Sleep apnoea in patients undergoing bariatric surgery

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ABSTRACT

INTRODUCTION: The objective of this study was to investigate the presence of obstructive sleep apnoea (OSA) among patients awaiting bariatric surgery and to evaluate if a change in symptoms and clinical measurements of OSA was seen one year after bariatric surgery.

METHODS: Patients awaiting bariatric surgery in the Region of Southern Denmark were invited to participate in an OSA examination during a 15-month period (2012-2013) using the Embletta device for cardiorespiratory monitoring before and one year after bariatric surgery. The Apnoea-Hypopnoea Index (AHI), weight, BMI and the Epworth Sleepiness Score (ESS) were measured prior to and one year after surgery.

RESULTS: A total of 56 patients were enrolled in the study, and 59% were found with OSA (AHI ≥ 5). Thirty-six patients were eligible for examination one year post-operatively. Twelve of these patients did not have OSA (AHI < 5) either at inclusion or at re-examination. In the remaining 24 patients with OSA, the BMI dropped from 44.4 prior to surgery to 30.8 kg/m^2 one year after surgery ($p < 0.01$). Mean AHI decreased from 12.8 prior to surgery to 3.7 one year after surgery ($p < 0.01$). There was no effect of weight reduction on the ESS.

CONCLUSIONS: A statistically significant reduction in AHI was seen in patients with OSA one year after surgery. No statistical differences were observed for ESS.

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Obstructive sleep apnoea (OSA) is a clinical condition characterised by obstruction of the upper airways following sleep-induced reduction of muscle tone, specifically in and around the tongue and pharynx. During the resulting apnoea, mounting hypoxaemia increases the inspiratory drive in the respiratory centre and eventually causes arousal. Although usually not fully awakened, the arousal deprives the patient suffering from OSA of both REM- and non-REM-sleep [1]. The OSA patient may gradually develop associated symptoms. Daytime sleepiness is frequently recognised and associated with an elevated risk of motor vehicle accidents. In severe cases, OSA may be complicated by hypertension, cardiovascular disease, stroke, decreased cognitive function and a diminished quality of life [2, 3].

OSA is graded by the Apnoea-Hypopnoea Index (AHI). AHI is the sum of apnoea and hypopnoea incidents during one hour of sleep. The severity of OSA is graded by the AHI into mild (5 ≤ AHI < 15), moderate (15 ≤ AHI < 30) or severe (30 ≤ AHI) [4]. Obesity is an important predisposing factor for OSA [5]. Studies report that the prevalence of OSA in patients undergoing bariatric surgery varies between 60% and 92% [6, 7]. In 46-58% of cases, the OSA can be classified as moderate to severe [6]. In Denmark, OSA is one of the criteria for performing bariatric surgery, but very few patients are actually referred to bariatric surgery for this reason.

The literature has shown that bariatric surgery has a significant effect on sleep apnoea, inducing resolution or improvement in the majority of cases [7-17]. Meta-analyses reported a decrease of AHI by 29 per hour following bariatric surgery in 525 subjects with a mean pre-intervention BMI of 51 [18]. Previous studies often show a high number of dropouts, which dropout generally exceeding 60% [7-17]. To the authors' knowledge, no Scandinavian studies have previously investigated the effect of bariatric surgery on sleep apnoea.

The aim of this study was to investigate the frequency of OSA among patients undergoing bariatric surgery and the effect of surgery on OSA in a group of Danish bariatric patients.

MATERIAL AND METHODS

Study design and setting

The study was cross sectional and prospective with systematic data collection from the Bariatric Surgery Clinic in the Region of Southern Denmark. In the 15-month period from March 2012 to June 2013, all patients awaiting bariatric surgery were invited to participate in the study. All invited participants fulfilled the Danish national guideline criteria for referral to bariatric surgery, which were: age > 25 years and BMI > 35 kg/m^2 plus at least one obesity-related complication or a BMI > 50 kg/m^2. All included patients had undertaken an 8% voluntary weight loss driven by dietary restriction in the course of a 3-6-month period before their surgery, as required by guidelines for patients subject to public payment.

ORIGINAL ARTICLE

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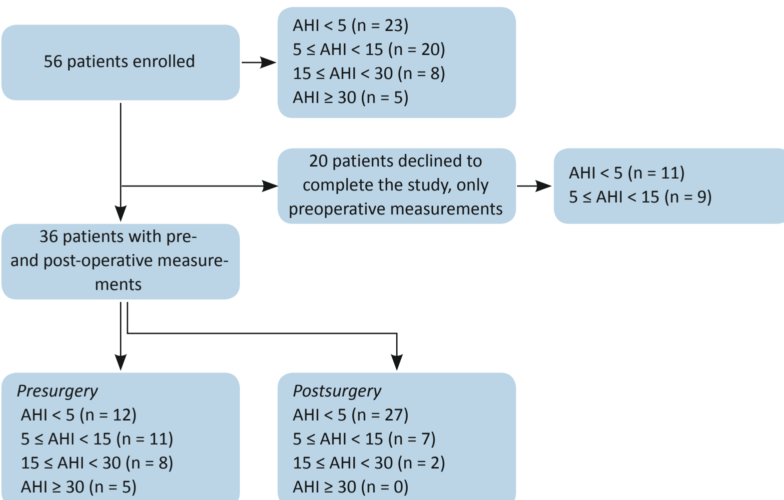
FIGURE 1

Flow chart of the enrolled subjects.



AHI = Apnoea-Hypopnoea Index.

Subjects who accepted to be enrolled in the study were screened for OSA by cardiorespiratory monitoring (CRM). CRM was performed prior to and one year after surgery. Patients with known facial deformity predisposing OSA, i.e. retrognathia, micrognathia, acromegaly and Down's syndrome were not included.

Cardiorespiratory measurements_

All patients were subjected to CRM using the Embletta home sleeping testing device. Measurements of peripheral desaturation, nasal airflow, abdominal and thoracic respiratory movements and snoring were obtained. All data were extracted from the algorithm in the Embletta device. An apnoea was registered when the amplitude dropped below 20% of the reference amplitude and was accompanied by a 4% drop in oxygen-saturation within 20 seconds. Hypopnoea was defined as a drop below 70% of the reference amplitude accompanied by a 4% drop in oxygen-saturation within 20 seconds. Peripheral desaturation events were defined as desaturations of at least 4% and the Oxygen Desaturation Index (ODI) as the number of desaturation events per hour. Pause of respiration was defined as a decrease in the amplitude of the thoracic and abdominal movements below 10% compared with the reference amplitude. The reference amplitude was the mean value of the amplitudes measured during the 240-second interval prior to the pause of respiration.

The Epworth Sleepiness Questionnaire (ESS) was used for subjective daytime sleepiness score [19]. Furthermore, weight and BMI were recorded.

Surgery

A Roux-en-Y gastric bypass (RYGB) was performed on all patients in the present series. RYGB surgery was performed at the public hospital of Southwest Jutland, Esbjerg, in the Region of Southern Denmark; all surgeries were performed by the same surgeon. The RYGB procedure involved creating a 20-ml gastric pouch, a 150-cm Roux-limb and a 60-cm biliopancreatic limb.

Statistical methods

In order to reach a level of significance of 5%, a total of 52 patients were needed based on a paired t-test (alpha 0.05, power 0.8) and a MIREDIF of 10 regarding AHI. Assuming that less than 10% would decline completing all examinations in the study, 58 patients had to be invited to participate in the study.

Data are reported as mean ± standard deviation (SD) or median and interquartile range (25-75 percentiles) as appropriate. A paired *t*-test or Wilcoxon's signed-rank test was used as appropriate, whereby each patient was considered his or her own control. A significant level of 0.05 was used.

Ethical standards

The Regional Ethical Committee (record number: S-20120004) assessed that the study was observational and non-notifiable. Data collection was approved by the local data protection agency, and the study was reported to ClinGov (ID: S-20120004jln).

Funding

This study was funded by "Fonden for Lægevidenskabelig Forskning m.v. ved sygehusene i Region Syd" and by the "Edith og Vagn Hedegaard Jensen fond".

Trial registration: ClinGov (ID: S-20120004jln).

RESULTS

A total of 56 patients who were candidates for bariatric surgery accepted to be enrolled in the study. Sixteen males and 40 females were included. Their mean age was 41.9 years (range: 24-57 years). The mean BMI at enrolment was 44.3 (SD = 4.4) kg/m². The distribution of AHI was as follows: 23 patients had AHI < 5; 20 patients had 5 ≤ AHI < 15; eight patients had 15 ≤ AHI < 30; five patients had AHI ≥ 30. Of 56 patients, 33 (59%) meet the definition of sleep apnoea (AHI ≥ 5). After the first measurement, 20 patients (36%) declined continuing the study and only presurgery CRM was obtained in these subjects.

In 36 patients, data from pre- and post-operative CRM were available. Differences between the group that completed the study versus the group that failed to obtain postsurgery CRM were evident regarding AHI.

Primarily, subjects who did not have OSA or had a mild grade of OSA were prone to opting out of the study (**Figure 1**). Among the 36 subjects who completed the study, 13 were males and 23 females, the mean age was 44.3 (SD = 8.9) years and the mean BMI was 44.4 (SD = 5.2) kg/m². Twelve of the 36 patients had an AHI < 5. The pre- to post-operative CRM results with focus on AHI, ODI and BMI are presented in **Table 1**. Patients with moderate and severe apnoea had the greatest AHI improvement. There was considerable variation in AHI and ODI among all patients.

Figure 1 shows the distribution of patients regarding OSA at enrolment among the 36 patients who completed the study. Twelve did not suffer from OSA. Eleven had mild OSA, eight had moderate and five had severe OSA. The corresponding numbers one year post-operatively were 27, seven, two and nobody, respectively (Figure 1).

The respiratory pattern regarding flow limitation and hypopnoea did not change significantly, whereas both the lowest and the mean oxygen saturation improved significantly (**Figure 2**). There was no effect of weight reduction on ESS because of pronounced overlap between the groups.

TABLE 1

Apnoea-Hypopnoea Index (AHI), oxygen desaturation index (ODI) and BMI before and 12 months after bariatric surgery in patients from Denmark. Data from presurgery values compared to postsurgery values are shown.

Investigated	Presurgery			Postsurgery			
modality	n	mean ± SD	median (R)	n	mean ± SD	median (R)	p-value
AHI							
AHI < 5	12	2.1 ± 1.2	2.3 (0-4)	12	2.1 ± 2.8	1.1 (0-9)	NS
AHI ≥ 5	24	18.2 ± 14.1	15.5 (5-65)	24	4.5 ± 4.9	2.5 (0-18)	< 0.01
Total	36	12.8 ± 13.8	7.0 (0-65)	36	3.7 ± 4.4	1.9 (0-18)	< 0.01
ODI							
AHI < 5	12	3.6 ± 3.3	3.5 (0-12)	11	1.7 ± 2.5	1.1 (0-9)	NS
AHI ≥ 5	23	25.9 ± 21.2	21.3 (4-95)	22	5.5 ± 5.6	3.3 (0-18)	< 0.01
Total	35	18.2 ± 20.3	11.3 (0-95)	33	4.3 ± 5.1	2.1 (0-18)	< 0.01
BMI							
AHI < 5	12	42.5 ± 4.3	41.2 (37-52)	12	30.6 ± 4.4	29.8 (25-41)	< 0.01
AHI ≥ 5	24	45.4 ± 5.4	43.5 (38-61)	24	30.9 ± 5.0	30.5 (23-42)	< 0.01
Total	36	44.4 ± 5.2	43.1 (37-61)	36	30.8 ± 4.8	30.1 (23-42)	< 0.01

AHI = Apnoea-Hypopnoea Index; ODI = Oxygen Desaturation Index; R = interquartile range: 25-75 percentiles; SD = standard deviation.

DISCUSSION

In the present series of bariatric patients who accepted investigation for OSA, 59% had OSA, which is slightly lower than reported in other studies, when a cut-off value of 5 for AHI is used to define sleep apnoea. This may be explained by the slightly lower mean preintervention BMI in our study [18]. Surprisingly, most patients only had slight or moderate sleep apnoea, and there were only few patients in the severe apnoea group. The age and gender in this material did not differ from observations in other studies [18]. The dropout rate was high, but lower than in previous studies [7-17]. In the present material, the dropout rate was 36% and most of the dropouts belonged to the group of patients with an AHI below five at enrolment. No other differences were seen between the groups.

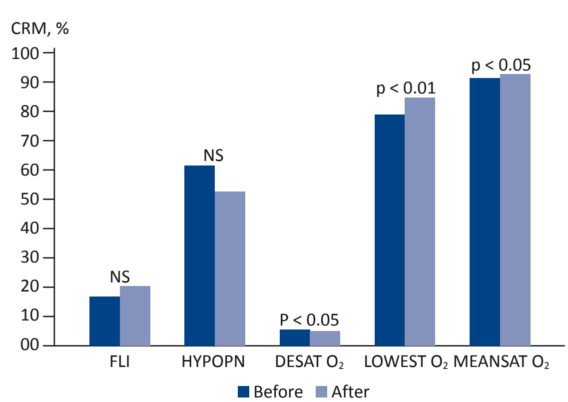
All patients had the same type of bariatric surgery from which they benefitted with substantial weight reduction and thereby lower BMI, which was accompanied by a corresponding reduction in AHI. Patients with an AHI below five at enrolment experienced no changes in their CRM registrations. These findings are well illustrated by the figures in Table 1.

In order to determine whether the improvement in AHI was associated with other changes in the respiratory pattern, we evaluated the flow limitation and the number of hypopnoea episodes. These parameters showed no significant changes, but the Oxygen Desaturation Index, lowest saturation, as well as the mean saturation improved significantly. It therefore seems possible that the weight reduction induces the most pronounced effect on the apnoea and not a sliding of the respiratory pattern towards more hypopnoea or flow limitation.

In the present study, the ESS showed no response to weight reduction and the accompanied reduction in AHI. ESS is a widely used tool in screening for OSA [20], and previous studies have documented a significant reduction in ESS after bariatric surgery [12-16]. In our study, the frequency and severity of OSA were lower

FIGURE 2

Respiratory pattern before and 12 months after bariatric surgery in patients from Denmark.



CRM = cardiorespiratory monitoring; DESAT O_2 = average O_2 desaturation; FLI = flow limitation index: breaths with flow limitation in percent of all breaths; HYPOPN = hypopnoea: sum of total apnoea and hypopnoea; lowest O_2 = lowest O_2 saturation observed during CRM measurement; MEANSAT O_2 = mean O_2 saturation observed during CRM measurement; NS = non-significant.

than those reported by previous studies. It could be speculated that the ESS is more sensitive when symptoms are more severe. A recent meta-analysis found the ESS to have the lowest sensitivity among other questionnaires when detecting OSA. However, compared with other questionnaires, the ESS showed the highest specificity [20]. This might explain the results observed in the present study.

CONCLUSIONS

There was a high and previously unrecognised frequency of OSA among Danish patients awaiting bariatric surgery. With a ensuing substantial reduction of BMI, bariatric surgery has a pronounced effect on AHI in the group of patients with OSA before surgery and the effect builds with increasing OSA severity.

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