Bariatric Surgery: Severity, Level of Control, and Time Required for Preoperative Asthma Control

Saulo Maia d'Avila Melo

Obesity Surgery
The Journal of Metabolic Surgery and Allied Care

ISSN 0960-8923

OBES SURG
DOI 10.1007/s11695-012-0776-z

Springer

OBES SURG
DOI 10.1007/s11695-012-0776-z

CLINICAL RESEARCH

Bariatric Surgery: Severity, Level of Control, and Time Required for Preoperative Asthma Control

Saulo Maia d'Avila Melo

Abstract
Background There is an increased prevalence of asthmatic, obese patients undergoing bariatric surgery. The objective of our study is to evaluate the severity, level of control, respiratory medication use, and time required for prebariatric surgery asthma control.
Methods This is a prospective study in which 88 obese asthmatics were evaluated by a pulmonologist in two steps, prebariatric surgery. In the first step, patients were evaluated for severity, level of control, and respiratory medication in use, categorized as bronchodilators and corticosteroids. In the second step, the time required for asthma control between steps and appropriate respiratory medication was determined.
Results Thirty-eight obese patients (43.2%) had intermittent asthma, 22 had mildly persistent (25.0%), 24 moderately persistent (27.3%), and 4 severely persistent (4.5%). There were 43 patients with controlled asthma (48.9%), 31 partly controlled (35.2%), and 14 uncontrolled (15.9%). The study sample showed a significant increase in bronchodilators in the first step and corticosteroids in the second step ($p \leq 0.0001$). Comparisons between steps showed significant differences with a reduction of bronchodilators and increase in corticosteroids in the second step ($p \leq 0.0001$). The mean time (days) required for asthma control between steps was 28.98±33.40 days, with significant differences between groups ($p \leq 0.001$).
Conclusions In prebariatric surgery, there was a higher proportion of intermittent asthma and uncontrolled asthma, with asthma severity influencing the achievement of asthma control and the time required for surgical release.

Keywords Asthma · Respiratory tract diseases · Obesity · Bariatric surgery · Morbid obesity · Bariatric medicine · Body mass index · Ambulatory care

Introduction

Obesity is a chronic systemic inflammatory disease that has reached epidemic proportions during the last two decades, becoming a public health problem worldwide [1]. The World Health Organization (WHO) predicts an alarming increase in this prevalence in the coming decades [1].

Clinical treatment of obesity with a change in lifestyle (re-education of eating habits, regular physical activity, and behavioral change) and pharmacotherapy to reduce weight in obese types II and III has been frustrating, with frequent recurrences, causing increased indications for bariatric surgery, which has grown rapidly in recent years by providing a marked and sustained weight loss over a long period of time [2–4].

In this obese population, there is the presence of several comorbid conditions that predispose it to postoperative complications, particularly related to cardiac and pulmonary functions [5–7]. Since bariatric surgery is an elective procedure, patients should be carefully selected and extensively evaluated preoperatively to avoid complications during the intraoperative and postoperative periods [6–8].

Asthma is the leading chronic inflammatory respiratory disease, currently with 300 million asthmatics worldwide [9]. There is an increased prevalence of obese asthmatics undergoing bariatric surgery [5] that must have their asthma under control, although it can be difficult to achieve this control [10, 11].

Previous studies comparing obese asthmatics before and after surgery have shown clinical improvement and

S. M. d. Melo
Federal University of Sergipe,
Aracaju, Brazil

S. M. d. Melo (✉)
Department of Medicine, University Tiradentes,
Rua José Olivio do Nascimento, 82,
Edifício Parque da Sementeira, apto 201, Jardins,
CEP 49025-730, Aracaju, Sergipe, Brazil
e-mail: smaia@infonet.com.br

Published online: 27 September 2012

reduction of the use of respiratory medication after surgery [12, 13]; however, no studies have evaluated, in this population of asthmatics, the initial clinical aspects and evolution of asthma control in prebariatric surgery.

Our objectives for this study were to evaluate the severity, level of control, respiratory medication use, and time required for asthma control during prebariatric surgery.

Materials and Methods

A prospective study was conducted at the Federal University of Sergipe (UFS), in the city of Aracaju, Sergipe, Brazil, between January 2007 and August 2011. We analyzed those obese patients referred for evaluation of surgical pulmonary risk during the eventual treatment of obesity, consecutively, according to the demand of the clinic, who would undergo clinical evaluation and use of spirometry. We selected patients with a diagnosis of asthma and excluded patients with other respiratory diseases, individuals unable to undergo spirometry, and those who did not return for reassessment of their asthma control. The indications for surgical treatment of obesity followed the guidelines of the WHO and the Ministry of Health of Brazil [1, 14]. The Research Ethics Committee at UFS approved the project, and a term of informed consent was obtained from each patient.

The diagnosis of asthma—its severity (intermittent, mildly persistent, moderately persistent, and severely persistent) and level of control (controlled, partly controlled, and uncontrolled)—was performed by a pulmonologist at the first consultation, according to the guidelines of the *Global Initiative for Asthma* [15], at which time patients were invited to participate in the study and were evaluated by questionnaire data on demographics, anthropometrics, presence of comorbidities, smoking habits, and respiratory medication use.

The clinical diagnosis of asthma was based on respiratory symptoms consistent with asthma (recurrent episodes of wheezing, breathlessness, chronic cough, chest tightness, and medication use), and the functional diagnosis of asthma was performed through spirometry by the demonstration of variable airflow limitation (FEV_1 <80 % predicted and FEV_1/FVC <75 %; airflow obstruction that resolves or significantly improves after administration of an inhaled short-acting agonist, FEV_1 ≥12 % and ≥200 ml) [15].

The respiratory medications were evaluated in two steps: The first step (first consultation) considered that medication used in the past 3 months, and the second step (final consultation) assessed the medication that had gained control of the asthma. The medications studied were β2 agonist used by any route of administration (inhalation: short or long-acting, oral, and aerosol), inhaled corticosteroids (IC) alone or associated with inhaled β2 agonist (short or long-acting), oral corticosteroids (OC), theophylline, inhaled anticholinergics, and any other respiratory medication reported by the patient.

The respiratory medications were categorized into two groups: the bronchodilator group (BD), i.e., β2 agonist (inhaled: short or long-acting, oral, and aerosol), inhaled anticholinergic and theophylline; and the corticosteroid group (CORT), i.e., IC, OC, and systemic. Patients who were using long-acting β2 agonists+IC in the same device were considered participants in both groups.

Asthma control was based on the presence of clinical symptoms (daytime and nighttime symptoms, worsening of limitation of daily activities, need for rescue medication, and exacerbations) and functional evaluation (FEV_1%) [15]. Asthma was defined as controlled when there was as absence of the clinical symptoms and use of rescue medication (short-acting β_2 agonist) in the last 15 days, besides having normal or near normal pulmonary function; partly controlled asthma was diagnosed when the patient presented one or two of the characteristics described above, per week; and uncontrolled asthma was diagnosed by the presence of three or more of these characteristics and/or exacerbation of a crisis. Clinical guidance and control was conducted for respiratory allergens, smoking, drugs, and diseases that trigger bronchospasm.

The measurement of FEV_1 used in the classification of severity and level of asthma control [15] was performed with a computerized spirometer (Microlab-3500; Cardinal Health UK 232 Ltd., UK), with results expressed as a percentage of the predicted [16].

In the first step, after clinical and functional evaluation, respiratory medications were prescribed according to the classification of asthma severity and adjusted to obtain outpatient asthma control [15], at which time the patients were released for bariatric surgery and instructed to maintain the respiratory medications in use.

Asthmatics classified as intermittent and controlled were released for bariatric surgery at the first consultation. Patients with mildly persistent and partly controlled or uncontrolled asthma were initially treated with IC (budesonide, 200 mcg) twice daily and a short-acting β2 agonist as a rescue medication; patients with moderately or severely persistent and partly controlled or uncontrolled asthma were treated with long-acting β2 agonist (formoterol, 12 mcg) associated with IC (budesonide, 400 mcg) two times a day, and advised to use a short-acting β2 agonist as a rescue medication [15].

Statistical analysis was performed using the software Statistical Package for Social Sciences, version 15.0 (SPSS Inc., Chicago, IL, USA). The results were expressed as number of cases (proportion), mean, and standard deviation. The calculation of 95 % CI for severity, level of asthma control, and the time required for asthma control between steps was conducted. A comparison between continuous variables was performed using the paired Student's *t* test. We used one-way ANOVA to compare asthma severity

(intermittent, mildly persistent, moderately persistent, and severely persistent) with the time required for asthma control between steps. The level of statistical significance was $p<0.05$.

Results

Among the 466 obese patients evaluated in prebariatric surgery, 92 were asthmatics (19.7 %); however, four were excluded (4.3 %) (two did not return for asthma control, and two had associated chronic obstructive pulmonary disease). Therefore, 88 patients were selected for this research.

Table 1 shows the general characteristics of the study population. There was a predominance of female (73.8 %), skin color (69.3 %; white), and nonsmokers (65.9 %), and among the comorbidities, there was a predominance of arterial hypertension (57.9 %), musculoskeletal disease (59.1 %), anxiety (59.1 %), obstructive sleep apnea–hypopnea syndrome (50 %), and patients reporting dyspnea on ordinary exertion (82.9 %). The mean BMI was 41.13±5.1 kg/m^2 (variation, 35.06–60.18 kg/m^2), 32 (36.4 %) patients with BMI between 35 and 40 kg/m^2 (variation, 35.06–39.9 kg/m^2), and 56 (63.6 %) patients with BMI ≥40 kg/m^2 (variation, 40.06–60.18 kg/m^2). The mean values of FEV_1 pre- and postbronchodilator were 79.76±14.09 and 84.01±13.46, respectively.

Table 1 General characteristics of the 88 obese asthmatics in the study

Variables	Results
Female gender[a]	65 (73.8)
Age[b] (years)	36.97±8.9
White race[a]	61 (69.3)
Height[b] (m)	1.63±0.08
Current weight[b] (kg)	110.82±18.14
BMI[b] (kg/m^2)	41.13±5.1
Dyspnea[a]	73 (82.9)
Smoking[a]	
Nonsmoker	58 (65.9)
Former smoker	25 (28.4)
Current smoker	5 (5.6)
Arterial hypertension[a]	51 (57.9)
Diabetes[a]	24 (27.2)
Musculoskeletal disorder[a]	52 (59.1)
Anxiety[a]	52 (59.1)
Depression[a]	19 (21.5)
OSAHS[a]	44 (50)
Other comorbidities[a]	27 (30.6)
Chronic rhinitis[a]	21 (23.8)
GERD[a]	17 (19.3)
Pre-BD[b] (FEV_1)	79.76±14.09
Post-BD[b] (FEV_1)	84.01±13.46

BMI body mass index; *OSAHS* obstructive sleep apnea–hypopnea syndrome; *GERD* gastroesophageal reflux disease; *Other comorbidities* hypothyroidism, coronary insufficiency, dyslipidemia, hepatic steatosis; *FEV_1* forced expiratory volume 1 s; Pre- and postbronchodilator values for FEV_1; *BD* bronchodilator

[a] Values expressed as *n* (%)

[b] Values expressed as mean±SD

Table 2 shows the severity and level of control for the asthmatics studied. We classified 38 obese patients as having intermittent asthma (43.2 %; 95 % CI, 32.8–53.5), 22 with mildly persistent asthma (25.0 %; 95 % CI, 16.0–34.0), 24 with moderately persistent asthma (27.3 %; 95 % CI, 18.0–36.6), and 4 with severely persistent asthma (4.5 %; 95 % CI, 0.2–8.9). As for the level of asthma control, 43 patients were controlled (48.9 %; 95 % CI, 43.75–54.04), 31 partly controlled (35.2 %; 95 % CI, 30.28–40.11), and 14 uncontrolled (15.9 %; 95 % CI, 12.13–19.66).

Figure 1a–c describes and specify the respiratory medications used by the 88 patients at each step and compares the two categories of medications.

In the first step, 30 (34.0 %) patients used one or more BD alone as their asthma medication (inhaled short or long-acting β2 agonist, aerosol, oral, theophylline, and anticholinergics), 11 (12.5 %) patients used IC+long-acting β2 agonist, 3 (3.4 %) used IC+short-acting β2 agonist, 2 (2.2 %) used OC associated with short-acting β2 agonist, and 1 (1.1 %) patient used OC+IC+long-acting β2 agonist. In the second step, 24 (27.2 %) patients used IC alone, and 28 (31.8 %) patients used IC+long-acting β2 agonist in the same device (Fig. 1a).

The quantities of medications used per patient in the first step, by category, are specified in Fig. 1b, showing that 41 patients (46.6 %) did not use any respiratory medication, 47 (53.4 %) used one or more bronchodilators, and 17 (19.3 %) used one or more corticosteroids. Thirty-nine patients (44.3 %) used only one bronchodilator, three (3.4 %) used

Table 2 Severity and level of asthma control in the study population

Variables	Results	95 % CI
Severity of asthma[a–c]		
Intermittent	38 (43.2)	32.8–53.5
Mildly persistent	22 (25.0)	16.0–34.0
Moderately persistent	24 (27.3)	18.0–36.6
Severely persistent	4 (4.5)	0.2–8.9
Levels of asthma control[a–c]		
Controlled	43 (48.9)	43.75–54.04
Partly controlled	31 (35.2)	30.28–40.11
Uncontrolled	14 (15.9)	12.13–19.66

[a] Values expressed as *n* (%)

[b] Classification of *Global Initiative for Asthma*

[c] 95 % CI confidence interval

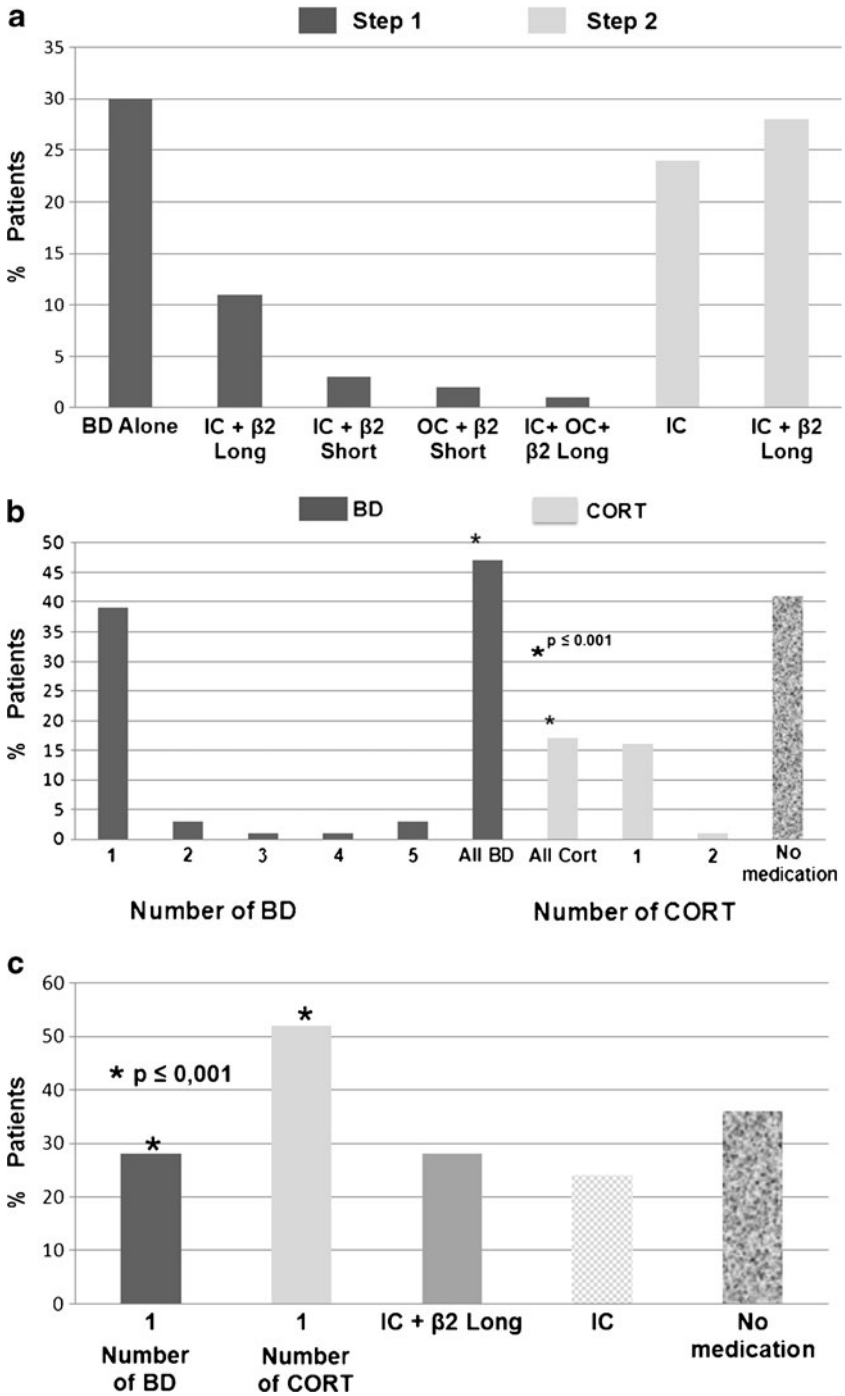

Fig. 1 **a** Describes the respiratory medications used by 88 patients in the first and second steps. *BD alone* β2 agonist (oral, aerosol, short- and long-acting), theophylline and anticholinergics; *IC* inhaled corticosteroids; *β2 long* long-acting bronchodilator; *β2 short* short-acting bronchodilator; *IC + β2 long* inhaled corticosteroids and long-acting bronchodilator used in the same device; *IC+ β2 short* inhaled corticosteroids and short-acting bronchodilator (rescue medication) in separate devices; *OC* oral corticosteroids. Values expressed as *n* (%). **b** Describes and compares the number of respiratory medications used per patient, by category of medication, in the first step of the 88 study patients. *BD* bronchodilators, *CORT* corticosteroids, *Total BD* sum of all bronchodilators. *Total CORT* sum of all corticosteroids, *No med* no respiratory medication. Values expressed as n (%). *$p \leq$ 0.0001, comparison of the mean BD versus CORT, per patient, Student's *t* test. **c** Describes and compares the respiratory medications used per patient in the second step, by category. *No med* no respiratory medication, *IC* inhaled corticosteroids, *β2 long* long-acting bronchodilator, *IC+ β2 long* inhaled corticosteroids and long-acting bronchodilator used in the same device. Values expressed as *n* (%). *$p \leq 0.0001$, comparison of the mean BD versus CORT, per patient, Student's *t* test

five bronchodilators, three (3.4 %) used two bronchodilators, one (1.1 %) used three bronchodilators, and one (1.1 %) used four bronchodilators. As for corticosteroids, 16 patients (18.1 %) used one corticosteroid (IC), and one patient (1.13 %) used 2 corticosteroids (IC+OC). The mean use of bronchodilators and corticosteroids per patient was 0.76±1.07 and 0.19±0.47, respectively, with a significant increase in bronchodilators ($p \leq 0.0001$).

Figure 1c shows the respiratory medications used per patient in the second step, by category, demonstrating that 36 patients (40.9 %) did not use any respiratory medication, 28 (31.8 %) used one bronchodilator (long-acting β2 agonist) and 52 (59.1 %) used one corticosteroid (IC), and of these, 24 patients (27.2 %) used IC alone, and 28 patients (31.8 %) used IC+long-acting β2 agonist in the same device. Short-acting β2 agonists (rescue medication) for relief of symptoms were not being used by any patient during the

last 15 days. The mean use of bronchodilators and corticosteroids per patient were 0.28±0.45 and 0.59±0.49, respectively, with a significant increase in corticosteroids ($p \leq 0.0001$).

Table 3 shows comparisons of the means of the respiratory medications used between steps in the sample total of 88 patients (by category) and in the restricted sample of patients who had used any respiratory medication during the first and second steps, 47 (53.4 %) and 52 (59.09 %) patients, respectively. In the sample total, the mean between all bronchodilators (0.76±1.07 vs. 0.28±0.45) and all corticosteroids (0.19±0.47 vs. 0.59±0.49) per patient showed significant differences between both categories of medications, with a reduction in bronchodilators and an increase in corticosteroids in the second step ($p \leq 0.0001$). The restricted sample showed a significant reduction in bronchodilators (1.43±1.09 vs. 0.52±0.50) and a significant increase in corticosteroids (0.38±0.61 vs. 1.00±0.00) in the second step ($p \leq 0.0001$). We also observed a significant increase in the use of IC alone (0.06±0.24 vs. 0.46±0.50) and of IC+ long-acting β2 in the same device (0.23±0.42 vs. 0.54± 0.50), ($p \leq 0.0001$).

Figure 2 shows that the mean time (days) required for asthma control between steps was 28.98±33.40 days (95 % CI, 21.90–36.06; range, 0–120 days) in our study sample. For intermittent asthma, the patients had their asthma controlled and were released for bariatric surgery on the same day of the initial evaluation. For mildly persistent asthma, the mean time was 36.14±24.78 days (95 % CI, 25.15–47.12; range, 0–90 days), for moderately persistent 58.13±24.75 days (95 % CI, 47.67–68.58; range, 30–120 days), and for severely persistent 90±24.49 days (95 % CI, 51.02–128.98; range, 60–120 days), with significant differences in the comparison of intermittent group versus persistent (mild, moderate, and severe; $p \leq 0.0001$), mildly persistent versus moderately and severely persistent ($p \leq 0.001$ and $p \leq 0.0001$, respectively) and moderately versus severely persistent ($p \leq 0.01$).

Table 3 Comparison of mean respiratory medications between steps, per patient, sample total, and restricted sample

Variables	1[a] step	2[a] Step	*p* value
Sample total	*n*=88	*n*=88	
Bronchodilator	0.76±1.07	0.28±0.45	≤0.0001
Corticosteroids	0.19±0.47	0.59±0.49	≤0.0001
Restricted sample	*n*=47	*n*=52	
Bronchodilator	1.43±1.09	0.52±0.50	≤0.0001
Corticosteroids	0.38±0.61	1.00±0.00	≤0.0001
IC	0.06±0.24	0.46±0.50	≤0.0001
IC+β2 long	0.23±0.42	0.54±0.50	≤0.0001

Sample total: all 88 patients in the study; restricted sample: only those patients that used any respiratory medication in the first (*n*=47) and second (*n*=52) steps. Values expressed as mean±SD, Student's *t* test

IC inhaled corticosteroids, *β2 long* long-acting bronchodilator, *IC+ β2 long* used the same device

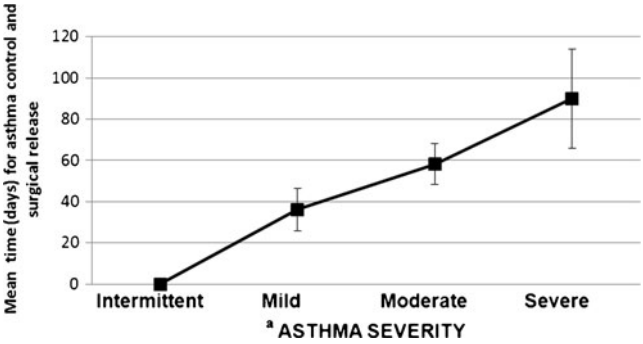

Fig. 2 Mean time (days) for asthma control and release for bariatric surgery, between steps, according to asthma severity. Values expressed as mean±SD and 95 % CI. *Superscripted a* Classification of Global Initiative for Asthma. Test ANOVA one-way. Significant differences between intermittent and persistent groups (mild, moderate, and severe; $p \leq 0.0001$), mildly persistent versus moderately and severely persistent ($p \leq 0.001$ and $p \leq 0.0001$, respectively), and moderately persistent versus severely persistent ($p \leq 0.01$)

Discussion

Our results showed that the majority of obese individuals with asthma in prebariatric surgery have uncontrolled asthma, requiring better therapeutic control to safely perform their surgery and that the severity of their asthma influences the time required to achieve this control.

Previous studies have evaluated the severity, pulmonary function, and respiratory medication use before and after bariatric surgery in obese patients with asthma, showing improvement in these parameters after surgery [12, 13, 17–19]. However, our study is the first to prioritize the evaluation of obese asthmatics in two preoperative steps, defining the asthma's severity, level of control and respiratory medication needed, based on guidelines and preoperatively determining the time required for asthma control.

Physicians specialized in respiratory diseases agree that the classification of asthma severity has as main function to guide the appropriate dose of medications for the patient to achieve and maintain asthma control in the shortest possible time [9, 20].

In the population of obese asthmatics, the use of clinical and functional parameters to determine severity and level of asthma control has been scarce [12, 13, 19].

A previous study evaluating 67 obese asthmatics in prebariatric surgery demonstrated degrees of asthma severity similar to our present study [5]. Similarly, other studies involving the general population have estimated severely persistent asthma at 5–10 %, moderately persistent asthma at 25–30 %, and mildly persistent or intermittent asthma at 60 % [20].

Reddy et al. [19], in a retrospective study, showed reduction in severity and respiratory medications after bariatric surgery in obese patients with asthma; however, the classification of asthma severity was defined solely by the use of medications preoperatively and postoperatively.

In the first step of our study, although most patients had persistent asthma (56.8 %) that is not controlled, 51.1 % primarily used bronchodilators in contrast to a reduced use of IC, including 30 patients (34.0 %) that used bronchodilators alone as the standard asthma treatment, which characterizes a therapeutic error [9, 20]. Currently, bronchodilators are used to control asthma symptoms during periods of exacerbations and for assisting IC in the control when these are insufficient [9].

Although in recent decades asthma has been characterized as a chronic inflammatory disease, and the anti-inflammatory treatment prioritized with inhalatory corticotherapy for control and prevention of exacerbations [9, 20], there persists even today among lay people and some doctors, who are not specialized in respiratory diseases, the old misconception of bronchospasm as the main asthma pathophysiological alteration and the exclusive use of bronchodilators as the main therapeutic approach. This mistaken therapeutic procedure, observed in our patients prior to the first consultation, explains the lack of asthma control in most obese individuals with asthma in the first step, since, after adequate therapeutic orientation in reference to asthma severity and use of IC as a standard medication for this treatment, asthma control was achieved in all patients, thus reducing the use of bronchodilators and even eliminating the use of OC in three patients.

The time required for asthma control was relatively short, even in moderately and severely persistent asthma. Assessments and guidance conducted preoperatively by a specialist in respiratory diseases—valuing and explaining the proper technique of using inhalers, treating comorbidities such as smoking, gastroesophageal reflux, and rhinosinusitis, removing anti-inflammatory and antihypertensive drugs triggering bronchospasm, and avoiding exposure to environmental pollutants —contribute to asthma control. Furthermore, we observed a good treatment adherence in this population of asthmatics, which may be explained by the previous psychological and organic distress caused by their obesity, associated with the failure of prior clinical treatments and the need to achieve asthma control for the surgical treatment of their obesity.

Some obstacles in our study should be cited. Limitation of regular physical activity is a variable that influences the classification of severity and level of asthma control. Morbidly obese patients, even in the absence of pulmonary pathologies, may have limited physical activity, explained by the excess weight. To avoid errors in diagnosis, we consider the worsening of physical activity when associated with other respiratory symptoms (wheezing and chronic cough) in recent weeks. We restrict our research to preoperative evaluation to obtain control and stabilization of the asthma, not going into the merits of a discussion about the respiratory orientation and hospital monitoring of our patients, making it necessary that future research be designed for this purpose.

Our study draws attention to an issue not previously discussed in the literature, showing that obese asthmatics, when properly instructed by a medical specialist in respiratory diseases who uses respiratory medications based on guidelines and who considers the clinical and functional parameters, do not have difficulty in quickly gaining control of their asthma.

In conclusion, in prebariatric surgery, we observed a higher proportion of intermittent and uncontrolled asthma, with the asthma severity influencing the achievement of asthma control and the time required to release the patient for surgery.

Financial Support None

Conflict of Interest None

References

1. World Health Organization. Obesity and overweight. Geneva: World Health Organization. http://www.who.int/mediacentre/factsheets/fs311/en/index.html. Accessed 2010.
2. Ballantyne GH, Svahn J, Capella RF, et al. Predictors of prolonged hospital stay following open and laparoscopic gastric bypass for morbid obesity: body mass index, length of surgery, sleep apnea, asthma, and the metabolic syndrome. Obes Surg. 2004;14(8):1042–50.
3. Cendán JC, Abu-aouf D, Gabrielli A, et al. Utilization of intensive care resources in bariatric surgery. Obes Surg. 2005;15(9):1247–51.
4. Pieracci FM, Barie PS, Pomp A. Critical care of the bariatric patient. Crit Care Med. 2006;34(6):1796–804.
5. Melo SM, Melo VA, Menezes Filho RS, et al. Prevalence and severity of asthma in obese adult candidates for bariatric surgery. J Bras Pneumol. 2011;37(3):326–33.
6. Eldar S, Heneghan HM, Brethauer S, et al. A focus on surgical preoperative evaluation of the bariatric patient—the Cleveland Clinic protocol and review of the literature. Surgeon. 2011;9(5):273–7.
7. Konrad FM, Kramer KM, Schroeder TH, et al. Anesthesia and bariatric surgery. Anaesthesist. 2011;60(7):607–16.
8. Varon J, Marik P. Management of the obese critically ill patient. Crit Care Clin. 2001;17(1):187–200.
9. Global Initiative for Asthma—GINA. Bethesda: Global Initiative for Asthma. http://www.ginasthma.org/uploads/users/files/GINA_Report_2011. Accessed 22 Jan 2012
10. Lessard A, Turcotte H, Cormier Y, et al. Obesity and asthma: a specific phenotype? Chest. 2008;134(2):317–23.
11. Dixon AE, Pratley RE, Forgione PM, et al. Effects of obesity and bariatric surgery on airway hyperresponsiveness, asthma control, and inflammation. J Allergy Clin Immunol. 2011;128(3):508–15.

12. Crémieux PY, Ledoux S, Clerici C, et al. The impact of bariatric surgery on comorbidities and medication use among obese patients. Obes Surg. 2010;20(7):861–70.
13. Sikka N, Wegienka G, Havstad S, et al. Respiratory medication prescriptions before and after bariatric surgery. Ann Allergy Asthma Immunol. 2010;104(4):326–30.
14. Ministry of Health. Obesity. Brasília. http://portal.saude.gov.br/portal/aplicacoes/reportagensEspeciais/default.cfm?pg=dspDetalhes&id_area=124&CO_NOTICIA=10078. Accessed 2010.
15. Global Initiative for Asthma—GINA. Bethesda: Global Initiative for Asthma. www.ginasthma.com. Accessed 27 Sept 2006.
16. Hankinson JL, Odencrantz JR, Fedan KB. Spirometric reference values from a sample of the general U.S. population. Am J Respir Crit Care Med. 1999;159(1):179–87.
17. Dixon JB, Chapman L, O'Brien P. Marked improvement in asthma after Lap-Band surgery for morbid obesity. Obes Surg. 1999;9(4):385–9.
18. Santana AN, Souza R, Martins AP, et al. The effect of massive weight loss on pulmonary function of morbid obese patients. Respir Med. 2006;100(6):1100–4.
19. Reddy RC, Baptist AP, Fan Z, et al. The effects of bariatric surgery on asthma severity. Obes Surg. 2011;21(2):200–6.
20. (2006) IV Brazilian Guidelines for the management of asthma. J Bras Pneumol 32(Suppl 7):447–474