performed nasopharyngeal endoscopy and observed that patulous ET dysfunction was caused by the loss of adipose tissue around the cartilaginous portion of the tube. In our study, based on the ETDQ-7-PT questionnaire, the incidence of ET dysfunction

at six months post-bariatric surgery was 16%. This result is consistent with the incidence rates in the literature (10.5–26.3%).^{1–4} The most common complaint among patients with ET dysfunction was the feeling of hearing their own breathing (26%). This contrasts with the findings by *Munoz* et al., who reported autophony as the most common symptom in 96.6% of patients diagnosed with patulous ET after bariatric surgery.³ Our results also demonstrated that the magnitude and speed of weight loss were significantly greater in patients with ET dysfunction. These findings have been corroborated by only one study to date.³ Other parameters influencing the onset of ET dysfunction in patients after bariatric surgery have not been described in the literature. Additional studies are needed to determine whether compensatory mechanisms for the loss of adipose tissue surrounding the cartilaginous portion of the ET could explain the absence of symptoms of ET dysfunction in some patients undergoing bariatric surgery. Long-term studies will be required to assess the incidence of symptoms after weight stabilization or potential weight regain. It is also important to evaluate the eating and lifestyle habits of these patients, along with ensuring adequate micronutrient supplementation. Future studies should also analyze the correlation between ET dysfunction and the type of bariatric surgery performed (e.g., gastric bypass versus gastric sleeve). Another crucial area for investigation is the development of therapeutic strategies for these patients, along with establishing an appropriate follow-up plan.

Our findings highlight that weight loss after bariatric surgery is a risk factor for ET dysfunction. Considering the substantial metabolic and emotional changes experienced by these patients during the postoperative period of bariatric surgery, ENT symptoms may be overlooked by patients as well as by physicians and surgeons. The emotional impact of weight loss and its role in the perception of ET dysfunction should also be studied. We recommend that general

surgeons performing bariatric surgery should proactively screen for symptoms of ET dysfunction postoperatively. Affected patients could benefit from early referral and management by an otorhinolaryngologist. The ETDQ-7-PT is a practical tool for screening ET dysfunction without significantly extending the duration of the appointment.

Conclusion

Bariatric surgery can lead to ET dysfunction, with a statistically significant relationship observed between ET dysfunction and the magnitude and speed of weight loss. ETDQ-7-PT may be useful for the clinical identification of ET dysfunction in patients undergoing bariatric surgery.

Conflict of Interests

The authors declare that they have no conflict of interest regarding this article.

Data Confidentiality

The authors declare that they followed the protocols of their work in publishing patient data.

Human and animal protection

The authors declare that the procedures followed are in accordance with the regulations established by the directors of the Commission for Clinical Research and Ethics and in accordance with the Declaration of Helsinki of the World Medical Association.

Privacy policy, informed consent and Ethics committee authorization

The authors declare that they have obtained signed consent from the participants and that they have local ethical approval to carry out this work.

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Scientific data availability

There are no publicly available datasets related to this work.

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