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Value of routine polysomnography in bariatric surgery

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Abstract
Background Obstructive sleep apnea (OSA), present in 60–70 % of bariatric surgery patients, is a potentially life-threatening condition when not detected and managed appropriately. The best available method to identify the severity of OSA is polysomnography. However, routine polysomnography measurements have not been accepted as standard modality in bariatric surgery. We report our experience with routine polysomnography in a cohort of patients undergoing bariatric surgery to determine the true prevalence of OSA with respect to the different severity levels as determined by the apnea–hypopnea index (AHI).
Methods AHI data were retrospectively collected from all patients who underwent bariatric surgery from 2012 onward, when the performance of preoperative polysomnography became mandatory. Mild, moderate and severe OSA were defined as an AHI ≥5, ≥15 and ≥30/h, respectively. Prevalence and number needed to screen (NNS) were calculated for all OSA severity levels.
Results A total of 1358 patients were included. OSA was detected in 813 (59.9 %; NNS: 2) patients. Moreover, 405 (29.8 %; NNS: 4) patients were diagnosed with an AHI ≥15/h and 213 (15.7 %; NNS: 7) with severe OSA (AHI ≥30/h). Extreme AHI thresholds of ≥60 and ≥90/h were detected in 79 (5.8 %; NNS: 18) and 17 (1.3 %; NNS: 77) patients, respectively.
Conclusion One-third of the bariatric surgery patients have an AHI ≥15/h and would benefit from continuous positive airway pressure therapy. In order to increase perioperative safety and avoid the preventable risk of perioperative complications, we recommend mandatory P(S)G prior to bariatric surgery.

Keywords Bariatric surgery · Gastric bypass · Obstructive sleep apnea · Continuous positive airway pressure

Abbreviations

AHI	Apnea–hypopnea index
BMI	Body mass index
CPAP	Continuous positive airway pressure
CV	Cardiovascular
IFSO	International Federation for the Surgery of Obesity and Metabolic Disorders
LRYGB	Laparoscopic Roux-en-Y gastric bypass
LSG	Laparoscopic sleeve gastrectomy
NNS	Number needed to screen
OSA	Obstructive sleep apnea
PG	Polygraphy
PSG	Polysomnography

Obstructive sleep apnea (OSA), the most common form of sleep apnea caused by repetitive upper airway obstruction, occurs in 2–4 % of the general population [1]. Older age, male gender and obesity predispose to OSA. In 60–70 % of

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individuals with a body mass index (BMI) greater than 35 kg/m^2, OSA is present [2, 3]. Accompanying symptoms include sleepiness (increasing the risk of traffic accidents), weariness and neurocognitive disorders. Untreated OSA is associated with long-term cardiovascular (CV), pulmonary and neurovascular risks such as hypertension, myocardial infarction, respiratory failure and death [4–6]. Additionally, two recent meta-analyses showed that OSA patients developed more cardiac events, respiratory failure and desaturations postsurgery [7, 8].

Identifying OSA is difficult as clinical symptoms, medical history and standardized questionnaires, either combined with or without neck circumference or BMI, have failed to determine the presence of OSA accurately [3, 9]. Polysomnography (PSG), measuring the frequency and duration of periods of apneas and hypopneas during a full night and subsequent interpretation of collected data, generates the apnea–hypopnea index (AHI), also known as the number of pharyngeal collapses per hour during sleep. In some clinics, this requires admission to the hospital and specific equipment and hence is time consuming and costly.

Increasing the pressure in the upper airway to prevent its collapse is the essence of managing OSA. The employment of continuous positive airway pressure (CPAP) devices has significantly reduced OSA associated mortality rates in large cohorts of individuals [6].

OSA is an important risk of perioperative complications in morbidly obese patients undergoing surgeries requiring general anesthesia [4]. We report our experience with routine clinical and ambulatory PSG and ambulant polygraphy (PG) in a cohort of patients undergoing bariatric surgery to determine the true prevalence of OSA with respect to the different severity levels as determined by the AHI and to evaluate whether this protocol is necessary to increase perioperative safety.

Materials and methods

Study design and population

All patients who underwent bariatric surgery met the International Federation for the Surgery of Obesity and Metabolic Disorders criteria for bariatric surgery and were consecutively entered in a database. From 2012 onward, the performance of P(S)G prior to bariatric surgery became mandatory. Therefore, all bariatric surgery patients were considered eligible since 2012. Patients who underwent either a laparoscopic Roux-en-Y gastric bypass (LRYGB) or laparoscopic sleeve gastrectomy (LSG) were included. Both primary and revisional procedures were included. P(S)G and bariatric surgical procedures were performed as previously described [3, 10].

Data on AHI were retrospectively collected from patient medical records and registered in an anonymous database. According to the international guidelines, OSA is diagnosed when the AHI is $\geq$5/h, moderate OSA is defined as an AHI $\geq$15/h, and severe OSA is present when AHI $\geq$30/h. The prevalences of AHI $\geq$60 and $\geq$90/h were also given in order to illustrate the severity and risk of some bariatric surgery patients.

Patients were referred to a pulmonologist for CPAP therapy when indicated. Indications were mostly an AHI $\geq$15/h, severe clinical symptoms or high AHIs in supine position. CPAP was prescribed in the preoperative period, and patients were asked to bring their CPAP mask and machine during admission. Prior to surgery, all patients were evaluated by an anesthesiologist, who decided whether patients required postoperative ICU admission. In most cases, this was decided when the AHI was greater than 30/h.

The institutional review board provided approval for this study. Informed consent was not necessary for this retrospective study design.

Statistical analysis

The number of patients with an AHI $\geq$5, 15, 30, 60 and 90 was calculated. The number of patients that should undergo preoperative sleep registration to detect these AHIs was calculated with the following formula: 100/(% of patients with an AHI $\geq$5, 15, 30, 60 or 90/h) and expressed as round number (i.e., 3.4 is rounded up to four). As the revisional surgery group is known to have lower preoperative BMIs, and therefore lower AHIs, the analyses were performed for the total study population, the primary surgery group and the revisional surgery group. Secondly, the number of CV, pulmonary and neurovascular complications were registered and compared between OSA severity groups, according to international definitions, i.e., AHI 0–5, 5–15, 15–30/h and $\geq$30/h.

Results

Study population

From January 2012 to October 2015, a total of 1417 patients underwent a LRYGB or LSG.

The preoperative AHI was missing in 59 patients due to several reasons (operation in 2012 ($n = 30$), P(S)G (and treatment) elsewhere ($n = 26$)) or other reasons ($n = 3$). Consequently, the AHI was available in 1358 (95.8 %) patients who were therefore included.

Primary surgery was performed in 1154 (85 %) patients, of which 1069 (78.7 %) patients underwent a primary

LRYGB and 85(6.3 %) a primary LSG. Consequently, 204 (15 %) patients underwent revisional surgery, mostly from laparoscopic adjustable gastric banding (LAGB) into LRYGB ($n = 183$; 89.7 %). Other procedures were LAGB to LSG ($n = 10$; 0.7 %), LAGB to LSG ($n = 8$; 0.6 %) or LRYGB revisions such as pouch revision ($n = 3$; 0.2 %). The study population consisted of 1126 (82.9 %) women and 232 (17.1 %) men. The mean age was 44.4 years (SD 10.8); mean BMI was 44.1 kg/m^2 (SD 6.4). The median AHI of the entire study population was 7.0/h (interquartile range 16.4).

Prevalence OSA

The numbers of patients with an AHI ≥5, ≥15, ≥30, ≥60 or ≥90/h are displayed in Table 1. The number of bariatric surgery patients that should undergo sleep registration to detect these AHI severity levels is shown in Table 2.

A total of 410 patients (30.2 %) received CPAP therapy ($n = 406$) or mandibular repositioning Appliance ($n = 4$), and 280 patients (20.6 %) were admitted to the ICU during the first night after surgery.

Postoperative complications

CV, pulmonary and neurovascular complications occurred in 31 patients (2.3 %) in the 30-day postoperative period. Out of these 31 patients, 16 were in combination with a surgical complication, i.e., anastomotic leakage, bleeding, stenosis or perforation. AHI class had no effect on this occurrence (Table 3).

Death occurred in four patients (0.3 %) due to surgical causes: asystole due to abdominal sepsis after anastomotic leakage ($n = 1$; AHI 50/h); subarachnoid hemorrhage after persistent anastomotic leakage ($n = 1$; AHI 8.1/h); ventricular fibrillation after anastomotic leakage ($n = 1$; AHI 23.5/h); cardiac tamponade due to iatrogenic injury during surgery ($n = 1$; AHI 23/h). There was no OSA-related mortality.

Discussion

OSA is a potentially life-threatening condition when not detected and managed appropriately. In current cohort, all patients underwent mandatory OSA screening prior to surgery. Although postoperative cardiovascular, neurovascular and pulmonary complications were found in current cohort, no significant difference was detected between OSA severity groups. As OSA has shown to be a significant risk factor for postoperative cardiac events and respiratory failure in literature [7, 8], this suggests that early recognition and adequate treatment is successful in decreasing OSA-related complications.

The best available method to identify the severity of OSA is PSG. However, routine PSG measurements in obese patients undergoing bariatric surgery have not been accepted as standard modality. In our study of 1358

Table 1 Number of patients with AHI ≥5, 15, 30, 60 and 90

Variable	Total study group ($n = 1358$)	Primary surgery group ($n = 1154$)	Revisional surgery group ($n = 204$)
AHI ≥5/h; *n* (%)	813 (59.9)	711 (61.6)	102 (50)
AHI ≥15/h; *n* (%)	405 (29.8)	365 (31.6)	40 (19.6)
AHI ≥30/h; *n* (%)	213 (15.7)	193 (16.7)	20 (9.8)
AHI ≥60/h; *n* (%)	79 (5.8)	71 (6.2)	8 (3.9)
AHI ≥90/h; *n* (%)	17 (1.3)	15 (1.3)	2 (1)

AHI Apnea–hypopnea index

Table 2 Number of bariatric surgery patients that should undergo sleep registration to detect an AHI ≥5, 15, 30, 60 and 90

Variable	Total study group ($n = 1358$)	Primary surgery group ($n = 1154$)	Revisional surgery group ($n = 204$)
AHI ≥5/h	2	2	2
AHI ≥15/h	4	4	6
AHI ≥30/h	7	6	11
AHI ≥60/h	18	17	26
AHI ≥90/h	77	77	100

AHI Apnea–hypopnea index

Table 3 Cardiovascular, pulmonary and neurological complications in the 30-day postoperative period

Variable	Complication within 30 days	
	No ($n = 1327$)	Yes ($n = 31$)
AHI 0–5/h; (%)	534 (40.2)	11 (35.5)
AHI 5–15/h; (%)	401 (30.2)	7 (22.6)
AHI 15–30/h; (%)	185 (13.9)	7 (22.6)
AHI ≥30/h; (%)	207 (15.6)	6 (19.4)

AHI Apnea–hypopnea index; $p = 0.452$

patients undergoing bariatric surgery, one-third of all patients had more than 15 apneas and hypopneas per hour when measured during P(S)G. These numbers are probably even higher as many patients underwent a PG instead of a PSG. A PG records the same parameters as a PSG except for the sleep architecture. Therefore, a PG measures the average AHI during a full night without differentiating between sleep and wake periods, whereas a PSG measures the average AHI only during sleep periods. As the AHI is zero when awake, patients who underwent a PG instead of a PSG might have an underreported AHI [10]. Although PG is less time consuming than PSG, mild OSA might be missed. However, the clinically more relevant moderate and severe OSA will still be detected. PG is therefore recommended as a less expensive but valuable alternative to PSG. Screening questionnaires should, however, be avoided as these have failed to diagnose OSA accurately [3, 9]. Although some questionnaires such as the STOP-BANG questionnaire can detect OSA patients, no questionnaire gives a sensitivity of 100 %. Additionally, we often see patients in our clinic without clinical symptoms who appear to have severe OSA during P(S)G. Unfortunately, we are not able to present these numbers as clinical symptoms were not documented consequently.

Discussion persists about the correlation between severity of OSA and perioperative risk in specific bariatric surgery patients [11]. In centers considering an AHI greater than 30 as a considerable risk, one out of seven sleep studies would detect one high-risk patient. Other centers adhering to a threshold of an AHI greater than 60, 18 sleep studies would yield one high-risk patient, while at a threshold of more than 90, 77 sleep studies would be required. In patients with very high AHI levels and poor CPAP compliance, admission to a clinical unit with continuous monitoring is recommended [4].

The number needed to screen is formally the number of patients that should be screened to prevent morbidity or mortality. Unfortunately, it is not possible to accurately determine the relationship between OSA and morbidity and mortality after bariatric surgery, as the presence of OSA has been poorly assessed in available bariatric studies [11]. Therefore, we used the AHI as parameter for determining the number needed to screen.

In conclusion, OSA is present in the majority of bariatric surgery patients. Moreover, one-third of the bariatric surgery patients have an AHI greater than 15/h and would benefit of CPAP therapy. In current study, no effect of OSA severity was seen on CV, pulmonary and neurovascular outcomes due to early recognition and adequate treatment of OSA. In order to increase perioperative safety and avoid the preventable risk of perioperative complications, we recommend mandatory P(S)G prior to bariatric surgery.

Compliance with ethical standards

Disclosures Prof. Dr. N. de Vries is a member of the Medical Advisory Board of NightBalance and has shares in Nightbalance. Prof. Dr. H. J. Bonjer receives personal fees from Olympus and grants from Johnson & Johnson, Applied Medical and Medtronic. Drs. C. A. L. de Raaff, Ms. A. S. Pierik, Drs. U. K. Coblijn and Dr. B. A. van Wagensveld declare that they have no conflicts of interest of financial ties to disclose.

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