Acta Scientific Otolaryngology

Volume 3 Issue 5 May 2021

Research Article

Role of Drug Induced Sleep Endoscopy in Diagnosing the Site and Severity of Obstruction in Patients with Obstructive Sleep Apnoea

Aditi Mahajan[1]* and Susan K Sebastian[2]

[1]Consultant, Department of ENT & Head,Neck Surgery, Government Multispeciality Hospital , Chandigarh, India

[2]Head of Department, Department of ENT & Head,Neck Surgery,St Stephen's Hospital,Tis Hazari,Delhi,India

***Corresponding Author:** Aditi Mahajan, Consultant, Department of ENT & Head,Neck Surgery, Government Multispeciality Hospital , Chandigarh, India.

Received: March 16, 2021

Published: April 14, 2021

Abstract

Introduction: The surgical management of Obstructive sleep apnoea (OSA) is based on the site and severity of obstruction of upper airway. The present study has evaluated these factors by performing a preoperative drug induced sleep endoscopy. The study aimed at diagnosing the site of obstruction in patients with obstructive sleep apnoea symptoms by drug induced sleep endoscopy and their relation to obstructive sleep apnoea syndrome severity.

Materials and Methods: The study was conducted on 30 patients aged between 12 - 65 years, presenting with symptoms of obstructive sleep apnoea. All patients underwent drug induced sleep endoscopy in operation theatre under propofol sedation.

Result: In our study the sleep endoscopy findings revealed multilevel obstruction in 90% patients with maximum obstruction seen at retropalatal site. All 30 patients had varying degrees of retropalatal obstruction. Hypopharyngeal obstruction was seen in 83.33%. Next common site of obstruction in patients was the base of tongue, causing obstruction in 50% of the patients. Least common sites were the nose/nasopharynx and larynx. In larynx, epiglottis was the common site of obstruction.

Conclusion: Drug Induced Sleep Endoscopy is a useful tool for the preoperative assessment and surgical planning OSA patients undergoing surgery management.

Keywords: Snoring; Polysomnography; Propofol; Obstructive Sleep Apnea; Sleep Deprivation; Sleep Endoscopy; Airway Obstruction

Introduction

Obstructive Sleep Apnoea Hypopnoea Syndrome (OSAHS) is often misdiagnosed and has great impact on society and also imposes health issues amongst patients [1]. In recent years there has been much interest in the assessment and management of patients with snoring and obstructive sleep apnoea syndrome (OSAS). Snoring may be just the production of sound during sleep or may represent a part of obstructive sleep apnoea hypopnoea. A good sleep influences hormonal release, glucose regulation and cardiovascular function [1]. Obstructive sleep apnoea hypopnea syndrome (OSAHS) is a sleep disorder which is characterized by multiple episodes of partial (hypopnoea) or complete (apnoea) upper airway [UA] obstruction [2]. Obstructive sleep apnoea causes derangements that occur due to repeated sagging of the upper airway like disturbance in sleep, low oxygen saturation, increased CO_2 retention, significant variation in intra-thoracic pressure and increase in the sympathetic activity.

There are reports showing that undiagnosed and untreated OSA increases the risk of fatal and nonfatal road side accidents by 2.5- fold [4]. OSA imposes great burden on CVS leading to increase in illness

and mortality in patients. The American Academy of Sleep Medicine classified OSA on the basis of apnoeic events per hour:

- Mild OSA - 5 to 15 events per hour,
- Moderate - 15 to 30 events,
- Severe - 30 events or more.

Polysomnography (PSG) is the gold standard diagnostic test for OSAS which gives information about the severity of OSAS and the degree of sleep fragmentation. Apnoea-Hypopnoea index and respiratory disturbance index can also be assessed PSG. The shortcoming of PSG is that it does not give any information regarding the level or degree of airway narrowing [10].

A successful surgery in OSA patients requires accurate identification of the pattern of airway obstruction, site of the same and therapy accordingly [12]. There is significant difference between awake state findings and the sleep-breathing situation [14] and so incorrect information may lead to wrong target identification and no improvement post-surgery.

Drug-induced sleep endoscopy (DISE) is a dynamic test that helps in assessing the upper airway collapsibility during drug induced sleep [15].

The use of sedation can cause false-positive results, as it evaluates sleep in only a short interval that is not representative of a night's snoring, and that the patient's snoring depends upon the stage of sleep [16].

Materials and Methods

This work hold to the values laid down in the Declaration of Helsinki (1964). The study was performed after clearance from the ethical committee. All patients enrolled gave full informed consent to participate in this study.

A cross sectional study was performed in our ENT department which enrolled 30 patients of age between 12 - 65 years who presented with symptoms of obstructive sleep apnoea.

Patients associated with other pulmonary diseases such as COPD, Interstitial lung disease, Bronchiectasis were excluded from the study group.

All patients included underwent drug induced sleep endoscopy in operation theatre. For all patients included in this following study.

Detailed medical history:

- Snoring, choking and witnessed apnoea, disturbance in sleep, unpleasant dreams at night.
- Headache, excessive day time sleepiness (Epworth sleepiness scale) during daytime.

Physical examination

Anthropometric measures: Height, weight, body-mass index (BMI), neck and waist circumference.

ENT examination: It includes:

- Nasal inspection: Nasal ala, vestibule description and anterior rhinoscopy were done.
- Tonsil size: It was graded 1 to 4 as follows:
  - Grade 1: The tonsils are in the tonsillar fossa, barely seen behind the anterior pillar.
  - Grade 2: The tonsils are visible behind the anterior pillars.
  - Grade 3: The tonsils are extended three quarters of the way to the midline.
  - Grade 4: The tonsils are completely obstructing the airway.

Modified Mallampati score (MMP) (Friedman., *et al*.): examining the oropharynx but without tongue protrusion.

Grades of MMP are as follows:

- Grade I: The tonsils, pillars and soft palate are clearly visible.
- Grade II: The uvula, pillars and upper pole are visible.
- Grade III: The soft palate is partly visible; while the tonsils, pillars and base of uvula are all invisible.
- Grade IV: The hard palate only is visible.

Sleep endoscopy was performed in operation theatre after obtaining informed and written consent.

Instrument used:

1. Flexible nasopharyngoscope
2. Camera
3. Light source
4. Pulse oximeter.

Technique of sleep endoscopy: In the operation theatre, the patient was placed in supine position, intravenous access was estab-

lished. An anaesthetist then induced sleep by sedating the patient with intravenous propofol 1 - 1.5 mg/kg upto maximum 2.5 mg/kg. The examination was started when the patient started snoring and developing symptoms of obstruction. Endoscopic inspection of upper airway was performed.

Five anatomical sites leading to obstruction along the upper airway were documented:

- Nose/nasopharynx (N),
- Uvulopalatine plane (P),
- Tongue base (T),
- Larynx (L), and
- Hypopharynx (H).

Also the evaluation of degree of collapse of pharynx evaluated at different levels. This was graded separately for each region:

- Grade I: < 25%,
- Grade II: 25 - 50%,
- Grade III: 50 - 75% and
- Grade IV: > 75% obstruction.

The site of obstruction, percentage of obstruction and minimum spo2 level reached during the endoscopy were noted.

Results

Mean age was-47 years (Figure 1) and Male: female ratio was 2.8:1 (Figure 2). Majority of patients presented with history of snoring associated with choking, witnessed apnoea disturbed sleep, excessive daytime sleepiness (Figure 3). Snoring and disturbed sleep were the main complaints (n = 26) (Figure 3). BMI was calculated for the patients and maximum patients belonged to "overweight group" with mean BMI 29.33 (Figure 6). Sleep endoscopy findings showed 90% patients had multilevel obstruction with only 10% with single level obstruction (Figure 10). 96.67% patients had obstruction at retropalatal level out of which 75.86% patients had grade 4 obstruction (Figure 11) followed by hypopharyngeal obstruction (83.33%) (Figure 13), nose/nasopharynx (66.67%) (Figure 14), retroglossal level obstruction (50%) (Figure 12) the level of larynx (most commonly due to epiglottis) (33.33%) (Figure 15). SPO_2 level was continuously monitored during the procedure and the lowest spo_2 encountered was 60% (Figure 16).

Observations

A total of 30 patients were included in this study. Patients belonged to age-groups ranging from second to sixth decade. Most patients belong to fifth decade with mean age 47 years (Figure 1).

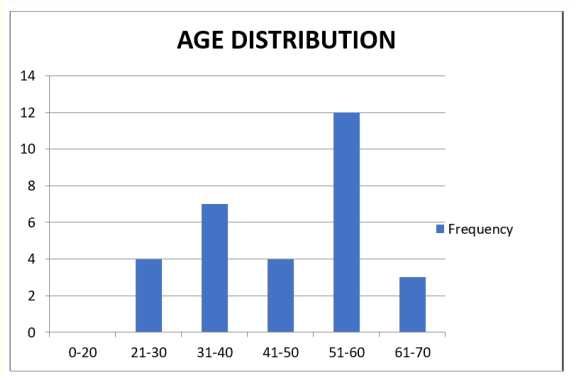

Figure 1: Age distribution.

Sex distribution

Out of 30 patients 26.67% (n = 8) were females and 73.33% (n = 22) were males (Figure 2).

Figure 2: Sex distribution.

Symptoms

Patients presented with multiple complaints of which snoring and disturbed sleep were the main complaints (n = 26) (Figure 3).

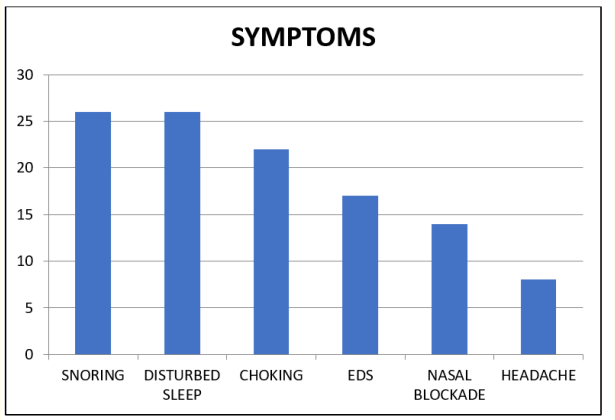

Figure 3: Symptoms.

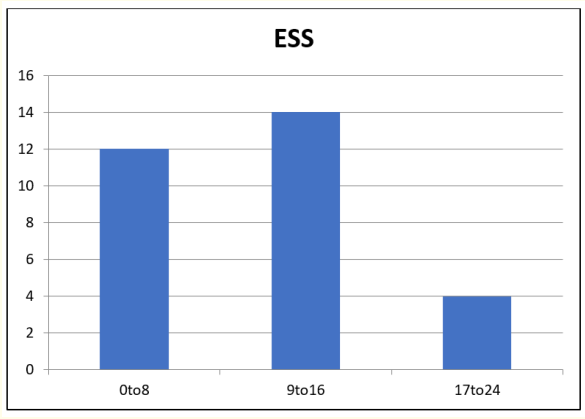

Figure 5: ESS.

Comorbidities

66.67% had associated comorbidities. 13.33% patients had hypertension (n = 4), 10% had diabetes mellitus type 2 (n = 3), 10% had both diabetes and hypertension (n = 3). Others had hypothyroidism (n = 3) seizure disorder (n = 1), dyslipidemia (n = 1), asthma (n = 1) (Figure 4).

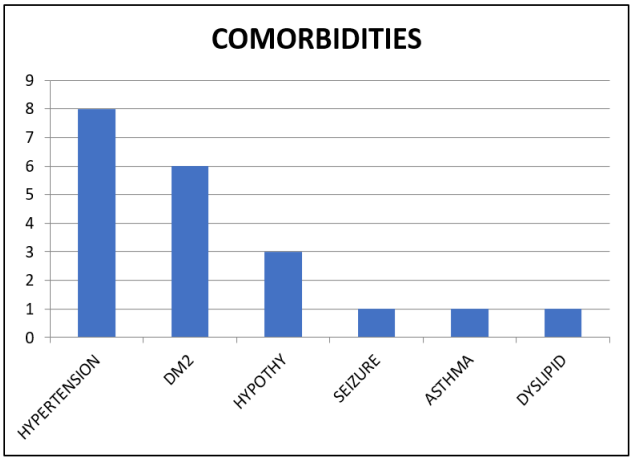

Figure 4: Comorbidities.

Epworth sleepiness scale (ESS)

ESS was also calculated for the patients and 46.67% patients had ESS score between 9-16 with mean score 9.9 (Figure 5).

Clinical examination

BMI

It was calculated for the patients and maximum patients belonged to "overweight group" with mean BMI 29.33 (Figure 6).

Figure 6: BMI.

Mallampati score

It was calculated and out of 30 patients, 70% patients had mallampati grade 3 (n = 21), 16.67% patients had grade 4 (n = 5), 13.33% had grade 2 (n = 4) (Figure 7).

Nasal examination

24 out of 30 patients had nasal obstruction.43.33% patients had inferior turbinate hypertrophy (n = 13), 10% had deviated nasal sep-

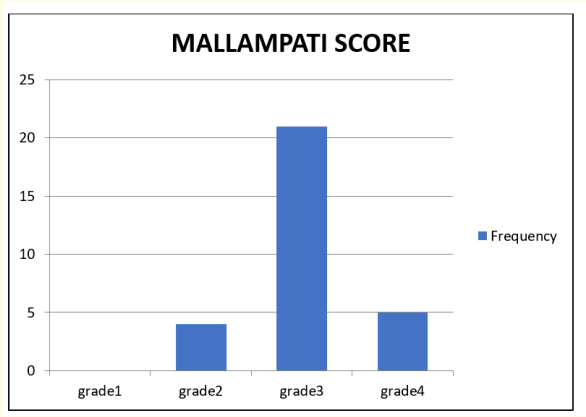

Figure 7: Mallampati score.

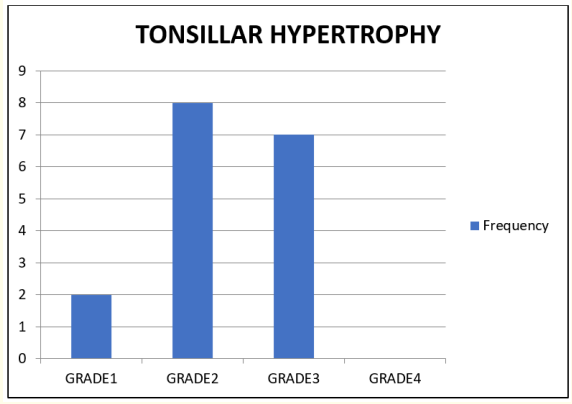

Figure 9: Tonsillar hypertrophy.

tum (n = 3), 26.67% had both inferior turbinate hypertrophy and deviated nasal septum (n = 8) (Figure 8).

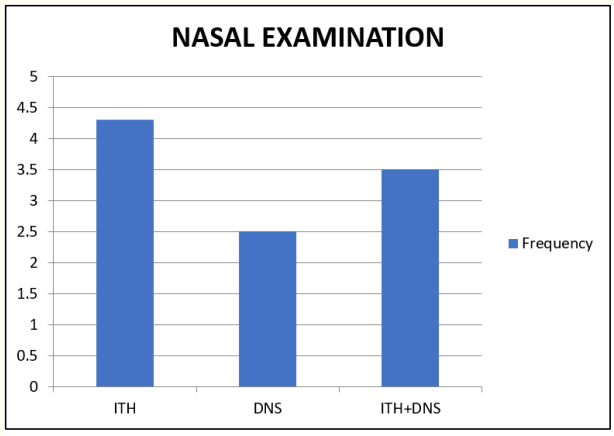

Figure 8: Nasal examination.

Level of obstruction

90% patients had multilevel obstruction with only 10% with single level obstruction (Figure 10).

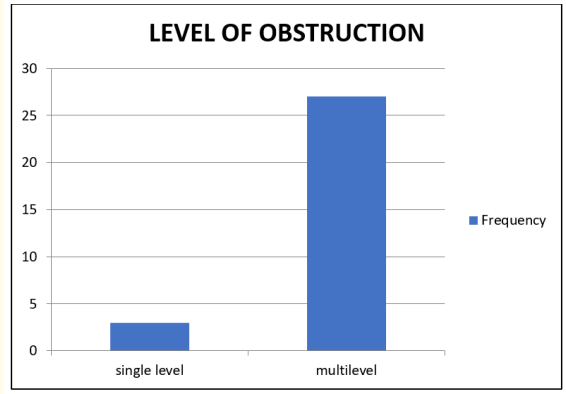

Figure 10: Level of obstruction.

Tonsillar hypertrophy

It was seen in 17 out of 30 patients. Of which 47.05% had grade 2 hypertrophy (n = 8), 41.17% had grade 3 hypertrophy (n = 7), 11.76% had grade 1 hypertrophy (n = 2), (Figure 9).

Sleep endoscopy findings

All patients had multilevel obstruction with retropalatal being the most common site causing significant obstruction and nose/nasopahrynx being the least common.

Retropalatal obstruction

96.67% patients had obstruction at retropalatal level with 75.86% patients having grade 4 obstruction (Figure 11).

Retroglossal obstruction

15 out of 30 patients (50%) retroglossal level obstruction with 46.67% patients having grade 3 obstruction (Figure 12).

Severity	Frequency	Percentage
Grade 1	2	6.67%
Grade 2	3	10.34%
Grade 3	2	6.67%
Grade 4	22	73.33%

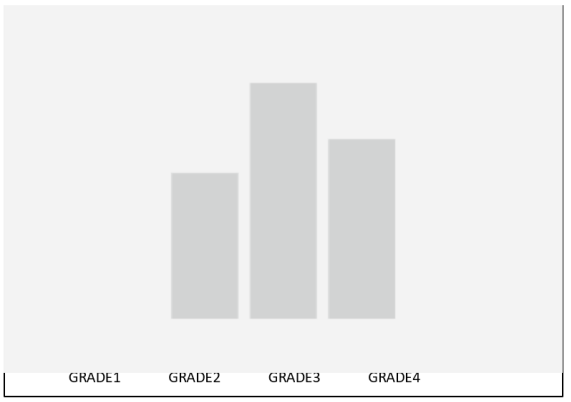

Figure 11: Retropalatal obstruction.

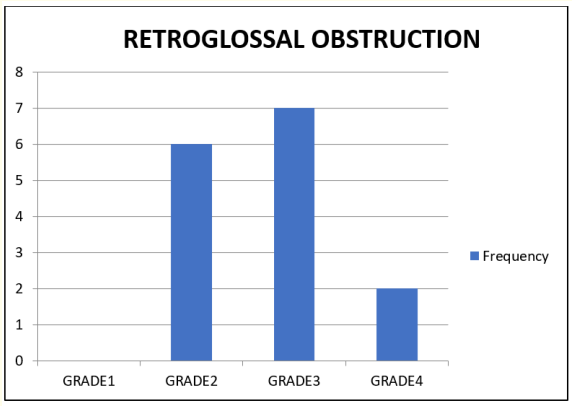

Figure 12: Retroglossal obstruction.

Hypopharyngeal obstruction

25 out of 30 patients (83.33%) had hypopharyngeal obstruction with 36% having grade 4 obstruction (Figure 13).

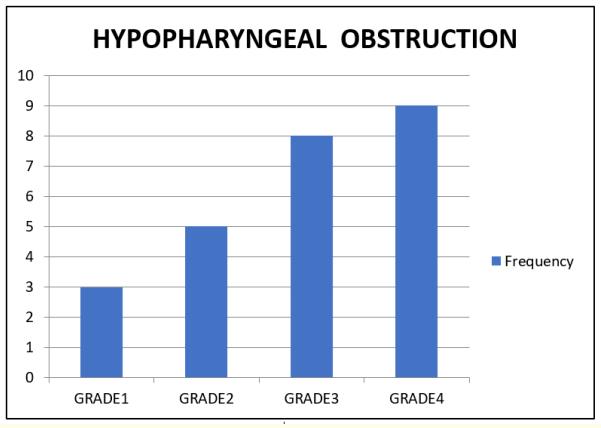

Figure 13: Hypopharyngeal obstruction.

Nose/nasopharynx obstruction

20 out of 30(66.67%) patients had obstruction t the level of nose/nasopahrynx with 55% having grade 2 obstruction (Figure 14).

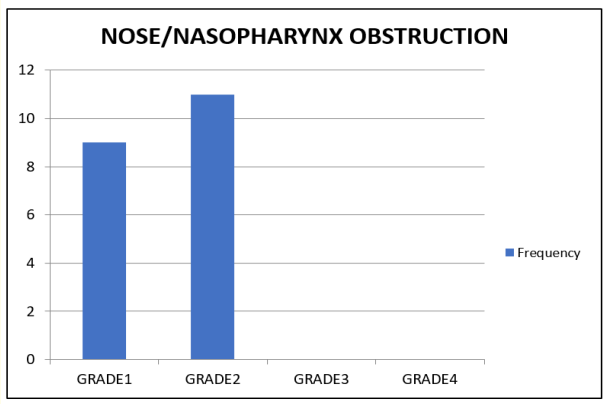

Figure 14: Nose/nasopharynx obstruction.

Laryngeal obstruction

10 out of 30 had obstruction at the level of larynx (most commonly due to epiglottis) (33.33%) with 50% patients having grade 3 obstruction (Figure 15).

Level of SPO_2

SPO_2 level was continuously monitored during the procedure and the lowest SPO_2 encountered was 60% (Figure 16).

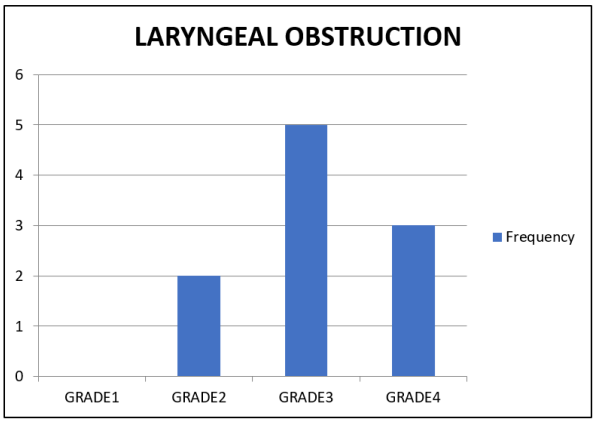

Figure 15: Laryngeal obstruction.

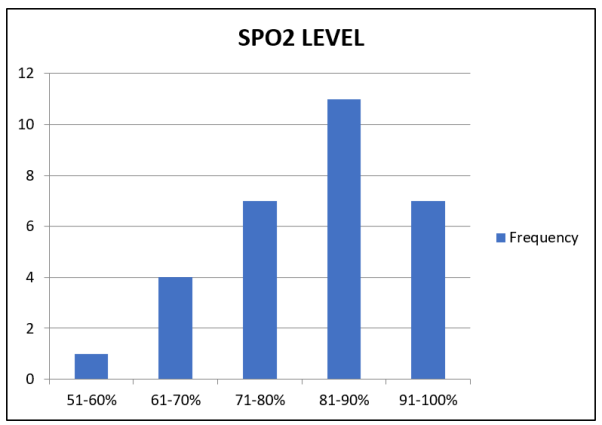

Figure 16: Intraoperative SPO_2.

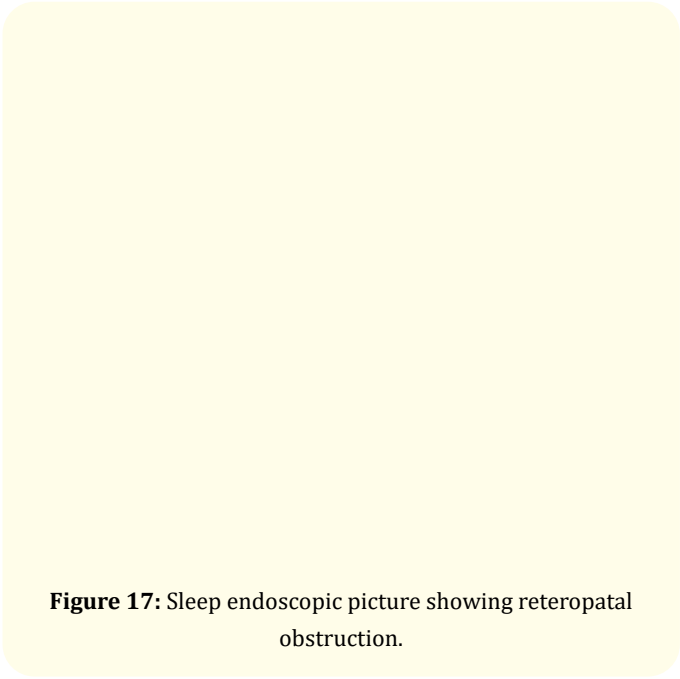

Figure 17: Sleep endoscopic picture showing reteropatal obstruction.

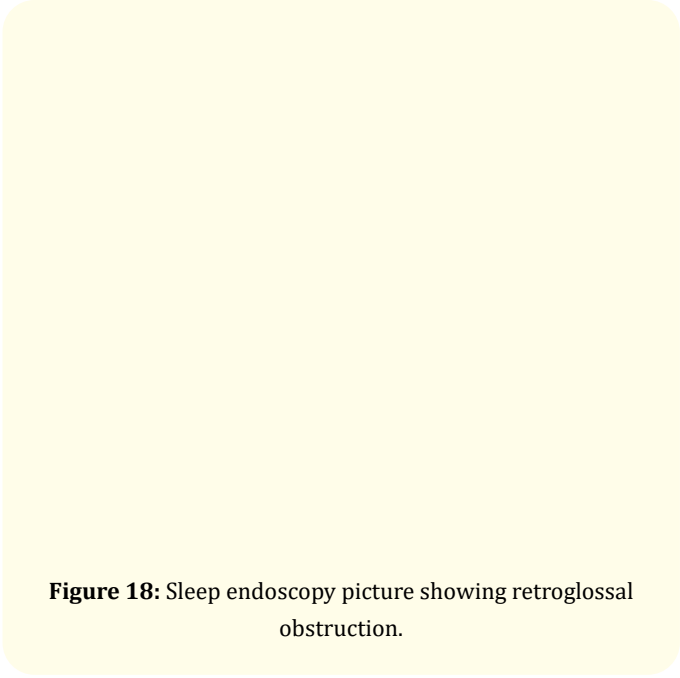

Figure 18: Sleep endoscopy picture showing retroglossal obstruction.

Discussion

In our study we found that OSA can affect any age group ranging between 20 to 70 years. It is not only seen in obese people but also in people with normal BMI. Every patient who snores does not necessarily suffer from OSA. Also snoring was seen in 86.67% of patients, therefore it is not necessary that all patients who suffer from OSA have snoring as a chief complaint. Mallampati grade is an important clinical predictor in the diagnosis of OSA and correlated well with the sleep endoscopy findings too (Figure 7). 90% patients (n = 27) had multilevel obstruction with only 10% (n = 3) with single level obstruction. In single level obstruction 66.67% had reteropalatal (Figure 1) and 33.33% had laryngeal obstruction (epiglottis) (Figure 3). Our data suggested that multilevel obstruction was notably

Figure 19: Sleep endoscopy picture showing obstruction at the level of larynx (Epiglottis).

associated with higher ESS as a higher number of sites of obstruction significantly correlated with higher ESS scores (Figure 5).

Abdullah., *et al*. [23] reported that most patients with OSA had multilevel obstructions thus it is not strange not to find a relation between the area of obstruction seen in the sleep endoscopy and the AHI. They also found that, at the supine retropalatal, average oxygen saturation has significant association with the severity of obstruction.

Pang., *et al*. [27] suggested that all 3 levels (palatal, lateral pharyngeal wall, and base of tongue) corresponded very well with the severity of OSA. Hori., *et al*. [31] reported that there was a significant correlation between the degree of narrowing of the retropalatal and apnoea index. They also noted that there was a significant difference in the frequency and degree of base of tongue collapse in patients with severe OSA. They reported that only 6.9% of patients with mild OSA had a 50% collapse of the base of the tongue region, as compared to 65.9% of patients with severe OSA.

Patients having grade 3 to grade 4 severity at the level of larynx had floppy or omega shaped epiglottis which obstructed the laryngeal airway. Floppy epiglottis was seen in patients belonging to a normal or overweight range of BMI. But patients with omega shaped epiglottis were also associated with severe OSAS.

Gazayerli., *et al*. [35] performed esophagogastroduodenoscopy on patients with body mass indexes ranging from 21 to 63 and noticed a significant correlation between BMI and the degree of concavity of the posterior epiglottal surface. They found that the posterior surface of the epiglottis in patients with normal BMI was minimally concave. As the BMI increased, the extent of concavity increased to the point at which total obstruction at level of the epiglottis was seen in extreme cases. They concluded that as BMI is correlated with OSAS severity, the abnormally shaped epiglottis is related to OSAS severity.

DISE is helping in identifying the pathogenesis behind OSA, the site of obstruction, the severity for the same and thus helping in providing proper treatment and deviating from the standard treatment which was given to all OSA patients. It has been seen in that number of patients do not tolerate CPAP (30 - 50%) [48]. For this reason, patients were trying to find any surgical approach to cater the problem. DISE gives the idea of the sites of obstruction, allows dynamic visualisation of the levels of collapse and the severity and pattern of collapse at each level, offering an important value of surgical success. Finally, sleep endoscopy helps in selecting candidates for other site specific interventions such as oral appliances and endoscopy-assisted CPAP titration [47]. Whenever surgery is indicated, DISE appears to be an important investigation in defining the type of surgery accurately.

Conclusion

Drug Induced Sleep Endoscopy is a dynamic test for assessing level and degree of upper airway obstruction in medicine induced sleep in OSAS and is an essential tool in preoperative evaluation when planning for surgery especially in presence of multilevel obstruction.

Our data suggests that DISE is easy to perform, safe, valid and reliable, as previously reported. We found a good correlation between DISE findings and clinical characteristics.

Based on the above mentioned observations which are supported with empirical evidences, the study conforms to the inferences drawn by the previous studies carried out in the similar area of interest.

Funding

No Funding was received.

Conflict of Interest

Mahajan A declares that she has no conflict of interest. Sebastian K S declares that she has no conflict of interest.

Ethical Approval

All examination and procedure done in this study involving human participants were according to the ethical standards of the institution and/or national research committee and with the 1964 Helsinki declaration and its amendments or comparable ethical standards.

Informed Consent

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

Bibliography

1. Lam J and Ip M. "Sleep and the metabolic syndrome". *Indian Journal of Medical Research* 131.2 (2010): 206-216.

2. Iber C., *et al.* "The AASM manual for the scoring of sleep and associated events: rules, terminology and technical specifications. Westchester, IL". *American Academy of Sleep Medicine* 7 (2007): 45.

3. He J., *et al.* "Mortality and apnea index in obstructive sleep apnea. Experience in 385 male patients". *Chest* 94.1 (1988): 9-14.

4. Sassani A., *et al.* "Reducing motor-vehicle collisions, costs, and fatalities by treating obstructive sleep apnea syndrome". *Sleep* 27.3 (2004): 453-458.

5. Ip MS., *et al.* "Obstructive sleep apnea is independently associated with insulin resistance". *American Journal of Respiratory and Critical Care Medicine* 165.5 (2002): 670-676.

6. Heinemann S., *et al.* "Occurrence of obstructive sleep related respiratory disorder in conjunction with gastro¬esophageal reflux". *Pneumologie* 49.1 (1995): 139-141.

7. Graf KI., *et al.* "Gastroesophageal reflux in patients with sleep apnea syndrome". *Zeitschrift für Gastroenterologie* 33.12 (1995): 689-693.

8. Teramoto S., *et al.* "Obstructive sleep apnea syndrome may be a significant cause of gastroesophageal reflux disease in older people". *Journal of the American Geriatrics Society* 47.10 (1999): 1273-1274.

9. Patil SP., *et al.* "Adult obstructive sleep apnea: pathophysiology and diagnosis". *Chest* 132.1 (2007): 325-337.

10. Kushida CA., *et al.* "Wise practice parameters for the indications for polysomnography and related procedures: an update for 2005". *Sleep* 28 (2005): 499-521.

11. Suslu AE., *et al.* "Comparison of two endoscopic examination methods, the Mueller manoeuvre and fiberoptic pharyngoscopy during sleep, in patients with obstructive sleep apnea". *Kulak Burun Boğaz İhtisas Dergisi* 16 (2006): 200-204.

12. Roblin G., *et al.* "Target controlled infusion in sleep endoscopy". *Laryngoscope* 111 (2001): 175-176.

13. Eichler C., *et al.* "Does drug-induced sleep endoscopy change the treatment concept of patients with snoring and obstructive sleep apnea?" *Sleep Breath* 17 (2013): 63-68.

14. Croft CB and Pringle M. "Sleep nasendoscopy: a technique of assessment in snoring and obstructive sleep apnoea". *Clinical Otolaryngology* 16 (1991): 504-509.

15. Campanini A., *et al.* "Awake versus sleep endoscopy: personal experience in 250 OSAHS patients". *ACTA Otorhinolaryngologica Italica* 30 (2010): 73-77.

16. Salama S., *et al.* "Role of sleep endoscopy in obstructive sleep apnea syndrome". *Egyptian Journal of Chest Diseases and Tuberculosis* 62.3 (2013): 467-473.

17. Berry S., *et al.* "Validity of sleep nasendoscopy in the investigation of sleep related breathing disorders". *Laryngoscope* 115 (2005): 538-540.

18. Stuck BA and Maurer JT. "Airway evaluation in obstructive sleep apnea". *Sleep Medicine Reviews* 12 (2008): 411-436.

19. Hong SD., *et al.* "Change of obstruction level during drug-induced sleep endoscopy (DISE) according to sedation depth in obstructive sleep apnea". *Laryngoscope* 123.11 (2013): 2896-2899.

20. Young T., *et al.* "Epidemiology of obstructive sleep apnea: a population health perspective". *American Journal of Respiratory and Critical Care Medicine* 165 (2002): 1217-1239.

21. Skatvedt O. "Localization of site of obstruction in snorers and patients with obstructive sleep apnea syndrome: a comparison of fiberoptic nasopharyngoscopy and pressure measurements". *Acta Otorrinolaringológica* 113 (1993): 206-209.

22. Dyken ME., *et al.* "Investigating the relationship between stroke and obstructive sleep apnea". *Stroke* 27 (1996): 401-407.

23. Abdullah VJ., *et al.* "Video sleep nasendoscopy: the Hong Kong experience". *Otolaryngologic Clinics of North America* 36 (2003): 461-471.

24. Norton PG., *et al.* "Snoring in adults: some epide¬miologic aspects". *Canadian Medical Association Journal* 128.6 (1983): 674-675.

25. Terris DJ., *et al.* "Reliability of the Mueller manoeuvre and its association with sleep-disordered breathing". *Laryngoscope* 110.11 (2000): 1819-1823.

26. Woodson BT and Wooten MR. "Comparison of upper-airway evaluations during wakefulness and sleep". *Laryngoscope* 104 (1994): 821-828.

27. Pang KP., *et al.* "Severity of obstructive sleep apnea: correlation with clinical examination and patient perception". *Otolaryngology–Head and Neck Surgery* 135 (2006): 555-560.

28. Ravesloot MJL and de Vries N. "One hundred consecutive patients undergoing drug-induced sleep endoscopy: results and evaluation". *Laryngoscope* 121 (2011): 2710-2716.

29. Hori Y., *et al.* "Endoscopic evaluation of dynamic narrowing of the pharynx by the Bernouilli effect producing manoeuvre in patients with obstructive sleep apnea syndrome". *Auris Nasus Larynx* 33 (2006): 429-432.as

30. Abdullah B., *et al.* "A videoendoscopic evaluation of the upper airway in South East Asian adults with obstructive sleep apnea syndrome". *Sleep Breath* 10 (2010): 431-437.

31. Rodenstein DO., *et al.* "Pharyngeal shape and dimensions in healthy subjects, snorers, and patients with obstructive sleep apnoea". *Thorax* 45 (1990): 722-727.

32. Schwab RJ., *et al.* "Dynamic upper airway imaging during awake respiration in normal subjects and patients with sleep disordered breathing". *The American Review of Respiratory Disease* 148 (1993): 1385-1400.

33. Hsu PP., *et al.* "Clinical predictors in obstructive sleep apnea patients with computer-assisted quantitative videoendoscopic upper airway analysis". *Laryngoscope* 114 (2004): 791-799.

34. Ryan CM and Bradley DT. "Pathogenesis of obstructive sleep apnea". *Journal of Applied Physiology* 99 (2005): 2440-2450.

35. Gazayerli M., *et al.* "A correlation between the shape of the epiglottis and obstructive sleep apnea". *Surgical Endoscopy* 20 (2006): 836-883.

36. Rodriguez-Bruno K., *et al.* "Test-retest reliability of drug-induced sleep endoscopy". *Otolaryngology–Head and Neck Surgery* 140 (2009): 646-651.

37. Aktas O., *et al.* "The role of drug-induced sleep endoscopy in surgical planning for obstructive sleep apnea syndrome". *European Archives of Oto-Rhino-Laryngology* 272.8 (2015): 2039-2043.

38. Hewitt RJ., *et al.* "Is sleep nasendoscopy a valuable adjunct to clinical examination in the evaluation of upper airway obstruction?" *European Archives of Oto-Rhino-Laryngology* 5 (2009): 691-697.

39. Kezirian EJ., *et al.* "Interrater reliability of drug-induced sleep endoscopy". *Archives of Otorhinolaryngology-Head and Neck Surgery* 136.4 (2010): 393-397.

40. Kezirian EJ., *et al.* "Drug-induced sleep endoscopy: the VOTE classification". *European Archives of Oto-Rhino-Laryngology* 268.8 (2011): 1233-1236.

41. De Vito A., *et al.* "European position paper on drug-induced sedation endoscopy (DISE)". *Sleep Breath* 18.3 (2014): 453-465.

42. Kotecha BT., *et al.* "Sleep nasendoscopy: a 10-year retrospective audit study". *European Archives of Oto-Rhino-Laryngology* 264.11 (2007): 1361-1367.

43. Sadaoka T., *et al.* "The value of sleep nasendoscopy in the evaluation of patients with suspected sleep-related breath-

ing disorders". *Clinical Otolaryngology and Allied Sciences* 21.6 (1996): 485-489.

44. Lee Hee Chull and Kim Sang Wook. "Retrospective analysis of Upper Airway Obstruction by Sleep Videofluoroscopy in Obstructive Sleep Apnea". *Journal of Korean Medical Science* 29 (2014): 243-247.

45. Cavaliere M., *et al.* "Awake versus drug-induced sleep endoscopy: evaluation of airway obstruction in obstructive sleep apnea/hypopnoea syndrome". *Laryngoscope* 123.9 (2013): 2315-2318.

46. Borek RC., *et al.* "Quantitative airway analysis during drug-induced sleep endoscopy for evaluation of sleep apnea". *Laryngoscope* 122 (2012): 2592-2599.

47. Civelek S., *et al.* "Comparison of conventional continuous positive airway pressure to continuous positive airway pressure titration performed with sleep endoscopy". *Laryngoscop*e 122 (2012): 691-695.

48. Vanderveken OM. "Drug-induced sleep endoscopy (DISE) for non-CPAP treatment selection in patients with sleep-disordered breathing". *Sleep Breath* 17 (2013): 13-14.

49. Johns MW. "A new method for measuring daytime sleepiness: the Epworth sleepiness scale". *Sleep* 14 (1991): 540-545.