Single-setting Combined Uvulopalatopharyngeoplasty and Laparoscopic Sleeve Gastrectomy as a Therapeutic Modality for Obesity-associated Obstructive Sleep Apnea

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Abstract: Objectives: To evaluate the outcome of single-setting laparoscopic sleeve gastrectomy (LSG) and uvulopalatopharyngeoplasty (UPPP) as a management policy for Obesity-associated sleep-disordered breathing. Patients & Methods: The study included 23 obstructive sleep apnea syndrome (OSAS) with body mass index (BMI) >40 kg/m^2. Preoperative OSAS evaluation included Epworth Sleepiness Scale (ESS) and polysomnography to determine the apnea-hypopnea index (AHI). OSAS was diagnosed if the patients demonstrated an AHI ≥15/h or ≥5/h with an ESS ≥10. Body weight (BW) and BMI were evaluated at 1, 3 and 6 months after surgery and the percentage of excess weight loss (%EWL) and the percentage of excess BMI loss (%EBMIL). AHI and ESS score were re-determined at 6 months after surgery and percentage of change was determined. Results: Mean total theatre time was 105.3±10.7, mean time till first ambulation was 2.5±0.7 hours, mean time for first oral intake was 41±11.2 hours and mean hospital stay was 4.9±0.8 days. LSG and postoperative dieting regimen allowed significant progressive BW reduction with a progressive increase of %EWL and %EBMIL at 6 months after surgery compared to percentages reported at 3 months after surgery. Moreover, BMI strata showed progressive change with 21 women had BMI <35 and only 2 had BMI >35 but <40 kg/m^2. Both ESS score and AHI evaluated at 6 months PO were significantly reduced compared to preoperative measures. At 6-m after surgery, the mean percentage of decrease of ESS and AHI were 66.3±10.5 (45.5-85.7%) and 80.4±7.5% (67.2-91%), respectively. Conclusion: Combined LSG and UPPP improved outcome of bariatric surgery for management of obesity-related OSAS without prolongation of theatre time or interfering with scheduled PO care of gastrectomy patients and should be advocated for management of such patients.
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1. Introduction

Obesity behaves like an epidemic with escalating progress up to a fact that the number of overweight and obese people in the world overtook the number of malnourished. As the obesity epidemic increases, health problems associated with obesity became more frequently than ever before; in 2007, 41% of women were classified as obese, with a BMI of 30 or higher. A wide spectrum of health problems has been associated with obesity, including cardiovascular disease, diabetes, metabolic syndrome, osteoarthritis, and obstructive sleep disorders (**Hebebrand and Hinney, 2009; Frossard *et al.*, 2009, Graves *et al.*, 2010; Veerman & Barendregt, 2010**).

Sleep-disordered breathing, particularly in the form of obstructive sleep apnea (OSA), occurs in approximately 4% of men and 2% of women 30 years old in the general population. OSAS is characterized by fragmentation of sleep with repeated awakenings through recurrent arterial hypoxemias, generalized startle reflexes, and recordable EEG arousals. Obesity, especially upper body obesity, is considered a major risk factor for OSA, and clinical assessments and sleep studies indicate a prevalence of OSA in very severe obesity (**Hiestand *et al.*, 2006; Spurr *et al.*, 2010**).

Sleep-disordered breathing is recognized as a major health problem and, with the increasing prevalence of severe obesity, it is likely that the prevalence of sleep-disordered breathing is also likely to increase. In addition, obese patients without sleep-disordered breathing have a significant increase in sleep disturbance and daytime sleepiness compared with non-obese control subjects, possibly related to metabolic or circadian disturbance (**Spurr *et al.*, 2010**).

Many studies have shown that there are major improvements in sleep disturbance and sleep-disordered breathing in obese subjects associated with weight loss. These improvements are consistent for medical, dietary, and surgical methods of weight loss. However, improvement of manifestations of sleep-disordered breathing may require additional therapies for residual breathing difficulties (**Weiner, 2008; Stephens *et al.*, 2008**); thus the present study aimed to evaluate the outcome of single-setting laparoscopic sleeve gastrectomy as a type of bariatric surgery and uvulopalatopharyngeoplasty as a management policy for Obesity-associated obstructive sleep apnea syndrome.

2. Patients and Methods

The present study was conducted at Departments of Otorhinolaryngology and General Surgery, Benha University Hospital since Jan 2009 till Jan 2010 to allow a minimum follow-up period of 6 months for the last case operated up on. After approval by Local Ethical Committee and obtaining written fully informed patients' consents, OSAS patients with body mass index (BMI) >40 kg/m^2, or BMI >35 kg/m^2 with severe obesity-related disease; over 5 years of obesity and failure in previous weight reduction therapy; with no endocrine-related obesity were enrolled in the study.

All patients underwent determination of demographic data including age, sex, weight, height and BMI was computed as the ratio of body weight in kilograms divided by the square of height in meters. (=kg/m^2), (**Khosla & Lowe, 1967**).

All patients underwent complete otorhinolaryngologic examination including history of any diagnosed sleep disorder, previous sleep studies, and use of nasal continuous positive airway pressure, and a questionnaire on sleep symptoms and quality of sleep. The applied questionnaire was the Epworth Sleepiness Scale (ESS), which was a validated measure of daytime sleepiness using the following scale to choose the most appropriate number for each situation: 0= would never doze, 1= slight chance of dozing, 2= moderate chance of dozing & 3= high chance of dozing. Inquired situations included watching TV, sitting inactive in a public place, e.g. a theatre or meeting, as a passenger in a car for an hour without a break, lying down to rest in the afternoon when circumstances permit, sitting and talking to someone, sitting quickly after a lunch and/or in a car while stopping for a few minutes in the traffic, then the sum of numbers was calculated (**Johns, 1991**). An ESS Score >10 was used to confirm the presence of excessive daytime sleepiness and the higher the score, the greater the severity of OSA (**American Sleep Disorders Association, 1997**).

Then, all patients had polysomnography, at a private sleep center, to determine the apnea-hypopnea index (AHI) which is defined as the average number of apneas plus hypopneas per hour of sleep. Apneas were defined by near absence of airflow for ≥10 s on the nasal pressure cannula signal. Hypopneas were defined as a decrease in airflow on the nasal pressure cannula signal for ≥10 s, accompanied by an arousal, a ≥4% desaturation, or both. OSAS was diagnosed if the patients demonstrated an AHI ≥15/h or ≥5/h with an Epworth sleepiness scale score ≥10 (**American Academy of Sleep Medicine, 2005**).

Preoperative preparation and Operative procedures

All patients received their preoperative preparation at home and admitted for final examination the night before surgery and preoperative anesthetic assessment for anesthetic risk and planning for postoperative (PO) management was also conducted. All surgeries were conducted under general anesthesia. With the patient intubated in supine position, preumoperitoneum was established to 15 mmHg, the patient was then placed in reverse Trendelenburg position; lowering the abdominal viscera and freeing the operative field in the upper abdomen. Then, trocars were placed and gastrectomy was conducted as shown in Figure 1. After proper positioning of the patient, uvulopalatopharyngeoplasty was synchronously conducted as shown in Figure 2. Time since induction of anesthesia till proper patient's positioning was recorded, then operative time for each procedure separately was recorded and added to time till positioning to calculate operative time for each procedure separately, total operative time since induction of anesthesia till recovery was also recorded. Hospital stay, intraoperative and postoperative complications were registered.

Postoperative care

After assuring patients' recovery, all patients received adequate postoperative analgesia using nalorfen ampoule, morphia and non-steroidal anti-inflammatory drugs were prohibited. Proper oxygenation was provided through nostril tubes, patients were transferred to surgical intensive care unit when their oxygen saturation (SpO_2) was >90%. In ICU, patients were maintained in semisetting position throughout the postoperative period with keeping an eye on pulmonary functions and continuous capillary hemoglobin SpO_2 monitoring, and continuous positive airway pressure (CPAP) was used according to need. The nasogastric tube was removed on the 1st postoperative day after a normal upper GI series with gastrographin for assurance of anastomotic line competence, then oral soft fluid was allowed and patients felt able to return home were discharged starting from the 2nd postoperative day with instructions to follow a liquid diet of low calories as possible for four weeks.

Postoperative monitoring

1. Body weight and body mass index were evaluated at 1, 3 and 6 months after surgery and the percentage of excess weight loss (%EWL) and the percentage of excess BMI loss (%EBMIL) were calculated as follows:
   %EWL= [(Preoperative–Follow-up weight)/Preoperative weight]x100
   %EBMIL=100– [(Follow-up BMI– 25/ Preoperative BMI – 25) x 100]
2. AHI and ESS score were re-determined at 6 months after surgery.

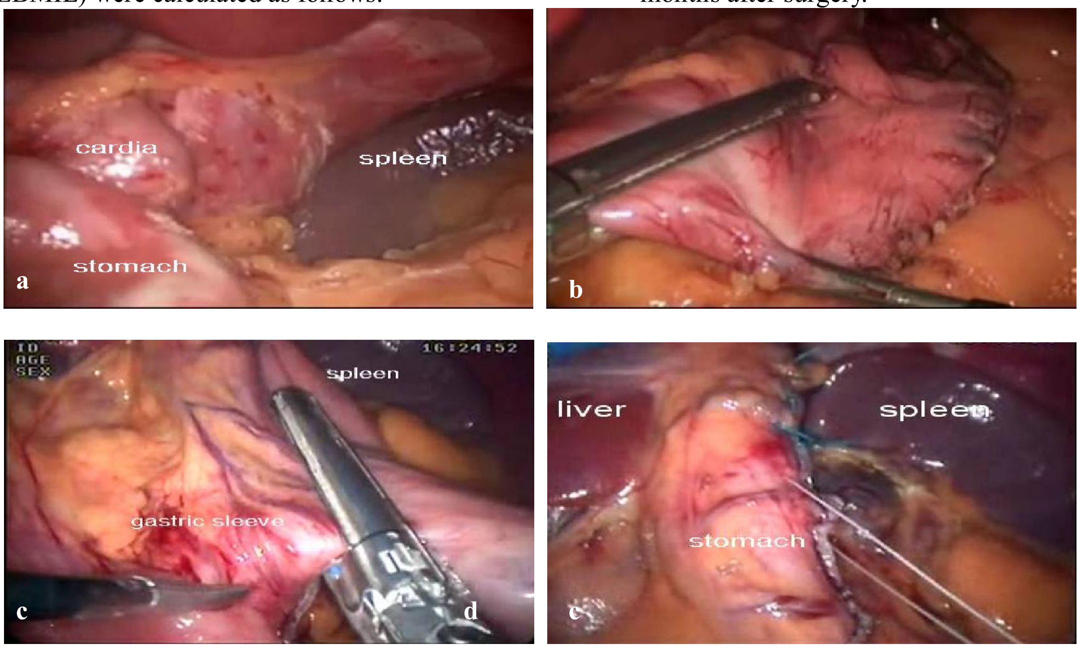
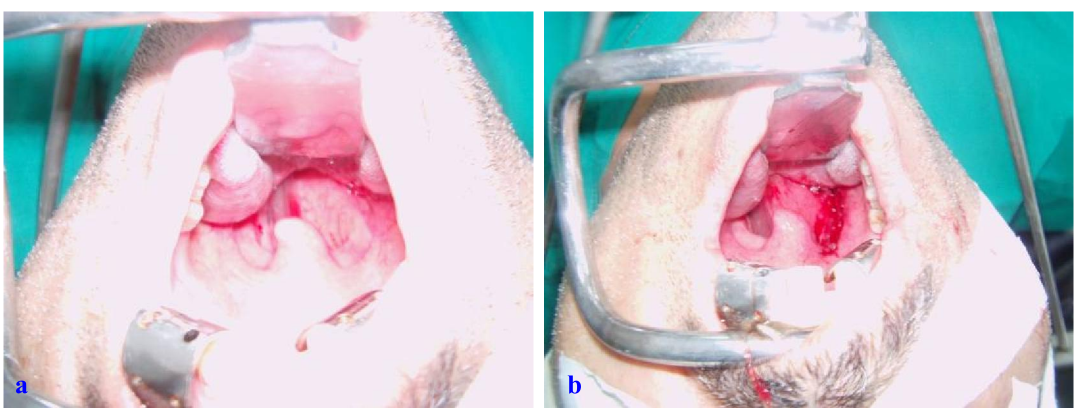


Fig. (1): Shows the operative procedure for sleeve gastrectomy:

a. Appearance of left hypochondrial structures after release of ligaments to free the greater curvature of the stomach.
b. The linear cutting endoGastro-Intestinal-Anastomosis (GIA) stapler was introduced through a right trocar towards the left shoulder, and to be placed at the point of the initial dissection on the greater curvature, creating a vertical cut on the gastric wall
c. Sequential firings of the Endo GIA are applied up to the esophagogastric junction leaving about 1 cm of fat pad along the lesser curvature (~3 cm width) to assure adequate blood supply on the lesser curvature for the sleeve.
d. Completion of gastrectomy leaving tube like stomach.



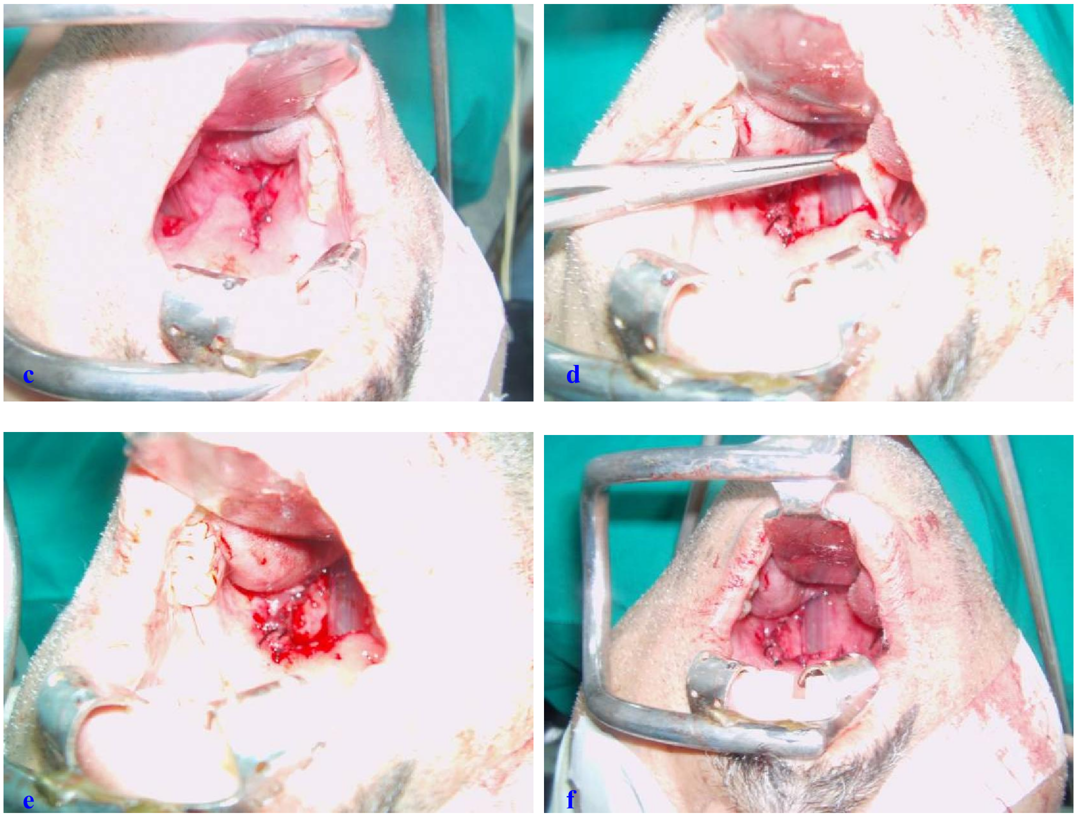


Fig. (2): Shows the operative procedure for uvlopalatopharyngeoplasty:

a. Preoperative appearance of the oropharynx showing pendulous uvula and narrow pharyngeal circumference.
b. Tonsillectomy was performed and followed by excision of the lateral pharyngeal fold on right side.
c. Closure of the resultant defect using direct interrupted approximating sutures without re-narrowing of the pharynx.
d. After completion of excision of the lateral pharyngeal fold on left side, redundant uvula was excised.
e. The resultant raw area after excision of redundant uvula tissue.
f. Completion of repair of uvular base.

3. Results

The study included 23 patients; 8 males and 15 females with mean age of 38.8±8.6; range: 28-51 years. Mean preoperative BMI was 44.4±1.9; range 42.2-49 kg/m^2. Mean preoperative ESS was 11.9±2; range: 7-16 and mean AHI was 52.5±12.4; range: 13-66. Detailed patients' enrollment data are shown in table 1.

Mean time for induction of anesthesia was 18.4±3; range: 12-24 min and mean time till recovery 25.8±3.2; range: 20-30 min. Mean operative time for LSG was 61.1±8.5; range: 50-80 min, while mean operative time for UPPP was 51.2±8.5; range: 40-65 min. Mean total theatre time was 105.3±10.7; range: 88-128 min, (Table 2). Mean time till first ambulation was 2.5±0.7; range: 1-3 hours and mean time for first oral intake was 41±11.2; range: 30-72 hours. Mean hospital stay was 4.9±0.8; range: 4-6 days. Detailed postoperative data were shown in table 3. All patients passed smooth postoperative course, apart from mild wound infection recorded in 4 patients (17.4%) and all responded to conservative treatment without surgical interference.

Sleeve gastrectomy and postoperative dieting regimen allowed significant progressive body weight reduction with a progressive increase of %EWL and %EBMIL at 6 months after surgery compared to percentages reported at 3 months after surgery. Moreover, BMI strata showed progressive change with 21 women had BMI <35 and only 2 had BMI >35 but <40 kg/m^2, (Table 4, Fig.3).

The applied surgical procedures resulted in significant reduction of both ESS score and AHI evaluated at 6 months after surgery compared to preoperative measures. All patients had 6-m PO ESS score <10 with a mean percentage of decrease of ESS of 66.3±10.5; range: 45.5-85.7%. Moreover, postoperative polysomnography showed significant improvement of OSA with a mean percentage of decrease number of apnea-hypopnea episodes of 80.4±7.5%; range: 67.2-91%, (Table 5, Fig. 4).

Table (1): Patients' enrollment data

	Strata	Number (%)	Mean±SD
Age (years)	<30 years	4 (17.4%)	28.8±0.5
	30-<40	9 (39.1%)	33.7±3.4
	40-<50	6 (26.1%)	45.3±3.9
	>50	4 (17.4%)	50.5±0.6
Weight (kg)	<110	1 (4.4%)	109
	110-115	9 (39.1%)	114±1.1
	>115-120	8 (34.8%)	117.4±1.7
	>120	5 (21.7%)	123±2.1
Height (cm)	<160	8 (34.8%)	159.3±0.7
	161-165	13 (56.5%)	163.6±1.3
	>160	2 (8.7%)	166
BMI (kg/m^2)	<45	16 (69.6%)	43.4±0.9
	>45	7 (30.4%)	46.8±1.4
Co-morbidities	DM	17 (73.9%)	
	Dyslipidemia	8 (34.8%)	
	Hypertension	13 (56.5%)	
	OSAS	23 (100%)	
	Joint pain	15 (65.2%)	
	Depression/anxiety	10 (43.5%)	
ESS score	<10	3 (13%)	8±1
	10-15	18 (78.3%)	12.2±1
	>15	2 (8.7%)	15.5±0.7
AHI	<40	3 (13%)	33.7±0.6
	40-50	3 (13%)	43.7±2.3
	>50-60	9 (39.2%)	55.1±1.1
	>60	8 (34.8%)	62.4±1.8

Data are presented as mean±SD & numbers; percentages are in parenthesis

Table (2): Operative times' data

Data	Finding
Time of induction of anesthesia (min)	18.4±3 (12-24)
Total UPPP operative time (min)	51.2±8.5 (40-65)
Total LSG operative time (min)	61.1±8.5 (50-80)
Recovery time (min)	25.8±3.2 (20-30)
Total theatre time (min)	105.3±10.7 (88-128)

Data are presented as mean±SD; ranges are in parenthesis
UPPP: Uvulopalatopharyngeoplasty LSG: laparoscopic sleeve gastrectomy

Table (3): Postoperative times' data

Data		Control
Time till 1st ambulation	1 hour	2 (8.7%)
	2 hours	8 (34.8%)
	3 hours	13 (56.5%)
	Total (hours)	2.5±0.7 (1-3)
Time till oral resumption	30 hour	5 (21.7%)
	36 hours	10 (43.6%)
	48 hours	5 (21.7%)
	60 hour	2 (8.7%)
	72 hours	1 (4.3%)
	Total (hours)	41±11.2 (30-72)
Hospital stay	4 days	8 (34.8%)
	5 days	9 (39.1%)
	6 days	6 (26.1%)
	Total (days)	4.9±0.8 (4-6)

Data are presented as mean±SD & numbers; ranges & percentages are in parenthesis

Table (4): Postoperative BMI data compared to preoperative data

		Preoperative	3- months PO	6-months PO
Weight (kg)		116.9±4.1 (109-126)	97±3.4 (91-105)*	87±3.7 (78-93)*†
%EWL			17±2.9 (9.6-21)	25.6±3.6 (19.1-31.7)†
Height (cm)		162.3±2.6 (158-166)	162.3±2.6 (158-166)	162.3±2.6 (158-166)
BMI (kg/m^2)		44.4±1.9 (42.2-49)	36.8±1.2 (35.3-39.5)*	33±1.4 (30.5-35.2) *†
%EBMIL			38.8±5.6 (23.4-46.8)	58.6±7 (46.9-68)†
BMI strata (kg/m^2)	>30-35	0	0	21 (91.3%)
	>35-40	0	23 (100%)	2 (8.7%)
	>40-45	16 (69.6%)	0	0
	>45	7 (30.4%)	0	0

Data are presented as mean±SD & numbers; ranges & percentages are in parenthesis BMI: Body mass index
%EWL: percentage of excess weight loss %EBMIL: percentage of BMI loss
*: significance versus preoperative data †: significance versus 3-m data

Table (5): Postoperative ESS scores and AHI compared to preoperative data

	Preoperative	6-months PO
ESS	11.9±2 (7-16)	4±1.3 (2-7)*
%ESS decrease		66.3±10.5 (45.5-85.7)
AHI	53.3±9.9 (33-66)	10.1±3.9 (5-21) *
%AHI decrease		80.4±7.5 (67.2-91)

Data are presented as mean±SD; ranges are in parenthesis *: significance versus preoperative data

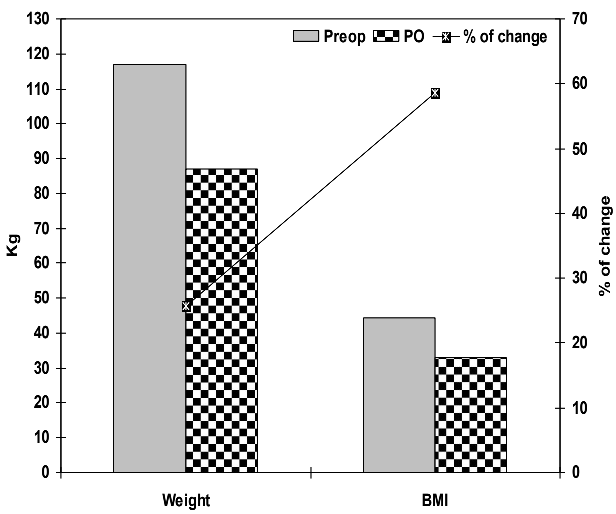


Fig. (3): Mean Preoperative and 6-m postoperative weight and BMI and the percentage of PO change

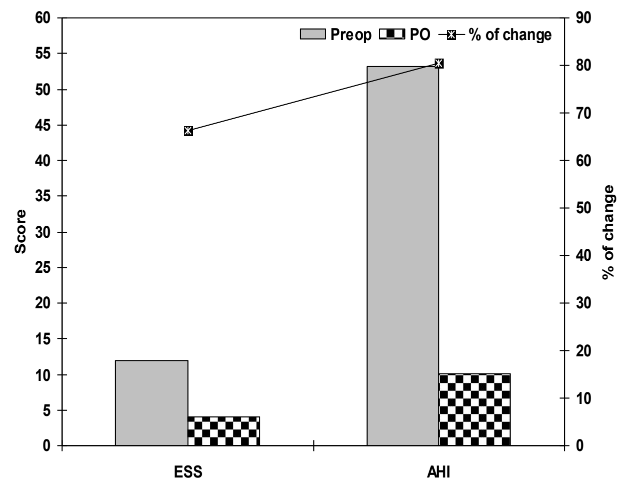


Fig. (4): Mean Preoperative and 6-m postoperative ESS score and AHI and the percentage of PO change

4. Discussion

Obesity especially approaching morbid levels is a risk factor endangering all body systems with varied extent. OSAS had multiple underlying pathologies; however, obesity constitutes a high risk factor participating in either pathogenesis or aggravation of OSAS. The current study included 23 OSAS obese or morbidly obese patients assigned for LGS surgery, all had associated co-morbidities with diabetes, hypertension and dyslipidemia were the most frequent morbidities, indicating strong association between obesity and manifestations of metabolic syndrome and go in hand with **Lopez *et al.* (2008)** who found the prevalence of OSA in severely obese patients was 71%, in morbidly obese with BMI 40-40.9 kg/m^2 the prevalence was 74% and for the superobese group with BMI 50-59.9 kg/m^2 the prevalence was 77% and in those with a BMI 60 kg/m^2 or greater, the prevalence of OSA rose to 95%. **Salord *et al.* (2009)**, found obese OSAS patients had higher fasting plasma glucose and triglyceride levels and a higher prevalence of diabetes than in obese non-OSAS and metabolic syndrome was also more frequent in subjects with previously untreated OSAS (92%) than in those without sleep disturbance.

All patients showed a significant progressive weight loss and decrease of BMI with a significant difference compared to BMI determined preoperatively and at 3-months PO with %EBMIL of 58.6% at 6-months PO; these data indicated the applicability of laparoscopic sleeve gastrectomy as a primary and definitive line for management of obesity and morbid obesity and go in hand with **Gagner *et al.* (2008)** who performed LSG for 63 super-super-obese patients with average preoperative BMI of 68 kg/m^2 and by 6 months postoperatively, the average BMI had decreased to 58 kg/m^2 and to 50 kg/m^2 one-year without further surgery. Moreover, **Sánchez-Santos *et al.* (2009)** reported a mean %EBMIL at 3 months of 38.8, 55.6 at 6 months, 68.1 at 12 months, and 72.4 at 24 months. **Gagner *et al.* (2006)** through the Second International Consensus Summit for Sleeve Gastrectomy documented that LSG was intended as the sole operation for an average %EBMIL of about 60% through 4 years follow-up and concluded that LSG for morbid obesity is very promising as a primary operation.

Gluck *et al.* (2011) reported %EWL of 49.9% and 64.2% at 3 and 6 months after LSG, respectively, and concluded that LSG was advocated as a safe and effective stand-alone procedure, especially in patients with BMI ranging between 35-43 kg/m^2. **D'Hondt *et al.* (2011)** reported no major complications after LSG and a mean %EWL of 72.3% and concluded that LSG is a safe and effective bariatric procedure.

The reported outcome of LSG could be attributed to the fact that LSG is putatively a purely restrictive operation that reduces the size of the gastric reservoir to 60–100 ml, permitting the intake of only small amounts of food and imparting a feeling of satiety earlier during a meal (**Rosen & Dakin, 2009**). Moreover, it has been suggested that attenuation of endogenous Ghrelin levels may also contribute to the success of LSG; Ghrelin, which is thought to be a hunger-regulating peptide hormone, is mainly produced in the fundus of the stomach and by resecting the fundus in LSG, the majority of ghrelin producing cells are removed, thus reducing plasma ghrelin levels and subsequently hunger, (**Langer *et al.*, 2005; Karamanakos *et al.*, 2008**).

Considering OSAS as the main target of the current study; all patients showed significant improvement of their disordered sleep manifested as significant reduction of both ESS and AHI scores so the applied procedures allowed significant improvement of both subjective and objective parameters of OSAS with a percent of decrease of 66.3% and 80.4%, respectively. These data were in line with that reported previously in literature as regards bariatric surgery as a line for management of OSAS. However, the outcome of combined LSG and UPPP was evident as manifested by the superior figures for improvement of ESS and AHI scores compared to other studies which were dependent on bariatric surgery alone.

Guardiano *et al.* (2003) reported that weight reduction following gastric bypass (GB) is associated with significant improvements in sleep apnea indexes after an average of 28 months, but re-evaluation after GB is necessary to identify and treat those patients who, despite subjective improvement, may continue to require CPAP for residual OSA. **Busetto *et al.* (2005)** reported that weight loss secondary to intra-gastric balloon application significantly reduced apnea-hypopnea index, however, in obese patients, the weight loss induced by the positioning of the intragastric balloon was associated with an increase in the size of the upper airway passage and after weight loss, both the mean pharyngeal cross-sectional area and the area at glottis level were still lower in obese subjects than in non-obese subjects.

Varela *et al.* (2007) reported a mean excess body weight loss of 73% at 12 months, mean ESS score was decreased from 13.7 preoperatively to 5.3 at 1 month postoperatively and concluded that weight loss associated with laparoscopic Roux-en-Y gastric bypass significantly improves the symptoms of sleep apnea and is effective in discontinuation in the clinical use of CPAP therapy with improvement of obstructive sleep symptoms occurring as early as 1 month postoperatively. **Mittempergher *et al.* (2008)** reported that after 1 year follow-up after bariatric surgery, a reduction in OSAS patients was observed and ESS <10 was detected in 77.5% and polysomnography (PSG) was negative in 80.3%.

Schultes *et al.* (2009) evaluated the outcome of distal gastric bypass operation on obesity and its related morbidities and found at eighteen months after the operation BMI had decreased to 31.9 kg/m^2, type-2 diabetes was in complete remission, and OSAS appeared to be improved. **Greenburg *et al.* (2009)** conducted a meta analysis for studies evaluating effect of bariatric surgery on obesity-associated OSAS and found 12 studies representing 342 patients were identified with a mean BMI was reduced by 17.6 kg/m^2 from 55.3 kg/m^2 to 37.7 kg/m^2 and apnea hypopnea index was reduced from baseline of 54.7 events/hour to a final value of 15.8 events/hour with a mean reduction by 38.9 events/hour.

Basso *et al.* (2011) reported that in patients with BMI around 45 kg/m^2, the mean BMI was 32.9, 30.6, and 31.7 at 6, 12, and 18 months and at 12 months, the diabetes, hypertension, and OSAS were cured on 88%, 57%, and 58% and concluded that SG is a safe and effective treatment for morbid obesity and is effective for co-morbidities resolution, especially for the treatment of diabetes.

In conclusion; combined LSG and UPPP improved outcome of bariatric surgery for management of obesity-related OSAS without prolongation of theatre time or interfering with scheduled PO care of gastrectomy patients and should be advocated for management of such patients.

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