Research Article

Maximum Phonation Time in People with Obesity Not Submitted or Submitted to Bariatric Surgery

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Background. Our aim in this investigation was to evaluate maximum phonation time in people with obesity not submitted to surgery and in people with obesity submitted to bariatric surgery and compare it with maximum phonation time of healthy volunteers. The hypothesis was that the reduced maximum phonation time in people with obesity would be corrected after surgery due to weight loss. Method. Maximum phonation time was evaluated in 52 class III patients (Group A), 62 class III patients who were treated by surgery 3 to 115 months before (Group B), 20 controls (Group C), and 15 class III patients whose maximum phonation time was evaluated before and two to six months after surgery (Group D). Maximum phonation time was measured in the sitting position with the vowels /A/, /I/, and /U/. Results. Maximal phonation time was shorter in groups A and B compared with that of controls. There was an increase in maximal phonation time after surgery (Group B); however, the difference was not significant when compared with that in group A. In group D, maximal phonation time for /A/ increased after the surgery. In group A, there was a negative correlation between maximal phonation time and weight or body mass index and a positive correlation between maximal phonation time and height. In group B, there was an almost significant positive relation between percentage of weight loss and maximal phonation time for /A/ (p = 0.08) and /I/ (p = 0.07). Mean values of spirometry testing (FEV1, FVC, and FEV1/FVC) in people with obesity (groups A and B), expressed as percentage of the predicted value, were within the normal range. Conclusion. Compared with healthy controls, maximal phonation time is shorter in people with obesity, with a tendency to increase after bariatric surgery, as a possible consequence of weight loss.

1. Introduction

Obesity is an important health problem with increasing prevalence around the world [1, 2]. It is associated with complications and high cost for its prevention and treatment [2]. Pulmonary function is affected by obesity, with lower than expected ventilatory pressures during inspiration and expiration, caused by a reduction in respiratory muscle strength, in functional capacity, in functional residual capacity, in expiratory reserve volume, in vital capacity, in total pulmonary capacity and in lung compliance and volume, as well as by an increase in airway resistance and pulmonary diffusion, heterogeneity of ventilation distribution, and hypercapnic respiratory failure [3–7]. People with obesity have found to have narrowing of the aerodigestive tract, including the hypopharynx, oropharynx, nasopharynx, and nasal cavities, caused by thickening of the lateral pharyngeal walls, medialized tonsillar pillars, and elongated and flaccid velum [8, 9], which may also affect the vocal quality [10–12].

The maximum phonation time (MPT) is an effective tool for the evaluation, diagnosis, and follow-up of patients in treatment for voice alteration [13, 14], which has been reported short in people with obesity [10–12]. There is a controversy about what happens to the MPT after
surgical treatment of obesity and consequent weight loss. While some studies have shown increased MPT after surgery [11, 15], others have shown no alteration [16, 17]. Our hypothesis was that (a) obesity decreases MPT, which is improved after surgical treatment of obesity; (b) there is a correlation of the duration of MPT with weight, body mass index (BMI), and neck circumference; and (c) obesity causes abnormalities in forced expiratory volume in one second (FEV₁) and forced vital capacity (FVC). The objectives of this investigation were to (1) evaluate the MPT in a group of people with obesity and in a group of people with obesity treated by surgery and compare it with a control group of nonobese healthy volunteers; (2) evaluate a group of people with obesity before and after surgical treatment of obesity; and (3) evaluate the correlation of MPT with weight, height, BMI, neck circumference, FEV₁, FVC, and the relation FEV₁/FVC (Tiffeneau index) in patients who were not treated surgically.

2. Materials and Methods

2.1. Participants. The MPT was evaluated in 52 patients with obesity (19 men) aged from 18 to 63 years (42.6 ± 11.6 years) with no surgical treatment of obesity and a BMI greater than 40 kg/m² (group A) and 62 patients with obesity (8 men) aged from 22 to 64 years (41.6 ± 11.0 years) who had been submitted to surgical treatment of obesity. All had a BMI greater than 40 kg/m² before the operation and were evaluated for MPT 3 to 115 months (median: 18 months) after surgery (group B) and 20 healthy controls (3 men), aged 18 to 62 years (40.2 ± 11.9 years), had a BMI between 21.9 and 26.0 kg/m². Weight loss in group B ranged from 11.3 kg to 78.0 kg, with a percentage of weight loss from 9.9% to 50.1% and a mean of 29.1 ± 10.0%. The mean and median age, weight, height, BMI, neck circumference, FEV₁, FVC, and the relation FEV₁/FVC (Tiffeneau index) in patients who were not treated surgically.

2.2. Surgery. Surgical treatment was performed by laparoscopic Roux-en-Y gastric bypass (RYGB). The procedure which has been standardized in our service is performed without a ring, and the length of the biliopancreatic and alimentary loops is of 100 cm each.

2.3. Spirometry. Patients of groups A and B were submitted to spirometry. The test was performed on a Pulmonet III spirometer (Sensormedics, Anaheim, CA, USA), according to the recommendations of the American Thoracic Society. The parameters analyzed were FEV₁, FVC, and the Tiffeneau index (FEV₁/FVC). The results were expressed according to the percentage predicted for age, height, and sex based on the equations of Crapo et al. [18].

2.4. Maximum Phonation Time. MPT was measured in all subjects in the sitting position, with the head in a resting position, looking straight. They were instructed to say the vowels /A/, /I/, and /U/, followed by /S/ and /Z/ after inspiration, in a prolonged and in habitual frequency and intensity. Each measurement was done in triplicate, and the mean of the three measurements of each individual was used for analysis. The MPT was measured in seconds with a digital stopwatch (Technos G183, Brazil).

2.5. Statistical Analysis. Statistical analysis was done with the correlation coefficient of Spearman (rho), analysis of covariance (ANCOVA), linear regression, and analysis of multiple effects. They were adjusted for gender and BMI. All analyses were performed with the software SAS® 9.2, and differences were considered significant when \( p \leq 0.05 \). The results are presented as mean, median, standard deviation, percentage and, in figure, interquartile range.

3. Results

The MPT for the sounds /A/, /I/, and /U/ were longer in the control subjects than in people with obesity (\( p < 0.04 \)), with or without surgery (Table 2). Men and women have the same results with the comparison between groups A and B and group C. The S/Z index was similar in the three groups, A, B, and C (\( p > 0.05 \)). MPT has the tendency to be lower in group A than in group B, but the statistical analysis did not show difference (\( p > 0.40 \), Figure 1).

In group D, there was a decrease in weight, BMI, and neck circumference after surgery compared with preoperative values. Preoperative MPT was shorter than that in controls, and the MPT for /A/ increased from 11.8 ± 4.5 seconds before the surgery to 13.0 ± 4.8 seconds after the surgery (\( p = 0.04 \), Table 3). There was no difference in the comparison before and after the surgery in MPT for /I/, /U/, or in the S/Z index (\( p = 0.30 \)).

In group A, there was a significant negative correlation of MPT with both weight and BMI, and a significant positive correlation between MPT and height (Table 4). Although no correlation was found of the MPT for /A/ and /I/ with neck circumference, there was a negative
correlation of the MPT of /U/ with neck circumference (p = 0.04). No correlation was observed between MPT and FEV₁, FVC, or FEV₁/FVC in group A. There was no relation between percentage of weight loss (p = 0.08 for /A/, p = 0.07 for /I/, p = 0.42 for /U/) and time after the surgery (p = 0.67 for /A/, p = 0.97 for /I/, p = 0.65 for /U/) with the MPT.

Mean values of FEV₁, FVC, and FEV₁/FVC in people with obesity (groups A and B), expressed as percentage of the predicted value, were considered within the normal range.

4. Discussion

As previously demonstrated [10–12], MPT was shorter in obese patients than that in nonobese subjects. Our results showed that, after surgical treatment of obesity and weight loss, there was no significant improvement in the MPT. However, our findings also suggested a small increase in MPT after the surgery, possibly requiring a longer postoperative period or even greater weight loss for the MPT to improve significantly. A previous study showed that it was possible to see improvements in MPT eight months after the surgery [15]. In our study, patients of group D showed an increase in the MPT of the vowel /A/ after the surgery and in group B an almost significant positive relation between percentage of weight loss and MPT for /A/ and /I/.

People with obesity have an altered voice quality, which is perceived as more strangled, hoarse, and breathy compared with nonobese ones [16]. Another study with class III subjects reported hoarseness, murmuring, vocal instability, altered jitter and shimmer, voice strangulation at the end of emission, and decreased MPT [12]. Shimmer is lower in people with obesity than that in normal weight individuals [19], and the fundamental frequency is not different between people with obesity and without obesity [10].

One would expect that the changes in the MPT in people with obesity would improve with weight loss, as a consequence of improvement in lung function [20]. Although this hypothesis may be true, such improvement may be slower than expected, not completed at the time of evaluation, or even show interindividual variability. Voice treatment may be indicated to achieve a better voice quality after the surgery even before the expected weight loss.

On the other hand, there are reports showing that there is no change in the MPT in people with obesity after the surgery [16, 17]. In one of these studies, although one-third of patients showed a change in the voice quality after weight loss, it was
Table 4: Spearman correlation coefficient (rho) of maximum phonation time (MPT) and S/Z ratio with weight, height, body mass index (BMI), neck circumference (NC), forced expiratory volume in one second (FEV$_1$), forced vital capacity (FVC), and the relation FEV$_1$/FVC measured in nonoperated people with obesity (Group A, n = 52).

|        | /A/ | /I/ | /U/ | S/Z |
|--------|-----|-----|-----|-----|
| Weight | −0.17 | 0.06 | −0.20 | 0.02* | −0.26 | 0.01* | 0.01 | 0.90 |
| Height | 0.23 | 0.01 | 0.18 | 0.04* | 0.18 | 0.05* | −0.03 | 0.74 |
| BMI    | −0.23 | 0.01* | −0.25 | 0.01* | −0.30 | 0.01* | 0.02 | 0.81 |
| NC     | −0.12 | 0.18 | −0.34 | 0.11 | −0.18 | 0.04* | −0.01 | 0.94 |
| FEV$_1$| 0.14 | 0.52 | 0.07 | 0.73 | 0.10 | 0.63 | −0.08 | 0.71 |
| FVC    | 0.06 | 0.77 | −0.03 | 0.88 | 0.07 | 0.76 | −0.24 | 0.26 |
| FEV$_1$/FVC | 0.07 | 0.75 | 0.19 | 0.37 | 0.05 | 0.82 | 0.14 | 0.51 |

* p < 0.05.

In conclusion, MPT is shorter in people with obesity before and after bariatric surgery, with no significant improvement after the treatment. However, MPT showed a tendency to increase in those operated patients.

Data Availability

The individual data used to support the findings of this study are restricted by the Human Research Committee of University Hospital of Ribeirão Preto, Ribeirão Preto Medical School, USP, in order to protect patient privacy. Data are available from the corresponding author via email (rodantas@fmrp.usp.br), for researchers who meet the criteria for access to confidential data.

Ethical Approval

All procedures followed were in accordance with the ethical standards of the responsible committee on human experimentation (institutional and national) and with the Helsinki Declaration of 1964 and later versions. The investigation was approved by the Human Research Committee of the University Hospital of Ribeirão Preto (IRB number 14757/2012).
Consent

Informed consent was obtained from all volunteers for being included in the study.

Conflicts of Interest

The authors declare that there are no conflicts of interest regarding the publication of this article. Dr. Roberto O. Dantas is member of the Board of Directors of the International Dysphagia Diet Standardisation Initiative (IDDSI).

Authors’ Contributions

Ana L. F. Fonseca participated in study planning, investigation, data collection, discussion of results, manuscript preparation, and decision to submit to publication. Wilson Salgado Junior and Roberto O. Dantas participated in study planning, discussion of results, manuscript preparation, and subsequent decision to submit to publication.

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