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Original Research Article

A COMPREHENSIVE STUDY OF INTERPRETATION OF POLYSOMNOGRAPHY IN THE SURGICAL MANAGEMENT OF ADULT OBSTRUCTIVE SLEEP APNEA PATIENTS

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Abstract

Background: Obstructive sleep apnoea is a sleep disorder that causes recurrent airway obstruction, leading to sleep fragmentation, daytime sleepiness, and increased cardiovascular risks. Continuous positive airway pressure intolerance necessitates surgical intervention. This study evaluated the surgical outcomes in patients with OSA by comparing pre- and postoperative polysomnography findings to determine treatment effectiveness. **Materials and Methods:** A prospective study was conducted on 30 patients with OSA at Stanley Medical College. Preoperative assessments included clinical examination, the Epworth Sleepiness Scale, and PSG. Drug-induced sleep endoscopy-guided surgical planning. The surgical procedures included uvulopalatopharyngoplasty, Z-pharyngoplasty, lateral pharyngoplasty, expansion sphincter pharyngoplasty, or combinations. Postoperative PSG was performed after one month, comparing the apnoea-hypopnoea index, SpO_2, ESS scores, and anthropometric parameters to evaluate surgical effectiveness. **Result:** Among the patients, 90% were men. UPPP was the most common surgery (46.7% of patients). The mean apnoea-hypopnoea index (AHI) significantly reduced from 33.64 ± 12.60 to 17.94 ± 7.92 ($p<0.0005$), and SpO_2 improved from 69.97 ± 12.18% to 84.17 ± 8.29% ($p<0.0005$). ESS scores decreased from 13.47 ± 2.96 to 2.33 ± 1.18 ($p<0.0005$). Anthropometric parameters, including BMI, neck circumference, and abdominal circumference, showed significant postoperative reductions. The chest circumference reduced from 95.80 ± 4.86 cm to 93.77 ± 4.74 cm and the abdominal circumference from 97.00 ± 7.53 cm to 94.83 ± 7.29 cm ($p<0.0005$). Severe AHI decreased from 53.3% to 10% in males, while mild AHI increased from 3.3% to 36.7%. **Conclusion:** Surgical treatment significantly improved sleep parameters, oxygenation, and daytime drowsiness. DISE-guided procedures effectively reduced AHI, supporting surgery as a viable option for selected patients with OSA.

INTRODUCTION

Sleep is a temporary state of unconsciousness interrupted by external stimuli and is organised into a cyclic pattern of stages. Obstructive sleep Apnea/hypopnea syndrome (OSAHS) is a significant medical condition that has been identified in the last 50 years. It is the most common cause of daytime sleepiness and causes significant morbidity. Recurrent episodes of upper airway collapse during sleep cause significant airflow reduction despite good respiratory efforts, characterising obstructive sleep apnoea (OSA) with arousal terminating the event.[1]

The estimated prevalence of SDB (apnoea-hypopnoea index of ≥ 5) was 19.5%, and that of OSAHS (SDB with daytime hypersomnolence) was 7.5%. Patients with OSAHS experience frequent upper airway obstruction during sleep, disruptive snoring, and excessive daytime sleepiness. It is associated with nocturnal hypoxemia, making it a disabling and hazardous condition.[2] Risk factors associated with a high prevalence of OSA are male sex, age, obesity, hormonal, and heritable factors, with obesity being the strongest.[3] Change in body weight is associated with a change in Apnoea Hypopnea Index (AHI) as a 10% weight change causes a parallel 30% change in AHI.[4]

Untreated OSA leads to excessive daytime sleepiness, cognitive dysfunction, impaired work performance, and a reduced health-related quality of life. Daytime sleepiness with OSA is more common in adult men (3–7%) than in women (2–5%).[5] OSA is the most common form of sleep-related breathing disorder. OSA and upper airway resistance syndrome (UARS) are two distinct entities in the spectrum of sleep-disordered breathing (SDB). OSA is characterized by "repetitive partial or complete collapse of the upper airway during sleep, resulting in disruptions of normal sleep architecture and arterial desaturations".[6]

OSA manifests as a reduction (hypopnoea) or complete cessation (apnoea) of airflow despite ongoing inspiratory efforts. The lack of adequate alveolar ventilation usually results in oxygen desaturation and, in prolonged events, a gradual increase in PaCO2. These events are often terminated by arousals. Daytime symptoms such as excessive sleepiness are related to sleep disruption and possibly recurrent hypoxaemia.[7] Patients with sleep apnoea have an increased risk of diurnal hypertension, nocturnal dysrhythmias, pulmonary hypertension, right and left ventricular failure, myocardial infarction, and stroke. Repetitive increases in sympathetic tone may cause diurnal hypertension. Sleepiness, fatigue, irritability, and personality changes are attributed to nocturnal desaturation and chronic sleep deprivation due to sleep fragmentation.[8]

Cardiovascular risk factors in metabolic syndrome are associated with OSA, potentially explaining the increased cardiovascular morbidity and mortality linked to this condition.[9] Patients with OSA are at a significant risk of nocturnal gastroesophageal reflux. Studies recording symptoms and oesophageal pH show that GERD is prevalent in patients with OSA.[10] SRBD is associated with considerable morbidity. OSA should be considered in patients with daytime hypersomnolence, regardless of BMI or snoring history. However, it remains less recognised and commonly diagnosed and is largely overlooked in our region. Improving sleep quality in these patients will enhance their quality of life and decrease morbidity.

Aim

This study aimed to evaluate the surgical outcomes of adults with OSA by comparing pre- and postoperative polysomnography.

MATERIALS AND METHODS

This prospective study was conducted on 30 patients with OSAS at the Department of ENT, Stanley Medical College, Chennai, for 12 months from September 2017 to September 2018. The Institutional Ethics Committee approved this study before its initiation. Informed consent was obtained from all patients.

Inclusion criteria

Patients diagnosed with Obstructive Sleep Apnoea Syndrome (OSAS), aged between 18 and 60 years, with a BMI < 35, and an AHI > 5 were included.

Exclusion criteria

Patients with craniofacial abnormalities, neuromuscular diseases, congestive cardiac failure, and COPD were excluded from the study.

Methods

All patients underwent a detailed clinical examination, including measurements of weight, height, neck, chest, and abdominal circumference, and BMI was calculated. The Epworth Sleepiness Scale (ESS) was administered, and patients were interviewed regarding their sleep apnoea symptoms, including snoring, fragmented sleep, and excessive daytime sleepiness. Symptom reports were confirmed by the patient's family members. Patients underwent overnight polysomnography (PSG) in the sleep laboratory. PSG included electroencephalography (EEG), electrooculography (EOG), electromyography (EMG), electrocardiography (ECG), pulse oximetry, oronasal thermistors, thoracoabdominal belts, and a microphone for snoring assessment. Respiratory inductance plethysmography was used to monitor abdominal and chest wall movements. Patients with an AHI >5 underwent Drug-Induced Sleep Endoscopy (DISE) to assess airway obstruction.

For DISE, patients were kept NPO for 4-6 hours before the procedure. Nasal packing with 4% xylocaine and adrenaline was performed, and glycopyrrolate (1 mg IM) was administered 30-45 minutes prior. The patients were positioned supine, and intravenous access was secured. Propofol was titrated (0.5-1 mg/kg) until the patient snored. A 4 mm flexible nasopharyngoscope was introduced through the nostril to evaluate airway collapse. Based on PSG and DISE findings, surgical interventions were planned, including UPPP, ESP, lateral pharyngoplasty, zetaplasty, and tongue base reduction, performed alone or in combination with each other.

Preoperative assessments and basic investigations were conducted, and the patient was kept NPO for 10 hours preoperatively. Nasotracheal intubation was the preferred. Postoperative care included ICU monitoring with a nasopharyngeal endotracheal tube for 24 hours. Vital signs and oropharyngeal bleeding were also monitored. On the first postoperative day, the nasopharyngeal tube was removed, and the patients started cold liquids and semisolid diets, followed by a soft diet. Intravenous antibiotics were administered for five days. Polysomnography was repeated after one month, and the postoperative AHI was compared with the preoperative values for analysis.

Statistical analysis: Data were presented as mean, standard deviation, frequency, and percentage. Continuable variables were compared using the independent sample t-test. Significance was defined by p values < 0.05 using a two-tailed test. Data analysis was performed using IBM-SPSS version 21.0.

RESULTS

The mean age of the patients was 38.77±10.22 years, and most patients were male (n=27, 90%), with three females (10%). The maximum number of patients underwent uvulopalatopharyngoplasty (UPPP) (n=14, 46.7%), followed by Z pharyngoplasty (n=7, 23.3%). Regarding Friedman's system classification, 18(53%) patients were classified as stage 1, 8(35%) patients were classified as stage 2, and 4(14%) patients were classified as stage 3. No patients were in stage 4. Before surgery, the Modified Mallampati Score (MMS) was 3 (n=13, 43.3%) and 4(n=17, 56.7%), and after surgery, all of them had a score of 1 [Table 1].

Table 1: Distribution of sex, surgery type, Friedman's classification, and MMS scores

			N (%)
Sex		Male	27(90%)
		Female	3(10%)
Surgery		Z Pharyngoplasty	7(23.3%)
		UPPP	14(46.7%)
		Lateral pharyngoplasty	4(13.3%)
		ESP expansion sphincter pharyngoplasty	1(3.3%)
		Mixed surgery	4(13.3%)
Friedman's classification		Stage I	18(53%)
		Stage II	8(35%)
		Stage III	4(14%)
		Stage IV	0
MMS	Pre	3	13(43.3%)
		4	17(56.7%)
	Post	1	30(100%)

In the preoperative period, no female patients had mild AHI, whereas 3.3% of male patients did. Moderate AHI was observed in 3.3% of female and 33.3% of male patients. Severe AHI was more prevalent in 6.7% of female and 53.3% of male patients. Postoperatively, mild AHI was observed in 3.3% of female and 36.7% of male patients. Moderate AHI increased to 6.7% in female and 43.3% in male patients. The number of patients with severe AHI was significantly reduced, with no female patients and only 10% of male patients [Table 2].

Table 2: Comparison of AHI severity between male and female patients.

			Sex N (%)	
			Female	**Male**
AHI	Pre	Mild	0	1(3.3%)
		Moderate	1(3.3%)	10(33.3%)
		Severe	2(6.7%)	16(53.3%)
	Post	Mild	1(3.3%)	11(36.7%)
		Moderate	2(6.7%)	13(43.3%)
		Severe	0	3(10%)

The mean weight decreased from 76.40 ± 8.63 kg to 74.08 ± 8.54 kg (p<0.0005, r=0.99). BMI reduced from 27.37 ± 2.92 to 26.53 ± 2.88 (p<0.0005, r=0.99). The height remained unchanged. Neck circumference reduced from 39.53 ± 3.53 cm to 37.58 ± 3.46 cm (p<0.0005, r=0.976), chest circumference from 95.80 ± 4.86 cm to 93.77 ± 4.74 cm (p<0.0005, r=0.977), and abdominal circumference from 97.00 ± 7.53 cm to 94.83 ± 7.29 cm (p<0.0005, r=0.987).

The AHI reduced from 33.64 ± 12.60 to 17.94 ± 7.92 (p<0.0005, r=0.842), and SpO_2 levels increased from 69.97 ± 12.18% to 84.17 ± 8.29% (p<0.0005, r=0.822). The ESS scores were reduced from 13.47 ± 2.96 to 2.33 ± 1.18 (p<0.0005, r=-0.213) [Table 3].

Table 3: Comparison of Anthropometric and Sleep Study Parameters

		Mean±SD	**Correlation**	**P value**
Weight	Pre	76.40±8.63	0.99	<0.0005
	Post	74.08±8.54		
Height	Pre	167.07±3.64	-	-
	Post	167.07±3.64		
BMI	Pre	27.37±2.92	0.99	<0.0005
	Post	26.53±2.88		
NC	Pre	39.53±3.53	0.976	<0.0005
	Post	37.58±3.46		
CC	Pre	95.80±4.86	0.977	<0.0005
	Post	93.77±4.74		
AC	Pre	97.00±7.53	0.987	<0.0005
	Post	94.83±7.29		
AHI	Pre	33.64±12.60	0.842	<0.0005

	Post	17.94±7.92		
SPO2	Pre	69.97±12.18	0.822	<0.0005
	Post	84.17±8.29		
ESS	Pre	13.47±2.96	-0.213	<0.0005
	Post	2.33±1.18		

In the Z-pharyngoplasty patients, BMI decreased from 26.66 ± 2.87 to 25.89 ± 3.04, ESS reduced from 14.00 ± 4.04 to 7.00 ± 0.99, SpO_2 improved from 73.00 ± 13.15 to 82.86 ± 10.73, and AHI decreased from 73.00 ± 13.15 to 82.86 ± 10.61. For UPPP patients, BMI decreased from 26.31 ± 2.63 to 25.46 ± 2.52, ESS reduced from 13.36 ± 2.32 to 2.36 ± 1.23, SpO_2 improved from 71.93 ± 10.32 to 86.43 ± 6.46, and AHI decreased from 71.92 ± 10.32 to 86.43 ± 6.46.

In lateral pharyngoplasty, BMI reduced from 30.15 ± 1.26 to 29.22 ± 1.62, ESS declined from 13.75 ± 1.78 to 2.25 ± 1.08, SpO_2 increased from 67.75 ± 11.21 to 83.50 ± 6.69, and AHI dropped from 67.75 ± 11.21 to 83.50 ± 6.69. For expansion sphincter pharyngoplasty, BMI decreased from 27.63 to 26.57, ESS declined from 12.00 to 2.00, SpO_2 increased from 66.00 to 82.00, and AHI decreased from 66.00 to 82.00.

In mixed surgery patients, BMI reduced from 29.49 ± 2.10 to 28.73 ± 1.62, ESS declined from 13.00 ± 3.39 to 1.50 ± 0.87, SpO_2 increased from 61.00 ± 12.51 to 79.75 ± 8.26, and AHI decreased from 61.00 ± 12.51 to 79.95 ± 8.26 [Table 4].

Table 4: Comparison of pre-and postoperative BMI, ESS, SpO_2, and AHI across surgical procedures

	BMI		ESS		Sp02		AHI	
	Pre	**Post**	**Pre**	**Post**	**Pre**	**Post**	**Pre**	**Post**
Z Pharyngoplasty	26.66±2.87	25.89±3.04	14.00±4.04	7.00±0.99	73.00±13.15	82.86±10.73	73.00±13.15	82.86±10.61
UPPP	26.31±2.63	25.46±2.52	13.36±2.32	2.36±1.23	71.93±10.32	86.43±6.46	71.92±10.32	86.43±6.46
Lateral pharyngoplasty	30.15±1.26	29.22±1.62	13.75±1.78	2.25±1.08	67.75±11.21	83.50±6.69	67.75±11.21	83.50±6.69
ESP expansion sphincter pharyngoplasty	27.63±0.00	26.57±0.00	12.00±0.00	2.00±0.00	66.00±0.00	82.00±0.00	66.00±0.00	82.00±0.00
Mixed surgery	29.49±2.10	28.73±1.62	13.00±3.39	1.50±0.87	61.00±12.51	79.75±8.26	61.00±12.51	79.95±8.26

DISCUSSION

In our study, among the 30 patients who underwent surgery for OSA, 14 underwent UPPP, seven underwent zetaplasty, four underwent lateral pharyngoplasty, one underwent expansion sphincter pharyngoplasty, and four underwent multilevel surgery. 90% of the patients were male, which aligns with the findings of Khan et al., where 81% of the study population was male. This suggests that OSA is more prevalent in the male population.[11]

In our study, obesity and overweight status were found to be significant risk factors, with 43% of patients being overweight and 26.7% being classified as obese. This finding correlates with the study by Chang et al., who identified BMI as an indicator of OSA severity.[12] Similarly, Pang et al. reported that in a study group with BMI <30, AHI significantly reduced from 44.2 to 12 postoperatively, and the lowest oxygen saturation improved from 78% to 85%.[13] These results support the role of obesity as a major contributing factor to OSA severity.

In our study, the mean preoperative AHI was 33.64 ± 12.6, which aligns with the findings of Pang et al. and Janson et al., where the mean AHI was 40.1 and 47.3.13,[14] This suggests that most patients with OSA fall under the severe category, a trend observed in multiple studies. The mean preoperative ESS score in our study was 13.47 ± 2.96, which aligns with the study conducted by Pang et al., where the mean ESS score was 14.5.13 This indicates that a significant proportion of patients experienced excessive daytime sleepiness, consistent with our findings.

Postoperatively, PSG conducted at the one-month follow-up in our study showed that AHI was reduced to <50% of preoperative values in 18 patients, resulting in a 60% success rate. This is comparable to the success rates reported by Khan et al. and Elshaug et al. which were 51% and 51.5%.11,[15] Also, Lin et al. reported a success rate of 66.4% after multilevel surgery, which agrees with our study.[16]

In our study, snoring was present in 100% of patients preoperatively, like the findings of Whyte et al., who reported that 97.5% of the patients snored preoperatively.[17] Following surgery, snoring was completely resolved in 27 patients and reduced in severity in three patients, as confirmed by their partners. The significant reduction in AHI observed in our study, from 33.64±12.6) to 17.94±7.92 ($p < 0.0005$), aligns with the findings of Pang et al. where AHI reduced from 44.2 to 12 following surgery.[13] Similarly, Lin et al. reported a significant reduction in AHI after multilevel surgery, with an overall success rate of 66.4%.[16]

The improvement in SpO_2 levels from 69.97±12.18 to 84.17±8.29 ($p < 0.0005$) in our study correlates with the findings of Pang et al. where the lowest oxygen saturation improved from 78% to 85% postoperatively.[13] The reduction in ESS from 13.47 (SD = 2.96) to 2.33 (SD = 1.18) ($p < 0.0005$) in our study is consistent with the study by Pang et al where the mean preoperative ESS was 14.5, showing that a

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significant proportion of OSA patients experienced excessive daytime sleepiness, which improved substantially post-surgery.[17]

Limitations

The limitations of this study include the one-month follow-up period, which is insufficient to assess the long-term effects of surgery. The sample was not randomised, potentially introducing a selection bias. A larger sample size would improve the accuracy and reliability of the findings.

CONCLUSION

Our study concluded that untreated OSA, a sleep disorder, leads to systemic consequences. We investigated patients with OSA who refused or failed CPAP. After identifying the obstruction site, patients underwent surgery to address the velum, tongue, tonsil, and uvula. A significant proportion of patients showed subjective and objective improvements, as determined by reductions in AHI, ESS, and snoring. All surgeries were effective, with proper preoperative investigations, appropriate surgery, and lifestyle modifications.

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