doubt, should they be offered to non-obese diabetics. Laparoscopic Sleeve gastrectomy is a reasonable option for metabolic surgery. More complex procedures have a higher rate of complications and should be done only as a part of controlled clinical trials.

Metabolic surgery is an exciting area, which is likely to have far reaching consequences on the treatment of Type II Diabetes Mellitus in future. However a scientific and cautious approach is required from the surgical community to avoid any mishaps, which could lead to premature death of this extremely promising treatment option.

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Bariatric Surgery for Treatment of Obstructive Sleep Apnea

Hemanga Bhattacharjee, Sandeep Aggarwal

Department of Surgical Disciplines, AIIMS, New Delhi

***Abstract**: Morbidly obese patients have a high prevalence of obstructive sleep apnea (OSA). Besides excellent weight loss, Bariatric surgery leads to significant impact on OSA. A majority of patients are off the continuous positive pressure (CPAP) machine within few weeks of the surgery. Reduction of fat around the neck leads to decrease in pressure on upper airways and breathing apparatus. Bariatric surgery also leads to improvement of inflammatory status which also is a factor leading to improvement in OSA after surgery. Bariatric surgery should be offered as treatment for OSA in patients with a body mass index (BMI) > 35 Kg/m^2. It can also be considered in patients with BMI between 30-35 Kg/m^2 and OSA.*

INTRODUCTION

Obstructive sleep apnea (OSA) is a disorder of sleep. Itis due to repetitive collapse of the upper airways leading to snoring, fragmented sleep, hypoxemia, hypercapnea, swings in intrathoracic pressure and increased sympathetic activity. Clinically the patient has excessive daytime sleepiness,snoring andpauses and choking spells in breathing during sleep. It is estimated that 2% of middle aged women and 4% of middle aged men suffer from OSA[1]. Prevalence of sleep apnoea increases with increasing body mass index (BMI).A ten percent increase in weight predicts a 6-fold increase in the odds of developing moderate-to-severe OSA[2]. Its incidence in morbidly obese patients has been reported between 38% and 93% and is more frequent in men[3]. As screening for OSA before BS is increasing, more and more patients of OSA are being detected; nevertheless, many researchers believe that it is still a under reported problem[4].Several severe health-related issues have been associated with OSA including those of premature death, sudden death from cardiac causes, traffic accidents, hypertension, ischaemic heart diseases, stroke, type II diabetes, increased neck circumference and visceral adiposity.

Clinical diagnosis of OSA is difficult. Diagnostic tools like the Epworth Sleepiness Score, the Maintenance of Wakefulness Test, the Berlin Questionnaire, Wisconsin Sleep Questionnaire, the STOP and STOP-BANG Questionnaire are commonly used for screening of OSA in bariatric patients. However, accuracy of these questionnaires is inconsistent[5]. The standard method of diagnosing OSA is via polysomnography (PSG). PSG test is done in sleep laboratory and patients need to stay overnight in the laboratory. PSG calculate the number of apnoea (complete cessation of airflow) and hypopnea (50% to 90% decrease in airflow and at least a 4% drop in oxygen saturation for >10 seconds) episodes in each hour of sleep. "Apnea hypopnea index" (AHI) or "respiratory disturbance index" (RDI) are two commonly used parameters to classify the degree of sleep disturbances. In general, an AHI of less than 5 is normal, 5-15 is mild sleep apnoea, >15 is moderate sleep apnoea, and >=30 is severe sleep apnoea[6]. Due to the high prevalence of OSA in bariatric patients and the risk of serious post operative consequences with undiagnosed OSA following bariatric surgery, many centres advocate routine use of pre operative PSG in all prospective bariatric surgery patients[7]. In general, most of the bariatric programmes are not conducting routine preoperative PSG prior to bariatric surgery. It is more of a tailored approach, only the patients with preoperative symptoms of OSA are referred for PSG[8]

BARIATRIC SURGERY AS A TREATMENT OPTION FOR OBSTRUCTIVE SLEEP APNEA

Medical therapy in the form of Positive Airway Pressure (PAP) is the primary treatment modality for OSA. Surgery is an option only in selected group of patients. The primary objectives of surgery in OSA are to increase the airway size and decrease the airway resistance, thereby reducing the work of breathing. The surgical proceduresfor OSA may be site-specific techniques like nasal surgery (septoplasty, turbinectomy), Uvulo-palato-pharyngoplasty or surgery on the base of the tongue. Surgical therapy may also involve upper airway reconstruction like maxilla mandibularadvancement, tracheostomy or non-airwaysurgery like bariatric surgery [9]. Bariatric surgery involves surgery on the gastro intestinal tract in order to create caloric restriction and sometimes mal-absorption in order to induce weight loss. The commonly performed bariatric procedures are adjustable gastric banding (AGB), Roux-en-Y gastric bypass (RYGB), sleeve gastrectomy (SG), and bilio-pancreatic diversion (BPD). These procedures are either restrictive, mal absorptive or both and are done laparoscopically in majority of the patients.

Presently, bariatric surgery is recommended in OSA patients with body mass index (BMI) more than 35kg/m^2 [10,11].

In majority of the patients,bariatric surgery improves or resolves OSA and the other parameters of sleep quality[12-15].

MECHANISM OF OSA IMPROVEMENT FOLLOWING BS

Improvement in OSA following bariatric surgery are due to weight

***Correspondence: Dr. Sandeep Aggarwal,** Department of Surgical Disciplines, All India Institute of Medical Sciences, New Delhi, India*
***e-mail:** sandeep_aiims@yahoo.co.in*

dependent factors like decreased mechanicalforce on the neck, upper airway or on diaphragm[13] as well as on certainweightindependentmetabolic factors[16]. Bariatric surgery reduces boththe visceral and the subcutaneousadiposity. Reduction of subcutaneous adiposity reduces the physical pressure on the neck, upper airway and the breathing apparatus. The reduction in visceral adiposity reduces the intra-abdominal pressure and thereby increases the diaphragmatic excursion. Thisimproved diaphragmatic function increases the oxygen saturation, decreases arterial carbon dioxide, andincreases arterial oxygen content. These positive pulmonary changes, in turn, affect the neurological pathways and cerebral centresresponsible for respiration[13].

The metabolic effects of bariatric surgery on OSA are due tothe alteration in the bile flow, reduction in gastric size, anatomical rearrangement of gastrointestinal tract, vagal manipulation and enteric gut hormone modulation.These anatomical and hormonal modulationsimprove the insulin resistance, adipokines, cytokines and systemic inflammationand are more common following mal absorptive procedures like RYGB[16]. The importance of anatomical rearrangement and hormonal modulation in OSA improvement is reiterated by the fact that AGB, which is a pure restrictive procedure with minimal metabolic component,is least efficacious in improving OSA when compared with other bariatric procedures[11]. Although AGB induces considerable weight loss but the improvement in OSA is not superior to supervised medical weight loss therapy[17]. Another possible metabolic effect is the reduction of inflammatory status after bariatric surgery. Obesity and OSA is associated with elevated level of inflammatory bio-markers in serum, thus correlating to a state of low grade systemic inflammation. The mal-absorptive bariatric procedures reduce the serum level of several inflammatory bio-markers, most importantly, the TNF-alpha, IL-6and TNF-alphareceptor 2. Reduction of these biomarkers signifies that the prevailinginflammatory state of bariatric patients improves with surgery which, inturn, influences the improvement of OSA status. Among the different biomarkers, the decrease in serum TNF alpha R is most impressive and independently determines the improvement of sleep apnoea achieved following bariatric surgery[18].

IMPROVEMENT ON OSA FOLLOWING BARIATRIC SURGERY

Following bariatric surgery, there is improvement of post-operative sleep quality, reduction in day time sleepiness, improvement in quality of life, decrease use of CPAP and decrease use of CPAP pressure requirement. These subjective improvements are seen regardless of the type of bariatric procedures[12]. Objectively, there is improvement in severity of OSA as measured by AHI or RDI score. In a larger series of 289 patients with documented OSA by PSG, there was significant decrease in mean RDI in post-operative PSG following Roux-en-Y gastric bypass. In addition, the patients also exhibit improvement in oxygen saturation, sleep efficiency and rapid eye movement latency[12].

In a meta-analysis by Buchwald et al., the OSA was resolved or improved in 83.6% of total population(95% CI,71.8%-95.4%). Gastric bypass (94.8 %) was the most successful procedure in improving or resolving OSA followed by gastroplasty (89.3 %), BPD (86.7%) and gastric banding (55.6%) being the least effective procedure[13].

In another meta-analysis of studies that carried out clinical assessment and PSG of the patients before and at least 3 months after bariatric surgery, there was decrease in the pooled mean AHI from 38.2 events/ hour (95%CI, 49.0-60.3) to 15.8 events/hour (95% CI, 12.6 – 19.0). The combined reduction in AHI was 71%. This is a significant improvement of OSA in bariatric patients.However, one interesting finding of this study was that in majority of the patients (62%), the mean residual AHI after surgery was more than 15 events per hour. This indicates that there ispersistent residual disease even though there has been considerable improvement. As such, the patients needfollow-upwith PSGafter weight loss surgeryand those with residual disease need continued treatment for OSA. This meta-analysis also found that the patients cured of OSA were lighter and younger than those who had residual OSA after bariatric surgery[14]. One limitation of this meta-analysis was that most of the included studies had a short term follow up. The final weight loss after bariatric surgery occurs after 1-2 years of surgery. As such, most of the patients were yet to achieve the complete benefit out of surgery as regard to weight loss and improvement of OSA.

There is only one randomised trial that had investigated the impact of surgical weight loss and supervised medical weight loss measures on OSA. The study revealed that though there was significantly more weight loss following bariatric surgery yet the improvement of OSA was not superior to conventional weight loss measures. However, the surgical arm received only AGB as the intervention. AGB is inherently associated with least improvement of OSA among the bariatric procedures which may probably explain the non-significant reduction of AHI score in this study[17].

In a recent meta-analysis of 13,900 patients who underwent bariatric surgery, 79%of patients experienced either resolution or improvement of their sleep apnoea. Among the different bariatric procedures, BPD was the most effective technique, 99% patients who underwent BPD had either improvement or resolution of their OSA. The percentage of patients showing either resolution or improvement in their OSA was 86% (SG), 79% (RYGB), 77% (AGB) and 88.5% (combined procedures)[15].

CONCLUSIONS

Significant proportion of severely obese patients is associated with OSA.Pre-operative PSG may be advised for all prospective bariatric surgery patients.Bariatric surgery is indicated for treating OSA in obese patients with BMI >35kg/m^2.BPD has the highest success rate in resolving or improving OSA followed by SG and RYGB. AGB is the least efficacious technique and its efficacy in treating OSA is not superior to conventional weight loss therapy. After surgical weight loss, patient should be followed up with PSG. Those patients with residual AHI more than 15 events/ hour needcontinued medical therapy for OSA.

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