COMPARATIVE STUDY OF MULLER'S MANEUVER AND DEXMEDETOMIDINE-INDUCED SLEEP ENDOSCOPY IN SNORING ADULTS

By:

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Dissertation Submitted in Partial Fulfillment of the Requirements for the Degree of Master of Medicine (Otorhinolaryngology-Head and Neck Surgery)

UNIVERSITI SAINS MALAYSIA

2016

ACKNOWLEDGEMENT

BISMILLAHIRRAHMANIRRAHIM

I am very grateful to my supervisors, Prof Baharudin Abdullah and Dr Hazama Mohamad for their extremely valuable guidance, criticism and suggestion in the completion of this dissertation.

My sincere thanks to the Dr Siti Nur Adyani Ismail and Dr Laila Abd Mukmin, a colleague from Anaesthesia Department who were helped me to involved in the procedure for the patients.

Thanks to all my lectures and fellow colleagues in the Hospital Universiti Sains Malaysia (HUSM) for the support, suggestion, guidance and encouragement during the completion of this dissertation.

Not to forget my thanks to all support staffs in HUSM for their precious time and opinions during the process of data collection and procedures to the patients.

A special thanks to Dr Wan Zahirudin for his guidance with the statistical data and his opinions and advices in the process of analysing the data and statistical analysis.

Last but not least, my special thanks to my dear family members especially my mom, Puan Yam Binti Mohamed, my beloved husband, En Mohamad Asri Abdullah and my lovely daughter, Nurul Farhah Amani for their patience that they have sacrificed, encouragement and understanding throughout my life.

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LIST OF ABBREVIATIONS

OSA	Obstructive Sleep Apnoea
UARS	Upper Airway Resistant Syndrome
OSAHS	Obstructive Sleep Apnoea/Hypopnea Syndrome
PSG	Polysomnogram
SDB	Sleep-disordered Breathing
FNPLS	Flexible nasopharyngolaryngoscope
AHI	Apnoea/hypopnea Index
ESS	Epworth Sleepiness Scale
TST	Total Sleep Time
EDS	Excessive Daytime Sleepiness
GERD	Gastro-esophageal Reflux Disease
COPD	Chronic Obstructive Pulmonary Disease
MVA	Motor-vehicle Accident
CPAP	Continuous Pulmonary Airway Pressure
BMI	Body Mass Index
DISE	Drug-induced Sleep Endoscopy
NOHL	Nose Oropharynx Hypopharynx Larynx
TCI	Target-controlled Infusion
AASM	American Academy of Sleep Medicine
EEG	Electroencephalogram
ECG	Electrocardiogram
EOG	Electro-oculogram
EMG	Electromyogram

ORL-HNS	Otorhinolaryngology-Head and Neck Surgery
WHO	World Health Organization
BISS	Bispectral Index Scoring System
ICC	Intraclass Correlation

ABSTRACT

Introduction

Sleep-disordered breathing (SDB) comprises a wide spectrum of sleep-related breathing abnormalities from simple snorer at the one end and obstructive sleep apnoea/hypopnea syndrome (OSAHS) at the other end. It is characterized by repetitive partial or complete collapse of the upper airway during sleep, resulting in intermittent cessations of breathing (apnoeas) and reduction in airflow (hypopneas) despite on-going respiratory effort. Flexible nasopharyngolaryngoscope (FNPLS) can identify and quantify the site and degree of obstruction that caused the snoring. However, we normally evaluate the patient when he or she is awake and in erect position, whereas snoring occurs when patient is in supine and sleeping. The endoscopic findings during awake endoscopy may not accurate to conclude the site responsible for the production of snoring. Sleep endoscopy in the naturally asleep patient is a diagnostic method permits the examiner to better determine the site that is responsible for the production of snoring. The drug used is Dexmedetomidine with or without Midazolam. This can be beneficial for the choice of the different and most appropriate treatment options for optimal benefits to the patients.

Objective

To compare awake endoscopy (Muller's maneuver) and drug-induced sleep endoscopy (DISE) findings in snoring individuals.

Study design

A cross sectional study was performed on patients aged more than 18 years old, with symptom of snoring planned for elective adenotonsillectomy and able to co-operate for FNPLS examination in Hospital Universiti Sains Malaysia.

Methodology

The consented patients who fulfilled the criterias were subjected to FNPLS with Muller's maneuver at ORL-HNS Clinic, HUSM. After that, patients were admitted to ward one day prior to elective adenotonsillectomy surgery. Pre-operative assessment was done to assess whether patients were suitable and safe for Dexmedetomidine-induced sleep endoscopy. Patients were induced with the drug prior to intubation. FNPLS was repeated once patients reached sleep state based on bispectral index scoring system (BISS) score.

Result

A total of 15 patients with symptom of snoring participated in this study. Sixty-seven percent of them are male. All patients showed only one level airway obstruction which is at retropalatal level. Sixty percent have concentric type and 40% have lateral type of airway obstruction during Muller's maneuver and during DISE, the configuration of airway obstruction was 80% and 20% respectively. During Muller's maneuver, only 33% of patients showed grade 1 (50-75%) of airway obstruction and 67% showed grade 0 (<50%) at retropalatal level. However, during DISE, 67% and 33% of patients showed grade 1 and grade 2 (>75%) of airway obstruction respectively. All patients showed

grade 0 at retrolingual level during both procedures. Our study showed that there was poor agreement between Muller's maneuver and DISE according to its degree and configuration of airway obstruction with ICC value was 0.14. Twenty percent of patients showed changes in the configuration of airway obstruction.

Conclusion

The degree of airway obstruction during DISE was more severe compared with the Muller's maneuver. There was different in configuration of airway obstruction observed between these 2 procedures. DISE permits better evaluation of the degree and level of airway obstruction.

ABSTRAK

Pengenalan

Gangguan pernafasan ketika tidur (SDB) merangkumi spektrum yang luas bermula daripada tahap berdengkur biasa hingga ke Sindrom Obstruksi Apnea Tidur (OSAHS). Ia menyebabkan pernafasan berhenti sekejap (apnoeas) dan pengurangan aliran oksigen (hypopneas) walaupun usaha pernafasan berterusan. Nasopharyngolaryngoscope fleksibel (FNPLS) boleh mengenal pasti dan mengukur tahap kesempitan salur pernafasan yang menyebabkan dengkuran. Walau bagaimanapun, kebiasaannya pesakit dinilai apabila dia sedar dan dalam kedudukan duduk, sedangkan berdengkur berlaku apabila pesakit berada dalam keadaan berbaring dan tidur. Penemuan ujian endoskopik semasa sedar mungkin tidak tepat untuk membuat kesimpulan tahap kesempitan salur pernafasan yang bertanggungjawab untuk menyebabkan pesakit berdengkur. Endoskopi tidur dalam pesakit secara tidur semula jadi adalah satu kaedah diagnostik untuk menentukan struktur dan bahagian yang bertanggungjawab yang menyebabkan pesakit berdengkur. Ubat yang digunakan adalah Dexmedetomidine dengan atau tanpa midazolam. Ini boleh memberi keputusan yang lebih jitu untuk menentukan pilihan rawatan yang paling sesuai untuk faedah optimum kepada pesakit.

Objektif

Untuk membandingkan ujian endoskopi semasa sedar (manuver Muller) dan ujian endoskopi semasa tidur di kalangan indivudu yang berdengkur.

Bentuk Kajian

Kajian ini dilakukan secara keratan rentas ke atas pesakit yang berumur lebih daripada 18 tahun, dengan gejala berdengkur yang akan menjalani pembedahan elektif adenotonsilektomi dan boleh memberi kerjasama semasa pemeriksaan endoskopi di Hospital Universiti Sains Malaysia.

Methodologi

Pesakit yang memenuhi kriteria akan melalui ujian FNPLS dengan manuver Muller di Klinik ORL-HNS, HUSM . Selepas itu , pesakit dimasukkan ke wad sehari sebelum pembedahan elektif ORL . Penilaian pra-pembedahan dilakukan untuk menilai sama ada pesakit adalah sesuai dan selamat untuk ujian endoskopi semasa tidur setelah diber ubat Dexmedetomidine. Pesakit telah diberi dengan ubat Dexmedetomidine sebelum intubasi. FNPLS akan dilakukan sekali lagi setelah pesakit mencapai keadaan tidur berdasarkan sistem skor indeks bispektral (BISS).

Keputusan

Seramai 15 pesakit dengan simptom berdengkur mengambil bahagian dalam kajian ini. Enam puluh tujuh peratus daripada mereka adalah lelaki. Semua pesakit menunjukkan hanya satu tahap saluran udara sempit iaitu pada tahap retropalatal . Enam puluh peratus menunjukkan konfigurasi jenis ‘concentric’ dan 40% mempunyai jenis “lateral’ semasa manuver Muller dan semasa endoskopi tidur , konfigurasi kesempitan saluran udara adalah masing-masing 80% dan 20%. Semasa manuver Muller , hanya 33% daripada pesakit menunjukkan gred 1 (50-75%) tahap kesempitan saluran pernafasan dan 67% menunjukkan gred 0 (<50%) pada peringkat retropalatal. Walau bagaimanapun, semasa endoskopi tidur, 67% dan 33% daripada pesakit menunjukkan gred 1 dan gred 2 (>75%)

tahp kesempitan saluran pernafasan masing-masing. Semua pesakit menunjukkan gred 0 di peringkat retrolingual semasa kedua-dua prosedur. Kajian kami menunjukkan bahawa terdapat perbezaan yang ketara antara manuver Muller dan endoskopi tidur mengikut tahap dan konfigurasi saluran pernafasan dengan nilai ICC adalah 0.14 . Dua puluh peratus daripada pesakit menunjukkan perubahan dalam konfigurasi kesempitan salur pernafasan.

Kesimpulan

Tahap kesempitan saluran pernafasan semasa endoskopi tidur adalah lebih teruk berbanding dengan tahap kesempitan semasa sedar. Terdapat perubahan dalam konfigurasi saluran pernafasan di antara 2 prosedur ini. Perubahan tahap kesempitan salur pernafasan semasa endoskopi tidur adalah lebih tepat dan jitu. Oleh itu , rawatan yang berbeza dan lebih tepat dapat memberi manfaat kepada pesakit.

INTRODUCTION AND LITERATURE REVIEW

1.1 INTRODUCTION

1.1.1 Introduction

Obstructive sleep apnoea (OSA) is a common but under-recognized condition with serious psychological, medical and occupational problems. It is one of the commonest sleep breathing disorders. Therefore, it needs to be properly evaluated in order to identify, diagnose and differentiate from other sleep disorders. Obstructive sleep apnoea is also a part of the spectrum of sleep-related upper airway obstruction problems that ranges from upper airway resistance syndrome (UARS) to OSA and, at the extreme, obesity-hypoventilation syndrome (Pickwickian syndrome). OSA is characterized by repetitive partial or complete collapse of the upper airway during sleep, resulting in intermittent cessations of breathing (apnoeas) and reduction in airflow (hypopneas) despite on-going respiratory effort. If these respiratory events occur more than five times per hour of sleep and are associated with symptoms, most commonly snoring, excessive daytime fatigue, and witnessed apnoeas, the term obstructive sleep apnoea/hypopnea syndrome (OSAHS) is applied. The gold standard to diagnose OSA is by polysomnogram (PSG) based on clinical symptoms and physical findings.

1.1.2 Prevalence of OSA

Obstructive sleep apnoea affects 24% men and 9% woman in United States (Young et al., 1993). The prevalence of OSA in Asians is estimated as 4.5% in males and 3.2% in females (Kim et al., 2004). One prevalence study done in Singapore concluded that OSA affects about 15% of the population. Prevalence among the major ethnic groups in

Malaysia was found to be 30%, 19.7% and 12% in Malay, Chinese and Indian respectively (Puvanendran and Goh, 1998). In Malaysia, it affects 7% of adults which are 8.8% male and 5.1% female (Kamil, Teng et al. 2007). Latest data from Thailand, which has a similar geographical and ethnic background have shown a prevalence of 11.4% (Neruntarat et al., 2011).

1.1.3 Severity of OSA

There are many tests to assess the severity of OSA. The tests can be subjective or objective. These tests include apnoea-hypopnea index (AHI), serum biomarkers, Epworth sleepiness scale (ESS) and PSG.

The AHI is the average number of apnoea and hypopnea per hour sleep. This index has been widely used to assess the severity of OSA. Many researchers also include the probability and degree of sleepiness along with AHI in assessing the severity of OSA as shown in Table 1.1.

Table 1.1 Severity Criteria of OSA

	Sleepiness	Apnoea-hypopnea Index (AHI)
Mild	Unwanted sleepiness or involuntary sleep episodes during activity requiring little attention (e.g., watching TV, reading)	5 – 15

Moderate	Unwanted sleepiness or involuntary sleep episodes during activity requiring some attention (e.g., meetings, concerts)	15 – 30
Severe	Unwanted sleepiness or involuntary sleep episodes during activity requiring active attention (e.g., operating a motor vehicle)	>30

The severity criteria consists of two components : severity of sleepiness and obstructive breathing events during sleep (Fleetham et al., 2006)

For screening of the severity of OSA, the ESS is the best available tool to guide the clinician as to the patient's perception of his/her sleepiness. It is a self-administered questionnaire with 8 questions. It provides a measure of a patient's general level of daytime sleepiness, or their average sleep propensity in daily life. ESS questionnaire is a quick, inexpensive and a flexible measure of chronic sleepiness (Krieger, 2000).

The ESS asks patients to rate their usual chances of dozing off or falling asleep in 8 different situations or activities that most people engage in as part of their daily lives, although not necessarily every day. The chances of dozing off was rated as 0 (would

never), 1 (slight chance), 2 (moderate chance) and 3 (high chance). The situations the patients were likely to be sleepy are :

1. Sitting and reading
2. Watching TV
3. Sitting, inactive in a public place (e.g in a cinema or meeting)
4. As a passenger in a car for an hour without a break
5. Lying down to rest in the afternoon when circumstances permit
6. Sitting and talking to someone
7. Sitting quietly after lunch without alcohol
8. In a car, while stopped for a few minutes in the traffic

The total score were calculated and scoring as normal, mild, moderate or severe as shown in table 1.2.

Table 1.2 Scoring of ESS

Scoring	Severity
<11	Normal
11 – 14	Mild
15 – 18	Moderate
>18	Severe

1.2 DEFINITION OF TERMS

Apnoea is defined by Bhattacharyya and Friedman (2009) as cessation of airflow for 10 or more seconds. It usually indicates complete obstruction of upper airway. Hypopnea is defined as at least 30% reduction in airflow for 10 seconds associated with a 4% decrease in oxygen desaturation. It denotes a transient reduction in pharyngeal resistance. OSA is defined by the presence of more than 5 obstructive apnoeas, hypopneas or both per hour of the patient's normal sleep hours. AHI is the combined numbers of apnoeas and hypopneas divided by total sleep times (TST) in hours.

1.3 RISK FACTORS

Multiple factors can contribute to obstructive sleep apnoea. The commonest are gender and aging. The other risk factors including obesity, tonsil and adenoid hypertrophy and craniofacial abnormalities such as micrognathia (Young et al., 1993).

1.3.1 Aging

Several studies have shown a higher prevalence of OSA in older population. OSA can happen at any age, but typically presents between age of 40 and 60 years old (Young et al., 1993; Ancoli, 1989). It has been reported that OSA is present in about 6% of people between the ages of 50 – 70 years old (Zamarron et al., 1999). The Sleep Heart Health Study, the proportion of people with an AHI >15 events per hour was approximately 1.7-fold higher in age group 60 to 99 years versus younger group age 40 to 60 years (Young et al., 2002). Age related anatomical changes in pharynx which lead to increase upper airway collapsibility explain the increase prevalence of OSA in older group of people (Malhortra et al., 2000). There was a significant decrease in the negative pressure reflex, increased deposition of parapharyngeal fat, lengthening of the soft

palate and changes in the bony shape surrounding the pharynx. The decrease in the negative pressure reflex associated with aging is consistent with other upper airway reflexes. As the negative pressure reflex allows the upper airway dilator muscles to compensate for a collapsing perturbation, this reflex is a primary mechanism whereby animals and humans maintain pharyngeal patency. The loss of this protective reflex with aging may therefore be a critical mechanism predisposing older persons to pharyngeal collapse.

1.3.2 Gender

Previous epidemiological studies have shown that OSA occurs more predominantly in males. Men are 2-fold likely to develop OSA with an estimated prevalence of 4% compared with women which is only 2% (Young et al., 2002). Males with OSA are more likely to have symptoms of snoring, apnoea or daytime sleepiness. In females, they tends to have depression or morning headache (Redline et al., 1994).

1.3.3 Obesity

The vast majority of OSA patients are obese and obesity is probably the most important risk factor for OSA (Young et al., 2002). There is a relationship between body weight and AHI: a 10% weight gain has been shown to predict approximately 32% increase in the AHI, and a 10% weight loss predicted a 26% decrease in the AHI (Peppard et al., 2000). Obesity can cause airway narrowing as a result of excess fat tissue around the neck. Neck circumference has also been reported to be useful as a predictor of OSA (Davies et al., 1992).

1.3.4 Familial factors

Familial factors may play a role in the pathogenesis of OSA. There is a report which support a genetic predisposition to OSA: a significant portion of SDB is associated with apolipoprotein E (ApoE) in the general population (Kadotani et al., 2001). ApoE is a class of apolipoprotein found in the chylomicron and Intermediate-density lipoprotein (IDLs) that is essential for the normal catabolism of triglyceride-rich lipoprotein constituents. Abnormal craniofacial anatomy is common in familial groups with OSA. A case control of first degree relatives of patients with OSA, showed that relatives of patient with OSA were more likely to have episodes of snoring and daytime sleepiness and had higher AHI. In addition, they also had narrower upper airways with maxilla and mandible that were more posterior than normal and longer soft palates with wider uvula (Mathur and Douglas, 1995). These findings suggest that genetic factors that determine upper airway structure and craniofacial anatomy may contribute to the aggregation of OSA in some families (Guilleminault et al., 1995).

1.4 PATHOPHYSIOLOGY OF OSA

In healthy awake individuals, pharyngeal patency is maintained by continual neuromuscular activation of the pharyngeal muscle by the central nervous system. This activation typically reduced during sleep, compromising the patency of the upper airway. The combination of reduced neural activation with anatomical abnormalities of the pharynx lead to the stage for obstructive apnoeas and hypopneas in patients with OSA (Mathew et al., 1984). The anatomical abnormalities can be due to excessive posterior pharyngeal wall tissue, an enlarged tongue or low-hanging palate. Pharyngeal collapse or narrowing can be periodic or non-periodic. Periodic obstruction produces apnoeas, hypopneas, or both interspersed with normal airflow. During non-periodic

obstruction, there is sustained increase in airflow resistance with or without associated desaturation. This sustained increase in resistance can trigger sleep disruption and daytime somnolence, in which case it has been termed the upper airway resistance syndrome. Pharyngeal narrowing can occur at multiple sites in patient with OSA. These include nasal cavity, nasopharynx, velopharynx, oropharynx and hypopharynx. The velopharynx is the primary site of occlusion in the majority of patient.

Total occlusion or critical narrowing of the upper airway either fully eliminates or substantially reduce ventilation. This in turn allows the development of hypercarbia and hypoxia. Respiratory effort progressively increases in response to these chemo-stimuli eventually triggers an arousal. This leads to a surge of pharyngeal dilator muscle activity and resolution of the upper airway obstruction. This process can repeat itself continuously during the night, allowing intermittent hypercarbia and hypoxia, fragmented sleep and triggering adrenergic surges with each cycle (Weiner et al., 1982).

1.5 CLINICAL PRESENTATION OF OSA

Patients with OSA may present with a wide spectrum of symptoms that range from simple snoring to a more complex symptoms that can cause personality changes. The symptoms are usually divided into daytime and nocturnal symptoms (Skomro and Kryger, 1999). Table 1.3 shows the summary of OSA symptoms. The nocturnal symptoms of OSA are more characteristic and tend to be more specific for the disease. Daytime symptoms are usually the result of sleep disruption caused by apnoea or hypopnea and associated with arousals and awakenings (Pagel, 2009).

OSA is commonly associated with loud snoring, apnoeic events such as choking and gasping during sleep (George et al., 2003). But, the only two symptoms that make the patients visit the clinic are snoring and excessive daytime sleepiness (EDS) (Dobbin and

Strollo, 2002). In addition, choking and breathing pauses seen by partner during sleep is the third common reason for referral to sleep clinic (Schlossan and Elliott, 2004).

Table 1.3 Subjective symptoms of OSA

Daytime symptoms	Nocturnal symptoms
Sleepiness	Snoring
Morning headache	Observed apnoeas
Neurocognitive impairment	Drooling
- Impaired memory	Dry mouth
Diminished quality of life	Choking/gasping
- Fatigue	Bruxism
Mood and personality changes	Frequent awakenings
- Depression	GERD symptoms
- Anxiety	Nocturia
- Irritability	
Sexual dysfunction	
- Impotence	
- Decreased libido	
- Irregular menses	

Adapted from Bhattacharyya and Friedman (2009).

1.6 COMPLICATIONS OF OSA

1.6.1 Hypertension

Hypertension is the commonest complication among OSA patients that affect 40% of them. About 30% of middle-aged male with hypertension have OSA. Young et al. (1993) demonstrated a close relationship between the level of blood pressure and AHI. Other clinical trials reported that presence of OSA was associated with increase risk of developing hypertension 1.5 to 3-fold (Lavie et al., 2000).

1.6.2 Pulmonary Disorders

1.6.2.1 Pulmonary Hypertension

OSA can cause pulmonary hypertension which can results in right heart failure. Weitzenblum et al. (1998) reported that 15% of OSA patients have an increased in pulmonary artery pressure.

1.6.2.2 Chronic Obstructive Pulmonary Disease

Chronic obstructive pulmonary disease (COPD) can coexist with OSA which has been reported in 15% of patient (Chaouat et al., 1995).

1.6.3 Cardiac Disorders

1.6.3.1 Ischemic Heart Disease

Nocturnal hypoxemia and increased adrenergic tone resulting from obstructive apnoea hypopnea might predispose to cardiac ischemia in patients with OSA and coronary artery disease. The risk of having myocardial infarction is greatest during hypoxemia combined with increased heart rate and blood pressure. Peker et al. (2002) reported that 37% of patients with OSA initially reported cardiovascular disease, as opposed to only 7% in patients without OSA. Over 7 years follow-up, newly diagnosed cardiovascular disease was identified in 57% of patients that were untreated for OSA and only 7% of patients whom were adequately treated. These findings showed that OSA has a major role in the development of coronary artery disease.

1.6.3.2 Arrhytmias

Patients with OSA are more prone to have cardiac arrhythmia. Hoffstein and Matieka (1994) detected arrhythmia in 58% of patients with OSA. They are prone to have bradycardia during the apnoeic episode, followed by tachycardia at the end of the episode. Other abnormalities are sinus arrest, second-degree heart block, atrial tachycardia, paroxysmal atrial fibrillation, atrial flutter and premature ventricular contraction.

1.6.3.3 Congestive Heart Failure

OSA elicits increase in the sympathetic activity in patients with congestive heart failure thus accelerating the cardiac disease process (Bradley et al., 2003). Continuous positive

airway pressure (CPAP) treatment in patients with OSA and congestive heart failure increases baroreflex receptor sensitivity and resets the operating point of the baroreceptor to lower the blood pressure, thus reducing the heart rate. CPAP also improves upper airway obstruction, allowing overnight reduction in mean intrathoracic pressure.

1.6.4 Cerebrovascular Disease

Cerebral perfusion fluctuates during apnoeas, which might compromise blood flow to some area of the brain. An odd ratio of 3.2 for the occurance of stroke has been reported in patients with snoring, and an odd ratio of 8 for stroke has been reported in patients with witnessed apnoeas, sleepiness and obesity with snoring (Palomaki et al., 1991).

1.6.5 Motor-vehicle Accident

Increases in work related and motor vehicle accidents (MVA) may contribute to the increased mortality in patients with OSA. Masa et al., (2000) reported that AHI more than 15 per hour was associated with high risk of accident.

1.6.6 Social Disturbances

Patients with OSA may develop deficits in the cognitive domains of attention, concentration, executive function, verbal and visuospatial memory, constructional abilities and psychomotor functioning (Aloia et al., 2002).

Patients with OSAHS have significantly impaired quality of life (Jenkinson et al., 1997) and social functioning (Kales et al., 1985) and a high prevalence of minor psychiatric morbidity (Engleman et al., 1993).

More than two thirds of patients with severe OSA had problems of social and interpersonal functions, especially in work performance, marital and family relationship (Ulfberg et al., 1996). In a large epidemiological survey of overweight subjects showed that OSA patients had poorer health status than asymptomatic subjects, lower economic income and increased psychiatric care, multiple divorces and impaired work performance (Grunstein et al., 1995).

One of the major consequences of impaired quality of life may be minor psychiatric illness such as anxiety and depressive disorders. One third to one half of OSA patients have significant psychiatric symptoms (Engleman et al., 1995).

1.7 PHYSICAL EXAMINATION

Physical examination of the patient with suspected OSA can reveal characteristic findings suggestive of upper airway obstruction and associated SDB. Blood pressure should always be recorded as both hypertension and hypotension have been found in patients with SDB. Common physical findings of OSA patients are shown in Table 1.4. Physical examination includes oropharynx examination to assess tonsils size and tongue position, nose and nasopharynx, BMI, neck circumference and endoscopic examination to assess the degree of airway obstruction.

Table 1.4 Common physical findings in OSA patients

Craniofacial	Retrognathia
	High arched palate
	Temporomandibular dislocation
Pharyngeal	Macroglossia
	Erythema/edema of uvula
	Elongated, low-lying soft palate
	Tonsillar pillar hypertrophy
	Tonsillar enlargement
	Retropalatal, retroglossal space restriction
Dental	Overjet
	Malocclusion
	Bruxism
	Orthodontia
Nasal	Asymmetric, small nares
	Inspiratory collapse of alae and internal valves
	Septal deviation
	Inferior turbinate hypertrophy

Adapted from Bhattacharyya and Friedman (2009).

1.7.1 Oral/Oropharynx examination

Examination of the pharyngeal structures may reveal further evidence of airway obstruction. These findings include macroglossia (often associated with lateral lingual scalloping by adjacent teeth), erythema and edema of the uvula due to snoring, and redundant lateral wall soft tissue with tonsillar pillar hypertrophy, and tonsillar enlargement which is a particularly significant cause of obstruction in children. The degree of oropharyngeal crowding can be further characterized by the Friedman tongue position, formerly called the modified Mallampati score, which incorporates visual assessment of size, length, and height of the soft palate and uvula.

1.7.1.1 Tonsil Size

During intraoral examination, the tonsils size were assessed. Figure 1.1 shows the tonsils grading. The size was graded as grade 0 to grade 4 as below :

0) Grade 0 was used to denote that the patients has had a tonsillectomy

1) Grade I tonsils were in the tonsillar fossa barely seen behind the anterior pillars

2) Grade II tonsils were visible behind the anterior pillars

3) Grade III tonsils extended three quarters of the way to midline

4) Grade IV tonsils were completely obstructing the airway, also called as ‘ kissing’ tonsils

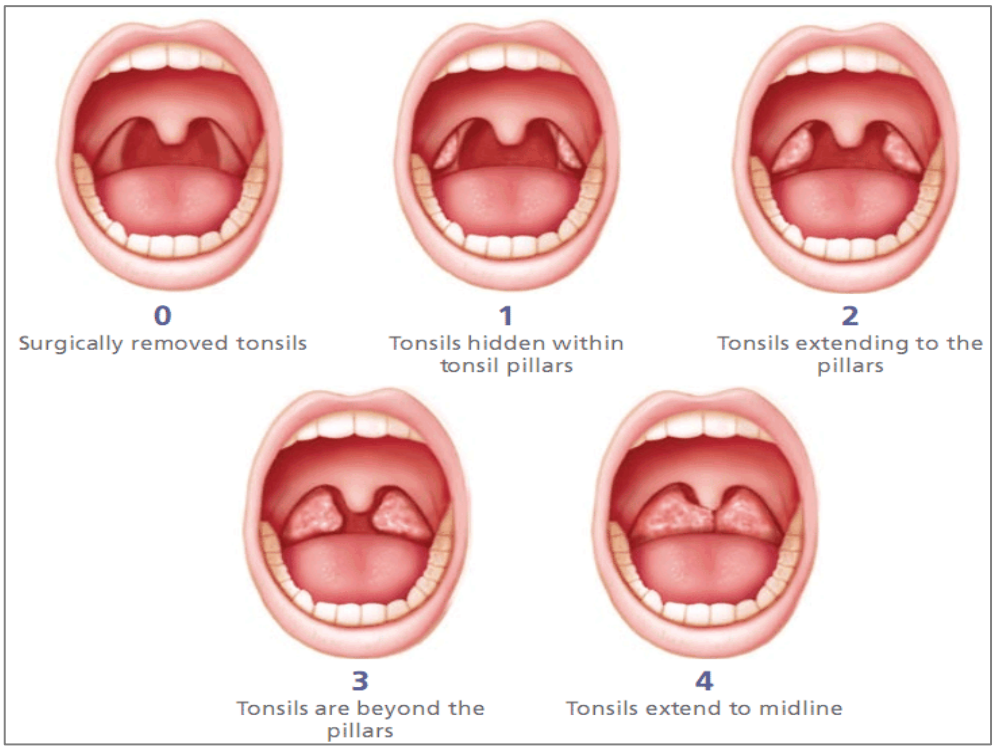

Figure 1.1 Clinical grading of the tonsils size

1.7.1.2 Friedman Tongue Position

FTP assessed the degree of oropharyngeal crowding which incorporates visual assessment of size, length, and height of the soft palate and uvula. These structures represent the anterior limit of the upper airway, and a lowlying, elongated, or enlarged soft palate/uvula decreases airway caliber and increases susceptibility to obstruction. Figure 1.2 shows diagram of FTP grading. It was grading from 1 to 4 depending on the relative size and positions of the soft palate, tip of the uvula, tongue, and tonsillar pillars :

1) Grade I: tonsils, pillars and soft palate were clearly visible

2) Grade II: the uvula, pillars and upper pole tonsils were visible

3) Grade III: only part of the soft palate was visible; the tonsils, pillars and base of uvula could not be seen

4) Grade IV: only the hard palate was visible

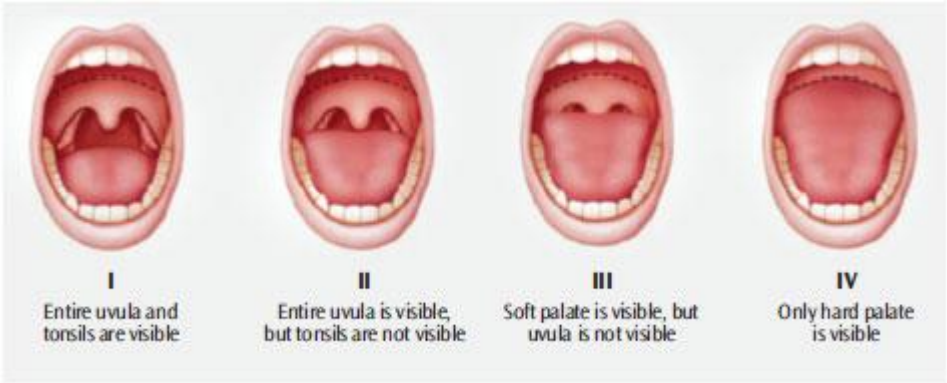

Figure 1.2 Friedman tongue position

1.7.2 Nose/Nasopharynx Examination

Examination of the nose is one of the component of the upper airway evaluation. Although nasal obstruction is rarely the sole cause of SDB, it appears to occur with higher frequency in OSA. Inspection of the nose should note the size and symmetry of nares, collapsibility of internal/external valves and nasal alae with inspiration, evidence of septal deviation or prior nasal trauma, and hypertrophy of the inferior nasal turbinates.

Identifying nasal obstruction can be particularly important in patients with SDB who have difficulty tolerating nasal continuous positive airway pressure (CPAP) therapy as

treatments such as septoplasty and turbinate reduction can decrease nasal resistance with resultant improvements in CPAP compliance and comfort.

1.7.3 Body Mass Index

Obesity has also been frequently associated with OSA, particularly in women, and measurement of height and weight followed by calculation of body mass index (BMI, kg/m^2) to define and quantify obesity are important components of the physical examination. Grunstein et al. (1993) demonstrated that a BMI of at least 25 kg/m^2 was associated with a 93% sensitivity and 74% specificity for OSA.

The BMI was classified as below by World Health Organization (WHO), 2004:

Underweight	BMI < 18.5 kg/m^2
Normal range	BMI 18.5 – 24.9 kg/m^2
Overweight	BMI ≥ 25 kg/m^2
Obese Class I	BMI 30.0 – 34.9 kg/m^2
Obese Class II	BMI 35.0 – 39.9 kg/m^2
Obese Class III	BMI ≥ 40.0 kg/m^2

1.7.4 Muller's Maneuver

Snoring as well as apnoeas can be simulated by most people and a direct effect of the Muller's maneuver may be seen during wakefulness. Thus, snoring simulation and the effects of the Muller's maneuver have been used in upper airway evaluation before surgical intervention in patients to predict surgical outcome and to improve patient selection. The Muller's maneuver is a safe and simple examination that does not exert relevant strain on the patient. Fiberoptic nasopharyngoscopy with Muller's maneuver, first described by Borowiecki and Sassin (1983). This maneuver consists of asking the patient, during the flexible nasofibroscopy, making a forced effort to breathe in with the mouth and nose closed. A nasopharyngolaryngoscope is introduce through the nostril in the direction of the larynx until it overpassed the soft palate, providing a view of the oropharynx and hypopharynx. The patient will be asked to do the maneuver and the retropalatal and retrolingual collapse is observe (Figure 1.3).

However, we normally evaluate the patient when he is awake and sitting, whereas apneas occur when patient is lying down and sleeping. The reliability of the Muller's maneuver remains highly questionable and the evaluation of the maneuver seems highly subjective and hard to reproduce. There is some evidence that the sites of obstruction detected with the Muller's Maneuver do not reliably reflect the sites of obstruction during sleep.

1.7.5 Drug-induced Sleep Endoscopy (DISE)

Sleep endoscopy in the naturally asleep patient was introduced by Borowiecki et al. (1978). Borowiecki and colleagues described a palatopharyngeal collapse at the end of

expiration and directly before inspiration in patients with OSA. They described different degrees of airway obstruction, often associated with a medialization of the lateral pharyngeal walls. Nasofibrolaryngoscopy under sedation is considered by some authors to be probably the best diagnostic method available for the identification of the specific site of pharyneal obstruction in snoring patients (Hsu PP, 2002). Croft and Pringle (1991), described upper airway endoscopy during induced sleep and concluded that this diagnostic method permits the examiner to better determine the anatomical area responsible for the production of snoring and the site of narrowing. The obstruction or collapse of the pharynx was examined under conditions that approximate physiological sleep.

The evaluation requires pharmacologic induction of sedation. The target depth of sedation is the transition from consciousness to unconsciousness (loss of response to verbal stimulation). Once the patient has reached a satisfactory level of sedation, a flexible endoscope is introduced into the nasal cavity. The levels and degree of snoring and obstruction are assessed. The obstructive patterns are described as being circular, antero-posterior and latero-lateral at the level of the soft palate, the tonsils, the tongue base, and the epiglottis. There are different classifications to describe degree of obstruction. VOTE classification system is commonly used to classify degree of obstruction. The degree of airway obstruction is defined as either none (0 = 0 – 50% obstruction), partial (1 = 50 – 75% obstruction) or complete (2 = > 75% obstruction).

Pringle and Croft compared their results of the Muller's Maneuver to those obtained by sleep endoscopy under sedation in a group of 50 patients and could demonstrate that treatment recommendations were not identical based on these two investigations to a

significant extent. Other authors also reported substantial differences in treatment recommendation when adding sedated endoscopy to simply using the Muller's maneuver. Campanini et al. (2010) showed, in a retrospective analysis of 250 patients, identical sites of obstruction during awake and sleep endoscopy in only 25 % of patients, as measured by the Nose Oropharynx Hypopharynx Larynx (NOHL) staging system, introduced by the same authors. Study by Hewitt et al. (2009) showed that after Muller's maneuver, a palatal intervention was recommended in 74.4 % (n = 70) of patients and after DISE, only 38 (54 %) of these patients
were recommended a palatal intervention.

Different sedation methods have been described, but there does not seem to be a standardized protocol for sedation methods. Drugs most commonly reported for use with DISE are propofol and/or midazolam. Some use propofol only, others use midazolam only. A computerized target-controlled infusion (TCI) system for propofol can be helpful and has been shown to be more accurate, stable and safe than a manual bolus injection (De Vito et al., 2011). Berry et al. (2005) demonstrated that TCI using propofol caused 100 % of snorers to snore, while 100 % of non-snorers did not snore. Target-controlled infusion has proven to be more accurate than a manual bolus injection and seems to be the way to go when it comes to infusion of sedative. Bispectral index monitoring could be an adjunct to the assessment of DISE, although this has not yet been studied thoroughly.

In our study, we chose to use dexmedetomidine as the drug is the preferred anaesthetic agent used by our anaesthetic team. Dexmedetomidine is a new generation highly selective α2-adrenergic receptor agonist. This drug is associated with sedative and

analgesic sparing effects. It also produces a unique, sleep-like state of sedation that can easily be reversed with verbal stimuli.

Dexmedetomidine sedation has been reported to mimic normal physiologic sleep in its cardiovascular and respiratory effects and experimental evidence has indicated that endogenous sleep pathways may be involved in dexmedetomidine-induced sedation. E. Huupponen et al., (2008) stated that analysis of sleep spindles shows that dexmedetomidine produces a state closely resembling physiological sleep in humans, which gives further support to earlier experimental evidence for activation of normal non-rapid eye movement sleep-promoting pathways by this sedative agent.

Taking the limited significance of the Muller's maneuver into account, there seems to be a potential for an improvement in treatment selection based on sedated endoscopy. There are subtle hints that sleep endoscopy under sedation may change the indication for a limited number of surgical intervention. No prospective data are available to date comparing success rates of surgical intervention with and without the use of sleep endoscopy under sedation.

1.8 DIAGNOSIS

1.8.1 Questionnaire

EDS in one of the commonest symptom in patient suffering from OSA. There are various methods of assessment used. ESS was first introduced in 1991 by Johns. It is a self-administered, eight item questionnaire for the participants to describe or estimate

how they doze-off inadvertently when engaged in activities involving low levels of stimulation, relatively immobile and relaxed. It is quick, inexpensive, flexible and able to measure chronicity of sleepiness. However, its accuracy was dependent on the participants interpretation and estimation. Many researchers used the ESS as a screening tool in OSA. They found that ESS is reliable and valid in order to determine subjective excessive daytime sleepiness (Ibrahin et al., 2007).

1.8.2 Polysomnogram

The gold standard for diagnosis of OSA is an overnight PSG (Epstein et al., 2009). An overnight PSG with recording of respiratory variables such as AHI and levels of oxygen saturation are measures used for the diagnosis of sleep apnea (Riley et al., 1995). In this diagnostic tool, multiple physiologic parameters are measured while patient sleeps. This study is typically obtained at night in a sleep laboratory for the purpose of identifying, as best as possible given the novel environment, the patient's typical sleep and its associated pathologies. The study typically supervised by a technician. There are full (16 channels) and partial (8 channels) PSG. A full night PSG usually provides an accurate picture of sleep characteristics and severity of OSA. Home cardiorespiratory studies can be used in the assessment of suspected OSA. The PSG includes:

1) Electroencephalographic (to determine arousals from sleep)
2) Electrooculoraphic (to detect rapid eye movement sleep)
3) Electromyographic (to detect limb movement that cause arousals)
4) Oxygen saturation by oral and nasal airflow (to measure oxygen saturation)
5) Chest wall and abdominal wall monitor (to document respiratory effort)
6) Electrocardiographic

7) Postural muscle tone
8) Sleeping position
9) Snore detector

According to the American Academy of Sleep Medicine (AASM), when factors inclusive of sensitivity, specificity, likelihood ratios, and strength of evidence are analysed, a categorization of four subtypes of sleep-monitoring procedures is the outcome (Force and Medicine 2009). Table 1.5 illustrates the level of objective sleep testing by AASM.

The result of PSG reported using AHI, which can be used to diagnose OSA and grading the severity of OSA.

Table 1.5 Level of PSG

Level	Description
I	Attended overnight full polysomnography (includes electroencephalogram [EEG], electro-oculogram [EOG], electromyogram [EMG], electrocardiogram [ECG], oronasal airflow, thoracic and abdominal movement, oxygen saturation, snoring level, and body position)
II	Unattended overnight full PSG (similar to level I study but conducted at the patient's home)