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ORIGINAL ARTICLE

Drug-Induced Sleep Endoscopy as a Selection Tool for Surgical Management of Obstructive Sleep Apnoea Syndrome: Our Personal Experience

M. B. Bharathi[1] · J Rajendra Prasad[2] · K. Satish[3]

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Abstract The role of Drug-induced sleep endoscopy as a selection tool for surgical management of obstructive sleep apnoea syndrome. Source of data: Polysomnography proved OSA patients, who are planned for surgery in dept. of ENT AND HEAD& NECK, JSS Hospital, Mysore. Study design: A prospective clinical study. Method: 30 Polysomnography proved OSA patients, age between 20 and 60 years have been selected for Drug Induced Sleep Endoscopy (DISE) after taking informed consent for proposed surgery. Inj propofol infusion given throughout the DISE procedure and upper airway nasal endoscopy performed for assessment of site of collapse (Retropalatal, Retrolingual, Hypopharyngral), type of collapse (circumferential, lateral) and severity of obstruction, Lowest SpO_2, apnoeic episodes and DISE findings were recorded. Out of these thirty patients 90% were male and 10% were female, observed that 66.7% of males and 40.7% of females belonged to 31–40 age group, and BMI of 63.3% of patient population were overweight, 20% were obese and 5% were normal. Mean fall in SpO_2 was 90.20 ± 2.77 in normal subjects, 83.05 ± 5.14 in overweight subjects and 68.83 ± 9.11 in obese subjects. Normal subjects had 0.4 ± 0.9 apnoeic episodes, overweight subjects had 0.9 ± 1.6 episodes and obese subjects had 4.0 ± 2 apnoeic episodes. We observed that 40% had retropalatal airway collapse, 23.3% had airway obstruction at the base of the tongue, 20% had airway obstruction with floppy epiglottis, 12% multiple level collapse, 6.7% of patient population had grade 4 enlarged tonsils, 3.3% had lateral pharyngeal wall collapse, and 0% hypopharyngeal collapse. Out of 30, 29 Patients underwent surgery (Expansion sphincter pharyngo plasty—14, Hyoid advancement—4, Uuvulopalatoplasty—10, Epiglottic surgery—6, Zeta pharyngoplasty—2, midline glossectomy—3, Endoscopic septoplasty—5, Inferio turbinoplasty—2, LASSER Assisted lingual tonsillectomy—1), All these 29 patient were followed for 3 months, at the end of 3rd month again Each subject was evaluated with a baseline Epworth Sleepiness Scale and LEVEL-3 PSG, the results were impressive with statistically significant. DISE is a dynamic, safe, and easy-to-perform technique that visualizes, the anatomical sites of snoring or apneas for assessment site of collapse (Retropalatal, Retrolingual, Hypopharyngral), type of collapse (Circumferential, Lateral) and severity of obstruction and guides the design of a tailor-made treatment plan for a OSA SURGEON in individual cases, which will improves perioperative outcome.

Keywords Polysomnography · DISE · BMI · Retropalatal collapse · Uuvulopalatoplasty

✉ J Rajendra Prasad
janga_janga98@yahoo.com

[1] Department of ENT, JSS Medical College and JSS University, Mysore, India

[2] Department of ENT and Head and Neck Surgery, JSS Medical College and JSS University, Mysore, Karnataka 570004, India

[3] Department of ANAESTHESIA, JSS Medical College and JSS University, Mysore, India

Introduction

Drug-induced sleep endoscopy (DISE) is performed widely and its validity has been demonstrated by several studies; in fact, it provides clinical information not available by routine clinical inspection alone [1]. Even though sleep endoscopy during natural sleep is an ideal test, it is an

impractical diagnostic tool because the study needs to be carried out during the night and the endoscope may disturb the sleeping patient. For these reasons, in 1991 Croft and Pringle [2] introduced Drug-induced sleep nasal endoscopy, which provides direct visualization of structural collapses of the upper airway under anaesthesia. The study during the awake state may offer erroneous information regarding upper airway obstruction. In fact, Campanini et al. [1]. recently demonstrated that awake and sedation ENT evaluation was identical in only the 25% of cases. In particular, discrepancies involved the oropharyngeal and laryngo-hypopharyngeal sites. Laryngeal obstruction was misunderstood in almost 33% of cases.

These results are very important because diagnostically inaccurate information can lead to relevant negative implications in terms of treatment choices, particularly for surgical cases. Identification of the site of obstruction and pattern of upper airway changes during sleep is a key point essential in guiding therapeutic approaches of obstructive sleep apnoea syndrome (OSAS). Several studies have demonstrated that DISE may help to specify therapy individually, leading to an increased surgical success rate [3, 4]. For these reasons, DISE has been an essential breakthrough in evaluation of OSA patients. Nevertheless, it has been widely criticized due to the use of sedation that may cause false-positive results, as it assesses sleep in only a short interval that is not representative of a night's snoring, and that the patient's snoring quality and quantity of apnoea occurrences varies with sleeping position and sleep stages.

The reliability of DISE is good, and studies on its safety and utility are promising. Nevertheless, it needs to be improved to reach the level of excellence expected of gold standard tests used in clinical practice. In particular, additional research is required to determine the correlations between data obtained during DISE and results of standard clinical evaluation. Finally, some limitations remain unresolved, the lack of standardized protocols and validated grading scales; potential differences with natural sleep, effects of intravenous anaesthetic agents, test–retest reliability among different examiners [5, 6].

In Our study we analyze the validity of the sleep endoscopy to assess the best treatment for patients with OSAS, particularly those who are undergoing surgical treatment.

Materials and Methods

Subjects

From January 2015 to February 2016, we included 30 patients aged between 20 and 60 years (mean age 47.36 years) who successfully underwent sleep endoscopy at our institution (Department of ENT, Head and Neck Surgery, JSS HOSPITAL, MYSURU, KARANATAKA). There 3 females. BMI ranged from 22.6 to 36.4 kg/m^2 (mean BMI 27.1 $\pm$ 2.38); mean neck circumference was 40.5 $\pm$ 2.6 cm with valuwere 27 males andes ranging from 31 to 47 cm; Mean Epworth index was 21.10. Mean apnoea–hypopnoea index (AHI) was 35 events/h.

Inclusion Criteria

Patients of age between 20 and 60, giving informed consent Patients subjected to polysomnography.

Exclusion Criteria

Patients of age less than 20 years or greater than 60 years Patients refusal. Patients with acute respiratory tract infections Patients with uncontrolled systemic disorders like diabetes cardiac arrhythmias etc.

Study Design

Single institution, longitudinal prospective evaluation of a consecutive group of patients that underwent DISE for management of OSAS. All patients were willing to participate and gave consent to their inclusion.

Baseline Assessment

Each subject was evaluated with a baseline Epworth Sleepiness Scale (ESS). All patients received a full otolaryngologic examination to evaluate awake status of upper airway and in particular, size of uvula, soft palate and tonsils, tongue base, vallecula, size and shape of epiglottis and Mallampati Score. Following this preliminary evaluation, a full-night comprehensive PSG was scheduled.

Polysomnography

Each patient underwent a full-night ambulatory cardiorespiratory monitoring (LEVEL-2 PSG), performed to assess the sleep-related respiratory pattern. PSG was monitored continuously during the sleep-endoscopy procedure using a portable device. PSG recordings included airflow (nasal cannula trasducer), oxygen saturation, snoring sound and heart rate. An experienced sleep technician performed the application sensors for instructing the patients in their correct application. The frequency of obstructive events is reported as AHI. OSA severity was defined as *mild* for AHI $\geq$ 5 and $<$ 15, *moderate* for AHI $\geq$ 15 and $\leq$ 30 and *severe* for AHI $>$ 30. PSG monitoring was also performed in continuous mode during the sleep endoscopy procedure.

Drug-Induced Sleep Endoscopy

In a controlled, monitored setting (continuous PSG monitoring, as specified in the previous paragraph) with the help of an anesthesiologist, all patients underwent DISE performed by a specialist ENT Head and Neck surgeon. Patients were induced to sleep with a low dose of Propofol (0.01 mg/kg) followed by a titration of propofol (3 mg/kg/h). Sedation level was monitored using bispectral index (BIS) monitoring When the patient was asleep and actively snoring with BIS between 50 and 70, a video-recorded fibreoptic nasopharyngoscope was used to assess the upper airway. In our procedures, the average BIS was 55.78 with a mean minimum BIS of 43.15 and a mean maximum BIS of 72.14 5. When the patient begins to snore and demonstrate airway collapse, The flexible endoscope is inserted through one of the nostrils and is placed on different levels of the upper airways to visualize the site of collapse in real time. Areas of obstruction (velum including soft palate and tonsils, tongue base, larynx and hypopharynx) were classified using a DISE scoring sheet reporting type of obstruction [complete (100%) or partial (grade I: 0–25%; grade II: 25–50%; grade III: 50–75%: grade IV: >75%)] and dynamic pattern of closure (anterior–posterior, concentric, laterolateral). The DISE scoring sheet was completed in a second time by the principal investigator based on DISE assessment.

In our institution, drug induced sleep endoscopy is generally contraindicated in patients propofol or midazolam allergies (albeit rare), owing to high risk. Relative contraindications are also severe OSA (an AHI > 70 events/h) and severe obesity, as these patients are regarded as poor candidates for sleep surgery.

Statistical Methods

The descriptive statistics was used to summarize the data by measuring mean, median, standard deviation and proportions. Inferential statistics was done using, Chi square test, ANOVA, correlation and Kruskal–Wallis test. All $p < 0.05$ is considered significant. All the measurements are done using SPSS version 21.0. The graphs were made using Microsoft Excel.

Results

Taking into consideration grade of the sites of obstruction observed during DISE, it was possible to establish their prevalence.

We observed that BMI of 63.3% of patient population was categorized under overweight. 20% were obese and 5% were normal. Mean BMI of the patient population was 27.71 ± 2.38 (Fig. 1).

Mean fall in SpO_2 according to age group was 87.80 ± 5.07 in 21–30 years of age, 84.54 ± 6.06 in 31–40 age group and 75.33 ± 9.47 in 41–50 age group. Highest was observed in age group 21–30 years. Compared BMI with SpO_2 and observed that mean fall in SpO_2 was 90.20 ± 2.77 in normal subjects, 83.05 ± 5.14 in overweight subjects and 68.83 ± 9.11 in obese subjects. Observed that normal subjects had 0.4 ± 0.9 apnoeic episodes, Overweight subjects had 0.9 ± 1.6 episodes and Obese subjects had 4.0 ± 2 apnoeic episodes (Fig. 2).

We observed that 40% Had Retropalatal airway collapse, 23.3% had airway obstruction at the Base of the tongue, 20% Had airway obstruction with floppy epiglottis, 12% Multiple level collapse, 6.7% of Patient population had grade 4 Enlarged Tonsils, 3.3% Had lateral pharyngeal wall collapse, and 0% hypopharyngeal collapse (Fig. 3).

Out of 30, 29 Patients underwent surgery(Expansion sphincter pharyngo plasty—14, Hyoid advancement—4, Uuvulopalatoplasty—10, Epiglottic surgery—6, Zeta pharyngoplasty—2, midline glossectomy—3, Endoscopic septoplasty—5, Inferio turbinoplasty—2, LASSER Assisted lingual tonsillectomy—1)

All these 29 patient were followed for 3 months, at the end of 3rd month again Each subject was evaluated with a baseline Epworth Sleepiness Scale (ESS) and LEVEL-3 PSG, the results were impressive with statistically significant (Table 1; Fig. 4).

Discussion

Patients with OSAS experience excessive daytime sleepiness, impaired concentration, snoring, recurring nocturnal awakenings and non-restorative sleep with an increased risk of obesity and cardiovascular disease leading to substantial socio-economic implications [7]. Diagnostic evaluation is crucial to choose the best treatment options. Baseline evaluation is very important, but it needs to be Integrated with data obtained by polysomnography and sleep endoscopy in order to obtain, for each patient, all

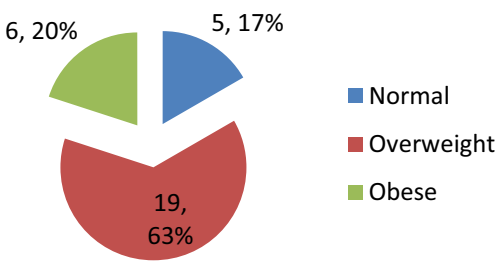

Fig. 1 BMI of population

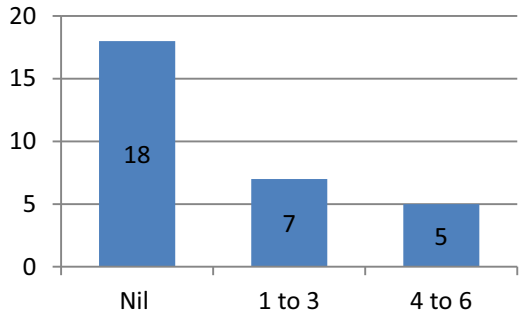

Fig. 2 Apnoeic episodes

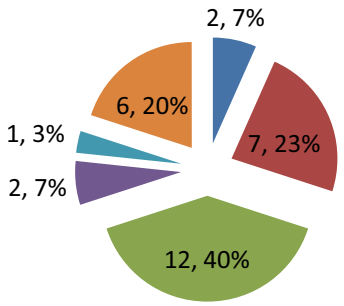

Fig. 3 DISE findings

relevant information about the Pathophysiology of the sleep airway obstruction. Currently, DISE is the most reliable standard method to determine the level, number and severity of sites of obstruction of the airway during the night in sleep apnoea patients and to specify the exact dynamic pattern of closure. In fact, even though overnight polysomnography is the gold standard diagnostic study for sleep-disordered breathing, it fails to establish the precise site of collapse.

Furthermore, the Muller manoeuvre has been questioned because it does not predict the success of surgery, location of upper airway obstruction or severity of the disease. In fact, measurement of the collapsibility of the upper airway during the awake state is not a good indicator of collapsibility during sleep, due to differences in term of muscle tone, sensitivity of reflexes and respiratory physiology, between the conscious and the unconscious states. Finally, plain film cephalometry and CT scans only provide static information about the bony structure without evidence of soft tissue collapse. For this reason, new insight is expected from tests such as DISE that add a dynamic evaluation to classical static ones during induced sleep. Dynamic magnetic resonance imaging (MRI) is promising, and is increasingly used in the evaluation of the site of collapse in OSA. In this field, newer studies have also led to a computational model of the human upper airway by signal averaging of MRI. Based on this model, various surgical interventions have been simulated, offering new possibilities in the improvement of surgical and nonsurgical approaches to OSA patients. Future studies will suggest the clinical value of its application in the standard diagnostic work-up [8, 9].

Our study compares the results of routine clinical and diagnostic evaluation with DISE results, evaluating the correlation between clinical indexes with number, dynamic pattern and severity of sites of obstruction. We scored four separate obstruction sites differentiating between partial and complete obstruction and defining the dynamic pattern of closure. We statistically correlated AHI, BMI and EPS not only with the number of sites of complete obstruction but also with partial ones, even though literature data are not consistent about this point.

We observed that a Retropalatal site is the most frequently involved in the obstruction followed by a Retrolingual site. Multilevel obstruction is more common than a single-level one. In addition, the results of our study show that multilevel obstruction was significantly associated with higher AHI. We demonstrated that a higher number of sites of obstruction significantly correlates with higher AHI, not only considering complete obstruction but also including sites with partial obstruction greater than 50%. Taking into account the dynamic pattern of closure, there is a significantly higher AHI only when a concentric pattern of closure is present, and in particular at an oropharyngeal site.

Thus, our study shows the appropriateness and reliability of the results obtained by DISE and their correlation with those obtained by polysomnography.

In our series, we found that a trend of higher BMI was associated with a higher number of sites of complete obstruction.

In our study, the depth of induced sleep was assessed using a BIS Monitor. In fact, the degree of upper airway narrowing can be intensified according to the depth of sedation. The monitoring of sedation during DISE is critical, especially in patients with mouth breathing. BIS, originally developed to validate the depth of anaesthesia, has begun to be used in sleep research.

The gold-standard treatment of OSAS is currently continuous positive airway pressure (CPAP), relegating other treatments—oral device and surgery—in case of failure of CPAP and only in moderate OSAS as the first option treatment. The introduction of DISE in helping to define the pathogenesis of the site of obstruction individually offers more targeted and tailored information that is changing the indications of initial treatment. Unfortunately, a significant number of patients do not tolerate CPAP (30–50%). For this reason, many patients try to find surgical therapy as an alternative solution. Based on the available data in cases in which surgery is indicated after standard pre-operative evaluation, surgeons still consider

Table 1 Comparison of AHI & ES scale Pre and Post operatively

Number	PRE OP ES	PRE OP AHI	POST OP ES	POSTOP AHI
1.	21	38	7	6
2.	20	38	9	8
3.	21	39	6	7
4.	20	35	9	9
5.	19	33	7	6
6.	18	39	8	9
7.	23	36	7	12
8.	21	35	11	5
9.	22	37	7	9
10.	18	35	8	11
11.	23	37	9	10
12.	21	38	10	12
13.	24	39	6	9
14.	22	36	8	6
15.	21	29	7	11
16.	20	36	9	9
17.	20	31	8	7
18.	19	35	9	8
19.	21	33	7	6
20.	22	34	9	4
21.	23	31	8	8
22.	21	35	9	9
23.	23	36	7	10
24.	23	37	9	9
25.	21	31	8	10
26.	20	37	9	8
27.	21	33	8	5
28.	21	34	9	8
29.	23	31	9	9
Average	21.10	35.10	8.17	8.55

ES epsworth scale, *AHI* apnoea hypoapnoea index

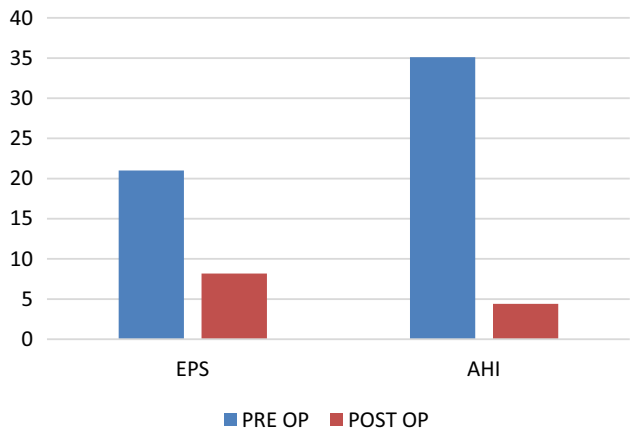

Fig. 4 Comparison table

sleep endoscopy as knowledge of the precise sites of obstruction is critical for successful sleep surgery; DISE, in fact, allows real-time identification of the levels of collapse and the severity and pattern of collapse at each level, offering an important predictive value of surgical success. Finally, sleep endoscopy shows potential for other applications and has been proposed for selecting candidates for other site specific interventions such as oral appliances and endoscopy-assisted CPAP titration [10].

In our series, as a final outcome of the diagnostic work up, surgery, oral device and CPAP were chosen based on DISE results. In particular, when surgery was indicated DISE appears to be fundamental in defining the type of intervention. In four cases, we preferred DISE over repeat polysomnography due to discrepancies between DISE results and AHI before suggesting the best treatment option. Several surgical approaches have been suggested for OSAS patients [11, 12], although the surgeon should consider DISE results before planning the optimal surgical treatment.

Conclusion

Our data suggest that DISE is safe, easy to perform, valid and reliable, as previously reported. Furthermore, we found a good correlation between DISE findings and clinical characteristics such as AHI and EPS, in agreement with literature data. In particular, we observed a significant association between higher AHI and higher number of sites of obstruction in terms not only of complete obstruction, but also of partial obstruction greater than 50%.

Based on our data, we suggest that adequate assessment by DISE of all sites of obstruction is very important, not only in patients with low-moderate AHI and EPS, but also in patients with high AHI or/and high EPS, which is important to plan multilevel surgery as it is more demanding and success may be harder to achieve. Moreover, it has recently been demonstrated that the test–retest reliability of DISE is good and that DISE has a relevant influence on treatment recommendations, positively influencing success rates of OSA therapy by addressing airway obstruction in a targeted fashion, leading to surgical treatment that is tailored to a specific pattern of obstruction.

Compliance with Ethical Standards

Conflict of interest None of the other is having conflict of interest in this study.

Ethical Approval All procedures performed in this studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

Informed Consent Informed consent was obtained from all individual participants included in the study.

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